UNIVERSITY OF NOVI SAD
Technical faculty “Mihajlo Pupin”
Zrenjanin, Republic of Serbia

In cooperation with partners

Industrial Engineering and Environmental Protection

IIZS conference

PROCEEDINGS

VI International Conference – Industrial Engineering And Environmental Protection (IIZS 2016)

Zrenjanin, 13-14th October 2016.

University of Novi Sad
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VI International Conference Industrial Engineering and Environmental Protection (IIZS 2016)

Proceedings

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INTRODUCTION

Departments of Mechanical engineering at Technical Faculty "Mihajlo Pupin", Zrenjanin, organized five international conferences:
1. »PTEP 2011 - Process Technology and Environmental Protection»,
2. «IIZS 2012 - Industrial Engineering and Environmental Protection»,
3. «IIZS 2013 - Industrial Engineering and Environmental Protection»,
4. «IIZS 2014 - Industrial Engineering and Environmental Protection»,
5. «IIZS 2015 - Industrial Engineering and Environmental Protection».

Industrial engineering is a field of technique, which includes the processes and procedures, plants, machinery and equipment used in manufacturing final products in different industries. The task of industrial engineers is that on the basis of theoretical and practical knowledge, solve specific problems in engineering practice, and the development of technology in the field of industrial production process.

The theme of scientific conference «IIZS 2016», covers the fields of industrial engineering, which are defined in the program of the conference, such as: Industrial Engineering, Environmental Protection Engineering and Occupational Safety, Process Technique, Energetics, Designing and maintenance.

The main goals of the conference can be indentified here: innovation and expansion of knowledge engineers in industry and environmental protection; support to researchers in presenting the actual results of research projects, establishing new contacts with leading national and international institutions and universities; popularization of the faculty and its leading role in our society and the immediate environment, in order to attract quality young population for studying at our faculty, cooperation with other organizations, public companies and industry; initiative for collecting ideas in solving specific practical problems; interconnection and business contacts; introducing professional and business organizations with results of scientific and technical research; presentation of scientific knowledge and exchange of experiences in the field of industrial engineering.

We express gratitude to:

- The partners of the conference – „Aurel Vlaicu” University of Arad, Faculty of engineering, Arad, Romania; University «St. Kliment Ohridski«, Technical faculty, Bitola, Macedonia; University Politehnica Timisoara, Faculty of engineering, Hunedoara, Romania; University of East Sarajevo, Faculty of mechanical engineering East Sarajevo, B&H, Republic of Srpska; University of agriculture, Faculty of agricultural engineering, Krakow, Poland; Technical university-Sofia, Plovdiv branch**,** Faculty of mechanical engineering, Plovdiv, Bulgaria; University of Niš, Faculty of mechanical engineering, Niš, Serbia,
- The management of Technical Faculty «Mihajlo Pupin», University of Novi Sad,

for supporting the organization of the conference «IIZS 2016». We are also grateful to all the authors who have contributed with their works to the organization of the scientific meeting «IIZS 2016».

We would like our Conference to become a traditional meeting of researchers, every year. We are open and thankful for all useful suggestions which could contribute that the next, International Conference - Industrial Engineering and Environmental Protection, become better in organizational and program sense.

President of the Organizing Committee
Prof. Ph.D Dragiša Tolmač

Zrenjanin, 13 - 14th October 2016.

Conference participants are from the following countries:

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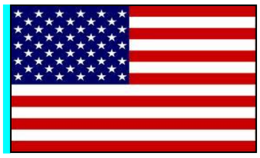

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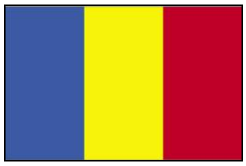

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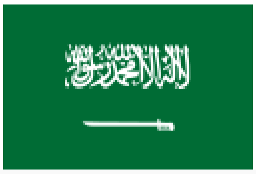

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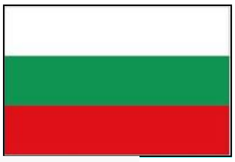

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Session 1. Industrial Engineering

Session 2. Environmental Protection Engineering and Occupational Safety

Session 3. Process Technique

Session 4. Energetics

Session 5. Designing and maintenance

Session 6. Student papers

Session 1.

Industrial Engineering

USING SEMANTIC WEB BASED TOOLS IN ENGINEERING EDUCATION

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Abstract: The Semantic Web is the next generation of Web, where data has structure and where the semantics of the data is described by ontologies, thus enabling information integration and reuse, and also interoperability between systems. The aim of this work is to design and implement semantic model for the system for managing of the learning process in the field of engineering education. In this way,a personalized environment that involves collecting a wide range of information about each student will be created. The basic criterion for the adaptation is the student's learning style by Felder Silverman model.
The proposed model is implemented in an existing LMS system that enables the transformation, adaptation, integration, visualization and management of semantically annotated learning objects within the electronic engineering courses in accordance with the adaptation criteria. As a part of the model evaluation, the operation of semantic elements of the system affecting the effectiveness of the proposed model was tested.
Key Words: Semantic Web, Ontologies, D2RQ, Protégé, Jena, Engineering education, Learning style.

INTRODUCTION

Semantic web

The term Semantic Web represents upgrade of the existing architecture of the World Wide Web, which improves the quality of data by enriching them with formal semantics. This means that the content is intended for use by the computer (processing, sharing, re-use), as opposed to content that is intended for use only by people. This will allow automatic agents reasoning based on web content, from which will incur an intelligent response to unforeseen situations. Semantic models of data sources represent the implicit meaning of the data by specifying the concepts and the relationships within the data [15].
The idea of Semantic Web was introduced in 2001. by [2] with the aim to establish a web that will not only link documents, but will also discover the meaning of the information in those documents. Semantic Web is defined as a web of data, ie. web that provides data storage, creating dictionaries and rules for data management. The researchers currently work actively to respond to these challenges, putting the focus on creating the basic architecture, the development of expressive and efficient ontology languages and techniques for efficient data mapping, and learning ontologies [5]. For the Semantic Web development it is important to define a large number of standards and technologies that are primarily within the competence of international organization for web standardization W3C (World Wide Web Consrtium).
Semantic Web applications in the field of engineering education is based on three essential features [1]: the ability for efficient storage and retrieval of information; the possibility of autonomous agents to improve the learning process and finding adequate information; the ability for support, expansion and increasing communication skills of people in a variety of formats without limitations in terms of space and time.

Semantic Web Architecture

The main feature of the Semantic Web architecture is layered hierarchy. Layered structure of the Semantic Web (Layer cake) was proposed by Berners-Lee [3]. The layered architecture is reflected in the fact that languages at higher level structures can use the syntax and semantics of the language at the lower levels. Due to the development of the Semantic Web, initial architecture was improved by the introduction of two new layers [4]. In this way the emphasis is on on the structure of the ontology. Fig 1. shows the structure of the Semantic Web, which is known as the Semantic Web Cake because of its specific form.

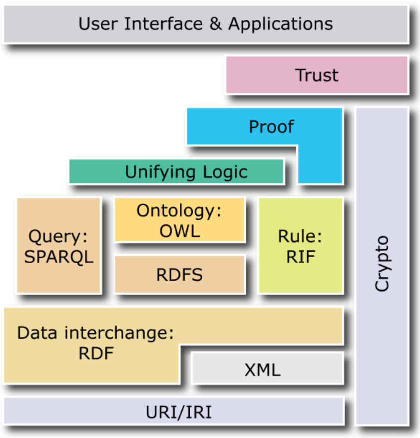


Figure 1. *Semantic Web Cake*

At the lowest layer of the Semantic Web hierarchical architecture are standards for the representation of text - Unicode and URI (Uniform Resource Identifier). Unicode provides a standardized presentation of the characters, while those resources that are not directly accessible via a computer network, but also abstract concepts that do not physically exist could be identified with the help of URIs. URI uniquely designates the Web resource by indicating the address at which its description is located.

On the second layer of the architecture of the Semantic Web is XML (Extensible Markup Language), which plays a role in the presentation of the content and structure of data on the web, and therefore it is essential for the interoperability of systems and web applications. At the next level is RDF (Resource Description Framework), which is a language for exchanging data on the Semantic Web. RDF is based on XML syntax form and is used to enrich the content with semantic. It provides implementation, distribution and re-use of structured metadata [6].

OWL (Ontology Web Language) is a standard language for describing ontologies. It provides greater expressiveness for describing objects and their relationships. Getting results from semantic queries is important in the context of the Semantic Web, because it provides a mechanism through which the users and applications interact with ontologies and data [9]. SPARQL (SPARQL Protocol and RDF Query Language) is a standard language for the semantic queries over RDF repositories. As a semantic query language, SPARQL is oriented to semantically mapped data, in the sense that it only queries the information described and contained in the semantic model, ie. there is no inference in the query language itself [13]. SPARQL query represents a pattern according to which triplets corresponding to this pattern will be selected automatically.

SWRL (Semantic Web Rule Language) allows users to write rules that can be expressed in terms of OWL concepts in order to provide better reasoning ability as compared to OWL itself. It is also used to define the mapping OWL-relations and to provide a query interface to the level of knowledge [12]. Semantically, SWRL is built on the basis of the same descriptive logic as OWL. It expands the set of OWL axioms by making them more precisely defined.

The last two levels, Proof and Trust, are the least developed in the hierarchy. Proof layer is used to check whether it should take into account the results obtained by the intelligent agents and to confirm the agent's behavior. Layer Trust provides a mechanism for confidence and balance between information users (human or machine) and information sources [14].

The implementation of ontologies in the domain of engineering education was first mentioned in the work of the author [11], and over the time the idea become more popular and important. Ontologies are used in various domains, most frequently in the domain of education with 31% [16]. Except in the field of education, ontologies are used in other areas: KDDM - knowledge discovery (Knowledge Discovery) and data mining (Data Mining) [10], content and information retrieval [8], knowledge management [17] and medicine [7].

Semantic web based tools in engineering education

Adaptive system in the field of engineering education based on semantic concepts includes the following components (Fig. 2.):

1. Moodle - A platform for managing the process of learning with a wide range of features like electronic online courses implementation and different types of users definition. In Moodle, data are stored in MySQL database.
2. D2R server - A mechanism for the translation of MySQL database into semantic database, ie. metadata. It provides manipulation with the mapped files as well as mechanisms for creating and testing queries over semantic repositories and other vocabularies, ontologies and semantic data.
3. Protégé - This softwae tool offers the possibility of creating the basic concepts and relations of ontologies and the creation of semantic rules.
4. Jena - Semantic Java development environment. It implements a semantic model that consists of three components: model of mapped data (D2R server individuals), ontological models (ontologies created in Protégé-u) and models of semantic reasoning (Pellet mechanism).
5. Web service that allows connection and two-way communication between Moodle and Jena.
6. Web service that allows connection between Moodle and external databases with academic research papers. The purpose of this service is the visual enriching of the learning objects in existing courses in the field of engineering education. Implemented web service represents the type of external API written in PHP.

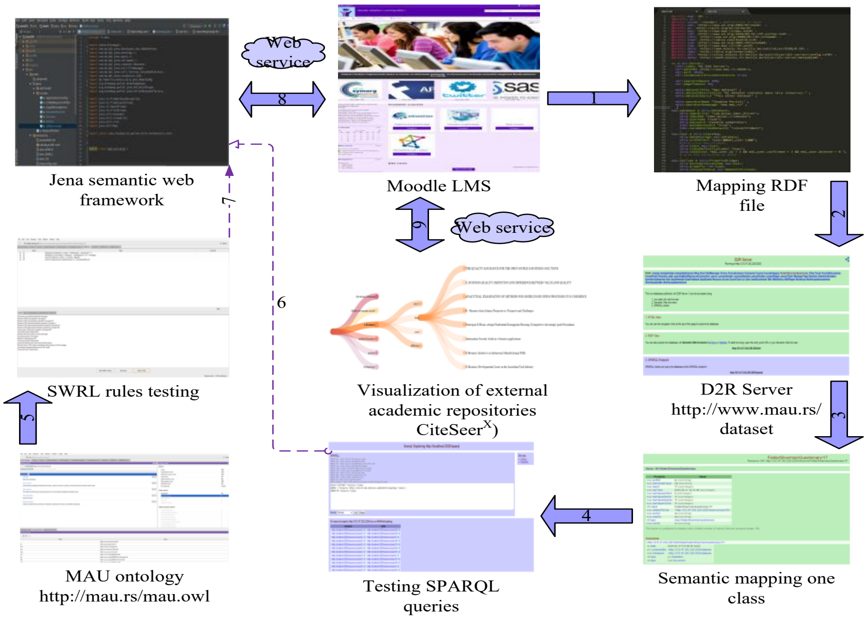


Figure 2. The architecture of the implemented semantic components in the field of engineering education

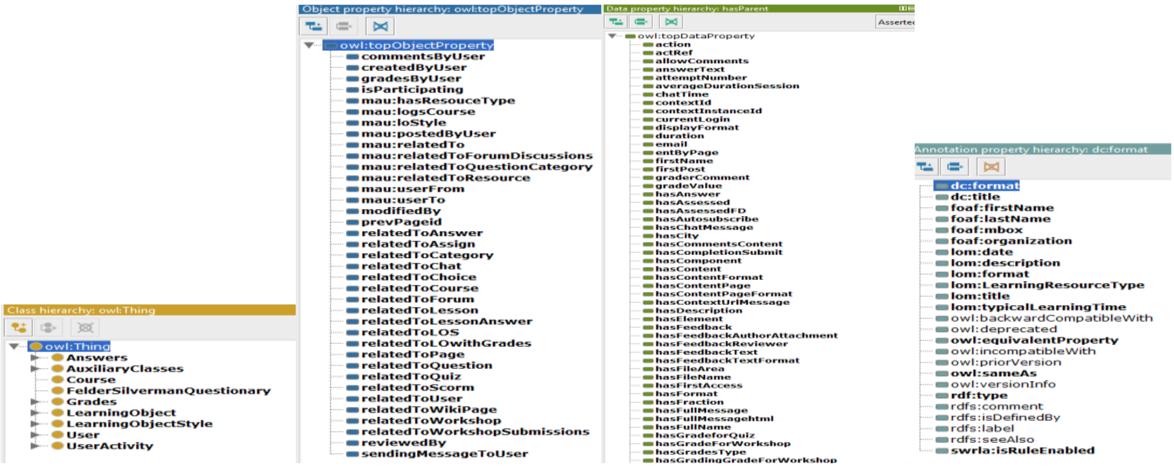
MATERIALS AND METHODS

Domain *MAU* ontology

In this chapter we will describe the process of development of domain *MAU* ontology that represents the main component of the semantic system. Protégé editor and Stanford[1] methodology were used to create ontology. Fig. 3 shows a) classes, b) object properties, c) data properties and d) annotated

[1] http://protege.stanford.edu/publications/ontology_development/ontology101-noy-mcguinness.html

properties of the implemented ontology. All elements defined in ontology are in accordance with *Moodle* components and functionalities.



a) b) c) d)

Figure 3. *MAU* ontology - Classes and properties defined in *Protégé*

Fig. 4 shows all elements of the *MAU* ontology.

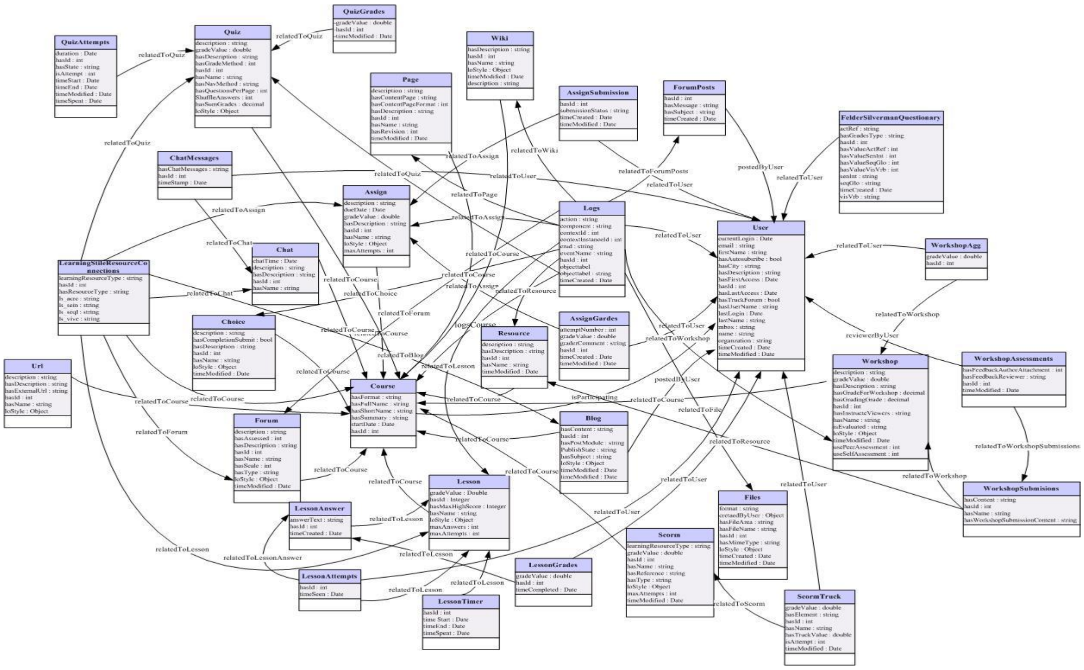


Figure 4. Components of the *MAU* ontology

RESULTS

Development and testing of the semantic rules

Protégé has built-in reasoning mechanisms that check consistency and regularity in the ontology. Pellet reasoning mechanism (OWL-DL) was used in the process of creating and testing of *MAU* ontology. Individual classes that participate in the process of semantic reasoning should be clearly defined at the beginning of creating semantic rules. SWRL language (Semantic Web Rule Language) was used to create semantic rules. It is written in SWRL tab in Protégé as shown in Fig. 5.

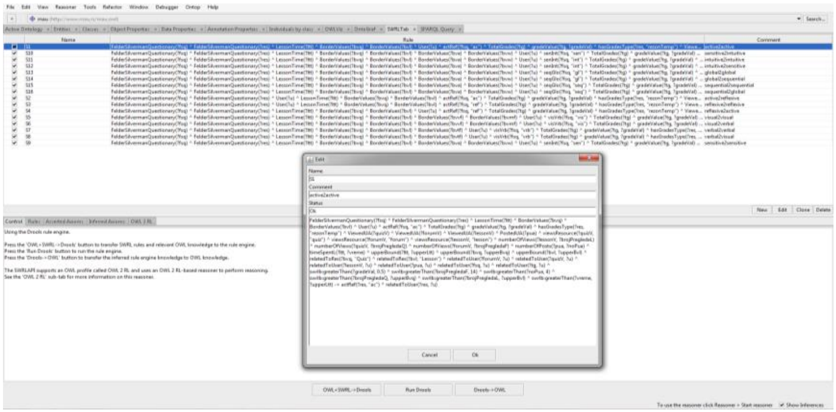


Figure 5. Development and testing of the semantic rules

The result of execution of semantic rules is student's learning style according to the Felder-Silverman model of learning style. After creating and testing semantic rules, they should be inplemented into the semantic environment. In our work we used Jena as semantic environment and Pellet[2] as inference engine.

Working in Jena semantic environment includes the following: creating a semantic model that consists of model obtained from D2RQ server instances and ontology model; creation of methods necessary for the system adaptation using APIs; the execution of semantic rules; performing semantic queries (Fig. 6.); applying semantic reasoning mechanisms and getting results of semantic reasoning; transfering semantic results to Moodle; creating of reports in Moodle based on obtained semantic results; updating Moodle MySQL database in real-time. Fig. 7. shows the resulting *MAU* ontology in RDF format, after inference process is done.

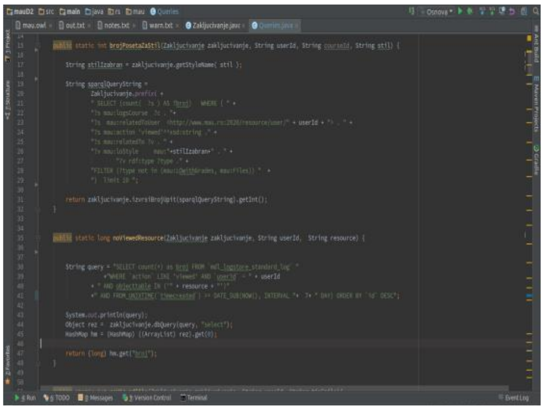


Figure 6. SPARQL queries

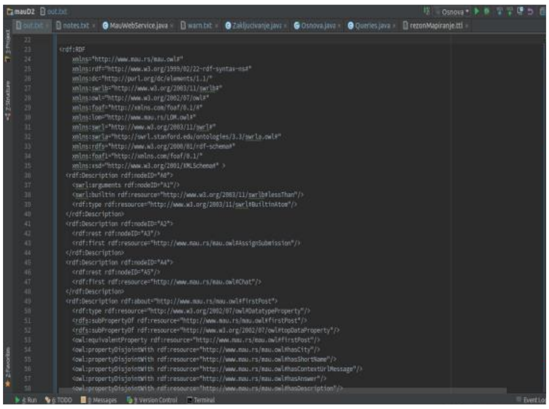


Figure 7. Resulting *MAU* ontology

After the processes of semantic mapping, ontology creation, design, testing and implementation of semantic queries and rules, the final step in the development of semantic models is to visually adjust the Moodle system to the user and to offer him/her more options for learning. User interface adaptation refers to the visual recommendation (as a link) of learning objects according to key words, which is done via a web service created for this purpose. Fig. 8. shows the visualization of existing learning objects for the chosen keyword *AJAX* from *CiteSeer*[x3] academic base. arXiv[4], DOAJ[5] and DbPedia[6] were also used as external academic repositories applied in this system.

[2] https://www.w3.org/2001/sw/wiki/Pellet
[3] http://csxstatic.ist.psu.edu/about

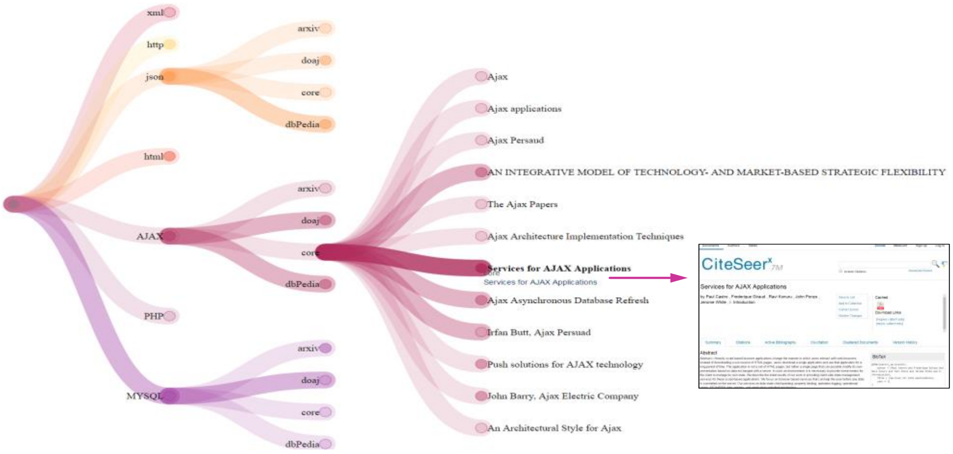


Figure 8. Visualization of existing learning objects from *CiteSeer^x* repository

DISCUSSION AND CONCLUSIONS

The implemtation of ontologies and semantic tools for dynamic adaptation of the educational system in the field of engineering education can be successfully applied in higher education institutions for the realization of personalized teaching activities. The results and the solutions proposed in this paper provide opportunities for further research in the field of implementation of ontologies and semantic development for more demanding concepts that provide different functionality.

In this paper we proposed services that provides integration of different system components. It is possible to develop additional software tools and packages and use the potentials of different social media. Integration of social networks and the development of services for social interaction is one of the possible ways to enhance students' motivation to work and improve their results during the learning process.

In accordance with the development of information systems and technologies and innovative directions of development of semantic applications and the Web, a growing number of universities and institutes provides open access to their semantic bases. The reason is simple, optimized and faster access to distributed and differently structured and described data. This concept can be used to solve the problem of interoperability, implementing the unified semantic standards for the description of the terms of the Semantic Web. Further research should be directed towards adaptation of learning objects based on various criteria: the expectations, learning styles, learning results, goals, motivation, skills, knowledge, and other social characteristics. The implementation of the concepts of the Semantic Web should be used in educational systems if the process of course content adaptation is dynamic, personalized and fully automated.

Acknowledgments

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[4] https://arxiv.org/
[5] https://doaj.org/
[6] http://wiki.dbpedia.org/

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ENTREPRENEURIAL INFRASTRUCTURE – CHARACTERISTICS OF BUSINESS ZONES

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Abstract: The paper presents general characteristics of entrepreneurial infrastructure - business zones. One of the modern ways of support to small newly established enterprises and entrepreneurs, which are in a development life phase, is the system of technological infrastructure: entrepreneurial incubators, technology centres, science parks and business zones. Those are different organizations which help entrepreneurs to develop their business ideas and to overcome more easily the initial problems in business, for which, in a wider context, the term business incubators is used, and also the clusters related to entrepreneurs who are in an advanced phase of entrepreneurship.
Key words: SMEs, entrepreneurial, entrepreneurial infrastructure, business zones

INTRODUCTION

The beginning of the nineties, characterized by the breakdown of the former state, the outbreak of civil war, especially at the territory of B&H, stopped not only the development of entrepreneurship but also the fundamental economic activities.
The support to the development of small and medium-sized enterprises in the Republic of Srpska had gained in importance in 2002, with the adoption of the Program of Small Business Development, and after that the Law on Stimulating the Development of Small and Medium-sized Companies was adopted. The adopting of the Law has created the basis for legislative, institutional and financial help to this area.
On the basis of the Law, during 2004, there were formed: Department for SMEs and Production Craftsmanship at the Ministry of Economy, Energy and Development of the Republic of Srpska and the Republic Agency for the Development of Small and Medium-sized Enterprises. At the same time, on a local level, local agencies for the development of SMEs were being established. The support to the development of SMEs at a local level is also given by municipal development departments which, together with the above mentioned institutions, make support network for the development of SMEs.
Infrastructure is important for entrepreneurial activities[3] and may have different forms and functions. As first, the development of trade and industrial growth require physical infrastructure, road and railway traffic and transportation etc.
After the World War 2, when the state had nationalized private property[4], the spirit of entrepreneurship at the territory of former SFRY, including B&H as well, was cut at the roots.
The economic philosophy of a new economic system was based on the criticism of all the aspects of capitalism such as individualism, private ownership over the means for production, entrepreneurship in a wider sense etc. Entrepreneurship was identified with private ownership. In the beginning[1] that had been small business. However, with further breakthrough and propagation of small business, the term private entrepreneurship occurred, which, as such, was accepted in official frameworks.
Namely, in the economic structure of the SFRY, especially after 1976, after the Law on Associated Labour had been adopted, a significant number of labour organisations (enterprises) emerged, of combine type, in the field of mining, metallurgy, metal processing industry, military industry, wood processing industry, with a great number of basic organizations of associated labour and complex organizations of associated labour, which had the disregard of market laws as a common feature. Such enterprises, being labour-intensive, were oriented to the employment of a great number of people. The society propagated the need of full employment. There was general safety, especially once when a

state job had been got. No one thought about a great individual engagement in the area of entrepreneurship.
The structure of individual sector consisted of agriculture, then of independent forms of production, service and construction craftsmanship and independent catering, independent car-transportation activity and independent trading activity. In the SFRY, the percentage of the employed, as stated by [1], in small enterprises from 7 to 100 employees was only 2.4%, and in enterprises with 1 to 6 employees was 5.6%. The number of employees was limited to 10. In the process of building socialism, the private sector was called small business, and it operated under numerous limitations in terms of what it could deal with, with whom and how many employees it could employ.
Such conditions are a phenomenon which is characteristic for all former socialist countries, and which is related to a lack of small and medium sized enterprises in the an economic structure, and, by means of that, to the absence of creating an entrepreneurial infrastructure.
In all developed Western countries and in many developing countries, entrepreneurship and small enterprises as a whole are supported by the state, state institutions and nongovernmental organizations in many ways[4]. Such an orientation of a market-developed countries has deep roots, regarding the fact that the capitalism has tried many development models as opposed to one-dimensional models of economic flows control which have been practiced more-less for decades in the countries of socialist and similar socio-economic systems.
Similarly to the leading countries of the West, many small countries which started with the implementation of market-capitalistic principles in the development of economy three to five decades ago, have reached an enviable level of development today[4] exactly due to the development of small enterprises.
The determinations of Bosnia and Herzegovina[1] related to the SMEs development sector rely on the recommendations of the European Charter and the Act on Small Business. The Law on Ministries and Other Control Bodies of Bosnia and Herzegovina has also defined the institutional framework in the field of issues in the sector of SMEs whose difficulties reflect, above all, in: approaches in defining policies, development strategies and goals in the sector of SMEs, competences, way of work a harmonized monitoring of the results in this area, mutual cooperation and profitability and excessive administration.
At the level of the Republic of Srpska, within the Ministry of Economy, Energy and Development, there is a department for small and medium-sized enterprises, the head of which is an assistant minister with the responsibilities in the work fields: development of entrepreneurship and craftsmanship, making of medium-term and long-term development plans and making of the development strategies of SMEs and entrepreneurial activity.
Pursuant to the (Law on Enterprises of the RS 2006), an enterprise is a legal person which performs the activity to gain profit, and an entrepreneur is a physical person who performs the activity to get profit and the activity of free profession, while an individual agriculturist is not an entrepreneur. The Law does not know the notion of small and medium-sized enterprise, and because of that the same provisions apply to them as to the other enterprises.
The new (Law on Business Companies 2008) is a modern regulation, greatly harmonizes with the directives of the European Union company law and as such should contribute to the creation of a legal framework complementary the internal market of the EU.
The Law on Business Companies of the Republic of Srpska[5] is based on the best solutions of modern national law of the surrounding countries, and also of some countries from Europe and the USA (Illinois), the Statute of the European Company from 2001, OECD Principles of Corporate Governance from 1998 etc. Entrepreneurship, in the sense of the (Law on Development of SMEs of the RS, 2013), is an innovative process of creation and development of business ventures or activities and of creation of business success at market. Entrepreneurial infrastructure presents spatial-technical forms for toe support of entrepreneurship development, with a special emphasis on establishing and development of SMEs.
In recent time[2], there is a greater emphasis in the commercialization of university research, especially through the creation of spin-off enterprises. They emphasize inhomogeneity of the concept of university spin-off enterprises and point out their heterogeneous properties.
The suggestions of[2] for the classification of university spin-off enterprisesare: independent spin-off enterprises, connected spin-off enterprises, with joint investment and as organizational units of

universities. Three key approaches are used for differentiating the types of university spin-off enterprises: researchers as entrepreneurs of spin-off enterprises, by the nature of knowledge transfer and the participation of external partners in a new company. These different criteria make the phenomena contained by the concept of university spin-off enterprises.

BUSINESS ZONES AS ENTREPRENEURIAL INFRASTRUCTURE

Formation and development of business zones is a long-term, planned activity directed to stimulation of economic development and employment at the territory of a local community, with the use of adequate equipped space and other instruments of support, which enable a more efficient and faster economic and spatial development of enterprises which operate in a zone.

Business zones (the Law on Development of SMEs of the RS 2013) are a form of entrepreneurial infrastructure which presents a constructionally arranged and communally equipped space, intended for a harmonised and planned use by a greater number of enterprises and entrepreneurs, where the planned and harmonised approach enables a joint use of the space, as well as of communal, administrative, financial, technical and other services, thus realizing lower costs of business.

The terms of entrepreneurial infrastructure and business infrastructure often have multiple meanings, because the development terminology mostly has not been set, because of its complexity, by a legislation, and the fact that those are relative new development mechanisms.

The notion of business zones can define the widest notion of zones in general, which presents a certain area of an infrastructurally equipped building lot which is regulated by spatial-planning documentation, intended for business, i.e. the creation of added value.

Pursuant to the first classification[4], the zones can be classified into four groups:

Specialized zones: incubators, technology centres, technology parks, centres for transfer of technologies and zones specialized for certain activities;

Industrial zones, present the areas with a great concentration of industry, predominated by big enterprises; Entrepreneurial – craft zones, present the areas with a great concentration of small enterprises and entrepreneurs; Agricultural zones are the zones founded on soil which is not intended for building and is used for agricultural production.

Pursuant to another classification, business zones can be classified in the following four categories: Industrial zones are larger zones mostly oriented towards bigger industrial enterprises from similar agricultural sectors, but also the small and medium-sized enterprises (SMEs) related on the principle of subcontracting with bigger enterprises. A special category of industrial zones are so-called industrial parks, whose specificity is to have a company as the operator which manages the zone on behalf of one or more owners. In developed countries, the operator can be in public property (public communal enterprises and/or municipality and sate), can be a public – private partnership or in private ownership. The aim of creating this form is a more efficient management of the zone and better planning of its development. Entrepreneurial zones are smaller zones primarily intended for SMEs and entrepreneurs, which have a more favourable support treatment with the aim of faster development, i.e. to invest in equipment, human resources and working assets, and less in the business premises. Business centres are business tones where business, trading and logistical centres oriented to service activities are groupedmost often. The building of business centres is most frequently a private or public-private initiative.

Technology parks are the zones directed to high technologies and usually emerge near universities (with technical faculties and institutes). Located in technology parks, there are usually small, micro and medium-sized enterprises based on high technologies, application of new knowledge and introduction of new practices to economy.

Besides the named classifications[4], on the basis of strategic importance, industrial zones could be divided into zones of strategic interest defined pursuant to different criteria, as projects of special interests, and emerge by an initiative of Government towards he realization bearers, which can be of different levels and legal status (from top to bottom) and local zones of municipal or regional importance and oriented towards smaller industrial capacities. Their size is from 10 to 60 ha, depending on the needs and possibilities of the organizer. The initiatives for the development of such zones originate from one or more municipalities (initiative from bottom to top).

Business zones present special organised business units in which, at one location, well connected with communications, the types of production and service activity on the principles of cluster organization are developed, with the use of developed infrastructure and accompanying services which have their specific industrial features.

Basically, business zones secure the competitiveness for businesses in two aspects. The first of them is related to the possibility of using the effects of integration of similar and related businesses within a zone, resulting in the making of competitive advantages for downstream activities within the zone by means of: access to different inputs in raw materials, components, packaging and services; lower transaction costs, because the locations of providers and producers are identical; efficient coordination based on availability and constant exchange of information among the buyers and suppliers in the zone; improvement of innovation process on the basis of good knowledge of the consumers' needs and of joint work in solving problems; specialization and efficiency rising and the application of new technologies in a strategic partnership of enterprisesin the zone; firmer integration of providers and related industries in the chain of values of enterprisesin the zone, especially in cases when downstream activities are orientated towards international markers; partnership with related industries in cases when they can service a few enterprises, for example when distributive enterprisesin the zone can distribute the products of a few producers.

The second aspect is related to efficiency offered by the location of the zone for its members by means of: decrease of investment costs for production and business objects; decrease of operational costs of functioning, transportation, maintenance and safety of an object, and the services organized in the zone; joint use of certain objects (laboratory, copy-room, energy sources etc.).

Business zones appear under different names. The terms also in use are: industrial park, economic zone, business zone, industrial possession, business zone, artisanal zone, eco-industrial park and some other, but basically they denote what has been stated under the notion of a business zone.

Regardless of how we name them[4], all of them have two characteristics in common: common location of enterprisesoriented to a mutual business cooperation and common structure of management. They vary one from the other in the sense of type and size. They are most often divided due to the type of investment, i.e. the preparedness for investment, to green field and brown field. In the first case, green field, we talk about the creation of business zones at completely new locations, while in the second case, a brown field zone has been created from already used ground and objects in industrial centres.

From the aspect of Bosnia and Herzegovina, especially significant is the use, or reactivation, of infrastructural capacities of former state enterprises, whose value gets rapidly destroyed by the lack of use. In cases when the reconstruction of existing capacities is more expensive then the construction of new ones – the advantage is given to the first option.

Business zones have certain specifities in relation to free zones which are, in many countries, one of the instruments for conduction of trading policies.

Namely, free zones are specially denoted and arranged areas of one state, where business activities take place under special conditions, mostly with certain benefits related to freeing of duties and taxes for activities directed towards export. So, free zones are basically the means of export promotion and of promotion od direct foreign investments to some countries.

Besides the stated differences, business zones and free zones also have some similarities, in the sense that both forms of organizations are directed towards the building of competitiveness by means of creating a competitive advantages of a certain location of production. Moreover, the free zones in industrially developed countries have lost significantly in their primary meaning of economic oases based on the advantages of a duty-free area and the avoidance of taxation, and they get more importance in creating the competitive advantages from the fundamentals of a quality infrastructure of a free zone, high technologies applied in the zone, advantages of specialization, innovations and low transactional costs and other advantages created by the business zones in a narrower sense.

Basic differences and similarities of business and free zones are shown in Figure 1. The similarities are shown in the intersection of squares, and differences in each of the squares which present particular forms of zones.

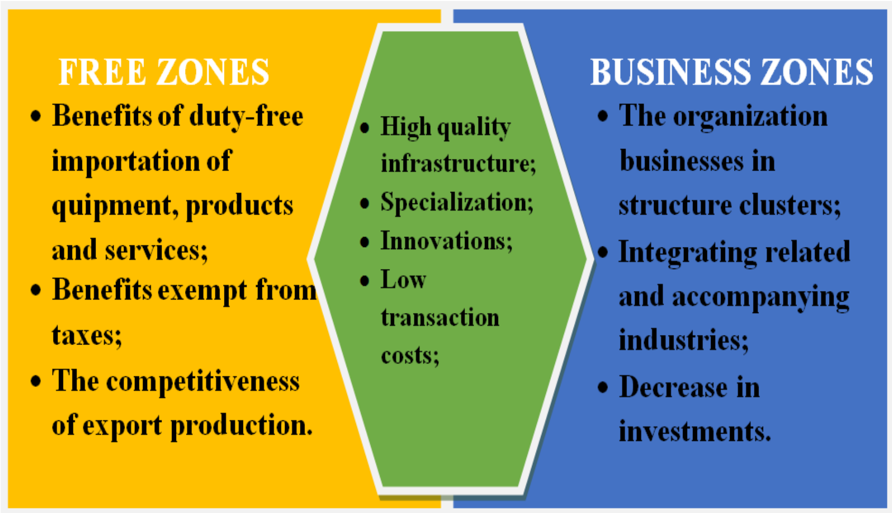

Figure 1. Is Similarities and differences between free and business zones

Business zones should be observed as one of instruments in realization of new industrial policies which promote many important economic goals. Among the goals, the following ones stand out: restructuring of production, growth of employment, rising of productivity and efficiency in economy, improvement of the technological level of production and business in general, improvement of export and export competitiveness and development of small and medium-sized enterprises (SMEs).
Building of competitiveness in a small country, especially in the conditions of responsibility for regional and local development, is related to the growing role of small and medium-sized enterprises. Specificity of a development based on the promotion of SMEs is related primarily to the need of creating a business environment in which the enterprises will have the conditions for building of sustainable competitive advantages. In many elements, the business environment of SMEs exhibits specificities. The enterprises do not have the strength to act independently at big markets because of their fragmentation, so it is logical that in the business environment they start to build a partnership and develop cooperation in horizontal and vertical dimension and to promote the cluster-type cooperation.
Namely, what cannot be secured as a desirable business environment in economy in general, is often achieved within business zones, so that they become attractive for the location of productions which mean the entering into a higher phase of competitiveness or mean a greater efficiency within the stadium of competitiveness which marks an economy guided by factors of development.
Some of the goals[4] for founding of business zones can be the following ones: securing of long-term conditions for development of small and medium-sized entrepreneurship and production craftsmanship, long-term decrease and alleviation of the trend of unemployment and support to entrepreneurs to open new job positions, especially within the production activities, stimulation of growth and development of entrepreneurs, especially in terms of development of new products, application of new technologies and support to export, facilitating of communication and support of cooperation among the entrepreneurs within a zone, especially the support for association in realization of concrete entrepreneurial and development projects, creation of conditions for transfer of a part of production activities from a narrower town centre to use that space for more adequate and profitable contents. Economic development of an area is greatly determined by available potentials, i.e. resources, at one side, and certain factors, i.e. the measures which create a favourable ambient and support to development, at the other side. Available resources for an economic development of a region, contained in: infrastructural capacities (roads, railway), natural potentials, power sources, installed economic capacities, personnel, with the geographic position, present a relatively solid basis for a future designed development of the Region.

CONCLUSION

Every local community or a set of local communities which are connected geographically, to attract a larger number of enterprises to their territory, the territory of the Region, takes various activities to improve the conditions of work of SMEs. Local community plays a very significant role, while the task of the country, or the government, is to activate the inner resources, as additional development impulses. A prudent activity of local communities with the aim of developing own infrastructure and entrepreneurial potential and attracting of investments can be a concept of regional development. Local community must develop an attractive environment for capital and enterprises. The establishment of business zones accelerates and simplifies the placement of spatial resources in the function of economic development, investments, growth and employment. Everywhere in the world, business zones present a significant instrument for the stimulation and development of entrepreneurship and general economic growth of a certain area. They are established on the basis of a clearly expressed interest between the businessman and bodies of local and regional government, with the support of higher levels of government and research-educational organizations, universities and institutes.

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EDUCATION AND PROMOTION OF WOMEN ENTREPRENEURS

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Abstract. In adult education, women are identified as a specific target group, which should be a vocation to become a significant holder of entrepreneurial activity. How are the knowledge, skills and competences prerequisite to any business enterprise, it is necessary to improve education for women, both in formal and informal education system. Non-formal and continuing education is aimed at the population of adult women. Aggravating factors affecting the low motivation of women to participate in adult learning and education are inadequate emancipated, unfavorable educational structure, challenging the family role of women-mothers, the difficult situation caused by belonging to rural areas and underdeveloped regions.
Key words: adult education of women, entrepreneurship, motivation wife.

INTRODUCTION

Affirmation of women entrepreneurship as a relevant objective of development of modern society, is supported by a number of international documents. The Beijing Declaration adopted in 1995 is the key document in which the integrated objectives and principles set out in the UN Charter, the Universal Declaration of Human Rights, in particular the Convention on the Elimination of All Forms of Discrimination against Women and among others the Declaration on the Right to Development. Women's entrepreneurship is recognized as an important mechanism for achieving equality, democratization and development of society, the preservation of peace and poverty reduction.
The phenomenon of female entrepreneurship includes new aspects, above all, that women want and need to reconcile family and professional obligations, and that his engagement in entrepreneurship highly personalized, transparent in him bringing his personality and values. Employment of women is lower than male employment, although more women in the population, they are most present workforce at one of the lowest-paid sectors - services, very few women in leadership and management positions, and the average earnings achieved by women in relation to men were lower in almost all activities.
From these studies, in short, to learn, and that women who have entered the private business well educated, that their professional composition varies, most are married, with children, to areas where they founded the private affairs, mainly belong to traditional female occupations that rarely have their own start-up capital, and to form micro or small enterprises.
The reasons for starting a new business are the most common means of ensuring the existence of family and children and the desire to prove their own abilities. The biggest obstacle they faced was called work on three fronts: the household, the children - family and work and gender discrimination [13].
In practice, women are often excluded from decision-making. Decides in small, informal, and as a rule, men's groups, which excludes women from institutional policy or diminishes their political power even when they are represented. Exclusion of women from institutional politics can slow down the democratic process and in the countries of ex-Yugoslavia. A particular problem to be solved is participation in public and political life of the multiple discrimination of women. The woman has more

than men in the world, or in the economy, according to official information and indicators, minorities all over the world.

Women's entrepreneurship as a phenomenon of our time, until recently, was paid very little attention. The first important scientific papers on this subject appeared in 1976. In the journal 'Journal of Contemporary Business' published work is' Entrepreneurship: A New Frontier Woman' 'which drew attention to the upward trend of this kind of entrepreneurship.

For example, according to statistics from 1972, about 4.6% of all US businesses are led by women. After investigations of the UN in 1995 two changes that have occurred in the last ten years have led to the establishment of a positive climate for the development of women entrepreneurship: a) the establishment of legal and legislative equality for women; b) ensuring equal access to vocational education and training for women.

Male resistance to women is stronger in Europe than in America. Polls in Italy and the UK have shown that nearly half of men and reject the idea that women can perform task managers. Statistical analysis of the population of managers in the US and Western Europe has shown that women make up only 3% of CEO’s of major companies and occupy about 12% of middle and lower management positions, even though they were in the labor force for more than 45%. In the literature, this phenomenon is explained by the existence of strong or impenetrable barrier, which is the result of a combination of all stereotypes. In the world there are three countries where women make up more than half of the employees. This is Sweden (60% of employees are women), Canada and the US (52% of employees are women). The other extreme are countries of the Middle East in which the proportion of women in the labor force between 35% (Israel) and 4% (Iraq, Saudi Arabia). Unfortunately, one of the still strong reasons meager representation of women in the management of their personal acceptance of "female roles" and from it emerged disinterest in leading or managerial career [5].

MATERIAL AND METHODS

In recent decades, as one of the possible directions of development of entrepreneurship allocated to the development of women's entrepreneurship. According to [10] women's entrepreneurship is an important, although an underused source of economic growth. Women's Entrepreneurship creates new jobs for themselves and others, and also provides the company with a variety of solutions for the management, organization and business problems. Women are a huge potential resource for economic growth, but they still need incentives, support and most importantly, carefully designed training programs and mentoring.

In this world omen still constitute a large minority of all entrepreneurs. According to the Global Entrepreneurship Monitor (GEM) global database of entrepreneurial activity are lower for women than for men in all countries participating in the GEM [8]. There are many studies based on the research of Women's Business Centers notes that institutional support for women's entrepreneurship contributes to counteract the stereotypes that women face and creates an environment that encourages intragroup solidarity and defines women as normative business leaders [2], [3]. In recent years, in the world and in Serbia, there has been no increase in the number of enterprises headed by women. According to the National Agency for Regional Development (NARD) in Serbia, women own or have a stake of 25% of all companies (in Europe, 34%) and in 17% of companies owned by women and also perform entrepreneurial functions [9].

In most cultures there is a strong division between male and female roles [4]. According to such cultural stereotypes that dominate, especially Arab countries, Latin America and the less developed regions of the world, managers can be only men. Women are expected to be subservient and dependent, not to stand out and to serve men. Even in developed democratic societies, where women enjoy formal equality, these cultural stereotypes are not completely eradicated. Different legal constraints that women are placed in a second-class status only recently removed from the legislation of most developed countries, and in underdeveloped are still very much present (for example, Switzerland's did not have the right to vote until 1971, France no regulation to protect women from harassment at work, and in the US women for the same job often receive lower wages than men).

Already in the 21st century things started to change. Between one quarter and one third of all businesses in the world today run by women with a growth rate up to two times, compared to the national average in the USA. Women are owners of approximately 30% of all businesses in the world. This is shown in Table 1.Entrepreneurs in developing countries now represent a vital driving force in all sectors of the economy, whether measured by the number of new jobs, the number of employees or the volume of realizing profits as shown in the following tables [12].

Table 1. Women-owned businesses in the world (in %)

Country	Year	Women-owned (%) enterprises
Netherlands	1992	8
Mexico	1990	9
Japan	1991	13
Germany	1993	15
Canada	1995	17
Australia	1994	18
US	1996	20

Profile of women entrepreneurs

Profile of women entrepreneurs from the existing private sector is analyzed in the framework of the project "Improvement of economic and social rights of women in Serbia and Montenegro", conducted by the United Nations Entity for Gender Equality and the Empowerment of Women (UN WOMEN in the period 2010-2012) [7]. Entrepreneurs are found in all regions of Serbia and in this regard, there are no major differences between the regions of Belgrade, Vojvodina, Sumadija and Western Serbia. Entrepreneurs are a little less present in the region of Eastern and Southern Serbia, where a lot of slow economic activity (only one in five entrepreneurs from the region).It is noticeable that young entrepreneurs (19-30) in business concentrated mainly in four sectors: industry, trade, knowledge economy and information and classic services. Entrepreneurs middle age (31-49) is strongly concentrated in the trade sector, followed by other sectors lag far behind, while the elderly (50+) are somewhere between the two previous groups.In Table 2 is shown Serbia's employment rate by age and sex (statistics from 2010, ssource: Statistical Office of the Republic of Serbia). According to the National Employment Service (2011) of the total registered unemployed at the end of 2010. At 52.69% are women. Of the total number of unemployed persons registered with the National Employment Service, mostly women in the age group 25-29 years 14.5%. Data on employment rates in Serbia by gender and age are given in the table below.

Table 2. Serbia's employment rate by age and sex (2010)

The employment rate		Age 15-19	Age 20-24	Age 25-30	Age 30-65
Gender	Male	52,1	61,6	75,4	88,0
	Female	35,4	51,6	70,8	84,7

Education of women entrepreneurs

Entrepreneurs are mostly microentrepreneurs, that is located at the head of companies employ fewer than 10 people. They are most common and individual owners that have business activities in some form of action, in the service sector.

Most often they have created a company and not a family business. Most entrepreneurs (68%) started their own business primarily because they could not in any other way to solve the problem of unemployment, or low-quality employment with other employers, while a minority did so because they recognized the best business opportunities or business ideas [11].

The share of entrepreneurs who started in their own business because they recognized the business opportunities is much lower in Serbia than in EU countries. Although comparisons should be treated with caution due to the application of different methodologies, the difference is beyond doubt: in the EU 27 "entrepreneurs opportunities for" an average of 66.5%, while "women entrepreneurs out of necessity" has 33.5%, which is almost the reverse proportion in relation to Serbia (EC, 2009b).
Higher education seriously increases the chances to enter into entrepreneurship for business opportunities and ideas, and not out of economic necessity. Thus, the motive economic necessity in the category of the most educated entrepreneurs present in 54% of cases, but in terms of primary and secondary education between 71% and 73%. This finding is not unexpected, and the work can be explained by the fact that employment conditions for women with higher education better, and their economic necessity less pressure to find a stand-alone solution. On the type of motivation for entry into entrepreneurship and entrepreneurial influence family tradition. Among young entrepreneurs (19-30), more than half (51.5%) had at least one parent entrepreneurs, while those among middle-aged women entrepreneurs 21.2% and 10.6% among the elderly. This finding is significant because it indicates that the investment in the current generation of entrepreneurs and at the same time investing in the future. According to author [6] it significantly increases the chances that children also present young entrepreneurs be entrepreneurs due to the identified business opportunities and ideas.
Serbia is the largest national organization of women entrepreneurs. ABW has a leading role in the organization of business women and providing superior support and promotion of Serbian entrepreneurs. The Association is actively engaged in advocacy to improve the business climate and encourage networking at the local, regional and international levels. Special emphasis is placed on the Association of professional development of its members, improving the knowledge and skills of women: training, seminars, lectures, presentations, additional training, retaining only an educated and informed woman can be a good manager and creator of his work. This is shown on Fig 1. (source: Statistical Office of the Republic of Serbia).

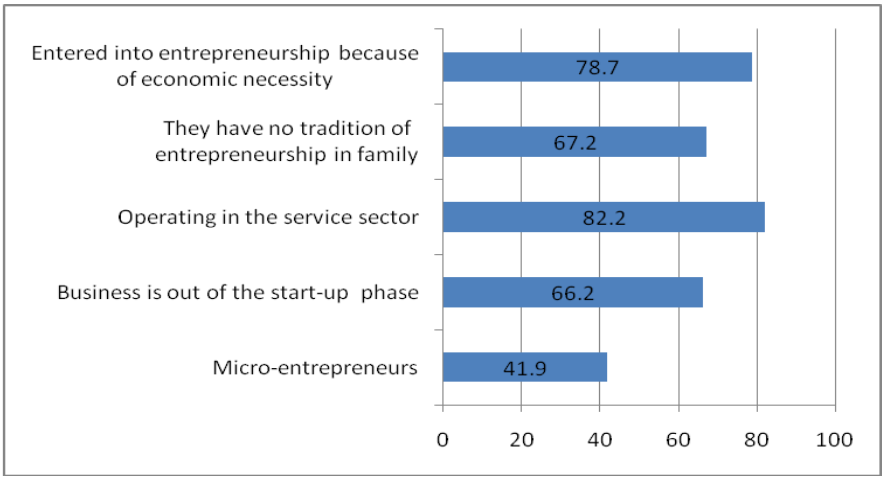

Figure 1. Entrepreneurial profile in women
Baseline Study on Women's Entrepreneurship, 2011.

RESULTS AND DISCUSSION

One of the most pressing problems of the economy and society in Serbia, as well as in most of the countries in the region, is the growing unemployment rate. The total unemployment in Serbia is around 25%, a lot of women's participation. According to the National Employment Service for the year 2011, the unemployment rate for women was 24.3% and for men 23.1%. Women in the working-age as 15-64 participate in total employment from 38.3%, while men with 52.4%. It is also long-term unemployment more pronounced in women than in men (unemployed women registered at NES seeking work 4.3 years and unemployed men 3.3 years). The average age of women 38.07 years. Regional trends in the unemployment rate drastically present in the female group (eastern and southern Serbia, rural areas). Also, differences in the educational structure of women compared to men show

that the largest share in the unemployment of women with incomplete primary education as well as secondary education.
Based on the research of the labor market for women, on the one hand, and the status of research in education, particularly the education of adult women, on the other hand, follows the identification of various problems and shortcomings that are related to the socio-economic picture of the country and the problems of the current system of education of adult women.

They identified key issues relevant to the understanding and improvement of adult education of women in Serbia, which stem from socio-demographic picture of the company: a) low level of economic development; b) the great disproportion in the economic, demographic and educational structure; c) slow population growth and reduce the number of children and young people and increase the number of elderly in the total population; d) poverty of a significant part of the population; e) high share of young women up to 30 years in total unemployment; f) unfavorable educational and qualification structure of the female population.

Proposals to address the shortcomings of how problems in adult education, and the key issues relating to socio-economic picture of the country, as well as a model for improving the existing system of adult education are [1]: a) Defining the priority goals of learning in adult education; b) Defining the organization and responsibilities of adult education within the Government; c) Compliance with other adult education policies and strategies as possible with the help of the model proposal Adult Education Strategy.

CONCLUSION

It can be concluded that women in Serbia are more affected by unemployment as compared to men, despite their higher average educational attainment levels. When you are trying to measure and statistically express poverty, women still occupy the infamous high-quoted position. On combating poverty among women should work primarily on the creation of new jobs for women. This would be in addition to achieving gender equality and create conditions for economic growth of society as a whole. To achieve this goal, it is necessary to overcome the stereotypes regarding the division of professions into male and female.
Women's entrepreneurship is becoming a reality and one of the main factors contributing to economic development in many countries. Political and economic changes in the past have created the possibility for women to set up companies and manage them. One possibility that is increasingly used today in countries with developed market economy, women control more than 25% of the total number of companies. Women's entrepreneurship is rapidly expanding around the world. Women represent more than one third of the total involved in entrepreneurial activity, while their participation in the informal sector of the economy is much larger. Generations of women in the world diverse heritage and education contribute to their environment and express very encouraging signs of entrepreneurial spirit.
The potential of women's entrepreneurship is manifested through a greater diversification between different economic sectors, younger entrepreneurs, at the aggregate level, which means a greater number of business activities focused on the knowledge economy and production, a lower concentration in the store. When entering the most important potential of women entrepreneurship are: determined not to give up easily, after the first attempt; The main disadvantages are a frequent entry into entrepreneurship because of the mere pressure of economic necessity and without sufficiently developed business ideas, while the obstacles are unfavorable resources to start, especially the lack of financial capital.
It should set the framework for a good and flexible system of adult education and modern education and training, or a system that will give everyone a chance to adults (and adult women) to continue to learn and develop their abilities based on work and life experience they already have.This development ability is something without which one cannot imagine a future society based on creative knowledge. This especially applies to the knowledge of individuals, who can thus encouraged to start their own business within the framework of shops, or small and medium-sized enterprises.

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IMPLEMENTATION OF PROJECT SCHEDULING APPROACH TO SERIAL PRODUCTION PLANNING

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Abstract: This paper presents some possibilities of applying project approach to scheduling of serial production. Since in conditions of modern and complex scheduling of production system by classic production process is more difficult to achieve optimal production results, it is also in this process necessary to include contemporary approaches and methods. By observing the production process as comprehensive, unrepeatable ventures that engage a certain time, material and human resources, requires the application of project scheduling approach to production processes. Analysis of the application of this approach to scheduling of serial production was carried out in the case of a manufacturing process for the product being manufactured in the company of defense industry "Sloboda" Cacak.
Key words: project approach, serial production, production scheduling, production cycle.

INTRODUCTION

Although the organization of the production process, due to its stochastic character, partly performs during the production itself, mainly everything must be planned in advance and specified in detail schedule. Satisfaction of contradictory objectives of scheduling relate to the maintenance of the set of terms, the planned optimal use of resources, shorter production cycles and lower production costs. This can not be achieved by ordinary observation of production as a set of repeating operations, but as a complex, unrepeatable venture, consisting of a large number of activities, which in its realization spend some time and resources.

Improved production schedules represent a competitive advantage obtained from productivity gains, efficiency improvements in operations management and greater customer satisfaction, [8], also it is a critical issue of production management, [11], because it involves several variables and constraints which influence different performance objectives of the production system, [2].

Some studies indicate a need that production scheduling should be adapted to real conditions in which it is implemented, [6], [3], [5], [4] which leads to the development and application of new of scheduling models.

In systems for producing complex and highly customized items, each item has its own characteristics which are often tailored for a specific customer in order that project scheduling approaches are suitable for production planning in such environments, [1].

Project approach to scheduling of production means that production is seen as a rounded, unique venture, whose aims and characteristics are pre-defined, and the time, material and human resources, involved in the process of realization, are limited. Only such an approach to the production, as the complex process whose outcome is uncertain and largely determined by the quality of planned activities and general process management, can bring the desired results. For this reason it is necessary to go beyond the established plan and implement some of the advanced methods of project management, of course with an accompanying software support, such as MS Project.

Project scheduling approaches for production planning are especially important and useful when particular kinds of production environments are considered, [1]. The scientific literature frequently deals the use of project scheduling approaches for production planning, [7], [9], [10].

ANALYSIS OF THE PRODUCTION PROCESS

In this paper will be presented some possibilities of the project approach to the serial production scheduling in the case of production for one of complex products being manufactured in the company of defense industry "Sloboda" Cacak.

The product which is used as an example consists of 12 positions for which preparation is necessary to realize a greater number of operations of different nature, duration and sequence of implementation.
An essential precondition for the successful termination of production processes, which would have application in a real production conditions is an understanding of the nature of technological process, mutual interdependence, operation sequence and the character of their realization. It is defined process flow diagram for the given product on the basis of a detailed study of its nature. (Fig. 1).

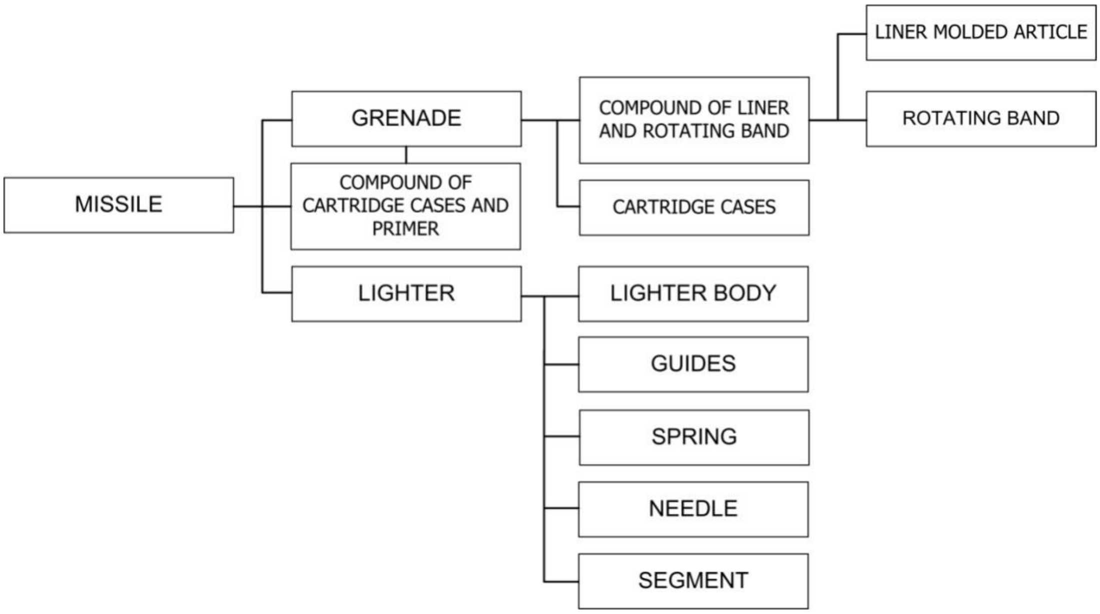

Figure 1. Process flow diagram for the observed product

In addition to the process of making 12 positions, which represent production activities, in the manufacturing process are included and some non-productive activities such as: Ordering of material, Material receiving and Testing, whose duration is conditioned by organizational factors. Duration of production operations is conditioned by organizational factors and applied type of operations sequence. Optimization of the production cycle, in the context of shortening terms of production, achieve an important role in improvement of the competitiveness of organization, [13]. Optimal organization of the order of production operations affects the realization of significant economic effects, which is an important factor for reducing the amount of current assets and the cost of the entire production, [15].
The highest level of synchronization of work processes, and therefore the optimal length of the production process can be achieved by implementation of parallel flow type operation. The sequence of operations in the realization of the observed production process will be designed according to the principles of pralel type of sequence operations.
According to, [12] total duration of parallel cycle type or the order of operations is.

$$T_{cp} = \sum_{i=1}^{m} t_i + (q-1)t_{i\,max} \tag{1}$$

Where:
T_{cp} – total time for overall cycle,
t_i – the duration of the *i*-th operation,
$t_{i\,max}$ – the duration of the longest operation,
q – the number of pieces in the series,
m – the number of manufacturing operations.

Based on a detailed analysis of the technological process, the character of individual operations, standardized implementation time of all operations and their mutual interdependence, it is performed calculation of estimated duration of the production process for each of the 12 positions for a series of 200 000 pieces. Table 1 shows an example of the budget of the duration of the production process for one of the positions (position leading ring), which became part of the observed product.

Table 1. Calculation of production process duration for position *Rotating band*

THE ASSEMBLY	Compound of liner and rotating band
ITEM	ROTATING BAND
ITEM CODE	0101.441.02.

No.	Operation	Machine	Capacity per a shift	Capacity per a day	Making time per piece in cmh	Number of products	Total time in cmh
1	Washing of elements	Manually	4500	9000	250	200000	1800000000
2	Slicing	Single spindle automat "Schwerdtfeger"	37500	75000	167	200000	15000000000
3	Annealing	Electrical Chamber furnace	25000	50000	257	200000	10000000000
4	Hardness test 2 %	Apparatus "Wolpert"	OVERHEAD OPERATIONS				
5	Calibration	Press "Karla Hurt"	5000	10000	150	200000	2000000000
6	Dressing	Containers and devices	50000	100000	15	200000	20000000000
7	Technical control	Visually	6500	13000	115	200000	2600000000
8	Transport between operation	Freight electric vehicle	375000	750000	10	200000	150000000000
	TOTAL				964		

TOTAL TIME FOR OPERATION	cmh	51400707.00
	hours	514.01
	days	34.27

RESULTS OF PROJECT DESIGN APPROACH APPLICATION IN SCHEDULING OF SERIAL PRODUCTION

Term plans can be seen as a more or less solid guidance on the order of realization of production operations and schedule of the resources, however during the implementation of a dynamic and largely unpredictable conditions of production will determine that the actual beginnings and endings deviate from the plan. Therefore, in the course of the realization of economic activities it is necessary to make corrections and update term plans. The project approach and the application of appropriate software support make this process much easier and more efficient.

In order to implement the project approach in the process of scheduling the manufacture, the production process will be viewed as a single, integrated business venture, consisting of the stages, engage certain material and human resources and has limited time for its implementation.

Based on a detailed analysis of technological process, available production capacity during this period, taking into account organizational and financial restrictions and other actual conditions in which the production takes place, it is determined the nature of dependencies of activities of the observed production process.

The need for effective implementation of the production process requires partial parallel implementation of specific activities, while connection-type: end - beginning does not adequately reflect the real conditions of production processes. According to, [1], a project approach to production scheduling represents more realistic the nature of the production process, by the introduction of additional types of connections: %Completed-to-Start (CtS) precedence (Fig. 2a), %Completed-to-Finish (CtF) precedence (Fig. 2c), Start-to-%Completed (StC) precedence (Fig. 2b), Finish-to-%Completed (FtC) precedence (Fig. 2d).

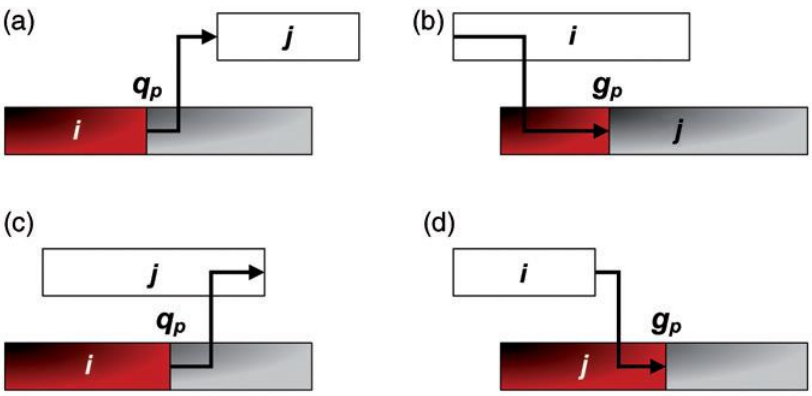

Figure 2. New feeding precedence relations [1]

Respect this approach in considering the dependencies between activities are defined dependencies in the observed event.
Multiple dependence of individual activities, determined by the nature of technological production process and limited resources, makes more complex the process of scheduling production by which exceeds the possibilities of planners. Implementation of software solutions is a precondition for efficient and precise scheduling. As software support in this paper is applied MS Project tool for effective planning and management of business ventures.
Based on the data obtained in the previous analysis of the production process, it is carried out detailed scheduling of the observed production process. By applying MS Project a gantt chart is created (Fig. 3) showing the observed production process as a business venture composed of a series of activities with precisely defined duration, that engage certain material and human resources. In addition to the process of making 12 positions, which represents manufacturing of activities whose duration is specified in the previous calculation, in the production process are included some non-productive activities such as ordering of materials, admition of materials and testing, whose duration is caused by organizational factors.

	Task Name	Duration	Start	Finish
	MISSILE	**373 days**	**Mon 8/8/16**	**Wed 1/10/18**
✓	Ordering materials	30 days	Mon 8/8/16	Fri 9/16/16
✓	Receiving materials	3 days	Mon 9/19/16	Wed 9/21/16
✓	**COMPOUND OF CARTRIDGE CASES AND PRIMER**	**55 days**	**Thu 9/22/16**	**Wed 12/7/16**
✓	**CARTRIDGE CASES**	**51 days**	**Thu 9/22/16**	**Thu 12/1/16**
✓	Cartridge cases-mechanical processing	51 days	Thu 9/22/16	Thu 12/1/16
✓	Preparation of compound of cartridge cases and primer	23 days	Wed 11/2/16	Fri 12/2/16
✓	Testing	3 days	Mon 12/5/16	Wed 12/7/16
	LIGHTER	**154 days**	**Thu 9/22/16**	**Tue 4/25/17**
✓	Making a Lighter body	56 days	Thu 9/22/16	Thu 12/8/16
	Making the Guides	154 days	Thu 9/22/16	Tue 4/25/17
✓	Making the Segment	69 days	Thu 9/22/16	Tue 12/27/16
✓	Making the Spring	51 days	Thu 9/22/16	Thu 12/1/16
✓	Making the Needle	33 days	Thu 9/22/16	Mon 11/7/16
	Laboration of Lighter	29 days	Fri 3/17/17	Wed 4/26/17
	Testing	3 days	Thu 4/27/17	Mon 5/1/17
	GRENADE	**314 days**	**Mon 8/8/16**	**Thu 10/19/17**
✓	Ordering materials	30 days	Mon 8/8/16	Fri 9/16/16
✓	Receiving materials	3 days	Mon 9/19/16	Wed 9/21/16
	COMPOUND OF LINER AND ROTATING BAND	**277 days**	**Thu 9/22/16**	**Fri 10/13/17**
✓	Making liner molded article	34 days	Thu 9/22/16	Tue 11/8/16
✓	Making rotating band	35 days	Thu 9/22/16	Wed 11/9/16
	Preparation of compound liner and rotating band	277 days	Thu 9/22/16	Fri 10/13/17
	Laboration of the Grenade	125 days	Tue 4/25/17	Mon 10/16/17
	Testing	3 days	Tue 10/17/17	Thu 10/19/17
	Completing of missile	56 days	Fri 10/20/17	Fri 1/5/18
	Testing	3 days	Mon 1/8/18	Wed 1/10/18

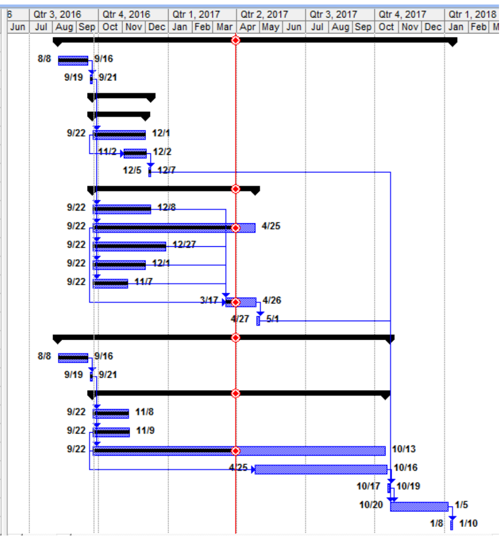

Figure 3. Production schedule for observed product created by MS Project software

The designed schedule plan, in the form of a gantt chart, provides us information about the scheduling of realization of all production and non-production activities involved in the production process, the exact time of the start and the end of the production process, as well as each individual productive and non-productive activities and scheduling of all of the resources. Based on information from the gantt chart, we can conclude that the observed production process for a series of 200 000 pieces can be realized for 373 days. If the process began on August 8th 2016, it would be implemented by January 10th 2018. as is shown in Fig. 4th

as of Sat 9/24/16

Dates

Start:	Mon 8/8/16	Finish:	Wed 1/10/18
Baseline Start:	NA	Baseline Finish:	NA
Actual Start:	Mon 8/8/16	Actual Finish:	NA
Start Variance:	0 days	Finish Variance:	0 days

Duration

Scheduled:	373 days	Remaining:	128.16 days
Baseline:	0 days?	Actual:	244.84 days
Variance:	373 days	Percent Complete:	66%

Figure 4. Report Project Summary

From the analyzed case, we can conclude that the project approach to scheduling and application of appropriate software support provide opportunities:

- Simple and effective monitoring of implementation of the production process;
- A clear overview and easy update of work calendars and simple implementation, resulting by changes in the created term plan;
- Review of busy jobs and engagement of resources in the period in which termination takes place at workplaces and operations;
- Simple scheduling of the operations, according to priority users;
- Review of operations by work orders and jobs, with precisely defined time of commencement and completion operations;
- Review of the utilization of the resources, used by the terminated operations for the production and the possibility of an effective response to the phenomenon of incomplete and uneven utilization of certain resources;
- Review of the degree of implementation of planned activities, the ability for identification of potential downtime or deviation from the defined plan, which opens opportunities for an adequate response;
- Successful reduction of cost and cost management;
- Simple time management and available resources;
- Easy coordination with plans for other production processes which are implemented in parallel with the observed production process, in order to facilitate management of resources involved in multiple processes simultaneously.

Observation of production processes, as well as enterprise project, whose realization is determined by limited resources, imposes the need for objective information about the engagement of the same in the course of realization of production.
Any use of time, materials, energy and human resources, above objectively required, is the inefficiency and the delays in production, which causes increasing costs, reducing the efficiency and effectiveness in production, [14]. Reports on the use of the resources, which are terminated to the manufacturing process, can be created in the software MS Project (Fig. 5) and may indicate the possible excessive use of individual resources. Based on such information, producers can react in time and avoid the emergence of bottlenecks in production.

	July	October	January	April	July	October	January
Press "ILR" - HPK 50	0.14	0.86					
Cartridge cases-mechanical processing	0.14	0.86					
Machine for trimming "HERLAN" BST/S	0.16	1.1	0.23	0.23	0.23	0.04	
Cartridge cases-mechanical processing	0.14	0.86					
Preparation of compound liner and rotating band	0.03	0.23	0.23	0.23	0.23	0.04	
Induction furnace "HERLAN" - HVG	0.14	0.86					
Cartridge cases-mechanical processing	0.14	0.86					
Special drill "FW"	0.14	0.86					
Cartridge cases-mechanical processing	0.14	0.86					
Sixfold Spindle automat Gildermaster AS-25	0.17	1.3	0.42	0.11			
Making a Lighter body	0.13	0.88					
Making the Guides	0.05	0.42	0.42	0.11			
Aggregate machine SAS Bagat	0.07	0.66	0.66	0.35	0.23	0.04	
Making the Guides	0.05	0.42	0.42	0.11			
Preparation of compound liner and rotating band	0.03	0.23	0.23	0.23	0.23	0.04	
Winding machine No 049918			0.38	0.62			
Laboration of Lighter			0.38	0.62			

Figure 5. Report *Resource usage* for part of resources used in observed production process created by MS Project software

CONCLUSION

Project approach to scheduling, as opposed to the classical, provides long-term view of the future activities in production. This approach to the planning of production activities reflects the nature of the production process and provide the basis for optimization of production results. Schedule plans, created by using the project approach with the implementation of MS Project software, provide the opportunities of simple and effective monitoring in implementation of manufacturing processes. Examples from practice, as well as numerous studies, point to the necessity of implementation of this approach to production scheduling with customized real conditions for realization.
Implementation of the project approach to scheduling, provides excellent results in specific production conditions, prevailing in the defense industry, company "Sloboda" Cacak.

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PROMETHEE USE IN PROJECT MANAGER SELECTION

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Abstract: Recruitment and selection of competent project manager are essential for the ongoing success of any project based organization (PBO). The key issue for decision making in personnel recruitment is selection of the right person to the right job. Although both are closely interrelated parts of a multistage decision process, recruiting activities generate applicants for jobs, and selection decisions must then be made that attempt to choose the subset of applicants, or the applicant, most likely to succeed. The main objective of this study is to develop a model based on PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluation) method for ranking personnel selection criteria. In this study, a decision making methodology is designed that employs PROMETHEE in order to help the personnel selection process. In this respect, the aim of using the PROMETHEE technique is taken into account to assess and rank the importance of criteria.
Key words: PROMETHEE, Decision making, Project Management, Personnel Selection, Project Manager selection.

INTRODUCTION

As in many decision problems, project manager selection problem is very complex in real life. Multicriteria decision making (MCDM) has been widely used to deal with decision-making problems involving multiple criteria selection of alternatives. To manage this project manager selection problem, the PROMETHEE method has been used in MCDM on project manager selection problems, in which qualitative information is traditionally transformed to numerical one using an ordinal scale. Chen et al. [1] for personnel selection used fuzzy linguistic PROMETHEE method. They used crisp value and linguistic value together for alternative evaluation. In a group decision making environment they show validity of their model with a numerical example for marketing manager selection. They considered English ability and experience as two quantity criteria, and market ability and communication ability as two quality criteria. Various methods have been proposed to decide on the selection of human resources. Liang and Wang [2] presented a model by using concepts of fuzzy set theory assess personnel fitness and job vacation. On the other hand, fuzzy sets decision theory suggested with Miller and Feinzig [3] for the personnel selection problem. Liang and Wang [4] developed a fuzzy MCDM methodology to find the final ranking values for candidates in personnel selection problem. Yaakob and Kawata [5] used fuzzy methodology for solving workers' placement problem. Lovrich [6] used fuzzy linguistic model for personnel selection. Capaldo and Zollo [7] presented a model based on a case study in FIAT Research Centre (CRF) that is a major Italian company. Butkiewicz [8] used fuzzy numbers for staff selection. Chen and Cheng [9] combined Group decision support system (GDSS) with MCDM in fuzzy environment to solve the personnel selection problem. Golec and Kahya [10] developed a hierarchical structure and use a fuzzy model for personnel selection.
The PROMETHEE methodology seems to be completely adequate to project manager selection problems because it models preferences within its procedures in a simple and flexible manner. Also, it is perfectly intelligible for decision makers since it represents one of the most intuitive Multicriteria decision methods. Therefore, it is chosen for the enhancement towards the evaluation of criteria and weights. In this paper, a decision making methodology is designed that employs PROMETHEE in order to help the project manager selection process. In this respect, the aim of using the PROMETHEE technique is taken into account to assess and rank the importance of criteria. Finally, an application in a project based organization (PBO) demonstrates the effectiveness of the proposed methodology. This study discusses the project manager selection procedure and how determining criteria importance by using PROMETHEE. A case study used to validate this model and analyses the results of the

validation. The case study is an in depth application of proposed methodology to assist in selecting project manager for an Iranian company. Results from case study will be presented as step by step.

MATERIAL AND METHODS

In a single-level analysis of pairwise fuzzy group decision making, each decision maker expresses his or her evaluation on each pair of alternatives based on whole criteria or based on each criterion when the criteria are considered explicitly. In the explicit criteria consideration, solutions based on each criterion are then aggregated into the final solution. The criteria may have the same or different weights. The weight for each criterion is determined separately based on the decision makers' consensus or by adjusting a decision parameter for the aggregation operator used. In most cases, the consensus is achieved by changing the weights of the decision makers [11]. In the other type, the decision makers are encouraged to modify their opinion to reach a closer agreement in opinions [12]. Also, fuzzy sets are employed to recognize the selection criteria as linguistic variables rather than numerical ones. The AHP is used to determine the weights of the selection criteria, in accordance with their relative importance. By the importance roles of decision makers, there are heterogeneous and homogenous group decision making. Heterogeneous group decision making environment allows the opinions of individuals to have different weights, while homogenous not. Dubios and Prade [13] pointed out that each individual is viewed as a subgroup, where the weight of an individual reflects the relative size of the subgroup, and reflect the relevance of the individual in the group.
The goal of this stage is the criteria evaluation based on PROMETHEE modeling for determining the weights of criteria. The basic elements of the PROMETHEE method have been first introduced by Professor Jean-Pierre Brans in 1982 [14]. This descriptive approach, allows the decision maker to visualize the main features of a decision problem: he/she is able to easily identify conflicts or synergies between criteria, to identify clusters of actions and to highlight remarkable performances. The prescriptive approach, named PROMETHEE [15], provides the decision maker with both complete and partial rankings of the actions. PROMETHEE has successfully been used in many decision making contexts worldwide. A non-exhaustive list of scientific publications about extensions, applications and discussions related to the PROMETHEE methods [16] was published in 2010. This part of the study uses the PROMETHEE in the group decision making environment. Visual PROMETHEE is the software implementation of the PROMETHEE methods. Visual PROMETHEE is developed by VP Solutions under the supervision of Professor Bertrand from the Solvay Brussels School of Economics and Management. Professor Bertrand has been developing and applying the PROMETHEE and GAIA methods for 30 years together with Professor Jean-Pierre Brans in Brussels. With Visual PROMETHEE you can share the expertise of a worldwide expert in the field of Multi criteria decision making and of one of the original authors of the PROMETHEE and GAIA methods. The purpose of this model is to enhance group agreement on the group decision making outcome by considering group decision making. Once the hierarchy is structured, the next stage is to establish the importance of each criterion and also to evaluate candidates based on the hierarchy.

RESULTS AND DISCUSSION

By considering that MAPNA is a project based company, the selecting project manager is a critical task for this company. Usually this selection is not done by a single person and a group of persons participate in the process. Usually, the group of decision makers consists of decision makers from different organizational departments and high level managers. In order to determine which applicant is best for the job position from candidates, three decision makers are invited. For more convenience, $D=\{DM_1, DM_2, DM_3\}$ is considered as the decision maker set. The committee was formed for evaluation of candidates and consists of three persons, executive deputy of MAPNA Company (DM1), and procurement deputy (DM2) and the administrative and financial deputy (DM3). It is necessary that to define the importance for each criterion by each of decision makers. The proposed framework was applied to this project based organization to see the benefits of this method. They gave some values (between 1 and 10) as shown in Table 1. The most important criteria will have been the nearest value to ten. The status and effects of the experts were taken into account to determine the weights of each expert, which is shown in Table 2:

Table 1. The determined attribute weights for the Decision Lab software matrix

	DM 1	DM 2	DM 3
Foreign Language	9	8	7
Computer Knowledge	7	9	9
Experience	10	10	10
Age	10	9	10
Gender	3	1	2
Labor Shift	3	7	9
Non-Smoker	3	7	9
Education	9	8	8
Weights of the Experts	0.55	0.40	0.35

Therefore, three decision makers DM1, DM2 and DM3 evaluate each candidate. Decision makers have weights 0.55, 0.40, and 0.35. Decision Lab 2000 software is used to get a PROMETHEE ranking. The given values to the criteria will be entered to the Decision Lab 2000 software and the same table as on Table 2 is made up as shown in the Figure 1.

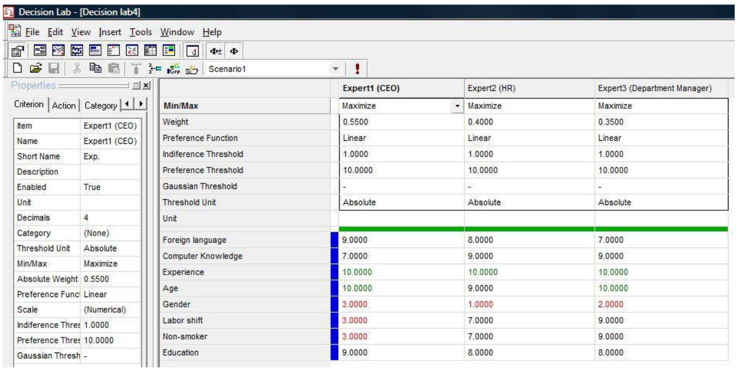

Figure 1. A screenshot from Decision Lab software

The criteria are then maximized since the highest number means the best value in this ranking. The criteria, defined functions, function parameters and the weights assigned to each expert is as seen in the Figure 2. All data entered into the program and calculated. As a result of calculations, the positive (Φ+), negative (Φ-) advantages and the net (Φ) advantages are streams of preferences are obtained as in Figure 2.

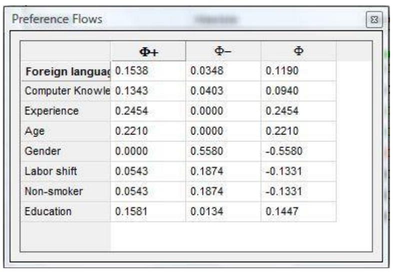

Figure 2. A screenshot of the preference flows from Decision Lab

After obtaining the preference flows, the partial ranking by using PROMETHEE I will be shown in Figure 3. It shows both positive (Φ+) and negative (Φ-) values and rankings for each criterion. However, it does not compare the conflicting actions.

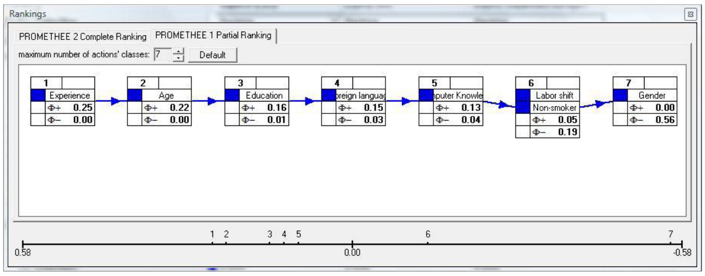

Figure 3. PROMETHEE I ranking

The PROMETHEE II (complete) ranking is shown in Figure 4. These are the net (Φ) values which positive values are subtracted from negative ones. (Φ= (Φ+)-(Φ-))

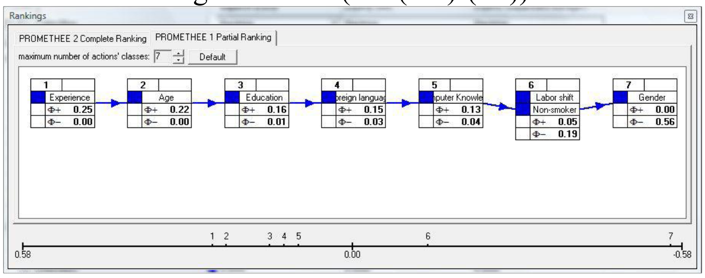

Figure 4. PROMETHEE II ranking

After all of these, the net flow values, from the preference flows table (Figure 4), are normalized and the important criteria are determined. The negative Φ- values (gender, labor shift, being non-smoker) are negligible and thereby they are ignored for calculation. The normalized attribute values are shown in Table 2.

Table 2. Normalized attribute weights

Foreign Language	0.14
Computer Knowledge	0.11
Experience	0.30
Age	0.27
Education	0.18

CONCLUSION

Project manager selection is a complex decision-making problem. It handles a large amount of data, which can come from quantitative and qualitative sources alike and so it would be useful to develop suitable decision-making methods to facilitate the project manager selection procedure. PROMETHEE method was used for multi criteria project manager selection procedure and a framework was presented. In the framework, some respected criteria were graded by 3 different authorized people in an PBO. The matching score of each criterion is determined, which is used as the evaluation for that selection, and ranked through PROMETHEE method. Finally, the framework is presented with a real-case study by the participation of a PBO and as a consequence positive feedbacks were taken from the firm.

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CAUSES OF DEBT CRISIS

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Abstract: In the early 1960s, Latin American countries and other developing countries around the world, have turned more towards the development of the national economy. As a result, these developing countries and developed Western countries prefer loan capital and their main resources are becoming international capital flows. Latin American countries are implementing import - substitution strategy of industrialization from the mid sixties to 1973. Macroeconomic resistance is highly dependent on the sustainability of the relationship GDP / debt. In this context, attention should be paid to the relationship between monetary and fiscal policy, as well as the consistency of exchange rate policy. This means, should be carefully weighed movement fiscal deficit of the public sector. In order to ensure a prosperous economic progress, caution is advised in the implementation of market liberalization and deregulation. The view that these measures may lead to increased productivity, can be called into question without the proper sequence in their implementation, in fact, they may have a negative impact on the economy.
Key words: debt crisis, debt, industry, investments, fiscal deficit

INTRODUCTION

Inappropriatefocus on imports, brings internal problems - oriented economy and leads to a lack of internal resources. This is because the Latin American countries overly rely on the loans for the growth. However, these loans are used for current consumption, and not for productive investment. The money is not used to for the resources mobilized, but to maintain the current, although desperate, the standard of living. In the same period, the western industrial countries have experienced economic depression. Their domestic demand has decreased, and there was a large surplus of international capital, which led to the growth of capital exports to developing countries.

There are several causes of the debt crisis. Debt structure plays an important role in its use and servicing. The main parts of the debt structure are: Commercial loans takeona largepart. The World Bank wants to continue lending to developing countries, while the economy was still good. And then, these countries are beginning to use new debt to repay its old debt. However, as soon as it occurs over a longer period comes to the growth of the deficit, the largest negative trade balance, or political unrest, and those who are involved in all this are losing faith in the market. When foreign exchange reserves sufficient to repay the debt, exchange rate falls. When this happens, banks no longer have an interest in the new Lend, foreign exchange reserves are reduced due to the outflow, and all this leads blast crisis.

When the debt of a country is concentrated in one or two currencies, the risk of exchange rate movements is greater. As soon as the rate increases, the external debt of the country is also increasing and repayment is becoming more severe.

As short-term external debt makes too much of the (above the internationally acceptable level), or if the conditions of repayment are not arranged rationally, it can cause problems paying off the debt. In fact, if financial liquidity is not sufficient to pay debt, it can lead to financial crisis.

The manner of using the loan is the best guarantor of repayment ability. In the long term, solvency depends on the speed of economic growth of the country. In the short term, solvency is determined by the rate of exports. So, what is worrying is not the structure of the debt, but its capacity. Some debtors have borrowed a lot of money, but have not made a repayment strategy with regard to the amount of investment, repayment or rate of macroeconomic development. They just built a number of large and reckless projects, which usually take a long time, but not enough for the return in the short term in relation to the repayment of existing debt. Also, there were a lot of debts that are not used in the production or import of capital goods, but for the imports of durable goods and luxury. This caused a

decline in investment rates and reduced ability for the return. There are some countries that have borrowed in the short term for the long-term investment programs, such as real estate, which can lead to the so-called. Financial bubble, which, when burst leads to crisis.
Deterioration of foreign trade causes interruption revenues from exports. Capacity of income from foreign currency sources determines the country's ability to repay its debts. If the country cannot adjust its export structure in line with changes in the international market, its export income will be reduced and the current account deficit will increase. This has a serious impact on their ability to service debt. At the same time, the current account deficit will increase dependence on foreign debt. When international investors lose confidence in borrowers, stop borrowing or by preventing the extension of the repayment time, leading to a debt crisis.
In order to recover from the financial crisis caused by the "other oil shocks", developed Western countries have led a series of policies and measures that raised the level of indebtedness of developing countries (Fig 1.). Since the seventies, developed countries, including the United States, practicing trade protectionism, which increases the trade deficit of the developing countries, which results in a reduction of their ability to repay debt.

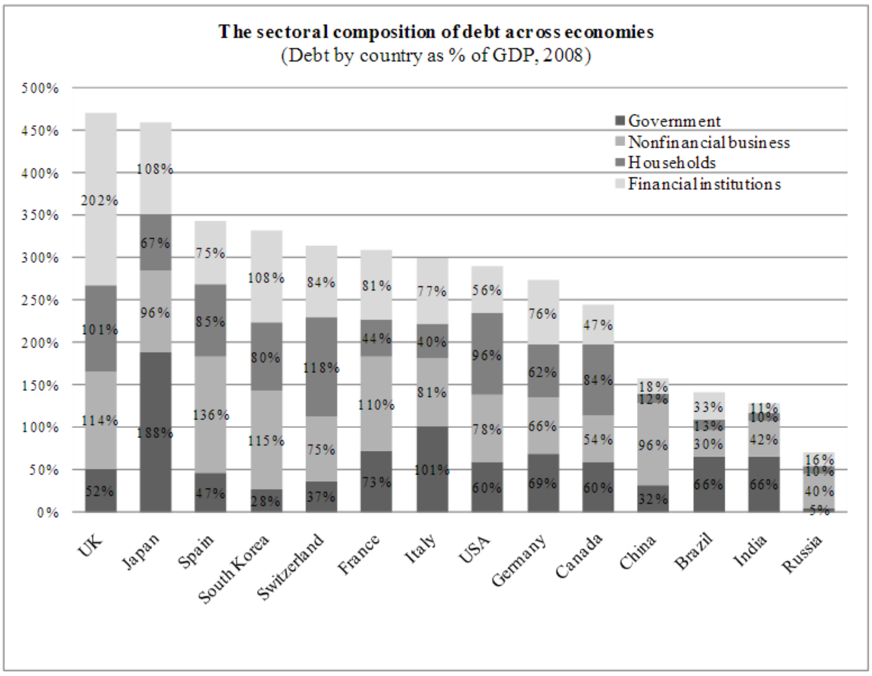

Figure 1. The structure of debt for several countries as of 2008, as % of GDP. (Source: McKinsey (2010) report).

MATERIAL AND METHODS

Proposals to solve the problem sustainability of public debt

In order to improve the system and policy of avoiding further debt crises in developing countries sporadically matter becomes a question of debt financing from reliable sources stemming the development of the financial infrastructure of the country. To achieve this aim, it is possible to define four basic relevant elements, namely: (a) the level of the country, (b) the bilateral level, (c) the regional level, and (d) at the global level [12].
Another factor that should be considered is the creation, promotion and / or the prosperity of the domestic market of government bonds and required financial derivatives, which are required to manage risk. It is important, as far as possible, avoid short-term loans and focus on providing relief to long-term investments. As for short-term debt, it is important to invest in effective monitoring and auditing of capital flows.
Unacceptable option is investing in short-term speculative capital. This can be prevented by changing the tax system. The key issue here is the creation of protection from foreign unforeseen actions. This

can be done so as to monitor the situation with the main currency and portfolio management of foreign exchange reserves, which requires an appropriate level of foreign exchange reserves.
The government should find a solution that, as often as possible, implement unscheduled repayment of the loan in order to avoid excessively high costs and interest, as well as the distribution of the existing high cost of debt, this should be done only if these actions show the impact on the rate of maturity of the debt. If foreign aid is available, it is possible to use this to advance the economy and reduce the cost of capital. All this means that we should establish systems that can contribute to warnings about unsafe jobs in advance, as well as systems analysis of sustainability in order to achieve a tolerable debt burden. In this context, of the utmost importance to monitor all elements of several sectors, such as the potential public obligations, external and internal, as well as public and private sector. This results in a more efficient institutional structure for precisely and accurately provide information. This means that the country's economy must become transparent and adapted to international standards, as far as possible. In addition, a good debt management includes minimization and reduction of credit, and the effective handling of loans.
In this area, it is important to use concessional resources, including grants under development in emerging economies, especially those of the least developed countries and regions that are depending oninternational exchange.
In addition, a very important issue becomes the ability of developing countries to manage the process of rejection of consequences of natural disasters, in which the most important are the following two.

RESULTS AND DISCUSSION

Fiscal and monetary pressures after natural disasters

Natural disasters can be a major problem for public finances and debt sustainability. When a natural disaster occurs, public finances suffer a double blow: (a) is reduced economic activity; (B) reduce the current and future tax revenue. At the same time, expand government expenditure for the financing of emergency humanitarian assistance and initial reconstruction. Although the size of the fiscal effects varieswhen it comes to different statistical methods and types of natural disasters, the impact of extreme events on the budget is usually significant [6].
It is estimated that natural disasters in the high and middle-income countries, between 1975 and 2008, the average impact on the increase in public expenditure by about 15%, and the reduction of public revenues by about 10% [7], which resulted in a combined increase budget deficit of about 25% [10]. On the other hand, one should not ignore the fact that under today's fiscal constraints, it is possible to increase government spending in order to stimulate consumption.
The economies with significant public debt often face a higher cost of new borrowing, which is a significant burden for taxpayers and further reduce long-term growth. According to estimates, major natural disasters have reduced government revenues by around 3% of GDP and increased the outstanding debts of over 8% of GDP [8]. Proof of this are the consequences of the Arab countries that are major natural disasters within just three years, contributed to the increase in the public debt to GDP by as much as 6.5 percentage points.
Generally speaking, the net fiscal impact largely depends on the degree of absorption of losses by the insurance sector. In fact, over the past two decades, only 20% to 40% of economic losses from natural disasters were covered by insurance, while the remaining 60% to 80% "parachute" at the expense of taxpayers [11]. This could be interpreted in such a way that there is a significant risk of unsustainable fiscal pressures on governments, especially in cases of frequent and deadly climate disturbances.
This trend requires the transfer of most of the costs of natural disasters in the private sector, through insurance and other mechanisms of financing risk. After all, such a statement is made and the UN Secretary-General Ban Ki-moon, who is in the report for 2013 on the risks of natural disasters, said that "the economic losses from natural disasters out of control and can be reduced only in partnership with the private sector ".

CONCLUSION

Risk Management of Natural Disasters (Disaster Risk Management: DRM) has been tested methodological framework developed around the world, implemented by international institutions, including the World Bank, the G20 and the Organisation for Economic Cooperation and Development (OECD), and include: Risk Management of Natural Disasters (Disaster Risk Management: DRM) has been tested methodological framework developed around the world, implemented by international institutions, including the World Bank, the G20 and the Organisation for Economic Cooperation and Development (OECD), includes [3]:

1. Risk assessment;
2. Financial management;
3. Reducing the risks.

DRM involves the identification, assessment and taking measures towards reducing the risks associated with natural disasters, in order to maximize the resistance of the country on these natural phenomena. In this sense, a good strategy DRM allows policy makers to reduce macro-economic losses caused by natural disasters.

Efficient management of the consequences of natural disasters begins with an assessment of risk, a fact that more and more respected decision makers around the world. Not only that, the point is that the insurers should play a central role in identifying and assessing the risks of natural disasters. Historically, this function is largely dominant in the domains of geologists, climatologists, seismologists and other scientific fields. However, despite the fact that their contribution to the understanding of natural hazards beyond doubt, their views and analytical methods belong to the natural sciences and can hardly contribute to the understanding of the complexity of this issue.

On the other hand, insurers use actuarial and stochastic modeling in the direction of the assessment of probability of specific natural disasters and quantify the extent of the potential economic impact, in order to create a detailed catalogue of the assets and business activities exposed to various types of natural hazards.

In this sense, insurers play a key role in the identification and assessment of risks from natural disasters. In order to raise the level of efficiency in risk assessment is necessary to integrate the two perspectives, therefore, combine the scientific understanding of any risk associated with the quantification of physical and monetary influence [1].

After getting to know the risk and its quantification, the next step is the establishment of mechanisms and plans to actively manage the expected financial flows. Transfer risk refers to the distribution of disaster risk best positioned players in terms of their capacity to manage the consequences resulting from risk events. As a general rule, adopted the view that government intervention is justified only when the private sector fails to provide services in the direction of eliminating the consequences. Nevertheless, this view becomes very questionable in the case of risk management of natural disasters, because the private insurance sector has the capacity and expertise to provide the necessary financial protection. Insurance can transfer the risk of natural disasters with taxpayers on global capital markets and reinsurance cheaper and more efficient, because they have access to international capital markets diversification of therisk in different geographical destinations and stakeholders.

Accordingly, the insurersare motivated to achieve higher efficiency, because insurance companies, unlike government, have experts who can set the amount of compensation losses. This expertise can limit the costs of time and transactions in connection with the reconstruction and recovery after natural disasters.

Nevertheless, the government continues to play a significant role in establishing the institutional framework necessary for the good functioning of the insurance market [2], especially effective regulatory regime. In some cases, such as the management of extreme wax risk of natural disasters, this may include the introduction of state or national fund reinsurance. Also, governments can take measures aimed at meeting the needs of people with low incomes, as well as some form of subsidizing essential insurance in high-risk regions, thus providing basic financial benefits.

In the absence of an adequate risk transfer to the private insurance market, governments are left with a kind of self-assurance in the context of preparing for natural disasters. However, despite the fact that it really involves a pre-financing or setting up contingent liabilities, this kind of self-insurance is quite inefficient, as it involves the usof dwindling public funds.

Private insurance, through mechanisms such as reinsurance and the issuing of bonds for the elimination of consequences of natural disasters, may be represented at the level of local communities, while the self-insurance leaves the full cost of the damage at the expense of taxpayers, which implies the conclusion of slowing growth and slow recovery. In this context, economic and business recovery is possible only in cases where the authorities have the capacity to invest in the reconstruction, or where they have effective financial measures to mitigate the effects of the occurrence of risk events, IE, they are able to cover most of the risk of unforeseen events.The conclusion is that, in addition to providing more effective aid in the transfer of risk and its funds, private insurance often provides customers with the reimbursement of actual losses. In contrast, government assistance in eliminating the consequences of natural disasters, often limited to basic needs or one-time fee, which includes inadequate compensation for losses incurred. The case of Serbia in 2014, but also in earlier periods.

The need to reduce risk is obvious, and it is becoming increasingly important in the context of climate change. Unstable fluctuations in climate and weather trends introduced an element of uncertainty in the financial risk management of natural disasters. Market risk and its financing in accordance with solutions that are developed today, can become obsolete in less than a decade, if the frequency and severity of baseline risk significantly change. In this context, an imperative of the requirements for adequate amendments in the risk management process and before and after natural disasters, to mitigate and adapt to the necessary measures.

In this process of public education plays a key role. The OECD concludes that public awareness of the risks of natural disasters is insufficient due to the low level of education, and that education is the basis and precondition for effective risk management strategy from natural disasters at national and regional level [9].

Other effective methods include changing consumer behaviour, the implementation of early warning systems, investing in new technologies resilient public infrastructure. Although the quantification of these effects is quite problematic, it is clear that the reduction in risk and investment returns significantly, especially when connected with insurance [4].

In the US, for example, it is estimated that every dollar spent to mitigate the effects of flooding impact on reducing future costs by as much as 4 USD. Similarly, models of insurance losses caused by the action of hurricanes in the US States, recognized the possibility of mitigation-reducing losses and up to 61% [5].

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GAGE REPEATABILITY AND REPRODUCIBILITY STUDY WITHIN THE CONCEPT OF SIX SIGMA

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Abstract: The main goal of the companies in today's world is to achieve a high profit, meaning they have to focus on the two most important issues – business effectiveness and efficiency. Six sigma represents a strategy that has been widely adopted in the world due to the reason it successfully fulfills this issues. This paper briefly discuss main concept of six sigma strategy and its methodologies with the focus on the measurement systems analysis as an important tool for assessing the validity of a measurement system. Within this analysis, gage repeatability and reproducibility study has been represented. The ANOVA and Xbar & R chart methods are briefly shown with their implementation in the Minitab software.
Key words: six sigma, measurement systems, analysis, repeatability, reproducibility, Minitab

INTRODUCTION

Six sigma is a statistical concept that measures a process in terms of defects. Achieving six sigma level of business means that processes are delivering only 3.4 defects per million opportunities (DPMO)—in other words, they are working nearly perfectly. Sigma (the Greek letter σ) is a term in statistics that measures something called standard deviation. In its business use, it indicates defects in the outputs of a process, and helps to understand how far the process deviates from perfection. [1]
The Six sigma methodology is a concept of quality management control and philosophy that is focused on the following aspects: [2]

- Improving customer satisfaction,
- Reducing quality costs and increasing company's profit,
- Information and facts during decision-making process,
- Reducing number of defects on products and services,
- Reducing process dispersion.

In order to meet these objectives the "six sigma" methodology requires full commitment of company's management on process improvement, focus on customers, the philosophy of perfection and the use of measurements instead of opinions. In statistical terms, the basic objectives of this methodology are the elimination of defects and minimization of process variation.
Two of the most widely spread "Six sigma" methodologies in the world are DMAIC and DMADV. DMAIC methodology is most applicable to the manufacturing or production side of a product or service, whereas DMADV methodology has found its role in examining and improving the customer relations side of a company.
Each methodology has its own set of guidelines and goals targeted at improving business processes through the use of data collection and statistical tools. While the methodologies are designed to achieve the same thing, there are noteworthy differences between the two that should be considered by professionals in leadership roles or in business environments with a wide range of organizational settings. [3]
The second stage within the represented "Six Sigma" methodologies is the measurement stage. This stage is responsible for forming measurement values and measurement systems according to process inputs and outputs. Also, it provides the collection of real and accurate data from the right place. If these data are inaccurate, bad decisions and conclusions will be made in the following stages of the methodology and, therefore, the proper completion of the measurement stage is of great importance for further work.

The subject of this paper is focused on the measurement system analysis as an important element of measurement stage of "Six Sigma" methodologies. The emphasis is put on the gage reproducibility and repeatability study which represents a statistical tool for efficient analysis of the amount of variation and measurement error of operator and measurement system. Also, the insight into gage R&R study in the Minitab software is given. The last chapter is the conclusion of the paper.

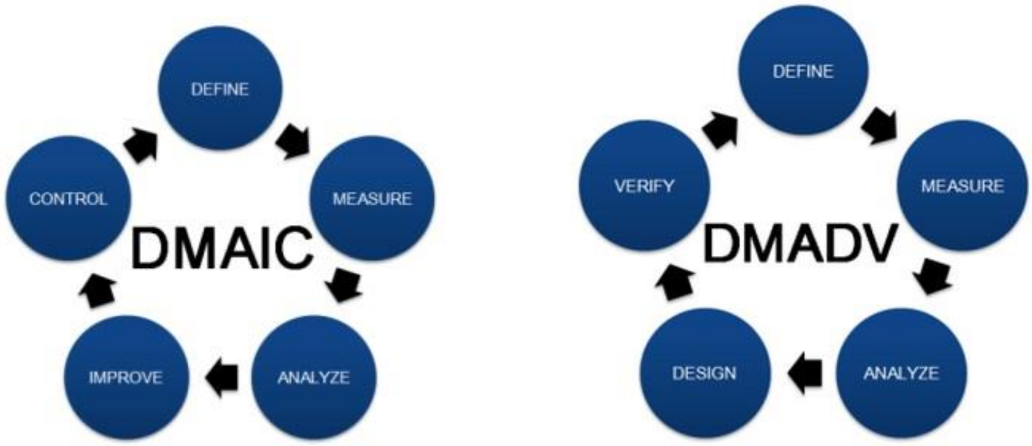

Figure 1. The stages of DMAIC and DMADV methodologies [3]

MEASUREMENT SYSTEM ANALYSIS

All measurement systems have error. The error may be so small as to be irrelevant or it may be so large that the data cannot be trusted. Regardless, they all have error. This means that if operators want to choose a gage they can trust, they need to understand the extent of this error, and this can be achieved through Measurement System Analysis [4].

Measurement system analysis (MSA) uses scientific tools to determine the amount of variation contributed by the measurement system. It is an objective method to assess the validity of a measurement system and minimize the factors contributing to process variation that is actual stemming from the measurement system [5].

Measurement System Analysis is a set of techniques that allow operators to assess how much error is being introduced by the measurement system. Once they understand the extent of this measurement error, they can give answers to questions like the following [4,5,6]:

- Out of the two gages, which one should be used on the current process?
- Is the measurement error low enough to make this gage useful for classifying product as within specification, or out of specification?
- Can operator be confident that this gage is correctly identifying scrap product?
- If operator wants to improve his process is this gage good enough to help him identify if he has improved the process?
- Is this gage good enough to enable operator to run a successful Statistical Process Control program on his process?
- What is causing the gage error, and how can operator reduce the amount of error?

The structure of the MSA analysis is given in the Figure 2. Starting point is the understanding the measurement error by the metrologist or relevant operators that are involved in the measurement process [4,5].

Two basic terms used for determining measurement error are the standard deviation and the mean value. Figure 3 represents the graph of normal distribution which shows all of these values. Normal distribution with the mean value equal zero and deviation equal one is marked with the green curve. Mean value represents the central point of distribution that defines the position of measurement error and is defined with Greek letter μ, whereas the standard deviation is used for describing the range of distribution, or the range of measured values and is defined with the letter σ [4,5,7].

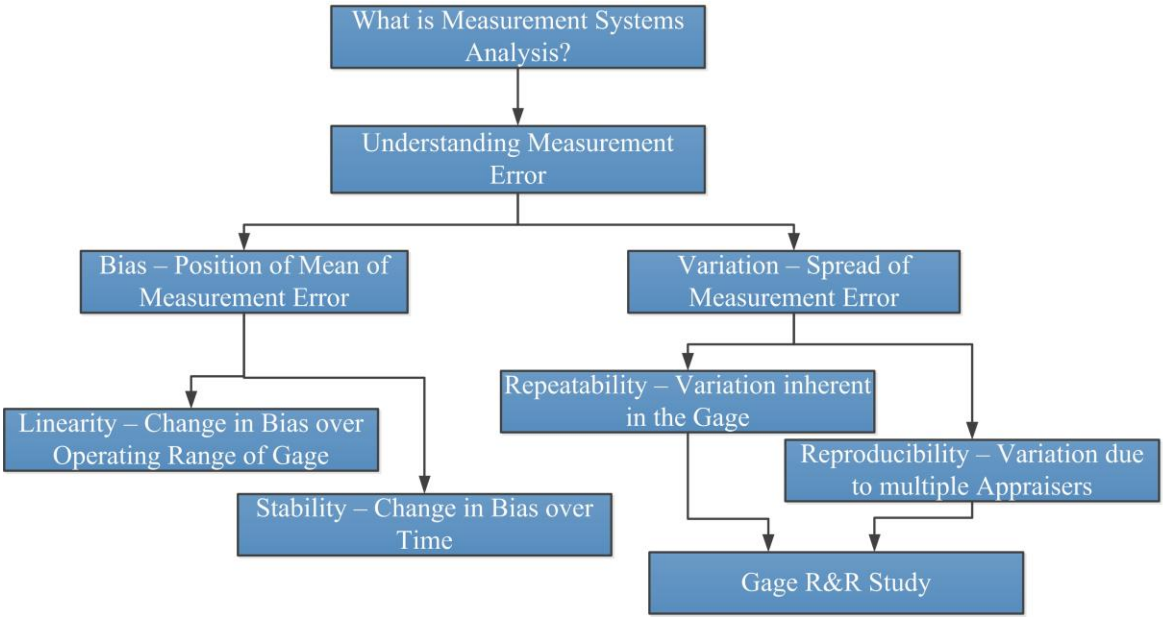

Figure 2. Structure of Measurement Systems Analysis [4]

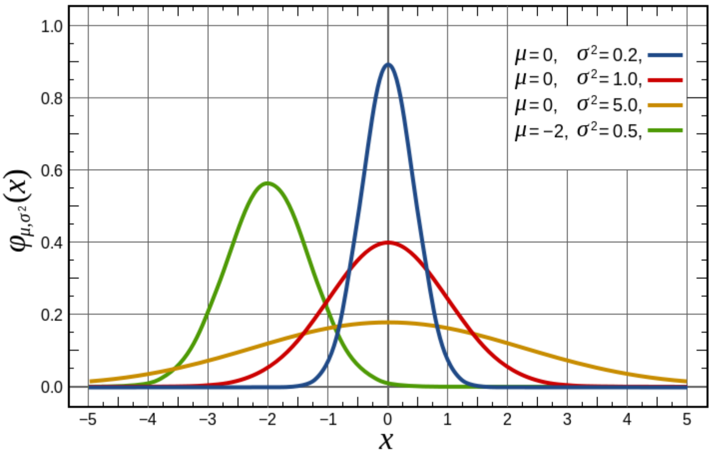

Figure 3. Probability of normal distribution with different parameters [8]

As Figure 3 indicates, operators are able to calculate bias, stability and linearity of the measurement system with the mean value μ. On the other side, with the standard deviation σ they can calculate repeatability and reproducibility – in short, to conduct Gage R&R study. The following chapter will provide some insights into this measurement study.

GAGE R&R STUDY

Gage Repeatability & Reproducibility Study is a statistical tool used for measuring the amount of variation in the measurement system that arise from the measuring instrument (gage) and the operator (appraiser) who performs the measurement. This study contains two components that are given in the following form (1) [6]:

1. Repeatability – Variation in measurements obtained with one measuring instrument when used several times by an operator (appraiser) while measuring the identical characteristic on the same part;
2. Reproducibility – Variation in the average of the measurements made by different operators (appraisers) using the same gage when measuring a characteristic on one part;

$$\sigma^2_{overall\ GRR} = \sigma^2_{repeatablility} + \sigma^2_{reproducibility} \quad (1)$$

Quality professionals know that measuring manufactured products is critical to maintaining the customer specification. They also know that measuring products is necessary for statistical process control systems designed to improve the manufacturing process itself. What is sometimes forgotten is that the data is only worthwhile if the measurement system itself is adequate. A gage R&R study tells operators if the measurement system is acceptable for its intended use and also shows which part of the measurement system is contributing the most to the variation of the measurements and helps operators plan improvements to the system. Three main sources of variation in the measurement system are the products themselves, the operator (appraiser) that takes the measurements, and the equipment used to perform the measurement (instruments, gages) [6,9].

GAGE R&R STUDY WITHIN THE MINITAB SOFTWARE

Many professionals involved in the six sigma projects are faced with great efforts and therefore stick to the simpler and faster access to statistical methods. Many references, such as [10,11], include the implementation of statistical methods for improving quality with the support of easy to use softwares. This chapter briefly represents the analysis of gage R&R study within the Minitab version 16.

Minitab is undoubtedly the software that deals with statistical problems in a very simple way. It was developed by professor at the University of Pennsylvania in 1972 and is widely used in the fields of mathematics, statistics, economics, sport and engineering. Minitab is great software primarily because of its simplicity for beginners and a wide range of tools for detailed analysis. Whether it is about calculation of mean values or analysis of research at universities, Minitab aids in solving monotonous statistical tasks.

Minitab software offers several studies that allow users to determine the variations stemming from the measurement system. There are three measurement studies within the Minitab 16 [12]:

- Gage R&R (Crossed) – This study is applied when the same parts are used across the entire study. That is every operator measures the same parts. In experimental design language, this is a two-factor factorial design with both factors are random effect factors (operators and parts are factors).
- Gage R&R (Nested) – This study is applied in the cases where one part can only be measured once. Once it is used, it can no longer be used. In this case, parts are nested within operator. Each operator measures different sets of parts. It is important to choose the parts (the experimental units) as homogeneous as possible, so that the variability due to operator reflects the uncertainty of operators not because of the different parts being used by different operators.
- Gage R&R (Expanded) – This study applies in the cases when the user is provided with “unbalanced” data. For example, due to the loss of some measurement results this “expanded” study enables the analysis of the measurement system without manual calculation of lost data. The older versions of Minitab do not have this study.

Minitab software offers two methods for assessing repeatability and reproducibility of measurements, and they are Xbar & R control charts and ANOVA (Analysis of Variance) method.

Xbar & R control chart method is consisted of two control charts. One chart represents the mean value (Xbar) which considers changes in the mean value of measurement process, while on the other side R chart (R=range) shows the changes in process dispersion. This method for R&R study is primarily useful due to the reason that changes are shown at the same time which makes it very efficient method for checking process irregularities.

The ANOVA method is considered to be much more accurate than the previous one [6,12]. The reason is that the ANOVA takes into account the interaction between operators and parts. Minitab 16 provides options for selecting different analysis of variance, such as ANOVA as the default method, then MANOVA (Multivariate Analysis of Variance), ANOM (Analysis of Means), as well as specialized charts for testing equal variations, bar charts, confidence intervals and graphs for main effects and interactions.

Figure 4 shows the overall variation in the measurement process. Xbar & R method divides the overall variation in three categories: part-to-part variation, repeatability and reproducibility, whereas the ANOVA method additionally divides reproducibility into operator and operator-by-part interaction.

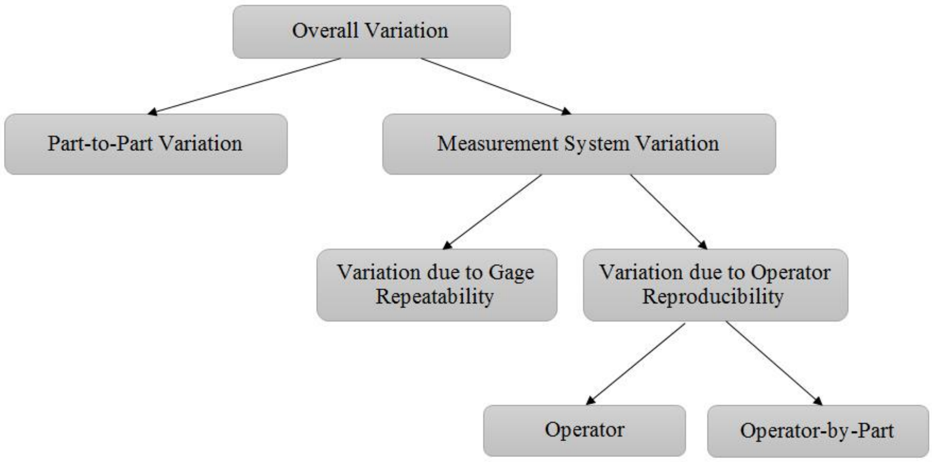

Figure 4. Components of overall variation within the Gage R&R study [12]

Minitab provides users with graphical and numerical measurement results. Here, only the ANOVA graphical representation of results will be shown. It is given in Figure 5.

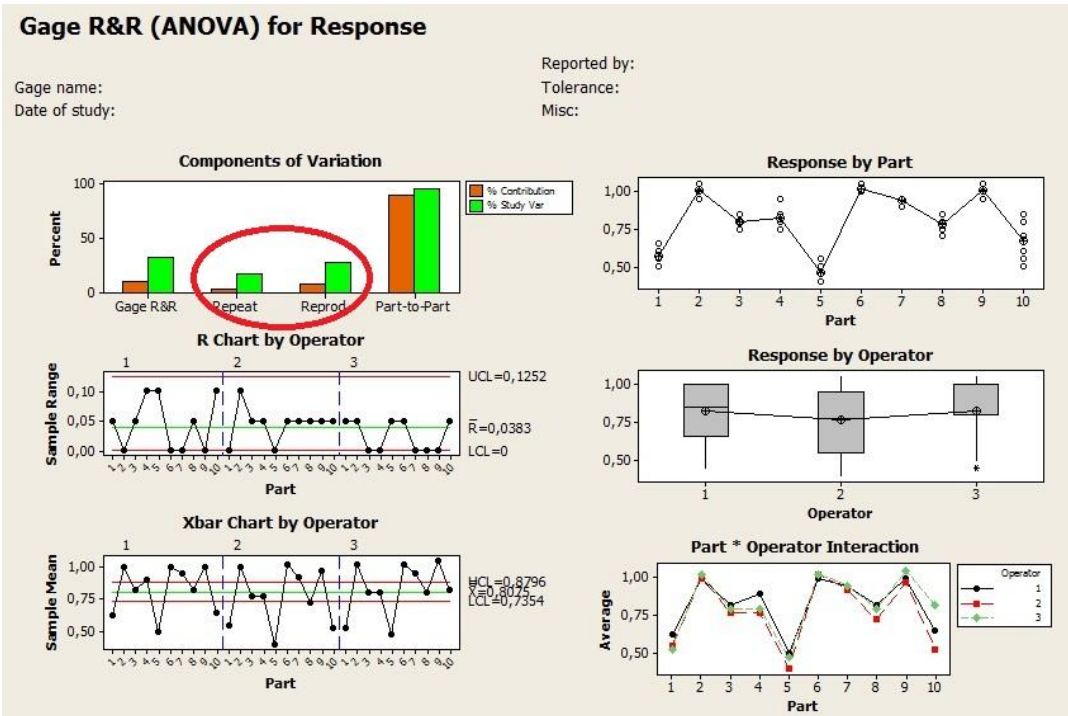

Figure 5. Graphical representation of ANOVA method for Gage R&R crossed study [12]

Six different graphs have the following meaning:

- Components of variation – histogram that shows the sources of variation and their contribution to the overall measurement variation;
- R control chart – shows that the measurement data for each part is under control.
- Xbar control chart – shows the mean value for each operator which indicates that the part to part variation is almost as great as the repeatability variation.
- Response by Part – shows all measurement data for each part;

- Response by Operator – shows all measurement data for each operator;
- Part*Operator interaction – shows the mean value of all measurements for each operator arranged by parts.

CONCLUSION

Adopting Six sigma strategy completely revolutionizes business organization and culture, offering the chance for optimal success. This strategy also represents a modern approach to improving processes and products through the use of statistical methods with the purpose of leaving a stunning impression on customers and users. With proper implementation, results are magnificent and Six sigma becomes a continuous activity of process improvement and cost reduction within the company.

As a part of five-stage Six sigma methodology, the measurement systems analysis represents a crucial point in this paper. Basic concepts are given with the focus on gage repeatability and reproducibility study. Minitab as a leading provider of software and services for improving quality and statistical education is successfully implemented in many well-known companies around the world.

Minitab version 16 uses analytical and graphical representations to show the contribution of operator and measurement system's variation in the overall measurement process. ANOVA and Xbar & R chart methods are some of the efficient methods for representing these measurement irregularities.

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3D MODELING OF CASTING TOOL USING SOFTWARE PACKAGE SOLIDWORKS

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Abstract: This paper shows the necessity of application of computer modeling for design and modeling of casting tools intended for special casting processes for more efficient and faster production and better quality of barricade columns cast. Solidworks 2013 package 3D modeling software tools were used for this purpose.
Key words: computer-modeling, casting, barricade pole, technical documentation

INTRODUCTION

Modern production in foundries is based on carefully drawn casting technology. Thus, technological development drawings for making casting tools can be considered as the first and most important phase in the cycle of production of castings.
In the construction of the cast is necessary to ensure that the casting technology in production provide the minimum expenditure of labor and materials and allows a maximum mechanized and automated production. That constructor of casting tools could decide on the method of molding, material models, and construction of the core, has to have data how many castings need to cast, the casting tolerance that should meet, where it will be placed etc. [1,2]
Using CAD software we perform the mechanical design and automation processes that are based on parametric modeling of full body. The program allows to convert basic 2D sketch into a full body model with simple but highly effective tools for modeling. This program prepares technical drawings of elements and systems.
Usage of CAD software contributes to a better design, complex parts are faster designed with the help of software that allows the user a visual representation of work and dimensions using CAD.
CAD software programs can provide compatibility of all components and their check and allows you at any time to add another part, which is impossible to achieve without modern software tools such as SolidWorks. One of the advantages of SolidWorks 2013 software package is that the techniques work sorted by the so-called "Module cards", identical to today's Microsoft solutions, which significantly facilitates the work and means that crossing by from module to module is not necessary. [3,4]
Further study shows modeling of casting barricade column (on the basis of cast, the construction of molds is made with all related aspects and conditions which one casting tool has to have). Then is shown the technical documentation - technical drawing of barricade column cast, as well as analysis of material consumption.

CAST MODELING

Before selection of software tools which will carrie out modeling, it is necessary to define the geometric structure - Design Intent components for which we form a 3D model.

Example - barricade column casting - Desing Intent: casting is axisymetrical shape and consists of a certain number of segments that can be created with one software tool "Revolve Boss / Base " semi-sectional rotation of given casting defined in one sketch, or by forming successive segments of software tools "Extrude Boss / Base" from the respective drafts.
Finalization of 3D models, such as the development of curvature of the edges on the right location, is done by the so-called "Pick & Place" programming tools "Fillet" and "chamfer".
The first step represents a defining closed sketches in the selected level (Top Plane), ie. shape and dimensions of a given semi-sectional cast (Figure 1) as the basis for the implementation of "Revolve

Boss / Base" software tool (Figure 2), which will form the basis of the model casting executive body, rotation of defined sketch around the axis of rotation, for the angle of 360 °.

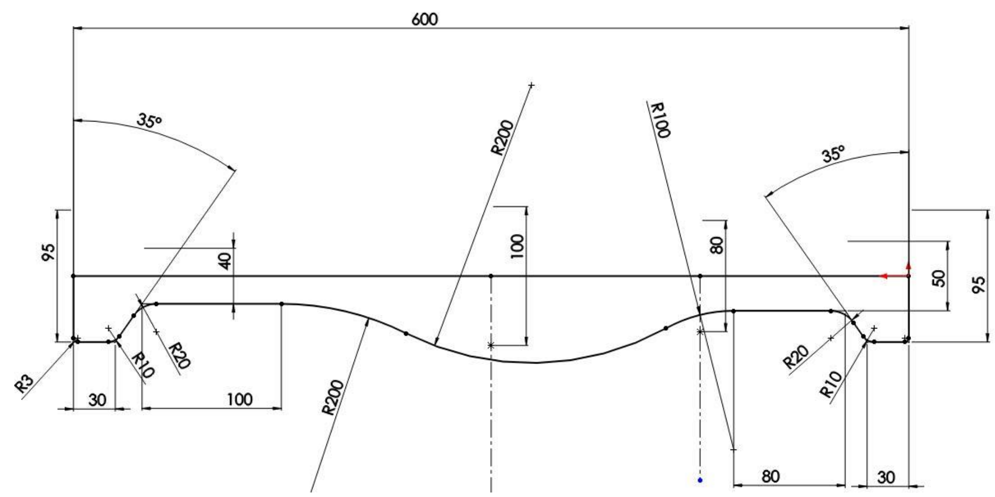


Figure 1. Formed sketch of semi-sectional casting [6]

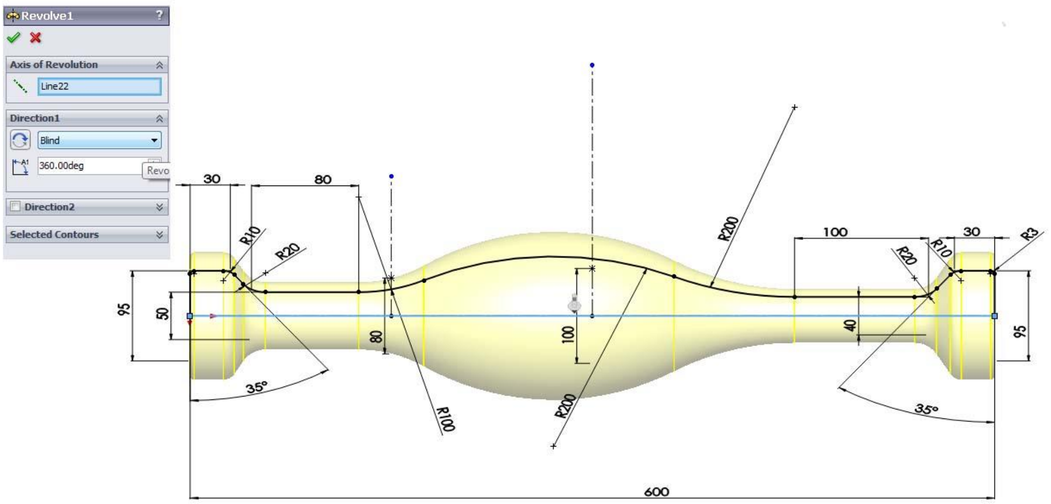


Figure 2. The basic form of the cast [6]

Module card for defining the sketch has a large number of software tools to facilitate the definition of the individual segments of the same sketches, such as Line, Rectangle, Circle, Ellipse, Slot, Spline, Fillet Sketch, Sketch Chamfer, then Dimension and Relations to define the dimensions and relations of 2D sketch entities.In the same tab, there are also software tools for copying, deleting, cutting, extension, diagnosis, and Mirror, Pattern, Trim, Extend, Repair. (Figure 3).

Figure 3. Layout of module cards with basic software tools for defining sketches

We must pay attention to material shrinking during the cooling of the cast,and therefore we need to increase the model with software tool "Scale". Barricade column is made of aluminum alloy AlCu and his shrinking we will express in percentages. Shrinking of aluminum alloy is 1.25%.

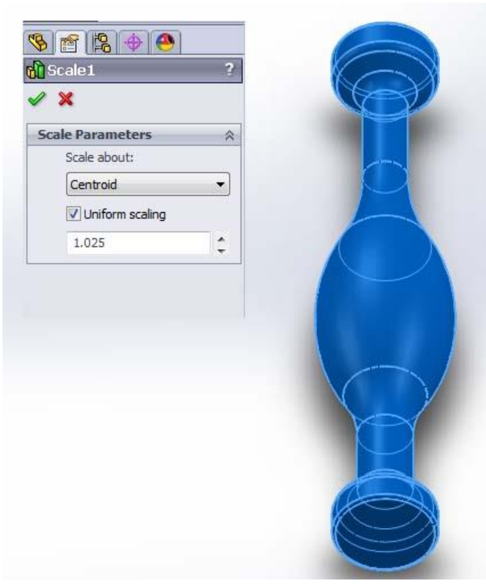


Figure 4. Model increase in percentage [6]

MODELING OF BARRICADE COLUMN

The construction of the finished work is based on the core and face cast, after we've done modeling core with stamps and face casting, we can form a finished part – barricade column. Creating barricade column along,, Top-Plane "is performed by importing predefined model,, core with stamps and face casting " with software tool " Insert Part ".

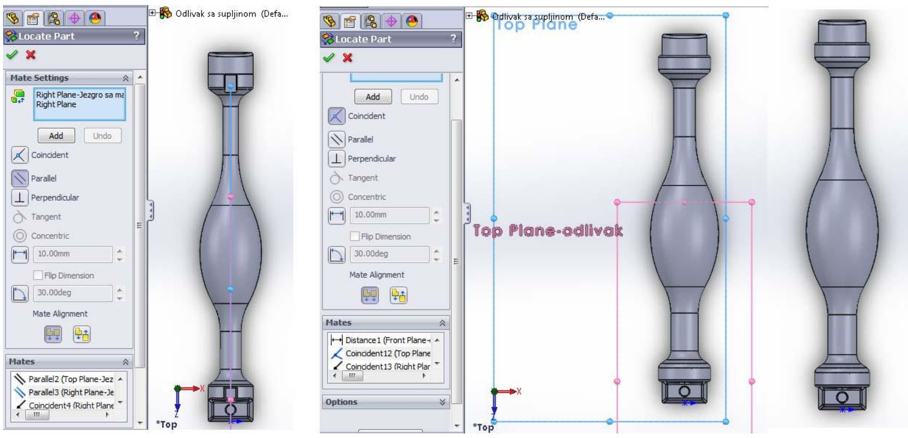


Figure 5. Positioning of the core and cast in the new part with software tool,, Insert-Part " [6]

It is necessary to lock all "External" connections - with a reference model Barricade column, in order to avoid changes in positioning,by changing the desired configuration of the same model .(Figure 6)

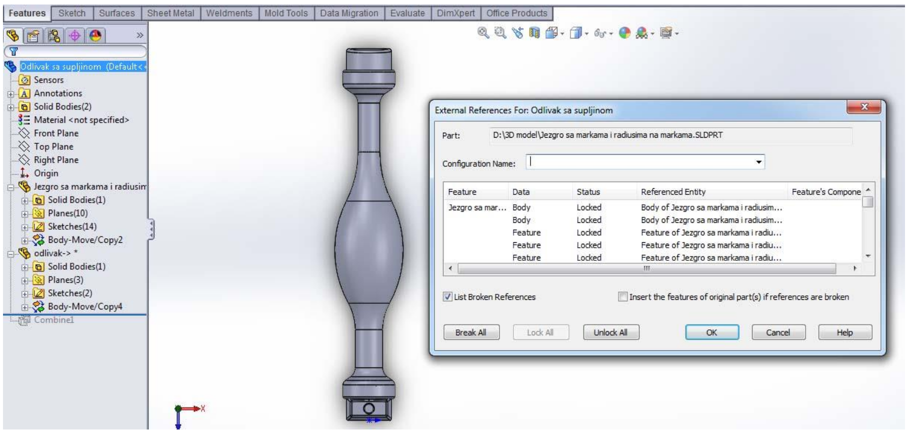


Figure 6. "External" references Interruption in relation to the basic model [6]

Below is a Boolean operations over the bodies with the following command,, Combine ". It is clear that the body must overlap. Under the command,, Combine-Subtract ", it is necessary to select a body over which we need to execute Boolean operations (select on the model or structural tree) (Figure 7)

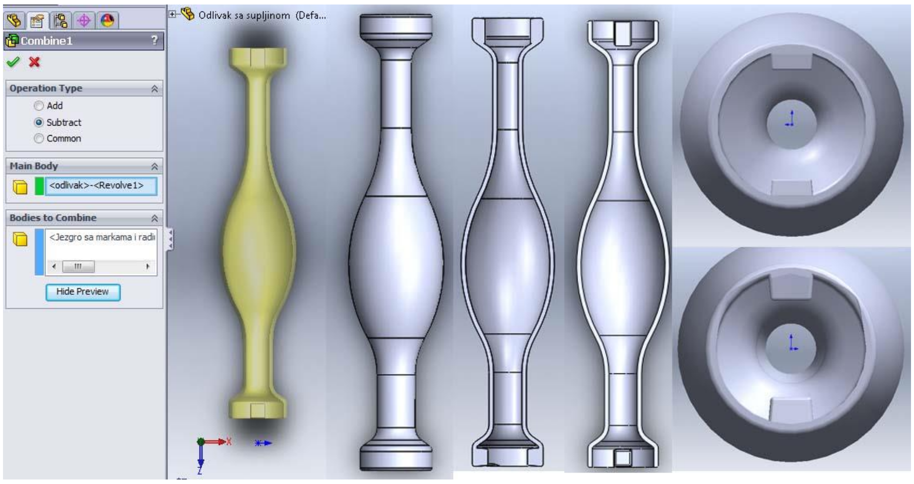


Figure 7. Forming barricade column using the "Combine-Subtract" [6]

Figure 8. Photorealistic image of barricade column [6]

TECHNICAL DOCUMENTATION WITH CONSUMPTION ANALYSIS

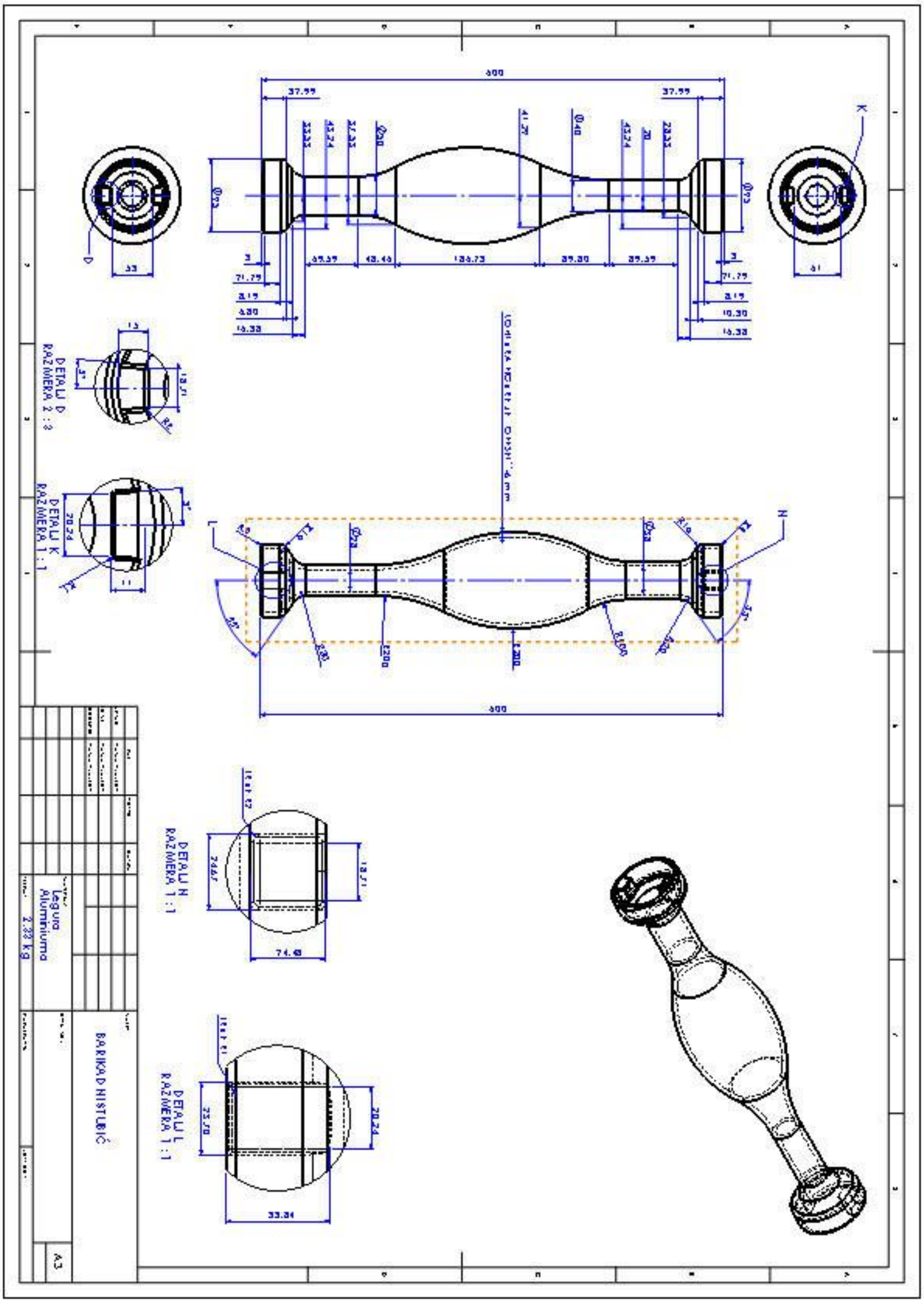
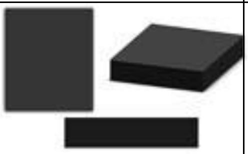
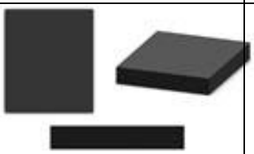
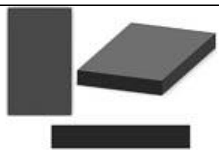


Figure 9. Technical drawing barricade collumn [6]

Analysis of material consumption

Construction of each tool includes, among other things, a specific bill of materials which is essential for its development Given the calculation must be analyzed in detail, to access tools construction more efficiently and with lower costs. When analyzing the necessary materials must be considered various factors that can affect the increase or decrease in the amount of material used, its purchase price as the cost of procurement of certain materials.

Table 1. Characteristics of mass tools from barricade columns [6]

Tools	Pre machining tool	Mass Properties prior to machining	Tool after machining operations	Mass Properties after machining	Pieces
Fixed half jezgrenika		$\rho = 7200\ kg * m^3$ $m = 203{,}040\ kg$ $V = 0{,}028\ m^3$ $P = 0{,}637\ m^2$		$\rho = 7200\ kg * m^3$ $m = 106{,}15\ kg$ $V = 0{,}01 m^3$ $P = 0{,}61\ m^2$	1
Movable half jezgrenika		$\rho = 7200\ kg * m^3$ $m = 94{,}75\ kg$ $V = 0{,}01\ m^3$ $P = 0{,}50\ m^2$		$\rho = 7200\ kg * m^3$ $m = 75{,}92\ kg$ $V = 0{,}01\ m^3$ $P = 0{,}55\ m^2$	1
Fixed half of the model		$\rho = 7200\ kg * m^3$ $m = 193{,}23\ kg$ $V = 0{,}03\ m^3$ $P = 0{,}80\ m^2$		$\rho = 7200\ kg * m^3$ $m = 175{,}901\ kg$ $V = 0{,}024\ m^3$ $P = 0{,}867\ m^2$	1
Movable half of the model		$\rho = 7200\ kg * m^3$ $m = 150{,}29\ kg$ $V = 0{,}02\ m^3$ $P = 0{,}75\ m^2$		$\rho = 7200\ kg * m^3$ $m = 134{,}14\ kg$ $V = 0{,}02\ m^3$ $P = 0{,}81\ m^2$	1

CONCLUSION

Nowadays there are many software packages, which enable us to facilitate design tools, simulation systems that help us in the construction of the casting system by using them we can simulate the casting ingot-casting molds. The paper presents the basic rules of CAD modeling where we pay special attention during the design phase of the cast. Although it seems that the casting technology is very simple, the rules require that we should be careful to take into account every step in the design process. It is not enough to melt material and pour it into a mold and thereafter realize that a number of errors appeared. Particular care should be taken about the construction of the cast. Construction of the cast must be such that with a minimum of effort we can make the casting, which will be made with cheaper funding and constructing a process, and that will eventually meet exploitative working conditions which are necessary.

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QUANTITATIVE METHODS FOR MATERIAL SELECTION-MATERIAL PROPERTIES CHART

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Abstract: This paper presents the selection of optimal materials for the production of basic constituent elements of electric iron: housing, heater and warming plate using material properties chart (map) quantitative method and Cambridge Engineering Selection software (CES). This work is a continuation and expansion of research [1]. The results were compared with results from the paper [1] in which selection of mentioned constituent elements of electric iron materials was done using two quantitative methods: the method of properties influence (digital-logic method) and the method of minimum deviation of actual properties compared to required (algebraic approach).
Key words: quantitative methods, material selection, material properties chart (map), CES software

INTRODUCTION

In the modern world there is more and more attention focused on the procedures for selecting the material from which a certain part will be made. Therefore, there is the obligation of engineers to properly decide which material, from a range of possible, is optimal for use, Fig.1. [2]. In addition to materials for producing a particular product requires skills, knowledge and experience of the people, as well as methods of constructing and more or less complex methods of production [2]. The number, variety and quantities of materials are increasing-from massive amounts of a small number of species to the current very large amount of a combination of many types. Today it is estimated that there are more than 70 000 types of technical materials [3], among whom more than 40 000 alloys based on metals [4]. The basic purpose of the quantitative methods application is as much of objectivity in the selection of materials [5].

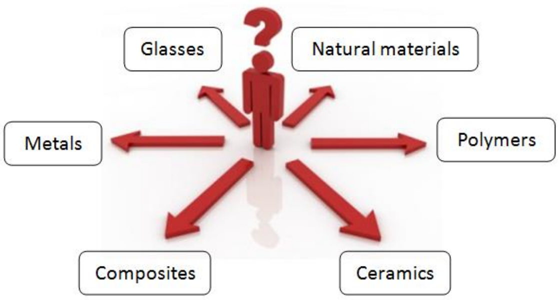

Figure 1. Selection of the appropriate material-downloaded and modified from [6]

The paper [1] describes the procedure of selection of optimal materials for the production of electric iron constituent elements: housing, heater and warming plate using quantitative methods for the materials selection: the method of properties influence (digital-logic method) and the method of minimum deviation of actual properties compared to required (algebraic approach). This paper and the results obtained were used as a basis for comparison with the results of the selection of optimal materials of the same constituent elements of electric iron obtained in this study using material properties chart (map) quantitative method and software Cambridge Engineering Selection (CES).

METHODS FOR MATERIAL SELECTION

Material properties chart (map)

In comparing the materials it is not often enough to take one property as a criterion of evaluation, but it is necessary to consider a combination of properties. Thus, for example, for parts which have to be lightweight and be rigid at the same time the density and modulus of elasticity should be evaluated, or for structures to secure from sudden expansion of cracks and fracture it is important at the same time high yield strength, but also high ductility and toughness. On the basis of this approach so-called "Properties chart" has been developed [2] where the diagram represents the framework regions of a number of properties of different material groups (Fig. 2). Assume that there are limitations in the process of design in terms of elastic modulus (e.g. E>10 GPa) and the density of the material (e.g. ρ <3000 kg/m^3), as shown in Fig. 2. Thereby, the materials should be selected in the window labeled "Search Region".

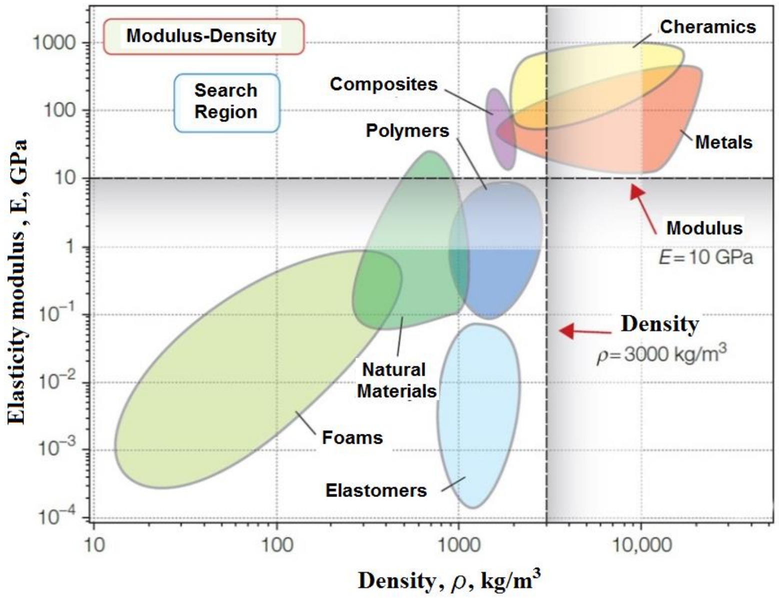

Figure 2. Material properties chart (modulus of elasticity-density) [2]

The closed line limits data for a group of materials, indicating a possible range of values regardless of the type of material. If the abscissa and ordinate are in logarithmic division, then the highest and lowest properties values can be displayed. In this way, it is easier to compare a group of materials, i.e. Framework material pre-selection. Diagrams feature gives the correlation between certain material properties.

Material selection of electric iron constitutive elements

The main criteria to be met by materials for electric iron constituent elements are shown in the table 1[1]:

Table 1. Criteria for material of housing, heater and warming plate

Housing	Heater	Warming plate
Low density	High specific thermal resistance	Good thermal conductivity
Low thermal conductivity	Low electrical resistance (excellent electrical conductivity)	Density
Low electrical conductivity	High temperature Providing	Corrosion resistance
Shaping	Oxidation resistance	Abrasion resistance
Fracture toughness	Spontaneous combustion resistance	Solubility
Hardness	Machinability	Machinability
Price	Price	Recyclability
		Price

Electric iron housing

Seven material properties were considered [1]: density, thermal conductivity, electrical conductivity, solubility, fracture toughness, hardness and price. Using CES Selector software, limitations for electric iron housing materials that can be considered are set. Lighter material with a density of 1100-1300 kg/m^3 with the maximum price of 3 €/kg is selected. Based on these properties, it is important that the fracture toughness is at least 4 MPa·m$^{1/2}$, the value of thermal conductivity is a maximum of 0.3 W/m^{0}C and that potential material is a good electrical insulator. Of course, the material must be machinability, so, it can be easily shaped by methods of injection molding, extrusion and the like, so that the required machinability is a minimum of 4. Based on the above, the CES software offers as a result of 5 different materials: acrylonitrile butadiene styrene (ABS), polyamide, polycarbonate, polyethylene terephthalate (PET) and polyvinyl chloride (PVC). If we take into account the hardness of the material, which is very important in this case, and limit the search to a minimum of 25 HV, we obtain the optimal material for the production of electric iron housing: polyamide, Fig. 3.

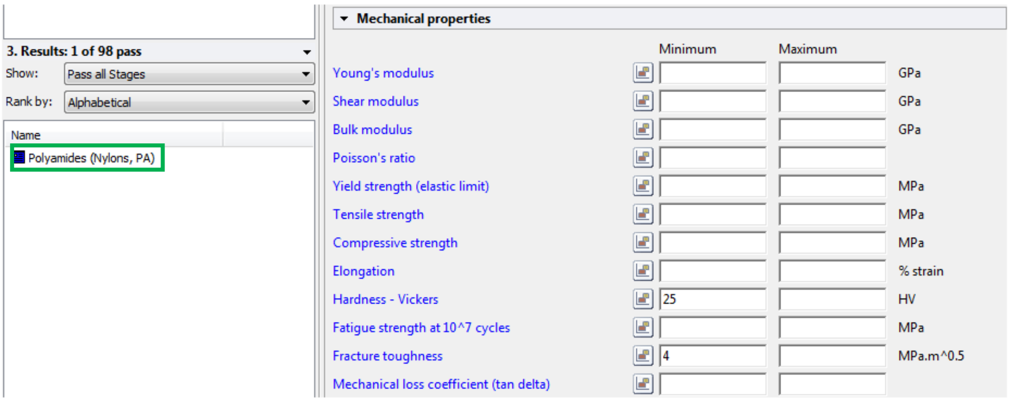

Figure 3. Optimal material for production of electric iron housing

Based on the given limits, the same result using the material property chart (map) is gotten (Fig. 4), where we can see that the optimal material, polyamide, is in the area shown in yellow.

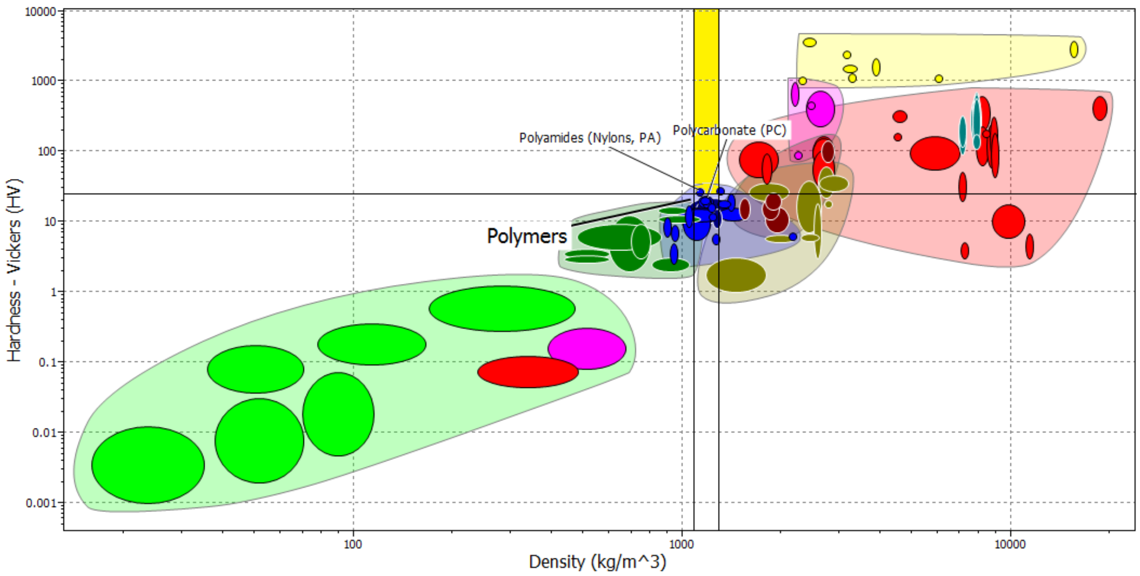

Figure 4. Material properties map (chart) for electric iron housing material

Electric iron heater

Six material properties were considered [1]: electrical resistance, thermal conductivity, electrical conductivity, the maximum heating temperature, machinability and price. The material that may be submitted by high-temperature heating during operation (800-900^{0}C) is selected while at the same time there are no its physical and chemical properties changes. Electrical resistance is also important, which should not exceed the value of 130 µohm·cm. Of course, the material must be a good electrical conductor and extremely machinable (drawing, bending) in order to achieve the desired shape of the heater. Based on the previously, CES software offers as a result a large number of different materials, even the 192. One of the main properties that the material for iron electric heater must meet is thermal conductivity. Its value is limited by interval of 9-10 W/m^{0}C. The price of material is indispensable. In this case, the maximum price should not be higher than 22 €/kg. If the last criteria is considered, the optimal material for the electric iron heaters is, in this case, Ni-Cr-Fe alloy (Nichrome), Fig. 5.

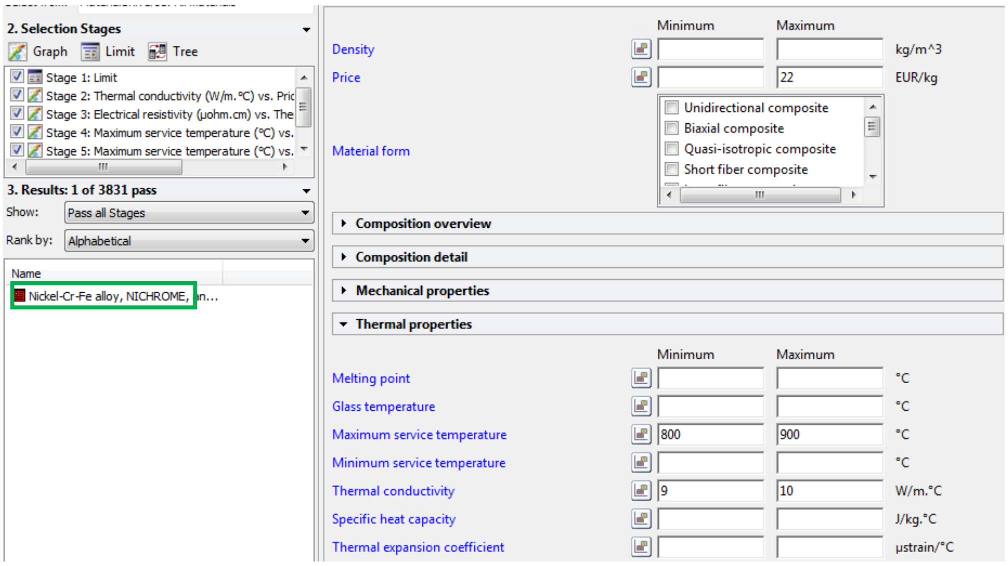

Figure 5. Optimal material for production of electric iron heater

Based on the given limits, the same result using the material property chart (map) is gotten (Fig. 6), where we can see that the optimal material, Ni-Cr-Fe alloy, is in the area shown in yellow.

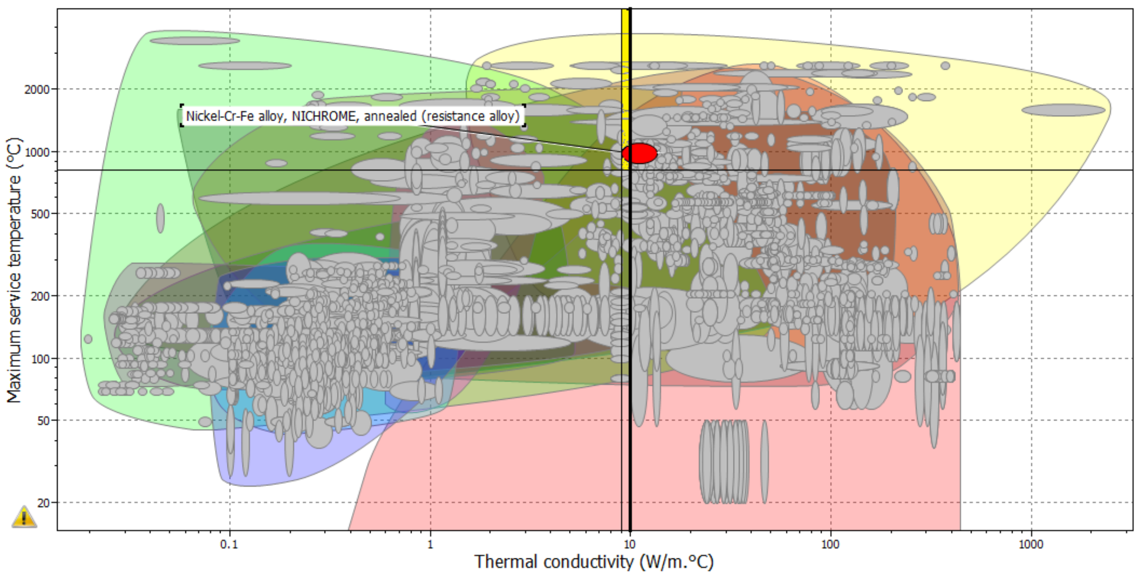

Figure 6. Material properties map (chart) for electric iron heater material

Electric iron warming plate

Five material properties were considered [1]: thermal conductivity, the maximum heating temperature, density, hardness and price. The material that needs to meet a minimum hardness of 50 HV is selected. One of the most important properties is the thermal conductivity, which the lower limit is set to 15 W/m^{0}C and the maximum temperature that the warming plate material can achieve during working life which value must be at least 150^{0}C. Based on the previously, CES software offers as a result of 3 different materials: Al alloy, Mg alloy and Silicon. An important property for the warming plate material is the mass of the material, i.e. its density, which is, in this case, limited by the value of up to 3000 kg/m^3. The price of material is indispensable. In this case, the maximum price should not be higher than 2 €/kg. If the last criteria is considered, the optimal material for the electric iron warming plate is, in this case, Al alloy, Fig. 7.

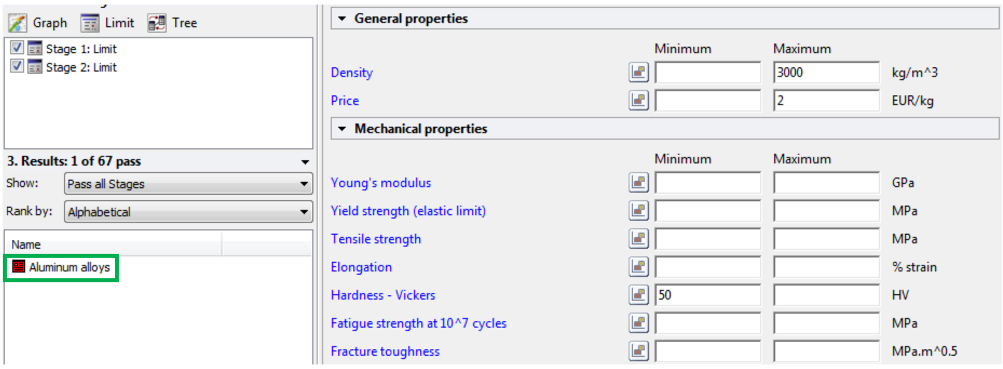

Figure 7. Optimal material for production of electric iron warming plate

Based on the given limits, the same result using the material property chart (map) is gotten (Fig. 8), where we can see that the optimal material, Al alloy, is in the area shown in yellow.

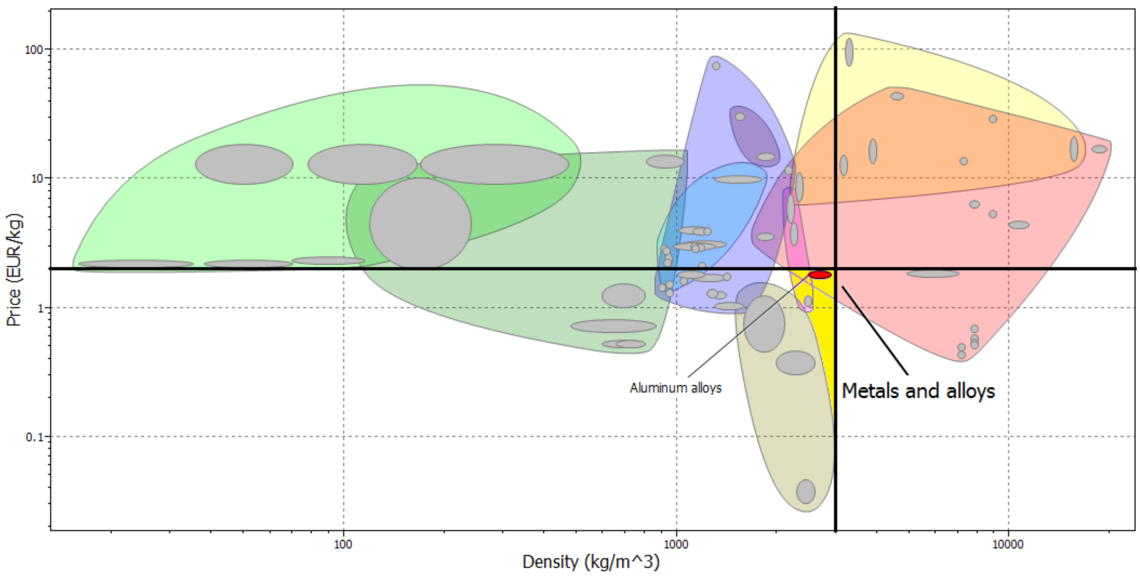

Figure 8. Material properties map (chart) for electric iron warming plate material

RESULTS AND DISCUSSION

Table 2 presents comparative results of the electric iron constitutive elements optimal materials obtained on the basis of two quantitative methods in paper [1] and results based on material properties chart (map) quantitative method processed in the previous section of this paper.

Table 2. Comparative results of the electric iron constitutive elements materials

Electric iron constitutive elements	Method of properties influence (digital-logic method) [1]	Method of minimum deviation of actual properties compared to required (algebraic approach) [1]	Material properties chart (map)
	Materijal		
Housing	Polyamide	Polyamide	Polyamide
Heater	Ni-Cr-Fe (Nichrome)	Ni-Cr (Nimonic 81)	Ni-Cr-Fe (Nichrome)
Warming plate	Al alloy	Polytetrafluorethylene (Teflon)	Al alloy

CONCLUSION

The material selection process is present in every part of the design process and directly affects the lifetime of the product [7]. Based on personal experience, developed methods for the appropriate materials selection and based on software support, it is possible to make a proper decision on the material to be used. This paper presents the optimal materials selection of the constituent elements of electric iron: housing, heater and warming plate using material properties chart (map) quantitative method. Based on the mentioned method, optimum materials for the housing, the heater and the warming plate of electric iron are, respectively, polyamide, Ni-Cr-Fe alloy (Nichrome 81) and Al alloy. The results were compared with the results of the optimum material from the paper [1] obtained using two quantitative methods: the method of properties influence (digital-logic method) and the method of minimum deviation of actual properties compared to required (algebraic approach). Based on these results, using the method of properties influence (digital-logic method) and material properties chart (map) quantitative method, we can ascertain that the obtained materials for the electric iron constituent elements are exactly the same, while in method of minimum deviation of actual properties compared to required (algebraic approach) Polytetrafluorethylene is approved as well as the optimal warming plate material. Of course, each of these quantitative methods has its own characteristics and, hence, the recommendation in the choice of materials is to use at least two of the methods. Further research can be extended by using some of the remaining quantitative methods for the materials selection.

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THE INNOVATIVE MODEL OF WORK ON THE COURSE IN COMPUTER GRAPHICS

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Abstract: The modern society is characterized by dynamic changes, intensive growth of production, information and telecommunication technologies, which makes way for quality changes in all sectors of society and especially in education. Increase and improvement in the efficiency of education and learning process could be realized through new education models, using a new education technology. Many foreign educational institutions have tried to deal with this issue by developing a model of distance learning.
Being permanently up-to-date with the latest achievements in the field of educational information and communication technology is a must. The use of information technologies will enable creating of a new basis for improvement of teaching process and open new opportunities to it.
Key words: computer graphics, Distance learning, e-learning

INTRODUCTION - EDUCATION SYSTEM IN SERBIA

The achievements brought about by the development of a modern society constantly impose the need for changing of education models. Such changes are often very slow due to the volume and inertia of an education system. On the other hand, the process of globalization has led to harmonization of different education models that are also locally specific and thus the education process has surpassed its national context.
Parallel to such changes to the system, there are also individual initiatives attempting to make the education system closer to real needs and possibilities of the environment. One of these initiatives, supported by a strong impulse of a rapid growth of information and communication technology and the advent of the Internet, resulted in modern forms of distance learning. One of the most interesting of these forms is indeed electronic learning (eLearning). At a rapid rate, this initiative has grown into one of the most important strategic points of modern educational institutions, which has led to numerous projects on a national and international level as well.
The education system of our country is undergoing significant changes.
In spite of a bad economic situation and lower standard of living, a growing trend in implementation of information and communication technology is perceived in our country. The traditional way of education where the teacher is active and learners are mere passive observers of classroom happenings should be combined with modern education which is learner-centred and which puts special emphasis on building up a learner’s personality and the way of acquiring knowledge by being active in team or individual work. What also should be pointed out is the importance of the use of information technologies as powerful “tools” in the process of acquiring knowledge. Advantages are enormous because, for example, by using electronic information resources and the Internet one can use many resources that provide information in various ways and forms, such as: text, pictures, sound, video, film etc.

Distance learning and e-learning

The introduction of educational technologies provides new opportunities for interpersonal communication. Thus, various distance learning courses and similar projects tend to substitute for a classical form of classroom education. These forms of education, learning without direct contact between the person who conducts the educational process (teacher, tutor) and those being taught (learners, students) are called “Distance Education” or “E-Learning”. Such education is used in various situations, for example, when learners are not able to attend lectures due to work obligations or geographical distance.

Distance learning provides the opportunity for a lifelong learning. Learners receive independent professional training at a place and time they choose, they go through the teaching material at their own speed and as many times as they want.
Regarding distance learning, there are several terms in use: Distance Learning, Distance Training, Distance Education, eLearning (e-Learning, "e"Learning), Online (On-line) Education, Virtual Instruction, Virtual Education. Taking these terms as synonyms is not a coincidence. What all of them have in common is the fact they assume the learning process in which knowledge resource and a receiver are physically far away and their relationship is mediated through the use of ICT, while each of these terms illustrates the nuances of options within the process of distance learning itself.

Multimedia lectures	Knowledge base (tree, nodes)	Tests base
Multimedia practice		Teaching materials
Most frequently asked questions		Useful links
Projects Assignments		Chat online consultation
Live consultation		E-mail consultation
Seminar papers		Mailing list
Conducting surveys		Video conferencing
Informing		Teachers' support
Help in work		Technical support
Monitoring progress		
Progress tests	Tests	Module tests

Figure 1. Some of the elements used in distance learning system

E-learning represents instructional content or the way of learning by the use of electronic technology. The mainly used educational materials include materials on CD-ROMs, DVD-ROMs, WBT (WEB Based Training), CBT (Computer Based Training), AoD (Audio on demand), VoD (Video on demand), quizzes, synchronous and asynchronous conferencing. The communication among users of this form of learning is electronic, while it could also occur in the real time – it could be direct.
A computer serves as an intermediary in the communication between an electronic teacher – an application installed on some server and a user demanding an answer. When a teacher and student are physically far away from each other, then e-learning is used as d-learning and communication could be instantaneous or postponed.

On Computer Graphics

Computer graphics is not entirely original topic because it uses some of the established techniques such as geometry, algebra, optics and human psychology for defining and solving of problems.
Geometry is used for providing a framework for description of 2D and 3D space, while algebra techniques are used for defining and evaluation of equivalence concerning a particular space.
The science of optics provides models for the description of light behaviour, while human psychology provides models for human vision and perception of colours.
The process of manufacturing is also in connection with computer description of designed objects, so the production is automated by means of the method named CAM (Computer-aided Manufacturing).

Interactive Computer Graphics

Graphics provides one of the most natural ways of communication with a computer. An ancient Chinese proverb saying: "One picture is ten thousand words worth" has become a catchword in our society only after the advent of cheaper technologies for picture production, in the first place for print, and then for photographs.

Although static pictures are good for information exchange, dynamic ones prove to be even better. A variation on the Chinese proverb is that a motion picture is ten thousand static pictures worth. This especially applies to phenomena that are variable over a period of time.

Electronic teaching material

Educational materials are the most important element of distance education. Concerning classical education, they represent only a support to the teaching process which is teacher-centred. On the other hand, educational materials are the main source of new knowledge and skills in distance education. The materials are at the same time the controllers of the teaching process because they lead each learner through the process of training and direct them towards the desired aim. Their role is a complex one whereas their impact on the quality and result of distance education is substantial.
For the course in Computer Graphics within the accredited study programme of distance learning, teaching material consists of several parts:

1. the presentations for the theoretical part of the course that is divided into 15 teaching modules
2. the assessment of knowledge that enables students to check their knowledge after every teaching module
3. the material for application of program packages CorelDraw12 and Adobe Indesign CS, which consists of:
    a. the explanations of particular options and program tools
    b. the interactive tutorial presentation
    c. the examples for students' work and practice.

The organization of the Course in Computer Graphics

Students are obliged to attend lectures and practice work once a week. Lectures and practice work are available to students according to the provided timetable. New content is posted every week and it is available until the end of that semester. During one week, there are forums and practice exercises after the practice work (students have to complete the exercises before the set deadline – the end of the week). Teacher is online every Tuesday from 6 to 8 p.m. so that students could communicate with her/him through the chat room.
In addition to the practice exercises, all students have to take a test task on CorelDraw 12 and Adobe Indesign CS, which is marked. The time of this test is previously determined (7th and 14th week). If a student does not complete all test tasks (set from 1st to 14th week- ***it is clearly indicated in every exercise whether the task within practice should be completed and sent to a lecturer***) with a required minimum of points, s/he can take that part again at the end of the course – the 15th week at School.
Students who fulfill the pre-exam obligations (all practice exercises and test tasks on CorelDraw 12 and Adobe Indesign CS done with at least minimum of points) have the right to take the final exam at School according to the exam timetable. If a student does not achieve the minimum of points in one part, s/he is allowed to take the same part at the end of the course. The final exam is organized at School according to the exam timetable.

Syllabus for the course in Computer Graphics at Higher Education Technical School of Professional Studies at Novi Sad

The course in Computer Graphics with the number of teaching instruction classes based on 1+2 scheme is one of the compulsory general courses and it is included in the curriculum for study programmes of information technologies and all study programmes within the department of Graphics (graphic design, graphic engineering, applied photography and web design). The theoretical part of the course is the same for all students as is the material for practice work in which differences exist only in the examples intended for student' independent work. These examples are modified to suit to each of the study programmes.

THE EFFICIENCY OF APPLICATION OF ELECTRONIC LEARNING TO THE COURSE IN COMPUTER GRAPHICS

The research included 59 students of the study programme Information Technologies (1st year of studying, 2nd semester) at Higher Education Technical School of Professional Studies at Novi Sad. The aim of the research was the efficiency of a contemporary course in Computer Graphics while the subject of research was theoretical and empirical study of students' achievements made by application of innovative models of teaching computer graphics.
For the research purposes, course content in Computer Graphics for the study programme of Information Technologies was used as the programme. The course content was based on innovative models of teaching which are modified for the purposes of distance learning. The course within the conducted research was organized on a weekly basis and lasted 15 weeks. Students' activities and obligations were defined in advance, as is provided in the previous section of this paper.
The aim of the research was to determine the effects of programme application through innovative models of work in the course of Computer Graphics.

The innovative model of work on the course in Computer Graphics

Within the innovative model of work on the course in Computer Graphics, interactive tutorials for every course unit were organized. A tutorial comprises multimedia material which gradually, step by step, presents to a student the way in which graphic objects are created, and thus it teaches a student how to use the tools and functions provided by the program environment of CorelDraw12 and Adobe Indesign CS.
Wink program was used for the making of these tutorials. Wink is a free software tool for creating presentations and tutorials about the use of some software package.
Tutorial presentations created in Wink program look like a lecture presented by a teacher at a class or practice work within program environment. The advantages of such presenting of a teaching material for students who applied for distance learning are huge:

- easy understanding of the CorelDraw12 and AdobeInDdesignCS program possibilities and work in the given environment
- visual display of creating graphic objects
- the possibility of stopping the presentation and independent creation of the presented
- the possibility of revising a particular teaching material
- step-by-step approach to presenting.

Following this type of presentations, a distance-learning student gets a visual picture of the creation of graphic objects and of their layout and organization in the environment. For the purposes of a better and more detailed explanation of the concepts and use of tools, the author of a tutorial is given the possibility of inserting comments and explanations in specific parts of the interactive material.

THE CONDUCTED RESEARCH

The aim of the research was to determine the effects of the application of the programme through innovative models of work on the course in Computer Graphics.
Research techniques and methods used for this research are:

- survey – getting students' opinions on advantages and disadvantages of such organization of a course;
- testing – determining students' previous knowledge of the course in Computer Graphics, i.e. the initial testing of knowledge

Research instruments:

- questionnaires and
- knowledge tests.

A survey of students – a survey conducted after the research included the students of experimental classes and it set out to provide the students' impressions of the experimental programme realization, i.e. of the innovative ways of work and learning. The survey was anonymous so as to let students be

more open when expressing their opinions. The questions asked in the survey are provided in the tables presenting the results.
Measuring of the relevant parameters and the analysis of the results were done according to the standard statistical methods.

Research results

The tables of research results present two categories of the crucial points. The first category is *Impressions about teaching material,* which is presented by the elements of marks given to the quality of teaching material, Table 1., organization of teaching material and technical quality of teaching material. The second category is *Application of teaching material,* Table 2. which is presented by the elements of marks given to clarity of the presented teaching content and to the possibility for independent dealing with tasks after the presentation of teaching material.

Table 1. The first category - *Impressions about teaching material*

the element of mark	excellent		very good		good	
	I group	II group	I group	II group	I group	II group
The quality of teaching material	8	16	12	10	8	2
The organization of teaching material	4	16	14	8	10	4
The technical quality of teaching material	4	14	16	9	8	5

Table 2. The second category- *Application of teaching material*

the element of mark	excellent		very good		good	
	I group	II group	I group	II group	I group	II group
The clarity of the presented teaching content	6	12	12	10	10	6
The possibility for independent dealing with tasks after the presentation of teaching material	8	12	10	12	10	4
Coping within the presented program	4	14	4	9	10	5

Comparing the obtained values, it is concluded that the II group is more satisfied with the technical quality and organization of teaching material. This implies that it was easier for them to follow the teaching material and deal with working in the presented program environment, as well as to apply the learnt matter.
After processing the results presented in the following tables.

Table 3. Representation of results

Previous knowledge of work in the program of CorelDraw 12	marks		
	excellent	satisfactory	without previous knowledge
I group	3	10	15
II group	2	11	16

Success in performing tasks	Marks			
	excellent	satisfactory	unsatisfactory	
I group	10	11	7	
II group	14	10	5	

it is realized and concluded that II group did the task more successfully, although a smaller percentage of students from group II had previous knowledge in this field. This fact directly implies good understanding of the matter by means of interactive presentation and subsequent easy recognition and application of the gained knowledge.

CONCLUSION

The advantages of eLearning platform for the course in Computer Graphics are the following:
1. achieving considerable market competitiveness in the region;
2. obtaining the system that meets the requirements set in the Standards for accreditation of higher education institutions;
3. obtaining an insight into the individual progress of every student;
4. getting control and supervision of the work of every teacher;
5. technical support is available to students 24 hours a day.

The advantages of interactive presentation of teaching material in the distance learning system are enormous. There is the unlimited number of repetition depending on the student's individual needs. Easy understanding of the matter, visual presentations of creating concrete examples with usage and customization of the tools certainly contribute to easier understanding of the matter and practical application of the gained knowledge.

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IMPROVING EFFICIENCY OF CNC LATHE USED IN MACHINING TECHNICAL PLASTICS

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Abstract: This paper analyses the process of improving efficiency of CNC lathe when performing experiments which involve machining plastics, as well as programming of fuzzy logic controller (FLC) for the required machining conditions in order to obtain optimal factors of cutting regime. The FLC input parameters were based on the results of previous empirical experiments and the personal experience of a technologist.
The programming involved three characteristic input values and one output value while the experimental results involved generating the main cutting force and the temperature in the cutting zone during machining on CNC lathe. The expected results of adaptation of FLC are based on an entire autonomy of the process and elimination of subjective errors.
Key words: CNC lathe, machining of plastics, fuzzy logic controller (FLC)

INTRODUCTION

The experiments aimed at obtaining relevant production factors were carried out on metals and the obtained exact results were shown in tables, diagrams and specialized printed publications available to wider public. The problem noticed in recent years is the absence of relevant production data about plastic materials and generally speaking, non-metals. Thermoplastics (or technical plastics as used in the paper) are very often machined in many plants worldwide and some parts of these materials have become an irreplaceable segment of numerous constructions, devices and on the whole, individually exploited elements. There are many examples which support what was previously said: mobile phones, car parts, meat grinders, etc. Although there is a great need of plastic machining in plants with all relevant factors and optimal cutting regimes in this region (former Yugoslavia), but also elsewhere, it has been reported that there are no reliable data about optimal cutting regimes for these materials and that the said regimes are mainly set ad hoc using the experience of production workers. Such an approach is not at all acceptable in modern production conditions and considerably affects the rise in production costs and "guaranteed" arbitrary delivery terms of the finished products. In modern production processes and in respect of market principles, this approach is not desirable and represents the lowest level of business communication.
Considering everything said in the previous paragraph, this paper gives a description of a program of experiment performance in turning of technical plastics on CNC lathe to obtain optimal factors of cutting regimes. The program is based on two characteristic wholes and the experimental results refer to generating the values of main cutting force in CNC lathe machining F_1 (N) and of temperature t (^{0}C) in the cutting zone of the proposed tribology system. In order to obtain as precise dimensions of the chips as possible, a numeric machine with 0.01 mm precision was used.
The first part of the experiment was set on the basis of the recognizable manner which is widely used in machining i.e. determination of relevant empirical input values. The second part comprises setting of fuzzy logic controller with the aim of eliminating personal influence on cutting regime factors. The technological cutting regime factors were determined on the basis of technical features of the machine itself.
The primary aim of the experiments was to obtain the main cutting force values by varying the cutting regime factors which directly affect the value of F_1 such as cutting depth $\mathbf{a_p}$ (mm), feed $\mathbf{f_n}$ (mm/rev) and cutting speed $\mathbf{v_c}$ (m/min) i.e. spindle speed **n** (rev/min). To validate the obtained results, another manner of obtaining data about the main cutting force through electrical parameters was assumed, which could be compared with the previous one. Thus, the applied equipment was optimized with the possibility of scaling some of the electrical quantities. All this is a small contribution to improving the production processes in order to increase their efficiency. The experiment can be applied to other cutting technologies such as drilling, milling and grinding, but it is also applicable in production conditions thus

improving production processes by introducing fuzzy logic controller and other systems within artificial intelligence.

MATERIAL AND METHODS

Machine used to perform the experiment

The experiment described in the present paper was performed using the lathe EMCO F5 CNC with the following characteristics:

- Electric motor drive power – 440 W
- Tool travel along X-axis – 150 mm
- Tool travel along Z-axis
- Machine precision – 0,01 mm
- Feed speed – 5-400 mm/min
- Spindle speed – 50-3000 rev/min
- Interface connection – RS 232

Workpiece

Photo 1 shows the workpiece made of technical plastics of dimensions Φ40 x300 mm. The workpiece holder is the chuck and the tailstock centre so its motion is revolving.

Cutting force

The comparison to metal machining using the same process is used in the present paper in order to determine the cutting force in turning of thermoplastics. If we consider the general oblique cutting, according to the authors [8 ,10] the resulting cutting force is resolved into three components normal to each other:

F1 –main cutting force
F2 –thrust force
F3 –feed force

The most important is the main cutting force F_1, and the other two are given in relation to it ($F_1 : F_2 : F_3 = 5 : 2 : 1$) . For this reason, a special attention is given to methods of measurement and calculation of F_1. The references offer several methods for experimental measurements of the main cutting force as well as several analytical methods for calculation of its value. In this paper we used the calculation method for experimental measurement and for calculation of this force we used the analytical method which, according to numerous authors, is given in equation:

$$F_1 = C_{k_1} \times a_p^{x_1} \times f_n^{y_1} \left[N \right] \tag{1}$$

where:
a_p [mm] –depth of cut
f_n [mm/rev] – feed
and the coefficients which depend on the type of the machining material: C_{k1}, x_1, y_1
C_{k1} is the specific cutting resistance for a_p = 1 [mm] and f_n = 1 [mm/rev] i.e. A = 1 mm^2, where A – is the cross section of the chip [3].
Values of these constants in machining of thermoplastics, in this case PTFE (polytetrafluorethylene), are determined according to [6].

RESULTS AND DISCUSSION

According to Table 1 the parameter ω [rev/s] is the angular velocity derived on the basis of parameter n. The parameter f_n (feed) is defined on the lathe in mm/rev and is based on the feed speed (v_f) defined by the manufacturer in mm/min.

According to the same table there will be 8 measuring in columns 0-7 based on combinations of binary values of adopted logic variables (a_p, f_n, n).

Table 1. Experiment plan

		0-measurement	1-measurement	2-measurement	3-measurement	4-measurement	5-measurement	6-measurement	7-measurement
a_p	(mm)	2	2	2	2	4	4	4	4
v_f	(mm/min)	80	80	300	300	80	80	300	300
$f_n=v_f/n$	(mm/rev)	0,133	0,067	0,500	0,250	0,133	0,067	0,500	0,250
n	(rev/min)	600	1200	600	1200	600	1200	600	1200
$\omega=\pi n/30$	(rev/s)	62,8	126	62,8	126	62,8	126	62,8	126

Mathematical model for determination of the main cutting force

A system of linear algebra equations can be written for one combination of turning regime as:

$$\begin{aligned} \ln F_{1\max} - \ln C_{k1} &= x_1 \ln a_{p\ \max} + y_1 \ln f_{n\ \max} \\ \ln F_{1\min} - \ln C_{k1} &= x_1 \ln a_{p\ \min} + y_1 \ln f_{n\ \min} \end{aligned} \tag{2}$$

According to the algebraic equation system (2) their matrix can be written and the resulting values are given in Table 2.

$$\begin{pmatrix} \ln F_{1\max} - \ln C_{k1} \\ \ln F_{1\min} - \ln C_{k1} \end{pmatrix} = \begin{pmatrix} \ln a_{p\ \max} & \ln f_{n\ \max} \\ \ln a_{p\ \min} & \ln f_{n\ \min} \end{pmatrix} \begin{pmatrix} x_1 \\ y_1 \end{pmatrix} \tag{3}$$

Table 2. Results for solving the system of equations (2)

	0-measurement	1-measurement	2-measurement	3-measurement	4-measurement	5-measurement	6-measurement
F_{1max}	347	158	1585	262	122	73	982
F_{1min}	149	9	226	218	17	60	27

The value(s) of cutting force F_1 (N) obtained using the formula (measured electrical components):

$$F_1 = \frac{U \cdot I}{L \cdot \omega} \tag{4}$$

Where the electric voltage is known to be U=220V as well as the free length of the turning tool i.e. imagined shank L=0.02m. Electric current I was calculated as the product of values of correction factor k_{sr} and the current measured using PLC and the formula:

$$I = k_{sr} x I_{PLC} \left[A \right] \tag{5}$$

Thus, the obtained values of force F_1 according to Table 4 were confirmed. In this case, the seventh measurement was not valid due to technical problems which occurred during the experiment.
The electric current was detected by using the contact pliers connected to the power cord of the tool or, if more precise measurement is needed, to one phase of the power cord. In order to improve the strength of the input impulse of electric current and to detect the flow rate (I) on the computer, the amplifier and the programmable logic controller (PLC) were directly connected to the computer input port of the computer.
The correction factor k was obtained as the value of the flow rate read on the ammeter of numerically controlled tool and the detected flow rate on PLC. Due to assumed changeability of electrical quantities during the experiment (decrease of voltage, overcharge, etc.), the value k_{sr} (mean value of correction factor) used for the calculation was determined for a series of repetitions.

FUZZY LOGIC CONTROLLER (FLC)

Criteria for selection of inputs

The input parameters in fuzzy logic controller are the parameters of cutting regime, feed speed-v_f (mm/min) and depth of cut a_p (mm), determined by technical characteristics of the machine.
Considering the defined input parameter of the cutting regime, another important parameter was selected, the temperature of the workpiece as a result of a similar experiment performed on the Potisje PA-22 lathe [7]. The temperature obtained in this experiment was detected on the top of the tool and measured using the temperature sensor rove through the tool handle up to the top of the tool cutting edge. The temperature of the workpiece and the chips was measured using Fluke 561 IC thermometer. The obtained values in the table were used to define temperature areas by programming fuzzy controller in this paper (Table 3).
The temperatures of the turning tool handle (JUS 9 1010 P10) are shown in Table 3 for experimental measurements (1-8), namely: maximum $t_{max,}$ minimum t_{min} and mean value $t_{sr.}$ The temperature of the handle (together with the temperature of the chips) was measured with the said Fluke 561 IC.
The initial temperature of the workpiece was 21.4 °C when measured.

Table 3. Table of temperature areas for the tool and the workpiece

			0	**1**	**2**	**3**	**4**	**5**	**6**	**7**
	t_{sr}	^0C	23,5	32,5	24,5	28	24	27,5	22	34,5
	t_{max}	^0C	25	37	25	30	25	30	23	39
	t_{min}	^0C	22	28	24	26	23	25	21	30
n_{max}	**1325**	*rev/min*			1325	1325			1325	1325
n_{min}	**910**	*rev/min*	910	910			910	910		
f_{nmax}	**0,089**	*mm/rev*			0,089	0,089	0,089	0,089		
f_{nmin}	**0.05**	*mm/rev*	0.05	0.05					0.05	0.05
a_{pmax}	**2**	*mm*		4		4		4		4
a_{pmin}	**1**	*mm*	2		2		2		2	
	t_o	^0C	23.8	52	22.2	36	25	28	24.8	48
	t_n	^0C	22.8	26	24.8	23.3	22.2	25.8	21.8	26.4

The table also shows the other two relevant temperatures, namely, t_o – temperature of the workpiece and t_n – temperature of the cutting edge on the rake face. The chips temperature, the temperature of the turning tool handle and the temperature loss around the working area of tribological system is not relevant for adaptation of the controller. The temperature of the turning tool nose (t_n) is also an unacceptable input parameter since the areas of critical temperatures on the cutting edge where the tool considerably loses its mechanical features have much higher values than the ones developed in the observed experiment. The temperature of the workpiece is a primary input parameter and the only accepted input parameter for adaptation of the controller based on the previously defined reasons given in the present paper.

Fuzzy logic controller adaptation based on Mamdani rules

One of the problems which occur in the process of turning is heating of the elements which participate in machining. Heating is the most intensive in the cutting zone i.e. in the zone when chip is separated from the base material. If the machining involves high speed steel tools, then the maximum allowed temperature is approximately 600 ^{0}C because after reaching the said temperature, the tool considerably loses its mechanical properties.

In the same process of machining technical plastics the problem occurs with the work material. It is a well known fact that thermoplastics are machined by the process of casting under pressure and after that they are machined until finally shaped (gears, chains and similar machine elements). The casting temperatures are different and they primarily depend on the chemical structure of the material. Thus, the temperature area of casting is 220 ^{0}C and rises to 440 ^{0}C [4,9]. The problem occurs in machining if the temperature exceeds 100 ^{0}C. Some plastics lose their mechanical properties at such temperatures and cause a serious problem. Plastics then adhere to the nose thus entirely changing the cutting geometry, which considerably affects the quality, accuracy and generally, the required geometric shape of the workpiece. Even the possibility of machining plastics by cutting at higher temperature may be questioned. The parameters of cutting regime (spindle speed, feed and depth of cut) as well as the nose radius, vibrations, accumulation of material (the built-up edge phenomenon) etc., mostly affect the development of higher temperatures in the cutting zone. According to the theory of cutting, the increased number of revolutions gives better quality of the machined surface. This is the principle the CNC machines are built on – to obtain as good quality as possible for as short time as possible.

Fuzzy logic controller adaptation based on Mamdani rules in this paper is supposed to regulate the number of revolutions of the main CNC machine spindle so that the workpiece temperature could be kept below 100 ^{0}C without using a coolant to avoid chemical reactions between the coolant and the base material.

The input parameters for the fuzzy controller are the temperature of the machined material, feed speed and depth of cut, and the outputs are number of revolutions of the main spindle. Acceptable temperature of the workpice ranges between ~ 20 ^{0}C and 100 ^{0}C, of the feed speed between 50 and 400 mm/min and of depth of cut between 1 and 5 mm. The controller is set according to 9 rules used to obtain the output number of revolutions. The adaptation of fuzzy controller is based on Mamdani controller [1,2,5].

All previously said lead to a logical question as to why the fuzzy logic controller is suitable for automatic system control, and the answer to it could be the following conclusions:

- Fuzzy controllers optimize already known solutions with the aim of obtaining the finished product along with the efficiency increase in the production process
- The price of the final product is considerably lowered due to continuity of the process under various influences
- Adaptability and elimination of errors in controlling is significant since there is no personal influence
- Possibility to change control in every moment according to the needs and requirements of the user

CONCLUSION

Modern market demands impose the tempo of development, creation and price of the required product. In order to satisfy the requirements, it is necessary to develop new products, introduce new machining technologies, new systems for controlling production and generally, to change the strategy of contemplating and working.

In the modern system of organization, a technologist of the machining does not act individually any more, but as a part of a team for development of technology. The production process control does not use previously defined cutting regimes, but the regimes change during the production process according to the current demands within already set possible limits. This process is regulated by controllers in order to facilitate work of the technologist and provide shorter period for making a product. Since traditional controllers are used for controlling within fixed limits, a need to introduce fuzzy logic controller emerged.

This enables optimization of the machining process in every moment. It significantly reduces the prices of products and increase market competitiveness, which is one of important prerequisites of intensive development and survival in the more and more demanding market.

Controlling the production processes which involve machines by fuzzy logic controllers caused a revolution in machining by cutting. Machining is thus performed free of personal influence of a technologist, the time needed to make a product is much shorter, distance control is provided and the machining process is optimized in every moment.

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METHODICAL COMMUNICATION AND DATA VISUALIZATION TOWARDS EFFECTIVE IMPLEMENTATION

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Abstract: Smart devices and Internet improved accumulation of big data which is used by many companies for predicting and analyzing their business. Big data requires technology for collecting, storing and analyzing data from various sources in various formats in real time. Successful data analysis is completed when effective data visualization is applied. Data visualization improves their interpretation. There are many tools for data analyzing and visualizing. Data analysis finalizes with decision making. Decisions prosper company's business and their progress.
Key words: Big data, data science, data visualization

1. INTRODUCTION

In today's world, world of Internet, mobile phones, world of consummation and shopping and world of big companies, strong competition and huge income, analyzing data became essential for success.
It is strongly connected with business intelligence and business decisions making. Since data became so large and complex, pure statistics became inadequate and a new filed called data science generated from it. Data science extracts knowledge from data collected in various forms, either structured or unstructured. It is combination of statistics, operation research, information and computer science, data engineering, learning, visualization, etc. Data science reveals meaning behind collected data and provides conclusions for business reactions. Large sets of data, collected from various sources, in various forms and sizes, with unpredictable velocity and in unknown volume is simply called Big data and the term attaches advanced technology, software and hardware. Data science and Big data must include data visualization to ease processing data for human.

2. DATA SCIENCE

Data science is an interdisciplinary field which extracts knowledge and meanings from data in various forms. It is derived from statistics [2], which became inadequate in Big data analytics. Data science combines statistics, data mining and predictive analytics [1], and interacts with disciplines such as mathematics, information science, computer science, data engineering. The main purpose of data science is interpreting data and managing large amounts of data despite hardware, software and bandwidth constraints. It merges data sources, ensures their consistency, and creates visualizations... It is important to process data and produce analysis in reasonable amount of time and produce information which helps in decision making. Today, almost every company requires data scientists with strong background in mathematics and computer science.

3. METHODICAL APPROACH

Analyzing big data gains a competitive advantage for a company. Data must be collected, stored and analyzed in a methodical way. Typical process of making a decision consists of setting a question, collecting, cleaning and storing data, organizing and analyzing data and taking an action based on a gained information. Data visualization is involved in almost every part of the process but most important visualization comes after the analysis and before decision making.

3.1. Forming a question

Companies and industries are utilizing consumer data for the purpose of improving their business and income. In the beginning of the strategic business decision making, manager needs to create a question which answer will help deciding. Questions are usually in the form of: will increase of something (in manufacture, sale,...) produce bigger income. Only when correct question is set, which answer in the end should always be yes or no, the process of predictive data analyzing begins. Sometimes, data analysis reveals answers that weren't even asked in the first place but the data showed strong correlations.

3.2. Data collecting and cleaning

The point of the process is to predict user behaviour based on their previous preferences. Customers are segmented into groups based on similar attributes, such as age, duration of being a client, pregnant women, parents, etc., and targeted actions, such as customizing marketing messages, are applied on each group.
Big data describes people's everyday behaviour, places they go, stores they visit and money they spend. Data is collected through peoples everyday behaviour, such as using credit card, sending an email, searching the Internet, buying online, completing the survey in the shop, hospital, etc [4].

Advantages of the Internet

The easiest way to collect data is from social networks where people exchange a lot of information about their habits, interests and personal information. It is possible to collect data about every potential customer interaction with company's web site or every conversation people are having about certain brand or keyword search and context it was being searched in. The potential of the Internet is infinite, it provides rapid access to numerous potential respondents and previously hidden population [10]. It reduces research cost, and is less time consuming than classic survey in person. Some of the data requires permission to be collected, and some does not, which represents an ethical problem as intrusion into people's private lives and personal information [8].

Ethical considerations

Even though Internet provides easy and fast way for data collecting, it is necessary to consider privacy and ethical issues in data analyzing [10]. Clients should be provided anonymity and confidentiality, and they should be aware of data and their usage in the research. When collecting via Internet, data should be encrypted to protect confidential information from hackers. Clients also should be aware which data is being collected and in which purpose. Data collectors should ensure that minors weren't included in the research without parents permission. The main problem is that people aren't aware that almost everything is being collected and used in data analyzing. They usually accept everything on the Internet without reading the agreement.

Data collecting and cleaning

Data is collected from various sources and there must exist a method how it is being handled. Manager and data scientist predict which data could correlate with certain occurrence. For example, collecting the information about client's age and profession could improve targeted advertising which could increase sales.
Collected data could be divided in three subsets [9]:
1. Data from traditional sources – which is collected through transactional systems or human resources systems.
2. Structured data from Internet of things – which is collected through sensors which are connected to Internet. There is a great volume of data, but data is standardized and doesn't require much transformation.
3. Unstructured data which combines media files in textual form and it needs advanced tools for transformation, cleaning and analyzing.

Big Data represents huge amounts of data that is easily collected from various sources (computers, mobile phones, satellites, cameras, etc.), but challenging for current computing technology. Storage also presents a problem, since petabytes and exabytes of data could be collected daily.
Data is collected in databases and it should be backed up in case of hardware damage. Databases are stored in physical infrastructure inside the company or somewhere in the cloud. Since the volume of data increases with the usage of smart phones and Internet, storage requirements became bigger. It is

no wonder that more and more companies decide to use infrastructure as a service (IAAS), which means using storage in the cloud, without worrying about maintenance.
Since data comes from multiple sources in different forms, before analyzing it must be cleaned and prepared for manipulation. Since data is used for decision making, presence of invalid data could lead to wrong conclusions. Data cleaning detects and removes errors and inconsistencies from data in order to improve their quality. Data quality problems are due to misspellings during data entry, missing information or other invalidities. Data which is incorrect, incomplete or improperly formatted or duplicated needs to be amended or removed. Big data implies integration of multiple sources which increases the need for data cleaning [5]. Sources often contain redundant data in different data representations which needs to be eliminated. For example, the same customer answers the poll both in the store and on the Internet, which provides double identical answers.
Data warehouses provide support for data cleaning but it must be adjusted to a given data set in order to be correctly applied depending on estimated data errors. Sometimes, data is collected from phone calls by determination of keywords. Data cleaning should recognize the same word with different extension, eliminate noise etc. Data cleaning is sometimes simply recognizing if some data is missing and replacing it with a symbol for missing or unanswered filed. For example, if the customer skips one question in the poll or doesn't finish the survey, cleaning should address the blank field and assign it a value so rest of the data is still usable.
Data cleaning presents a big obstacle in data analyzing. There are many data cleaning tools used to ease the process. Tools are often implemented with the tools for collecting and arranging. Using those tools saves a significant amount of time than fixing manually. The real problem is predicting the possible errors and creating an effective cleaning tool.
The best way to improve the whole process is designing smart ways of collecting and organizing data that will require less post-processing.

4. STATISTICAL ANALYZING

After the data has been organized, which includes storing and arranging, data is extracted and statistical and business analytics are applied. It is supposed to reveal hidden meaning behind data. Data science developed effective methods for analyzing. They include statistics and engineering over the extracted data.
However, it is not always advisable to blindly trust the results. It is desirable for a data scientist to investigate if the data provides information that doesn't make sense, or if they doubt something is not right. Errors in results occur if data is wrongly collected or cleaned. Since these results lead to decisions, they must be verified.

4.1. Data visualization

The concept of using pictured to understand data has been around for a long time. Creating maps and pie charts was known in early 19th century. However, technology gave it a whole new meaning, since computers made it possible to process large amount of data in real time [11].
Data visualization is present in almost each step of the decision making. It is part of data scientist's job. Many times, data is being visualized for marketing or educational purposes. Data visualization represents encoding data as visual objects, such as graphics in order to facilitate their interpreting. Visualized data should clearly communicate and stimulate attention [3]. It must help reveal hidden message behind data. Since 65% of all people are visual learners and information recall is significantly enhanced when tied to visual imagery [6], data visualization is a powerful tool for making complex environments easier to understand. Visualization shows interrelationships and trends that human mind was too weak to calculate, but computer did it.
Creating charts and infographics can be time-consuming, but there are tools, many of which open sourced, that help visualize big data, user just needs to pick the suitable one for their needs. Goal of data visualization is not only to simply visualize large sets of data, but to communicate with the observer clearly and effectively, to get them involved and interested. Visual representations of information must support information, strengthen it and present it within a provoking and sensitive context, depending on designer's creativity [7].

Before creating visual representation data must be prepared. First step is to carefully collect, clean and arrange data. analyzing is in the same time visualization because analyzed data is put into graphics at the same time as it is being analyzed.

4.2. Examples

Significance of data is usually represented in charts or a map. It can be static, if it is made for newspaper or billboards, or interactive, if it is made for previewing on the computer. Some of the examples are shown below.
The first example in Fig. 1.simply shows how many times a certain term has been searched in a year 2015.

Figure 1. Google search: A year in trends 2015

The second example shown in Fig. 2.is interactive and shows how people are tweeting about specific topic.

Figure 2. The one million tweet map

Since data is truly big, most of the data visualizations are interactive because they cover many areas and correlations.

5. DECISION MAKING

Managers are supposed to choose the action which will be applied based on the results given by data scientist. The whole meaning of data analyzing is to produce valuable information about trends in business in order to better sell products, target marketing efforts or produce better products to sell. If analysis shows that benefits of wanted action outweigh their risk, decision should be made.
Successful implementation covers asking the right question which will examine correlation between a certain occasion and their benefits, collecting data in the way that eases their organization and cleaning, analyzing data and reviewing the results, visualizing data and making the right decision.

6. CONCLUSION

Data is everywhere; in each credit card usage, web search, phone call, application download, car drive, school application, medical treatment, online purchase, etc. Companies use data to predict client's behavior and improve target marketing. Everything may be important, from client's age to their average income, and many things can correlate with company's business. It is very important to invest in data analytics since it produces important conclusions. It shows how some simple change in advertising affect sales or which keywords lead people to buy things.
Data is big and various. It comes in different forms, in big amounts and with unpredictable velocity. Hardware and software must be suitable for this kind of data. A lot of work is put into preprocessing and arranging data before analysis. Data must be properly cleaned which represents a major problem in data science. Analyzing data demands adequate scientists which are able to assume if analysis is wrong or atypical. It is important not to blindly believe in results, but to rethink their meaning. Typical errors in results are due to unclean data, which includes redundant or invalid data. If the cleaning is properly done, analysis should be correct.
Since human are visual they conclude better based on the image rather than numbers and lists of data. If data is properly displayed in graph or image, scientist or manager is able to easily detect appearances and correlation in data. Visualization is both art and science. It must be clean and communicative; it must be unambiguous and transparent.
Decision making is the main purpose of data analyzing. Based on analysis, decisions which precipitate business are made. Sometimes, new correlations are found unintentionally. While analyzing data, new regularities appear.
In business, managers must accept new ways of decision making. Without adaptation to big data and data science, little to no correct decisions could be made. It must be considered that data analyzing is time consuming and requires people and infrastructure resources. If the conclusions are wrong because data were poorly collected or cleaned, resources are wasted. Therefore, complete process must be taken seriously and handled with care and knowledge.

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ENVIRONMENTAL MANAGEMENT SYSTEMS: CONTEMPORARY TRENDS AND PRACTICES

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Abstract: Increased interest in environmental quality, as well as obligations arising from the EU accession process (particularly derived from the Chapter 27: Environment) impose trend of responsible environmental management. At the other hand, global trends such as the establishment of environmental management system based on ISO standards have the similar goals. The aim of this paperwork is to represent a comprehensive review of contemporary trends and practices in the field of environmental management, with particular regard to risk based approach. With no less importance, this paper seeks to demonstrate the application of risk-based environmental management practices in organizations already proven in the field of corporate social responsibility.
Key words: environment, risk, management, methodology

INTRODUCTION

Contemporary trends within the field of the environmental management indicate that there has been a obvious shift from the traditional "*top-down*" approach when defining the environmental protection policy, to the concept of environmental management towards a more open system of governance at all levels, where decisions are made on the distribution and use of environmental resources. If properly implemented, this approach recognizes the needs and obligations of those who most influence the use of environmental resources, without losing the possibility of involvement of the wider community in the management process. The basis for undertaking a series of activities starts from the harmonization of legislation, institutional organization in the field of environmental protection, funds raising etc. to concrete plans on taking preventive measures.

Compared to all environmental factors, it is possible to group existing approaches in environmental management, in next order:

1. the first group consists of pollution control mechanisms for each environmental factor individually, meaning independently of one another (i.e. Command and Control Regulations, which, for example, relates solely to the protection of water resources without considering the protection of soil, etc.). This approach is quite characteristic for the seventies of the twentieth century,
2. a second group consists of mechanisms that have a touch of integration, or perceived impacts of pollution globally, i.e. in respect of all environmental factors, but does not consider the activities and processes of society. This approach is characteristic for the eighties of the twentieth century,
3. the third group includes mechanisms which in addition to environmental factors considers factors of society, in terms of prevention, but only at the level of operators that generate pollution (consideration of material and energy flows). This approach is characteristic for the nineties of the twentieth century,
4. the fourth group consists of industrial ecology mechanisms where besides pollution prevention efficiency of utilization of environmental resources is also considered, as the performance reduction regarding emitted pollution, eco-efficiency and dematerialization of production. This approach is characteristic for the first decade of the twenty century,
5. fifth group consists of mechanisms that have a touch of sustainability, where in addition to industrial ecology, there is a look at the social component, inter and intra-generation justice, and a tendency towards an equitable distribution of profits as a result of the exploitation of environmental resources. This approach is characteristic for the second decade of the twenty-first century [1][2].

MATERIAL AND METHODS

As discussed in [3] a modern environmental management system (EMS) requires the identification of environmental aspects, root causes of their occurrence and calculus of their impacts. An illustrative flowchart of EMS procedures at the level of an organization is presented at Figure 1.

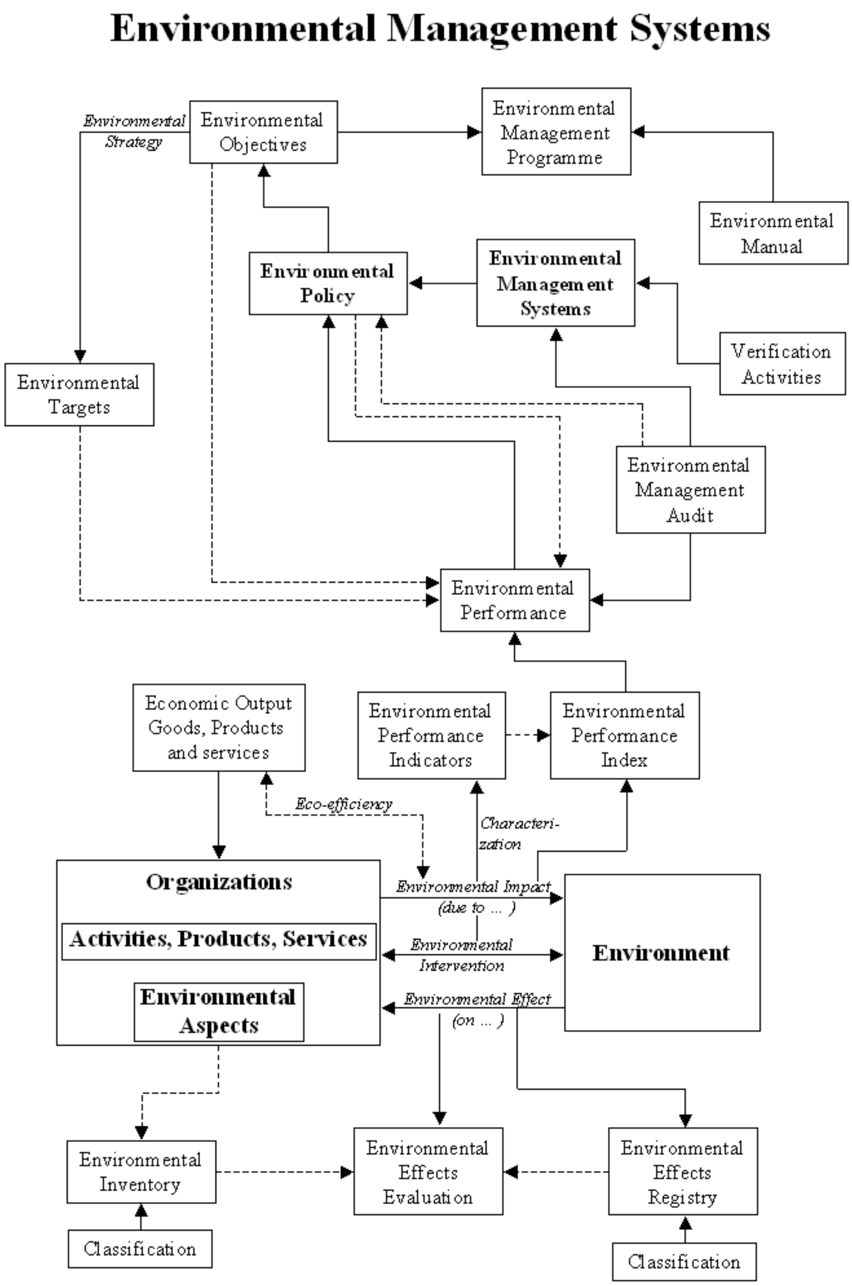

Figure 1. An illustrative EMS flowchart [4]

Planning the environmental protection management systems within an organization includes the identification of environmental aspects and selection of the most significant of them. The selection of the environmental aspects in certified organization that implements and operates an EMS depends on the available technology, experience, defined budget, defined mission and vision and, of course, the adopted environmental objectives mentioned within adopted environmental protection policy. The selection and prioritization of the abovementioned environmental aspects in certified organization should be based on the application of the proven methodologies, such as risk - based approach to the environmental management issues, seeking rather the preventive activities that restorative ones [5].

RESULTS AND DISCUSSION

Process of identification and characterization of environmental aspects represents a set of procedures defined within the guidance documents [6]. Although there are tools for ranking and environmental aspects prioritization, still challenge is an unbiased choice of significant aspects (with significant impacts) meaning allocation of limited resources (financial, human, technical…) in order to increase environmental performance.

As a contemporary trend, perhaps still not sufficiently recognized, risk - based approach to environmental management could be very useful approach to the issue of aspects ranking and prioritization. Within this approach, the significance of the environmental aspects (and its impacts) is defined based on the total score of the mathematical product between the degree of impact significance and the likelihood of occurrence, according to the previously defined criteria.

While the environmental impacts assessment consists of:

- environmental basis,
- potential impacts prediction,
- mitigation measures, and
- monitoring,

risk - based approach to environmental management meaning consideration of:

- hazard identification (in sense of likelihood),
- exposure assessment (in sense of importance), and
- risk characterization.

As an effective tool for visualization and comprehensive review of scored aspects, environmental risk matrix could be used, as shown in figure 2.

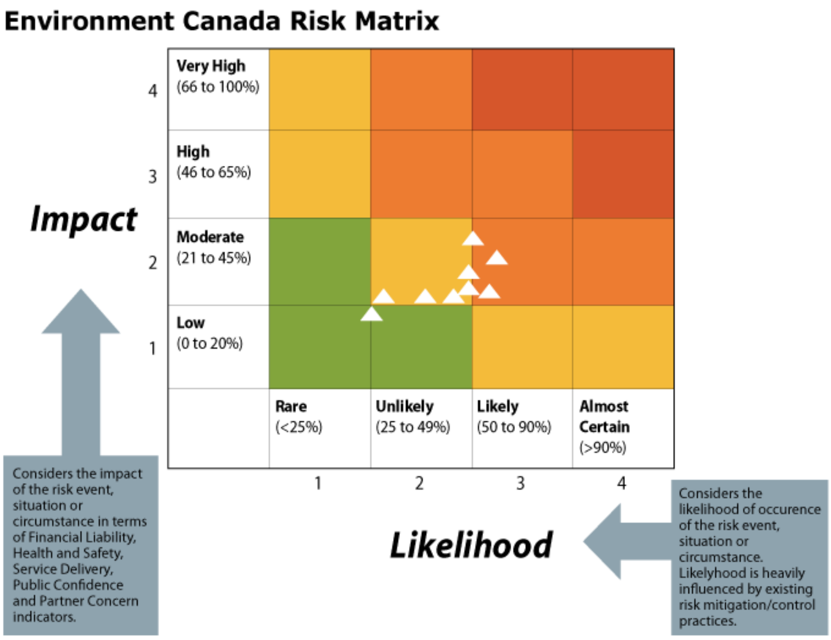

Figure 2. Environmental risk (harm) matrix, Canadian experience [8]

Nevertheless, it is always should beard in mind that risk - based approach to environmental management is related to environmental policy issue, objectives and environmental management plan dedicated to planed activities.

CONCLUSION

The basis for the preservation of environmental quality is existence of an effective environmental management system implemented at the all relevant activities and processes within organization. An objective selection of the most important environmental aspects means that the limited resources of organization are going to be allocated in the most positive manner (meaning greatest effects). With no less importance is a fact that effective environmental management systems actively contributes both to the environmental protection and corporate social responsibility of an organization.

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SOME ASPECTS OF DEVELOPMENT OF DUCTILE CRACK IN THE PROCESS OF COLD BULK FORMING

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Abstract: The main limiting factor in increasing the productivity of the process of cold bulk metal forming is the appearance of plastic fracture. However, proper design of a technological process can greatly increase formability of the material. For those activities it is necessary to fully understand all the factors that affect constituent stages of development and the appearance of macroscopic damage on metal components. Therefore, based on the available literature resources and our own research, the impact of the most dominant factors on accumulation of critical damage of microstructure in cold bulk metal forming processes with special reference to the impact of stress state was analyzed in this paper.
Key words: Ductile crack, stress state, cold bulk forming

INTRODUCTION

Plastic metal forming technology represents a very important and very broad technological area of production engineering. It is actually a highly productive technology which integrates a larger number of technological methods for obtaining metal components for a wide range of applications. According to relevant data [1], more than 80% of metal materials, in certain phases of processing, are being treated with some of the many technological processes of plastic forming.

The main characteristic of any deforming process is continuous change of the stress-strain state in order to obtain the required shape and dimensions of the working part. These changes usually lead to worsening conditions of processing, which is manifested by reduced formability potential of materials. The effects can be mitigated by appropriate choice of materials, heat treatment and design of manufacturing systems with the prevailing compressive stress in the forming zone. However, no matter what measures are taken, forming inevitably leads to the development of micro-structural damage. When the level of accumulated microstructure damage reaches a critical level, macroscopic defects can be observed on the workpiece that limit further processing of metals. In cold bulk forming the occurrence of plastic fracture is considered to be the main limiting factor for the continuation of production.

No matter that the phenomenology of initiation and development of plastic fracture of metal components represented a challenge for many researchers in the past, this issue still draws attention of scientific experts. It is known that a great deal of effort was invested to understand constituent phases of plastic fracture. In doing so, different approaches were used. A short review of mathematical description of the appearance of plastic fracture is shown in [2], and [3] analyzes the application possibilities of some criteria of plastic fracture. Also, extensive results are published in terms of quantification of microstructural damage and identification mechanisms of nucleation, growth and coalescence of microvoids, as initial forms of material destruction [4-6]. However, studies in the past have mainly focused on the forming process dominated by tensile stress components. On the other hand, there are also studies that deal with the issue of development of plastic fracture, quantification of microstructural damage and level of forming of the microconstituents in the process of upsetting [7-8].

Due to the complexity of the issues explored, the remaining part of this paper considers constituent phases of the development of plastic fracture with special attention to the factors that lead to initiation of various mechanisms of microstructure damage. In this respect very significant results may be those that will contribute to a better understanding of the impact of stress state on the occurrence of plastic fracture, taking into account the fact that it is possible to design machining systems that will stimulate the realization of a higher range of limit strain.

A SHORT REVIEW OF GENERAL CONSIDERATIONS

In the introductory part of the paper it was pointed out that the dominant limitation of metal processing with plastic forming, which is particularly evident in terms of the cold bulk processing, is the appearance of cracks or fracture. From the engineering point of view, there are two types of fracture: plastic and brittle fracture (Figure 1). The division is done depending on the level of plastic strain (accumulated energy) to which the material is subjected to before the damage.

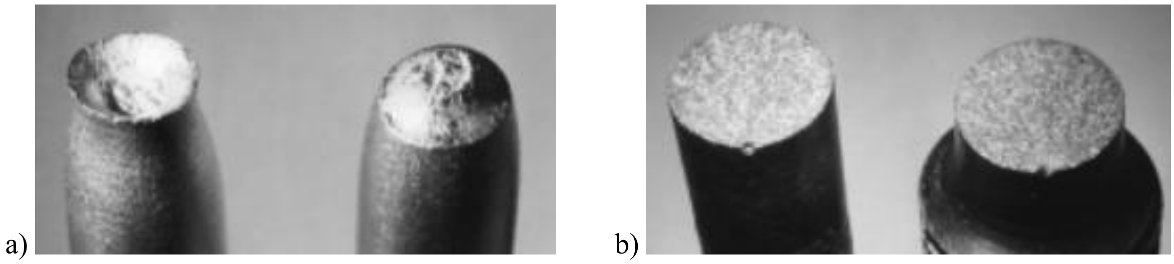


Figure 1. Types of fractures in metallic materials a) plastic shaped glasses and cone, b) brittle [9]

The appearance of broken surfaces in plastic and brittle fracture of steel with 0.4% C is shown in Figure 2. In morphological terms, the surface of plastic fracture contains large and small pits (created in the oxide non-metallic inclusions and carbide sediments), while on the surface of brittle fracture there are changes in cleavage plane on the subgrain limits with characteristic "river patterns" [10].

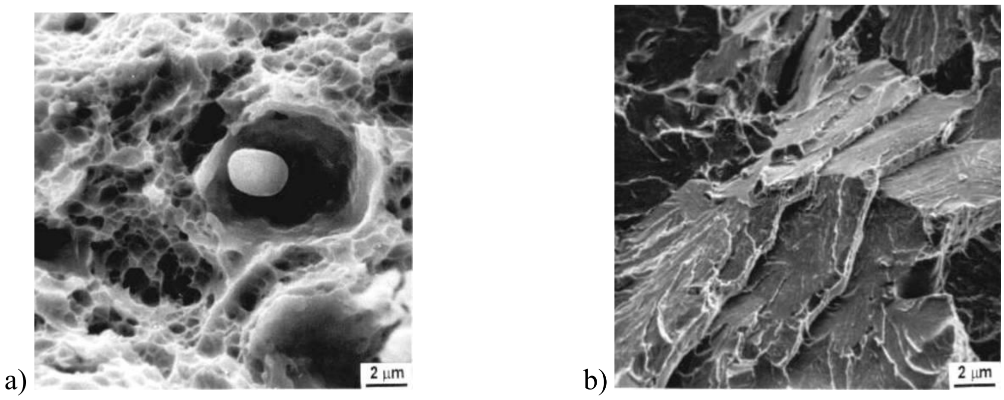


Figure 2. The appearance of broken surfaces - steel 0.4% C: a) ductile crack and b) brittle crack, (SEM) [10]

Plastic fracture tends to occur at higher amounts of strain and is characterized by relatively slow destruction of metal with considerable accumulation of energy. The emergence and development of plastic fracture in the process of tension is carried out through the following phases, which are schematically shown in Figure 3:

- nucleation (generating) of microcavities,
- the growth of microcavities,
- interconnection (coalescence) of microcavities, and
- fracture (destruction) of materials.

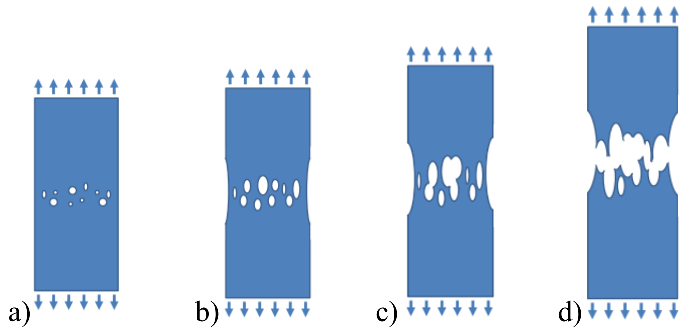


Figure 3. Schematic representation of phase of tensile plastic fracture:
a) nucleation, b) the growth, c) coalescence, d) destruction of materials [11]

It is known that in the process of super plastic forming of extremely pure materials the fracture can occur preceded by an extremely high value of plastic strain. However, for now only plastic fracture is considered the main reason for unsuccessful processing in conventional processes of bulk forming. Moreover, it should be noted that in the metal forming there are cases where plastic fracture is a projected part of the technological process of processing (e.g. Spark forming).

NUCLEATION OF MICROCAVITIES

In principle, commercial materials and alloys contain more hard and brittle secondary phases, which oppose the smooth running of a forming process. Microvoids are generated in areas around hardly formability particles as a result of a high strain level of the metal base. If the material contains only one type of secondary phases, at some point, under unfavorable constellation of stress-strain relations nucleation of microvoids can occur. With the increase of external load in the process of forming, strain strengthening of material and generation of higher tensile values takes place on the boundary surfaces of crystal grains of the metal base and secondary phases. When the strain reaches a critical value, border areas are separated, and there is a fracture of particles. The influence of the type and volume of particles of secondary phases on the plasticity of steel material in tension is shown in Figure 4.

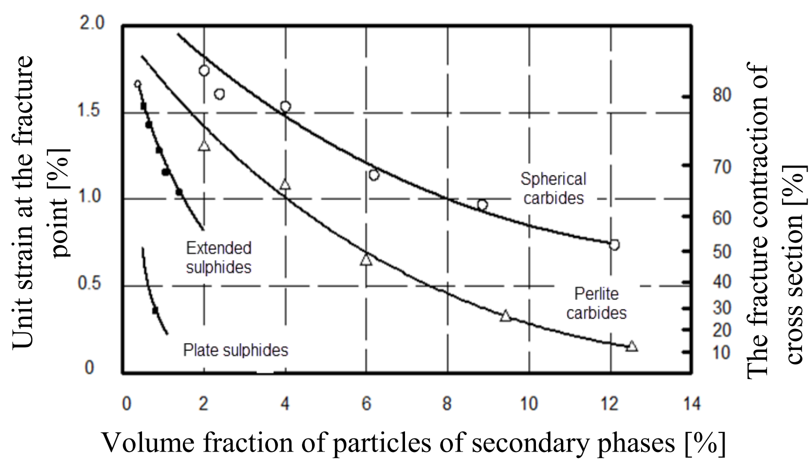


Figure 4. The impact of the volume fracture of particles of secondary phases on plastic properties of steel in tension [12]

In the initial phases of development of plastic fracture, nucleation of microcavities takes place continuously, but not the same time in all secondary phases. First microvoids are mainly generated by larger particles (usually on a non-metallic inclusions) and with increasing the level of strain they grow, with simultaneous nucleation process in the smaller particles. The process becomes even more complicated for materials which contain several types of secondary phases. The mechanism of nucleation of microvoids in steel materials can be different [4-7]. One of the often present mechanisms is decohesion, the occurrence of microvoids at the interface between the second phase and the metal base. The microvoids occur as a result of various possibilities of strain of soft base and hard particles of secondary phases. In general, decohesion may be present in border areas between the grains of the metal base.

The size of the critical strain, at which the process of nucleation of microvoids begins to unfold with mechanism of decohesion, is influenced by several factors [13]: content, size, shape and orientation of the particles of the secondary phase, particle strength, strength of metal base, generated stress state on border surface, strength of border surface, achieved level of strain, the ratio of hydrostatic and effective stress, processing temperature, deformation speed, and so on. According to literature data, to different theoretical approaches are used to define the critical level of deformation in which the secondary particles lose their connection with the metal base.

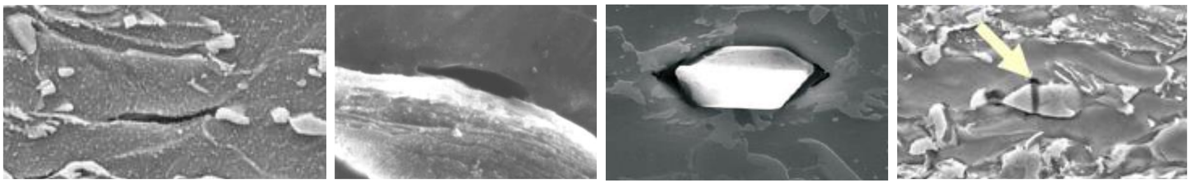
On the basis of energy criteria, nucleation of microvoids on the border surface between the secondary phase particles and metal base can happen when local concentration of accumulated elastic energy becomes equal to the amount of energy needed to create a new surface. However, this condition is not sufficient, because it does not take into account the effects of local plastic deformation. Strain criterion is based on the assumption that the greatest influence on the formation of microvoids decohesion is exerted by the increasing level of strain, causing intense accumulation of dislocations near the border surface. According to stress criteria, beginning of decohesion primarily depends on the size of surface stress at the border surfaces, i.e. on the strength of the border surface. The stress-strain criterion assumes that large stresses and large strain are necessary for the process of nucleation with mechanism of decohesion. This in practical terms means that a high dislocation density is not a sufficient condition for the creation of microvoids, but shear stresses are necessary in order to move dislocation loops to the border surface. Regardless of the possibilities offered by the above criteria, in micromechanical modeling of nucleation microvoids with mechanism of decohesion it is assumed that the particles of the secondary phase are deformed only elastically, and metal base plastically [14]. Another mechanism of nucleation of microvoids in the process of forming is fracture of secondary particles. Previous studies have shown that in terms of cold forming the start of fracture depends on the shape, size and brittleness of particles, but predominantly on the level of strain. The main impact of brittle particles in the generating and development of microstructural damage is manifested by the change of the local stress state, in the zone of its immediate surroundings. Size of stress concentration primarily depends on the form of secondary particles. In doing so, the smallest effect is manifested by spherical particles. However, for other types of particles, stress concentration is intense and not only present on the border surface, but extends to a metal base. Therefore, the dimensions of the microvoids which are generated by fracture mechanism of lamellar particles are higher than the dimensions of microvoids resulting from the fracture of globular particles. To describe the fracture mechanism of secondary particles two models are used: fiber load model and dislocation model [13]. Regardless of different theoretical approaches, both models are formulated on the assumption that local stress increase due to forming of the metal base with sliding mechanism is necessary for the development of microvoids in the particles.

According to Benzerga [15], there are key parameters that affect the nucleation of microvoids. Their effect is, depending on the dominant mechanism, represented in Table 1.

Table 1. The impact of key parameters on the mechanism of nucleation of microvoids [15]

Parameter	Trend of influence	
	Decohesion	Fracture
Flow stress of metal base	-	+
The coefficient of deformation reinforcement of metal base	-	+
Elongation of particles of secondary phase	-	+
The strength of particles of secondary phase	+	+
Axial load	-	+
Transverse load	+	-
The ratio of hydrostatic and effective stress (σ_H / σ_e)	+	-

Typical examples of nucleation of microcavities nucleation with decohesion mechanisms and fracture of the secondary particles are shown in Figure 5. At the same time mechanisms of decohesion and fracture are shown in Figure 6.



a) b) c) d)

Figure 5. Mechanisms of microcavities nucleation: a) decohesion on the border area of ferrite grain [5], b) decohesion and creating of microcavities at the border area of martensite / ferrite [6], c) decohesion on border area of dual phase steel and aluminum-oxide inclusions [16], d) nucleation of microcavities with mechanism of fracturing martensite particles [4]

In addition to the mechanism of nucleation due to decohesion or fracture of secondary particles, microstructure damage in the process of deformation can occur in other ways. Sidjanin and Miyasato [6] observed that the nucleation of microcavities in tension happen in places of tripartite merger of border area between the two ferrite grains and martensite - Figure 7.

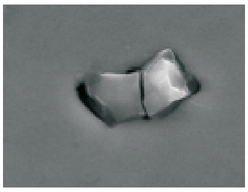


Figure 6. Nucleation of microcavities of with mechanism of decohesion and fracture [16]

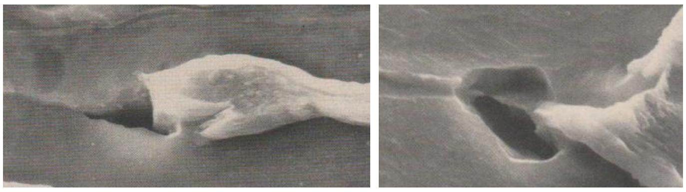


Figure 7. Nucleation and growth of microcavities at place tripartite merger between the two ferrite grains and martensite [6]

Microcavities can be generated in places of tripartite merger of crystal grains of the metal base (e.g. where three ferrite grains are connected), but it mainly happens only at higher level of strain [7].

GROWTH OF MICROCAVITIES

The growth of microvoids phase is closely related to the presence of hydrostatic stress because the intensity of growth greatly depends on the character of the effect of certain components of the stress (domination of compressive or tensile stress) in the forming process.

The initial research of this phase of the development of plastic fracture aimed to analyze a microvoid in the infinite part of the plastic material. It was found that the intensity (speed) of growth of cylindrical (McClintock) and spherical shape cavities (Rice and Trasey) depends on the realized stress-strain state and coefficient of strain hardening [13, 17]. Therefore, the material damage caused by coalescence of microvoids will be promoted only in high ratio of hydrostatic and effective stress. Further research of Rice and Trasey is concerned with the analysis of the impact of strain hardening in the process of growth of microvoids. The results showed that the increase in strain hardening requires a higher ratio $\sigma H / \sigma ef$, if a constant value of growth rate of microvoids should be retained. Rice and Trasey's microvoids growth model is based on the analysis of a single microvoid and does not take into account the possibility of their mutual interaction, and does not foresee eventual damage to the material.

The best known constitutive model to describe the growth of microvoids in material damage when tightening has been proposed by Gurson [14]. He defined a criterion of approximate growth of cavities in porous materials with a rigid perfectly plastic material base. The model has been further improved by Tvergaard, who studied strain and damage in the development of a series of cylindrical microvoids based on a simulation using finite element method, taking into account the strain strengthening in the matrix material [18]. A typical example of the growth of microvoids in the tension process is shown in Figure 8. SEM results were obtained during the research of the impact on the distribution of martensite microstructure in the development of damage to the two-phase ferritic-martensitic steel [4].

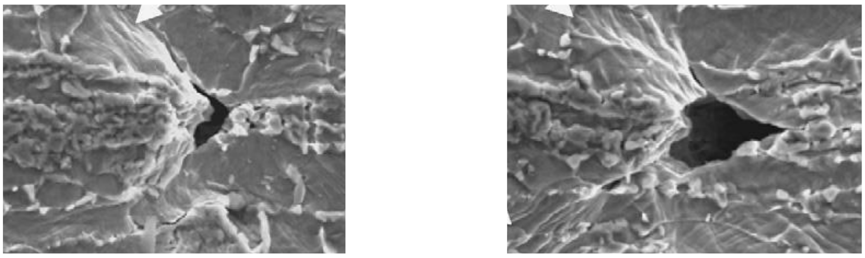


Figure 8. The growth of microvoids in tension of dual phase ferritic-martensitic steel [4]

In paper [2] more information was announced concerning different theoretical approaches used in defining criteria of plastic fracture which are based on models of microvoid growth.

COALESCENCE OF MICROCAVITIES

The final phase of development of plastic fracture is characterized by the intense coalescence of microvoids (Figure 9). With the less plastic materials the process of connecting of microvoids begins immediately after their nucleation. However, if the material has a certain potential of deformability the coalescence will take place in the microvoids, which previously increased significantly.

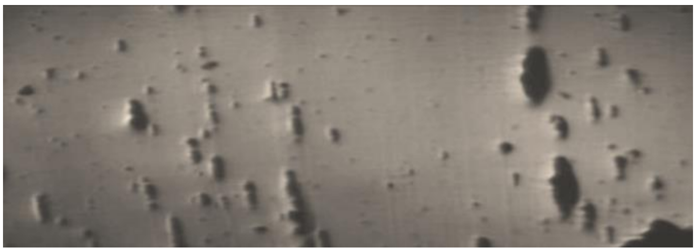


Figure 9. Connecting cavities in the area of sample fracture in tension [19]

The most important and most commonly used criterion of coalescence of microvoids has been suggested by Tvergaard and Needleman. Basically, it is a modification of the Gurson's model, according to which the coalescence of cavities occurs at a critical value of cavity fraction. In doing so, the effects of nucleation of new and growth of existing cavities are taken into account. Benzegra [15] proposed a micromechanical model of coalescence of cavities based on microstructural parameters such as the size of the ligament between the cavities, and the shape and distribution of cavities. The model can successfully predict the acceleration factor of coalescence and critical volume fraction of cavities in Tvergaard - Needleman's criteria.
According to [15], coalescence of microvoids can be done in two ways, depending on several parameters, with the character of generated stress state effect having the strongest impact (Figure 10).

a) b)

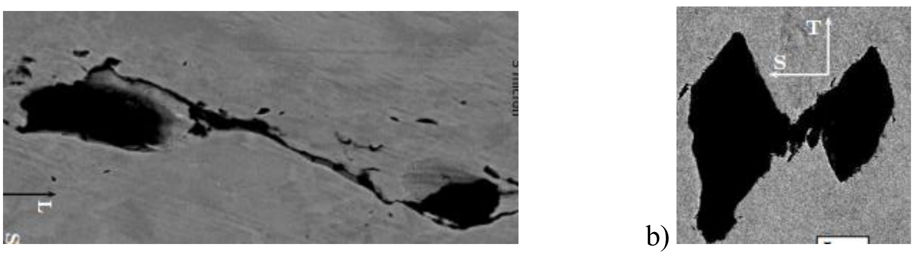


Figure 10. Coalescence of microvoids: a) fracture of the ligaments due to shear instability, a) fracture of the ligament due to reduction in cross-section [15]

Forming processes that are implemented when compressive stress prevails are characterized by the occurrence of coalescence due to tearing ligaments between microvoids due to shear instability - Figure 10a. On the other hand, due to the effect of tensile stress, coalescence occurs gradually, as a result of reduction in cross-section of ligaments between the microvoids, which have previously increased substantially - Figure 10b.

THE EFFECT OF STRESS STATE ON THE OCCURRENCE AND DEVELOPMENT OF PLASTIC FRACTURE - "STRESS TRIAXIALITY" CONCEPT

The previous analysis of phases of plastic fracture indicates that the generated stress state activates certain mechanisms of microvoids nucleation, where the start and intensity of microstructure damage are directly affected by the character of external load. For the same level of plastic strain, the level of damage to the constituents of microstructure is larger under the influence of tension in comparison to the compressive stress state. Therefore, in the scientific and technical literature the effect of stress state on the development of damage to the material is studied by using the so-called "stress triaxiality" concept, which basically constitutes dependency of the effective strain at the point of fracture formation) on the ratio between hydrostatic and effective stress $\eta = \sigma_H / \sigma_e$:

$$\varphi_e^g = f\left(\eta = \frac{\sigma_H}{\sigma_e}\right) = f\left(\frac{\dfrac{\sigma_1 + \sigma_2 + \sigma_3}{3}}{\dfrac{1}{\sqrt{2}}\sqrt{(\sigma_1 - \sigma_2)^2 + (\sigma_1 - \sigma_3)^2 + (\sigma_2 - \sigma_3)}^2}\right) \tag{1}$$

Where σ_i, i=1-3 are the main components of normal stress.

This approach enables to present the character of stress state and to take into account its impact on the emergence and development of plastic fracture.

In the past, a number of studies have been published that have focused on this issue (e.g. Atkins [20], Brünig [21-22], Li [23], Barsoum [17]). The results of experimental - numerical research have shown that in addition to increasing the level of strain, the ratio σ_H / σ_e plays a key role in the formation of fracture in the plastic material. Variation in η factor is mostly achieved through tensile tests, where real or virtual models of samples were used with different geometrical configurations of the reference part. In paper [24] it was pointed out that Bao and Wierzbicki also extensively studied the impact of character of stress state on plastic fracture. Perhaps the most important result of their work is the criterion that graphically interprets the dependence of effective strain in the fracture φ_e^g on the ratio $\eta = \sigma_H/\sigma_e$ - Figure 11. According to Bao - Wierzbicki criterion, the critical level of accumulation of microstructure damage occurs when effective deformation reaches an amount that is greater than the limit values shown in Figure 11.

However, it is obvious that this phenomenon affects the conditions in which forming process takes place. In fact, depending on the value of "stress triaxility" factor η, which, among other things, affects the activation of specific mechanisms of coalescence of microvoids in the process of deformation two morphologically different types of plastic fracture can occur.

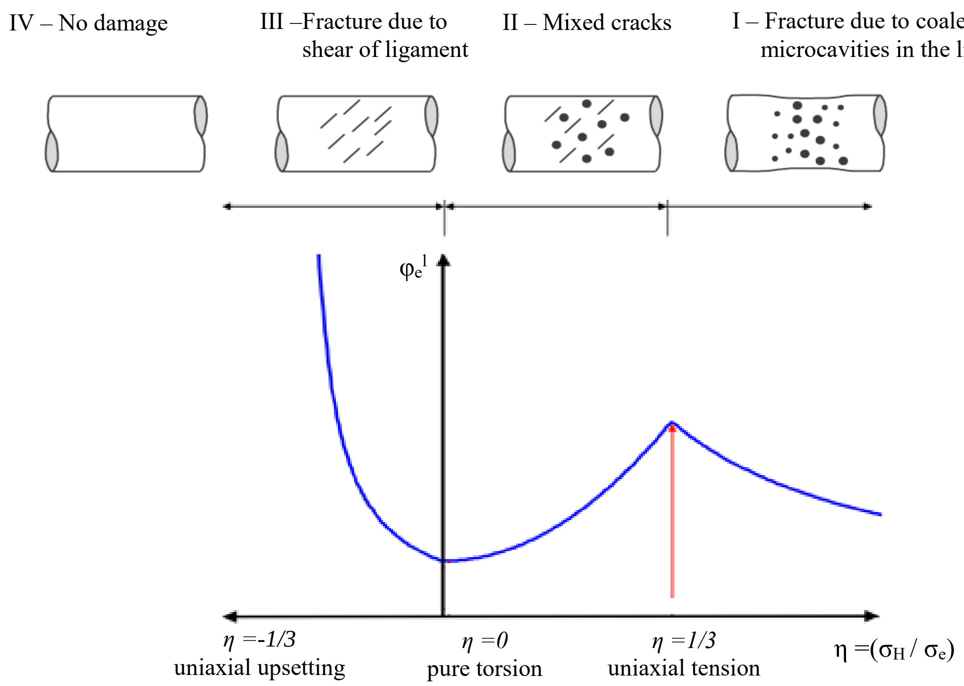
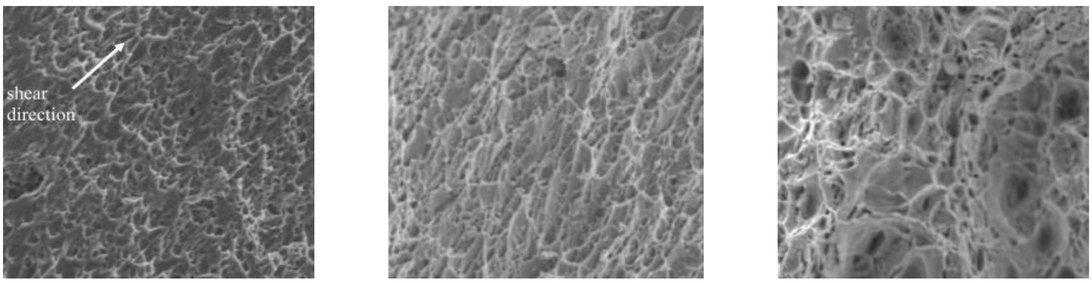


Figure 11. Graphical representation of Bao - Wierzbicki criterion - dependence of the effective strain at the fracture point on ratio (σ_H / σ_e) [24]

If such a state of stress is generated in the material where factor $\eta <0$, the coalescence of microvoids takes place with mechanisms of tearing ligaments due to shear instability. Macroscopic damage to metal components that arise in these circumstances are known as "shear" pitting fractures. But, if $\eta > 1/3$, then damage is generated as a consequence of nucleation of microvoids, wherein the growth and finally coalescence occur due to decrease in their mutual distances. In this case "level" pitting fracture arises. In the transition area $0 < \eta < 1/3$ simultaneous action is characteristic of both coalescence mechanisms. It is experimentally confirmed that the value of $\eta = -1/3$ is the lower limit below which hydrostatic power has no effect on the value of strain at the fracture point.
Barsoum and co. [17] have, through extensive studies of this issue, confirmed the influence of "stress triaxility" factors on the occurrence of plastic fracture. By changing the stress conditions from low to high values of η factors, using SEM microscopy, the effect of different mechanisms coalescence of microvoids was identified (Figure 12), which affected the morphology of fracture surfaces. The appearance of the fracture surface, which was formed at low values of η factor is characterized by small shallow pits (the average value of less than 5 microns, [17]), whose elongation orientation is in the direction of shear (Figure 12a). This is due to the impact of the stress state, which did not allow high growth of microvoids before their coalescence. Figure 2.15c reveals a completely different mechanism of plastic fracture. There are great deep pits on the fractured surface. They occurred as a result of significant growth of generated microvoids, which was fueled by high values of η factors. Some of the microvoids before coalescence reached value up to 15 microns, [17].



a) η =0,47 b) η =0,85 c) η =1,10

Figure 12. The appearance of broken surfaces in high-strength steel: a) low value of η factors, b) the transition area, c) high value of η factors [17]

But, Barsoum and co. claim that it is more reliable to predict the initiation and development of plastic fracture through a parameter that characterizes deviation stress state (Lode parameter). This especially refers to the processes of forming in which low values of "stress triaxility" factor are present. Explicit influence of stress state on the value of forming limit, as numerical indicators of material formability, has been experimentally verified in many published studies. The results presented in [25] show that when testing samples made from low carbon steel about eight times higher value of the effective strain limit is obtained under the conditions of uniaxial compression than when the same samples were deformed by uniaxial tension. A typical example of the influence of stress state on the possibility of forming has been presented in the paper by Kampuš and et al. [26]. The results of experimental studies indicate an increase in formability of the material in the process of deep drawing with a reduced wall thickness, by an additional force which compresses the workpiece rim during processing. Also, the results show that the strain limit can increase up to 40% in this way. The paper further points out the possibility of obtaining pieces with flat rim, which is not typical in the processing of the same parts without intensified compressive effect. Extensive research results on the impact of stress state on the limit design possibilities in the process of cold bulk metal forming were presented in the publication by Vujović [27].

CONCLUSION

Initial microstructural state is a very important factor in the formability of the material, because the distribution, orientation, shape and proportion of particles of secondary phases have a dominant influence on the nucleation and growth of microvoids. But, the forming process is equally important because the creation of an adequate processing system can affect the generation of the stress-strain state that will slow the development of damage in microstructure and propagation of plastic fracture. Thus, an integral approach when studying possibilities of limit forming, based on multidisciplinarity, represents a promising solution for optimal and rational design of technological processes in cold bulk processing.

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Session 2.

Environmental Protection Engineering and Occupational Safety

CASE STUDY: ASSESMENT OF ENVIRONMENT POLUTION DURING CONSTRUCTION AND OPERATION OF SMALL HYDRO POWER PLANT SHEMNICA

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Abstract: Subject of this article is to review the condition of environment during construction and operation of small hydro power plant (SHPP) 'Shemnica' with ref. No. 267 in the village Malovishte, Municipality of Bitola, Macedonia. Possible negative impact on the environment will be assessed and measures will be determined in order to protect the environment during construction and operation of the SHPP for the needs of the Company ENERGOREMONG-MZT-Herz DOO Bitola. The case is even more specific since the location of the SHPP is in the National Park (NP) 'Pelister' that is protected by the Law with very strict regulative and standards regarding changes in environment during construction and operation phase.
Key words: environment, hydro power plant, protection measures, noise, dust, waste

INTRODUCTION

One of the objectives in the development of water management of Republic of Macedonia is full and rational utilization of the hydro potential of waterways within multifunctional systems. Of the total usable hydro potential in the country, some 30,5% have been used so far. Construction of small hydro power plant on the river Shemnica represents realization of the objectives of Spatial Plan of the Republic of Macedonia for rational and full utilization of water resources in the country. Small hydro power plants can be built independently, at places where they would not endanger conditions for realization or functioning of greater regional energy systems.
Assessment for pollution coming from SHPP Shemnica, located in the vicinity of NP 'Pelister' and its influence on the environment with description of current situation of the environment regarding natural-geographic characteristics of the area, climate-meteorological conditions of the area and condition of three media, namely air, water and soil.

MATERIAL AND METHODS

Natural – geographic characteristics of the area

Location of the SHPP is approximately 20 km from the city of Bitola, south from the village of Malovishte, at an altitude between 1099,24 and 1255,55 m.

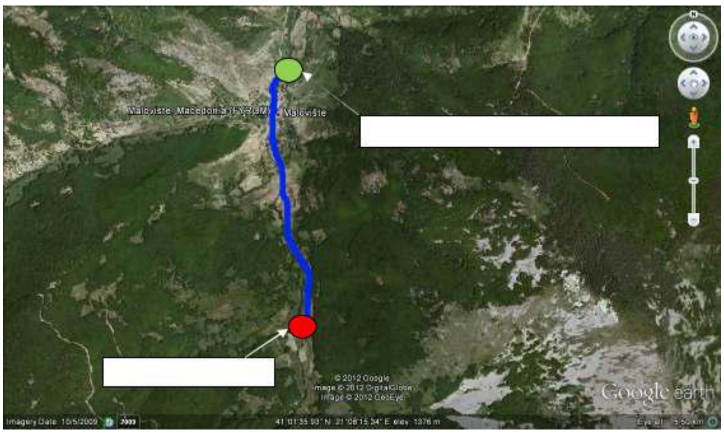

Figure 1. *Satellite image of the location of SHPP 'Shemnica'*

This location is completely inside the borders of NP 'Pelister'.

Hydrogeological characteristics of the area

Hydrogeological characteristics of the researched location depend upon morphological characteristics of the terrain, geological composition and climatic conditions. From the hydrogeological point of view, the complete area of the researched location belongs to the Vardar basin, which, as a main water artery accepts waters from the surrounding smaller rivers. One of the most important rivers in this area is river Shemnica with its smaller tributary Malovishka, that has flow of 1-2 m^3/sec, depending on the time of flow measurement, i.e. it is larger during winter and lower during summer months. Remaining water flows that can be found at the researched area are temporary and ran dry during summer period. Within the investigated area, along the route of the pipeline, several water sources at different elevations with small yields are also registered.

From the hydrogeological aspect, solid rock mass: series of green shales and metagabbro have low water permeability, are characterized with slight porosity and high values of filtration coefficient represented with blocks with sandy gravel and as a part of deluvial sediment represented by sandy grains. Hydrogeological insulators from friable rock mass include certain part of deluvial built mostly from sandy and clay dust, characterized with capillary or super-capillary porosity and poor filtration characteristics.

Influence of climatic elements (temperature, humidity, solar insulation, cloudiness, precipitation, wind, etc.) and climatic factors, affect the development and existence of the entire living world, complete human activity and certain processes in nature, as significant element in the biosphere [1],[2],[3].

In the Republic of Macedonia two climate types prevail – Mediterranean and Continental. Therefore, two specific seasons exist: cold and wet winter, characteristics of Continental climate and dry and hot summer that corresponds to Mediterranean climate. Apart from Mediterranean and Continental, in higher mountainous areas, mountain climate occurs, characterized with short and cool summer and pretty cold and medium wet winters where precipitation is usually in a form of snow.

IMPACT OF SHPP ‘SHEMNICA’ ON THE ENVIRONMENT

Harmful effects vary in intensity, spatial distribution, diversity and duration of the impact. Result of these harmful effects is usually degradation of the entire eco-system through pollution and devastation of soil, water and air.

Influence on the air, expressed through:

- Air pollution by flying dust fractions (solid particles), emission of harmful gases (CO_2, NO_x, CO, etc.);
- Change of microclimate and creation of zones with specific microclimate, different than the climate of the surrounding area;
- Noise as specific factor of environment pollution, both from the psychological (comfortable) and physiological aspect.

Influence on the water, expressed through:

- Change in regime of underground and surface waters;
- Possibility of migration of some harmful components causing pollution of surrounding underground and surface water flows;

Influence on the soil, expressed through:

- Change in micro relief and orography of the terrain as a result of which there is change in landscape;
- Taking up of valuable agricultural land;
- Change in paedological and geological composition of the soil;
- Destabilization of natural orographic structures and buildings constructed on the surface, due to the action of seismic effects;
- Waste generation.

Influence on the air, water and soil, which are basic bearers of the entire living world, lead directly to changes and cause damage, i.e. degradation of flora and fauna, either created by nature or created by humans.

Air emission – emissions of gases and dust

Air emissions, according to the Law on protection against pollution, are categorized as: emissions from boilers, stationary emissions from stationary and mobile sources and potential and fugitive emissions [3],[4].
Air emissions during the construction of the project are more intense with the increased presence of machinery on site. These emissions are of temporary character and will not have serious impact on the environment. Dust occurred during excavation for project implementation, as well as during ground clearing.
It can be noted that the main effect from gas and dust emissions at the location during construction phase are intense, but without permanent effect. In the operation (exploitation) phase, no harmful air emissions were recorded.
Internal combustion engines running on diesel fuel emit exhaust gases containing cca 180 organic compounds as harmful substances. Lead content in gasoline is up to 0,6 g/l. Approximately 75% of lead content is emitted through exhaust gases and cca 95% of sulphur content is burned to SO_2.

Contents of part of emitted harmful substances is given on following table:

Table 1. Contents of part of emitted harmful substances

COMPOUND	GASOLINE ENGINES	DIESEL ENGINES
	g/l	g/l
Sulphur dioxide	0,4	4,5
Nitrogen oxides	20	90
Organic volatiles	40	110
Total suspended particles	3	15
Carbon dioxide	220	90
Lead	0,45	0
Benzo pyrene	20 mkg/m^3	10 mkg/m^3

Long-term exposure to toxic substances mentioned above, adversely affects human health: smoke affects the respiratory system and skin, lead affects respiratory, nervous and blood system, nitrogen oxides cause asthma, allergies and cancer. Carcinogenic effects are also caused by solid particles from burning.

Maximum permissible concentrations (MPC) for harmful substances are given in following table:

Table 2. Maximum permissible concentrations (MPC) for harmful substances

Compound	Emission quantity	Emission concentration
	MPC (g/hour)	MPC (mg/m^3)
Lead	25,00	5,00
Nitrogen oxides	50000,00	500,00-800,00
Hydrocarbons		500,00
Formaldehyde	100,00	20,00
Solid particles		130,00
Carbon monoxide		650,00
Carbon dioxide (%)		2,50

Use of environmentally friendly fuels that are currently being introduced in petroleum products retail, will drastically help to reduce the negative environmental impacts. Green belt around the object as a natural filter will also contribute to the reduction of the alleged air pollution.

Conclusion: From the operation of the facility it is established that there are NO volatile organic components (VOC).

Emissions to water and sewage

From the description of the project with its activity and the technological description of the activity performed, we can conclude that during the operation of SHPP 'Shemnica' there will be no technological process that will cause occurrence of wastewater.
During construction of SHPP 'Shemnica' wastewater appeared in from sanitary character from the employees of SHPP. Mobile toilets TOIFOR were used. For sanitary needs expected average daily production of wastewater ranges from 50 - 120 liters per person. According to available data, for smooth operation of this capacity, there are 25 employees in the company.
According to above mentioned standard average production of 120 liters per person, in total the daily production of sanitary wastewater reaches maximum of 3 m^3.
Average physical condition of wastewater from this sources, based on correlation with average quality of canal water would be as follows (in g/l):

Table 3. Average physical condition of wastewater in g/l

matter type	mineral	organic	Total	BPK-5
Suspended	230	590	820	385
a) deposited	135	360	495	180
б) non-deposited	95	230	325	205
Dissolved	725	725	1450	110
TOTAL	955	1315	2270	495

During the construction of SHPP 'Shemnica' there was no impact on groundwater since the construction predicts only shallow excavations.
Operability of SHPP could result with minor potential impact on water quality, especially during maintenance activities and control of infrastructure and equipment.

Municipal Solid Waste (MSW)

During the construction of this capacity, very small amount of biodegradable solid waste was produced due to daily activities of employed persons, while it is not expected any production of solid waste during the operation because there will be no permanent staff in the SHPP.
Around 1 kg of waste per person daily, in a form of paper, plastics, food remains, tin and cardboard packaging are expected. Certain quantities of waste cardboard and plastic packaging of raw materials should be added to this type of waste.
Municipal waste will be collected in a metal container and will be taken over by the public utility company which operates in the municipality of Bitola, which will further be recycled or deposited at the city landfill.

Emissions to the soil

During preparatory works, minimum negative impact of the location due to humus removal and leveling of the terrain foreseen for construction of buildings (intake weir, pipeline, power house and auxiliary road) is expected [4],[5]. Material from the excavation, if the conditions allow, should be reused (for instance, to backfill the pipeline since it is underground), while the excess of soil should be deposited to a place allocated by the Investor.
Most adverse influences occur during the construction phase and are usually result of using the construction machinery. Having in mind the presence of construction machinery at the construction site, during construction works, there is potential danger of releasing fuel and oil and their penetration into ground (soil) thus causing direct groundwater pollution. This influence is of short term character and limited only to construction phase.
In exceptional circumstances, spillage of hydraulic oil can occur. The same is not present in larger quantities (~50 liters) and it would be gathered in concrete bathtub under the turbine. In case of spillage during transportation of hydraulic oil, it is planned to remove the top layer of contaminated

soil and its transportation to a location allocated for such purpose. Contaminated soil will be replaced by a clean one. Continuous emission in soil are not expected during construction phase.

Conclusion: from all of the above, we can conclude that the object, subject of this article, does not contaminate the ground (soil).

Noise, vibration and non-ionizing radiation

Noise is every sound that is not wanted by the perceiver, because it is unpleasant, loud, or interferes with hearing [7], [9]. Sound with greater intensity, regardless of whether or not it is registered by the sensory system of humans (or animals) may have especially harmful influence on their organisms. This influence primarily reflects on the central nervous system, and through it, to other organs as well (including the heart and blood vessels, endocrine glands, etc.).

Because the investor plans to build SHPP 'Shemnica' using latest technology, but because the company is located outside of populated area and not surrounded by other objects, it is expected that the noise will be in accordance to the Law on protection against noise in the living environment (Official gazette of RM, No. 79/07).

Due to the fact that the object is located outside urban area – area with IV degree of protection against noise (Rulebook for location of measuring stations and measuring points, Official gazette of RM, No.120/08) noise emissions are expected to be lower than permitted according to the Rulebook for limits on noise levels in the environment (Official gazette of RM, No.147/08).

Level of noise emitted from the establishment has been measured and it is found that the level is in accordance to the Rulebook for preparation of elaborates for environment protection (Official gazette of RM, No.147/08) and with the Rulebook for limits on noise levels in the environment (Official gazette of RM, No.147/08).

RESULTS AND DISCUSSION

Measurement of dust in the occupational area

Dust measurement is performed with handheld dust detector DUSTMATE (Fig. 2), product of TurnKey, Great Britain. The instrument has nefelometar that collects air through a pump, while the dust is measured with laser beams. Instrument possesses built memory for data logging. Measuring range of the instrument is from 0 to 6000 $\mu g/m^3$, with particles of diameter 0,5 to 20 μm and possibility for measurement of total solid particles (TSP), PM10, PM2,5 and PM1,0.

Measurement of microclimate and physical hazards

Measurements are performed by means of specialized calibrated device for measuring of temperature, humidity, air flow, noise and illumination, product of METREL Slovenia, type MI6201 MULTINORM (Fig.3). This instrument also has built in memory that can record great number of measured values.

Figure 2. Results from the performed measurements of dust with the instrument TURNKEY DUSTMATE

Figure 3. Results from performed measurements of noise in front of the powerhouse

From the measurement results it can be concluded that there is a certain amount of noise that does not exceed the permissible values, but is quite close to it. The noise is continuous throughout the 24-hour operation of the power house where the turbine impeller is installed. This condition is not recommendable for the health of population living nearby, so certain constructive measures are required to diminish these effects.

In order to protect the environment at the part where, currently, mesh is installed, it is necessary to install **panels for noise protection**.

Мерни места за бучава измерени во околина на МХЕЦ Шемница, бр. 267

Мерно место	Измерена вредност во dB(A)
Мерно место - 1	52.2
Мерно место - 2	58.5
Мерно место - 3	54.6
Мерно место - 4	48.2
Мерно место - 5	47.1
Мерно место - 6	70.3

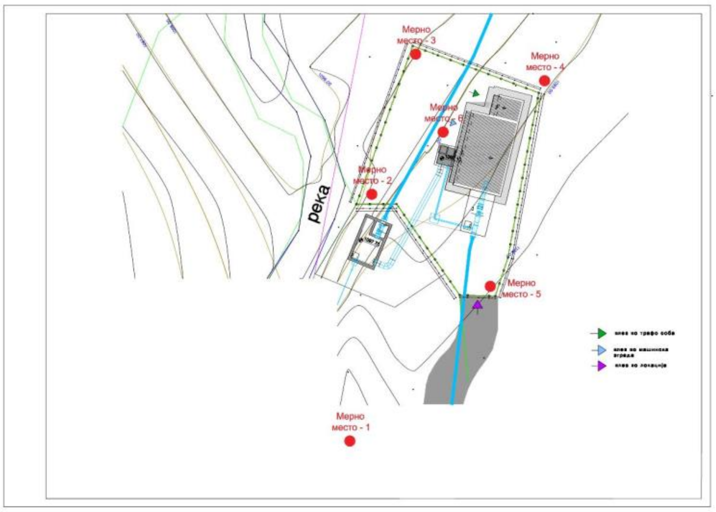

Figure 4. Measuring points for noise measurement in the vicinity of SHPP ‘Shemnica’

Figure 5. Setting up a structure for stacking the panels for noise protection

Protection for air pollution

Anti-dust protection should be carried out by spraying water on roads and the construction site during dry weather. Planting lush vegetation around potential sources of contamination is a natural dam against emission of particles into the surrounding living space.

Water protection

1. To be careful for leakage when working with oil, and to dispose waste properly;
2. Organization of construction site with cabins, toilets with organized maintenance;
3. Particular attention should be paid in order to avoid increased deposition of materials at river crossings;
4. For water protection inside hydro power plant, filters for purifying water are installed.

Waste management

1. Reduce of waste by the employees;
2. Signing of contract with the public utility operating in municipality of Bitola for taking and further management of non-dangerous waste;
3. Appropriate storage of dangerous materials near the barracks and their use during the construction. Installation and utilization of suitable system for deposition in order not to harm the environment.

Flora and fauna protection

1. Fencing of construction site in order to enable safe passage of animals;
2. Covering of pipeline and reinstating the route to its original condition;

3. Reducing plants cutting, as much as possible, along the route of the pipeline;
4. Restoring vegetation cover with native species;
5. Maintaining minimum river water flow;
6. Use of existing access roads/minimize the construction of new access roads.

CONCLUSION

The subject of this article is to explore the probability of endangering living environment during construction of Small Hydro Power Plant (SHPP) on river Shemnica. An analysis of the environmental ecosystem has been made. An analysis of technical equipment and construction of intake water weir on river Shemnica, pipeline and power plant has been made from the point of view of their impact on the environment. We made a retrospective of the theoretical potential sources of environmental pollution. Measurement of noise around the power house of the SHPP has also been made. We tried to establish a methodology for assessing the impact of the plant environment, whether it exists and if it does, which measures my assistance, by research. This methodology can be used for preparation of ecological elaborates for environment and ecosystem protection during operation of small hydro power plant. Analyzed example is typical because the subject SHPP is located in National Park ‘Pelister’, protected by the Law and with very high criteria regarding environment protection.

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ESTIMATION OF ENVIRONMENTAL IMPACT OF BUILDING ENERGY BY LIFE CYCLE ASSESSMENT

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Abstract: The share of building sector in total energy consumption is around 40%. Benefits of energy-efficient construction are reflected through financial savings as well as environmental protection. Measures for energy savings in the construction are often related to reduction of heat losses through the building envelope. These savings apply only on energy needed for building operational phase. Very often the phase of material extraction and the construction are not taken into consideration. Sustainable construction involves application of building materials that are not harmful to the environment. For the assessment of environmental impact of buildings and building components the most suitable method is life cycle assessment-LCA. LCA can be easily applied for new buildings and the refurbishment of old buildings to assess the impact on the environment of whole building or the particular streams and flows such as energy flow. Selection of building materials is crutial for nearly zero energy buildings because the embodied energy of such buildings is equal to whole energy consumption. Impact of construction sector on the environment could be significantly reduced by using green eco materials or waste generated products instead of finite natural resources.
Key words: life cycle assessment, buildings energy consumption, embodied energy

INTRODUCTION

Preservation and the protection of the einvironment nowadays is one of the biggest challenges for scientists especially due to the evident climate changes often related to extensive usage of energy and green house gasses emissions. Literature review shows that residential buildings account for 40% of total energy consumption in the world. Although the energy efficiency measures impact on energy consumption reduction, this refers to the aspect of the building usage. Beside operational phase buildings demant energy for production and transportation of materials, construction and disposal. Environmental impacts related to the materials extraction, production and transport need more careful examination. The awareness of environmental pollution does not necessarily mean protection. Regulations, analysis tools, dedicated professionals, activism and changes in behavior are needed in order to change from consciousness to environmental protection [1]. Extensive literature review shows that the main instruments for environmental protection are: Life Cycle Assessment-LCA, Environmental Impact Assessment-EIA, Strategic Environmental Assessment-SEA, Environmental Risk Assessment -ERA and others such as Cost-Benefit Analysis (CBA), Material Flow Analysis (MFA) and the Ecological Footprint. [2] This research deals with the methodology for life cycle assessment of buildings and the possibility of using this methodology for understanding the impact of energy consumption of a building through all stages of the life cycle.

LIFE CYCLE ASSESSMENT (LCA)

The methodology of life cycle assessment (LCA) was developed during the 1990s and it was a subject of many criticisms after being published. Since then this method has undergone numerous corrections and harmonization [2]. International Organization for Standardization (ISO) determined the application of LCA method through standard ISO 14040 in 1996/97 and since then this methodology is under constant development which can be verified by the fact that the original version of the standard was replaced by a new version in 2006.
LCA method analyzes complex processes, input and output flows of materials, energy and pollutants. Life cycle assessment represents a scientifically based method and covers the entire life cycle of products, processes or activities ranging from extracting and processing of raw materials, production

process, transport and distribution, use, maintenance, recycling, reuse and disposal. [3] This methodology allows calculation of global or regional impacts based on energy consumption, waste generation and other impact categories (e.g. global warming, ozone depletion, nitrification and acidification) [4]
When analyzing buildings life cycle (Figure 1.) it can be noted that it starts with the extraction of raw materials, proceeds with manufacture of products, construction on site, usage of a building, maintenance, refurbishment, operation and at the end of life cycle demolition, waste processing and recycling. [5] .

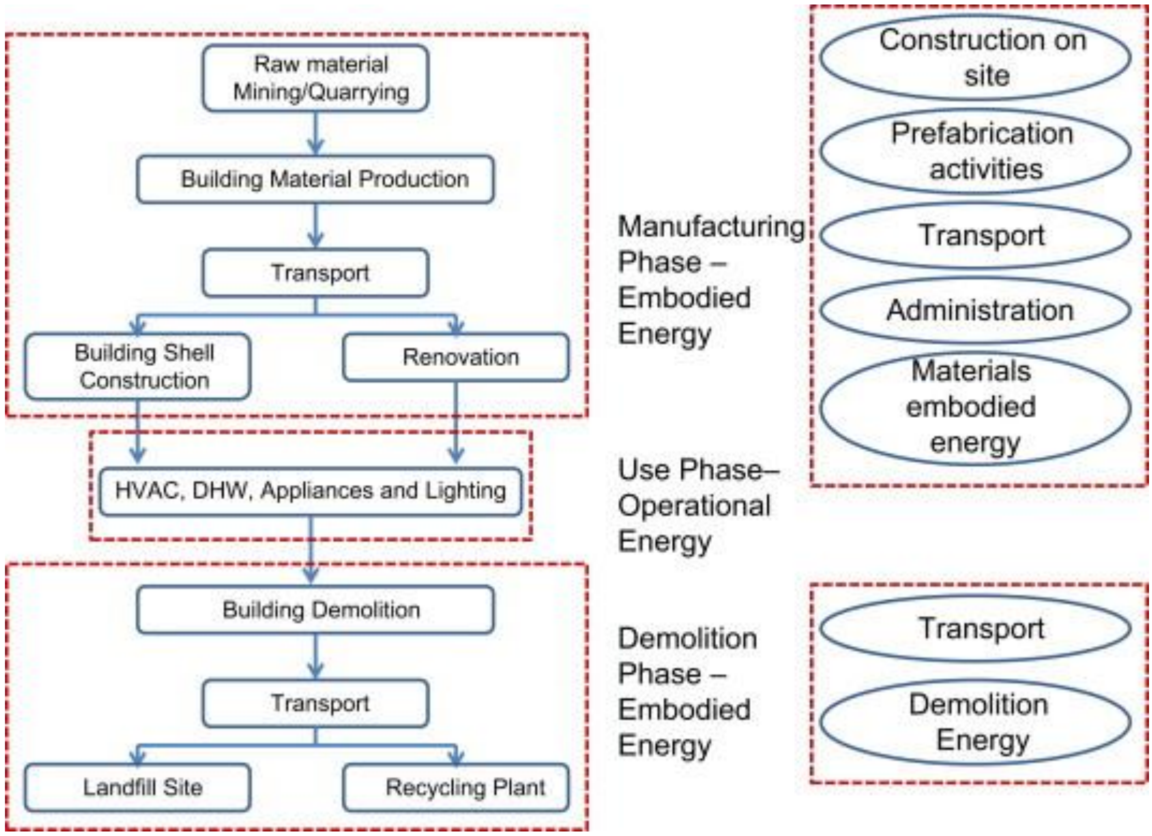

Figure 1. Life cycle energy of a building. [6]

LCA method includes four phases: (1) The definition of objectives, (2) life cycle inventory analysis (3) Life cycle impact assessment and (4) interpretation [2, 7]

Goal and scope definition
Defining goals and objectives involves determining the reasons for conducting the study as well as the target audience. Scope of the study should be clearly defined. Hence, at this stage it is important to define report formats that are required by this study.
When setting the boundaries of the system several stages of the life cycle as well as individual processes and flows should be taken into account. According to the boundaries of the system there are several types of LCA analysis: "from cradle to grave”, "from cradle to gate", "from gate to gate" and "from cradle to cradle". [3, 7] For a new building system boundaries should be set from cradle to grave and include all the building life cycle stages, from material production to end of life. For existing buildings life cycle includes remaining operational service of the building as well as the demolition and waste management. LCA for refurbishment of existing buildings should take into account the transportation of new materials, demolition of old building components and the construction and operational phase. Operating energy has the largest share in total energy demand of a building. Recent studies showed that the operation phase of a residential building (estimated for 50 years) accounts around 91-93% of total energy consumption. [8] Bribian in his research showed that among 60 LCA studies conducted in Northern and Central European countries usually considered lifetime of a building was 50 years. In Netherland usual lifetime for dwellings is 75 years and for offices 20 years [9].

Inventory analysis
Inventory analysis includes collecting data and procedures for the purpose of calculating the inputs and outputs of the system production. Collected data could be classified as: 1-inputs of energy, raw materials and others, 2-products and waste, 3- emissions to air, water and land and 4-other aspects of the environment. After collecting data by means of measurement, calculation or estimation they are validated and connected with processes and flows.

Life Cycle Impact Assessment- LCIA
Life cycle impact assessment (LCIA) is the third and according to many researchers the most important phase of LCA method as it assesses the significance of potential impacts on the environment. LCIA must be coordinated with other phases of LCA and consists several sub-phases such as:

- election of field of impact, indicators and models
- LCI results classification
- calculation of the indicators (characterization)
- identification of models and factors

LCIA phase considers only details that are defined in the goal and scope of application.

Interpretation
During the phase of interpretation of the life cycle assessment the results from LCI and LCIA phases are analyzed together. Together with the phase of goals and objectives phase interpretation frames the study and forms an essential part. At this stage the conclusions, the limitations and the recommendations are being generated. Strategy reporting is an integral part of the LCA method which requires adequately presenting data, methods and assumption that have been reached in the study to appropriate audience.

LCA OF MATERIALS USED IN BUILDINGS CONSTRUCTION

Buildings use great deal of raw materials involved in construction process that demand high energy consumption. Embodied energy is the quantity of energy needed for mining, building material production and transport to the construction site. Embodied energy of low-energy buildings is higher then in conventional buildings. From a life cycle perspective,when shifting from standard houses toward low-energy buildings, the relative share of operating energy decreases, while the relative share of embodied energy increases.
For the assessment of embodied energy of different materials applied in construction processes researchers use different databases such as the University of Bath's inventory of carbon and energy database, the Dutch Institute of building biology and Ecology (NIBE) environmental classification of building products, the environmental product declarations database Okobau.dat used in the German sustainable building certification scheme, DGNB. [5], Other researchers use DEAM database or databases from the Swiss Agency for the Environment, Forests and Landscape, the SimaPro software and from a Franklin Associates report. [4] Other common data sources include the US Life Cycle Inventory Database, TRACI, BEES, US Census Data, US National Renewable Energy Laboratory, GEMIS [10] and ATHENA sustainable materials institute database.
Characteristics of the most commonly used materials in building construction, as well as their impacts on the environment are given in the Table 1. Bribian et al. research showed that the use of hollow concrete blocks instead of reinforced concrete could save 20% of the cumulative energy over a 50-year life cycle. [9] The usage of recycled building materials especialy steel and aluminium could save up to 50% of the embodied energy. LCA studies that have been carried out for thermal insulation showed that syntethic materials such as polyurethane foam demand great amount of embodied energy as well as other resources comparing to wood and rock wool or natural fiber insulation.

Table 1. LCA results for several types of materials for building construction (adapted from [9])

Building product	**Density(kg /m3)**	**Thermal conductivity(W/mK)**	**Primary energy demand(MJ–Eq/kg)**	**Global Warming Potential(kg CO2–Eq/kg)**	**Water demand(l/kg)**
Ordinary brick	1800	0.95	3.562	0.271	1.89
Light clay brick	1020	0.29	6.265	−0.004	1.415
Ceramic tile	2000	1	15.649	0.857	14.453
Ceramic roof tile	2000	1	4.59	0.406	2.456
EPS foam slab	30	0.0375	105.486	7.336	192.729
Rock wool	60	0.04	26.393	1.511	32.384
Polyurethane foam	30	0.032	103.782	6.788	350.982
Cellulose fiber	50	0.04	10.487	1.831	20.789
Wood wool	180	0.07	20.267	0.124	2.763
Cement	3150	1.4	4.235	0.819	3.937
Reinforced concrete	2546	2.3	1.802	0.179	2.768
Concrete	2380	1.65	1.105	0.137	2.045
Sawn timber, softwood	600	0.13	20.996	0.3	5.119
Glued laminated timber	600	0.13	27.309	0.541	8.366
Reinforcing steel	7900	50	24.336	1.526	26.149
Aluminum	2700	239	136.803	8.571	214.341
Polyvinylchloride	1400	0.17	73.207	4.267	511.999
Flat glass	2500	0.95	15.511	1.136	16.537
Copper	8920	380	35.586	1.999	77.794

Asif and co-researchers [11] discovered in their case study of LCA on residential building that concrete is the most significant material not only in terms of quantity used and embodied energy, but also for the associated environmental impacts. Concrete stands for 61% of the total embodied energy of the home due to its very large quantity proportion in any construction of the building. Energy values indicate that the total embodied energy of the home is 227.4 GJ. for three-bedroom semi detached dwelling home in Scotland.

CONCLUSION

Buildings use energy from its construction to demolition. During the construction of new buildings or the refurbishment of old various alternatives of building materials and compositions can be implemented. For ‘zero-energy’ buildings the embodied energy is the only life cycle energy used and the material selection is the most critical factor. By assessing the impacts of whole building or building energy flows on the environment through LCA method engineers could easily choose among materials and apply the ones that are „green“ enough in accordance with the project budget .

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GREEN ROOFS

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Abstract: Roofs are much more than mere 'functional components' that protect the structure of a building. They give character to both individual buildings and entire city quarters. Roofs attract urban designers looking for socially responsible concepts, which are opposed to the loss of natural living space and offer solutions to the problems such as precipitation management or the urban heat island effect of densely populated cities. This paper discusses extensive, intensive, and semi-intensive green roofs.
Key words: green roofs, extensive greenery, intensive greenery

INTRODUCTION

Building design changes constantly, but the function of buildings always remains the same: protection, comfort, and warmth during winters and coolness during summers. The research conducted over the past several decades indicates that buildings are the highest energy consumers (about 40% of total global consumption), so their environmental impact has come into focus in the previous years. In addition to standard energy efficiency measures, such as façade reconstruction or door and window replacement, increased emphasis has been placed on the construction of green roofs as a potential energy efficiency measure, wherever it is feasible, but primarily in urban environments.
Green roofs provide additional green surfaces in urban areas with limited open space, but they also raise the value of buildings. The appeal of these roofs is best corroborated by the fact that they can also be conceptualized as public gardens, or business or recreational spaces, which offer numerous possibilities for use [1, 2].
Green roofs are commonly built on flat rooftops. Flat-roofed buildings are one of the symbols of modern architecture. The most important representatives of this architectural trend are Le Corbusier, Walter Gropius, Bauhaus School representatives, Frank Loyd Wright, and others. Le Corbusier defined the roof garden as a key living space for future urban population.
Austrian architect Friedrich Stowasser was one of the first architects to stress the significance of green roofs as a means of non-aggressive resistance against negative evolution. He saw nature as heightened reality, a source of universal harmony, and he believed that it should be protected from its worst enemy – humans. He wanted the time spent in his buildings to imitate the time spent in nature. He also considered trees to be a constituent part of human constructions. Hence, his buildings typically include trees and shrubbery on rooftops.
In the late 20th century, the fundamental principles of green architecture were established, pertaining not only to green roofs, but also to extensive and intensive greenery on large buildings, as well as green façades.
In recent years, much attention has been given to roof gardens, which initiated the construction of numerous green roofs of extraordinary design. Today, green roofs are constituent elements of bioclimatic architecture [3, 4].

ADVANTAGES AND DISADVANTAGES OF GREEN ROOFS

Green roofs can serve as balconies, because their inclination should be minimal, only enough to allow water to drain. A 0.5% inclination is sufficient. On the other hand, the inclination should not exceed 40° due to erosion and in order to preserve the compactness of the green mass. There are construction technologies that enable construction at higher inclinations, but they are also costly. Depending on the building statics, the weight of the green roof should also be considered. There are roofs with the soil layer as thick as 50 cm but there are also those very thin soil layers.

Green roofs have certain advantages over regular roofs:

- they reduce energy consumption in buildings because they act as thermal insulation, thus reducing building heating and cooling expenses by ca. 20%;
- they protect the roof from UV radiation and mechanical damage, which extends the roof's life;
- water is retained and it slowly evaporates, thus preventing high-volume drainage into the storm sewer, which in turn eliminates the need for additional sewerage infrastructure;
- they reduce dust levels in the surrounding area;
- they regulate air humidity;
- they provide new habitats for plants and animals;
- they absorb sound, thus reducing traffic noise levels;
- they raise the market value of the building;
- they create additional space for walking or resting;
- they enhance their surrounding visually and aesthetically.

However, these roofs also have some disadvantages:

- their cost is usually higher than that of regular roof systems;
- they require frequent maintenance, which also incurs additional costs;
- building structure has to bear additional load [1, 5].

GREEN ROOF TYPES

The most widely used green roof construction joins the reinforced concrete panel as the load bearing construction to the applied insulation system, depending on the desired effects and the thickness of greenery in the top soil layer and planted greenery [6 -9] .

Depending on their thickness, green roofs can be:

- extensive,
- intensive,
- semi-intensive.

Table 1. Provides the features of extensive and intensive roofs.

Parameter	**Extensive**	**Intensive**
Vegetation	Sedum, grass, medicinal and culinary herbs	Grass, ornamental shrubs, trees
Height	< 15cm	25–100cm
Irrigation	Mostly without	Always required
Weight	50–150kg/m^2	250–1000 kg/m^2
Walking space	None/Limited	Yes
Water tank	4-12mm	18-39mm
Load bearing capacity	Mostly sufficient	Requires very strong roofing construction
Maintenance	Very rarely	The same as regular gardens
Inclination	Up to 45º	Flat or terraced

Figure 2 shows buildings with green roofs.

Figure 2. Green roofs: 1) Green roofs of the *Skogar* museum, Iceland;
2) *Earth house* in Switzerland

EXTENSIVE GREEN ROOFS

Extensive green roofs are impassable roofs. They should be planted with grass that is extremely resilient to drought and with ground cover plants no more than 30 cm in height, i.e. extensive greenery, which requires only 5-15 cm thick soil layer. The structural load of such roofs is 50 to 200 kg/m^2. Extensive covers are suitable for inclined roofs and for converting old roofs into green without any changes in the construction, which is not adjusted to bear larger loads. Extensive roofs are not intended for recreation, heavy weights, or trees.

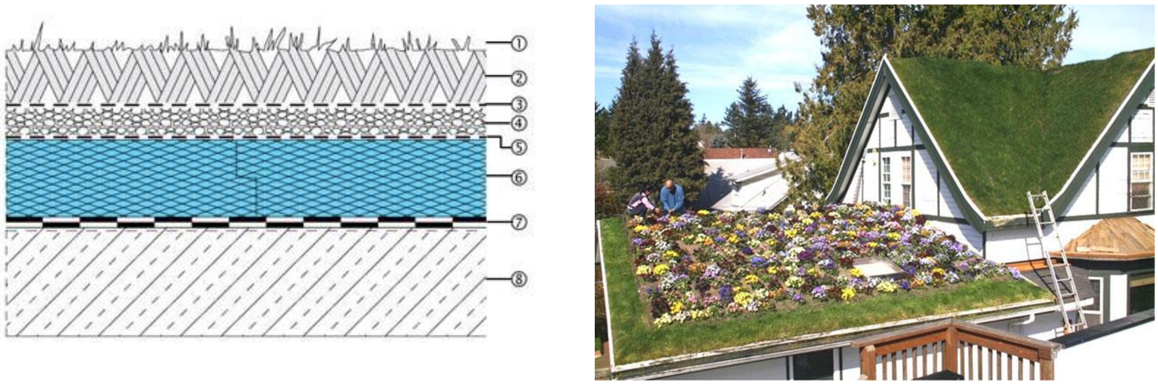

Figure 3. Extensive roof with drainage system: 1) extensive lawn – vegetation; 2) soil layer 80-100 mm thick; 3) separation/filtration layer; 4) drainage layer; 5) fabric (e.g. polypropylene) 110-140 g/m^2; 6) insulation material; 7) bituminous waterproofing sheet; 8) concrete ceiling

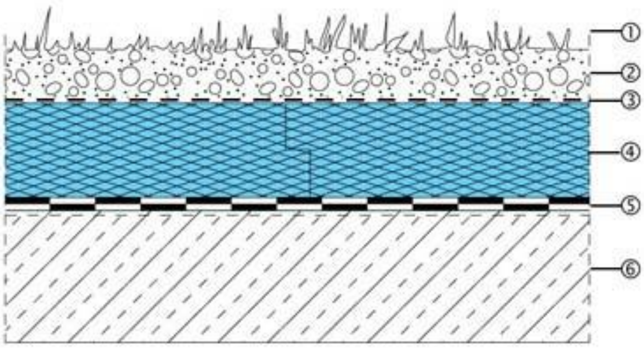

Figure 4. Single-layer extensive green roof: 1) extensive lawn – vegetation; 2) drainage vegetation layer 80-100 mm thick; 3) fabric (e.g. polypropylene) 110-140 g/m^2; 4) insulation material; 5) bituminous waterproofing sheet; 6) concrete ceiling

INTENSIVE GREEN ROOFS

Roof gardens – intensive roofs – are multifunctional green roofs, which retain large amounts of water. It is suitable for lawns, perennial plants with deeper substrate, shrubs, and trees. Such roofs allow the integration of pathways, terraces, access roads, playgrounds, swimming pools, etc. There are essentially no limits to the design provided that the building structure allows it. Intensive green roofs are passable and are covered in large shrubbery, trees, and other taller plants ranging from 0.50 m to 4.0 m. Medium and tall shrubbery and shorter trees, i.e. intensive greenery, require ca. 1.20 m thick soil layer for normal growth, while their load on the structure is 300-500 kg/m^2.

Intensive green roofs have a relatively flat surface with 1-1.5% or up to 3% inclination. Intensive roofs require considerably more care and maintenance, for instance, more frequent fertilization and larger amounts of minerals for large plants to grow. Depending on the choice of plants, sometimes water tanks are required, as well as irrigation, fertilization, and maintenance systems, just like with regular gardens.

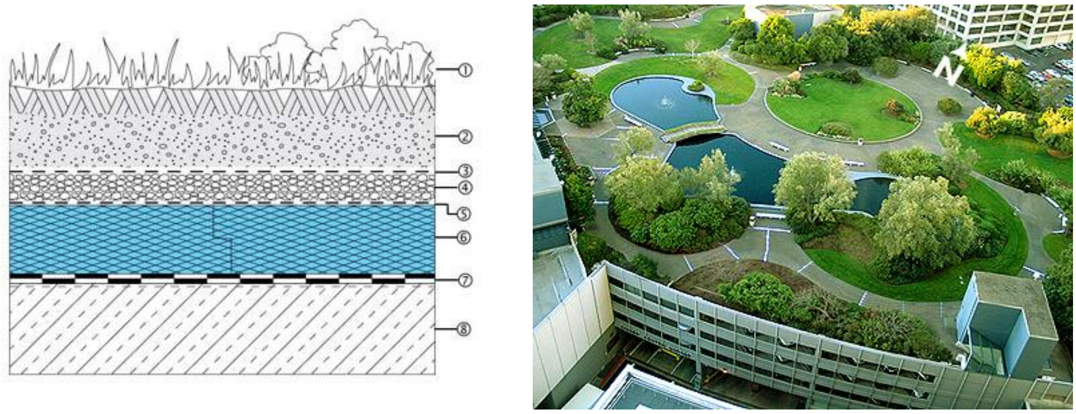

Figure 5. Intensive green roof: 1) vegetation; 2) drainage soil layer 200 mm thick; 3) separation/filtration layer; 4) drainage layer; 5) fabric (e.g. polypropylene) 110-140 g/m^2; 6) insulation material; 7) bituminous waterproofing sheet; 8) concrete ceiling

SEMI-INTENSIVE GREEN ROOFS

Semi-intensive green roofs share the properties of extensive and intensive roofs. Parts of these roofs are passable and are used for rest or recreation. They are designed as extensive roofs with low maintenance requirements, while being accessible and open for public use, which is a property of intensive roofs. They include plants 0.25-0.50 m tall, with the soil ca. 0.20 m thick, which adds about another 250 kg/m^2 load on the building structure. The plants that are usually used for these roofs are also very low-maintenance, e.g. grasses or medium-height sedums.

Figure 6. Semi-intensive green roof

CONCLUSION

Green roofs can be found in many countries, having recently grown quite popular in urban areas, where particular and more resilient plants are used, with a special drainage technique. Flat, usually concrete, roofs are a common issue in cities, as they often leak and create problems for the upper floor occupants. Through conversion into green roofs, they become useful and aesthetically pleasing. Green roofs protect the roof structure from extreme temperature shocks, provide space for walking or resting, reduce water drainage issues, reduce heat radiation and reflection with their green layers, aesthetically enhance the surrounding area, completely eliminate the negative effects of dust, and reduce the negative impact of traffic noise. They also protect the roof insulation and roofing from UV radiation and balance out daily temperature fluctuations, thus extending the life of the roof system.

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USING MATHEMATICAL MODELS TO PREDICT THE EMISSIONS OF LANDFILL GAS AND ITS COMPONENTS FROM LANDFILLS

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Abstract: This paper presents and explains the following mathematical models for prediction of landfill gas emissions from landfills: LandGEM EPA, TNO, and EPER. We used the LandGEM EPA v.3.02 mathematical model to predict landfill gas, methane, carbon dioxide, and non-methane organic compounds from the non-sanitary landfill "Bubanj" in Niš. The mathematical model was applied to the active section of the Niš landfill.
Key words: mathematical models, landfill, emission, landfill gas, methane

INTRODUCTION

Landfill gas (LFG) is formed in the process of anaerobic degradation, i.e. degradation of organic waste in the absence of oxygen. The average composition of LFG is 35-60 $\%_{vol}$ of methane, 37-50 $\%_{vol}$ of carbon dioxide and trace amounts of carbon monoxide, nitrogen, hydrogen sulphide, fluorine, chlorine, aromatic hydrocarbons, and other gases [5]. The global warming potential of methane is 21 (GWP=21) [2] . This means that the influence of methane on the greenhouse effect is twenty-one times higher than the influence of direct carbon dioxide emission. On the other hand, methane is a highly flammable gas, which commonly causes landfill fires, which in turn leads to increased emission not only of carbon dioxide but also of a series of toxic substances formed due to uncontrolled combustion or thermal degradation of municipal waste with different chemical composition. The degree of chemical pollution of the atmosphere, soil, and water depends on the composition, quantity, and properties of hazardous materials present in emitted LFG, which can lead to even more serious consequences in case of a landfill fire, and they are seldom physically limited only to the landfill complex but more often propagate beyond it.

MATHEMATICAL MODELS

Mathematical models are used for predicting emissions of LFG and its main components – methane and carbon dioxide. These models are aimed at presenting simply and quickly the complex changes that occur in landfills during waste degradation and to make the obtained results representative. LFG generation is usually modelled by means of a first-order kinetics equation based on the data on the amount of waste deposited over time, waste composition, waste disposal period, and other relevant factors for LFG formation. The models can be used to predict LFG generation in both sanitary and non-sanitary landfills. Depending on the model, the prediction is based on the amount and type of deposited waste, time of waste disposal, slow- and fast-decomposing fractions in deposited waste, fraction percentage in waste, amount of organic carbon in waste, etc. With some models the type of LFG degassing system is also considered.

LandGEM EPA model

The EPA model is based on the LandGEM (Landfill Gas Emissions Model), which is used to calculate the amount of generated methane in a landfill according to the landfill design capacity, methane generation potential, amount of deposited municipal waste, and landfill age [3]. LFG generation can be expressed with the following equation:

$$Q_{CH_4} = \sum_{i=1}^{n} k_{CH_4} L_0 M_i e^{-kt} \tag{1}$$

where:

Q_{CH_4} - methane emission rate[m$^3{}_{CH_4}$/y],
k_{CH_4} - methane generation constant (AP42 default=0.04) [y^{-1}],
L_0 - methane generation potenti (AP42 default=100) [m$^3{}_{CH_4}$ /t$_{waste}$],
M_i - mass of waste in ith section [t],
t - age of the ith increment or section [y^{-1}].

To better use this model, special software was developed that provides graphic representation of calculated volume emissions of LFG, methane, carbon dioxide, and non-methane organic compounds. The LandGEM model is able to assess methane and other LFG components' volume emissions annually, for the entire period of waste disposal at a given landfill, or after landfill closure and recultivation.

TNO model

The TNO (The Netherlands Organisation of Applied Scientific Research) model is based on the amount of degradable organic carbon in deposited waste and on waste quantity. LFG generation decreases exponentially with time. LFG generation can be expressed with the following equation [4]:

$$\alpha_t = \zeta 1,87 A C_0 k e^{-kt} \quad (2)$$

where:

α_t - landfill gas production at a given time [m$^3{}_{LFG}$ /y],
ς - dissimilation factor [-],
1,87- conversion factor [m$^3{}_{LFG}$ /kg$_{Cdegraded}$],
A- amount of waste in place [t],
C_0- amount of organic carbon in waste[kg$_C$/ t$_{waste}$],
k - degradation rate constant [y^{-1}],
t - time elapsed since depositing [y].

Dissimilation factor value ς is 0.58, degradation rate constant k is 0.094 y^{-1}, while the values for the amount of organic carbon C_0 are taken from Table 1.

Table 1. Values of organic carbon content for TNO model [6]

Waste category	Organic carbon content [kg$_C$/ t$_{waste}$]
Contaminated soil	11
Construction and demolition waste	11
Street cleansing waste	90
Sewage sludge and compost	90
Commercial waste	111
Shredder waste	130
Coarse household waste	130
Household waste	130

German EPER model

The German EPER (The European Pollutants Emission Register) model analyzes household and commercial waste. It is expressed with the following equation [4]:

$$M_e = M \cdot BDC \cdot BDC_f \cdot F \cdot D \cdot C \quad (3)$$

where:

M_e - amount of diffuse methane emission [t$_{CH_4}$ /y],
M - annual amount of landfilled waste [t$_{waste}$/y],

BDC - proportion of biodegradable carbon [t_C/t_{waste}],
BDC$_f$ - proportion of biodegradable C converted [-],
F - calculation factor of carbon converted into CH_4 [t_{CH_4} /t_C],
D - collection efficiency [-],
C - methane concentration [%].

Proportion of biodegradable carbon *BDC* is a constant with the value of 0.15 t_C/t_{waste}, proportion of biodegradable C converted *BDC*$_f$ is 0.5, and the factor of carbon converted into methane *F* is 1.33 t_{CH_4}/t_C. The values for gas collection efficiency *D* can be as follows: 0.9 when the gas is uncollected, 0.4 when it is collected by means of active systems for LFG degassing, and 0.1 when the waste is covered with inert material on a daily basis.

RESULTS AND DISCUSSION

Calculation of LFG emission was performed using the mathematical model for LFG emission prediction, LandGEM v.3.02, developed by the US Environmental Protection Agency. LandGEM v.3.02 [3] is based on a first-order equation, which is used to calculate the volume emission of methane formed through waste degradation. Emission of LFG and its components, such as methane, carbon dioxide, and non-methane organic compounds (NMOC) was calculated according to equation (1).
The non-sanitary landfill in Niš has been in use since 1968 and it was designed to be used until 2017. The calculations of LFG generation at the non-sanitary landfill “Bubanj” in Niš were based on the population number data from the Statistical Office of the Republic of Serbia. According to the 1971 census data, the city of Niš had a population of 127.564, and according to the latest census in 2011, the population numbered 260.237. The data pertaining to waste amounts, which was used to calculate the generation of LFG and its main components, was taken from the research conducted by the Faculty of Technical Sciences, University of Novi Sad.
The total area of the existing landfill is 31.07ha and it comprises three closed down sections S1, S2, S3 and an active section S4. The active S4 section covers the total area of c. 2.85ha, which has been in use since June 2010 and which was designed to be used until 2017 [1].
Figure 1 shows the prediction of LFG volume emission, obtained from a LandGEM v.3.02 simulation [33].

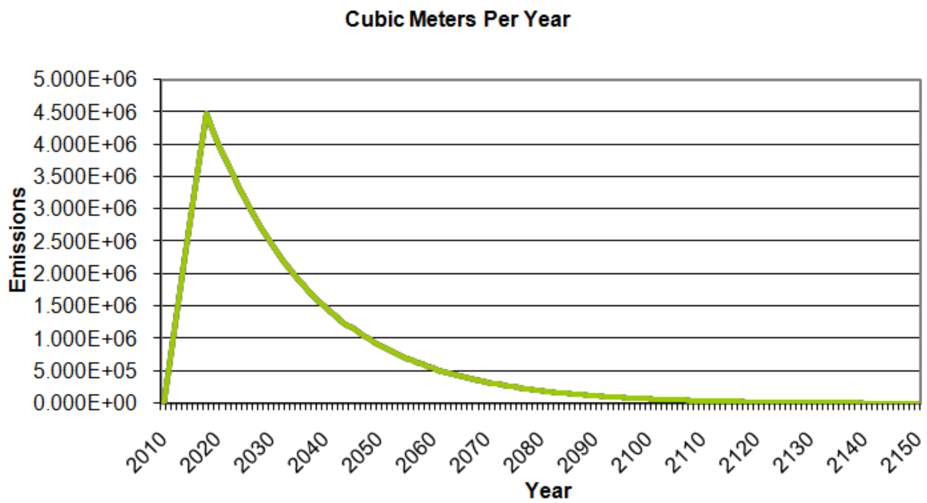

Figure 1. Prediction of total LFG volume emission in the active section of non-sanitary landfill “Bubanj” in Niš

Predicted LFG volume emission for 2016 is 3.425x10^6 m^3/year. The maximum LFG volume emission of 4.486x10^6 m^3/year is expected in 2018, after which the emission will begin to decrease. In the ten

years following the maximum emission level, LFG emission will drop by 30% and after twenty years by more than 50%.
Another LandGEM v.3.02 simulation was used to predict methane volume emission from "Bubanj" landfill, as shown in Figure 2.

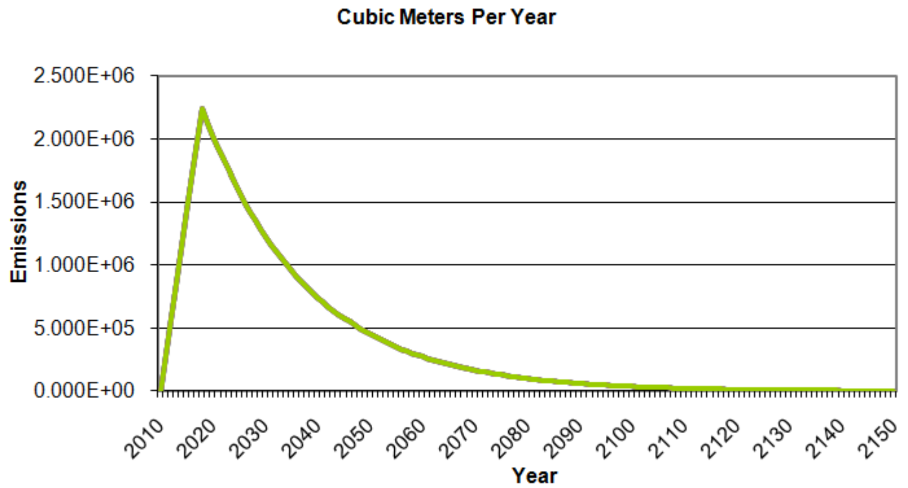

Figure 2. Prediction of total methane volume emission in the active section of non-sanitary landfill "Bubanj" in Niš

Methane volume emission predicted for 2016 is 1.713x10^6 m^3/year. Increase in methane volume emission is expected until 2018, when it will reach the maximum of 2.243x10^6 m^3/year.
Figure 3 shows the prediction of total volume emission of carbon dioxide.

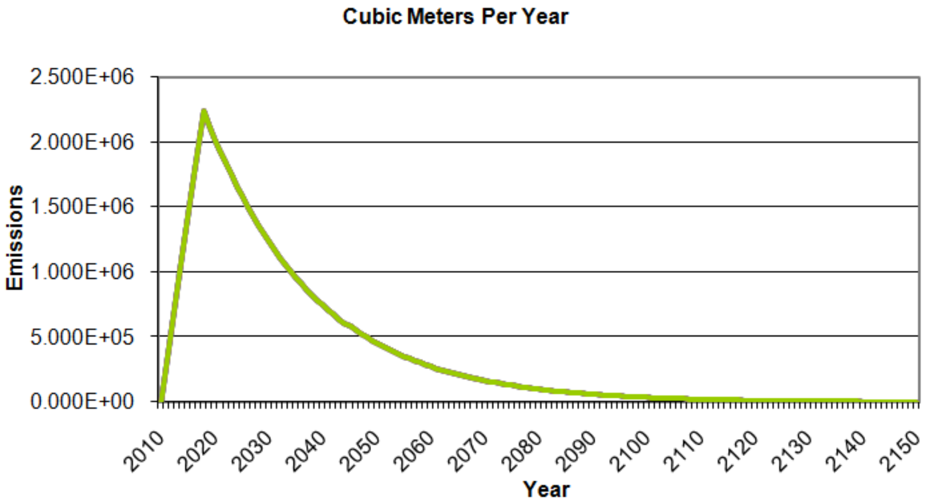

Figure 3. Prediction of total carbon dioxide volume emission in the active section of non-sanitary landfill "Bubanj" in Niš

Predicted carbon dioxide volume emission for 2016 is 1.713x10^6 m^3/year. Carbon dioxide emitted from the Niš landfill will reach its maximum volume emission of 2.243x10^6 m^3/year in 2018.
Figure 4 shows the prediction of total volume emission of non-methane organic compounds.

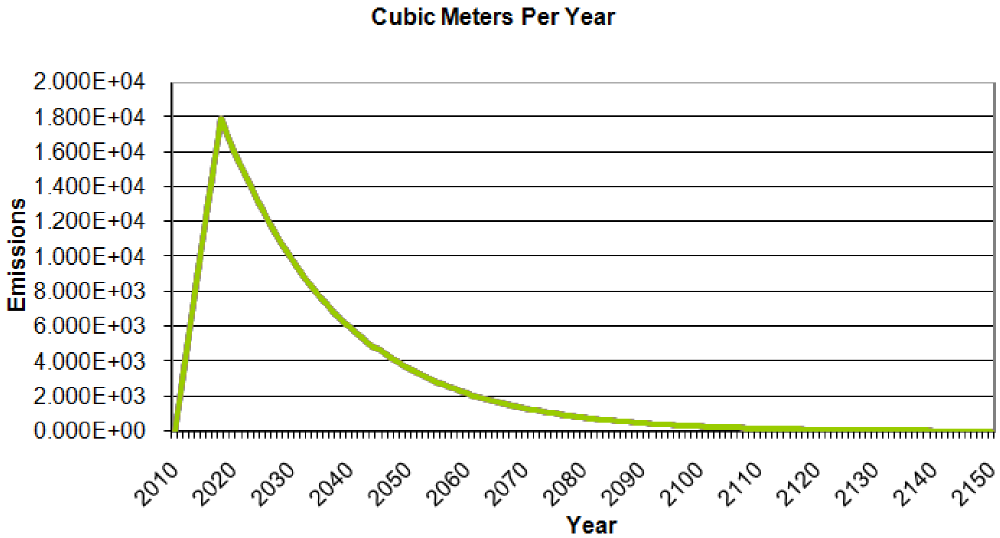

Figure 4. Prediction of total non-methane organic compound volume emission in the active section of non-sanitary landfill “Bubanj” in Niš

Predicted non-methane organic compound (NMOC) volume emission for 2016 is 1.37x10^4 m^3/year. Increase in NMOC volume emission is expected until 2018, when it will reach the maximum of 1.794x10^4 m^3/year

CONCLUSION

The choice of the mathematical model LandGem US EPA v.3.02, which was used to predict LFG volume emission, was justified. This model can predict both volume and mass emissions of LFG, methane, carbon dioxide and non-methane organic compounds. It can be applied to both sanitary and non-sanitary landfills. Prediction of the emission of LFG and its components was demonstrated for the non-sanitary landfill “Bubanj” in Niš, from the beginning of its operation to years after it will have been closed down. Another advantage of this model is that it provides tables and graphs of calculated LFG volume and mass emission in the course of each year.

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TRANSFORMER OIL AND POTENTIAL RISKS FOR ENVIRONMENT

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Abstract: Safe handling and manipulation of transformer oil in the electrical energy distribution and other sectors are to be realised in a manner and procedure that will not pose a risk of water, soil or air pollution for the protection of environment, life and health of people. Implementation of the necessary preventive and corrective measures for environmental protection, fire protection, safety and health at work is, among other things, mandatory, including the respect for and the realisation of legal provisions, standards and regulations for the purpose of safe and optimal treatment and management of transformer oil, and prevention or reduction of negative impact on the environment and human health. The study presents the sources of transformer oil, testing and determining the trend of transformer oil's important features in the exploitation, with particular emphasis on potential negative impact on the environment, safety and health, therefore the results, recommendations and conclusions are given.
Key words: transformer oil, electric power distribution, potential risk, environmental protection, safety and health of people, fire protection.

INTRODUCTION

Transformer or insulating oil is often used in the operation of oil transformers, which also includes transport, storage, filling, handling of oil in the operation of various devices and managing used oil. There is a potential risk of environmental pollution and/or danger to human health and life in every operation stage, especially in emergency situations in case of spillage, evaporation and/or formation of flammable products. In order to prevent or mitigate undesirable consequences of such phenomena, timely inspections, implementation of all the measures needed and appropriate rehabilitation are required. The study analysed essential characteristics of oil and transformers in the power transformer stations belonging to the MH "ERS" ZEDP "Elektro-Bijeljina" joint-stock company Bijeljina and the potential risks to the environment. Business activities of the above mentioned company are: distribution, supply and production of electricity [1].

MATERIAL AND METHOD

Transformer oil

The oil in a transformer, as shown in Figure 1, is insulation, cooling; it assists in extinguishing sparks, dissolves gases formed during the degradation of oil, and dissolves gases and moisture from the cellulose insulation and atmosphere. Transformer oil may be of mineral or synthetic plant origin. [2]

Figure 1: Transformer connected to electrical grid in an insulated bulkhead [2]

Transformer oil is transported in rail tank cars or tanker trucks, barrels or metal containers, with mandatory inspection in order to prevent uncontrolled spillage and contamination. Supply of transformer oil depends on the need for replacement, topping up, sampling and other ordinary and extraordinary situations.
The transport containers must be clearly marked with a tag containing the name of oil and the manufacturer, designation according to the standard, batch number, and date of delivery. Storage areas must comply with the regulations that apply to the corresponding petroleum products, i.e. must be well ventilated and cool with ambient temperature not higher than 50ºC, and without potential sources of fire. The barrels are stored in either closed or covered area, not exposed to contamination and corrosion, and are laid on wooden pallets [3], as shown in Figure 2.

Figure 2: Stacking of barrels on wooden pallets

Classification and generation of waste transformer oil

Waste transformer oil is classified as hazardous waste [4]. Waste transformer oil and other types of hazardous and non-hazardous waste are generated in the processes of maintenance, overhaul, replacement of electrical equipment and other activities of electricity distribution companies. Waste transformer oil is generated in the following situations:

- After the analysis of transformer oil sample; if the results show unsatisfactory quality, the replacement with new oil follows;
- If damage to the power transformer caused discharge of transformer oil into the environment;
- If damage to the power transformer caused discharge of transformer oil in the transformer oil pit collector.

Metal barrels containing waste insulating/transformer oil is marked with stickers (displaying hazardous properties of the substance), and identification card.

Test method and trend determination of dielectric strength of transformer oil in exploitation for the aim of analysis of environmental impacts, potential risks and safety

Dielectric strength of transformer oil is tested according to the standards JUS N.A5.014, SRPS N.A5.014, SRPS EN 60156. Testing the dielectric strength of insulating oil is, in principle, the same for all types of oil (for transformers, switches and capacitors), whether they are new or used ones.
Since the dielectric strength is extremely sensitive to the slightest contamination of the sample, careful sampling is essential. Insulating oil samples for testing dielectric strength are to be taken only by persons qualified and experienced in the handling of insulating transformer oil or persons working under their direct supervision.
The oil sample is taken at the spot, which is considered to be less pure, for example, at the lowest point of the transformer [5], as shown in Figure 3.

Figure 3: Discharge of oil at the lowest point of transformer

The control sample is taken in dry weather, but if taken in wet weather conditions, special protective measures (e.g. protection from rain, wiping, drying, and waterproof covers for sample transport, etc.) are to be taken [6].

During sample preparation, the sample container needs to be shaken gently and overturned several times in order to provide, to the fullest extent possible, the homogeneous distribution of impurities contained in the oil and avoid creation of air bubbles. Immediately thereafter, the sample is poured into a test cell, slowly, to avoid the formation of air bubbles. The oil temperature at the time of the test should be equal to the ambient temperature; the best is around 20 ^{o}C. This temperature must be recorded. [5]

Samples of the new oil delivered in tankers or barrels and used oils are tested in the existing state, without prior processing.

Testing is conducted as the electrodes are connected to alternating voltage frequency of 50 Hz, which, starting from zero, is evenly increasing by 2 kV/s until it reaches a value causing the overshoot. The test will be repeated six times with the same filling of the cell.

Dielectric strength is the arithmetic mean value of the six results obtained, if no value deviates by more than 25% from the arithmetic mean value. If there is a deviation, the entire procedure is to be repeated.[5]

Record on testing is to include overshoot voltage, expressed in kV, obtained in the course of all tests carried out and the mean value of all results. The type of electrodes used, the frequency of the test voltage and oil temperature are to be also entered into the records. [5]

RESULTS AND DISCUSSION

During the exploitation (operation) of a transformer, the transformer/ insulating oil is often used, thus there is a potential risk of environmental pollution and/or danger to human health and life, especially in emergency situations. It is highly significant not only for the users of the transformers in associated substations and other high-voltage installations, but also for the relevant professional engineering institutions, to know the prescribed transformer oil's features values and their monitoring, what the potential risks to the environment and humans' safety are and what the life cycle of the individual elements of the plant is. This is particularly important for the power transformers, which are the most expensive, the most sensitive and the most risky part of the plant.

The transformer lifetime depends on the lifetime of its insulation, which consists of transformer oil and solid compounds [1]. In this respect, the importance of testing and trend determination of dielectric strength of transformer oil at substations and other power installations is recognised.

When it comes to defining the time limits for the purpose of this analysis, the adopted time limit is 5 years.

Significant facts and results are observed on the basis of the analysis of various factors, small or great influence on the dielectric strength of oil in the transformers installed in power transformer stations belonging to the "Elektro-Bijeljina" joint-stock company Bijeljina within the above mentioned time period.

The average value of dielectric strength of oil in the transformers installed in various associated substations (TS) and other power transformer stations of voltage level 35/10 kV, has ranged from 138.5 to 261.6 kV/cm [1].
In general, the strength of oil indicates a downward trend, as shown in Figure 4.

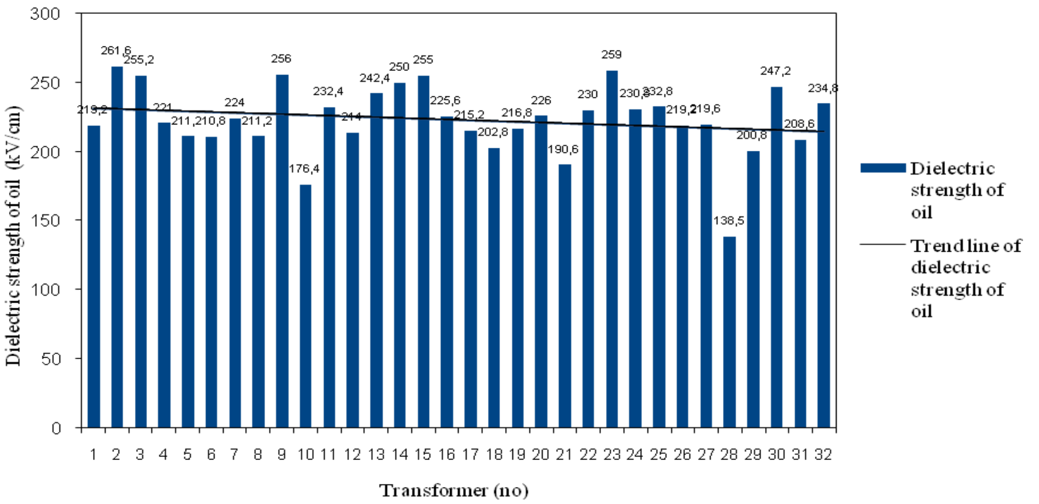

Figure 4: Dielectric strength of oil in transformers installed in power transformer stations belonging to the “Elektro-Bijeljina” joint-stock company Bijeljina

Age of the transformers installed in the power transformer stations belonging to the Company, voltage level 35/10 kV, in the reporting period ranged from 8 to 50 years [1] and is on the rise, as shown in Figure 5, which is not a positive trend from the standpoint of environmental protection, labour safety, technical, economic and other aspects.

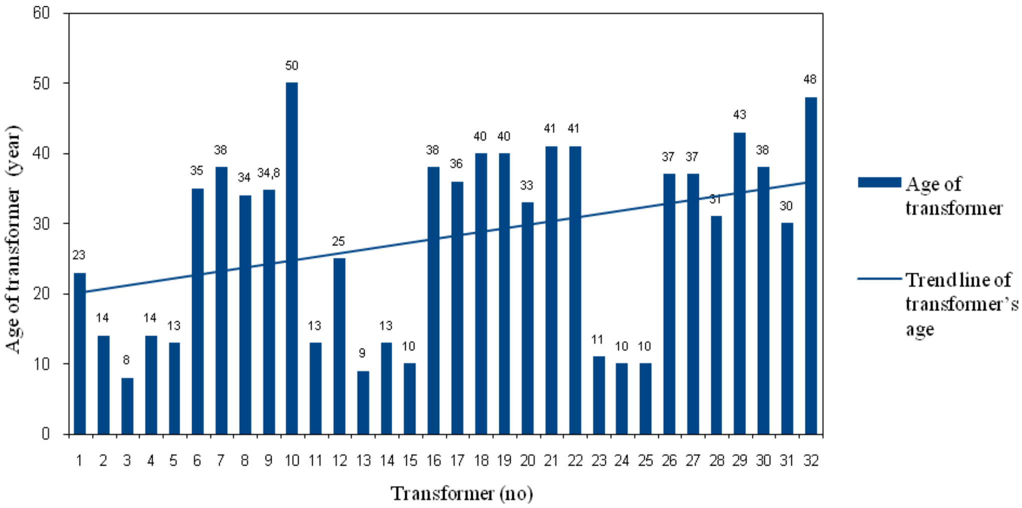

Figure 5: Age of transformers installed in power transformer stations belonging to the “Elektro-Bijeljina” joint-stock company Bijeljina

In the reporting period, the trajectory of transformer age was inversely proportional to the value of dielectric strength of oil, as shown in Figure 6.
With the increasing trend in transformer’s age, the decreasing trend in the value of dielectric strength of oil is recorded at the same time.

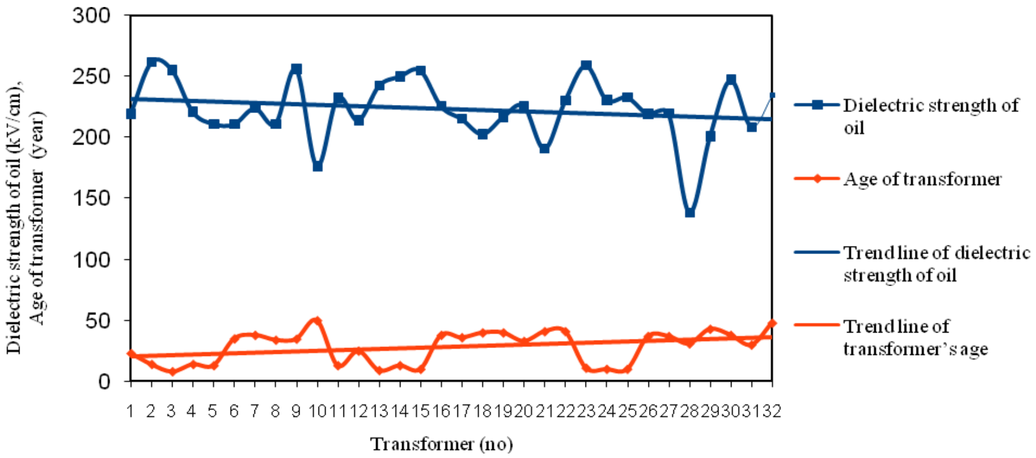

Figure 6: Dielectric strength of oil and age of transformers in power transformer stations belonging to the “Elektro-Bijeljina” joint-stock company Bijeljina

The lifespan of the power transformer is difficult to assess. This causes a great deal of attention, both here and on the global scale, because a large number of transformers, particularly in developing countries, are at the end of life. Most power transformers in the world have been in operation for over 30 years [7]. The average age of transformers in power transformer station of 35/10 kV voltage level in the “Elektro-Bijeljina” joint-stock company Bijeljina is 28 years [1].
Available methods do not provide a fully accurate data for determining the status or the end of transformer’s operating life. Therefore, a team consisting of experienced engineers, technicians and other experts is obliged to carry out a series of additional analyses, tests, inspections and audits regarding the above mentioned. The most common transformer related problems are about transformer oil leaks, the malfunctions of cooling systems and various elements, which in certain situation, particularly in emergency situations, may pose a risk to the environment.
In accordance with previously analysed data, it is evident that dielectric strength of transformer oils in operation has a decreasing trend, as opposed to the age structure of the transformers in researched systems, which has significantly deteriorated. Unless appropriate measures and activities are taken, the continuation of the decreasing trend in dielectric strength of oil in the transformers installed in the power transformer stations of the above mentioned and other similar power distribution systems in the region, is forecasted. Such forecast requires a quicker response by the relevant experts in order to cease these trends, or at least partially reversed them. When reviewing aforementioned problems, be sure to take into account the requirement that the minimum value of dielectric strength of transformer oil is 120 kV / cm [6] in the transformers installed in associated substations of 35/10 kV voltage level, which represents the required threshold of used insulating oil, according to the standards [5]. Those findings, based on the results of conducted research and forecasted future trends of mentioned factors, need to be taken extremely seriously, with special emphasis on increasing risk of accidents and possible negative effects on the environment, safety and health of people.
Some power plants - substations are missing transformer oil pit collector, which would prevent oil spills from the transformer into the environment in case of malfunctions, system elements failures and emergencies.
Experts from the field of engineering, protection etc, as well as the competent authorities, must have open communication based on an integrated basis, and the possibility of efficient cooperation between themselves, with responsible persons and the public [8], that all are the indispensable system links.

CONCLUSION

The negative impact of transformer oil on the environment is multiple. The most common risk is the risk of waterways and soil contamination. Particularly dangerous is the presence of oil in the water flow of so-called sanitary protection zone used to supply the settlements with top quality water.

Main conclusions resulting from the analysis in this study are that the dielectric strength of transformer oils in operation has a trend of constant decrease and that the age structure of the transformers installed in the substations and other power transformer stations in researched or other similar power systems in developing countries has significantly deteriorated. It is necessary to act urgently and to rapidly procure and install new transformers and transformer oils in the power systems or generally overhaul the existing transformers with transformer oil regeneration in the most power transformer stations, or to carry out the activities as a combination of the aforementioned. This is very important, especially when taking into account the fact that the transformer operation safety directly depends on the dielectric strength of transformer oil, likewise potentially negative impact of transformer oil on the environment in case of system failure or small/large spillage/ discharge of oil into either water or soil, especially in case of emergencies. The need for consistent preventive actions is imposed as imperative in the integration with the implementation of technical measures and activities from the fields of environmental protection, fire protection, safety and health at work, as well as other forms of protection. The aforementioned activities are to eliminate or reduce to a minimum any potential contingency situations and the above listed negative trends in the power transformer stations, which could lead to accidents, the negative impact of transformer oil on the environment, as well as substantial risk to both the environment and the life and health of people.
Some substations of 35/10 kV voltage level are missing transformer oil pit collector, which would prevent oil spills from the transformer into the environment in case of emergencies or accidents, thus it is necessary to construct, as soon as possible, a transformer oil pit collector, which is a preventive measure and recommendation, in accordance with general and specific environmental objectives, investment plans and priority activities.
The local authorities are to be requested to establish the centres for waste oil collection at preferred and safe locations in their area of responsibility. Waste collection centres should have an easy access and enabled quick evacuation in case of spillage and/or other emergencies. This will eliminate the additional costs for preparatory works and other activities, and provide easier access and manipulations with minimum risk to the environment and human health.
Based on the conducted research presented in this paper (study) and data synthesis from the domain of subject matter, it can be concluded that the results, recommendations and conclusions, in addition to the researched system, may be applied to most power distribution systems, particularly in transition economies of European Union.

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RECOVERY POSSIBILITIES THROUGH PELLETIZING OF THE PULVEROUS WASTES STORED IN THE REGIONAL PONDS

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Abstract: The implementation in the industrial practices of the accounting technologies of the ferrous powdery wastes, now stored in the regional ponds of the nearby ferrous industry, mining and energetic sectors, assure in time the repossession of this place occupied by the wastes, to the natural environment. The recovery through pelletizing of the pulverous ferrous wastesstored in the regional ponds can be significant for the environmental protection, given by the increase of recovery for pulverous wastes and reduction of depository spaces for these wastes. The economical aspect is reflected by transferring depositary expenses to other purposes. In the paper some researches and relevant results are presented, regarding the obtaining of the pellets, using wastes resulted from ferrous industry (steel dust, agglomerating–furnace dust), mining (red mud, galvanically sludge) and energetic (thermal power plant ash) sectors. In addition, in the pellets recipes, graphiteis used as the reducing agent, respectively bentonite and lime are used as binders. The resulted pellets have a sufficient resistance for uses at the charge of the electric arc furnaces and represent an excellent addition material, for the refining slag formation, at the steel elaboration.This aspect is very important for us – specialists in the steel elaboration. In this paper, we presented some experimental results obtained in the processing of pulverous wastes through a pelletizing operation.
Key words: ferrous pulverous wastes, pellets, environmental protection

INTRODUCTORY NOTES

Resource recovery and recycling from millions of tons of wastes produced from industrial activities is a continuing challenge for environmental engineers and researchers. Demand for conservation of resources, reduction in the quantity of waste and sustainable development with environmental control has been growing in every part of the world. [1–4, 15–17]
In the last decade, manufacturing technologies for metallic materials all over the world have reached a high performance level, demonstrating a high capacity to adapt to the changes due to conditions imposed on raw materials and energy, necessary to increase productivity and decrease specific use, as well as obeying to stricter environmental regulations. [1–4, 15–17]
The remarkable results obtained in modern iron factories were possible through implementation of management systems into industrial activity, systems that imposed the analysis, evaluation and selection on changes at the level of technologies and equipment's, respectively the alternative technologies. [4, 11–14]In such a complex, this management component offers the main information, with which the engineer may establish the moment of genesis for the secondary material, namely the phase in which the problem of recycling can be put into practice and research.[5–17]

Figure 1. The waste hierarchy

The waste management hierarchy indicates an order of preference for action to reduce and manage wastes, and is usually presented diagrammatically in the form of a pyramid. The hierarchy captures the

progression of a material or product through successive stages of waste management, and represents the latter part of the life–cycle for each product. The aim of the waste hierarchy is to extract the maximum practical benefits from products and to generate the minimum amount of waste. The proper application of the waste hierarchy can have several benefits. It can help prevent or reduces the waste disposal, conserves resources and stimulate the development of green technologies.
For Romania the recovery of ferrous wastes represents a priority for the durable development strategy because the natural resources of some raw materials categories are poor or insufficient and the resources can substitute part of the raw materials with significant low costs. [1–4, 11]Comparatively with the practice and the world wide manifested tendencies, the Romanian industry registers gaps in the powder wastes collection, transportation and storage area, as well as in that of the recovery technologies area by their recycling or reusing [5–17]. Thereby, the approach of the superior recovery of small and powder ferrous wastes problem was considered necessary and convenient.

Figure 2. Recovery of ferrous wastes strategies

The administration of secondary materials must represent a problem of strategy in the internal practice of the company, taking into account the following objectives:
≡ reducing to the minimal level the quantity of secondary products
≡ minimizing through recycling the secondary products obtained from a technological process
≡ increasing the degree of recovery (transforming wastes in useful by–products for other sectors)
≡ dominating through supervising and control of problems with a negative impact upon the environment, that can occur when treating and transporting wastes.

Especially in ferrous industry, but in other industrial areas as well, a large number of dusty, pulverous wastes result and part of them are re–introduced into the economical circuit, deposited into settling ponds, thus representing pollution sources for the environment. The economical importance of re–using ferrous scraps in ferrous metallurgy is obvious, if we consider that in most cases these scraps can be an important element of steel furnace charges, as they can replace, in a certain proportion, the iron. It clearly results that any tone of re–used ferrous scraps, which are re–introduced into the siderurgical production, leads to significant investment and exploitation expense savings. Besides this economical aspect – which is primordial – in ferrous powdery scraps re–usage we can mainly solve the problem of environmental pollution (air – water – soil) through depositing these industrial scraps.[5–17]

METHODS

Pulverous ferrous wastes are present in all cases in the form of oxides. For the recovery of iron, they must be objects in a reduction process, either in a furnace, case in which these wastes are components of the raw material (previously processed as pellets, briquettes or agglomerate), or in electric arc furnaces, as secondary material with a complex fusing–oxidizing character or as a slag foaming agent. The researches and experiments presented in the paper had as objective a joining of the economical imperative of maximum recovery of a certain ferrous wastes category: dusty (pulverous) wastes, with the social aspect of eliminating pollution in the environment in order to re–establish and maintain environmental equilibrium.[5–17]
Waste processing and recycling in mineral and metallurgical industries brings together the currently used techniques of waste processing and recycling, their applications with practical examples and

economic potentials of the processes.In countries with a well–developed iron industry, pulverous ferrous wastes are recovered in a proportion of over 90% through re–introduction in the steelmaking circuit. From the point of view of their chemical composition and granulometry, waste recycling proved profitable technologically, economically and ecologically.[1–4, 15–17]The recovery of pulverous ferrous wastes is practiced with several waste recycling technologies, namely:

- recovery through agglomeration – in this processing technology, pulverous ferrous wastes (steel plants dust) compose the agglomeration charge in a proportion of 2–3% (sometimes together with other ferrous wastes like sunder, blast furnace dust, agglomeration dust, etc.).
- recovery through pelletizing – this technology involves using steel plant dust as unique component in the agglomeration charge, or in a mixture with pulverous ferrous ore or other pulverous wastes for producing pellets.
- recovery through briquetting – at this variant, generally the briquetting charge used more ferrous wastes, adding powders with high carbon and lime dust content.
- recovery through the carbo–ferrous method – this technology used a number of small and pulverous wastes from the steel, energy and mining industry such as: the electrical steelworks dust, the agglomeration and furnace dust and slurry, scale and scale slurry, ore waste, steelworks slag, coal dust, coke dust, scrap electrodes (graphite), thermal power plant ash and lime dust.
- recovery through reduction without initial processing – this technology require iron reduction from powder wastes either with a gaseous reduction agent, or with carbon, obtaining iron sponge, used in electric arc furnace charge.

The recovery through pelletizing is a technology involves using steel plant dust as unique component in the agglomeration charge, or in a mixture with pulverous ferrous ore or other pulverous wastes for producing pellets. [5–17] The obtained pellets, according to their quality, determined mainly by the processing technology, can be used:

- in furnace charges, as raw material, together with agglomerate, and, eventually, with ore;
- in reduction equipment charge, to obtain metallized pellets and use them as raw material in electric arc furnace;
- in charge of electric arc furnace as auxiliary material to form slag and correct the chemical composition, or as foaming agent.

In some cases where economic considerations are justified, waste materials can be agglomerated into pellets for reintroduction to the feed system. In most other cases, waste materials are considered as loss materials and discarded.

AREA OF RESEARCH

Our research analyzed the possibilities of economical usage in siderurgy, namely in electric arc furnaces, of pulverous ferrous wastes stored in the regional ponds of the nearby ferrous industry.
The use of these wastes is important because not only the iron is recycled and the environment is protected, but because nearby Hunedoara, they exist as:[5–11]

- ferrous wastes from steel plant (fine and pulverous dust) – approximately 10,000 tones, currently resulting from technological steel making processes;
- ferrous wastes from agglomerating plants and blast furnaces (fine and pulverous dust) – approximately 250,000 tones, deposited in regional ponds of the nearby of town, in some areas dating from more than 15–25 years;
- steel ore wastes, approximately 3.5 million tones, deposited in other two ponds.

Currently, pulverous ferrous wastes are re–introduced into the economical circuit through their use as raw material (2–3%) in agglomerating charges. Steel dust is also used for producing pellets for iron making or for the charging in electric arc furnaces (pellets). The pelletizing solution is required along the integrated operational flux (raw materials – agglomeration – blast furnaces – steel plants). Having in view the fine granulation of these fine and pulverous ferrous wastes, we consider that the re–introduction into the agglomerating charges is the optimal solution. Considering the remarks above, as well as the fact that in the area of Hunedoara there is a siderurgical company, which was restructured, we are of the opinion that the use of these pellets is the optimal solution. In this sense, the steel dust – having the finest granulation – suits the requirements for pelletisation.

Our research analyzed also the possibilities of economical usage in pellets production of the mining and energetic sectors, respectively red mud, galvanically sludge and thermal power plant ash, from regional ponds of the nearby Oradea and Brasov.[15–17]

EXPERIMENTS, RESEARCHES AND RESULTS

A variety of pulverous wastes can be included in the mix of materials for pelletizing, including converter sludge, blast furnace sludge, ladle slags, sinter fines, mill scales, iron ore fines, lime and dolomite dusts.[5–17]
A number of critical factors influence the pelletizing process, namely:

- ≡ the chemical and physical properties of pulverous wastes to be processed;
- ≡ the number of pulverous wastes to be pelletized;
- ≡ the moisture content of the blend.

The fine materials structure formation is important not only to ensure a certain lumps size but also to obtain the given physical and chemical properties of pellets structures. There exists an appropriate causal relanshionship between the technological parameters of structure forming processes (pulverous wastes) and the qualitative properties of the fabricated prepared materials (pellets).
Our paper presents in the following lines the experiments and the results regarding the re–introduction into the economical circuit of the following ferrous pulverous wastes: steel dust and agglomerating–furnace dust.
The wastes from mining sector (red mud, galvanically sludge) and energetic sector (thermal power plant ash), together with the steel dust and the agglomerating dust were subjects of the pelletizing process, in presence of graphite,used as the reducing agent, respectively bentonite and lime, used as binders. The experiments were put into practice in the iron laboratories of the Faculty of Engineering in Hunedoara. [15–17]The recipes compositions for the pelletizing charges in Table 1 are presented.

Table 1. The pelletising recipes, [%]

	Wastes type	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13
1.	Steel dust	37	18	29	32	21	11	57	72	–	72	–	69	68
2.	Agglomerating–furnace dust	28	45	29	32	42	53	11	–	72	–	72	–	–
3.	Red mud	14	7	10	10	11	11	11	12	12	–	–	–	23
4.	Galvanically sludge	9	18	20	10	11	11	11	12	12	24	24	23	–
5.	Graphite	4	5	5	4	–	–	–	–	–	–	–	1	2
6.	Bentonite	6	5	4	4	5	5	3	4	4	4	4	3	5
7.	Lime	2	2	3	4	4	5	3	–	–	–	–	2	2
8.	Thermal power plant ash	–	–	–	–	5	4	2	–	–	–	–	–	–

Figure 3. Pellets

The input pulverous wastes are prepared, blended, mixed and conditioned correctly before being fed in a controlled manner into the pelletizing disc. The material is then granulated to a size and shape that can be tailored to suit each customer's individual requirements. After pelletizing, the pellets were dried (in air stream) the process being guided in such a way as to reach a resistance of a minimal 100 daN/pellet.[11,15–17]

DISCUSSIONS

The researches and experiments put into practice, led to the following considerations:

- ≡ two different types of pulverous ferrous wastes (steel dust and agglomerating–furnace dust) are processed through pelletising, together with two wastes from mining sector (red mud, galvanically sludge) and one from the energetic sector (thermal power plant ash), in presence of reducing agent (graphite) and binders (bentonite and lime);
- ≡ theutilization of these wastes presents an important interest considering the large quantities that are deposited in the ponds (especially the pulverous ferrous wastes). Due to these large quantities there is the danger of their break–down, having severe consequences upon the environment;
- ≡ the results allow the re–introduction into the economical circuit of some pulverous ferrous wastes which can replace a part of the waste iron, which is a deficitary raw material in the steel making processes;
- ≡ according to the target had in view (recuperated iron, correction of the slag's chemical composition) the quality of the pellets and the adequate recipe is chosen; technically speaking, the pulverous ferrous additions can be used to produce complex additions, which are very useful for active slag formation;
- ≡ from the point of view of the compression resistance, the pellets are adequate to be used in the electric arc furnaces which are used in steel making.
- ≡ a considerable decrease of environmental pollution would be possible in the vicinity of these ponds, and this would an action of considerable social impact (dust draws disappear through air streams, the risk of falling ill decreases, as well as that of soil sliding and water pollution);

CONCLUSIONS

Based on the study regarding the recovery possibilities of pulverous ferrous wastes deposited into settling ponds, nearby ferrous industry sectors in the area of Hunedoara, respectively mining and energetic sectors in area of Brasov and Oradea, we consider that the processing technology through pelletizing is viable on economical and environmentally basis. At the same time, we take into consideration for the future to recover pulverous ferrous wastes through briquetting, if we have in view the conditions provided by the analyzed areas.

In fact, the main benefits of pelletizing of in fine and pulverous wastes, now stored in the regional ponds of the nearby metallurgical, mining and energetic sectors, are:

- ≡ minimizes the disposal costs (lowest possible volume of material is sent to landfill);
- ≡ converts heterogeneous waste streams into a homogeneous lump agglomerate suitable for material handling;
- ≡ helps comply with environmental regulations on airborne dust emissions;
- ≡ promotes sustainable steelmaking.

The results confirm the research validity and recommend their implementation in the industrial practice. The products obtained (pellets), used as raw or auxiliary material in the iron and steel processes, help reduce costs for ferrous raw materials and bring technological, economical and environmental benefits, such as:

- ≡ increasing productivity,
- ≡ reducing the specific energy consumption, and
- ≡ increasing the degree of iron recovery.

Reintroducing the small and pulverous ferrous waste in the economic circuit, both those resulted from the current production flows and those disposed in ponds, leads to pollution reduction at the water–air–ground levels in areas surrounding the generators of such wastes. Moreover, it renders to the natural environment the spaces occupied as a result of their storage.

All over the world, it is used to produce cast iron in furnaces, being blasted into the mixture with coal dust through the blast inlet of the furnace, as well as casting iron in electric arc furnace, using it as a replacement for common slag foaming agents at electric arc furnaces provides both environmental and economical aspects. The environmental aspect is given by the considerable reduction of environmental pollution, both by the increase of recovery for pulverous wastes and reduction of depository spaces for these wastes. The lack of reintroduction in the economical cycle of this pollutant flows as well as the ones deposited in dump sites or in ponds leads to the reduction of the pollution in the waste neighboring areas at water–air–soil level. One of the most important advantage of the recycling process consists of the fact that the spaces occupied by this type of waste is returned to the natural environment. The economical aspect is reflected by transferring depositary expenses to other purposes.

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APPLICATION OF ELECTROCHEMICALLY SYNTHESIZED FERRATE(VI) IN THE TREATMENT OF PHENOL CONTAMINATED WASTEWATER FROM WOOD INDUSTRY

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Abstract: Treatment of wastewater (WW) from wood industry is of great importance due to high concentration and toxicity of phenol and its derivatives. High concentration of phenol in WW of wood industry originates from pentachlorophenol (PCP), which is used for wood conservation. According to the Regulations on Hazardous Substances in Water [1] allowed phenol concentration in waters of the III and IV class is 300 mg/l. Conventional methods for removal of phenol from WW are either environmentally or economically unacceptable. The use of ferrate(VI) as a multifunctional chemical reagent has significant advantages over conventional methods. The subject of this paper is treatment of samples of WW from wood industry - from thermal dryer and steam chamber, by electrochemically synthesized ferrate(VI). The initial concentration of phenol in the sample from thermal dryer was 27 mg / l and in the sample from steam chamber 30 mg / l. This wastewater also has a high content of natural organic matter (COD of the sample from the thermal dryer was 3233.1 mgO_2/l and COD of the sample from the steam chamber was 4692.1 mgO_2/l). The efficiency of phenol removal by ferrate(VI) was 74.85% and 72.67% for samples from thermal dryer and steam chamber, respectively.
Key words: ferrate(VI), phenol, wood industry, wastewater treatment, COD

INTRODUCTION

A large amount of attention has recently been focused on the removal of phenol and its derivatives from wastewater (WW) due to their toxicity and high concentration in wastewater. Phenol is a common pollutant in industrial discharges and is also believed to be an intermediate product in the oxidation process of higher molecular weight aromatic hydrocarbons. Their high concentration in the WW of wood industry originates from pentachlorophenol (PCP), which is used for wood conservation [2].

The contamination of water system by phenols and their compounds is a major problem because of the toxicity of phenol even at low concentrations. Toxic phenol concentrations are in the range of 10 - 24 mg / l for humans and from 9 - 25 mg / l for aquatic life. Lethal concentration of phenol is around 150mg / 100ml [3]. Phenol and phenolic compounds are designated as priority pollutants by the Environmental Protection Agency in the US, and take 11th place in the list of 126 undesirable chemicals [4].

Phenol and phenolic compounds are classified as teratogenic and carcinogenic compounds [5]. Phenolic compounds are well known for high salinity, acidity, chemical oxygen demand (COD) and low biodegradability [6]. In addition, they have low volatilities and easily form azeotropes and eutectics [7]. All these properties make them difficult to treat.

Phenol has acute and chronic effects on human health [4]. Inhalation and dermal exposure to phenol is highly irritating to skin, eyes, and mucous. The other acute health effects are headache, dizziness, fatigue, fainting, weakness, nausea, vomiting and lack of appetite at high levels. Effects from chronic exposure (longer than 365 days) include irritation of the gastrointestinal tract. Phenol also can change blood pressure and can cause liver and kidney damage. Nervous system is affected negatively for long time exposures. Animal studies have not shown tumors resulting from oral exposure to phenol, while dermal studies have reported that phenol applied to the skin may be a tumor promoter and/or a weak skin carcinogen in mice.

Due to its toxicity to aquatic life and humans, regulations for phenol concentration in WW are very strict. Maximum allowable discharge concentration of phenol varies from country to country, but generally it is about 10 mg / l [8]. According to the Ordinance on Hazardous Substances in Water [1] the maximum content of phenol in the waters of categories I and II is 1 mg / l, while in the waters of categories III and IV the limit is 300 mg / l.

Conventional methods for removing phenolics from wood industry WW include biological degradation, solvent extraction, adsorption and chemical oxidation [6, 9–11].

Biological treatment is economical and environmentally friendly method but at high concentrations of phenol, application of this method is not possible because of the inactivation of microorganisms. Other disadvantages are necessity of large land area and long time for microbial degradation, which makes this process less flexible in design and operation [12].

In the solvent extraction method the residual phenol concentration in wastewater barely meets the strict US Environmental Protection Agency (EPA) requirements (less than 1 mg/L in the wastewater) [13]. What is more, the separation of solute from the solvent is expensive and the loss of solvent requires additional treatment.

The adsorption process is proven to be efficient for the removal of organic contaminants and it is usually used only to treat dilute wastewater [14]. The most popular adsorbent is activated carbon due to its excellent adsorption abilities for phenolic compounds [15]. Drawback of this method is high initial cost; the regeneration of saturated carbons is also costly and results in loss of adsorbents. In addition, this treatment requires complexing agents to improve properties of activated carbon [15].

One of the possible methods of phenol removal from aqueous environments is chemical oxidation by ferrate(VI), an environmentally friendly oxidant, coagulant and disinfectant (Jiang, 2007). Ferrate(VI) is an adequate alternative to conventional methods because of its suitable physical and chemical properties such as high oxidation potential (2.2 V in acidic conditions and 0.7 V in alkaline conditions), forming of oxygen from water oxidation and high capacity for coagulation of iron(III)hydroxide as a product of ferrate(VI) reduction [16]. Ferrate(VI) can be produced by chemical or electrochemical synthesis. Ferrate(VI) produced by electrochemical synthesis has many advantages compared to chemically synthesized ferrate(VI) [17], such as simplicity and cost-effectiveness of the treatment (the use of one chemical, one system for dosing an mixing and less sludge production), exceptional purity of obtained ferrate(VI), as well as avoiding the formation of toxic by-products which originate from the application of chlorine and its compounds. Chlorine-based oxidants are not favorable option due to reaction of phenol with dissolved organic compounds and formation of toxic chlorine organic compounds such as 2-chlorphenol [18]. One more advantage of electrochemically produced ferrate(VI) is that it has no instability problem and needs no transportation, and because of ecological advantages it can be implemented in wastewater treatment practice, *in situ*.

The aim of this paper is to examine the possibility of phenol removal from wood industry WW by electrochemically synthesized ferrate(VI).

MATERIAL AND METHODS

Two wastewater samples from the wood processing plant were used in the experimental work: a sample from the thermal dryer and a sample from the steam chamber. The initial concentration of phenol in the sample from the thermal dryer was 27 mg / l and in a sample from the steam chamber 30 mg / l. This wastewater is also characterized by a high content of natural organic matter. Chemical oxygen demand (COD) of the sample from the thermal dryer was 3233.1 mg O_2 / l and of the sample from the steam chamber 4692.1 mg O2 / l. pH value of the sample from the thermal dryer was 4 and pH value of the sample from the steam chamber was 5.

The process of the treatment was performed using Jar test with a four-unit stirrer (Velp JLT4).

In the first step of the treatment both samples were treated with 30 mg / l $KAl(SO_4)_2$ of p.a. quality purchased at Sigma-Aldrich, St. Louis, Missouri, USA in order to remove suspended solids with a prior setting of pH value to 7.

In the second step of the treatment the samples were treated with the solution of electrochemically synthesized ferrate(VI) concentration of 8 g / l in molar ratio phenol : ferrate(VI) = 1 : 5. The process of electrochemical synthesis of the alkaline solution of ferrate(VI) was based on transpassive anodic dissolution of iron alloys in a 10 M NaOH solution, in accordance with previous studies [17,19] and it was carried out in a laboratory facility for electrochemical synthesis of ferrate(VI), Fig. 1.

Figure 1. Device for electrochemical synthesis of ferrate(VI)

The change in the concentration of phenol and COD value of the samples were determined using standard methods at MOL Institute, Stara Pazova.

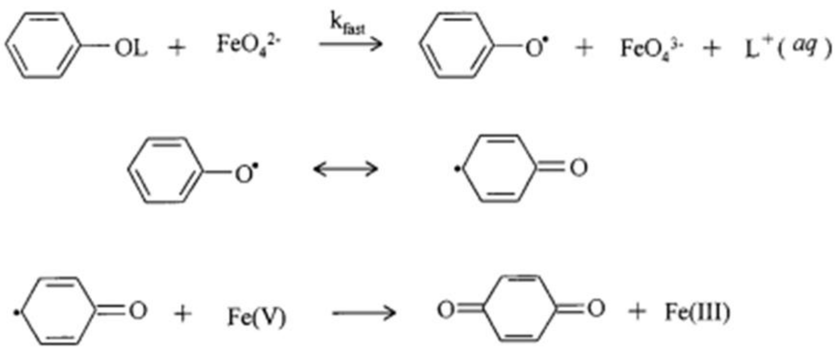
RESULTS AND DISCUSSION

Results of phenol removal by ferrate(VI) from the samples of wastewater from the thermal dryer and steam chamber are shown in Table 1.

Table 1. Reduction of the phenol concentration in the samples of wastewater from the thermal dryer and steam chamber before and after the treatment

	Phenol concentration in the untreated sample, mg / l	Phenol concentration in the treated sample, mg / l	Removal efficiency, %
Thermal dryer	27	6,79	74,9
Steam chamber	30	8,20	72,7

The results of the treatment shows high removal efficiency of phenol by ferrate(VI), 74.9% and 72.7%, for wastewater from thermal dryer and steam chamber, respectively, Table 1. Phenol is removed from aqueous solution by flocculation and coagulation with ferrous hydroxide, reactions 1 – 3, which is obtained as a product of ferrate(VI) reduction and has a very developed absorption area [20]. Since ferrous hydroxide has an extremely low solubility in these conditions, presence of residual Fe is not expected.



(1)

(2)

(3)

Possibility of phenol removal using ferrate(VI) was additionally confirmed by determining the value of COD in the samples treated by ferrate(VI), Table 2.

Table 2. Percentage of COD removal during oxidation reaction of phenol by ferrate(VI)

	COD of untreated sample, mgO_2 / l	COD of treated sample, mgO_2 / l	Reduction efficiency of COD, %
Thermal dryer	3233.1	2384	26.3
Steam chamber	4692.1	2594	44.7

The samples from thermal dryer, Figure 2, and steam chamber, Figure 3, were also characterized by high initial COD values, 3233.1 and 4692.1 mgO_2 / l, for thermal dryer WW and steam chamber WW, respectively.

(a) (b) (c)

Figure 2. Sample of WW from the thermal dryer (a) before the treatment; (b) after the first step of the treatment by $KAl(SO_4)_2$; (c) after the second step of the treatment by ferrate(VI)

After the addition of ferrate(VI) into the solution, showed a COD reduction of 26.3 % for thermal dryer and 44.7 % for steam chamber. Using higher doses of ferrate(VI) could reach a more efficient reduction of COD values which requires further optimization of the treatment process of WW from wood industry by ferrate(VI).

Figure 3. Sample of WW from the steam chamber before the treatment and after the second step of the treatment by ferrate(VI)

CONCLUSION

The aim of this study was to examine the possibilities of phenol removal from WW from wood industry in the reaction of oxidation by freshly electrochemically synthesized ferrate(VI). The paper shows the possibility of efficient removal of phenol by ferrate(VI) from the samples of wastewater from wood processing industry characterized by a high content of phenols and high COD value. Due to the catalytic effect of ferrous hydroxide, resulting product from the reaction of ferrate(VI) reduction, high efficiency of phenol removal from the wastewater is achieved: 74.9 % removal efficiency for the sample from thermal dryer and 72.7% removal efficiency for the sample from steam chamber. Since the treated water had a high COD value for more effective treatment it is necessary to increase the added amount of ferrate (VI).

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Session 3.

Process Technique

SELECTION OF OPTIMAL PARAMETERS PIPELINE - CRITERIA, INVESTMENTS IN OIL PIPELINE, ANNUAL COSTS

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Abstract: This paper analyzes the optimal parameters of the pipeline - the criteria, investments in the pipeline, the annual costs. Transportation of crude oil from oil fields to refineries, pipelines can be done, rail tank cars, tank trucks, river and sea tankers. Each of these modes of transport has its own technological and economic limitations of the application, which must be taken into account in solving specific problems.
Key words: parametric pipeline investments, the annual costs.

INTRODUCTION

Transportation of crude oil from oil fields to refineries, pipelines can be done, rail tank cars, tank trucks, river and sea tankers.
Train freight presupposes the existence of a developed network of railways, where the implementation of the transport of crude oil builds an industrial track from the farm to the existing rail system. Railway transport crude oil from a field has an advantage over transport pipeline if the length of industrial tracks smaller and if done or transport of small quantities at greater distances.
Road transport of crude oil has increased the possibility of application in relation to rail transport because road routes developed by the railway. Road transport shows the advantage over other modes of transport for the transport of small quantities of oil.
River transport of oil is caused by buoyancy and razgranatošću waterways or rivers and canals. This mode of transport offers a better economy of transport over other modes of transport when it comes to large quantities of oil.
Maritime transport crude oil is practically no competition in overcoming large transport routes and the sea as a barrier. Only on shorter routes, the platform on the sea to the land, sea pipelines can be competitive in this form of transport.
Each of these modes of transport has its own technological and economic limitations of the application, which must be taken into account in solving specific problems.
In considering the application of Transportation Pipeline and comparisons with other modes of transport should be considered an oil pipeline whose technological characteristics provide the required level of functioning while achieving optimal economic conditions. The price of transport is the one that defines the choice of transport methods and parameters of the pipeline and their technical characteristics.

SELECTION CRITERIA OPTIMAL PARAMETERS PIPELINE

The pipeline is a complex structure that makes the shipping terminal, an oil pipeline in the strict sense of the word - a pipeline and receiving terminal. Dispatch terminal represents the object on which it is installed, oil depot and initial pumping station. The pipeline in the strict sense of the word includes piping, equipment, pipeline pumping stations and the cathodic protection systems and telecommunications.
Receiving terminal consisting of a reservoir space for receiving oil system manipilaciju and pump units which provide referral oil refining process (if the receiving terminal near the refinery) or transhipments in tankers (if the receiving terminal on the shore of the river channel or sea).
On the subject of terminals, optimizing the storage premises. Capacity of storage space, the number of reservoirs and reservoir types which can meet the required storage capacity subject to the election procedure and optimization.
The greatest preoccupation at the pipeline presents a selection of the technical characteristics of the pipeline, the initial pumping stations and intermediate stations. The route of the pipeline operating

pressure of the pipeline, tube type, quality and wall thickness, type and quality of equipment of the pipeline, the number of pumping stations, power, pumps and other types of the basic technical parameters that are subject to the process of optimization.
In considering the process of optimizing we will mainly remain at the choice of the route, the diameter, the number of pumping stations and power stations.
Selection of the optimal size of the individual parameters includes finding the most suitable size in relation to established criteria. When the pipeline may be present, mainly three criteria. The first criterion which has the largest application of the selection criteria of those technical characteristics of the pipeline that will support the lowest total annual costs. In conditions when not have sufficient capital may be required to build the pipeline with such technical characteristics that allow minimum investments. Thus, the first criterion takes into account the total annual costs, ie., On the economy throughout the entire lifecycle of an oil pipeline to the second criterion of the minimum investment in a way neglected the technical and economic requirements before the pipeline during its service life.
In wartime conditions, and in certain special situations the speed of construction and commissioning of the pipeline can not be a criterion of optimality. Of course, the optimality criterion can be a combination of the above criteria. For example, the construction of a pipeline with a minimum annual costs of transport, where construction may not exceed 18 months. The process of choosing the best parameters in the application of economic criteria (minimum annual costs or minimum initial investment) requires at finding alternative solutions considered investment - the price of the object and annual maintenance costs.
How real is the economic budget for the entire service life of the pipeline would be required consideration of alternative solutions to include investment operations that will occur during this period, and changing capacities. To make investments in different time periods (for example, in the first, fifth and tenth year) according to a variant of construction could be compared with capital investments from other variants (which are, for example, is planned in the first year, the seventh and twentieth year) needed all the investments are reduced to the same level. This reduction is carried out so-called process of discounting. This process involves evaluation of the invested capital in different periods of time (years) to the value in the first year of investment. In this way, variants with different technical solutions and different dynamics of capital investment are reduced to the same comparative level, because all the value of capital invested in different years have been reduced (valuation) to the value in the first year of construction. Of course, the invested capital can be discounted, ie., Focus and awareness of the value of invested capital is reduced to the last year of exploitation.

DETERMINATION OF INVESTMENTS IN OIL PIPELINE

Investments in the pipeline include investments in the construction of pipelines and investments in the construction of pumping stations. The amount of investments in the pipeline are determined investment in preliminary - final works, the supply of equipment and materials, construction - assembly work and other unallocated expenses.
The preparatory work falls making the investment - technical documentation, procurement of equipment and materials, solving property rights and investments organization. The final phase includes technical acceptance of the facility, functional testing and commissioning.
Investment - technical documentation includes conceptual design, investment program, performing projects and tender documents for the procurement of equipment and materials as well as for the works.
Solving property rights involves performing procedures to obtain the right to enter the land (where necessary and ownership), along the route of the pipeline for the discharge of the performing works and maintenance work on the pipeline during the period of exploitation.
This group includes activities related to the organization of investment, providing financial resources, the process of procurement and storage of equipment and materials, coordination of all activities related to preparation and realization of investments.
The most significant part of the cost of construction of a pipeline has a price of pipes, equipment and pipeline pump price. Price pipes and pipe elements depends on the type of pipe, the quality of the steel and the diameter and wall thickness. If the fluid is transported by pipeline without the aggressive

content of components (sulfur - hydrogen, carbon - dioxide) then used pipes and pipe fittings made of carbon steel. The presence of aggressive components involves the use of steel resistant to these components, ie., Steel containing chromium, molybdenum and nickel or stainless steel. There are several types of stainless steels and their price can be up to three or four times higher than the price of carbon steel.

It is common in the procurement of pipes expressing prices in € / kg or din / tonne. This means that the cost of the pipeline depends on the weight of the pipe, which is a direct function of the diameter and wall thickness. The thickness of the pipe wall near the quality of the material (5L X-42, 46, 52, 56, 60, 70) of which are manufactured pipe affects the type of construction of the pipeline. Type of construction of the pipeline is defined by the coefficient of security whose value is adopted according to population density and the presence of objects that should be protected or that have an impact on the pipeline. Thus the passage of the pipeline through densely populated areas using thicker pipes compared to pipes that are used to pass through agricultural areas. When crossing major vovotokova used pipes with greater wall thickness which meets the increased requirements in safety.

The pressure of the pipeline, or the size of the maximum operating pressure, also has an impact on the cost of the pipeline. So, if you take that pipeline price for Class 20 bar (ANSI 150) is equal to one, then the class of the pipeline pressure of 50 bar (ANSI 300) by 59% higher, ie., 1.59 from the price of the pipeline for 20 bars, a for class 100 bar (ANSI 600), the price is 68% higher or 1.68 putacena pipeline pressure of 20 bar.

The pipes can be welded and seamless with different ways of welding. Seamless pipes are more expensive than welded pipes. Electric welded pipes are more expensive than resistance welded pipes. Price building installation work includes the preparation of the terrain, stretching along the pipe, welding pipe and pipe elements, testing of welded joints, cleaning and pipe insulation, trench digging, laying sections of the pipeline in the trench, backfill pipes, installation of tube caps and connecting sections, making crossing below roads and watercourses and their connection to the pipeline sections, hidroproba pipeline, draining water from the pipeline cathodic protection and development of the technical inspection of the facility.

The amount of costs of these works depends on the morphological and mechanical characteristics of the soil through which the pipeline passes. The cost of producing is different whether it is executed on the mountain, mountain, plains, the wooded, swampy areas or areas of permafrost.

Price excavation trench in the soil that makes the humus and clay is different from the price of making a trench in stone. Unstable areas, zones with landslides impose remediation of landslides or application specific constructive solutions to eliminate the possible influence of landslides on the stability of the pipeline. Passing through the wetlands requires impeding the pipeline weights or concrete lining. Similarly, in the transition vovotokova. The other costs include control and various costs that are implemented during the construction of a pipeline not covered by the previous group of costs.

Based on data from the journal "Oil and Gas Journal" made the price of pipeline per kilometer depending on the diameter. This price applies to the market in the US - in the year 1990. Data are given in table 1.

Table 1. The price per kilometer of pipeline

Prečnik		Cena izgradnje cevovoda u $/km	Jedinična cena $/m-prečnika/m-dužine
inch	m		
12	0,323	160.340	496
14	0,355	170.350	500
16	0,400	202.765	506
18	0,457	223.985	490
20	0,508	245.200	482
22	0,559	266.420	477
24	0,609	287.640	472
26	0,660	308.750	468
28	0,711	330.050	464

In the above table are given data on the cost (total value) built a pipeline to a meter in diameter and a meter in length. This way of displaying prices used for the quick and rough estimate of investment needed for the construction of a pipeline. A common application of this method of expressing the price in $ / inch diameter / km in length or shorter price inch - kilometers. From the presented data on the movement of prices is seen that the one with the increase in diameter mild decline, by € 496 $ / m / m at 0,323 m in diameter and 464 of the $ / m / m at a diameter of 0.711 m. However, in the rough, the first budget of a drobro serves Expression prices using the average unit price.
Price pumping station consists of the price of pumping units, installation of the unit price and the price of site preparation for the development of pumping stations, as well as the construction of buildings for this station and associated infrastructure. The price depends on the type of pump and the pump drive motor from the pump. The most expensive pumps are driven by diesel - engine driven pumps are cheaper gas - a cheap motor pumps with an electric motor.
Price pumping stations are usually expressed in dinars (or dollars) per unit in power (kW). Table 2 shows the price movement of pumping stations depending on the size of installed capacity. The data presented in this table are also carried out on the basis of data from the journal "Oil and Gas Journal" as well as the cost of building the pipeline.

Table 2. Price pumping stations

Snaga pumpe (kW)	Investiciona ulaganja		
	Elektro pogon ($/kW)	Pogon na gas ($/kW)	Dizel pogon ($/kW)
200	3535	4216	4880
500	1224	2108	3060
1000	1088	1836	2380
2000	1054	1734	2176
3000	986	1635	2060

Building installation work depends on the size of the pumping station, or from the installed capacity and the characteristics of the location where the station is built. These features include the accessibility of the site, ie., Distance to roads, the conditions of the electricity, water, mechanical and other properties of the soil and more.

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OPTIMAL PARAMETERS PIPELINE - OPTIMAL ROUTE SELECTION, SELECTION OF OPTIMAL PIPELINE DIAMETER

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Abstract: This paper considers the optimal parameters of the pipeline - optimal route selection, selection of the optimal diameter pipeline. When calculating the price of transport pipelines, as well as in the selection of optimal parameters of the pipeline with the criterion of the minimum annual cost, based on the budget consists of annual costs.
Key words: parameters, pipeline diameter pipeline.

ANNUAL COST OF OIL PIPELINE

The annual cost of the pipeline consist of depreciation, interest on equity, insurance and maintenance costs pipeline.
Depreciation represents the statutory obligations of the funds during the exploitation of an object in order to ensure its reproduction, or replaced with new ones at his physical or technological obsolescence.
The basis for calculating depreciation is the value of the pipeline, and pipelines, pumping stations and related facilities and the amortization rate. The regulations of each country governing the depreciation rate for buildings and equipment. Amortization Ages pipeline ranges from 15 to 20 years. However, when calculating amortizaciije must take account of the depreciation of each component Ages pipeline. Thus, the pipe goes amortization Ages 15- 20 years, but for the telecommunications system of 5 to 10 years. Pumping stations are depreciation Ages 10 to 15 years and at pumping stations should take account of the amortization of certain components century. For example, pumping stations have amortization Ages 10 years, automation system 5 years Buildings 20 - 25 years. Costs related to interest and security depend on the amount of capital on which the interest is paid or the value of the object to be secured, and the height of interest rates or insurance. So, for example, the annual interest rate ranges 8 - 10%, while the rate of insurance is about 1% of the value of the insured object. Maintenance costs include the costs of pipeline maintenance operation pipeline (pipelines, pumping stations and related facilities). This includes staff salaries, the purchase costs of raw materials, spare parts, maintenance equipment, repairs to emergency conditions, driving energy (electricity, fuel, lubricants) and others. The staff includes staff working in the dispatch center, maintenance of telecommunication systems, maintenance of the line of the pipeline and pumping stations, as well as the staff who planned the operation and maintenance and supervision.
The total annual cost of the pipeline can be represented by the equation:

$$Tu = Tcevovoda\ Tpump\ station \tag{1}$$
$$Tu = \alpha * Icevi\ Ecevi + \beta * Ipumpi\ Epumpi \tag{2}$$

Where are they:
Seats - the value of the pipeline - investments,
α - part of the value of the pipeline, which must be repaid each year (depreciation, insurance, interest)
Zečevo - operation costs of the pipeline,
Ipump - the value of investing in a pumping station,
β - part of the value of pumping stations, which must be repaid each year (depreciation, interest, insurance)
Epumpi - operating costs of pumping stations.

OPTIMAL CHOICE OF PIPELINE ROUTE

The simplest example of laying an oil pipeline between two points A and B points to the problem of finding optimal routes. The map can be between points A and B cause any network configuration. The intersection of lines that form a network called nodes, and the lines between nodes look longer. The network can be set up so that points A and B lie in knots. From point A to point B can be reached using a variety of longer, set the allowed path (the illegal ones that make loops). The task is made up of optionally putanjer longer such values, that gives the maximum or minimum size criteria.

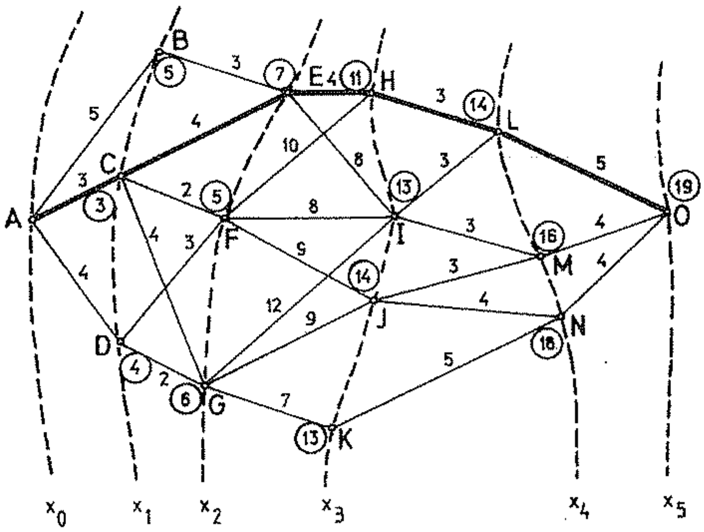

Figure 1. Selection of the optimal pipeline route

The most common application of the minimum criteria have annual costs, ie., The selection of the route that has a minimum annual costs. It has already been stated that the criteria can be the smallest investments, during the construction and reliability of the constructed pipeline so that the search route that provides at least annually costs the pipeline, or the route that provides the highest reliability and the pipeline route that provides the shortest construction time and route with a combination of specified criteria. For example, the lowest annual costs and the shortest construction time. If adopted for the selection of optimal routing criteria that the optimal one route that provides a minimum annual costs, then we solve the equation:

$$\Sigma Ti\ Li = min\ * \qquad (3)$$

Where: Ti - annual costs per km pipeline,
Li - the length of a longer route that goes in the network in km.

Finding the optimal route of imposing appropriate mathematical methods to determine the optimal route in a network of suitable paths. There are a number of methods to treat the problem of the shortest path and which are used in solving the task. Otherwise, these methods are subject to continuous improvement. Figure 1 provides an overview of the selection of optimal route of a pipeline, where the optimality criterion taken the price of building the pipeline (minimum investment).

OPTIMAL CHOICE OF DIAMETER PIPELINE

Selection of the optimal diameter compared to annual costs represent a comparison of the costs and expenses of the pipeline pumping stations in versions with different diameters pipelines. In considering the varieties that we have to decrease costs by reducing the diameter of the pipeline, while keeping costs increasing pumping stations. In Figure 2, showing the movement of costs related to

pipeline and pumping stations. This picture is best illustrated by the character of changes in costs of oil pipelines with a diameter change the method of selecting the optimum diameter.
Total annual costs related to the pipeline can be expressed by the following equation:
$Tuk = N\ C1 * + C3\ C2\ D * * + L\ C4\ L *$ (4)

Where are they:
N - pump power in kW,
C1 - the total annual cost of pumping stations in dinars ($) / kW / year,
C2 - the annual cost of the pipeline ($) din / per meter in diameter and one meter of pipeline (costs depend on the diameter)
C3 - the annual cost of pumping stations which are not connected to power ($) / $ / yr,
C4 - the annual cost of the pipeline, which depends on its length in ($) din / m
If we start from the equation for force pumping:
$N = Q\ P * / 1000 * \eta p$ (5)

Where pressure P represents the pressure required for overcoming the losses of pressure which is obtained from the equation of flow.

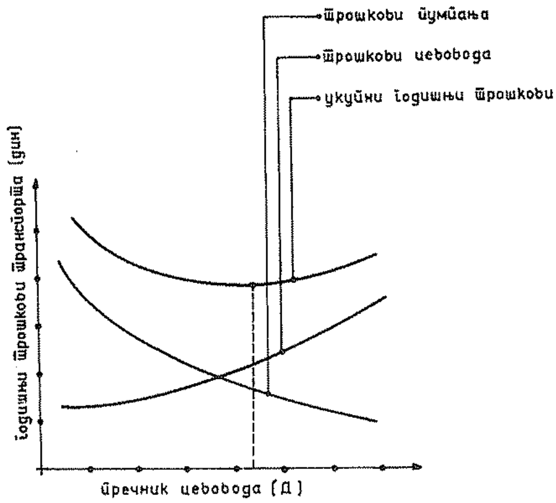

Figure 2. The movement costs of pipelines and pumping stations

$\Delta P = \lambda * L / 2\ D * v2\ \rho = 0.811392 * Q2\ \lambda * \rho * L / D5$ (6)
Substituting $\Delta P = P$ in the equation for the power we have:
$N\ \lambda = 0.811392 * Q3\ \rho * L / D5 * 1000 * \eta p$ (7)
The equation for the total cost of the pipeline taking shape after the inclusion of the expression for the force:
$Tuk = [0.811392 * \lambda * Q3 * \rho * L / D51000\ \eta p *] * C1 + + C3\ C2\ D * + L\ C4\ L$ (8)
From this equation we can come to the fore for optimal diameter if we find the first derivative of the equation and perform his equality with zero. In this way we obtain an optimal D:
$D = (4.05696 * 10\ {-3} * Q3 * \lambda * \rho * Cj / \eta p * C2), 0.1666$ (9)

Where are they:
D - inner diameter of the pipeline in m,
Q - flow in m3 / s,
ρ - density of oil in kg / m3,
λ - coefficient of friction,
ηp - use of pumps,
C1 - the total annual cost of pumping stations in dinars ($) / kW,
C2 - the annual cost of the pipeline ($) din / per meter in diameter and one meter of pipeline (costs depend on the diameter).

In considering the varieties that we have to decrease costs by reducing the diameter of the pipeline, while keeping costs increasing pumping stations. For smaller diameters are larger pressure drops, so more power is needed to pump their compensation, and with greater force growth and pumping costs.

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FUTURE DIRECTIONS OF THE NATURAL GAS INDUSTRY

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Abstract: Innovations are used in a broad range of new developments in the natural gas industry and are found in a wide variety of extraction, separation, solid-state gas sensing for air pollution monitoring, adsorbent materials for environmental separation, and corrosion inhibiting areas. The commercialization of new innovations promises to have a substantial effect on the natural gas industry in the coming decades and will continue to reshape all segments of the industry. Research and development is essential if the industry is to achieve exceptional performance possibly enabling more efficient and less expensive recovery and manufacturing processes.
Key words: natural gas industry, new technologies

1. INTRODUCTION

Over the past several decades, the natural gas industry has been transformed into one of the most technologically advanced industries in the world. New innovations have reshaped the industry into a technology leader, in all segments of the industry. This paper will present the role of technology in the evolution of the natural gas industry, focusing on technologies in the exploration and production sector, as well as a few select innovations that have had, and will continue to have, a profound effect on the potential for natural gas.
Some of the major recent technological innovations in the exploration and production have lead to both economic and environmental benefits and include innovative advances in the exploration and production sector. In addition, two other technologies that are revolutionizing the natural gas industry include the increased use of liquefied natural gas, natural gas fuel cells, and the potential for use of nanotechnology in the gas industry.

2. ADVANCES IN EXPLORATION AND PRODUCTION

New technologies serve to make the exploration and production of natural gas more efficient, safe, and environmentally friendly. Despite the fact that natural gas deposits are continually being found deeper in the ground, in remote, inhospitable areas that provide a challenging environment in which to produce natural gas, the exploration and production industry has not only kept up its production pace, but in fact has improved the general nature of its operations.

3-D and 4-D Seismic Imaging

The development of seismic imaging in three dimensions greatly changed the nature of natural gas exploration. This technology uses traditional seismic imaging techniques, combined with powerful computers and processors, to create a three-dimensional model of the subsurface layers. 4-D seismology expands on this, by adding time as a dimension, allowing exploration teams to observe how subsurface characteristics change over time. Exploration teams can now identify natural gas prospects more easily place wells more effectively, reduce the number of dry holes drilled, reduce drilling costs, and cut exploration time.

CO_2-Sand Fracturing

Fracturing techniques have been used since the 1970s to help increase the flow rate of natural gas and oil from underground formations. CO2-Sand fracturing involves using a mixture of sand and liquid carbon dioxide to fracture formations, creating and enlarging cracks through which oil and natural gas may flow more freely. The CO2 then vaporizes, leaving only sand in the formation, holding the newly enlarged cracks open. This type of fracturing effectively opens the formation and allows for increased recovery of natural gas and (1) does not damage the deposit, (2) generates no below ground wastes, and (3) protects groundwater resources.

Coiled Tubing

Coiled tubing technologies replace the traditional rigid, jointed drill pipe with a long, flexible coiled pipe string. This greatly reduces the cost of drilling, as well as providing a smaller drilling footprint, requiring less drilling mud, faster rig set up, and reducing the time normally needed to make drill pipe connections. Coiled tubing can also be used in combination with slim-hole drilling to provide very economic drilling conditions, and less impact on the environment.

Measurement While Drilling

Measurement-While-Drilling (MWD) systems allow for the collection of data from the bottom of a well as it is being drilled. This allows engineers and drilling teams to access to up to the second information on the exact nature of the rock formations being encountered by the drill bit. This improves drilling efficiency and accuracy in the drilling process, allows better formation evaluation as the drill bit encounters the underground formation, and reduces the chance of formation damage and blowouts.

Slim-hole Drilling

Slim-hole drilling is exactly as it sounds; drilling a slimmer hole in the ground to get to natural gas and oil deposits. In order to be considered slim-hole drilling, at least 90 percent of a well must be drilled with a drill bit less than six inches in diameter (whereas conventional wells typically use drill bits as large as 12.25 inches in diameter). Slim-hole drilling can significantly improve the efficiency of drilling operations, as well as decrease its environmental impact. In fact, shorter drilling times and smaller drilling crews can translate into a 50 percent reduction in drilling costs, while reducing the drilling footprint by as much as 75 percent. Because of its lower cost and reduced environmental impact, slim-hole drilling provides a method of economically drilling exploratory wells in new areas, drilling deeper wells in existing fields, and providing an efficient means for extracting more natural gas and oil from undepleted fields.

3. LIQUEFIED NATURAL GAS

Cooling natural gas to about -260°F at normal pressure results in the condensation of the gas into liquid form (*liquefied natural gas*, LNG). When mixed with air and vaporized, liquefied natural gas will only burn in concentrations of between 5 and 15% by volume. In addition, liquefied natural gas, or any vapor associated with liquefied natural gas, will not explode in an unconfined environment. Thus, in the unlikely event of a liquefied natural gas spill, the natural gas has little chance of igniting an explosion. Liquefaction also has the advantage of removing oxygen, carbon dioxide, sulfur, and water from the natural gas, resulting in liquefied natural gas that is almost pure methane.
The increased use of liquefied natural gas is allowing for the production and marketing of natural gas deposits that were previously economically unrecoverable.

4. NATURAL GAS FUEL CELLS

Fuel cells powered by natural gas are a promising new technology for the clean and efficient generation of electricity. Fuel cells have the ability to generate electricity using electrochemical reactions as opposed to combustion of fossil fuels to generate electricity. In practice, fuel cells result in very low emission of harmful pollutants, and the generation of high-quality, reliable electricity as well as other benefits, including:

Fuel cells provide the cleanest method of producing electricity from fossil fuels. While a pure hydrogen, pure oxygen fuel cell produces only water, electricity, and heat, fuel cells in practice emit only trace amounts of sulfur compounds, and very low levels of carbon dioxide. However, the carbon dioxide produced by fuel cell use is concentrated and can be readily recaptured, as opposed to being emitted into the atmosphere.

5. NANOTECHNOLOGY IN THE NATURAL GAS INDUSTRY

Nanotechnology comprises (1) the design of atomically engineered *building blocks*; (2) the assembly of these building blocks into new, nanostructured materials with specific characteristics; and (3) the assembly of these materials into useful devices. Nanostructures are often arranged or self-assembled into highly ordered layers arising from hydrogen bonding, dipolar forces, hydrophilic or hydrophobic interactions, gravity, and other forces Amasciangioli and Zhang, 2003).

The structures and properties of nanostructured materials have now been elucidated in a number of important areas and a fundamental understanding of the relationships among these areas is beginning to unfold. The extraordinary mechanical, electronic, and chemical characteristics of nanostructures (nanotubes) have captured the imagination of scientists and engineers (Baughman et al., 2002). Nanotubes generally consist of hexagonal lattices of carbon atoms arranged spirally to form concentric cylinders (Iijima, 1991). The tubes are nearly perfect crystals and thinner than graphite whiskers. Generally speaking, there are two types of carbon nanotubes (CNTs): single-walled carbon nanotubes (SWNTs) and multi-walled carbon nanotubes (MWNTs). As their names imply, SWNTs consist of a single, cylindrical graphene layer, where as MWNTs consist of multiple graphene layers telescoped about one another. Single-wall nanotubes have a diameter of approximately 1.4 nm, and multiwall nanotubes consist of between 2 and 30 concentric tubes that form an outer diameter of 30 to 50 nm. Nanotubes range in length from a few tens of nanometers to several micrometers.

Nanomaterials are frequently associated with alternative energy sources such as solar, fuel cells and the hydrogen economy and, as a result, their application in the gas industry is less frequently discussed (Bell, 2004). The natural gas industry faces a range of materials-related challenges, which lead to increased costs and limit the operating envelope of the relevant technologies. This represents a significant market opportunity for nanomaterial-based solutions.

Gas separation membranes rely on the difference in chemical or physical interaction between the components present in the gas mixture and the membrane material. This difference causes one of the components to permeate faster through the membrane than the other. Gas absorption membranes are used as contacting devices between a gas flow and a liquid flow. The absorption liquid on one side of the membrane causes the separation by selectively removing certain components from the gas stream on the other side of the membrane.

The performance (selectivity and permeance of a single gas or binary gas mixtures) of these membranes is directly related to the material of construction. Ceramic composite membranes with micro-porous support structure (mainly alumina) covered by a thin intercrytalline layer consisting of mainly of silica, zeolite, and palladium alloy are widely used. They are fabricated in two different orientations: flat-plate and tubular. Depending on the application, the membranes can be impregnated with nanoparticles in order to plug the intercrystalline pores of the membrane and make the membrane selective towards a specific gas.

The resulting membranes behave unlike similar membranes embedded with metal oxides, carbon black or other nanoscale parties. Instead of the reduced permeability typical of *filled* membranes, this new class of membrane had increased permeability and enhanced selectivity, and a useful ability to filter gases and organic vapours at the molecular level. The new nanocomposite membranes are more selective and faster acting than previous versions used for molecular separation, which could have implications for many applications of the technology. Nanostructured ceramic membranes are used for high temperature catalytic reactions, and building solid oxide fuel cells.

To date, hexavalent chromates are the most effective corrosion inhibitors. However, they are carcinogens and regulations will soon prohibit their use in most coatings. Recently, nanoparticle based organic corrosion inhibitors have been developed and found to be highly effective. These nanoparticles have organic corrosion inhibitors anchored to the surface that are triggered to release by the corrosion process. While anchored, the corrosion inhibitors are non-leachable, but when released

they migrate to arrest corrosion at the metal surface. These materials provide excellent corrosion resistance in epoxy primers on high strength aluminum alloys.
The cost of establishing and implementing ordinary monitoring systems is extremely high; use of analytical instruments are time-consuming, expensive, and can seldom be applied for real-time monitoring in the field, even though these can give a precise analysis (Lee and Lee, 2001). Hence, a new generation of detectors, solid state gas sensors, offer an excellent alternative for environmental monitoring due to low cost, light weight, extremely small size that result in increased gas adsorption and higher sensitivity (Hauptmann, 1993). These sensors are not deployment-restricted and can be deployed to receive data for transmittal through a wireless GIS network system for rapid monitoring (Pummakarnchana et al., 2005).
Many different approaches to gas detection are available but metal oxide sensors remain a widely used choice for a range of gas species. These devices offer low cost and relative simplicity, advantages that should work in their favor as new applications emerge, but issues with sensitivity, selectivity, and stability have limited their use, often in favor of more expensive approaches.
Hooker, 2002).
Adsorption processes are dominating technologies that have attracted continuous investment in research and development. Adsorbent materials are increasingly being applied and new adsorbents are constantly being invented and modified for various environmental applications such as the removal of sulfur dioxide (SO_2), nitrogen oxides (NO_X) and volatile organic compounds (VOCs) from gas streams. Adsorbents of the traditional types such as commercially available activated carbons, zeolites, silica gels, and activated alumina have worldwide market. New adsorbent materials with well defined pore sizes and high surface areas are being developed and tested for potential use in the natural gas industry and in environmental separation technologies.

6. CONCLUSIONS

Nanomaterials as a subset of nanostructured materials possess unique surface, structural, and bulk properties that underline their important uses in various fields such as gas separation, sensor, corrosion inhibitor, and air pollution monitoring. Nanomaterials are also of scientific and technological importance because of their vast ability to adsorb and interact with atoms, and molecules on their large interior surfaces and in the nanometer sized pore space.
The application of nanomaterials need not be limited to revolutionary technologies. In some cases significant benefit could be derived by simply replacing equipment fabricated from conventional materials with a nanomaterial-based equivalent. Having established the viability of nano-based products using such a displacement approach it should then be easier to introduce other, more fundamentally different technologies as the industry becomes more generally tolerant of nanomaterials.

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INTRODUCTION OF NEW STANDARDS IN FUEL QUALITY CONTROL AND IMPROVEMENTS IN URBAN AIR QUALITY

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Abstract: This paper presents an overview ofregulations and standards pertaining to engines and fuel composition. It also discusses the emission of pollutants originating from petrol or diesel combustion in the engines of Euro III, Euro IV, Euro V,and Euro VI technology standards. The justification for introducing and implementing new standards is shown through the example of the City of Niš, in which air quality analysis revealed that increased SO_2concentrations can be caused by the use of low-quality fuel.
Key words: pollutant emission, automotive fuel, MSATs, EURO norm,ULEV, SRPS ENstandards

INTRODUCTION

Over the last several decades, humanity has been facing intensive environmental pollution. Originally, the pollution was biological and local, but today, in the age of modern industrial, urban, and transport development, environmental pollution has become a global problem. People's awareness is currently directed towards sustainable development, i.e. towards establishing a harmonious relationship between the economy and the environment, which has not been degraded through the use of various technologies whose purpose is to meet the ever more demanding standards of living. Modern society has a need for increasing transport of people and goods, so environmental protection poses a challenge from that aspect, as well. Transport is a globally significant source of air pollution in all its major modes – road, rail, air, and water. Despite technological improvements and promotion of cleaner engines and fuels, pollution caused by transport is constantly increasing as the growing human population increases the intensity of transport as well as the number of vehicles.
Motor vehicles emit large concentrations of carbon dioxide (CO_2), carbon monoxide (CO), hydrocarbons (C_xH_y), nitrogen oxides (NO_x), suspended particulate matter (PM_{10} and $PM_{2.5}$), and other substances in smaller concentrations that are more or less toxic, such as benzene, formaldehyde, acetaldehyde, 1,3-butadieneand lead (where leaded petrol is still used). Toxic substances emitted with motor vehicle exhausts are called mobile source air toxics, abbreviated MSATs. Emission of these substances is becoming more intense with the increase in the number of motor vehicles and with rapid urbanization, which directly results in the degradation of air quality and the environment. One of the primary tasks of environmental protection is to reduce the impact of motor vehicle pollutants. Accomplishment of this task requires a comprehensive strategy, which commonly includes four key components, as shown in Figure 1.

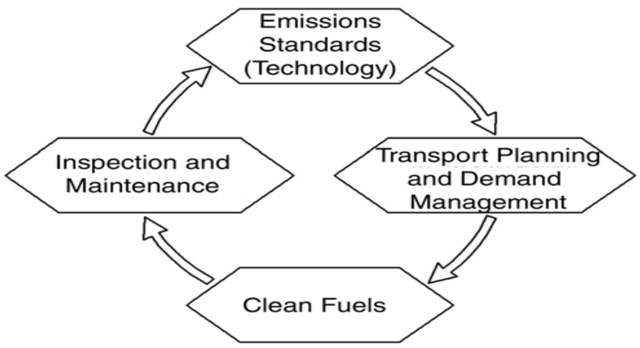


Figure 1. Elements of emission control strategy [5]

REGULATIONS AND STANDARDS FOR MOTOR VEHICLE EMISSIONS

The vehicle production norms and standards pertaining to the emissions from automotive fuel combustion that have to be met in the EU are called Euro norms for short. Non EU members have created their own local standards to preserve air quality in areas with high vehicle frequency.

The USA has its legislation on exhaust quality, which differs from the European, e.g. LEV (Low Emission Vehicle), ULEV (Ultra Low Emission Vehicle),etc. A comparative analysis can reveal that there are significant differences between standards that are implemented in the EU and in the USA. The differences are the most prominent for prescribed limit values and for applied quantitative methods for substances emitted in motor vehicle exhausts. In 1969, the USA was the first to enact a series of regulations aimed at reducing motor vehicle emissions and to require the automotive industry to develop new technologies. The "Clean Air Act" was the first act on clean air, enacted by the US Congress in 1970. The automotive industry now cooperates with the legislators on the passing of norms for long-term and timely enactment of new regulations, although it was initially opposed to the implementation of certain norms. Table 1 shows the LEV 2 standard for passenger vehicle emissions in California administered by the Californian Air Resources Board, whereas federal regulations fall under the jurisdiction of the Environmental Protection Agency (EPA).

Table 1. LEV 2 standard for passenger vehicle emissions in California[7]

Emission category	Vehicle service life		CO		NO_x		PM	
	Mi	km	g/mi	g/km	g/mi	g/km	g/mi	g/km
TLEV[1]	50,000	80,467	3.4	2.1	0.40	0.25	-	-
	120,000	193,121	4.2	2.6	0.60	0.37	0.04	0.025
LEV[2]	50,000	80,467	3.4	2.1	0.05	0.03	-	-
	120,000	193,121	4.2	2.6	0.07	0.04	0.01	0.006
ULEV[3]	50,000	80,467	1.7	1.1	0.05	0.03	-	-
	120,000	193,121	2.1	1.3	0.07	0.04	0.01	0.006
SULEV[4]	120,000	193,121	1.0	0.6	0.02	0.01	0.01	0.006

[1]TLEV (Transitional Low-Emission Vehicle);[2]LEV (Low-Emission Vehicle);[3]ULEV (Ultra-LEV);[4]SULEV (Super-ULEV)

Europe introduce motor vehicle emission regulations after the USA. In 1971, the UN European Commission enacted the ECE 15/00 regulations for passenger and light commercial vehicles, when the limits were 32 g/km for CO and 11 g/km forHC+NO_x. Subsequent amendments imposed even stricter limit values. Currently, the EU enacts all regulations on motor vehicle emissions. Tables 2 and 3 show the regulations defined by Directive 70/220/EEC, the base directive that has undergone frequent changes.

Table 2. Passenger vehicle emission limits in Europe [7]

Standard	**Dateof entry into force**	**Fuel type**	**CO**	**HC+NO_x**	**HC**	**NO_x**	**PM**
			g/km	g/km	g/km	g/km	g/km
Euro 1	1 July 1992 (EC93, 91/447/EEC, 93/59/EEC)	Petrol	2.72	0.97	-	-	-
		Diesel	2.72	0.97	-	-	0.14
Euro 2	1 Jan 1996 (EC96, 94/12/EC, 96/69/EC)	Petrol	2.20	0.5	-	-	-
		Diesel	1.00	0.7	-	-	0.08
Euro 3	1 Jan 2000 (98/69/EC, 2002/80/EC)	Petrol	2.30	-	0.20	0.15	-
		Diesel	0.64	0.56	-	0.50	0.05
Euro 4	1 Jan 2005 (98/69/EC, 2002/80/EC)	Petrol	1.00	-	0.10	0.08	-
		Diesel	0.50	0.30	-	0.25	0.025
Euro 5	1 Sep 2009 (715/2007)	Petrol	1.00	-	0.10[a]	0.06	0.005[b]
		Diesel	0.50	0.23	-	0.18	0.005
Euro 6	1 Sep2014 (715/2007)	Petrol	1.00	-	0.10[a]	0.06	0.005[b]
		Diesel	0.50	0.17	-	0.08	0.005

Table 3. European regulations for goods vehicles g kW^{-1} h^{-1}[7]

Goal	Dateandcategory	Test	CO	HC	NO_x	PM	Dim m^{-1}
Emission standards for petrol engines							
Euro III	2000	ESC&ELR	2.1	0.66	5.0	0.1 0.13*	0.8
	1999 EEVs	ESC&ELR	1.5	0.25	2.0	0.2	0.15
Euro IV	2005		1.5	0.46	3.5	0.2	0.5
Euro V	2008		1.5	0.46	2.0	0.2	0.5
Euro VI	2013		1.5	0.13	0.4	0.1	
Emission standards fordieseland gas engines, according to ETC test g kW^{-1} h^{-1}							
Goal	Dateand category	Test	CO	NMHC	CH_4[3]	NO_x	PM[b]
Euro III	1999 EEVs	ETC	3.0	0.40	0.65	2.0	0.02
	2000		5.45	0.78	1.6	5.0	0.16 0.21*
Euro IV	2005		4.0	0.55	1.1	3.5	0.03
Euro V	2008		4.0	0.55	1.1	2.0	0.03
Euro VI	2013		4.0	0.16	0.5	0.4	0.01

Engines withcylinder capacitybelow 0.7 dm^3 and theRPMabove 3,000 min^{-1}; a–only for natural gas engines, b–not applicable for gas engines in 2000 and 2005, c–THC(Total Hydrocarbon Content) fordieselengines; EEVs – Enhanced Environmentally Friendly Vehicles (very low emission engines); ELR – European Load Response (new, proposed by OICA/ACEA); ETC – European Transient Cycle (new, proposed by FIGE); OICA – Organisation Internationale des Constructeursd'Automobiles; ACEA – Association des Constructeurs Europeens d'Automobiles; FIGE – Forschungsinstitut für Geräusche und Erschütterungen.

Since October 2005, manufacturers must provide evidence and guarantee that every new model does not exceed emission limits for a specified period prescribed by the manufacturer, depending on vehicle category (Table 4).

Table 4. Vehicle categories and guaranteed emissions[6]

Vehicle category (according to UNECE)	Kilometres oryearspassed(whichever happens first)	
N1 and M2	100,000 or 5 years	160,000 or 5 years
N2, N3≤ 16 t M3 Class I, Class II, Class A and Class B≤ 7.5 t	200,000 or 6 years	300,000 or 6 years
N3>16 t M3 Class III and Class B>7.5 t	500,000 or 7 years	700,000 or 7 years

In addition to passenger vehicle emission standards, the ECE96 regulation from 15 Dec 1995 also determines the emission from diesel engines in non-road mobile machinery and agricultural and forestry tractors. Corresponding directives were also adopted by the EU Commission.

REGULATIONS AND STANDARDS ON AUTOMOTIVE FUEL QUALITY

In recent years, requirements for improved fuel quality have been harmonized with the need for preserving a healthy environment, so they now include control of impact on water, soil, bio systems, etc., in addition to the existing fuel composition control, combustion products, and air quality control. Changes in quality requirements for liquid petroleum-based fuels followed the changes in automotive industry engine construction and changes in environmental protection requirements. Basic quality specifications for liquid petroleum-based fuels in Europe are well known, and they are given through specifications for 1993, 1999, 2004, and 2009. Even though years for transferring to well-known specifications are essential to fuel manufacturers, some countries with less powerful economies have still not met all the requirements. Certain EU members with highly-developed automotive industry have already introduced liquid petroleum-based fuels according to 2009 specifications by enacting strict environmental laws.

Quality requirements for liquid petroleum-based fuels are defined by the following standards:

- EN 228:2012 –Automotive fuels – Unleaded petrol – Requirements and test methods;
- EN 590:2013 –Automotive fuels – Diesel – Requirements and test methods.

The biggest changes in product quality related to the adherence to specifications occurred with automotive fuels, especially petrol and diesel. The table below shows the key parameters of petrol and diesel quality in the EU (Table 5) [8].

Table 5. Key parameters for liquid petroleum-based fuels[8]

	1993 Specification	1999 Specification	2004 Specification	2009 Specification
Petrol				
SULPHUR, ppm by mass, max.	500	150	50	10
AROMATICS,% vol., max.	Not specified	42	35	?
BENZENE,% vol., max.	5	1	1	?
OLEFINS, % vol., max.	Not specified	18	18	?
OXYGEN	Not specified	2.7	2.7	?
RVP, kPa, max., (summer)	Nationally specified limits	60	60	?
E 100°C, % vol.		46	46	?
E 150°C, % vol.		75	75	?
Diesel				
SULPHUR, ppm by mass, max.	2000 (500 from 1995)	350	50	10
CETANENUMBER, min.	49	51	51	?
DENSITY, kg/m^3, min.	860	845	820-845	?
DISTILLATION 95% vol.,°C	Not specified	360	360	?
POLYAROMATICS % by mass, max.	Not specified	11	11	?

In Serbia,the quality ofpetrolandliquid fuelsis specified in the Regulations on Technical and Other Requirements for Liquid Petroleum-based Fuels(*Official Gazette of the Republic of Serbia,No. 132/12, 63/13,*and *75/13*), adopted based on the Law on Technical Requirements for Products and Conformity Assessment(*Official Gazette of the Republic of Serbia,No. 36/09*):

- Selling of unleaded petrol that contains a maximumof 13 mg/l of lead;
- Selling of unleaded petrol that contains a maximumof 650 mg/l of sulphur;
- Selling of diesel fuel that contains a maximumof 10 mg/kg of sulphur.

SRPS EN 228standard specifies the requirements and methods of testing for unleaded petrol for sale and delivery. It is implemented for unleaded petrol used in petrol engine vehicles, which are designed to operate on unleaded petrol. [8]

SRPS EN 590 standard specifies the requirements and methods of testing for motor vehicle diesel fuel for sale and delivery. It is implemented fordiesel used in diesel engine vehicles, which are designed to operate ondiesel fuel that containsup to 7 % (v/v) of fatty acid methyl esters (FAMEs). [8]

SRPS EN 14214standard specifies the requirements and methods of testing forfatty acid methyl esters (FAMEs), sold in the market as fuel for diesel-engine motor vehicles, as heating supplement concentrates (with 100% concentration), and as additives to fuels for diesel-engine motor vehicles, in compliance with EN 590 standard, or to heating oils. [8]

SRPS EN 15376standard specifies the requirements and methods of testing for sale and delivery of ethanol used as a filler for motor vehicle fuels in compliance with EN 228 requirements. This document provides relevant characteristics, requirements, and testing methods for (bio)ethanol, which are required in order for this product to be eligible for use as a fuel blending component for motor vehicles up to 10 % (v/v). If this percentage exceeds 10% (v/v), the requirements need to be re-examined.[8]

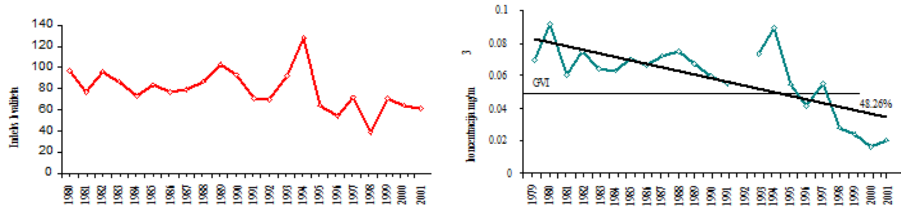
Petrol combustion in engines depends on a number of properties, such as: octane quality, oxygenate content, olefin content, aromatic content, and benzene content.

Diesel fuel properties that influence emissions and engine performance include: cetane number (CN), aromatic content, density, sulphur, and ASTM distillation.

DISCUSSION

The most recent studies from all over the world have revealed that pollutant emission from automotive fuel combustion significantly contributes to environmental degradation in big cities. Thus, introduction of new regulations and standards in this area is justified. It is expected that the implementation of new standards will yield visible results for the improvement of urban air quality. Insufficient fuel quality control and non-compliance with the regulations could substantially threaten air quality in urban areas.

One example of urban air quality degradation due to low-quality automotive fuel is the status of air quality in the City of Niš. Niš is located in the Niš Valley near the confluence of the Nišava and the Southern Morava rivers, at 43°19′ latitude and 21°54′ longitude. The municipal area covers the area of 596.71km^2, and with its population of 255,518 it is the third largest city in Serbia. Geographically, it is located at the junction of very important Balkan and European routes. According to the data provided by the Serbian Ministry of Interior, Niš Police Administration, there are 61,013 registered passenger vehicles in Niš, 450 buses and coaches,2,532 light commercial vehicles, 1,544 heavy commercial vehicles,and 1,522 mopedsandmotorcycles. Air quality control, which is primarily conditioned by the activity of energy sources and pollutant emissions from traffic, is conducted on a regular basis in Niš since 1965. Figure 2 shows the results of the analysis of air quality in Niš between 1980 and 2001, which wasconducted based on statistical processing of previously obtained sulphur dioxide (SO_2) concentrations. Changes of calculated air quality index (AQI) values correspond to changes of mean annual SO_2concentrations.



a b

Figure 2. (a) Changes of air quality index in Niš from 1980 to 2001, (b) Changes of mean annual SO_2 concentrations from 1980 to 2001 [1]

Based on several years of analysis of air quality (1980-2001) in relation to SO_2, it is unusual that air quality in Niš was better during the heating season than during the off-season in 1993 and 1994, which is why air quality for a broader city area was mapped using a radial basis function (RBF) network. The RBF network was used to predict SO_2concentrations in the parts of the city where concentrations had not previously been measured, based on which a map of air quality fields was created.

Figure 3. Map of air quality fields for heating off-season in the City of Niš 1993-1994[1, 4]

Analysis of air quality fields (Figure 3) indicates that during the analyzed period there was a formation of fields with low air quality (orange colour, AQI 100-150) and considerably low air quality(red colour, AQI 150-200) in the heating off-season. These air quality fields include city streets and intersections with high frequency of traffic, and their formation is caused by combustion of automotive petrol and diesel used by c. 90% of motor vehicles in the city. It should be noted that motor vehicles are ground-level sources with a total urban SO_2 emission share of 5.9%. Nevertheless, the actual emitted amount of SO_2depends on fuel quality and composition, fuel combustion completion, and driving conditions. Due to international sanctions imposed against the Federal Republic of Yugoslavia, during 1993 and 1994 vehicles ran on automotive fuels of a different elemental composition and much lower quality. Consequently, the impact of motor vehicles as ground-level sources was crucial to the formation of lower air quality fields during the heating off-season. The results of air quality analysis conducted in Niš justify the introduction of standards for fuel quality and motor vehicle emissions. According to the International Fuel Quality Centre, in 2012 Serbia was ranked 93rd in terms of fuel quality on a list of 100 countries. Serbia's bottom placement on the list was due to high sulphur concentrations in automotive fuels, which were compliant with the national regulations at the time. New Regulations onFuel Quality in Serbia, which are compliant with EU regulations, entered into force in July 2013. A system for fuel quality control, which is prescribed by the regulations and which involves marking and monitoring of fuel quality, was established on 1 Feb 2014. [1,4]

CONCLUSION

Standards for motor vehicle exhaust quality control as well as for fuel quality vary across the globe, as do the opinions regarding their assessment. Yet, introduction and control of regulations for both motor vehicle emissions and automotive fuels is fully justified. Environmental processes and conditions that lead to its degradation usually originate from disregard or inadequate enforcement of current laws. Thereare numerous examples of reckless use of energy generating products, and the City of Niš is one such example – in 1993 and 1994, increased sulphur concentrations in automotive fuels resulted in sulphur dioxide ambient air concentrations during the summer that considerably exceeded their limit values. In order to preserve a clean and healthy environment, it is necessary not only to implement stricter control of enforcing the regulations, but also to work on environmental revitalization.

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APPLICATION OF HEAT PUMPS IN THE OPERATION OF DISTILLATION COLUMNS

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Abstract: Steam recompression became the standard technology for heat pumps and their application in distillation processes. This technology achieves significant energy savings, up to 50%. The economic use of these technologies is restricted to column with approximately 30°C temperature difference, which covers only a fifth of columns that are currently in use. Second generation of heat pumps designed to further heat integration, not only to increase the potential energy savings, but also on the expansion of the scope of application, since this pump can be used with columns that have a higher temperature differences.
Key words: heat pumps, production, energy, distillation

INTRODUCTION

Distillation is a major separation technology in refineries and chemical process industry, because of the attractive characteristics of purification, large production capacity and reflux relations, as well as a simple project design. Sophisticated techniques have become state of the art for the separation of flow, with less favorable thermodynamic properties, especially in the case of small volatility and in the case of azeotropic mixtures. The high energy consumption with distillation columns (1-100 MW) and small thermodynamic efficiency (5-10%) are still the main shortcomings. Over the years, developed a series of improvements aimed at reducing of operating and capital costs: reduction of diameter of the column and the heat capacity of rebojler and-or the height of the column, the development floor high-capacity centrifugal devices or demister with structured packing, columns with dividing walls (DWC's) that allow the separation of three raw materials in one column, etc. [1]. Unlike improvements in VLE (vapor-liquid equilibrium) or in the floor of the column, such as improvement in the column, a number of improvements concerning the reduction of energy consumption, are attached to the outer elements of the column, such as a capacitor and rebojler. These enhancements include side rebojler, dephlegmator heat pumps [2], [3].

METHODS

Energy savings

A systematic approach to improving the energy efficiency of industrial processes, developed the "onion" model, which is presented in Figure 1.

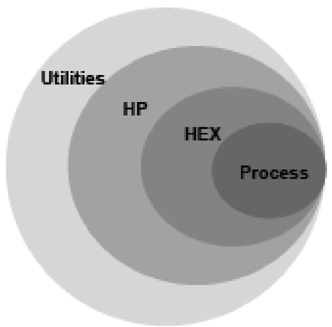

Figure 1. Onion model for improving energy efficiency

In the first shell are processes that takes place in the reactors and separators (Process), which carried out optimization of energy consumption. Power consumption can be further reduced by using heat integration heat exchanger (second shell). Once the optimized integration, further reduction of energy can be achieved in the third shell: heat pump (HP). Heat pumps are pieces of equipment that are used to compensate for the heat from the low temperature source to a higher temperature. Interest in the use of heat pumps is higher with the increase in the global awareness of the limited amount of fossil fuels and with problems arising from greenhouse gases.

Distillation column - the configuration of the heat pump

The aim of using heat pumps in the distillation is to use the heat of condensation is carried evaporation in rebojler. As the temperature of the rebojler is higher requiremets for this heat pump is bigger. Basically there are two ways to integrate heat pumps and distillation column, ie. to reconstruct conventional column: by compression of the vapor phase column (VC) or with recompression of the vapor phase (VRC) as shown in Figure 2, together with conventional column (CC).

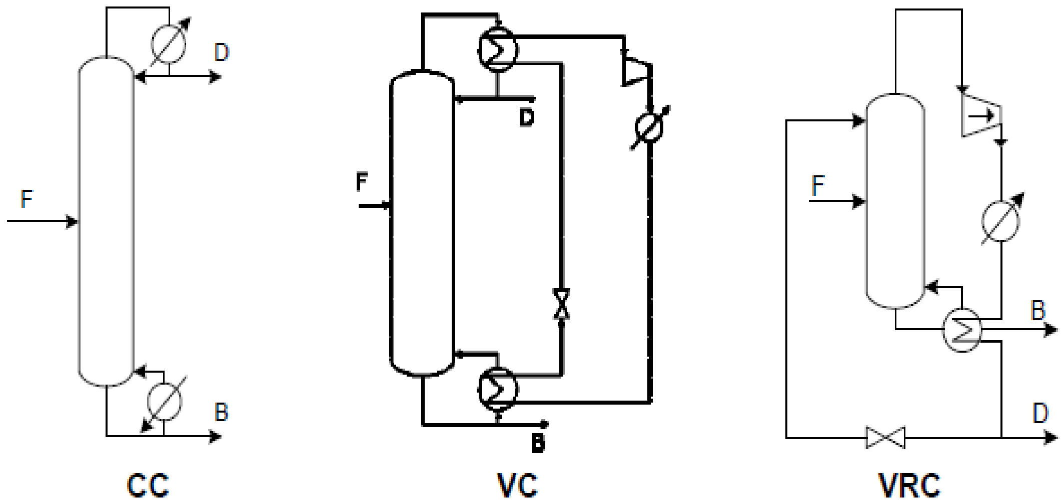

Figure 2. Conventional column (CC); the column with the vapor phase compression (VC); column with recompression vapor phase (VRC)

In conventional column (CC) heat is added to rebojler (B), and the output of the condenser (D), while the column itself is adiabatic.

In VC reconstruction the working fluid is evaporated in the condenser, compressed to a higher temperature (saturation) and condensed in rebojler and cooled, by expansion through gas valve to a temperature below the saturation temperature of the condenser.

In VRC option a working fluid is vapor phase which is separated from the top of the column who being compressed, condensed into rebojler and partly refluxed to the top of the column, after the pressure reduction valve. It is necessary to install a small trim capacitor, due to the balance of heat input, which generates the highest compression. An interesting alternative to the VRC is lower flash column bottom flash column (BFC) [4],[5].

How the heat pump can be added to distillation column, is shown schematically in Figure 3.

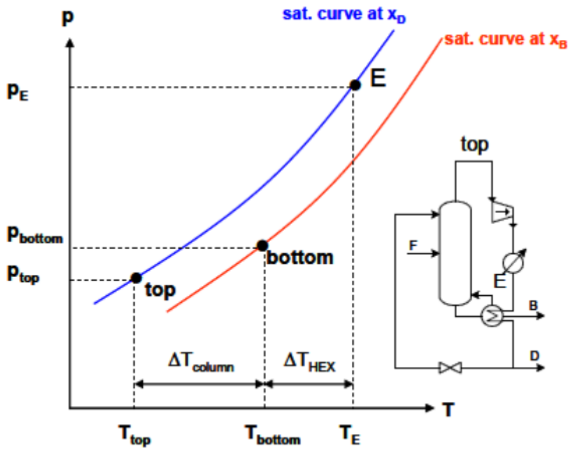

Figure 3. PT diagram of VRC cycle

Two curves for distillate saturation and composition at the bottom, x_D and x_B, are based on thermodynamic model. Since most of the column is designed on the basis of the pressure at the top, this pressure, p_{top}, is selected first. For the required purity of the distillate x_D, the temperature at the top the x_D saturation curve. The pressure at the bottom is determined on the basis of the pressure drop and the x_B T_{bottom} saturation curve.

DISCUSSION

The heat pump is a part of the equipment, machine, which pumps heat from a lower to a higher temperature. Based on the of the first law of thermodynamics, the amount of heat delivered to the warmer tank (Qh) at a higher temperature (Th) is equal to the amount of heat that is recovered (Qc) from a cold reservoir at low temperature (Tc) and external work. This dependence is given by the following equation:

$$Q_h=Q_c+W \tag{1}$$

Measure of the efficiency of heat pumps is performance coefficient (COP). For the heat applications that is ratio of heat delivered to a higher temperature compared to the inserted work:

$$COP = Q_h / W \tag{2}$$

The above theoretical value COP can be obtained on the basis of Carnot's cycle COP_C:

$$COP_c=Th/(T_h-T_c) \tag{3}$$

Where Th-Tc is the temperature difference, or raising the temperature, ie. "*temperature lift*", which is the difference between the temperature in the column and the temperature difference in the exchanger. The relationship between two COP values of is energy efficiency of heat pumps, ηe:

$$\eta_e=W_C/W_{VRC} \tag{4}$$

This is shown in Figure 4 for the Carnot cycle and in VRC-TS diagram for $Q_h = Q_{reboiler}$.

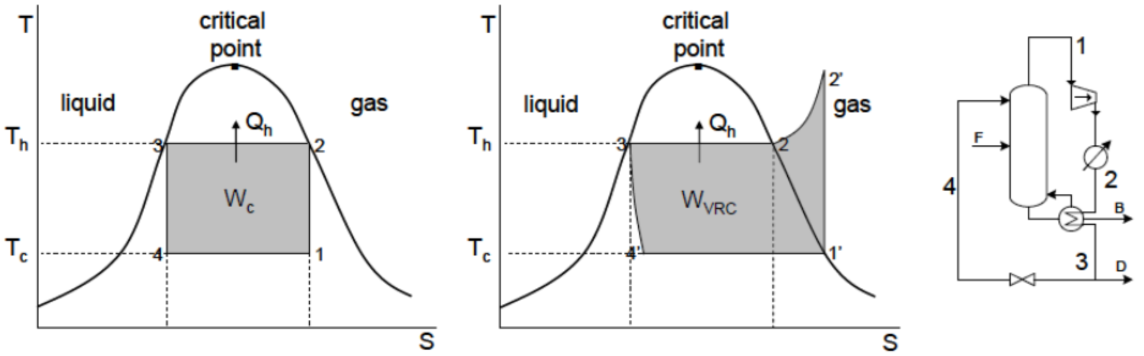

Figure 4. TS-diagram of Carnot's cycle and reverse Rankin's cycles for VRC

Whether the system with a heat pump leads to energy savings, depending not only on the efficiency of the heat pump, but also the efficiency of the steam boiler, η_{boiler}, and efficiency of power plants from which is powered compressor, η_{el} . Primary energy consumption for the conventional column is:

$$PE_{cc}=Q_{rebojler}/\eta_{boiler} \tag{5}$$

For column with compression of the vapor phase (VEC), that is:

$$PE_{VRC}=W/\eta_{el}=Q_{rebojler}/COP*\eta_{el}=Q_{rebojler}*(\Delta T_{column}+ \Delta T_{HEX})/(\eta_e*T_h*\eta_{el}) \tag{6}$$

The primary energy savings is calculated based on the difference consumption of primary energy, conventional and VRC column:

$$PES=PE_{cc}-PE_{VRC}=Q_{rebojler}*(1/\eta_{boiler}-*(\Delta T_{column}+ \Delta T_{HEX})/ (\eta_e*T_h*\eta_{el}) \tag{7}$$

This equation shows that the primary energy savings decreases with increase in temperature difference in the column.

CONCLUSION

For the temperature lift below 20^0C compact heat exchangers with small ΔTHEX are of fundamental importance for the performance of a heat pump system. VRC should be used for temperatures, temperature lifts from below 30^0C, which represents about 23% of the total number of pinch columns.

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CONTROL AND MONITORING SYSTEM OF THE MINERAL WOOL PACKAGING PROCESS

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Abstract: This paper presents the control and monitoring system of the mineral wool packaging machine. The machine works synchronized with the final part of the mineral wool production plant. After the wool passes under the horizontal and transverse saws, the molded pieces of wool come in the packaging machine via the transporter system. Shrink foils dosage, transporterlaunching, packages managing, foils welding and packages treatment in the thermal chamber are automated. The packaging machine is controlled by PLC. Setting and review of the parameters, such as temperature of thermal chamber and weld of foil width and temperature, are done on a TOUCH terminal connected with PLC. The control system is connected to a plant SCADA system.
Key words: packaging machine, mineral wool, shrink foil, control, monitoring

INTRODUCTION

The production of mineral wool takes place in a complex plant which consists of a number of technical and technological units: a raw material warehouse (coke, stone, dross and brickets), raw materials transport to the beam scale for measuring and dosing unit, a cupola furnace, filtration systems, centrifuges, binders preparation, fuels storage (heavy oil, oil, gas), burners, compressor stations, poly condensation chamber (PC), saws for longitudinal and transverse cutting of the wool, the ventilation and dust collection system, packaging and transportation lines of final products in the warehouse. Technological scheme of the plant is shown in Figure 1 [1].

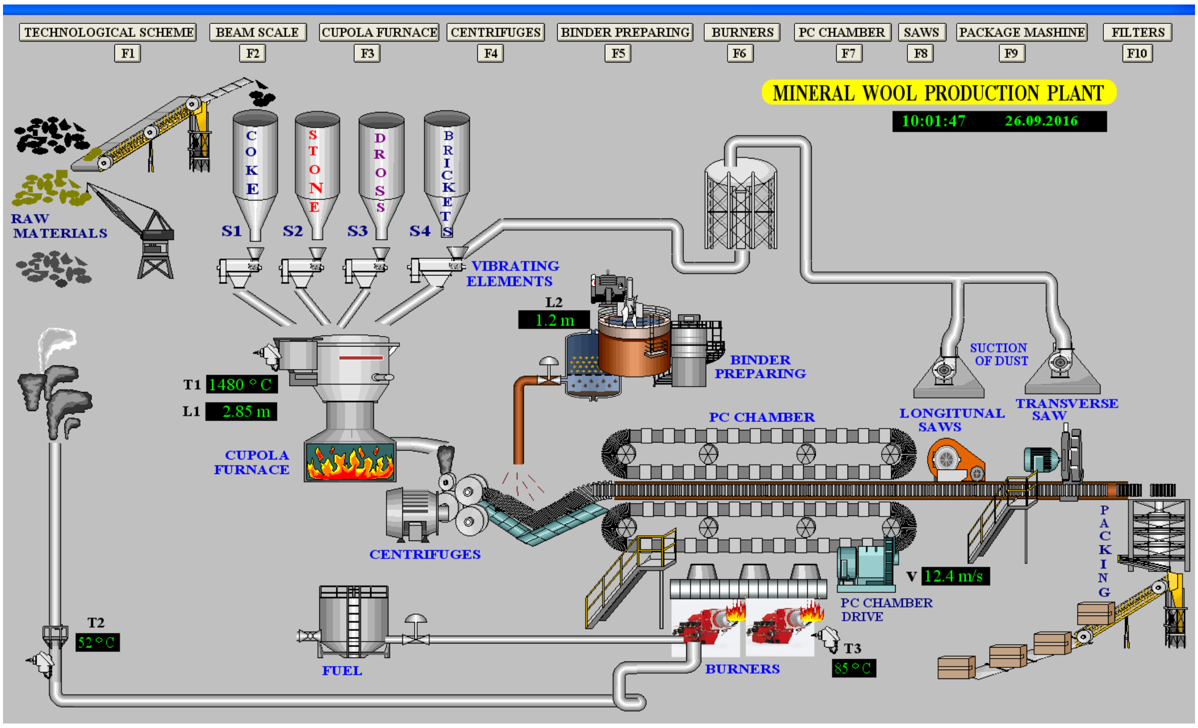

Figure 1. Technological scheme of mineral wool production plant (a SCADA screen).

The subject of this work is the packing machine used for packaging of mineral wool in shrink foil. It can be also applied in flat packaging of other similar products. The machine can work independently or as a part of a mineral wool production plant. When the machine is operating within the plant, its operation is synchronized with the operation of the plant. Namely, the packer control unit and the control units of the system saws and poly condensation chamber (PC) are in communication. The saws are used for longitudinal and transverse cutting of mineral wool in given size panels. The polymerization of phenol-formaldehyde resin is performed in PC under the effect of the circulation of hot air. As a result of that, water evaporation occurs as well as fixation of binder which is added in the mass untwisting phase when so-called felts produces. E.g. if the assortment of 10 cm thickness plate is produced, the packaging machine control unit forms 5 plate packs so the height of package is 50cm. In case of producing a 5 cm thickness plate, the packer automatically forms10 packs of mineral wool plate. PLC (programmable logic controller) control unit in conjunction with a TOUCH SCREEN panel provides the automatic operation of the packer. Monitoring and parameters settings are performed on the TOUCH SCREEN panel. The operator has a role in monitoring of the machine operation and in the replacement of rollers with foil [1, 2].

2. CONTROL LOGIC

Control block diagram of packaging machineis shown in Figure 2.The control unit is PLC Omron CJ1M with a processor unit CPU 21, which has 10 integrated digital inputs and 6 integrated digital outputs.There are also used one digital input module ID 211 with 8 inputs, one digital output module OC 211 with 8 outputs, two analog modules: module ADO41 - V1 with 4 analog inputs and DA081 module with 8 analog outputs. Corresponding outputs of frequency converters (data of speeds - signals 4 ÷ 20mA) are connected on the analog inputs, and the 4 ÷ 20mA signals are lead from analog module output, which sets the engine speed for unwinding foil. The status of all switching elements in the system (circuit breakers, fuses, over current motor protection, safety thermostats, micro switches, photo sensors, inductive sensors) is linked on PLC digital inputs. The signals for starting the dispensing foil motor and transporters, heaters in thermal tunnel heating sections, heaters for cutting and welding of shrink foils, signals for launching the pusher and devices for sticking a label with the product type and the barcode come out from digital inputs. The power source (AC/DC module) is PA 202. The communication protocol is SYSMAC WAY. The control program is written in the CX - Programmer. Communication with the testers control unit and PK is realized via PROFIBUS. The control logic enables a synchronized operation of all the packer elements [1 - 4]. TOUCH panel NS8 TV01 - V2 (Omron), which is installed in the distribution cabinet, has been applied as a control console. The mentioned panel is powered with a voltage source AC/DC 5V, 1A (Omron). The panel is connected with PLC via RS 232 communication. Several screens are realized and two of them are shown in Figure 3 and 4. Entering and reviewing the packer parameters are enabled for the operator through this screens. For the functioning of the packaging system it is important that the packaging machine work is synchronized with the production line. The packaging machine control unit, blade control unit and PC are in constant communication. The LED on the panel lights up green when there is synchronization between the two control units. LED flashes and colored red with a text message if there is no synchronization. Setting the parameters of packaging machine is controlled via buttons on the screen: “TRANSPORTERS”, “HEATERS”, “PACKAGES”, “ALARMS” or by the indicated function keys. For example, by pressing the "HEATERS" or F2 key, the menu with the settings of working and the alarm temperature values of thermal tunnel heating sections is open (shown in Figure 4). The shrink foils temperature welding regulation is also performed here, by adjusting the voltage and current of the cutting heaters and welding foils. There are two work modes: manual and automatic. Entering the automatic mode, the database list of shrink foils types is provided to the operator. The temperature value is automatically set by clicking on a particular type of foils. During work, if necessary, these values can be adjusted [1, 5, 6].

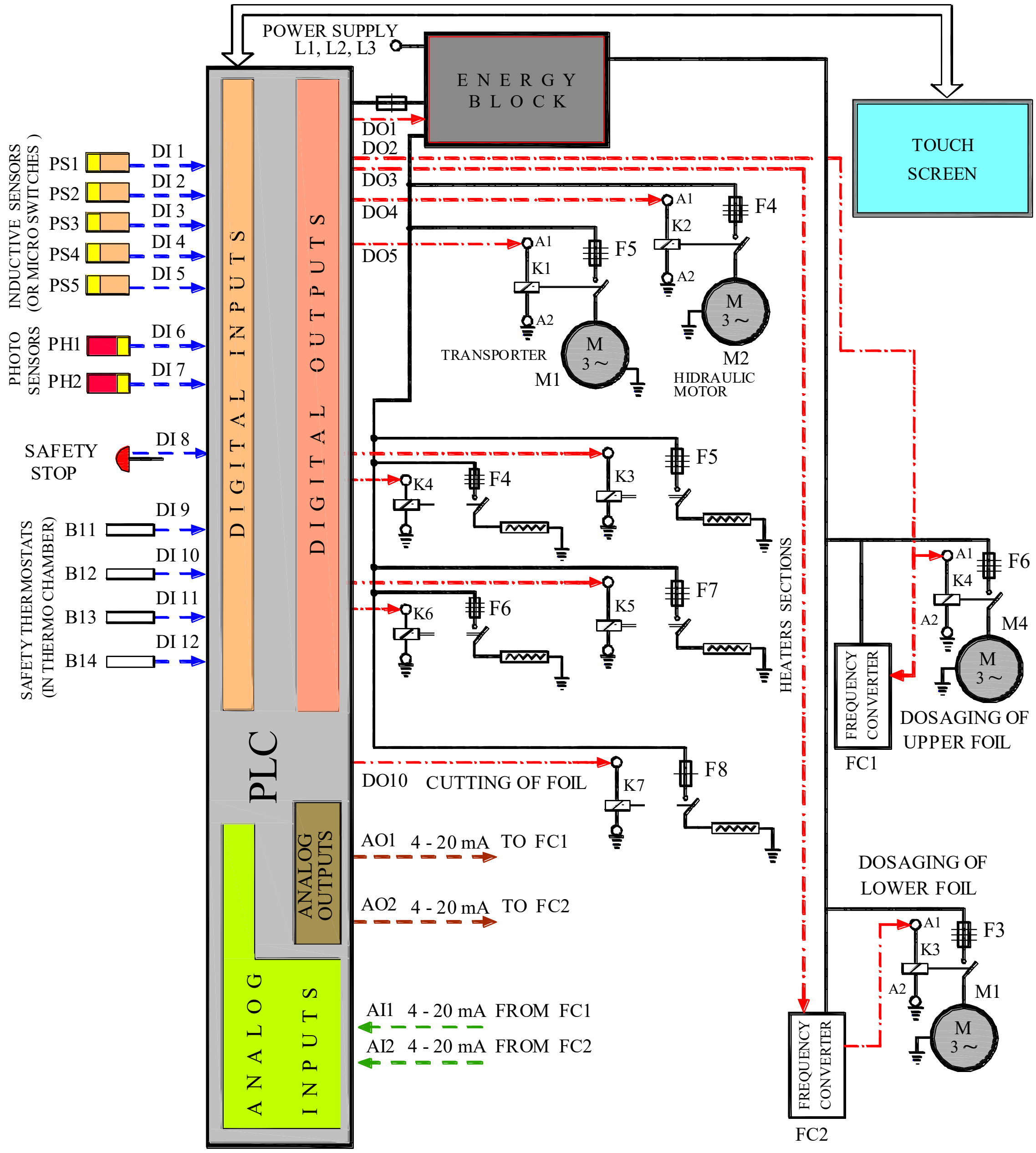

Figure 2. Block diagram of control mineral wool packaging machine

ELECTROMOTOR DRIVE

Five three-phase asynchronous motors are installed in the packaging machine:
- drive transporter 1 (motor - M1).This transporter is a part of the table for mineral wool plate accepting,
- drive transporter 2 (motor – M2).This transporter is a part of the thermal tunnel,
- drive up/down(motor – M3),
- dosage of lower shrink foils (motor – M4),
- dosage of upper shrink foils (motor – M5).

Electro hydraulic motor M3 is used for lowering and lifting mechanism associated with a table for receiving plates that come with the mineral wool production lines.
If the initial state is the upper position of the table, after the arrival of the first plate of mineral wool, the table is lowered for plate thickness by a motor M3, which makes room for another plate. Determination of electro hydraulic motor steps is performed by control unit according to the algorithm and based on

the thickness range of wool on the line. The final positions of the table (upper and lower) are registered in the final position switches (inductive sensors). Depending on the plate assortment thickness, which is on the line, the package is formed, the table goes down into the lower position and the transporter driven by motor M1 starts. Stopping the transporters is performed by photo sensors (transmitter - receiver), which register the absence of a stacked plate on the transporter. This transporter with a roller is a part of the table and it leads stacked plates to the thermal tunnel entrance, where hydro pneumatic pusher works, and pushes the plate to the middle of the tunnel. This is where the cutting and simultaneous welding of the lower and upper shrink films occur. These foils are unwound by the motors M4 and M5 which have a frequency regulation (regulators FC1 and FC2). The regulators are coupled with the control unit, which also controls the operation of the heaters for cutting and welding foil. The time and temperature of welding can be adjusted. A formed package is accepted by another transporter (which is the part of the thermal tunnel) rotated by a motor M2 [1, 2].

THERMAL CHAMBER

In the thermal chamber (thermal tunnel) package wrapped with shrink foil is exposed to heat by using an electrical heater. There are four heating sections: on the ceiling, on the floor, on the left and right side of the chamber. The heaters operation is regulated by the control unit. The temperature measurement in sections is done by using Pt100 probes. As security elements limit thermostats were installed. The temperature is regulated up to the 220 ºC.

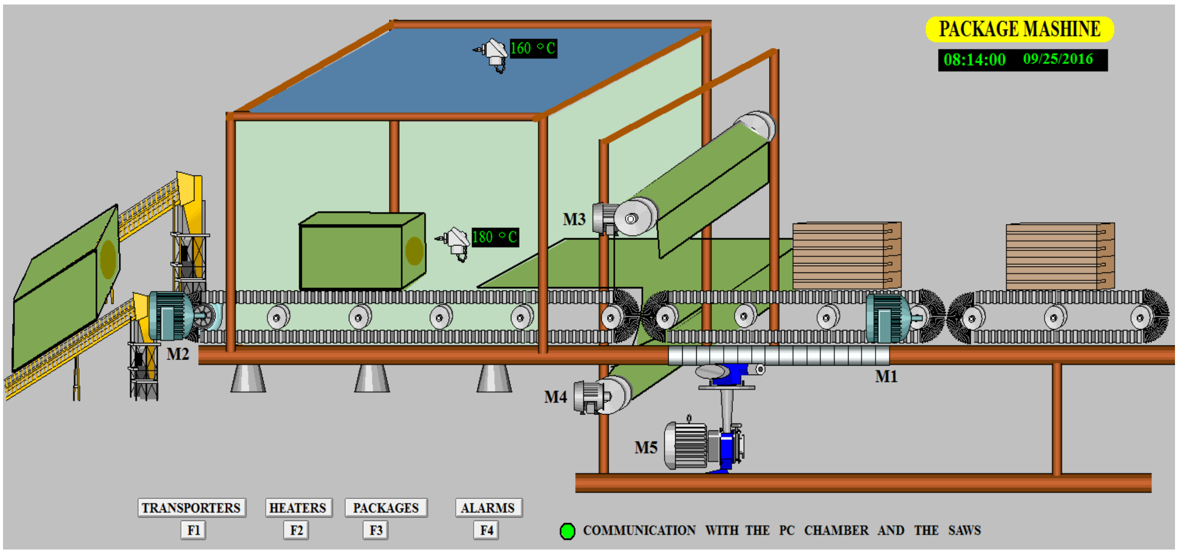

Figure 3. Packaging machine SCADA screen

The temperature is automatically adjusted according to the type of the available shrink foil. For practical reasons, the possibility of manual adjusting of the heating section temperature is also provided via the TOUCH panel (Figure 4). Passing through a thermal tunnel, the foil shrinks in the vertical and horizontal direction, forming a solid package which is ready for further transport. The control logic regulates the work of the transporter drive that passes through the thermal tunnel (motor M2). M2 starts after the expiration of the time which is needed for thermal foil collection. After the expiry of the preset time (that is different for each type of foil), the motor M2 is started and the package comes out of the tunnel, cools and goes into the warehouse. At the exit from the tunnel the control unit activates the device for sticking labels and counting packages. Processing speed of 6 packs per minute satisfies the needs of the plant for mineral wool production [1].

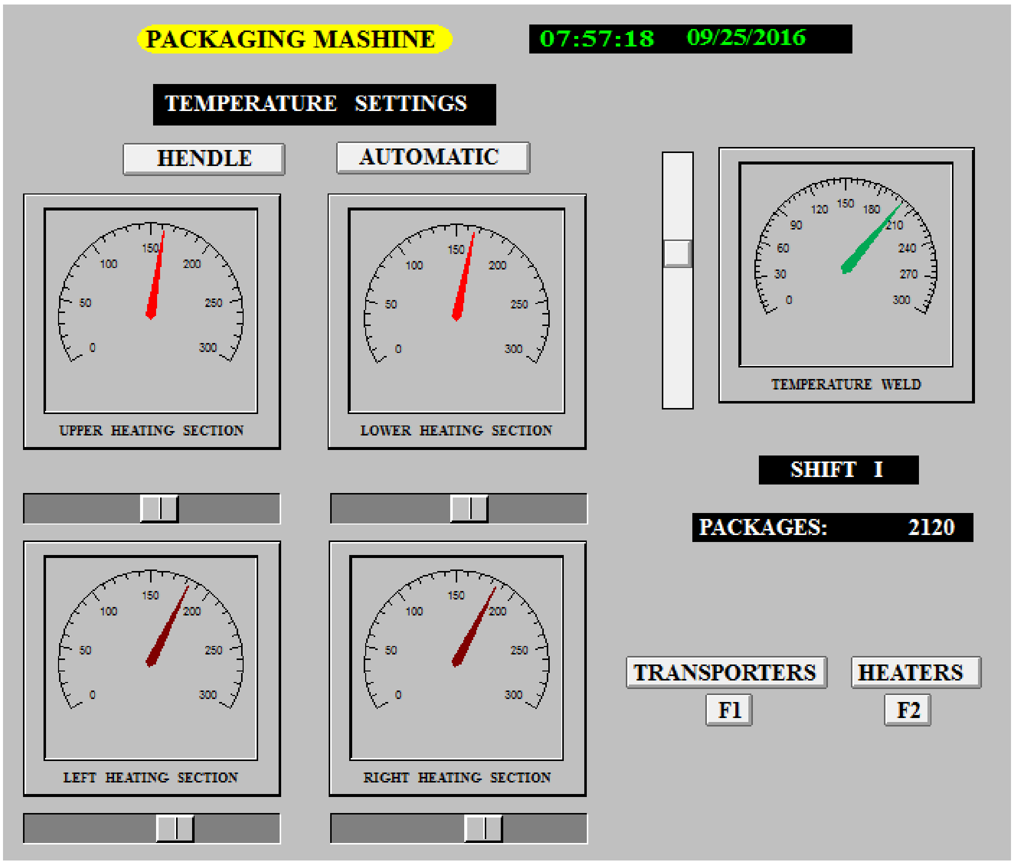

Figure 4. The touch panel screen for monitoring and adjusting the heater temperature

ALARMS

In case of excess temperature in heating sections, in a certain percentage which is defined as a pre-alarm status, the yellow lamp on the panel lights up with the corresponding text message which shows the percentage of the overrun. The alarm occurs also in case the temperature is below the appropriate value. In case of reaching critical values, the corresponding lamp is colored red and the sound alarm starts. The alarms also turn on when there is an activity of the fuses, over current protection of the transporter motor, safety thermostats or other safety elements that are connected to the control unit. The alarm statuses from the frequency regulators are also transmitted to the panel. The operator receives a text message with a sound alarm when it is necessary to replace the rollers with shrink foils. Alarm also starts in the case of deviation from normal state of current welding foil heater [1].

CONCLUSION

This paper describes the work of the automatic machine for mineral wool panels packaging into shrink foils. Compact packages, which can be further transported, are received at the exit of the machine. The packaging speed of 6 cycles per minute fully satisfies the requirements for the mineral wool production plant. The touch panel allows easy parameter settings and monitoring. Based on the entered data about the available types of shrink foils, the control system adjusts the power of the heater in thermal tunnel heating sections, which enables the optimal time to form a package. The heater power and time cutting and welding foil are adjusted. Frequency converters of motors perform optimally shrink foils unwinding from the rolls. Adjustment of the steps of pickup plate lowering is automatically synchronized with the production line, based on the data of mineral wool assortment that is produced.Itis made possible to attach the labels on each package and to count packages. The thermal tunnel temperature data, welding temperature data and the packets number are transmitted by communication to the central SCADA system.

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COST ANALYSIS OF MAKING PRESSURE VESSEL USING BASIC MATERIAL WITH DIFFERENT QUALITY

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Abstract: In this work are represented production costs of a pressure vessel where basic materals are alternatively P235GH, as well as P355GH. For both materials it is done calculation of wall thickness of the cylindrical shell and calculation of wall thickness of torispherical end. The price of the product depends on calculated wall thickness and characteristics of material. Applying different materials in production of pressure vessel P235GH and P355GH, it was found that the slight difference is in favor of material P355GH.
Key words: pressure vessel, materials P235GH i P355GH, cost analysis

INTRODUCTION

Pressure vessel is closed space designed and built with the aim to contain fluids under pressure, including connectors for joining and networking with other equipment. Tank for compressed air serves to provide the necessary amount of compressed air within compressor facilities, according to the needs of the development network. The reservoir is also used for additional cooling of the compressed air and has an impact on reduction of pulsation.
Pressure vessel is cylindrical container made of carbon steel sheet and it can be produced in two options: as vertical and horizontal. Container can be composed out of one or more partitions. On the pressure vessel are placed connectors required for operation. [1] [2]
The aim of this study is to determine production costs of a pressure vessel where is basic material alternatively P235GH as well as P355GH. P235GH and P355GH are low carbon steel. For both materials it is done calculation of wall thickness of the cylindrical shell and calculation of wall thickness of torispherical head. The price of the product depends on calculated wall thickness and characteristics of material. The real price of materials and finished parts are taken as well as common norms for certain operations.
Technical data and suggestions were obtained by production company ,,EVROBROD'' D.O.O. that deals with shipbuilding, manufacturing and mounting of the process equipment for food, oil and chemical industry including pipelines, manufacturing and mounting of the steel constructions in civil engineering, as well as providing of various services in the field of machine, mechanical and locksmith works. [3]

2. PROJECT TASK - TECHNICAL SPECIFICATIONS

Create project and technical documentation - main machine project is an air tank. Pressure vessel should be vertically designed with following basic data (table 1):

Table 1. General data [3]

Pressure equipment	Pressure vessel
Manufacturer	EVROBROD
The year of production	2014.
Design, form	Vertical
Operating pressure	17 bar
Calculation pressure	17 bar
Operating temperature	od – 10° C do 40° C
Calculation temperature	50° C

Medium	Air
Volume of the pressure vessel	$10\ m^3$
Testing pressure	24,31 bar
Mass of empty vessel	2741kg / 3360 kg
Category	IV
Modil	G

In preparation of technical documentation designer should use all valid regulations and standards applicable in this field. In addition, it is necessary to take care about implementation of health and safety measures and environmental protection.
Design, construction and testing of pressure vessel must be done according to regulations SRPS EN 13445/1 to 5 with respect to the Regulations on technical requirements for design, making and evaluation of equipment under pressure adjustment (Pravilnik o tehničkom zahtevima za projektovanje, izradu i ocenjivanje usaglašenosti opreme pod pritiskom (saglasnik RC 87/11). [4]
The following basic materials were applied (for Shell, Deep torispherical end, Reinforcement of mahhol, Reinforcement of supporting leg, Reinforcement of lifting lug) - P235GH and P355GH.

3. CONSTRUCTIVE CALCULATION

In project task it is done calculation of wall thickness of the cylindrical shell (calculation of the shell for materials P235GH and P355GH) and calculation of wall thickness of torispherical end (for materials P235GH and P355GH). In further work it is shown only calculation of wall thickness of the cylindrical shell and calculation of wall thickness of torispherical end for material P355GH.

Table 2. Basic data [3]

Material	**P355GH**
Outside diameter	$\mathbf{D_e} = 1800\ \text{mm}$
Calculation pressure	$\mathbf{P_d} = 1{,}7\text{MPa}\ (17\text{bar})$
Calculation temperature	$\mathbf{T_d} = 50°\text{C}$
Test temperature	$\mathbf{T_{test}} = 20°\text{C}$
Test pressure	$\mathbf{P_{test}} = 2{,}431\text{Mpa}\ (24{,}31\ \text{bar})$
Corrosion allowance	$\mathbf{c} = 1\ \text{mm}$
Addition to allowed thickness deviation	$\boldsymbol{\delta_e} = 0{,}3\ \text{mm}$

3.1. Calculation of wall thickness of the cylindrical shell for material P355GH

Analytical thickness welded wall shell

$$\mathbf{e_a} = e_n - \delta_e - c = 11 - 0{,}3 - 1 = 9{,}7\ \text{mm}$$

Nominal calculation tension

$$f = \min\left\{\frac{R_{p0,2/50°C}}{1{,}5}; \frac{R_{m/20°C}}{2{,}4}\right\}$$

Nominal tension for the test conditions

$$f_{\text{test}} = \frac{R_{p0,2/20°C}}{1,05}$$

Table 3. Tensile strength material [6]

$R_{p0,2/50°C}$ = 343 (N/mm^2)	Tensile strength shell material at calculation temperature (50°C)
$R_{p0,2/20°C}$ = 355 (N/mm^2)	Tensile strength shell material at test temperature (20°C)
$R_{m/20°C}$ = 490 (N/mm^2)	Tensile strength material

$$f = \min\left\{\frac{343}{1,5}; \frac{490}{2,4}\right\} = \min\{228,6 \; ; \; 204\}$$

$$f = 204 \text{ MPa } (\text{N/mm}^2)$$

$$f_{\text{test}} = \frac{355}{1,05} = 338 \text{ MPa } (\text{N/mm}^2)$$

Necessary shell wall thickness for work conditions

$$e = \frac{P_d \cdot D_e}{2 \cdot f \cdot z + P_d} = \frac{1,7 \cdot 1800}{2 \cdot 204 \cdot 0,85 + 1,7} = 8,78 \text{ mm}$$

$$e < e_a \text{ tj. } 8,78 \text{ mm} < 9,7 \text{ mm}$$

It is taken **11 mm** sheet metal wall thickness of cilindrical shell according to regulation SRPS M.EO.021

3.2. Calculation of wall thickness torispherical end for material P355GH

- According to standard SRPS EN 13445-2/2010 –

Calculating thickness of torispherical end **e** which needs to be the largest value between $\mathbf{e_s}$, $\mathbf{e_y}$, $\mathbf{e_b}$.

$$e_s = \frac{P \cdot R}{2 \cdot f \cdot z - 0,5 \cdot P}$$

$$R = 0,8 \cdot D_e = 0,8 \cdot 1800 = 1440 \text{ mm}$$

$$e_s = \frac{1,7 \cdot 1440}{2 \cdot 204 \cdot 1 - 0,5 \cdot 1,7} = 6,01 \text{ mm}$$

$$e_y = \frac{\beta \cdot P \cdot (0,75 \cdot R + 0,2 \cdot D_i)}{f}$$

β- coefficient which is read from the diagram on Figure 1 based on the following relations

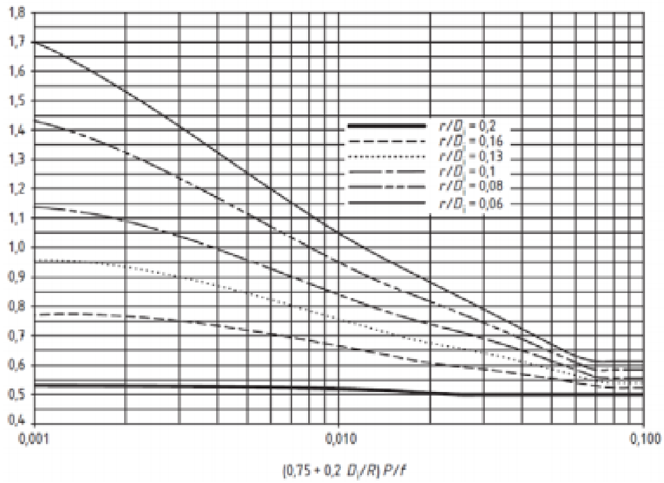

Figure 1 Coefficient β for torispherical ends – for calculation

(1) $$\left(0{,}75 + 0{,}2 \cdot \frac{D_i}{R}\right) \cdot \frac{P}{f} = \left(0{,}75 + 0{,}2 \cdot \frac{1780}{1440}\right) \cdot \frac{1{,}7}{204} = 0{,}083$$

Here is $D_i = 1780\ \mathrm{mm}$ for assumed torispherical end thickness of 10 mm

(2) $$\frac{r}{D_i} = \frac{0{,}154 \cdot D_e}{D_i} = \frac{0{,}154 \cdot 1800}{1780} = 0{,}1557$$

Here is $r = 0{,}154 \cdot D_e$ for deep torispherical ends according to SRPS M.EO.021

From the diagram on figure 1, β=0,68:

$$e_y = \frac{0{,}68 \cdot 1{,}7 \cdot (0{,}75 \cdot 1440 + 0{,}2 \cdot 1780)}{204} = 8{,}13\ \mathrm{mm}$$

$$e_b = (0{,}75 \cdot R + 0{,}2 \cdot D_i) \cdot \left[\frac{P}{111 \cdot f_b} \cdot \left(\frac{D_i}{r}\right)^{0{,}825}\right]^{\left(\frac{1}{1{,}5}\right)}$$

$$f_b = f = 204\ {}^{N}/_{mm^2}$$

$$e_b = (0{,}75 \cdot 1440 + 0{,}2 \cdot 1780) \cdot \left[\frac{1{,}7}{111 \cdot 204} \cdot \left(\frac{1780}{277{,}2}\right)^{0{,}825}\right]^{\left(\frac{1}{1{,}5}\right)}$$

$$e_b = 7{,}14\ \mathrm{mm}$$

$$e = \max(6{,}01\,;8{,}2\,;7{,}14)$$

$$\mathbf{e = 8{,}2\ mm}$$

4. COST ANALYSIS [5]

4.1. Material prices

In the following tables can be seen real and actual prices for deep torispherical end and reinforcement of mahhol.

Table 4. Deep torispherical end

Material	**Deep torispherical end**	Price ($^{din}/_{kg}$)	Quantity (Kg)	Quantity (Piece)	Total price (Din)
P235GH	$\emptyset$ 1800 × 14 SRPS M. EO. 021	70,00	401,80	2	56252,00
P355GH	$\emptyset$ 1800 × 11 SRPS M. EO. 021	120,00	315,20	2	75768,00

Table 5. Reinforcement of mahhol

Material	**Reinforcement of mahhol**	Price ($^{din}/_{kg}$)	Quantity (Kg)	Quantity (Piece)	Total price (Din)
P235GH	14 × $\emptyset$ 908/$\emptyset$ 508	65,00	43,50	1	2827,50
P355GH	11 × $\emptyset$ 908/$\emptyset$ 508	72,00	43,50	1	3132,00

4.2. Prices of working operations

In the following tables (table 6,7,8) can be seen common norms for some working operations.

Table 6. Parts of the shell, torispherical end

Working operation **Parts of the shell, torispherical end**	Unit norm	Quantity	Needed time ($^{min}/_{h}$)	Working hour price (din)	Total price (din)	Remark
Recording	10 $^{min}/_{m}$	28,26 m	$^{282,6}/_{4,71}$	1500,00	7065,00	
Flame cutting	12 $^{min}/_{m}$	28,26, m	$^{339,12}/_{5,65}$	1500,00	8478,00	P335GH
	16 $^{min}/_{m}$	28,26 m	$^{452,16}/_{7,53}$	1500,00	11304,00	P235GH
Grinding, rounding of the edges for V-groove weld	12 $^{min}/_{m}$	28,26 m	$^{339,12}/_{5,65}$	1500,00	8478,00	
Bending parts of the tread rollers	60 $^{min}/_{kom}$	3 kom	$^{180}/_{3}$	3750,00	11250,00	
Parts composing the tread rollers	240 $^{min}/_{kom}$	5 kom	$^{1200}/_{20}$	1500,00	30000,00	

-Welding of butt weld joints - V compound - Grinding the root of the weld - Welding on the side roots	$80\ ^{min}/_{m}$ $95\ ^{min}/_{m}$	28,26 m 28,26 m	$^{2260,8}/_{37,68}$ $^{2684,7}/_{44,7}$	1500,00 1500,00	56520,00 67117,50	P355GH P235GH

Table 7. Reinforcement of the shell, torispherical end, rate

Working operation **Reinforcement of the shell, torispherical end, rate**	Unit norm	Quantity	Needed time $(^{min}/_{h})$	Working hour price (din)	Total price (din)	Remark
Hydraulic cutting scissors	$1\ ^{min}/_{rez}$	32 reza	$^{32}/_{0,5}$	3750,00	1875,00	
Recording	$10\ ^{min}/_{m}$	4,5 m	$^{45}/_{0,75}$	1500,00	1125,00	
Flame cutting	$12\ ^{min}/_{m}$ $16\ ^{min}/_{m}$	4,5 m	$^{54}/_{0,9}$ $^{72}/_{1,2}$	1500,00 1500,00	1350,00 1800,00	P355GH P235GH
-Welding fillet weld joints - Fillet weld joint - Height of fillet weld $a = 8\,mm$	$60\ ^{min}/_{m}$	11,95 m	$^{717}/_{11,95}$	1500,00	17925,00	

Table 8. Connectors

Working operation **Connectors**	Unit norm	Quantity	Needed time $(^{min}/_{h})$	Working hour price (din)	Total price (din)	Remark
Flame cutting	$12\ ^{min}/_{m}$ $16\ ^{min}/_{m}$	2,08 m	$^{24,96}/_{0,41}$ $^{33,28}/_{0,55}$	1500,00 1500,00	624,00 832,00	P355GH P235GH
Chamfering	$12\ ^{min}/_{m}$	0,57 m	$^{6,84}/_{0,11}$	1500,00	171,00	
Welding seamless pipe DN50	$80\ ^{min}/_{m}$ $95\ ^{min}/_{m}$	0,57 m	$^{45,6}/_{0,76}$ $^{54,15}/_{0,90}$	1500,00 1500,00	1140,00 1350,00	P355GH P235GH

Welding fillet weld joints	$68\ ^{\text{min}}/_{\text{m}}$	2,08 m	$^{141,44}/_{2,35}$	1500,00	3536,00	P355GH
	$110\ ^{\text{min}}/_{\text{m}}$		$^{228,8}/_{3,81}$	1500,00	5720,00	P235GH

4.3. Total costs and price difference

Table 9 shows total costs and price difference making pressure vessel for materials P235GH and P355GH.

Table 9. Total costs and price difference

	P253GH	P355GH	Difference
Working operations	385230,80 din	361197,80 din	24033,00 din
Material	208990,70 din	229056,20 din	20065,50 din
Total price	594221,50 din	590254,00 din	**3967,20 din**

CONCLUSION

Applying different materials in production of pressure vessel P235GH and P355GH, it was found that the slight difference is in favor of material P355GH.
Exploitation conditions of the tank are not extreme in terms of operating or calculation temperature as well as operating pressure.
This difference in total price of making would be more significant if operating or calculation temperature were higher in favor of material P355GH because P355GH compared to material P235GH has much better mechanical properties at increased temperatures.
According to the previous statement, for increased temperatures, we would get more significant differences in material thickness which would cause significantly higher weight of the tank made with material P235GH.
Certainly, in this case, because of higher operating temperature, costs of labor would be increased because of increasing thickness and weight of the tank from material P235GH. [6]

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MODERN MANAGEMENT TECHNIQUES IN OPERATION OF AN AUTO PARK

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Abstract: The normal functioning of the vast and complex mechanism of national economy, ensuring good supply technical requirements of each branch, sub-branches, enterprises or administrative units, achieving rhythmic and full burden of foreign trade, marketing the beneficiaries, needs goods household consumption, depends to a decisive extent by the proper functioning of transport. Therefore, it considers the development and modernization of transport growth from economic efficiency of this vital area of the economy. Environmental pollution consists of those actions that cause ecological equilibrium or may harm the health, peace and comfort status of people or cause damage national economy by changing natural factors or created through human activities. Transports adversely affect quality of the environment by noise, air pollution and water.
Key words: management, auto park, cost, pollution

INTRODUCTION

Transport is therefore one of the main branches of material production. Deployment of this activity involves high energy consumptions and other resources of great importance. Therefore, the continuous increase transport efficiency requires optimizing the volume of goods to be transported, optimize distances, distances use, use of existing capacity and optimize energy consumption.
Satisfaction of the needs transport of the national economy is achieved through a unique network bringing together all branches of transport: rail, road, sea, air, pipelines and cartage. In other words, different kinds of transportation are part of a unified country's transport and works in interaction and collaboration in order to fully satisfy quantitative and qualitative, timely and efficient transportation requirements of the national economy and population.
Normally, implementing solutions requires efforts to reduce costs, which in turn translates into resource consumption. Therefore, other criteria that have to meet cost reduction solutions is efficiency, i.e. involve an effort whose cost is justified by the effect achieved in terms of increase in the ratio resources consumed / value created.
Opportunity cost reduction solutions is the fact that some solutions are more important and/or have higher priority than other solutions to reduce costs.
This means that the company must be able to perform the effort provided by the solution, and this effort to lead unequivocally desired result in terms of durability and efficiency to reduce costs.
Also, a simply reducing cost level does not automatically mean increased resource efficiency. This is because the nature of the relationship of the various categories of resources consumed value created by those inputs is complex.
Thus, there are certain resources, optimization of consumption which lead to major positive effects, which spreads to the whole process of value creation developed within the company (eg reducing losses of raw materials in storage processes, reduced scrap, reduced defects in terms of after-sales service costs).
The company being analyzed the field of urban, suburban and metropolitan people code CAEN 4931 and transport related activities, namely activities of bus stations.
The transport network has over 333 km, double track the movement of buses and minibuses performed on road networks in cities and neighboring localities. Is performed daily by bus 113 semi-racing, representing 3506 km and 215 minibuses running semi-racing and 4304 km daily.
About 1.1134 million passengers are transported annually and are paying annually perform approximately 35.1 million kilometers of which 12 million kilometers minibuses.
SWOT analysis carried out by a specialized firm in 2015 revealed the following:

- **Strengths** refer to the internal and represent resources and capabilities that the company has and which are superior to those held by other similar companies;

- **Weaknesses** refer to the internal environment and resources and capacities are insufficient or inferior to those of the other similar companies and the existence of illegal transport of persons;
- **Opportunities** relate to the external environment and represents the amount of favorable developments in the external environment company, and may take forms very different based on legislative changes, European integration and enabling the community to develop a superior form in whole or in fields of interest;
- **Threats** refer to the external environment and the trend did it's taken together, which may take forms very different, starting with a change of mentality, loopholes and economic developments negative or unstable affecting the Company's ability to achieve strategic goals who proposed them.

Appreciation of the operation of a fixed asset buses and minibuses nature should be made taking into account the normal duration of operation. According to current legislation on classification and the normal useful life of fixed assets. Thus, the following durations are set down for fixed assets for the transport of persons listed in the table below:

Table 1. The runtimes of transport means

No.crt.	Transport means type	The normal economic lifecycle (years)
1.	Minibuses	4-8
2.	Interurban city bus	5-9
3.	Urban city bus	4-8

As regards the analytical situation of the transport means it is as follows:

Table 2. The composition of the auto park

Types	Numbers	Seniority function(years)	Technicalstate
MINIBUSES			
Iveco	22	6	Good technical condition
Mercedes	7	5	Good technical condition
BUSES			
Javelin	14	9	Satisfactory technical condition
Otokar	4	4	Good technical condition
Renault	6	8	Satisfactory technical condition
Isuzu	8	4	Good technical condition
TOTAL	**61**		

MODERN METHODS PROPOSED TO ENHANCE THE OPERATING PERFORMANCE AUTO PARK

Next, we will approach aspects related to reducing costs by upgrading, reducing fuel consumption and efficiency applying software.Statistical analyzes on the work of ITP station (periodic technical inspection) authorized by RAR, that the average age of vehicles that compose Auto Park of the company was 6 years old in 2015.

Between 1-4 years were situated 18.67% of the vehicles submitted for periodic technical inspection in the range 5-9 years undercurrents 37.6% of vehicles, and more than 10 years was 43.37%. For vehicles in actual condition maintenance between two periodic technical inspections, without special training, they have it resulted that the most common defects were recorded for electrical installation, lighting, signage and the auxiliary 35% and polluting emissions 20%.Faults other equipment including tachograph and speed limiter is 13%, decks, rims, tires suspension, around 13%, visibility, 12% braking system, 4%, steering system, 3% and noise, fuel leaks and oil, 2%.

Costs for maintenance and repair of buses and minibuses above, consumption increased by fuels consume significant resources of society; therefore the decision was taken to limit the losses by a program of implementation of modern methods that improve the quality of services offered and maximizing profit company.

Figure 1 shows the following categories of methods supported by efficiency, realism and opportunity.

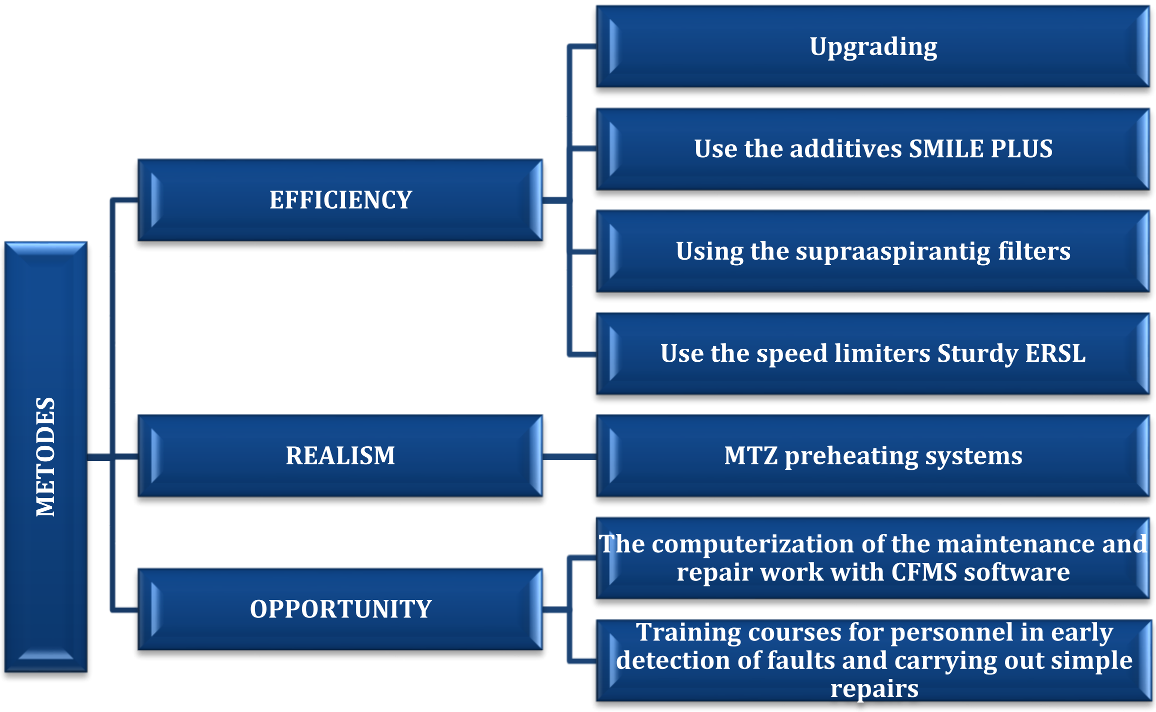

Figure 1. Modern methods proposed to enhance the operating performance auto park

Retrofitting the auto park by buying new cars

In this case, it will take three measures:

≡ decommissioning and quashing buses with expired term operating and selling them at auction as scrap or dismantling parts used and their selling itself;

≡ purchasing of at least ten new buses to complete and renew the current fleet of company vehicles. With the acquisition of these new buses and replacing those with outdated standard life of about 10 years, will be reduced substantially, with cca.40%, repair costs and replacement parts, fuel and RAR fees for ITP's performance and will substantially improve transport conditions for passengers;

≡ modernizing the auto park, it will acquire from European Funds, another group of 10 new ecological buses (hybrid - electric and diesel or gas).

Given that, in the car park of the company is currently at least 18 buses, duration of operation and rate of scrapping borderline life by harnessing them as scrap following recovery of spare parts, windows , plastics etc., can get additional revenue of at least 40000 euro.

Reducing fuel consumption

Overall, the auto park currently consumes approximately 2250 liters of diesel in a normal working day. Depending on the vehicle type and characteristics of the route that it serves, decreasing consumption will be customized using the following methods:

a) The use of additives to Otokar and Isuzu buses

Smile Plus it is an environmentally friendly additive that helps reduce fuel consumption and a biocatalyst additive used to improve the quality of all types of liquid fuel.By adding the additive, fuel quality will be improved and it will burn more evenly and completely, and for the same power your engine will need about 5-15% less fuel.

b) The use of speed limiters on minibuses Iveco

The auto park of the company owns a 22 of Iveco Daily 50C15 minibus which was proposed installation of speed limiters modern express purpose of reducing fuel consumption and better fuel storage quantities. Speed limiters are a measure intended to prevent competitive nature of commercial freight operation (and bus) that would give rise to a lack of speed compliance on public roads.

c) The use over-aspirant filters for the most vehicles in the fleet

Over-aspirant filters (made by Corneliu Birtok Baneasa) are special and have a very good supply of combustion air in internal combustion engines.This method is quite cheap first recommendation of the manager of our society to be implementedto the car park of cars, especially those with high fuel consumption. This high throughput of air supply brings many advantages: more engine power, reducing fuel consumption and reducing emissions and exhaust, etc.

d) Preheating system for the cooling liquid to 3000 cm^3 diesel engines

A cold start the engine is inefficient, increases wear and reduces its lifetime. This requires a high consumption of fuel and higher maintenance costs. The proposed system is integrated into the engine cooling circuit and thus heats before starting. The engine will start even at low temperatures. Moreover, the cab driver would be preheated and have a pleasant temperature. Since the heater operates independently of the engine, fuel consumption will be minimal during breaks. Preheated engine starts more easily even at very low temperatures (even-25°C), thereby protecting the starter, battery and electrical system of the car. Engine oil will solidify engine not preheated, thus ensuring engine lubrication immediately after startup. MTZ preheater will implement the company Eurokomax.

Computerization and monitoring of transport and current repair works

The CFMS software is a fleet management software. Is an application that provides a better record on the work of national and international transport, both in terms of managerial and financially.

It is developed according to market specific carriers of Romania and manages expenses resulting from vehicle fleet, grouped by companies within the group, department, cost center, location.

Warn the expiry revisions, contracts, insurance applications for certificates and contains the module so that expenditure can be effected only based on each department advised approvals accepted in part. It provides a clear overview in real time on all processes necessary for the smooth transport activity.

Training of the personnel to detect premature failures and perform predictive maintenance

Improving staff training is the means by which it can influence decisively the downside, both the number of accidents at work and that of occupational diseases and an increase in operational performance and better perform their duties, a transport undertaking.

Given these issues were decided by the manager of the company hiring Institute for Training in Road Transport, a subsidiary of Hunedoara in employee training and development company active, through courses both for drivers and for dispatchers and chiefs column.

RESULTS AND DISCUSSION

Refueling buses and minibuses is based on consumption norms proposed a technical committee according to the categories of vehicles fleet vehicles.

Establishing daily consumption is based on standardized consumption depending on the distance of each route and comparing actual consumption is the norm in inventory. Consequently, to reduce fuel consumption methods proposed will have the following costs of implementation.

With average fuel consumption of 2,000 liters/day, resulting a monthly supply of diesel required about 60 000 liters. The mixture of additive-diesel is made at a rate of 1ml: 10l, so it will purchase 6000 ml additive at a total price of 1700euro. Smile Plus additive increased efficiency not only lowers consumption by 15-20%, but helps the engine through a better functioning and the environment by reducing pollutants.

Speed limiters would decrease consumption by a variable percentage depending on the characteristics of the route. The cost of their purchase amounts to 8500 euros and their installation is in its machine shop, this lowering total cost of implementation by 10%. Purchase and installation of limiter protects us against fluctuations in the price of diesel predictability normal consumption.

Following discussions beforehand with Corneliu Birtok Baneasa will be installed on buses Dennis Javellin the over-aspirant filters at a promotional price of 100-150 euros/ filter, aiming their effectiveness during 6 months. Based on the results of implementing the program filters will expand or discard it.
MTZ preheating systems from the company Eurokomax minibuses are suitable for engines with a displacement of 3000 (or higher) or turbo diesel. The advantages of this method decreases the noise when starting the machinery, it brings optimal engine operating status in a short time. For the current year will be installed 10 preheaters at a price of 650 euros/unit.
Car Fleet Manager Software (CFMS) costs only 399 euros /year included having used server plus five workstations and free maintenance for two years.
Training courses and retraining of drivers and staff TESA varies between 100 and 150 euros, with this protocol in collaboration with Training Institute of Road Transport, a subsidiary Hunedoara. The professionalism of these trainers did lead to the accumulation of knowledge by staff of the company in the early detection of faults and to drive vehicles in an efficient and environmentally friendly.

CONCLUSION

To understand the necessity of implementing new methods to reduce costs, we will assess the structure of the operating costs from previous years based on data from the financial statements. Thus, we have:

Table 3. Structure of operating expenses in the period 2013-2015

Indicators	2013		2014		2015	
The cost of consumable materials	538688.4	29.68%	584241.1	31.32%	690277.8	36.64%
Energy and water expenses	26984.89	1.49%	23400.22	1.25%	22791.56	1.17%
Expenditure on goods	6304	0.35%	6589.333	0.35%	10726	0.55%
Staff costs	901143.8	49.65%	914658	49.04%	911964.9	46.69%
Expenditure on external services	89632.67	4.94%	82426	4.42%	79253.78	4.06%
Expenses for taxes	21836.67	1.20%	26302.44	1.41%	11937.11	0.61%
Depreciation and amortization	216620	11.93%	213894.9	11.47%	204558	10.47%
Other operating expenses	13881.33	0.76%	13755.11	0.74%	18761.56	0.96%
Total operating expenses	1815092	100%	1865267	100%	1954392	100.%

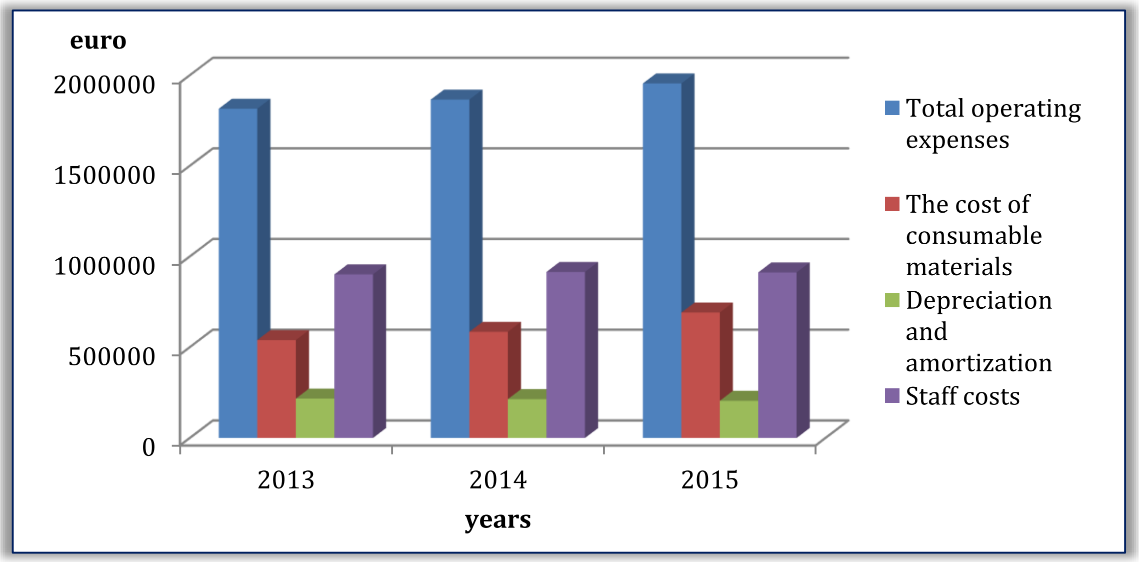

Figure 2. Operating expenses

From the table above it is noted that in the period under review the main expenditure categories are:

- costs of consumables with a share of about 33%;

- ≡ personnel costs accounting for approximately 48%;
- ≡ amortization costs accounting for approximately 12%;
- ≡ other expenses with small weights under 2%.

In the category of consumable materials, the main share is occupied by fuel. Fuels (mainly diesel) are used for most categories of vehicles in the fleet, so it was necessary to streamline the adoption of the above methods.Using additives brings a reduction of the steps as follows: the first three feeds produce a decrease in consumption of only 5-8%, and after the fourth power consumption drops by up to 15%. In conclusion supports this method of economically, making a saving of 10000 euro/month on diesel fuel additive price being 1700 euro, but especially in ecological perspective because it greatly reduces the pollutants in the atmosphere.

By limiting speed to 90 km/h this cannot be exceeded normal consumption, maintaining a predictable level of fuel stock purchased in advance, giving us an active protection against fuel price fluctuations. Calculate payback of this investment in 3-4 years.

After talking with the inventor of the over-aspirant filters, by mounting them on our buses, desired a drop in consumption by at least 10% or more. This can be assessed only after a period of study of at least 6 months.

Introducing systems preheat diesel engines have proven much time, especially in winter, when the engine must be brought to optimum operating at very low temperatures.

Therefore calculation of depreciation on investment was made only for the winter months. Minibuses were used to study the winter norm of 60 liters of diesel in addition to other seasons, so we have equipped 10 minibuses for the 600 liters of diesel for a total price of 750 euro. The price of a preheater being 650 euro/apparatus that the 10 buses equipped costs will amortize in less than 9 years.

The multitude of advantages offered by CFMS software gives us hope in an 8-10% decrease in both the cost of maintenance and repairs, and the cost of personnel staff by eliminating the chart of a post dispatcher used for drafting and recording sheets way. Also in margin cut costs and improve staff enter through specialized training courses helping us an early detection of faults.

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ORGANIC FOOD PRODUCTION AS A FACTOR FOR SUSTAINABLE DEVELOPMENT

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Abstract: Serbia is rich in natural potentials which provide a good basis for the future development of organic farming, given the fact that natural resources are limited. The composition and structure of natural resources are highly suitable for organic production. The country's relatively unpolluted land, favourable climate, abundant water resources and preserved biodiversity are some of the main organic farming requirements satisfied. Organic production is not possible without at least a minimum level of preservation of natural resources in areas where organic farming is practiced; on the other hand, organic production itself has a positive effect on the preservation and improvement of environmental quality in these areas. Small plots of land can be advantageous for this production, particularly in upland areas, and used specifically for organic production as the conversion period is short. They can be used for vegetable farming because the soil is uncontaminated owing to distance from roads. Positive experience indicates that potatoes, rye, oats and root vegetables can be successfully grown in these areas. Another advantage is the wealth of indigenous cultivars of apples, pears and plums which are highly resistant to pathogenic pests and environmental conditions, and hence suitable for cultivation without the use of mineral fertilisers and chemical agents.
Key words: Serbia, organic farming, sustainable development

INTRODUCTION

Organic farming is a new concept of food production which originated in the 1980s in developed countries in response to increasing environmental pollution problems. This new concept of production is a chance for Serbia to use its potentials and resources to develop a competitive organic production sector. Over the years, there has been a steady increase in this sector in the number of consumers, consumption and land area under organic production, which indicates great potential for further growth.
Organic agriculture is a type of farming which relies on the use of crop rotation, manure, compost and biological control of harmful organisms to maintain soil productivity and control pests on farms. Organic farming avoids the use of synthetic fertilisers, pesticides, plant growth regulators, animal drugs, food additives and genetically modified organisms. There has been a rising demand for organic products on a global scale. The domestic organic market is small and undeveloped. All parts of the organic production chain are included, but they lack interconnection, and the sector is disorganised, resulting in lack of coordination and collaboration among projects, activities and stakeholders.
The development of the domestic market is retarded due to poorly organised production, distribution deficiencies and poor promotion through media channels. Farmers' associations are focused on production and are not strong enough to organise or promote the organic sector. Government is the main impetus in the development of organic farming.

ELABORATION AND DISCUSSION

The concept of sustainable development was first mentioned in 1982 at the Nairobi Conference. In 1983, the UN General Assembly passed a resolution on taking the initiative to establish the World Commission on Environment and Development. In 1987, the Commission published a report titled "Our Common Future" addressing issues concerning the negative impacts of uncontrolled demographic and economic growth, and stressing the need to define the concept of sustainable development. The term "sustainable development" was established in 1989 and officially proclaimed in the so-called Bergen Declaration (1990) at the Ministerial Conference in Bergen, Norway, organised by the Norwegian Government in collaboration with the UN Economic Commission for

Europe. The concept of sustainable development was adopted by the European Union and United Nations in 1990 and 1992, respectively. The worldwide adoption of this concept was furthered by knowledge of severe global changes and environmental pollution. The most powerful definition of sustainable development is the one proposed by the Brundtland Commission [1]: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

The definition of sustainable development formulated by the Brundtland Commission includes two key concepts: (1) the concept of needs, which comprises the conditions for reaching or maintaining an acceptable life standard for all people, and (2) the concept of limitations imposed by the level of technology and social organisation on the environment's capacity to meet present and future needs. The concept of needs is the basis for intragenerational equity, whereas the concept of limitations underlies intergenerational equity. In terms of environmental management and environmental economics, sustainable development is defined as "the management of Earth's resources in the way to ensure their long-term quality and sufficiency" [2].

The concept of sustainable development includes a number of components which depict its link and harmonisation with the needs and limitations of the environment. These are: balanced economic growth, social justice and a sound environment. Balanced economic growth (production and consumption) implies a judicious use of natural resources for the production of multi-purpose and multiple-use products with the smallest possible amounts of waste material and harmful emissions generated. Social justice requires an appropriate global policy and adoption (and observance) of a number of legal and other instruments specifically focusing on health, education and population policy. Also, social justice should be established at the national level as well, through civil and other rights, paying due attention to the status of women who are unfortunately still considered second-class citizens in many countries.

A sound environment is secured through sustainable development. As the environment is polluted and degraded, the following gradual steps should be taken towards its restoration: prevent further degradation, improve existing factors, reconstruction, revitalisation, recultivation, renaturalisation or other types of renewal, new development plants should include all guidelines i.e. principles regarding sustainable development, particularly the ones related to the prevention of causative agents of potential risks [3].

The importance of the sustainable development concept primarily lies in establishing a balance among its components, thereby counterbalancing the harmful effects of human activities on the environment and, hence, ensuring the survival of the industrial civilisation (the economic approach is implied).

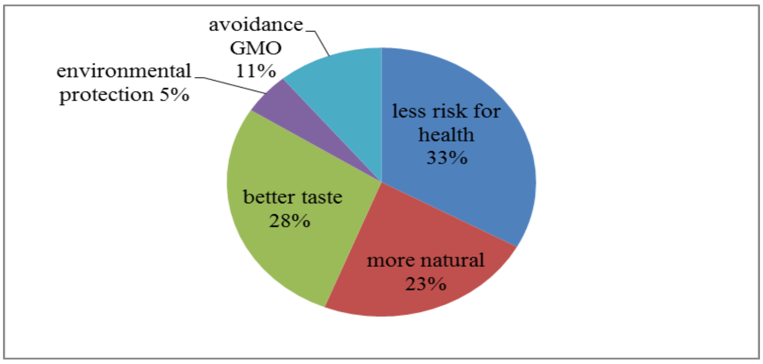
The idea and conception of sustainable development rely on the following principles:

- precaution, risk prediction, cause prevention, new environmental evaluation, changing behavioural patterns, changing consumption patterns and establishing necessary demographic institutions and processes.

The precautionary principle involves preliminary analysis and assessment of potential harmful effects during planning and implementation of all development-related actions such as the use of resources and space, effect on biodiversity, pollution etc. The risk prediction principle is based on the preliminary assessment of the effect of planned actions, especially if they are concerned with dangerous, poisonous and other processes, substances or actions which may lead to pollution or risk, based on similar experiences and situations. The cause prevention principle is the most important step in environmental protection, as it ensures long-term development of the environment. Moreover, it prevents future treatment of the consequences of side effects. The principle advocating new environmental evaluation comprises completely new approaches: the ecosystemic or multidisciplinary approach; the ethical approach, towards the environment and its factors, towards the preservation of resources, plants and animals, in one's immediate and distant environments, towards other people, nations, generations; the future-oriented approach, involving continuous planning and leaving options for others to create their own development, rather than being controlled by previous generations; advocating a moderate state of development entailing a new paradigm of "survival" and a modest standard of living instead of material growth and luxury; moderate and frugal use of the environment and its richness, especially non-renewable energy and biodiversity. The principle of changing behavioural patterns is an important requirement for sustainable development, focusing on a new philosophy of live – survival. Through behavioural change, human conduct towards the environment

changes from destruction to protection. It implies a change from a consumer mentality to a mentality characterised by a reasonable and modest use of resources, in both production and consumption, which is designed to meet only human essentials without any wish for luxury and splendour. Consumption should be free of remains (any type of waste; in other words, complete recycling). The principle of establishing new demographic institutions and processes refers to the need to include demographic dynamics and its trends in environmental and sustainable development programmes, given the fact that demographic growth is the main factor in threatening the biosphere and its ecosystems [4].
Organic production is a system involving the ecological management of production, processing, packaging, storage, transport, labelling, marketing and control of organically produced food in accordance with the standards of the International Federation of Organic Agriculture Movements (IFOAM), EU regulations adopted in 2007 and Codex Alimentarius – a joint FAO / WHO programme (Food and Agriculture Organisation/World Health Organisation).
Organic agriculture is defined by the IFOAM as follows: “Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved.“ [5]
“Organic production is an overall system of farm management and food production that combines best environmental practices, a high level of biodiversity, the preservation of natural resources, the application of high animal welfare standards and a production method in line with the preference of certain consumers for products produced using natural substances and processes.“ [6]
The principle aims of organic agriculture are: to produce high quality nutritious food; to preserve ecosystems; to maintain and increase long-term fertility of soils; to use, as far as possible, renewable resources of energy; to maintain the genetic diversity of agro- and ecosystems; to protect the environment i.e. reduce all types of pollution coming from agriculture to ensure that farmers’ basic needs are satisfied and adequate gain attained. This production system first emerged as a movement in economically developed countries. It is estimated that the percent contribution of these products to the world food market will continue to increase in the coming years. [7]
Organic production is more different from conventional production than from other types of alternative agriculture. Organic farming is a fully controlled system. Production conditions must be adapted to country-specific conditions and legally regulated. These primarily include the isolation of plots, livestock farms and processing facilities from potential sources of pollution, a low level of harmful substances in soils, suitable quality of irrigation water, harmonised development of plant and animal production, trained experts and producers, and the need for continuous innovation and advancement of knowledge.
Organic production is based on four coordinated ecological principles:
- principle of health, principle of ecology, principle of fairness towards nature and life, principle of production sustainability to preserve the well-being of current and future generations of people and ecosystems.
Principle of health – Organic agriculture should maintain and enhance the health of soils, plants, animals, humans and the planet as one and indivisible. The role of organic agriculture, in either farming, food processing, distribution or consumption, is to support and foster the health of ecosystems and organisms from the smallest ones existing in the soil to people. Specifically, organic farming is intended to produce high quality, nutritious food that contributes to preventive health care.
Principle of ecology – Organic production should be based on natural inputs and processes rather than on synthetic ones. Organic farming should attain ecological balance through careful design of farming systems, establishment of habitats and maintenance of genetic and agricultural diversity. Principle of fairness – Organic farming should build relationships that ensure fairness in view of the common environment and life chances. Fairness is characterised by respect, justice and care of the shared world, both among people and in their relations to other living beings. Principle of care and protection – Organic agriculture should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations of people and the environment. Organic farmers should promote efficiency and increase productivity, while preventing risks related to health and well-being [8].

As estimated by OECD, people purchase organic products for several reasons: fewer health risks (33%), better taste (28%), organic food is more “natural“ (23%), avoidance of genetically modified products at any cost (11%), contribution to environmental protection (5%) (Graph 1) [9].



Graph 1. Reasons to consume organic products
avoidance of GMOs, environmental protection
better taste, more natural, fewer health risks

In developed industrial societies, the middle class is well educated and has good purchasing power, which is the main reason for the fact that the sale of organic products is highest in developed countries, in this social stratum. As a relatively low percentage of income is spent on food, price is not an issue for these consumers to opt for organic products.

A typical buyer of organic products lives in an urban area, mostly in a city; pays great attention to product characteristics, such as quality, production method and origin; typically holds a university degree and is a member of the middle class, an intellectual, a newspaper reader and an internet user, having medium to high purchasing power [10].

As regards the average age of a typical buyer of organic products, variations are observed across countries. A typical European consumer of organic food is a representative of a younger generation of consumers, between 25 and 35 years of age. In Great Britain and Italy, average buyers are generally people under 30 and those between 50 and 70 years of age. In Ireland, their age ranges from 35 to 55. The conclusion is that the consumer profile is also dependent on the age of the organic market concerned. In mature organic markets (the ones which developed the earliest), such as Great Britain and Denmark, older consumers are more numerous [11].

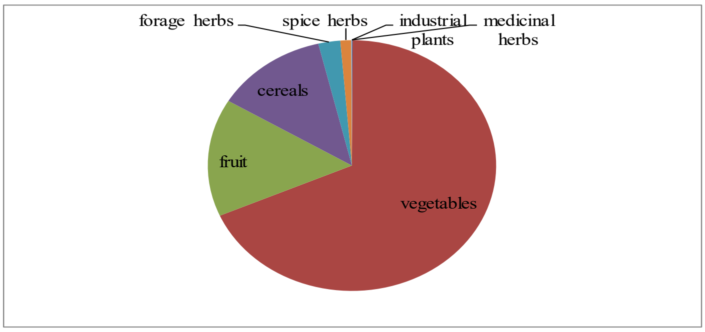
According to data released by the Ministry of Agriculture, the total land area under organic farming in Serbia in 2013 was 3,865 ha, and about 30 ha were subjected to conversion. Although arable land area under organic farming in the last several years has increased at an annual rate of 20%, its percentage in the total agricultural acreage is still low, considering the abundance of natural resources in Serbia [12].

According to current data, there are about 224 organic producers in Serbia; however, their number is estimated to be much higher, but they are not registered, for a variety of reasons.

According to research data compiled by the FIBL, Serbia ranks second among European countries in terms of the total land area (652,000 ha) used for the collection of organic wild fruits in protected areas. Major companies specialising in organic food production include Slovan (Selenča); Foodland (Belgrade), Zadrugar Agricultural Cooperative (Ljubovija), Marni (Kruševac), Lion Food (Belgrade), Suncokret - Sunflower (Hajdukovo), Lela (Torak), Mamužić Biofarm (Ljutovo) and Bilje Borča (Borča), and almost 95% of the production is export-oriented to markets in the European Union, USA and Japan [13].

In Serbia, the organic production method is used to grow fruit, vegetable and field crops. Regions suitable for organic fruit production are western and southern parts of Serbia, whereas Vojvodina is suitable for vegetable production. The organic farming method is less commonly used for livestock production as the cost of the process is higher than for fruit and field crops. Nevertheless, some progress has been made as some producers have already started to grow indigenous breeds using this method. In 2012, the organic method gave yields of 430,500 kg vegetables; 95,500 kg fruit; and

79,500 kg cereals, whereas the amount of medicinal herbs produced was the lowest, about 425 kg (Graph 2)[14].



Graph 2. Yields of organic products in Serbia, 2012 (in kilograms)
Medicinal plants, Industrial crops, Forage crops, Culinary herbs
Field crops, Fruit crops, Vegetable crops

Serbia has the following basic potentials for safe food production: arable land; nature reserves; forest zones offering ideal agroenvironmental conditions for production; huge climatic diversity as a factor in the production of different plant and animal species; cheaper labour in Serbia than in developed countries; organic food supply on the European market is lower than demand, which is a chance for Serbia to take [15].

There has been a substantial deficiency in organic cereals, vegetables, oil crops and meat in European Union countries. Producers converting to organic production must invest in appropriate machinery, tools and equipment, seeds and planting material, facilities, certification costs, along with conversion-related losses. Processors must satisfy related standards and adapt equipment, materials and packaging. The current legal framework stipulates the allocation of grants for the development and advancement of organic production coming from three sources: the state budget, donations and other funding sources [12].

Support measures include two main groups: measures explicitly intended for the promotion, development and improvement of organic production, and accompanying measures of importance for the development and advancement of organic production.

The first group of measures includes measures to support farmers and other beneficiaries who satisfy requirements during conversion or production to help ensure continuity in production, during the certification process for organic production and organic products, during education and training in organic production, for the set-up of demonstration trials in organic production and organic sector development, during the operation of extension services, when organising into associations, etc.

The second group of measures (accompanying measures) are indirectly useful as they support the promotion and protection of local products, the exportation of agricultural products, the introduction of quality systems, etc.[16].

CONCLUSION

About 0.3% of the total arable land in Serbia is under organic farming, as opposed to 24% in Europe, mostly in Spain and Italy (more than a million hectares). Vojvodina and Šumadija regions have the largest percentage of land under organic production, but this type of farming is becoming increasingly common in western and southern parts of Serbia. As projected by the Serbian Ministry of Agriculture, Forestry and Water Management, the total land area under organic farming should be more than 50,000 ha by 2016, with as many as 600,000 ha set as a long-run target.

Organic production is associated with the multifunctional nature of agriculture and ensures the preservation of village life, tradition, authentic culture and traditional craftsmanship, and the development of a specific type of rural tourism i.e. ecotourism. Lack of consumer awareness, an undeveloped market, low demand, a low standard of living, high costs of control and certification and lack of plant protection products are just some of the many problems facing organic producers.

According to research data for the Šumadija region, people buy organic food mostly because they understand its role in reducing health risks (33%), followed by reasons such as better taste of organic products, organic food is more natural, avoidance of genetically modified products in their diet, and consumption of organic products to control illness.
The organic sector has been largely promoted by supermarkets through the inclusion of organic products in their product portfolio, thus leading to the popularisation and increased sale of these products. Serbia is rich in natural potentials which provide a good basis for the future development of organic farming, given the fact that natural resources are limited. In addition, Serbia has relatively unpolluted soils, a favourable climate, abundant water resources and preserved biodiversity.
Most agricultural land is owned by natural persons i.e. family farms. Small plots of land can be advantageous for organic production, particularly in hilly and upland areas, for the cultivation of berries and indigenous apple, pear and plum cultivars highly resistant to pathogenic pests and environmental conditions.
The main advantages of organic farming in Serbia are the suitability of natural resources in terms of composition and structure, proximity to the European market, and harmonisation of related laws and regulations with EU standards.
The primary reason behind the low percentage of organic farms in Serbia is that producers and extension service providers lack knowledge of organic production, its importance and technology used. Moreover, further constraints include low financial ability of producers; an insufficient market supply of plant nutrition and protection products, seeds and planting material; underdevelopment of both the market structure and the domestic market for organic products; and an insufficient number of producers' associations and their poor organisation.

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Session 4.

Energetics

ENERGY AND ENSTOPHY INVESTIGATIONS IN REGULARIZED NAVIER-STOKES EQUATIONS

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Abstract: Conservation of energy and enstrophy in fluid flow are important because these quantities organize a flow and characterize change in the structure of the flow in time. To that aim, these quantities have to be conserved by our model equations, if a simulation of a fluid flow is to be properly performed. Herein, we explore the conservation of these properties for a high order fluid flow model based on Navier-Stokes equations. We are showing that our model conserves these essential quantities of energy and enstrophy, and that they tend to the Navier-Stokes quantities as the corresponding model parameters tend to zero.

INTRODUCTION

In the field of fluid mechanics, there are three important physical principles: Newton's second law, force equals mass times acceleration, applied to a continuum; Newton's law of viscosity, which relates shear stress in a fluid to the rate of distortion of fluid elements; and the conservation of mass, which states the mass of an isolated system remains constant over time. The application of these three important principles gives an essential set of partial differential equations for governing the motion of fluids: the Navier-Stokes Equations (NSE).

For a region Ω and $0 < t \leq T$, the Navier-Stokes equations are defined as

$$\mathbf{u}_t + \mathbf{u} \cdot \nabla\mathbf{u} - \mathrm{Re}^{-1}\Delta\mathbf{u} + \nabla p = \mathbf{f},$$

$$\nabla \cdot \mathbf{u} = 0,$$

where $\mathbf{u}(x,t)$ is the fluid velocity, $p(x,t)$ is the fluid pressure, and $\mathbf{f}(x,t)$ is the body force and Re is a dimensionless number known as the **Reynolds number**, defined as

$$\mathrm{Re} = \frac{\rho V L}{\mu},$$

where ρ is the fluid density, μ the dynamic viscosity, V the reference speed, and L the reference length.

The NSE are a set of nonlinear partial differential equations, meaning that the question of the existence and uniqueness of their solutions must be raised for the given boundary conditions. In the case of the NSE, two typical types of boundary conditions are the no-slip boundary conditions, which the velocity vanishes on the boundary of the domain, and the space-periodic boundary conditions, which are used to study idealized flows far away from real boundaries. In two dimensions, the existence and uniqueness of these solutions has largely been proven. However, in three dimensions, where practical fluid flows arise, the mathematical theory is still incomplete; thus existence and uniqueness of solutions have not been fully understood, [3].

Direct Numerical Simulation

Direct Numerical Simulation (DNS) is used to properly simulate persistent eddies in three-dimensional flow, [6]. It involves solving the NSE, resolving all scales of motion, with the appropriate initial and boundary conditions to the flow considered. Each simulation gives a single realization of the flow, [9].

Conceptually, DNS is one of the simplest modeling approaches. When it is applicable, it is one of the most accurate of approaches, and has one of the highest levels of description. Unfortunately, as the number of degrees of freedom increases (i.e. mesh points), the need for computer resources increases so rapidly that DNS can feasibly be applied only to flows with low to moderate Reynolds numbers. This is depicted by Table 1 below. As such, direct numerical simulation of many important and interesting flows is not practically possible, [6]

Table 1. The various length scales and mesh points needed to analyze the given flows at high Reynolds numbers, [4].

Flow	**Re**	**Mesh Points**
Model Airplane	7×10^4	10^{10}
Subcompact Car	6×10^5	10^{12}
Small Airplane	2×10^7	10^{16}
Atmospheric Flows	Very Large	10^{20} and higher

Direct numerical simulation was largely impractical until the 1970s, when sufficiently powerful computers became available. Even today, however, it is still not entirely practical due to its high computational cost. Motivated by the limitations of DNS, other modeling approaches are often used, such as Large Eddy Simulation (LES) and regularization models, [7, 9].

Large Eddy/Regularization Models

Large Eddy Simulation is less expensive than Direct Numerical Simulation, and it is thus a reliable approach to large-scale flows. In LES, the user selects a length scale of interest. The idea is then to simulate accurately motion of eddies of size $l > O(\delta)$. Since the large eddies are believed to be deterministic, i.e., not random in nature, this approach is feasible. Further, since the small eddies have universal structure, their effects on the large eddies should be modelable, [1 ,2, 6]. Herein, we will study a high order accuracy fluid flow model, the so-called Time Relaxation model.

ENERGY

Let $\|\cdot\|$ represent the L^2 norm on our domain Ω, and $(\mathbf{u},\mathbf{v}) = \int_\Omega \mathbf{u}\cdot\mathbf{v}$ is the usual L^2 inner product. The energy balance is obtained by integrating the Navier-Stokes Equation along the region Ω (assuming $\mathbf{u=0}$ on boundary or periodic boundary conditions):

$$\int_\Omega [\mathbf{u_t}\cdot\mathbf{u} + \mathbf{u}\nabla\mathbf{u}\cdot\mathbf{u} - \mathrm{Re}^{-1}\Delta\mathbf{u}\cdot\mathbf{u} + \mathbf{u}\nabla p] = \int_\Omega \mathbf{f}\cdot\mathbf{u} \qquad \text{i.e.}$$

$$\int_\Omega \mathbf{u_t}\cdot\mathbf{u} + \int_\Omega \mathbf{u}\nabla\mathbf{u}\cdot\mathbf{u} - \mathrm{Re}^{-1}\int_\Omega \Delta\mathbf{u}\cdot\mathbf{u} + \int_\Omega \mathbf{u}\nabla p = \int_\Omega \mathbf{f}\cdot\mathbf{u} \qquad \text{i.e.}$$

$$\frac{1}{2}\frac{d}{dt}\int_\Omega \mathbf{u}\cdot\mathbf{u} + \int_\Omega \mathbf{u}\nabla\mathbf{u}\cdot\mathbf{u} - \mathrm{Re}^{-1}\int_\Omega \mathbf{u}\Delta\mathbf{u} + \int_\Omega \mathbf{u}\nabla p = \int_\Omega \mathbf{f}\cdot\mathbf{u}.$$

Then,

$$\frac{1}{2}\frac{d}{dt}\int_\Omega \mathbf{u}\cdot\mathbf{u} = \frac{1}{2}\frac{d}{dt}\|\mathbf{u}\|^2$$

$$\int_{\boldsymbol{\Omega}} \mathbf{u}\nabla\mathbf{u}\cdot\mathbf{u} = (\mathbf{u}\boldsymbol{\nabla}\mathbf{u},\mathbf{u}) = 0$$

$$\mathrm{Re}^{-1}\int_\Omega \Delta\mathbf{u}\cdot\mathbf{u} = -\mathrm{Re}^{-1}\int_\Omega \nabla\mathbf{u}\nabla\mathbf{u} + \mathrm{Re}^{-1}\int_{\partial\Omega} \nabla\mathbf{u}\cdot n\cdot\mathbf{u} = \mathrm{Re}^{-1}\|\nabla\mathbf{u}\|^2$$

$$\int_\Omega \mathbf{u}\nabla p = -\int_\Omega p\Delta\mathbf{u} + \int_{\partial\Omega} p\mathbf{u}\cdot n = 0.$$

Therefore,

$$\frac{1}{2}\frac{d}{dt}\|\mathbf{u}\|^2 + \mathrm{Re}^{-1}\|\nabla\mathbf{u}\|^2 = (\mathbf{f},\mathbf{u}).$$

Integrating with respect to time t yields,

$$\int_0^T \frac{1}{2}\frac{d}{dt}\|\mathbf{u}\|^2 + \int_0^T \mathrm{Re}^{-1}\|\nabla\mathbf{u}\|^2 = \int_0^T (\mathbf{f},\mathbf{u}).$$

Thus, the equation becomes

$$\frac{1}{2}||\mathrm{u}(T)||^2 + \mathrm{Re}^{-1}\int_0^T \|\nabla \mathrm{u}\|^2 dt = \frac{1}{2}||\mathrm{u}(0)||^2 + \int_0^T (\mathrm{f},\mathrm{u})\mathrm{dt},$$

where $\frac{1}{2}||\mathrm{u}(t)||^2$ is the kinetic energy, $\mathrm{Re}^{-1}\int_0^T \|\nabla \mathrm{u}\|^2 dt$ is the total energy dissipated over $[0,T]$, and $\int_0^T (\mathrm{f},\mathrm{u})dt$ is the total power input. Thus, the energy equality has the physical interpretation, [6]:

$$\begin{aligned}&\text{kinetic energy}(T) + \text{total energy dissipated over } [0,T]\\ &\qquad = \text{initial kinetic energy} + \text{total power input.}\end{aligned}$$

Hence, in the absence of body force and viscosity, the energy is conserved.

ENSTROPHY

Before describing enstrophy, it is necessary to discuss the closely related concept of vorticity. Vorticity, defined as the curl of the velocity vector u, rises due to the viscous or frictional effects of a fluid. Vorticity is mathematically defined as

$$\omega = \nabla \times \mathbf{u}.$$

Enstrophy is itself the integral of the square of the vorticity vector,

$$Enstrophy(t) := \frac{1}{2}\|\boldsymbol{\nabla} \times \mathbf{u}\|^2 = \int_\Omega |\boldsymbol{\nabla} \times \mathbf{u}|^2 d\boldsymbol{x} = \frac{1}{2}(\boldsymbol{\nabla} \times \mathbf{u}, \boldsymbol{\nabla} \times \mathbf{u}),$$

and it is an important concept in fluid dynamics because it determines the rate of dissipation for kinetic energy, [6]. It, and by extension vorticity, is also important in the solutions to the Navier-Stokes equations. In solving the existence and uniqueness of the NSE, there are two types of solutions: strong solutions, in which the enstrophy is finite at all times, and the weak solutions, in which the enstrophy may become infinite at some instants of time.

In two dimensions, the weak solutions are, in fact, strong solutions, the solutions are unique, and they exist for all time. In the three-dimensional case, however, is a bit more complicated. Weak solutions are known to exist for all time, but are not known to be unique. Conversely, strong solutions are known to be unique and to exist on a certain finite time interval, but it is not known if they exist for all time, [5].

In two dimensions, energy and enstrophy are similar, as vorticity has one component in the direction normal to the flow. This causes many constraints on the dynamics of the turbulence. As such, fluid flow in two dimensions must conserve enstrophy as well as energy, and the enstrophy and energy cascades may not exist on the same portions of a domain, [5].

The enstrophy balance for the Navier-Stokes equation is obtained by multiplying the Navier-Stokes equation by $\Delta\mathbf{u}$, to obtain

$$\mathbf{u_t} \cdot \Delta\mathbf{u} + \mathbf{u} \cdot \nabla\mathbf{u} \cdot \Delta\mathbf{u} - \mathrm{Re}^{-1}\Delta\mathbf{u}\Delta\mathbf{u} + \nabla p\Delta\mathbf{u} = \mathbf{f}\Delta\mathbf{u}.$$

Integrating over the domain Ω, the above equation becomes

$$\int_\Omega \mathbf{u_t} \cdot \Delta\mathbf{u} + \int_\Omega \mathbf{u} \cdot \nabla\mathbf{u} \cdot \Delta\mathbf{u} - \int_\Omega \mathrm{Re}^{-1}\Delta\mathbf{u}\Delta\mathbf{u} + \int_\Omega \nabla p\Delta\mathbf{u} = \int_\Omega \mathbf{f}\Delta\mathbf{u},$$

where

$$\int_\Omega \mathbf{u_t} \cdot \Delta\mathbf{u} = -\int_\Omega (\nabla \times \mathbf{u_t})(\nabla \times \mathbf{u}) = -\frac{1}{2}\frac{d}{dt}\int_\Omega |(\nabla \times \mathbf{u})|^2 = -\frac{1}{2}\frac{d}{dt}\|\nabla \times \mathbf{u}\|^2 \ ,$$

$-\int_\Omega \mathrm{Re}^{-1}\Delta\mathbf{u}\Delta\mathbf{u} = -\mathrm{Re}^{-1}\int_\Omega \Delta\mathbf{u}\Delta\mathbf{u} = -\mathrm{Re}^{-1}\|\Delta\mathbf{u}\|^2$, and

$$\int_\Omega \nabla p \Delta u = (\nabla p, \Delta u) = 0.$$

Let $\mathbf{f} = \mathbf{0}$, then multiplying by -1 and integrating with respect to time T, we have

$$\int_0^T \left[\frac{1}{2}\frac{d}{dt}\|\nabla \times \mathbf{u}\|^2 + Re^{-1}\|\Delta\mathbf{u}\|^2\right] = 0.$$

This yields

$$\frac{1}{2}\|\nabla \times \mathbf{u}(T)\|^2 + \mathrm{Re}^{-1}\int_0^T \|\Delta\mathbf{u}\|^2 dt = \frac{1}{2}\|\nabla \times \mathbf{u}(0)\|^2.$$

Thus, $\mathrm{Re}^{-1}\int_0^T \|\Delta \mathrm{u}\|^2 dt$ is the enstrophy dissipation.

TIME RELAXATION MODEL

The ideal purpose of the model is to get good simulations for velocity and pressure at high Reynolds numbers. This becomes a problem in the simulation of the velocity u, as there are many small scales and structures that are difficult to capture and resolve, especially in three-dimensional flow.

To that end, a very fine mesh is needed when Navier-Stokes equations are used without any stabilization or regularization. These fine meshes are not feasible in many applications, and thus there is a need to develop and analyze fluid flow models that can capture the behavior of velocity and pressure on much coarser meshes at high Reynolds numbers.

Herein, we study the so-called time relaxation model that was initially introduced in [10, 11]. It is obtained from the Navier-Stokes equations by adding an extra term of viscous nature. The model is defined as

$$\mathbf{u}_t + \mathbf{u} \cdot \boldsymbol{\nabla}\mathbf{u} - \mathrm{Re}^{-1}\Delta\mathbf{u} + \nabla p + \chi(\mathbf{u} - \bar{\mathbf{u}}) = \mathbf{f},$$

$$\nabla \cdot \mathbf{u} = 0,$$

where χ is a scalar constant, and $\bar{\mathbf{u}}$, the filtered velocity, i.e. it is the solution of the partial differential equation

$$-\delta^2\Delta\bar{\mathbf{u}} + \bar{\mathbf{u}} = \mathbf{u},$$

where δ is the filter width.

The time relaxation term $\chi(\mathbf{u} - \bar{\mathbf{u}})$ in the above model has the aim to drive the unresolved scales and fluctuations to zero as time increases. It is a stabilization type of term that induces artificial viscosity proportional to the difference between $\mathbf{u}$ and $\bar{\mathbf{u}}$, i.e. proportional to the fluctuations, [4].

We want to understand what happens to the energy and enstrophy of a fluid that is driven by this time relaxation model. If there are some changes in the partial differential equations of Navier-Stokes, there might be a change in energy and enstrophy as well. This is presented next.

ENERGY STUDY FOR THE TIME RELAXATION MODEL

Taking the equation for the time relaxation model, multiplying by velocity, integrating in space and time, and following the steps from the NSE case gives the energy balance for our model

$$\frac{1}{2}\|\mathbf{u}(T)\|^2 + \int_0^T \mathrm{Re}^{-1}\|\nabla\mathbf{u}\|^2 dt + \int_0^T \chi \int_\Omega (\mathbf{u}-\overline{\mathbf{u}})\mathbf{u}\, d\mathbf{x}\, dt = \frac{1}{2}\|\mathbf{u}(0)\|^2,$$

where $\int_0^T \chi \int_\Omega (\mathbf{u}-\overline{\mathbf{u}})\mathbf{u}\, d\mathbf{x}\, dt$ is the extra dissipation. Therefore, the Time Relaxation model has the same energy as the Navier-Stokes equations, but an enhanced energy dissipation E_{TRM}, defined as

$$E_{TRM} = \int_0^T \mathrm{Re}^{-1}\|\mathbf{\Delta u}\|^2 dt + \int_0^T \chi \int_{\mathbf{\Omega}} (\mathbf{u}-\ \overline{\mathbf{u}})\mathbf{u} dt.$$

It is showed that the additional dissipation term satisfies

$$\int_0^T \chi \int_\Omega (\mathbf{u}-\overline{\mathbf{u}})\mathbf{u}\, d\mathbf{x}\, dt \geq 0,$$

and thus its effect is not negligible, [4]. Thus, the additional energy dissipation in the time relaxation model causes the energy to dissipate faster. Based on solving the partial differential equation $-\delta^2\Delta\overline{\mathbf{u}} + \overline{\mathbf{u}} = \mathbf{u}$ for $\overline{\mathbf{u}}$, define an operator

$$\mathrm{G}:=(-\delta^2\Delta + I)^{-1}, \text{ i.e.} \mathrm{G}(\mathbf{u}) = \overline{\mathbf{u}}.$$

It is proved that G is symmetric positive semi-definite, [7, 8], showing that the above extra dissipation term is nonnegative.

ENSTROPHY STUDY FOR THE TIME RELAXATION MODEL

Multiplying the equation for the Time Relaxation model by $\Delta\mathbf{u}$, integrating in space and time, and following the steps from the NSE case, we obtain the enstrophy balance for the time relaxation model (assuming no body force), given by

$$\frac{1}{2}\|\nabla\times\mathbf{u}(T)\|^2 + \int_0^T \mathrm{Re}^{-1}\|\Delta\mathbf{u}\|^2 dt + \int_0^T \chi\delta^2 \int_\Omega \Delta\overline{\mathbf{u}}\cdot\Delta\mathbf{u}\, d\mathbf{x}\, dt = \frac{1}{2}\|\mathbf{\nabla}\times\mathbf{u}(0)\|^2,$$

where $\int_0^T \chi\delta^2 \int_\Omega \Delta\overline{\mathbf{u}}\cdot\Delta\mathbf{u}$ is the additional enstrophy dissipation. Therefore, the Time Relaxation model has the same enstrophy as the Navier-Stokes equations, but again enhanced enstrophy dissipation ε_{TRM}, defined as

$$\varepsilon_{TRM} = \int_0^T \mathrm{Re}^{-1}\|\Delta\mathbf{u}\|^2 dt + \int_0^T \chi\delta^2 \int_\Omega \Delta\overline{\mathbf{u}}\cdot\Delta\mathbf{u}\, d\mathbf{x}\, dt.$$

When $\chi = 0$ and/or $\delta = 0$, this integral is zero, and we are back to the Navier-Stokes equation. Thus, the derived enstrophy equation will be the same as the one for the Navier-Stokes equation. This result is valid for both the energy and enstrophy balances.

CONCLUSION

The Navier-Stokes equations are significant in the field of fluid dynamics because they govern the motion of fluid flow, which leads to many applications, such as in industry, climate, weather forecasting, and biomedicine.

The concepts of energy and enstrophy are important in the mathematical theory of Navier-Stokes equations, and they are of essence in determining the existence and uniqueness of the solutions, which is still an open Clay million-dollar prize problem.

Since the Navier-Stokes equations conserve energy and enstrophy, a model for fluid flow problems should as well. Herein, we showed that the Time Relaxation model conserves them too, but it does have a modified enhanced energy and enstrophy dissipation caused by the time relaxation term. Also, if the time relaxation parameter χ, and/or filter width δ equal to zero, then the Navier-Stokes energy and enstrophy quantities are recovered. This is crucial, since when χ, and/or δ equal to zero, the equations of the Time Relaxation model are equivalent with the Navier-Stokes equations.

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EXPECTED RESULTS FOR HEAT DEMANDS IN GLASS HOUSE SPACE, IF THE TRANSPARENT WALLS ARE COATED WITH A PROTECTIVE FILM

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Abstract. This model explains the heat flow in a confined space with transparent walls (glass or plastic). A software is used to analyze the behavior of transparent walls coated with "LLumar" film. This film has many advantages, but in this paper, we will focus on energy savings. Energy savings give quick return on investment and are considered a smart investment. Energy-saving LLumar film can increase performance of almost every window system, significantly reducing energy consumption and requirements. Professional energy audits have shown that buildings with LLumar film can achieve annual energy savings of up to 15%, blocks 99% of harmful UV rays and improves comfort by reducing heat and glare. Regardless of whether it is residential, commercial or glass house space as described in this paper, LLumar the world's leading brand of architectural film for decades improves the well-known buildings around the world with proven results. LLumar films will greatly increase energy efficiency, appearance and functionality of glass partitions. The results are lower overhead expenses, increased comfort, improved privacy and better protection from accidents. Heat balance in glass house space is shown in the following pages.
Key words: thermal resistance, glass wall, glass house, demand for heat.

INTRODUCTION

Foil LLumar is a modern product for changing the characteristics of the transparent wall. Composing various elements in the structure of the foil, the manufacturer offers solutions to several problems that occur anywhere where glass partitions are used. For example, in construction, the effect of increasing the aesthetic value of the glass and protection against external views and provide a foil widely used as modern architectural material. The main benefit of using LLumar foil is energetic efficiency. Dual layer wall foil - glass has a brand new thermal characteristics compared to the mono slice transparent wall. With the addition of the foil, it controls the quality and quantity of energy flow through the transparent wall.With this, the glass gets new energy role, and the closed space new microclimate features

DESCRIPTION OF THE COMPUTER PROGRAM

The computer program to calculate the heat flow through transparent walls requires prior preparation, [3]. It consists of shaping the input data file, the day time, air temperature, air relative humidity, moisture contained in the air density of the air, air speed, intensity of solar radiation. The state of indoor air selects the user program. The used data is related to the city of Bitola (Macedonia) and placed in the file "LOTUS".
Once you take the input values into account the program goes on to calculate the following: coefficients of heat transfer, temperatures of transparent walls and heat flows. The calculation is repeated for every hour of the day and the output values are registered.
The hourly data is taken over a period from 1967 to 1976. This data exists for every month and every hour, and in Table 1 the average values for this period are being considered. These values exist for the whole period of growth (from September until May) of the culture (in this case a tomato) in a greenhouse. February is just taken as an example so we can give a presentation which is shown in Table 1, [1], [3], [4].

Table 1. Hourly data for external and internal conditions, temperature of: transparent wall on the inside and outside and heat needs for February, [1], [3], [4].

Hour	t_{vn} °C	φ_{vn} %	v_n m/s	F_{sz} W/m^2	t_{vv} °C	t_{zv} °C	t_{zn} °C	Q W
1	-1	85	2.3	0	16	7	1	20786
2	-1	85	2.3	0	16	7	1	20786
3	-1	85	2.3	0	16	7	1	20786
4	-1	85	2.5	0	16	7	1	20885
5	-1	85	2.5	0	16	7	1	20885
6	-1	85	2.3	0	16	7	1	20786
7	-1	85	2.3	8	19	9	3	22384
8	-1	85	2.3	185	23	11	1	25126
9	0	85	2.5	385	23	16	5	16005
10	1	83	2.5	449	23	16	3	15733
11	2	80	3.0	509	23	17	3	15339
12	3	75	3.0	528	23	18	4	13288
13	3	70	3.5	543	23	20	6	11225
14	4	70	4.0	524	23	18	5	13733
15	4	70	3.5	486	23	19	6	12476
16	4	70	3.5	430	23	18	6	13946
17	3	70	3.0	192	23	14	4	22036
18	3	75	2.5	0	19	10	4	21282
19	2	77	2.5	0	16	9	6	16035
20	1	80	2.5	0	16	9	6	16027
21	1	80	2.5	0	16	9	6	16027
22	0	80	2.5	0	16	6	1	20920
23	0	85	2.5	0	16	6	1	20844
24	0	85	2.5	0	16	6	1	20844
							Total	438183

With these values you can calculated the amount of heat you need for an year, Table 2. These examples relate to a specific transparent wall.

Table 2. Heat needs for one heating season for structures with an area of 208 m^2 and a volume of 613 m^3 dual hard plastic wall with air layer 15 mm, [2], [3].

Month	Q Wh/month
9	-9241140
10	2111937
11	5008170
12	7923290
1	14110022
2	12269124
3	11449974
4	8616300
5	5473081
6	2383110
Total	60103868

An example of calculations for heat need at different transparent walls is given in Table 3. When we assume that the same structures is protected by a glass partition that has a thermal resistance of 0.01 m^2K/W and we glue LLumar foil on it, it changes the transparency of the plastic wall. Different films have different transparency, and therefore the heat needs are different. We have no further calculations for walls made out of different materials, other than plastic.

Table 3. Thermal resistance and annual heat needs for different kinds of transparent walls for structures with an area of 208 m^2 and a volume of 613 m^3, [3], [5], [6].

Material for transparent walls	R m^2K/W	Q MWh/year
Single plastic wall thickness 1 mm	0.01	127
Dual plastic walls with air space between walls:		
5 mm	0.08	100
12 mm	0.15	81
Dual hard plastic walls with air space between walls:		
6 mm	0.09	98
12 mm	0.11	92
15 mm	0.24	60

In Table 4 the heat needs for February with transparency of 10-90% are presented, while in the Table 5 the annual heat needs for the heating season with varying transparency are presented.

Table 4. Heat needs in February for a different transparency walls, [2], [3].

Transparency %	Q W
10	1300583
20	1274131
30	1247680
40	1221229
50	1194777
60	1168326
70	1141875
80	1115423
90	1088972

Table 5. Annual heat needs for different transparency walls, [2], [3].

Transparency %	Q W
10	6734351
20	6453539
30	6172726
40	5891914
50	5611101
60	5330289
70	5049476
80	4768663
90	4487851

CONCLUSIONS

LLumar foils, which already have commercial level achieved: venting the sunshine of 10-90%, reflecting the sun's rays by 10-50% and absorption of sunlight by 30-60%. Composition of the foil is determined by the required barrier properties that are specified by designers. The foil is used for setting new glass areas and for already completed projects as a corrector of the condition. The foil is mounted by gluing (pressed or water) on the outside or inside of the transparent wall according to function, to reject or retain the sun's rays, thereby, to reduce or retain heat inside the building.

NOMENCLATURE

F_{sz}	W/m^2	- intensity of solar radiation
R	m^2K/W	- thermal resistance
Q	W	- demand for heat
t_{vn}	ºC	- external air temperature
t_{vv}	ºC	- internal air temperature
t_{zv}	ºC	- temperature inside of the transparent wall
t_{zn}	ºC	- temperature outside of the transparent wall
v_n	m/s	- speed of wind
φ_{vn}	%	- relative humidity of the external air

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APPLICATION OF ENERGY INDICATORS IN ASSESSING THE IMPACT OF THERMAL POWER PLANTS ON THE QUALITY OF THE ENVIRONMENT

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Abstract: This paper presents an analysis of the impact of thermal power plants on the environmental quality in the Republic of Serbia. The operation of the mining-energy complex, based on the transformation of primary lignite energy into secondary energy leads to serious consequences for the quality of air, water, and soil.
Results of monitoring the emission concentrations of carbon dioxide, nitrogen oxides, sulfur dioxide and particulate matter show that the focus of environmental goals should be to reduce cross-border pollution. It is necessary to harmonize the plans and programs within the environmental management system in thermal power plants with the guidelines from the European directives. Application of energy indicators is the basis for determining the consequences of thermal power plants operations.
Key words: thermal power plants, energy indicators, energy processes, environmental quality

INTRODUCTION

The views of European Union to bring the negative impact of fossil fuels to a lower level are a basis for solving the problem of environmental pollution on the territory of the Republic of Serbia. The application of renewable energy sources, that are present in the Republic of Serbia, such as solar energy, biomass, geothermal and wind energy, can greatly alleviate the environmental problems.
Lack of funding for improving the energy sector is affecting the fact that work is being done on mitigating the effects of pollutant emissions and the investments in the renewal of obsolete equipment. Small coal reserves, as a non-renewable energy source, indicate that it is necessary to follow European trends and create conditions for the realization of the basic principles of sustainable development.
Energy indicators, as a tool that can point to changes in the environment, are a good basis for comparison of the situation in the previous and next period, at the national level. In order to obtain insight into the changing environment, through concrete examples, this paper has systemized the influence of four pollutants that affect the deterioration of air quality. Monitoring the levels of carbon dioxide, nitrogen oxides, sulfur dioxide and particulate matter is the basis for assessing the impact of the most important thermal power emission sources in the Republic of Serbia on the quality of the environment.

METHODS

Emissions of SO_2, PM_{10} and NO_2, as indicators of environmental quality

Monitoring the impact of thermal power plants on the quality of the environment presents the application of modern methods and laboratories, which would be able to follow the dynamic and complex processes in detail. Through the application of environmental indicators and energy indicators, there is a possibility to carry out the research on the presence of pollutants in the air environment and the application of corrective measures for the protection of the environment which are based on the limited amount of information.
The analysis of objective indicators can serve as a basis for organizing the management system in thermal power complexes. The implementation of decisions aimed at protecting the environment, based on energy indicators is an effective form of presentation of information necessary for the systematic solving of pressing problems. Reducing large amounts of data on changes in the composition of air, water, and soil, down to several key indicators, forms the basis that precludes finding excuses for timely responses in the case of exceeding the emission limit values.

The paper monitors the emissions of SO_2, PM_{10} and NO_2, as indicators of environmental pollution, because the Reports on the state of the environmental quality of the Republic of Serbia [1, 2] provided the results of the analysis. These indicators can be categorized as pressure gauges that are characterized as short-term indicators, or as indicators which are necessary to establish at the earliest time possible. It is necessary to define the value of the indicators once in a year.
In order to clarify the tendency of deterioration of the environmental quality, the calculation of base and chain index was performed, based on the data from these annual reports.
Chain index (L i) for a given year is calculated according to the formula [3]:
Li= N/(N-1)*100, (1)
where:
N - is the value of the concentration of pollutants in the year.
The base index (B i) for a given year is calculated according to the formula [3]:
Bi= N/Nb*100 (2)
where:
N - is the value of the concentration of pollutants in the year and
N b - is the value of the concentration of pollutants in the year that was chosen as the base year.
Values of chain and base index of the annual concentration of SO_2, PM_{10} and NO_2 in the Republic of Serbia is presented graphically, for a clearer perception of the real situation.
Values of chain indexes of the annual concentration of SO_2 in the Republic of Serbia are presented in Figure 1.

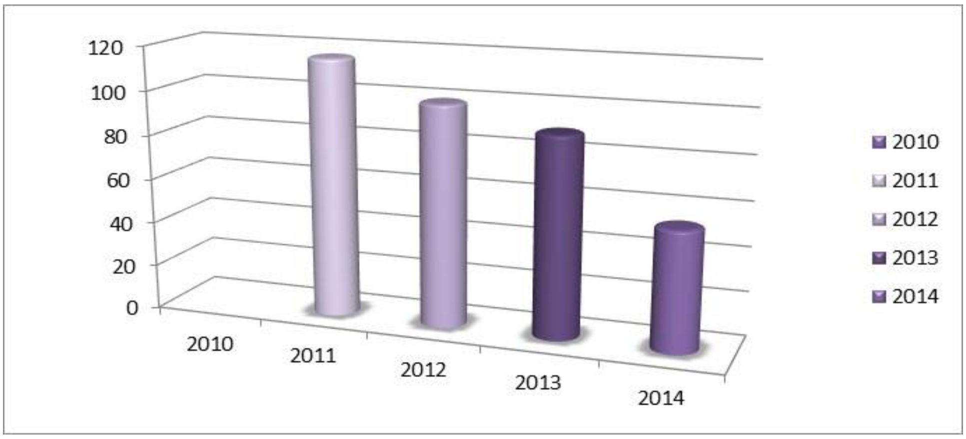

Figure 1. Annual chain index graph for the concentration of SO_2 in the Republic of Serbia

Based on the graphic display (Figure 1) of the chain indexes of annual concentrations of SO_2 in the Republic of Serbia it can be concluded that index value is declining from the year 2010 to 2014, which is the last year for which data are available.Values of base indexes of the annual concentration of SO_2 in the Republic of Serbia are presented in Figure 2.

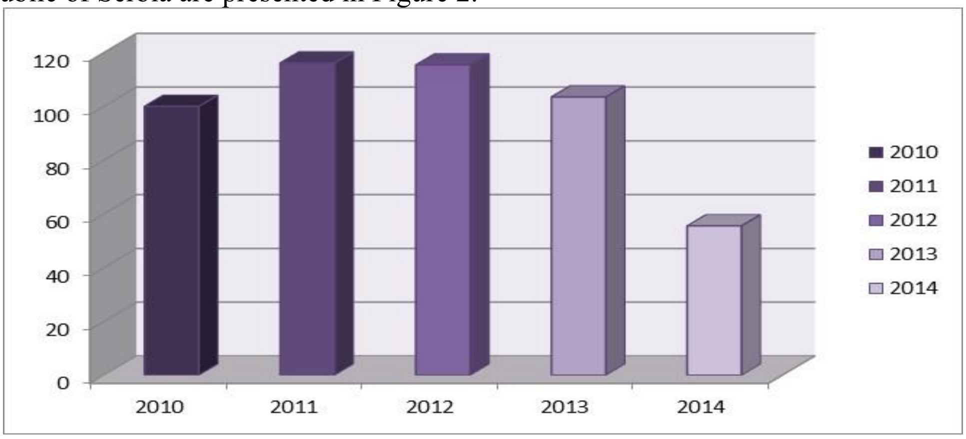

Figure 2. Annual base index graph for the concentration of SO_2 in the Republic of Serbia

Based on the graphic display (Figure 2) of the chain indexes of annual concentrations of SO_2 in the Republic of Serbia it can be concluded that the value of the index increases until the year 2013, compared to the base year 2010, and that in 2014 it had the lowest value.

Values of chain and base indexes of the annual concentration of PM_{10} in the Republic of Serbia are presented in Figure 3.

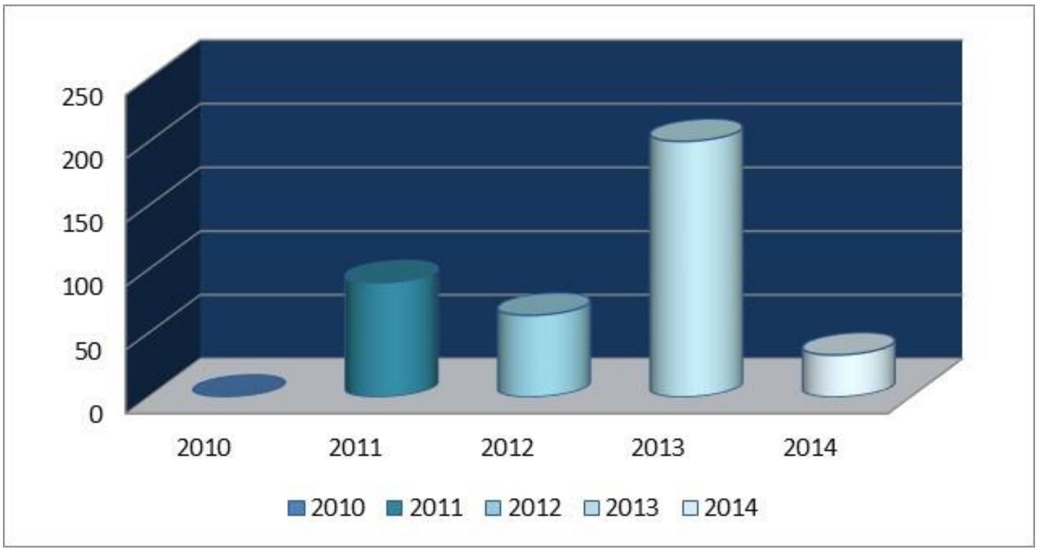

Figure 3. Annual chain index graph for the concentration of PM_{10} in the Republic of Serbia

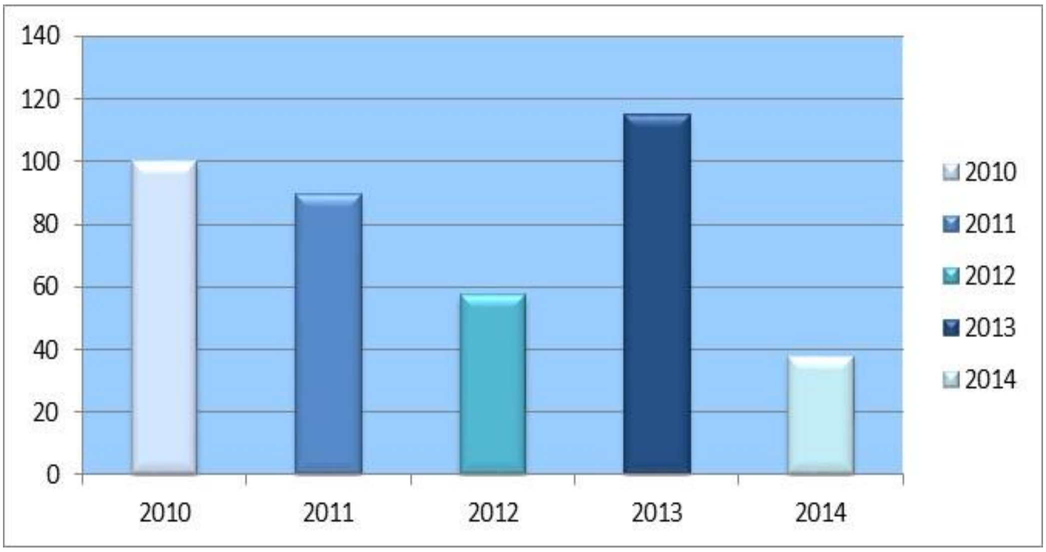

Figure 4. Annual chain index graph for the concentration of PM_{10} in the Republic of Serbia

Based on the graphic display of the chain indexes of annual concentrations of PM_{10} in the Republic of Serbia it can be concluded that of the chain index has an extremely high value for 2013 (Figure 3), although it is noted that the base index has a maximum value for the same year (Figure 4).

Values of chain and base indexes of the annual concentration of NO_2 in the Republic of Serbia are presented in Figure 5 and Figure 6.

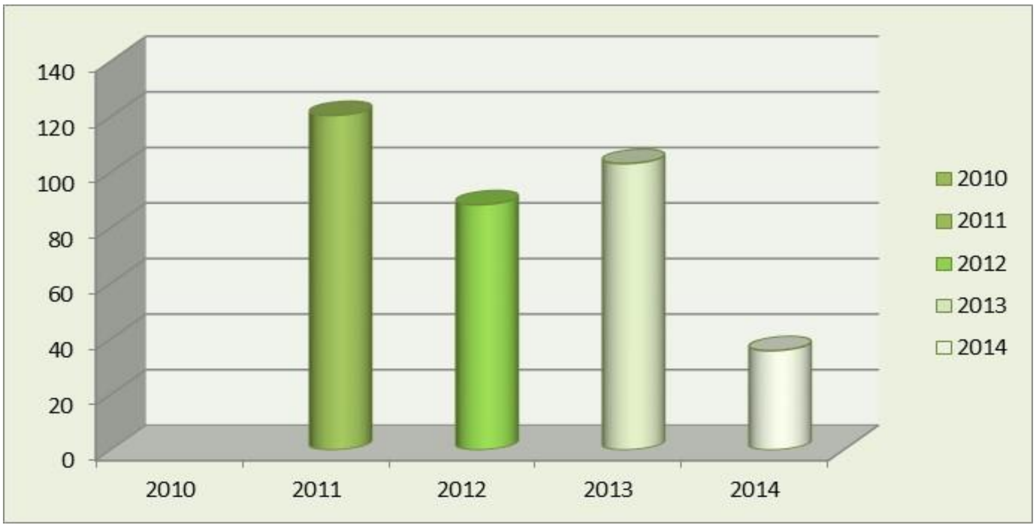

Figure 5. Annual chain index graph for the concentration of NO_2 in the Republic of Serbia

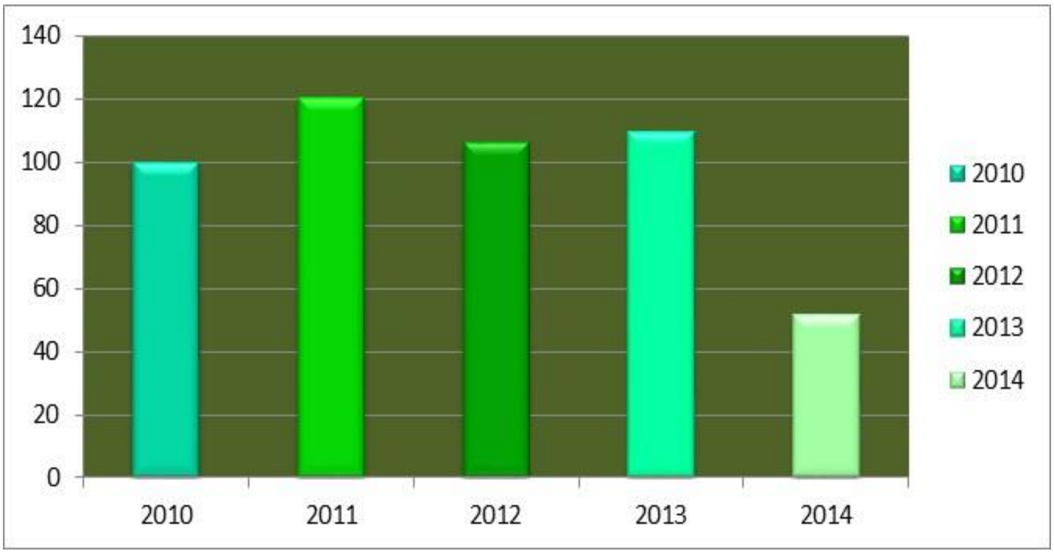

Figure 6. Annual base index graph for the concentration of NO_2 in the Republic of Serbia

Based on the graphic display of the chain indexes of annual concentrations of NO_2 in the Republic of Serbia it can be concluded that he chain index has the highest value for the year 2011 (Figure 5), as well as the base index (Figure 6).

Emissions of SO_2, PM_{10} and NO_2 as indicators of the impact of thermal power plants on the environmental quality

The consequences of thermal power plant operations that are used for the combustion of fossil fuels is reflected on the impact of the energy sector in general. Emissions of SO_2, PM_{10} and NO_2 from the process of transformation of coal energy into electrical energy are monitored in the context of studies that are presented in annual reports on the state of the environment. Based on the available data, we calculated the comparative values of the base and the chain index of average annual concentrations of SO_2, PM_{10} and NO_2 and presented them graphically.

Comparative values of chain and base indexes for the mean annual concentrations of SO_2 emitted from the four point sources of pollution, thermal power plants of the Republic of Serbia ("Kolubara", "Morava", "Kostolac A" and "TE Kostolac B") are presented in Figures 7.

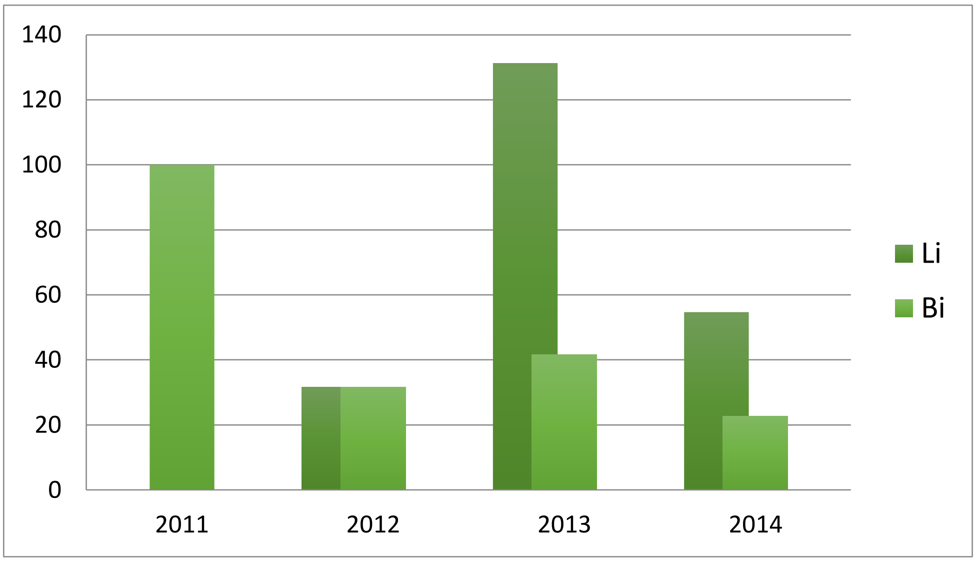

Figure 7. Chain and base index of mean annual concentrations of SO_2 emitted from four thermal power plants ("Kolubara", "Morava", "Kostolac A" and "TE Kostolac B")

Based on the graphic display (Figure 7) and chain and base index values for the average annual concentration of SO_2 it is concluded that chain and base index has the highest values for the year 2013, and that the chain index has about three times greater value.

Comparative values of chain and base indexes for the mean annual concentrations of PM_{10} emitted from the four point sources of pollution, thermal power plants of the Republic of Serbia are presented in Figure 8.

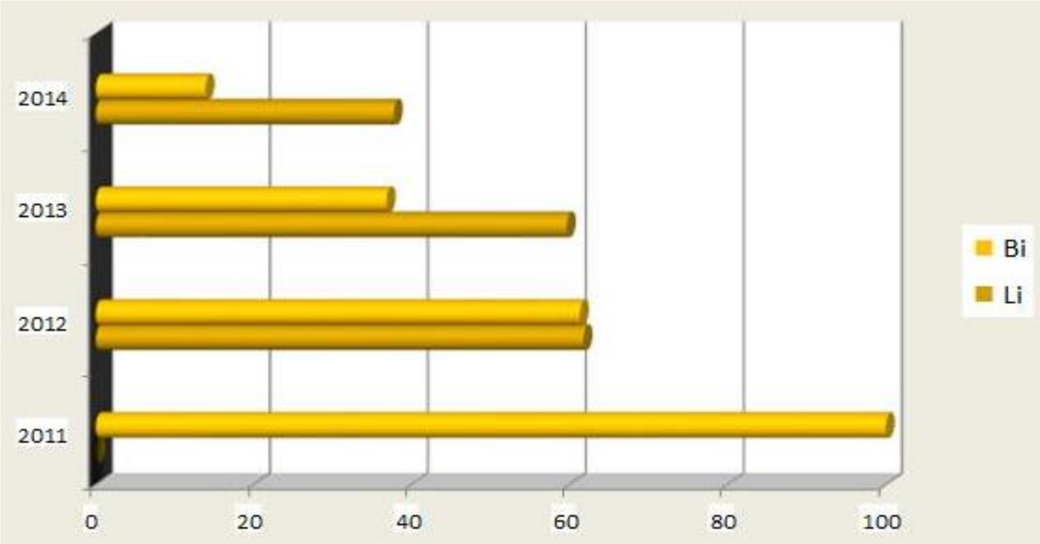

Figure 8. Chain and base index of mean annual concentrations of PM_{10} emitted from four thermal power plants ("Kolubara", "Morava", "Kostolac A" and "TE Kostolac B")

Based on the graphic display (Figure 8) and chain and base index values for the average annual concentration of particulate matter (PM_{10}) it is concluded that chain and base index has the highest values for for 2012, and they are about the same, provided that it does not account the base year.

Comparative values of chain and base indexes for the mean annual concentrations of NO_2 emitted from the four point sources of pollution, thermal power plants of the Republic of Serbia are presented in Figure 9 .

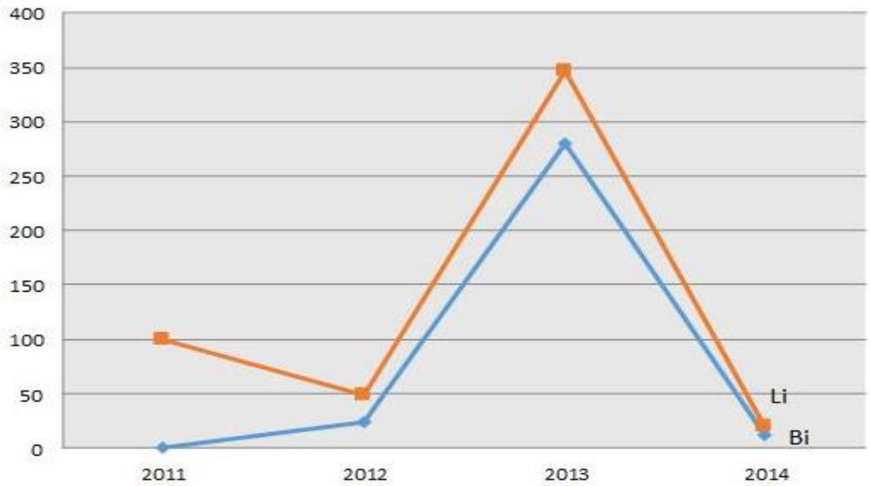

Figure 9. Chain and base index of mean annual concentrations of NO_2 emitted from four thermal power plants ("Kolubara", "Morava", "Kostolac A" and "TE Kostolac B")

Based on the graphic display Figure 9 and chain and base index values for the average annual concentration of particulate matter (PM 10) it is concluded that chain and base index has the highest values for 2013, and they are about the same, provided that it does not account the base year.

RESULTS AND DISCUSSION

Although the tendency of the energy sector planning in the European Union is to reduce the use of fossil fuels to a minimum, the Republic of Serbia still has a low level of utilization of available renewable sources. Based on the graphic display of the annual concentration of pollutants, it can be seen that there are problems in the functioning of the environmental protection system in thermal power plants and that annual emission concentrations do not have a trend of decline. The application of the environmental indicator is the basis for identifying problems and drafting of plans and programs for reducing the negative consequences of the fossil fuel use.

CONCLUSION

The operation of thermal power plants whose functioning is based on the lignite energy has a dominant role in the energy sector of the Republic of Serbia, although it is indisputable fact that there is energy potential for the use of renewable energy sources. Investments in the adaptation of the existing thermal power plants and upgrading of the systems for purification of pollutants are necessary. Care must be taken to the trend of increased environmental pollution, and the levels of concentration of pollutants emissions. By tracking the value of the concentration of SO_2, PM_{10} and NO_2, conditions are created for the analysis of the real situation and management of the environmental protection system based on the established values of the indicators of energy and the environment.

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THE SYSTEM FOR MANAGING AND FAST SECTIONING OF 10kV LINE

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Abstract: This paper proposes a technical solution for the system of management and fast repair and malfunction removal on long 10kV lines that supply the buyers in mountainous regions. Through realization of this system the length of the interval in which the users are without power in this area during malfunction removal is being significantly reduced, as well as during regular maintenance. All the equipment and power switch are used in combination with the system for automatic restoration of power supply set in an appropriate TS 35/10 kV. On the basis of the multi-criteria method, optimization of the locations for setting of the power switch was also conducted. The method is illustrated on an actual example of electric distribution network to which the system has been installed.
Key Words: Automatic Restoration of Power Supply, Electric Distribution Network, Automatization Management, Multi-criteria analysis

INTRODUCTION

Suspensions of mid-voltage electric distribution network originated from malfunctions or overload of certain sections which initiate the automatic opening of appropriate switches. Such action of the switch causes suspension of power supply to several parts of electric distribution network. After suspension of the supply, what follows are numerous activities usually referred as locating or isolation of the section (or an element) with the malfunction, and then repair of power supply.
These activities consist of:

- Identifying the part of the network that contains the malfunctioning part,
- Identifying the very malfunctioning element and its isolation from the rest of the network,
- Restoration of the supply on the part of the network not influenced by the malfunction, but which has lost the power supply due to the malfunction.

Searching for and isolation of the malfunctioning elements, as well as the restoration of the supply, are among the most serious problems in managing electric distribution network. The choice of these procedures largely depends on the equipment available to locate the malfunction, as well as on a number of remotely controlled equipment in the network. The span of the referred installed equipment is quite wide – from poorly equipped networks, without any equipment for locating the malfunction and without remotely controlled equipment, to modern equipment for locating malfunction (micro-processing units with malfunction recorders, detectors for signalizing the voltage presence and malfunction detectors, etc.) and a large number of remotely controlled equipment [2], [5].

The equipment to achieve this function most often includes:

- micro-processing units with malfunction recorders, installed into the exit cells of supplying TS,
- detectors for signalizing the voltage presence and malfunction detectors installed into the depth of SN network, with or without remote signalization,
- Linear sectionalizers-fuses installed in the depth of SN network.

For each combination of the equipment available for locating malfunction and remotely controlled equipment, the proposed procedure should offer the most efficient plan of action for searching the section or the element malfunctioning, for isolating the malfunction and restoring the power supply. The higher level of equipment for locating malfunction allows a shorter expected period without supply and less undelivered energy due to malfunctions.
This paper proposes a technical solution of the system for fast discovery and removal of malfunction on long 10kV lines which supply the users in mountainous regions. The system is intended to be installed in transmission stations of the "tower" type, and comprises of a power switch and a managing part of the system. All the equipment and power switch are used in combination with the system for automatic restoration of power supply set in an appropriate TS 35/10 kV. On the basis of the multi-criteria method, optimization of the locations for setting of the power switch was also conducted. The optimization was conducted on the basis of comparison of costs of construction, costs of maintenance, duration of the power supply break, and also hiring of electrical teams [7].

MATERIAL AND METHODS

Description of the system

This system is intended to be installed in transmission stations of the "tower" type, and comprises of a power switch and a managing part of the system (Condenser supporting device, RTC device and supporting relay for remote managing of power switches PU-106). The distribution of the equipment is presented in the Figure 1a and 1b. All the equipment and power switch are used in combination with the system for automatic restoration of power supply set in an appropriate TS 35/10 kV.
In case of malfunction on a part of the line, through the reaction of an appropriate protection, the power switch of 10kv line in the transmission station TS 35/10kV would turn off. By turning off the 10kV line, all the power switches deep in the network, set in transmission station of the "tower" type, would also turn off [3]. At the moment the voltage disappears, Condenser supporting device gives an impulse to turn off the power switch.

Figure 1a. Storage of managing equipment in TS "tower"

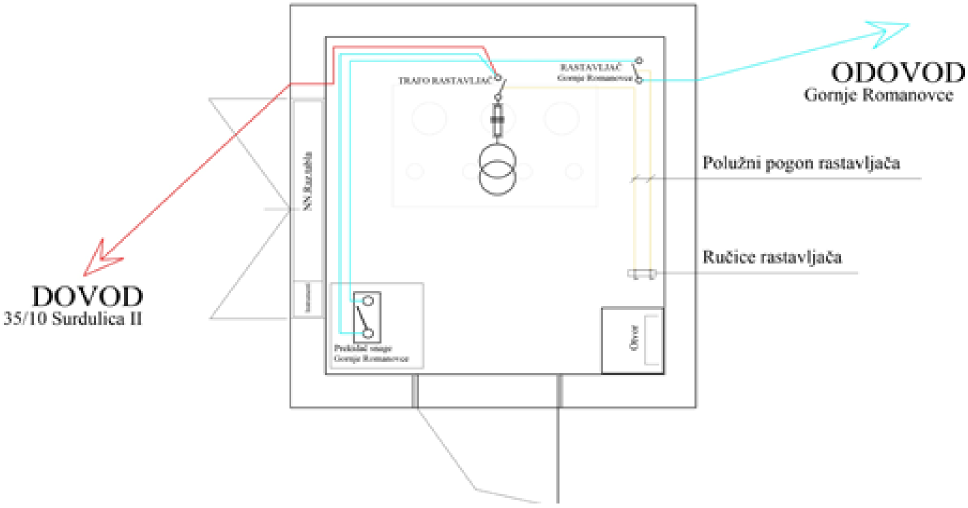

Figure 1b. TS 10/04 Donje Romanovce – tower Disposition of equipment

Automatic Restoration of Power Supply turns on 10kV, so that the sectioning and turning off of the transmission line is performed by a power switch [1]. With remote managing of the power switch at the points of transmission lines in the towers (through RTC system) the malfunction is localized. The managing scheme is presented on the Figure 2.

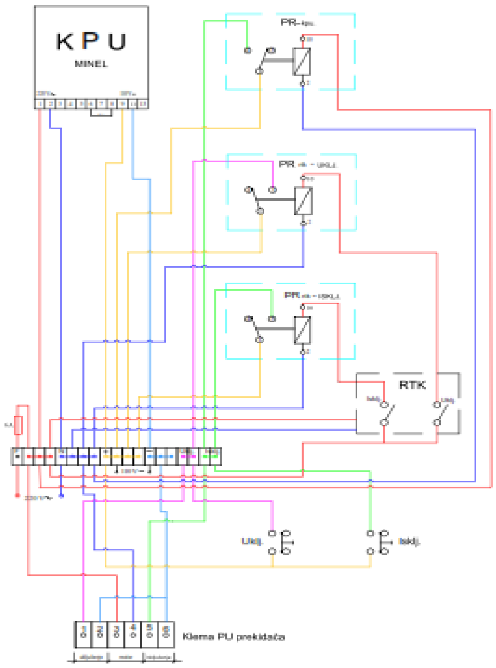

Figure 2. The managing scheme of the device for remote turning off of the malfunctioning section

The efficiency in finding malfunctions is increased by installation of the devices to locate malfunctions in particular branches; thus, much higher precision and finding the micro-location of the malfunction is achieved. As shorter 10kV lines of mountainous regions, which are connected to 10kV lines of plain regions, during malfunctions in the hilly areas, only the power switches in TS towers though which the supply network of the hilly area is established is turned off [8]. The optimal locations of setting the switch are determined by the multi-criteria analysis described in the next section.

Optimal places of insallation

Determining on the optimal location for setting the remotely controlled switch is performed through multi-criteria analysis. The multi-criteria decision making is an area that has been gaining significance for the past two decades, since every process of decision making requires consideration of numerous criteria, which are often conflicting or expressed in different units of measurement [6]. Since the 60s onwards, a large number of multi-criteria analysis has been developed, which can be classified on several grounds.

One of the most important classifications of the method of multi0criterai decision making was provided by Hwang and Yoon [9], who classified 17 different models according to type and important traits of information for decision maker. According to the type of information the referred methods are divided into two groups:

- Methods without information on attributes (The domination method, MAXIMIN method, MAXIMAX method)
- Methods which require particular information on attributes (Conjunctive method, Disjunctive method, Lexicographic method, The Analytic Hierarchy Process AHP method, ELECTRE, TOPSIS)

As in the models of multi-criteria decision making different and conflicting criteria occur, in order for the model to be solvable, it is necessary to transform the attributes, as follows: classify the qualitative attributes; modify the attributes of the same criterion; perform normalization and linearization od the attributes and define the weight coefficients of the criterion [4].
The first manner of transformation of the attributes comprises of turning the attributes into interval scales, and the so called bipolar scales are mostly used. For the very procedure of turning the attributes into the interval scales a scale of for example 10 pints is chosen, 0 is ascribed to the lowest level, and 10 the highest level of physical realization. In this procedure it is best to determine on the middle of the interval, since this marks the boundary between the desirable and undesirable. Even though this method is known as quite arbitrary, in the actual situations it provides very good results. The second manner of transformation of the attributes is the normalization of the attributes, which could be twofold:

- Vector normalization – each vectors is divided by its norm, which differs depending on whether the criteria are of the maximum or minimum type.
- Linear normalization is performed when the result (output) of a criterion is divided by its maximum value, so the transformed output is calculated with the following formula:

$$l_{ij} = x_{ij}/x_j^* \tag{1}$$

In which:

$$x_j^* = \left\{x_j \middle| \max_i x_{ij}\right\}; i = 1, \ldots, m; j = 1, \ldots n \tag{2}$$

In this paper, the linear normalization was performed, while the choice of the optimal alternative is performed by the MAXIMIN method, the choice of the most favourable alternative is performed with the following relation:

$$a^{*} = \left\{ a_i \middle| \max_i \min_j l_{ij}\,; i = 1, \ldots, m; j = 1, \ldots n \right\} \tag{3}$$

a_i – the total available collection of alternatives in a model $i = 1, \ldots, m$

l_{ij} – linearized values of the decision-making matrix $i = 1, \ldots, m;\ i = 1, \ldots, n$

The values obtained with the linear normalization are in the interval between (0,1) and the result is more favourable as the value is closer to one.

Example of calculation

As an illustration of the proposed method, the actual electric distribution network in Surdulica is going to be used, as presented in the Figure 3. The lengths of branches and number of uses in each nod are presented in the very picture. The speed of the team taken is 20km/h. For the total network, the taken intensity is λ = 50 1/100 km, time of repair 2hl time needed for remote dissembling 5 min.

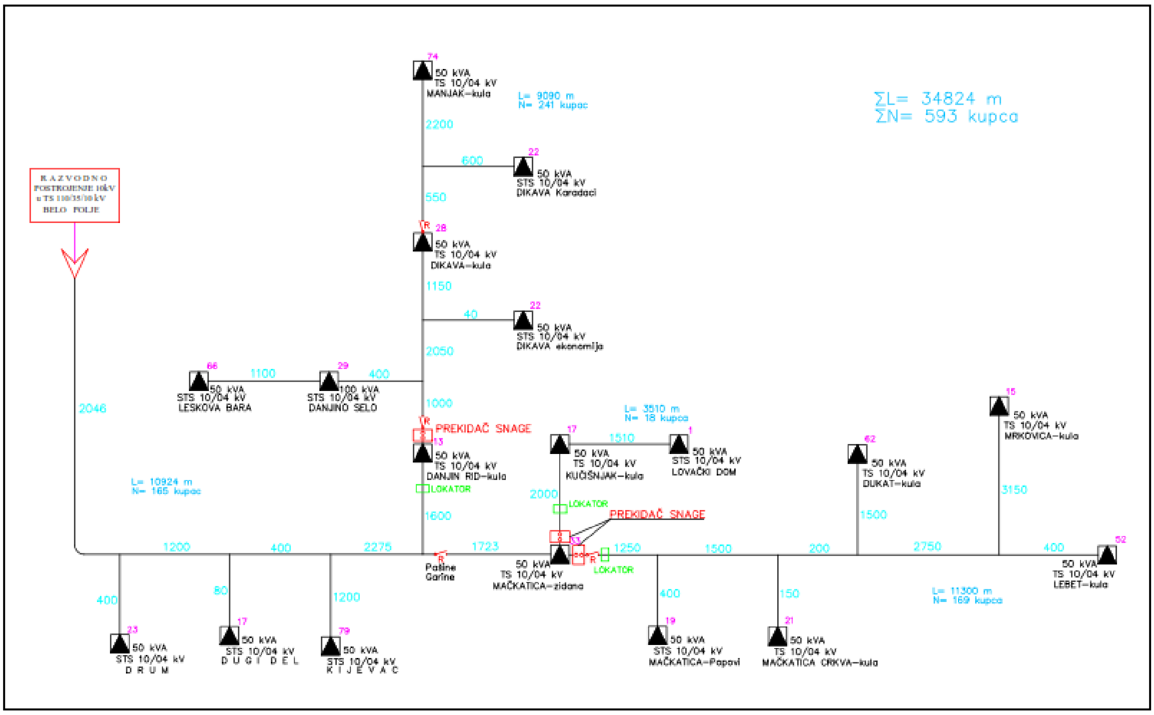

Figure 3. 10 kV line with the proposed locations for switch installation

Four alternatives presented in the table have been considered. The following was used as criteria: The System Average Interruption Duration Index (SAIDI), the total cost of installation and maintenance of the switches and accompanying equipment, as well as the costs origination from undelivered energy borne by the users. The very process of obtaining these values is beyond the scope of this paper.

Table 1. Alternatives for installing the power switches

	Alternative	SAIDI	Cost of installation and maintenance	Cost of users due to the energy undelivered
1	1 switch in TS Daljin Rid	32,04h	3 200	29 000
2	1 switch in TS Mačkatica (exit Lebet)	30h	3 500	20 000
3	1 switch in TS Mačkatica (exit towards Lovački dom)	31,6h	3 000	20 000
4	2 switches (Daljin Rid i Mačkatica)	26h	6 200	9 000

Linearized values of different criteria according to (1) and (2) are presented in the table 2.

Table 2. Linearized values of criteria for different alternatives

Alternative	SAIDI	Cost of installation and maintenance	Significance of the user
1	0,81	0,93	0,31
2	0,86	0,85	0,45
3	0,82	1	0,45
4	1	0,48	1

Using (3), it can be concluded that the most favourable alternative is marked with number 4 (a^*= 0,48).

RESULTS AND DISCUSSION

This system reduces power offs of the complete line due to sectioning, during revisions, repairs or cleaning of the section of the corridor from vegetation (separating of line separators in the state without voltage). For the managing part, apart from Condenser supporting device, RTC device and supporting relays for remote managing, there are buttons for the local turning on and off of the PU-106 switches set in the part of the low-voltage junction board.

CONCLUSION

With the realization of the system for remote sectioning of the section malfunctioning the duration of the interval without power is significantly reduced for the users in these areas during removal of malfunctioning, and also during regular mainenance (revisions, repairs or cleaning of the line from vegetation).
This system has been successfuly realised in the area of ED Leskovac – section Surdulica, at the exits that mainly go through mountainous and wood areas. This found application also with the short 10kV lines of the mountainous regions, which connect the 10kV line to the lines of the plain regions, in order to decrease the corresponding indicators of reliability (SAIFI and SAIDI). The proposed method of choice of location successfully deals with the problem of optimisation of multiple different criteria.

Acknowledgments

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ANALYSIS OF TRANSFORMER, MOTOR AND OTHER TYPES OF OIL FLOW IN ELECTRIC POWER DISTRIBUTION SYSTEM IN DEVELOPING COUNTRIES

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Abstract: Flows of transformer, motor and other types of oil in electric power distribution system require certain analyses over the safe handling and efficient management of oil flow in the above mentioned system for not only the purpose of environmental protection but the integration with other forms of protection and the implementation of adequate protection measures. The set of system activities is to be realised in the distribution of electrical energy and other complex activities, which includes continuous education of all participants in charge of monitoring, control and management of various types and quantities of the flows of waste and new oils, creation and update of the internal documents, collection and temporary storage of waste oils within the organisational units and final disposal of waste. The study presents the analysis and treatment of transformer, motor and other oils in the MH "ERS" ZEDP "Elektro-Bijeljina" joint-stock company Bijeljina, which shows the types, quantities and flows of oil, treatment and solution methodologies, including other activities to be implemented in the electricity distribution system in developing countries.
Key words: transformer oil, motor oil, electricity (power) distribution, analysis of material flows, waste, environmental protection, safety and health at work, fire protection.

INTRODUCTION

A set of activities undertaken during the handling of new and waste oils, as well as directing and control of oil flows must be carried out in order to have the least impact and acceptable level of risk to the environment and human health, reduce the use of natural resources, minimize the waste, reduce its adverse impact on the environment and enable reuse and recycling of waste and safe waste disposal. Transformer, motor and other oils are being generated in the processes of maintenance, reconstruction, replacement of power equipment, motor vehicle maintenance and other activities, as well as other various types of waste for which the enterprises belonging to the electricity distribution system are obliged to undertake appropriate protection measures and activities in order to control and manage the aforementioned, in the manner prescribed by laws and bylaws.

MATERIAL AND METHOD

Oils used in electric power distribution system

Regular or periodic replacement or control of oil quality is conducted for the transformers (as shown in Figure 1) and other electric appliances, machines, tools and/or vehicles, which operate by using oil as a lubricant, insulation or heat transfer. The same is also conducted during the regular maintenance and planned overhaul.

Figure 1: Transformer connected to the electrical grid in substation 35/10 kV [1]

Different types of oil are used in electric power distribution systems: insulating oil (transformer oil and oil switches), hydraulic oil, gear oil, motor oil [1]. These types of oil may be of mineral or synthetic origin. Choosing the type of oil for individual devices, tools and vehicles depends on the nature and working conditions, status and degree of wear.
Waste - used oil includes all priory mentioned mineral or synthetic oils that are either used and/or contaminated by physical or chemical impurities.

Waste insulating oil (transformer oil and oil switches)

Of all the stages in the life cycle of transformer oil, the longest is the stage of use [2]. Waste transformer oils and other wastes are being generated from the complex process of reconstruction, overhaul, maintenance, replacement of power equipment, as well as other activities of electrical distribution companies. Processed insulating oil in the switches is collected by a substation electrician who fills the Record on replacement based on which the keeper of either central or working unit's warehouse completes the form Entry of waste materials into warehouse and performs temporary storage of insulating oil and other waste [1], as shown in Figure 2.

Figure 2: Storage of oily waste [3] and containers for oil safe disposal

Waste motor, hydraulic and gear oils

Changing of motor, hydraulic and gear oil in vehicles and operating machines is done in authorised institutions or workshops within the electrical distribution company. If the oil is changed in an authorised institution, the waste oil management is the responsibility of the institution. Changing of motor, hydraulic or gear oils is based on the proceedings initiated of by a clerk in charge of car park.

Material Flow Analysis – MFA method

The MFA is a systematic approach to displaying the material flows and stocks within the spatial and temporal limits of the system. The MFA locates materials through a restricted system. Therefore, it connects the sources, pathways and interim or final disposal sites. The MFA takes into account the principle of mass balance based on the law of conservation of matter. The balancing of all the input and output components enables the forecasting of critical statuses of either discharge or accumulation [4].
Stock and flow diagrams enables insights into flows relevant to resources and environmental aspects in order to choose the most efficient strategies for reduction and prevention of oil. [5]
Application of the MFA procedure offers the possibility to develop ways to reduce the problem of independent pollution. As a result, the MFA reveals possible problems in terms of current and future legal frameworks. It enables immediate detection of problems that may arise in the future. The MFA is a method which may provide a detailed review of the material and substances in the organisation's flows thus provides environmental management system.
The spatial limit (boundaries) of the system is determined by the scope of this study, which is mainly engaged in the distribution of electricity. Accordingly, the limit (boundary) is defined area of real (fixed) infrastructure, including the environment. The relevant processes taking place on site are included.

Due to the specific structure and business activities of the company itself in the electric power distribution system, as well as the business operation method, one-year time limit has been adopted for the purpose of this analysis.
When it comes to defining the process within the electric power distribution system in order to have a more comprehensive overview of the entire situation, the process has been defined at the appropriate levels. The appropriate level means defining of all distribution units - working units under the Elektro-Bijeljina company as separate processes or as independent portions of organisational complex. Spatial limits (boundaries) of these distribution units are the geographical boundaries of their organisational units.

RESULTS AND DISCUSSION

Flow analysis of insulating oil (transformer oil and oil switches), motor and other oils, including waste oils, and its management must be carried out in an appropriate manner in order not to jeopardize human health and to prevent environmental pollution. The MFA is the basis for the monitoring of material and generated waste flows.
After the completion of the oil public procurement, the selected bidders deliver oil to the central warehouse, where the oil is distributed from to the working units' storages. Oil procurement depends on the need for topping up, sampling, oil changing and other regular and extraordinary activities, thus the terms of procurement are usually not uniform. Process of generating waste oil and other hazardous waste is a particularly problematic stage because of the complex organisation of analyzed system for monitoring the quantitative and qualitative variations within the general trend of the generated waste movement, as well as the establishment of efficient control mechanisms. Waste oil generation is caused by: the analysis of the transformer oil sample - if it results in an unsatisfactory quality, the replacement with new oil follows; if the oil leaks as a result of damage to the transformer, motor vehicle, operating machine or any other device in either regular or extraordinary circumstances, then the refilling of oil or replacing it with new oil follow. [1]
As a logical continuation, the temporary storage usually comes after the generation of hazardous waste, which means storing hazardous waste on its way to the waste treatment plants and final disposal. The capacities of temporary storage facilities have to meet the existing requirements, so while designing, the calculations are made for twice the amount of hazardous waste than the one which is usually generated between the two cycles of treatment, i.e. the transport. [6]
Waste oil is collected in the containers or other appropriate packaging and shipped to a warehouse of a working unit. Due to the accumulation of large quantities of hazardous waste in one place, this stage is a major challenge in terms of organisation in order to prevent possible accidents. For this reason, the constant control is necessary, not only by immediate responsible participants, but also by regulatory authorities.
In case of changing oil during the transformer overhauling in authorised institutions, the waste oil management is the responsibility of the institution. If the institution does not operate in accordance with standard ISO 14001, it is the obligation of power distribution company to manage the waste oil [1], [7].
Results of the waste oil analysis in the "Elektro-Bijeljina" joint-stock company Bijeljina show that the share of the amount generated in the waste oil flow per working unit is: 43% in Vlasenica, 33% in Bratunac, 20% in Bijeljina and 4% in Zvornik, as shown in Figure 3.
The aforementioned waste oil analysis results are logical, given that the overhauls, repairs and reconstruction of certain power units, which belong to the above mentioned working units, most intensely in Vlasenica, Bratunac and Bijeljina, were done in the period analyzed. The management of waste oils generated in the working unit Ugljevik is the responsibility of an authorised institution, which does the oil change treating it furtherly in accordance with the legislation.
At the level of enterprises belonging to the electricity distribution system, the short-term or long-term contracts are signed with authorised organisations dealing with the disposal of waste oils and thus solving generated waste issue.
Further movement of waste oil flows and operation of the oil management system include transportation to the waste treatment plants, which significantly increases the risk of accidents and threat to the population and environment in the broader areas, along the transport route to be used.

In relation to the above, all types of waste oil stored temporarily in the warehouses of the Company's organisational units are transported for recycling by the contracted authorised institution specialised in the management and disposal of waste oils.

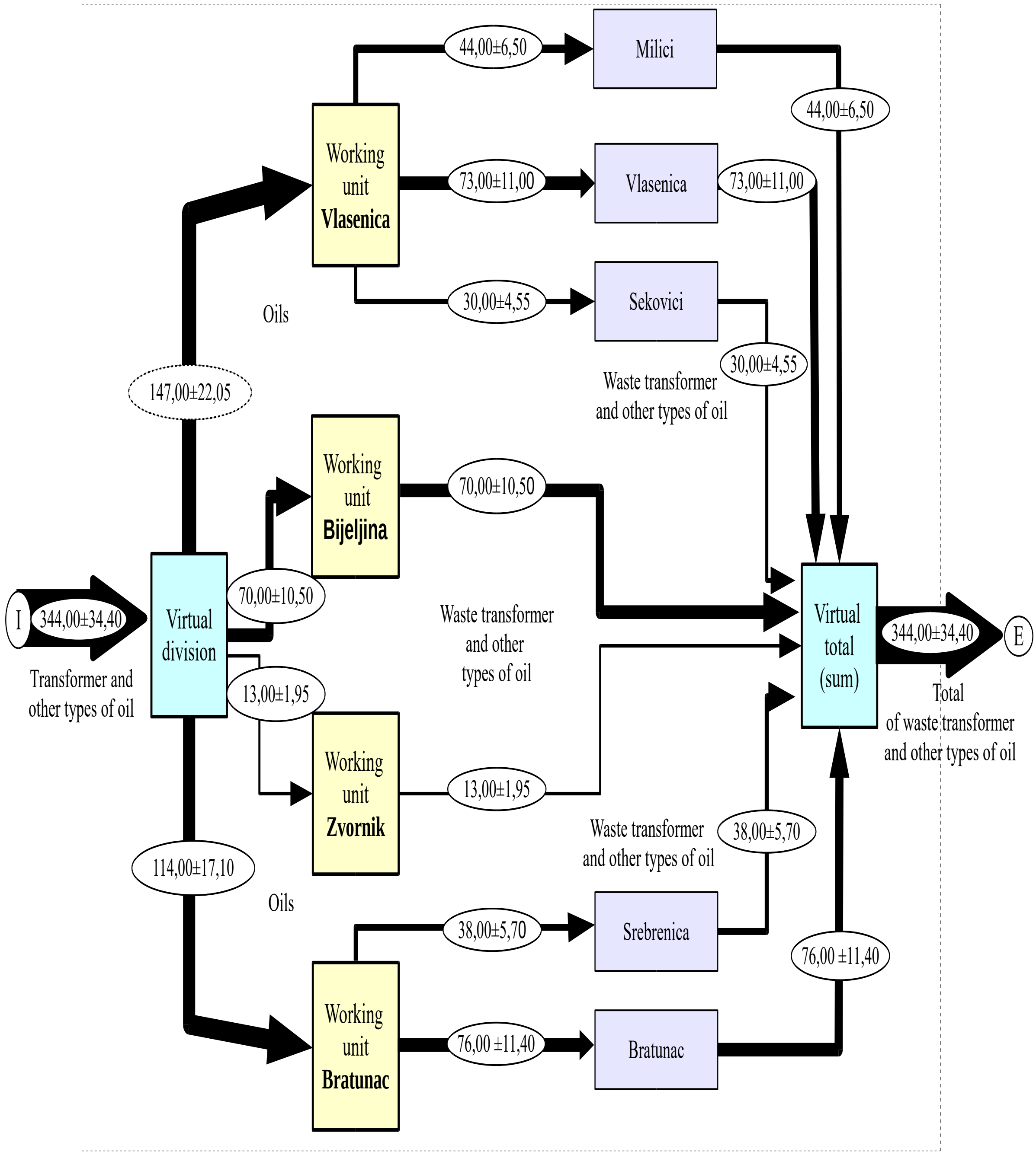

Figure 3: Analysis of oil flows in working units under the "Elektro-Bijeljina" Company (l/year).

Based on the collected various data, the analysis and its results, it was established that there is not always completely accurate record or information about how much oil is topped up into individual transformer and/or other devices, as well as the records on other possible activities. The mentioned facts make it difficult and limit detailed analysis of oil flows and waste materials.
In accordance with the above analysis results, Figure 4 displays the proposed monitoring of the flows of oil and information, as a form of the enhancement and achievement of the necessary level of material flows monitoring in order to improve the existing recording, for the aim of more efficient environmental protection.

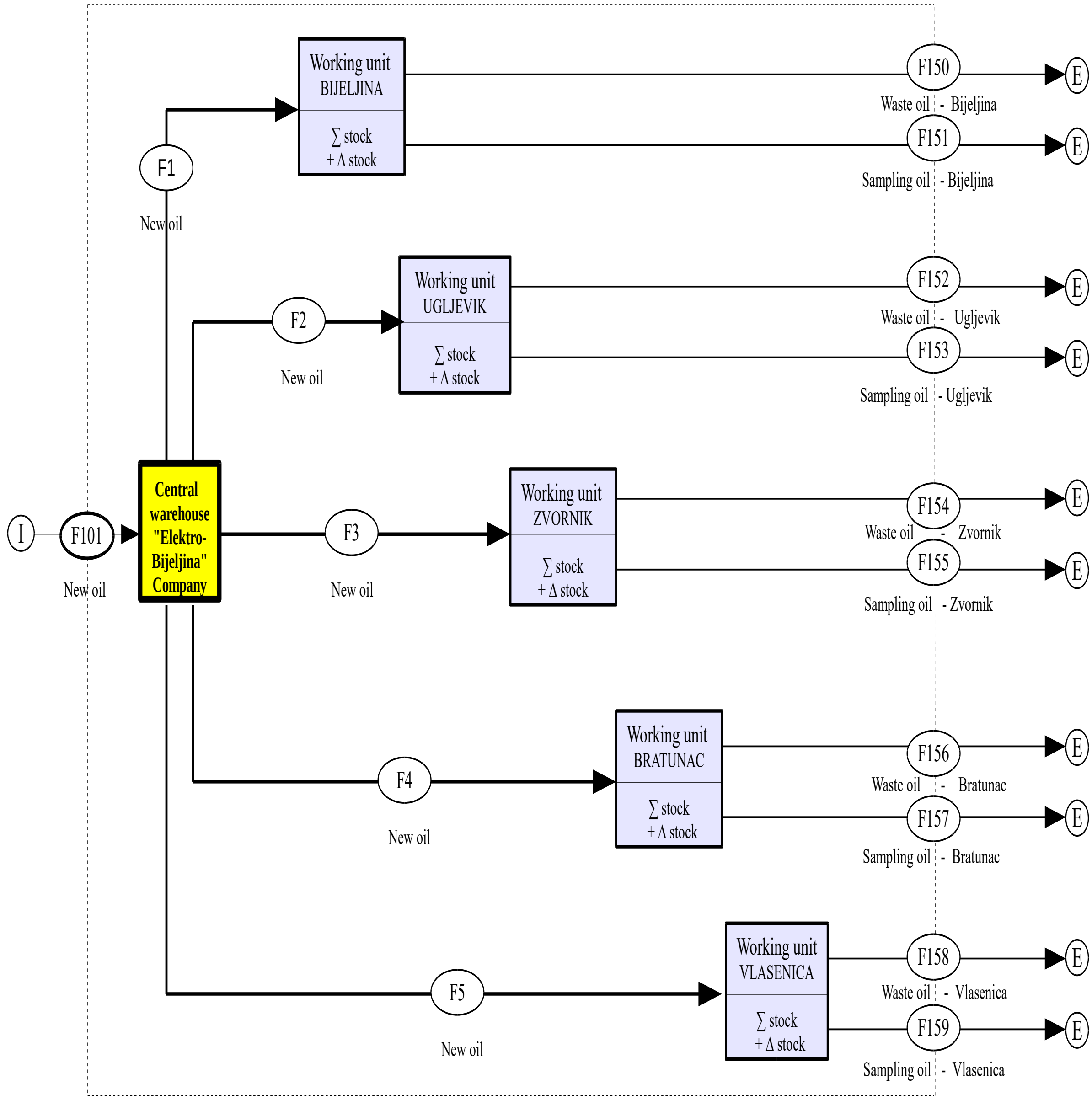

Figure 4: Diagram of proposed monitoring of flows of materials and informations

If the transformer, motor and/or other oils are unwillingly and uncontrollably discharged (spilled) into the environment (soil, groundwater or surface waters), the corrective measures are required to be implemented, which involve the collection of oil, safe disposal and rehabilitation of the consequences. The oil collected while taking samples or overflowing is categorised as waste oil [8]. Material flow analysis is the basis for the hazardous waste management [9]. The obligations and requirements for environmental protection are met by analyzing the flows of new and waste oil and implementing waste management procedures.

CONCLUSION

Control of analyzed flows of transformer, motor and other oils is not fully functional and adequate for the existing record-keeping method, which requires improvement. Currently, waste water records are kept in accordance with ogranisational division of the Company, in amounts/quantities that are generated in different working units, often without defining the exact place or the process of waste generation (the power station and/or other type of facility). Therefore, such records are not always accurate, timely and/or complete, thus result in analysis quality loss.

The mentioned conclusion, among other things, is one of the disadvantages of different distribution systems, mainly in developing countries (economies in transit), and is an important parameter that needs to be improved in further work and system operation.

Work teams that carry out operational activities, interventions and maintenance of the power distribution systems, although they are continuously obliged, do not always submit report on the transformer topped up and the oil quantity used, and/or the returned amount of oil after taking samples. This prevents the possibility of precise record-keeping and quantification of waste, including the possibility of analysing the generation place. Because of the above mentioned, there is not always complete records on the waste generation place and all generated waste flows.

By seriously applying the results of flow analyses of various waste oils, including synthesis of all the data analyzed in the company that was subjected to the research or similar enterprise in developing countries, the MFA may significantly contribute to the environment protection, better functioning and faster development of the electricity distribution system, through the increase in: the speed and quality of the necessary information circulation, the safety of all active entities, profitability, timely and comprehensive fulfillment of legal obligations, level of business image and general progress of the underlying system, thereby increasing the degree of positive impact on the entire social community, based on scientific grounds.

Based on previous statements and analyses, it is necessary to build, soon as possible, temporary storages for waste oils and other hazardous waste at the localities where missing, or expend storages in order to ensure a sufficient and safe space for temporarily storing the waste oils and other materials, which some localities lack at present.

Based on conducted research presented in the study and various analyses of transformer, motor and other oils, methods, and the synthesis of numerous data, it can be generally concluded that the described problem solving method, recommendations and other positive suggestions, as well as the optimal waste management methods, in addition to researched system, can be applied to most of the power distribution systems, particularly in developing countries for the purpose of environmental protection.

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DESIGNING AN SOLAR AIR HEATING COLLECTORS IN TWO MODULAR SOLAR PANELS BUILD INTO A „DO-IT-YOURSELF” TYPE PROJECT USING RECYCLED MATERIALS

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Abstract: This paper shows a DIY (“do-it-yourself”) type project.“Do-it-yourself” (DIY) is the method of building, modifying, or repairing something without the aid of experts or professionals. Academic research describes DIY as behaviors where individuals engage raw and semi-raw materials and component parts to produce, transform, or reconstruct material possessions. By promoting projects of this kind, students can understand that unconventional energy is available for everyone, at a minimal cost and with good results comparing to systems that are on the market. Students can also make a general impression that using unconventional energy represents the next stop towards the future in all the branches of the industry and protecting the environment. This paper presents the processes of designing and development of a heating system that uses solar energy. The heating system consists of two parts. The first part consists of a photovoltaic solar panel made from 36 photovoltaic cells capable of developing 65 W and 3.6 A. The second part is made of recycled materials (aluminum cans), forming radiant tubes.
Key words:heating systems, solar energy, photovoltaic solar panel, radiant tubes

INTRODUCTION

These days, people have been talking a lot about renewable energy. The world is growing too dependent on non-renewable energy, such as fossil fuel, natural gas, oil and coal. There needs to be another idea to be green and environmentally friendly. These renewable energy sources can be used for hundreds of years without hurting the environment. There has been much research going on in science labs and farms across the country, so these sources are always evolving into better and better things. The sources are almost limitless, but there are some common ones. The most widely used heating installations in current technologies are based on burning fossil fuel but we should take in consideration that health policies nowadays are directed towards lowering the use of this kind of fuel. Nowadays, to ensure the proper conditions we need to live in, every home must be built with a heating system, with enough efficiency to ensure the optimal use of heat and water. An example of a heating system of this kind transforms the solar energy, which is unlimited into heat. The uses of heating systems based on renewable energy represent the cheapest solution to produce heat. [1-4, 7-9, 12, 15]
If effective support policies are put in place in a wide number of countries during this decade, solar energy in its various forms – solar heat, solar photovoltaic, solar thermal electricity, solar fuels – can make considerable contributions to solving some of the most urgent problems the world now faces: climate change, energy security, and universal access to modern energy services.
The largest solar contribution to our energy needs is currently through solar heat technologies. The potential for solar water heating is considerable. Solar energy can provide a significant contribution to space heating needs, both directly and through heat pumps. Direct solar cooling offers additional options but may face tough competition from standard cooling systems run by solar electricity. Solar energy offers a clean, climate-friendly, very abundant and inexhaustible energy resource to mankind, relatively well-spread over the globe. Its availability is greater in warm and sunny countries.
Taking into consideration the time that needs to be taken to develop new technologies and at the same time the replacement of old and outdated current equipment’s, it is necessary to speed up the development of technologies that can sustain the production of cheap and clean energy. [1-4, 7-9, 15]
At the same time, the line of thought and the lifestyle in the society that we live in, needs to be stimulated and rejuvenated for a change to really happen.
Today, renewable energy accounts for over 20% of total global electricity generation, with solar ranking fourth after hydro, bioenergy and wind. The majority of solar energy technologies on the market today are based on the ‘photovoltaic effect’, whereby an electric current is produced in a material when

exposed to light. [7-9, 15] Solar energy could account for 8–15% of global electricity in 2050, depending on factors such as market demand, energy policy, manufacturing costs and technological advances. [7-9, 12, 15]

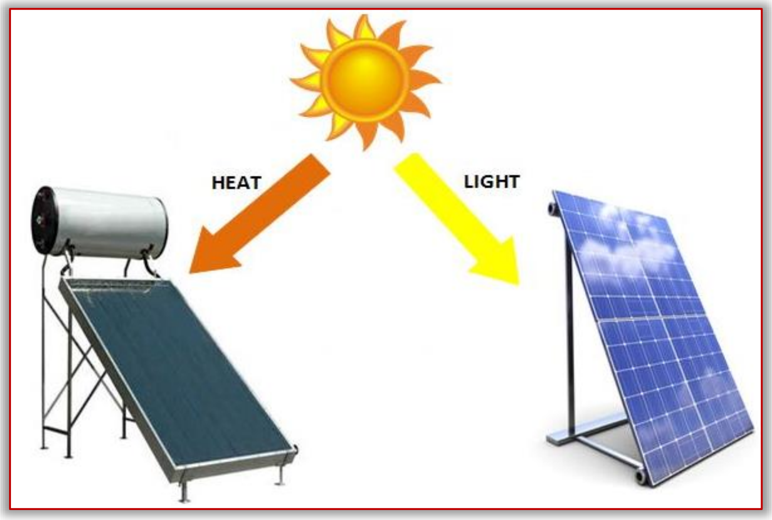

Figure 1. Solar heat and solar photovoltaic

The main concern is that on short and medium notice, renewable energy sources cannot be a complete alternative. However due to the huge possibilities that these new technologies can bring, we are experiencing heavy funding in these area of research. Renewable technologies are advantageous because of many reasons [1-4, 7-9, 15]:

≡ they do not polluted,
≡ they require minimal cost of productions, and
≡ the solar energy is inexhaustible, and so on.

The solar energy is without doubt the most widely used renewable energy source. Every day the sun provides our planet 20.000 times the energy that the population of Earth needs, and in just three days, the Earth receives from the sun the equivalent of all the fossil fuels that our planet disposes of. Solar-based electricity can also take part in preserving our planet's climate changes that area alarming lately. Photovoltaic solar panel transforms energy coming from the sun into electrical energy. These panels do not have to be watched and require a minimal maintenance. Current photovoltaic modules show a minimal degradation after 20 years. [1-4, 7-9, 15]
Photovoltaic solar modules, commonly referred to as "solar panels," are the main collection devices in a renewable solar energy system and are the components that actually convert the Sun's rays into a daily source of clean and sustainable power. Simply put, photovoltaic solar panels create electricity by converting radiant sunlight into usable electrical power via a phenomena coined the "photovoltaic effect." They work by using individual solar cells (PV cells) that contain a photovoltaic material that converts energy from the Sun into a flow of electrons. [7-9, 14-15] Now, modern renewable energy systems have come around and are economically viable for both commercial and residential applications. Solar panels are not all you need, modern systems require supporting components including high tech batteries, charge controllers and junction boxes. [1-4, 7-9, 15]

METHODS / DESCRIPTION OF WORK

The paper shows the design and the production of a heating system using solar energy. The system is composed from two modules. The plant uses in whole energy collected from the sun, namely: radiant panel absorbs energy emitted by solar rays and converts it into heat. For directing heat formed in the aluminum tubes used was photovoltaic panel, which transforms the solar energy into electrical current. For the evacuation of air has been used fan supplied in the same way. [4-6, 16, 17]
The first solar module consists of a handmade photovoltaic panel made from 36 solar cells that produces 65W and 3.6 A. [4-6] The second solar module consists of recycled aluminum soda cans, cut from the

top and connected at their top forming radiant tubes. The tubes are being placed in a wooden box containing two rooms: one of evacuation and one of admission. These two rooms are being connected through the tubes. The airflow is provided from two air fans placed in the two special rooms inside the wooden box. [4-6]

Figure 2. The first module – the photovoltaic panel [4-6]

Below are presented the few steps to follow showing you how to make a solar panel out of soda cans. It is advisable to perform a thorough assessment of your home insulation in order to improve heating efficiency and minimize all possible losses. [4-6, 13, 16-18] This is very important because after minimizing heat loss in your home, you can actually install smaller solar system and get the same result as with the twice-bigger heating system. First, we build the housing for solar collector, which is typically, is made of wood.Solar absorber is made out of beer and soda aluminum cans, painted in matte-black paint resistant to high temperature. The upper part (cover) of cans is specifically designed to provide more efficiency in heat exchange between the cans and the passing air. [4-6, 13, 16-18] Glue the cans together to form a column the same length the wood frame has. We used heat resistant metal adhesive to fix them. Then paint the columns a deep shade of true black, using a thermally conductive paint. It is important to have this dark shade because this is what converts the solar energy into heat, which can be harnessed in the form of flowing hot air. [4-6, 13, 16-18]

Figure 3. The second module – the panel from recycled aluminum soda cans [4,5]

MATERIALS AND EQUIPMENT USED FOR MAKING THE INSTALLATION

For the photovoltaic module the following were used 36 photovoltaic solar cells, Plexiglas, glass (0.77 x 0.67 m), led used for verifying that the panel works and flux markers. [4-6, 13, 16-20] For the radiant panel were used 110recycled aluminum soda cans, wooden boards, easily expandable poliuretanic foam, and cellulosic isolating material. In both cases, special equipment used for montage (boring mill, milling drill, jig saw, cutter) are used. [4-6]
The systems above presented are simple small passive solar heaters made from recycled aluminum drinks cans and a simply photovoltaic cells, and are used to heat a garage. If the building to be heated is well insulated, a solar heater such as this can lift the temperature by a significant number of degrees. A larger heater or a number of similar heaters can be used to heat larger spaces, or to heat smaller spaces to a higher temperature. [4-6, 13, 16-20]
"Do-it-yourself" solar air heating collectors are one of the better solar projects. They are easy to build, cheap to build, and offer a very quick payback on the cost of the materials to build them. They also offer a huge saving over equivalent commercially made collectors. [4-6, 13, 16-20]
Two of the more popular designs are the pop can collector and screen absorber collector. The pop can collector uses columns of ordinary aluminum soda pop cans with the ends cut out. The sun shines on the black painted pop cans heating them, and air flowing through the inside of the can columns picks up the heat and delivers it to the room. [4-6, 13, 16-20] The screen collector uses two or three layers of ordinary black window insect screen as the absorber. The sun shines on the screen and heats it, and the air flowing through the screen picks up the heat and delivers it to the room.

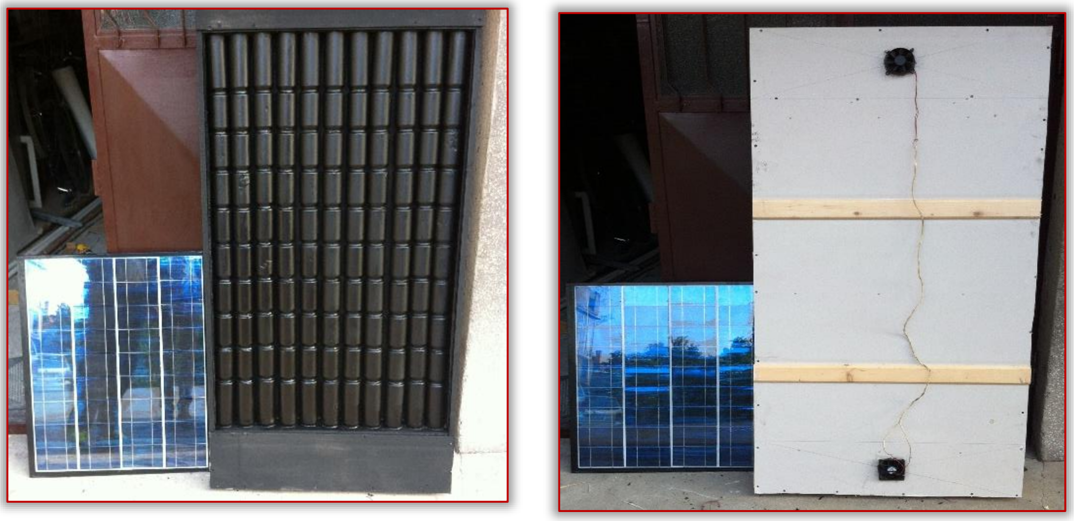

Figure 4. Modular panels

We have seen that soda cans can be repurposed in many ways in our homes, especially by transforming them into decorative items. This time, soda cans find themselves a practical role in our homes by becoming a solar panel. Of course, it takes some ingenuity, patience and basic knowledge of thermodynamics to turn those beverage empties into a powerful and efficient passive solar energy cell. Passive means that it does not generate electricity directly, but rather passively assists a standard generator or serves as heating. More specifically, the heat energy from the sun then transfers through the very conductive aluminum into the air inside. [4-6, 13, 16-20]
This solution fits as a glove to those homes built in isolated areas, while it is also an efficient means of saving money in urban areas as well.

ECOLOGICAL ASPECTS

Aluminium cans (soda or beer) are easy to recycle and there are huge environmental benefits for doing this - yet many cans still go to landfill. If we recycle more cans we can reduce the amount of raw materials needed to produce new products. All the soda cans came from a local recycling depot.

Many of the drink products we buy are packaged in cans made from aluminium and this material can be recycled after we have finished with them to make either new cans or other products.
Aluminum cans are very easy to recycle. Aluminum can be melted down and made into new products repeatedly because it never breaks down or loses quality.Most recycled aluminum is used to make new cans. From the time a can arrives in a recycling facility, it takes just 60 days to melt it down, turn it into a new can, fill it with a new beverage and place it back on store shelves. Recycled cans are also used to make other kind of products.
Due to the lightweight and smaller price tag, it does not move as much as the other, more expensive metals does. In fact, when compared with copper, lead, nickel, tin and zinc, it is the least expensive metal. This is generally because it is also the most prevalent.

CONCLUSIONS AND FUTURE IMPROVEMENTS

Over the last few years, DIYers have mostly settled on a few types of solar air heaters to make. This type was inspired by the commercial solar air heater, which uses recycled aluminum soda/beer cans stacked end-to-end to create long tubes for the air to flow through. The cans are painted black and act as the absorber. Many DIYers make this type, probably due to the abundant supply of cans and the „coolness" of the approach. Just as with the can solar air heater, the air flows inside the downspout taking heat from the inner surface as it makes contact with it. This paper shows an experimental heating system that uses solar energy. With further research, we can add many improvements to the installation. At the current level of development, the first step in upgrading the photovoltaic module is to assemble a storage battery that can accumulate the energy, so that it can function overnight. The second step is to assemble an invertor that inverts the continuous electricity into alternative electricity. That way household device can be powered from the photovoltaic module.
It is really easy and simple to build cheap pop can DIY solar panels for supplemental home heating, by re-using scrap parts and empty pop cans. Pop can DIY solar panels are actually thermal panels that heat and recirculate the air inside the room. Water, or any kind of liquid is not used here, which makes these panels resilient to extremely low temperatures and winter freezing accidents.
Solar absorbent / collector is crafted using empty beer and soda aluminum cans, painted in matte-black paint resistant to high temperature. The upper part (cover) of cans is specifically designed to provide more efficiency in heat exchange between the cans and the passing air.
DIY solar air heating collectors are one of the better solar projects. They are easy to build, cheap to build, and offer a very quick payback on the cost of the materials to build them. They also offer a huge saving over equivalent commercially made collectors.
The radiative solar energy reaching the earth during each month is approximately equivalent to the entire world supply of fossil fuels. Thus, from a purely thermodynamic point of view, the global potential of solar energy is many times larger than the current energy use. However, many technical and economic problems must be solved before large-scale use of solar energy can occur. The future of solar power deployment depends on how we deal with these constraints, which include scientific and technological problems, marketing and financial limitations, and political and legislative actions including equitable taxations of renewable energy sources.
However, even with all the research and development in the solar industry, one thing is for certain, solar panels are the best way for homeowners to create electricity simply and efficiently. Regardless of the myriad of technological advances, solar panels will remain the primary component of home solar energy production systems for the near future. There will always be various different types of photovoltaic cells being developed in an effort to improve efficiency and production costs, but the modern solar panels are amazing.

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ENERGY BALANCES OF PUBLIC BUILDINGS IN THE CITY OF NOVI SAD

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Abstract: The aim of the study was to analyze the cost of energy services to the buildings of public use in the City of Novi Sad. The analysis considered the average amount of used energy, energy costs and CO_2 emissions, as well as the average value of energy indicators (specific annual consumption of electricity, specific annual heat consumption, specific annual water consumption). This detailed representation of the size of energy indicators should represent a benchmark for future energy projects which need to be performed in order to achieve energy savings of at least 1% per annum.
Also, this paper presents a preliminary design of a new energy-efficient facility self-heating eco-house, the future building of the Energy Agency of Novi Sad.
Keywords: Energy efficiency, energy balance, renewable energy sources

INTRODUCTION

Houses of our ancestors were energy sustainable, as made from natural materials, wood, mud, cane, land and similar materials. But, after the Second World War in the former Republic of Yugoslavia was not taken into account the quality and comfort of the then housing, but the quality, also to be as soon as possible address the issue of the large influx of rural population to the cities.
The largest number of residential buildings in the Republic of Serbia today is in energy class G, which means that for heating consume more than 175 kWh/m^2 per year. [1]. Here we should also add the fact that because of the age of buildings and installations on them from year to year increase maintenance costs. The average energy required to heat buildings in Serbia is about 2.5 times higher than in EU countries. In Serbia, 70% of the buildings has no insulation, which is one reason why they spend about 40% of energy. For investment in high-quality insulation is necessary today an investment of 18 €/m^2.
One of the main reasons for implementing energy efficiency in buildings is the protection of the environment, or. reduction of CO_2 and other harmful gases into the atmosphere [2-4]. For example, the application of measures of economic efficiency of CO_2 and other harmful gases in Germany was reduced by 27%, and today the Federal Republic of Germany 1/3 of its energy gets from renewable energy sources.
The European Commission has proposed a five-point action plan for European energy security and solidarity through [5]:

- construction of infrastructure and the diversification of energy supplies;
- international energy relations;
- creation of oil and gas reserves and the mechanisms of response to emergencies;
- energy efficiency; and,
- best use of domestic resources within the EU.

Efficient use of energy achieve the following aims [6]:

- increase the security of supply of energy and its efficient use;
- increasing the competitiveness of the economy;
- reducing the negative impact of the energy sector on the environment;
- encouraging responsible behavior towards energy policy based on the implementation of efficient energy use and energy efficiency measures in the sectors of production, transmission, distribution and consumption of energy.

ENERGY AGENCY CITY OF NOVI SAD

Energy Agency of the City of Novi Sad was established in 2005; its founder is the Assembly of Novi Sad. The Agency is a legal entity and was established in order to carry out development, technical and regulatory affairs in the field of energy within the jurisdiction of the City, as well as activities in the field of energy by the Republic or the Community of Vojvodina delegated to the City.
The role of the Agency consists of continuous and quality performance of development, technical and regulatory affairs in the energy sector of the City and the implementation of the priority objectives of the energy policy of the city, such as:

- ensuring optimal and secure energy supply and energy in the City,
- create strategies and plans for sustainable energy development of the City,
- reduce energy consumption, reaching and maintaining to a certain quality of municipal services and comfort in public buildings,
- reduction of energy consumption in the private and commercial sectors, and that this is not at risk of quality housing, and the performance of commercial activities,
- reduce energy consumption, and energy costs in public utility companies, along with reaching and maintaining adequate quality of municipal services,
- use of renewable energy with the maximum use of resources in the City,
- creating conditions to as many users as they become available and accessible different fuels (gas, heat, electricity, renewable energy sources)
- reducing negative impacts on the environment from the use of that energy, and due to other activities,
- education of the population about the rational use of energy, examples of energy efficient appliances and renewable forms of energy.

After 31 December 2020, all new buildings in the EU will have to spend energy in the amount of "close to zero" and energy could significantly should be covered from renewable sources. Today, across Europe are build buildings that produce up to 5 times more energy than they consume. One such project of highly efficient buildings (future building of the Energy Agency of the City of Novi Sad) was done by academician Veljko Milkovic [7]. Property area basically is 600 m^2. It is the office building Self-Heating Eco House, which is characterized by: sustainable construction, eco-innovation, high energy efficiency, passive solar architecture, vertical greening, etc. fig.1. At the facility reflective surface to 2.5 times increases light and heat in the building. From the renewable energy sources are represented solar energy (panels and collectors), heat pump and biomass boiler.


Figure 1. The appearance of the future building of the Energy Agency of the City of Novi Sad

MATERIAL AND METHODS

The aim of this work was to be done the energy balance of 207 objects (tab.1) public spending in the City of Novi Sad in 2014. The analyzed objects of public spending in the City of Novi Sad are the responsibility of different actors and different levels of administration. The analysis also considered the average amount of energy used, energy costs and CO_2 emissions, as well as the average value of energy indicators (specific annual consumption of electricity, specific annual heat consumption, specific annual water consumption).

Table 1. The analyzed objects of public spending in 2014.

Groups of public buildings by function	The types of public facilities	Number of objects
Facilities of educational institutions	Kindergartens	75
	Elementary schools	39
	High Schools	16
Health centers	Health clinics	29
	Pharmacy	19
	Health institutions	6
Facilities of social protection	Nursing center	2
	Others	1
Facilities of Cultural Institutions	Community centers	2
	Theatres	2
	Museums	1
	Others	6
Administrative buildings	Administration buildings municipal / city / state	2
	Public buildings and public utility companies	7

RESULTS AND DISCUSSION

In tab.2 are shown the amount of used energy, energy costs and CO_2 emissions observed at public facilities in 2014. On observed facilities totaled 22,551,932 kWh of electricity, 23,506,254 kWh of heat energy and 24,766,469 m^3 of natural gas, tab.2. Total costs for energy products amounted to 526,527,591 dinars, ie. for electricity 158,682,691 dinars, for heat energy 233,103,435 dinars and for natural gas 134,741,465 dinars, tab.2. For the total spent energy into the atmosphere is emitted 43,001,252 kg CO_2, i.e. for electricity is emitted 24,378,552 kg CO_2, for heat energy 9,391,582 kg CO_2 and for spent natural gas 9,231,118 kg CO_2, tab.2.

Table 2. Spent amount of energy, energy costs and emissions of CO_2

ENERGENT	Consumption of energy	Costs for energy	Emission CO_2
Electricity	22,551,932 kWh	158,682,691 din	24,378,552 kg
Heat energy	23,506,254 kWh	233,103,435 din	9,391,582 kg
Natural Gas	24,766,469 m^3	134,741,465 din	9,231,118 kg
	T O T A L =	**526,527,591 din**	**43,001,252 kg**

In tab.3 are shown the average values of energy indicators (specific annual consumption of electricity, specific annual consumption of heat energy, specific annual water consumption) for 2014. Thus, the specific annual electricity consumption was lowest in administrative buildings 32 kWh/m^2 yr., and highest in social care institutions 123 kWh/m^2 per year, tab.3. Lowest specific annual heat consumption was in the administrative buildings of 65 kWh/m^2 per year, and the highest in health institutions and institutions of social protection 289 kWh/m^2 per year, tab.3. The lowest specific annual water consumption was in the administrative buildings of 0.16 m^3/m^2 per year., and the highest in cultural institutions 44.97 m^3/m^2 per year., tab.3.

The results presented in tab.3 indicate that there is scope for improving energy efficiency in certain public buildings in the city of Novi Sad. One of the models of energy efficiency improvements could certainly be a model public-private partnership called. ESCO model investment.

Table 3. Average values of energy indicators and specific costs in the energy balance

ANALYSED FACILITIES	Energy indicators for 2014					
	Specific annual electricity consumption		Specific annual heat consumption		Specific annual water consumption	
	Per unit area of the object(kWh/m^2 per year)	According to user (the actual number of regular users) (kWh/user per year	Per unit of heating surface of the object (kWh/m^2 per year)	According to user (the actual number of regular users) (kWh/user per year)	Per unit area of the object (m^3/m^2 per year)	According to user (the actual number of regular users) (m^3/ user per year)
Utility companies	81	787	85	8,360	17.76	46.18
Cultural institutions	58	2,303	103	5,976	44.97	756.24
Elementary schools	29	193	133	862	0.90	7.54
High schools	66	354	146	506	0.70	3.16
Health institutions	78	1,148	289	4,376	1.18	23.75
Institutions of social protection	123	914	289	2,075	3.72	29.23
Health clinics	59	1,276	236	5,319	1.29	30.22
Pharmacy	108	1,839	122	2,447	1.46	28.55
Preschool institutions	50	510	138	2,148	1.63	10.79
Administrative buildings	32	814	65	1,633	0.16	3.21
AVERAGE CONSUMPTION	68.40	1,013.80	160.60	3,370.20	7.38	93.89

CONCLUSION

In recent years, a household is a term that energy efficiency is the newest renewable energy source. Legal regulation in the Republic of Serbia has prescribed that from 2012 all new buildings must have energy passports, and improving energy efficiency is considered to be the public interest. The spearheads of application flows of energy efficiency should be a local government, which should become producers and not just consumers of energy. In the case of public buildings in the city of Novi Sad were identified the biggest consumers of energy, which will be the highest investments in the energy efficiency of buildings.

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IMPROVING ENERGY EFFICIENCY IN PUBLIC BUILDING IN THE MUNICIPALITY OF ČAČAK

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Abstract: There are a lot of important factors that influence building energy consumption. The building energy saving effect is an integrated acting result, it has a relationship between thermal characteristics of the building envelope, ventilation ways, efficiency of heating system, and the increasing range of energy saving rate will be different as the energy saving measures are different. In this paper, the public building in the municipality of Čačak was analyzed in order to examine the impact of different retrofitting measures on heating energy consumption. In terms of retrofitting to study, various energy efficiency measurements have been considered such as improving levels of insulations of different building envelope elements. Results show that the annual heating energy consumption could be reduced up to 61 %.
Key words: energy efficiency, public building, saving energy

INTRODUCTION

Improving energy efficiency in buildings is one of the most cost-effective ways across all sectors to reduce energy consumption and hence greenhouse gas emissions. More than a third of the primary energy used in developed countries is used to heat, cool, and light buildings or is utilized within buildings. Energy efficiency is at the cornerstone of the European energy policy and one of the main targets of the Europe 2020 Strategy for smart, sustainable and inclusive growth adopted by the European Council in June 2010. This includes the objective for a 20% reduction in primary energy consumption by 2020. As energy related emissions account for almost 80% of total EU greenhouse gas emissions, the efficient use of energy can make an important contribution to achieving a low-carbon economy and combating climate change, [1-3].
Public policies in the most countries to promote building energy efficiency have addressed many of the same issues. These include: Building codes, Energy efficiency certificates, Promoting energy efficiency in public buildings, Training and certification of experts and White-certificate programs. Building codes have been effective in improving energy efficiency in new buildings and in some buildings undergoing major refurbishments, because they are mandatory and generally quite specific about requirements. Energy certification of buildings is a key policy instrument for reducing the energy consumption and improving the energy performance of new and existing buildings, [4,5].
One way to improve energy efficiency is to modernise public buildings because hospitals and schools are among the most important public facilities in Serbia. In this paper the possibilities of improving energy efficiency of public facility which is owned by the city of Cacak is analyzed. The current energy condition of the object have been proposed, than measures to increase energy efficiency and the energy state of the object after the application of the proposed measures are shown.

MATERIAL AND METHODS

Case study

The subject of analysis is a public facility Medical Health Care Center Čačak. Location is in the urban area of Čačak and it is free to all four sides. The floors of the building are Su + P + 1 with a total area of 3579,09 m^2, as shown in Fig. 1.
To build a site the standard structure for this type of object is used. Horizontal bearing elements are "Avramenko" concrete ceiling, whose overall height from the floor and ceiling is 45 cm. All vertical bearing elements are reinforced-concrete columns. Roof construction is wooden with supporting beams and pillars, which relies on reinforced-concrete construction, which is set for thermal insulation of durisol panels. Over these elements beds, wall panelling, plating of boards, tar paper and tin covers

are set up. On the outside of the roof structure was set up copper sheet thickness of 1 mm, while inner roof planes are made of tin plated copper.

Figure 1. The external appearance of the building and the view of situation of the Medical Health Care Center Čačak

Facade walls are constructed of brick or hips of the slag thickness from 25 to 38 cm depending on the position, while the partition walls constructed of hollow brick thickness of 7 cm. The walls are derived, without thermal insulation. All parapet walls are made of the hollow and clay brick, thickness 25 cm. Flooring in the areas are covered with linoleum, ceramic tiles or concrete. Thermal envelope of the building has an area of 6442,37 m^2. The building is attached to a remote system of heating with individual gas boiler room that is located in the courtyard in the Health center.

Present state energy audit

The analyzed object belongs to the category of objects for health care and social protection, as defined by the State Regulations on energy efficiency in buildings. This building is an existing building and it applies energy rehabilitation, which is also defined in the Regulations. The program KnaufTerm2 PRO S, version 27.2 was used for energy efficiency analysis of the Health Center building in the current state.
Based on the conducted investigation, it is possible to analyze and evaluate the energy efficiency of the building of the Health Centre in Cacak in the current state. The results show that the annual transmission heat losses through certain parts of the building envelope in the current situation are:

1. External walls: 112417,16 kWh;
2. Pitched roof: 97916,75 kWh;
3. Window and curtain wall: 140545,99 kWh;
4. Partition walls towards the unheated area: 11102,92 kWh;
5. Ceiling below unheated space: 161805,10 kWh;
6. Floor above unheated space: 8987,82 kWh;
7. Ground walls (basement): 46842,85 kWh;
8. Ground floors: 111551,21 kWh.

The Fig. 2 shows the heat loss percentage through certain components of the facility in the total heat losses.
The analysis of heat losses shows that the greatest heat loss is through the basic ceiling below unheated space located below the ceiling, as this surface is the largest of all the areas that make up the thermal envelope of the object and which accounts for 18,5 %, and was conducted without heat insulation. Then the greatest heat losses are through windows and curtain wall, although their surfaces 11,78 % of the total thermal envelope. Losses through the exterior walls and under the floor of the facility amount to about 16 % of total heat loss. By analyzing the characteristics of the circuits forming the thermal envelope of the building, it was noted that the heat transfer coefficients of all the areas that make up the thermal envelope of the object is greater than the allowable values that are defined in the

State Regulations on the energy efficiency of buildings. It was also observed that the thermal envelope assemblies such as external slanted walls and a piece of the roof above the heated area leads to the formation of condensation.

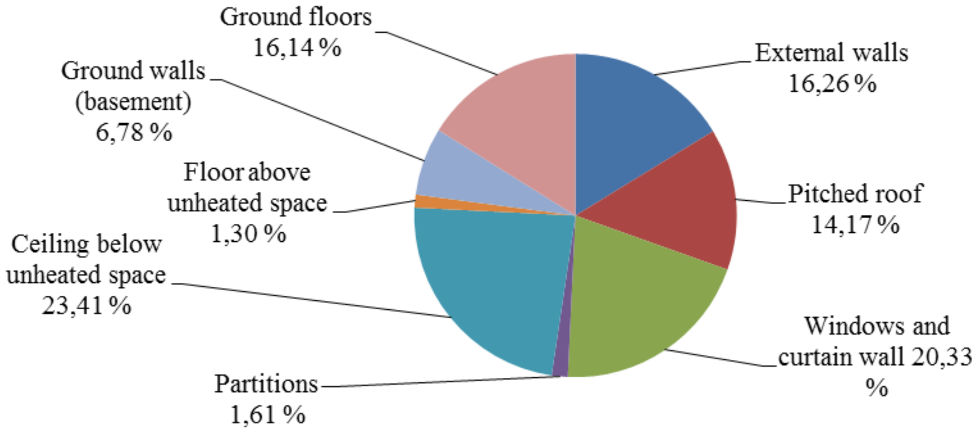

Figure 2. Percentage shares losses through the envelope building elements in the total heat losses in the present state of building

Total energy demand for transmission losses of the building is 733,77 MWh and for ventilation losses 229,86 MWh, in its present state. Annual energy building gains in the current state are:

1. Solar gains: 91,37 MWh;
2. Gains from energy consumption: 23,84 MWh;
3. Gains heat from electrical appliances: 45,36 MWh.

Annual energy consumption for heating the building in its present state, using the central gas heating system is 803 MWh, while specific annual heat consumption for heating is 276,48 kWh/m^2. Since the adoption of energy-class benefits of the specific thermal energy for heating systems operating with a recess, on the basis of which this building belongs to the energy class F. Regulations on the energy efficiency of buildings stipulates that the maximum allowed annual consumption of energy for heating buildings allocated to health care and social protection 120 kWh/m^2. Based on the results of the analysis can be concluded that the annual energy consumption for heating of the Health Centre in Čačak 2.3 times higher than allowed for the analyzed object.

Review of measures to improve energy efficiency

Based on the analysis of energy efficiency of the building, it was noted that it is necessary to improve the thermal characteristics of all the components that make up the building envelope and proposes the implementation of the following measures, [6]:

1. On the external walls add a thermal insulation Knauf Insulation FKD-S Thermal 7 cm thickness and on the side walls add thermal insulation Knauf Insulation NaturBoard FIT-G PLUS 8 cm thickness, both on the outside of the building wall;
2. In order to prevent condensation in the roof structure is necessary to reconstruct the roof and replace the covers. On the roof, under the roof construction, install vapor permeable film layer Knauf Insulation LDS 0.02, then a layer of Termal mineral wool Knauf Insulation Unifit 035 thickness of 18 cm and a vapor barrier Homeseal Knauf Insulation LDS 5 Silk. Aluminum replaced with the cover tiles;
3. It is necessary to substitute the existing five-chamber PVC windows and curtain wall with double-layer glass thickness of 4 mm filled with air thickness of 12 mm with six chamber PVC windows with low-emission double-layer glass (4 + 12 + 4) with krypton;
4. On the walls towards the unheated space should be placed insulation rock mineral wool Knauf Insulation NaturBoard FIT-G PLUS thickness of 5 cm;
5. From the floor joists above unheated spaces to remove a layer of cod and the underside of the installed thermal insulation rock mineral wool Knauf Insulation CLT C1 8 cm thick and a layer of vapor permeable film;

6. On the basic ceiling below an unheated attic space on the bottom side install thermal insulation of mineral wool Knauf Insulation Unifit 035 8 cm thickness and a layer of vapor permeable film;
7. On the brick walls in the ground, basement, which are oriented to the south, add insulation rock mineral wool Knauf Insulation FKD-S Thermal 4 cm thickness and on the other basement walls made of concrete in the ground, it is necessary to add on the inner side the same insulation thickness of 5 cm and a layer of vapor permeable film;
8. On the floors of the facility in working spaces in the basement proposes to install a slab of rock mineral wool Knauf Insulation NaturBoard POD EXTRA thickness of 9 cm and utility rooms and 8 cm thickness cement screed.

Proposed measures to improve energy efficiency of the object can be achieved by using elements (material) Knauf systems that are tailored to each individual site which can improve and meet the requirements defined in the Regulations for the Energy Efficiency Facility for existing buildings for this purpose.

Implementation of the proposed measures to increase the energy efficiency of the building is fully justified. Table 1 provides an overview of the coefficient of heat transfer through the thermal envelope of the building in its present condition and after the implementation of measures to improve the energy rating of the building. After the application of the proposed measures will not come to the formation of condensation in all the assemblies of the building.

Table 1. Review of the heat transfer coefficients through the thermal envelope of the building of the Health Centre in Čačak

Building envelope structure	Umax (W/m^2K)	Present state		Proposed state	
		U (W/m^2K)	Satisfied	U (W/m^2K)	Satisfied
External walls	0,40	1,595	No	0,379	Yes
External slanted walls, north-south oriented	0,40	3,378	No	0,400	Yes
Pitched roof above heated area	0,20	1,464	No	0,152	Yes
Window and curtain wall	1,50	2,800	No	1,300	Yes
Partition walls towards the unheated area	0,55	2,294	No	0,546	Yes
Ceiling below unheated space	0,40	2,564	No	0,374	Yes
Floor above unheated space	0,40	0,544	No	0,361	Yes
Ground wall, south oriented	0,50	1,013	No	0,461	Yes
Ground wall, other	0,50	1,592	No	0,485	Yes
Ground flor - utility rooms	0,40	2,375	No	0,395	Yes
Ground flor – working spaces	0,40	3,155	No	0,376	Yes

* According to the Regulations on energy efficiency in buildings

RESULTS AND DISCUSSION

After the implementation of measures to improve energy efficiency of the building annual transmission heat losses through certain parts of the building envelope should have the following values:

1. External walls: 20386,27 kWh
2. Pitched roof: 10166,22 kWh
3. Window and curtain wall: 65253,50 kWh
4. Partition walls towards the unheated area: 2642,63 kWh
5. Ceiling below unheated space: 23601,84 kWh
6. Floor above unheated space: 5964,35 kWh
7. Ground walls (basement): 15890,35 kWh
8. Ground floors: 15143,94 kWh.

Figures 3 and 4 show a comparative analysis of transmission heat losses data and their percentage share in the total heat loss of the building, for the present and the proposed case. The analysis results

showed that after the implementation of measures for improvement of building energy efficiency the transmission losses through all the elements decrease, but their share in total losses changed.
After the application of the proposed measures for improving energy efficiency the greatest reduction in transmission losses could be expected in pitched roof in which the losses can be reduced by up to 90 %, while the floors on the ground and floors below an unheated area can be achieved reduction of heat loss up to 85 %. Reduction of heat transmission losses through the exterior walls could be up to 82 % and by replacement of a window can be achieved energy savings up to 53 %. Total energy use for compensation of transmission losses of the building in the present case amounts to 202 MWh. The application of the proposed measures can be achieved annual energy savings up to 73 % for the entire object. Solar heat gain in the present case was reduced by 46 % and amounted to 49,10 MWh, while the gains from energy consumption and electrical appliances remained unchanged. Annual energy consumption for building heating in the present state is 313 MWh, which is 61 % less than it consumes in its present condition.

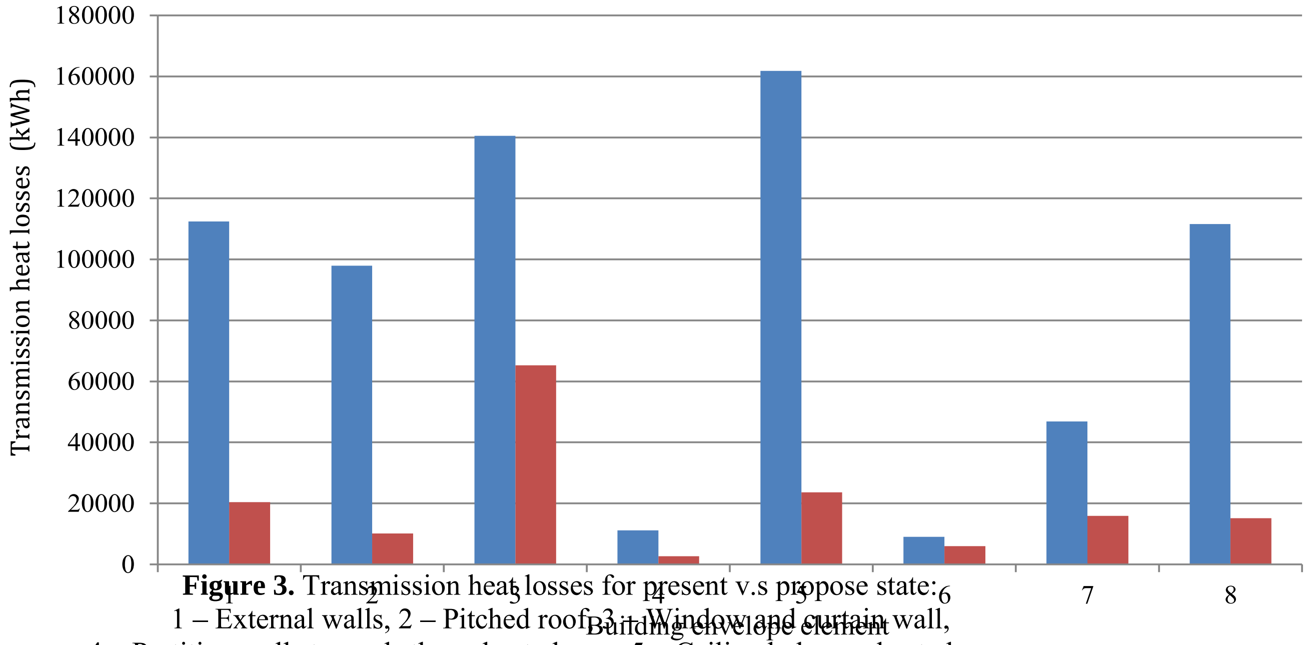

Figure 3. Transmission heat losses for present v.s propose state:
1 – External walls, 2 – Pitched roof, 3 – Window and curtain wall,
4 – Partition walls towards the unheated area, 5 – Ceiling below unheated space,
6 - Floor above unheated space, 7 – Ground walls, 8 – Ground floors;

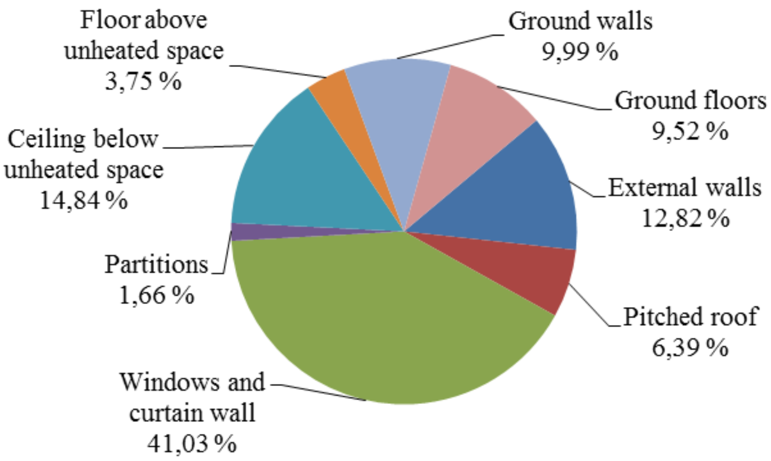

Figure 4. Percentage shares losses through the envelope building elements in the total heat losses for the propose state of building after implementation of measures for energy efficiency improvements

For the proposed state of the building specific annual heat consumption will be 107,83 kWh/m^2, which is below the 120 kWh/m^2, which represents the maximal value of heat energy specific consumption of existing buildings allocated to health care, according to the Regulations for energy efficiency in buildings Republic Serbia. After implementation of measures for improvement of energy efficency, analyzed object belongs to C energy class, which is two ranges up according to present state.

CONCLUSION

This paper considered the impact of retrofit schedule influence on energy use. The research suggests that improving all building envelope elements insulation level helped significant heating energy reduction. Results show that after applying the proposed measures CO_2 emission can be reduced from 192 CO_2/year t to 75 t CO_2/year. Plenty of studies have considered the effect of improving fabrics' thermal property on heating energy consumption and some provided strong evidences why we need to improve public building energy efficiency. However, even in objects that have achieved specific standards, the energy consumption may be dramatically different depending on the occupants' energy use behavior, and any extensions or alterations they make to the objects. More research is needed into the effects of occupants behavior on energy use which will allow for more targeted interventions to be applied.

ACKNOWLEDGEMENTS

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RENEWABLE ENERGY IN TURKEY: POTENTIAL, CURRENT STATUS AND FUTURE ASPECTS

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Abstract: Due to the numerous advantages such as being unlimited, clean and environmental friendly, usage of renewable energy sources is supported through incentives in Turkey as well as all over the world. Consequently, energy supply from renewables has increased rapidly in the last decade in Turkey. This work represents the renewable energy potential and current status of power production from renewables in Turkey. In addition, future aspects of renewables in Turkey is discussed in the current study. According to the results, it is clear that Turkey still have a huge renewable energy potential that can be very useful to decrease energy import.
Key words: renewable, energy, potential, status, Turkey

1. INTRODUCTION

Sustainable energy has the key role in sustainable development especially for Turkey that cannot the energy requirement with indigenous sources and imports approximately %70 of its energy requirement. Sustainable energy equals to renewable energy. Investing in renewable energy is a good chance for Turkey since Turkey can reach three important goals stated in the development action plans with it: Sustainable development, decreasing energy import and increasing energy security [1, 2].
As Turkey's reliance on imported natural gas for power generation has given rise to concerns over supply security and the country's bulging current account deficit, support of domestic energy sources such renewables has gained a new urgency [3].
In this paper Renewable energy potential and usage of Turkey for different resources are briefly given and future perspectives are discussed.

2. ENERGY SUPPLY AND DEMAND OF TURKEY

Turkey is a developing country with a strong economic growth and energy needs of Turkey increases rapidly. Total primary energy supply of Turkey was 129.7 million tonnes of oil-equivalent (Mtoe) in 2015 representing an increase of 54% compared to 2005 as seen in Fig. 1 [4,5]. Natural gas, oil and coal covered 30.2%, 30.1% and 27.3% of this value respectively equal to a third of TPES in 2015. The country is highly depended on oil and gas imports and only 32.2 Mtoe (24.8%) of energy supply is met by domestic production. Renewable sources constituted 48.9% of all domestic energy production with hydro providing 17.9%, geothermal 14.8%, biomass 10.1%, wind 3.1% and solar 3%. It is estimated by the government that TPES will reach 222.4 Mtoe by 2020 [4]. Total final consumption (TFC) of Turkey was 85.8 Mtoe in 2014. Considering TFC for 2004, it has increased by 35.8% in 10 years. Oil consumption accounted for 35.6% of TFC whereas natural gas, electricity and coal accounted for 22.6%, 20.6% and 12.3% respectively [5]. A great part of the electricity demand of Turkey is produced from natural gas (38.6%) although most of the used natural gas is imported from various countries. Natural gas is followed by coal (28.3%) which made up 67.7% of total generation from fossil fuels in 2015. Renewables are third pillar in power generation with sharing hydro 25.8%, wind 4.4%, geothermal 1.3%, biofuels and waste 0.6% and solar 0.2% of total production [5]. There is also a rapid increase in electricity demand, which is annually approximately %5, as given in Table 1 [1]. Turkey's official energy policy goals to minimize energy import and maximize the usage of indigenous energy sources until 2023.According to 2010-2014 action plan of Minister of Energy and Natural Sources, Turkey's goal is to produce 30% of electricity production from renewable energy sources [1].

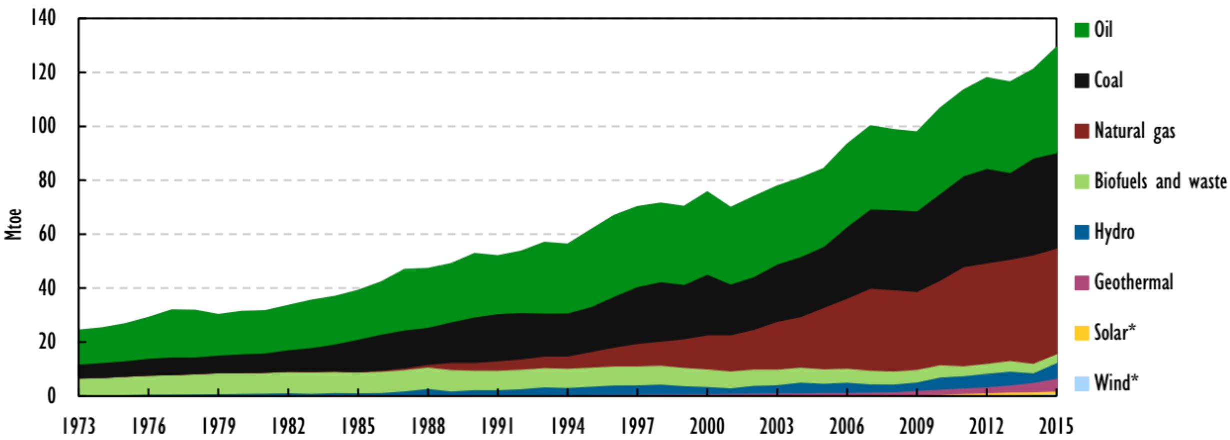

Figure 1. Total primary energy supply of Turkey, 1973-2015

Table 1. Electricity production and demand of Turkey in last 10 years

Year	*Gross production (million kWh)*	*Rate of increase (%)*	*Electricity demand (million kWh)*	*Rate of increase (%)*
2005	*161,956*	*7,5*	*160,794*	*7.2*
2006	*176,300*	*8,9*	*174,637*	*8.6*
2007	*191,558*	*8,7*	*190,000*	*8.8*
2008	*198,418*	*3,6*	*198,085*	*4.3*
2009	*194,813*	*-1,8*	*194,079*	*-2.*
2010	*211,208*	*8,4*	*210,433*	*8.4*
2011	*229,395*	*8,6*	*230,306*	*9.4*
2012	*239,496*	*4,4*	*242,370*	*5.2*
2013	239,293	-0,1	245,687	1.4
2014	251,963	5,3	257,220	4.7
2015	259,611	3	26,828	2.6

3. POTENTIAL AND CURRENT STATUS OF RENEWABLES IN TURKEY

3.1. Hydropower

Table 2. Present status and future plans of HEPPS in Turkey [6]

Potential	**Number of HEPP**	**Total installed Power (MW)**	**Mean annual production (GWh/year)**	**Ratio (%)**
In operation	562	26,161	90,773	58
Under construction	104	5,927	17,875	11
In program	717	13,984	48,911	31
Total	1,383	46,072	157,559	100

Hydropower is a very imported renewable energy option for Turkey because there is huge hydropower potential. The gross theoretical viable hydroelectric potential in Turkey is 433 billion kWh, which is 1% of the world, technically viable potential is 216 billion kWh and the economically viable potential is 158 billion kWh. 104 HEPPs that have 5927 MW installed and 17,875 GWh/year generation capacities are still under construction as seen in Table 2. According to development plans, the installed hydroelectric power capacity will be 46,072 MW once the new HEPPs are constructed and the goal is to produce 140.000 GWh electricity from hydropower by 2023 [6].

3.2. Wind Energy

Total installed capacity has reached 4,498.4 MW in Turkey by the end of 2015. 11,543,050 MWh electricity is produced from 113 wind power plants in this year [1]. The wind energy potential atlas (REPA) is presented by Electrical Power Resources and Development Administration to determine the wind energy potential of Turkey in 2006 and it is presented in Fig.2 [7].

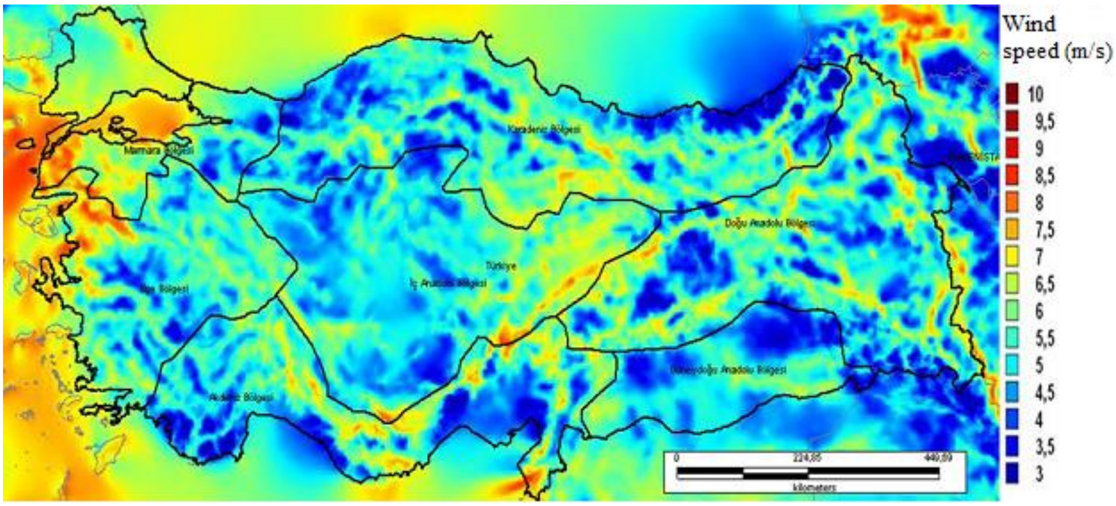

Figure 2. Wind energy potential atlas of Turkey [7]

According to REPA, the most attractive sites of Turkey are west site and Marmara region and there can be 130 billion kWh of electricity from a potential of 48,000 MW generated in areas where the wind velocity is greater than 7 m/s at an elevation of 50 m as given in Table 3 [8,9].

Table 3. Wind energy potential of Turkey [8,9]

Level of the wind	Classification of the wind	Wind power intensity at 50m high (W/m^2)	Wind speed at 50 m high (m/s)	Total area (km^2)	Ratio of the area	Total installed power (MW)
Average	3	300-400	6.5-7	16,781.39	2.27	83,906
Good	4	400-500	7-7.5	5,851.87	0.79	29,259.36
Very good	5	500-600	7.5-8	2,598.86	0.35	12,994,32
Awesome	6	600-800	8-9	1,079.98	0.15	5,399.92
Incredible	7	>800	>9	39.17	0.01	195.84
Total				26.351,28	3.57	131,756.40

If the average wind energy potential is taken also into account, there is total 131,756.40 MW potential in Turkey where the total area of this potential corresponds to 3.57% of Turkey.

3.3. Solar Energy

Turkey has huge solar energy potential compared to other European countries. According to study of Electrical Power Resources and Development Administration, the daily mean radiation time is 7.2 hours and the daily mean radiation is 3.6 kWh in Turkey. The solar energy potential atlas of Turkey (GEPA) is given in Fig.3 [7]. Southeastern Anatolian and Mediterranean regions are the areas with highest solar radiation as given in Table 4 [7]. The solar energy potential of Turkey is calculated as 380 billion kWh by taking into account the areas that have inclination lower than three degrees and solar radiation more than 1650 kWh (4600 km2) [7,8]. Turkey is not in bad situation about using solar energy. Water heating with solar energy is very widespread in Turkey. The thermal energy produced by solar collectors has been 290 toe in 2001 [7]. Producing electricity with solar energy becoming more popular because it is clean and easy to use but still usage of it is low since it is still expensive.

By the end of 2015, applications for 4,352 unlicensed solar power plants that have 3642 MW installed power capacity applications are made in total and 371 of these that have 255 MW power capacity has been accepted [1].

Figure 3. Solar energy potential atlas of Turkey (GEPA) [6]

Table 4. Solar radiation amounts by region in Turkey [7]

Region	Total solar energy (kWh/m^2-year)	Radiation time (hour/year)
Southeastern region	1,460	2,993
Mediterranean region	1,390	2,956
Eastern Anatolia region	1,365	2,664
Central Anatolia region	1,314	2,628
Aegean region	1,304	2,738
Marmara region	1,168	2,409
Black Sea region	1,120	1,971

3.4. Geothermal Energy

Turkey is in seventh place in the world and in first place in Europe as having geothermal potential between 31,500-60,000 MWt. Actual thermal potential is calculated as 4809 MWt and 34% (1306 MWt) of it is used. Electrical technical potential is calculated as 1000 MWe (6,7 billion kWh/year) and total installed geothermal plant capacity for electrical power generation has been 114 MW by the end of 2011 [1,10,11]. There are 1500 hot and mineral water sources that have temperatures between 20-242 ºC available in Turkey. Geothermal energy sources distribution in Turkey is shown in Fig.4[12]. There are 90,000 houses, 3,000 m^2 stoves, 400 spa facilities that use geothermal energy for heating [1,11].

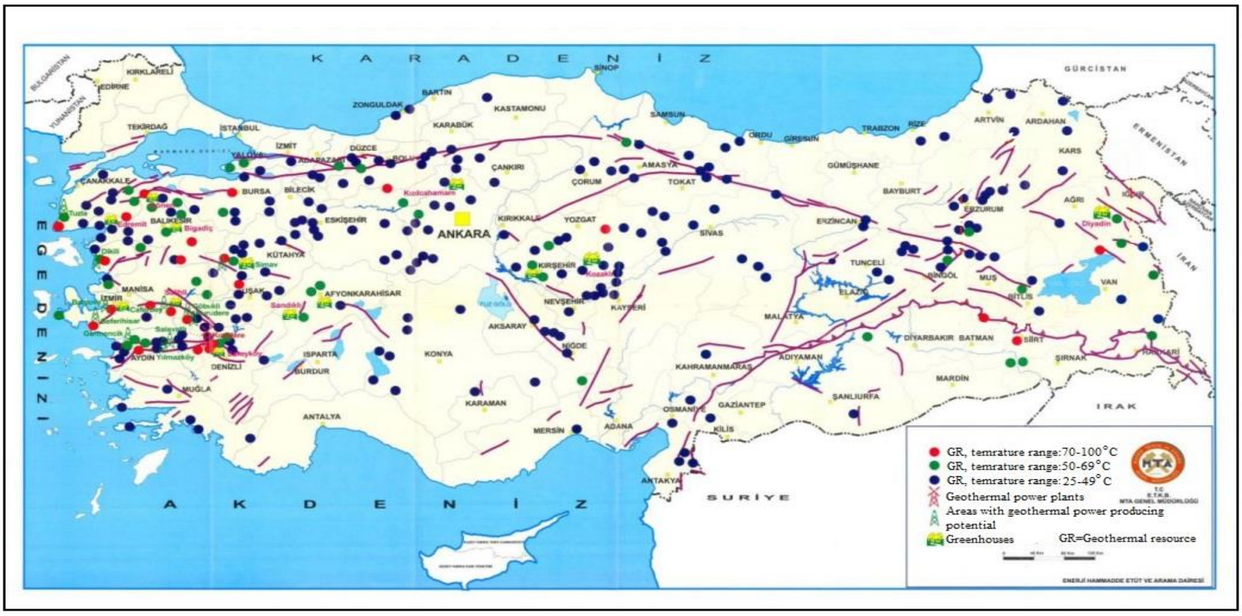

Figure 4. Geothermal energy sources distribution in Turkey

3.5. Bioenergy

Biomass energy is mostly used in low developed regions of Turkey for home heating with classical methods. Studies about energy production with modern biomass plants are very limited in Turkey. Ministry of Energy and natural sources has planned biomass production to be 7530 billion tons' oil equivalent by 2020. This value has been 17 billion toe in 2000. The technical viable potential of Turkey is calculated as 40 Mtoe/year, and the economical viable potential is calculated as 25 Mtoe/year [12]. There are 43 biomass plants that are licensed by the Energy Market Regulatory Authority (EPDK) where 10 and 7 of those are in partial operation and not in operation respectively. The total capacity of biomass power plants in Turkey is 288,583 MW_e [1,8, 13]. The biogas potential of Turkey is calculated to be 1.5 – 2 Mtoe/year. Nearly 180 million m^3/year biogas is produced from 20 biogas plants in Turkey [14].

4. FUTURE ASPECTS

As the 17th largest economy in the world and 6th largest in Europe, Turkey will experience an increase in its energy demand in the future. Over the last ten years Turkey has become one of the fastest growing energy markets among the OECD countries in the world, in parallel to its economic growth. In addition, Turkey has been second largest economy on demand for electricity and natural gas after China. Projections performed by Ministry of Energy and Natural Resources of Turkey confirm that this situation will continue to be valid for medium and long term. Turkey's energy policies and strategies are based on energy supply security, alternative energy resources, diversity of energy resources, utilization of domestic energy resources to create additional value to economy, liberalization of energy markets, and energy efficiency. Due to this perspective, special emphasis has been made to maximum utilization of local and renewable energy resources as highest priority. The rapid pace of urbanization, the economic expansion and rising per capita income are the main drivers of the energy demand. The energy demand is expected to increase around 4-6% per annum in the next 10 years [4].

The objective of Turkey's energy policies is to ensure secure, sustainable and affordable energy by diversifying energy supply routes and source countries, promoting indigenous energy production and energy efficiency to moderate growth of total final consumption. These energy ambitions are enshrined in the Vision 2023, Turkey's economic development strategy to 2023, the year that marks the 100th anniversary of the Republic of Turkey. This vision comprises a number of energy targets which aim to make Turkey one of the ten largest economies in the world with annual exports of USD 500 billion. In the area of energy, Vision 2023 aims at promoting indigenous energy resources, including coal (lignite), raising the share of wind and geothermal energy in the electricity mix to reach 30%; reducing

energy consumption by 20% below 2010 levels, through improved efficiency and starting up two or three nuclear power plants.
Renewable energy has been one of the important topics on Turkey's energy policy. The significant progress that has been made in the field of renewable energy started after the enactment of the Law on Utilization of Renewable Energy Resources for the Purpose of Generating Electrical Energy (Renewable Energy Law, REL) in 2005. After 2005, the Turkish government kept producing, updating and implementing several laws and regulations to support the investment to reach the goal. According to the Ministry of Energy and Natural Recourses, the total amount of investments required to meet the energy demand in Turkey by 2023 is estimated to be around USD 110 billion, more than double the total amount invested in the last decade. Turkey's ambitious vision for 2023, envisages especially interesting targets for the renewable part of the energy sector. These targets include:

- 34,000 MW capacity of hydro power plants;
- 20,000 MW capacity of wind power plants;
- Minimum 5000 MW of solar power plants;
- Minimum 1000 MWe geothermal energy; and
- 1000 MWe installed capacity for Biomass energy

5. RESULTS AND CONCLUSION

Turkey has abundant renewable energy potential. If sufficiently exploited and efficiently distributed, this potential would take a part on meeting the energy demand of Turkey in the future. In this case, Turkey plans to increase hydroelectricity, wind and geothermal energy and the other renewable sources production in the near future. The Turkish government announced a 30% objective for renewable energies by 2023 with plans to push wind energy up to 20000 MW of installations for the same year. The most important and high potential renewables are Solar and wind energy among the all renewables. So many investments are on the way. To be more successful about the energy policy, Turkey should figure out long term future perspectives after the year 2023 and 2030.

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HYDROPOWER PLANTS OF TOMORROW

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Abstract: Ocean waves are an immense, unused source of energy. The potential to use sea waves' energy is definitely an option. Researches in this area lead us to necessity to meet renewable energy sources such as sea waves. This paper introduces us to water power, which is a natural source of renewable energy, the power of waves which could represent technically and ecologically appropriate solution to use water power. The further text would also represent the technology used to turn the power of waves unto electric power and types of turbine and devices which are the latest technology in this area. The goal of this paper is to present the existing devices, the way in which they function, efficiency and safety of these devices in view of environment.
Key Words: Sea waves, Turbines, Renewable energy sources, OCW Technology, High and low tide.

INTRODUCTION

For millions of years the Earth has been finding ways to create all it needs for further development and life. Though the process of evolution, it has brought to its surface creatures for which mare survival is just an option, the creatures that strive for development, beauty of life and improving technology which would allow this. However, the development of technology led to destruction of nature, and people, after many years, understand the problem they have created and work on its solution. Global warming, as one of the main problems nowadays, represents an increase in the average temperature of air and ocean water, which becomes particularly evident from the mid-20th century. From the beginning of the 20th century up to its end the temperature of the Earth's surface increased for 0,74±0,18 C°. This increase in temperature is caused by an increased level of gases, "the greenhouse effect", which result from human activities, such as burning of fossil fuel and destroying of forests.
In the last one hundred years, the amount of carbon dioxide in the atmosphere increased for 25%. As this gas lets through the short-length waves of the Sun, and absorbs the long-waves radiation of the Earth, this leads to an increase in the temperature of the lower layers of the atmosphere, so that the so-called "the greenhouse effect is produced". Lately, carbon dioxide has been joined by some other gases (chlorofluorocarbons of Freon, methane, nitrous oxide, ozone) which are unnaturally emitted into the atmosphere [3]. As already said, "the greenhouse effect" leads to a significant increase in the average temperature on the Earth. This would lead to increased evaporation and increased amount of rainfall, with the probably changed schedule of rainfall, which would farther influence agriculture. In addition, due to spreading of ocean and melting of ice, the level of the world's seas would rapidly increase (maybe even up to 100cm).
The effect these gases create, now and in the future, would differ from region to region. What is certain is that, even is the emission of the negative gasses stops, the heating would occur even after the year of 2100.
The question of ecology and our legacy is forced upon us. The whole world is debating on climate changes and what should be measures taken in this regard. Possible options are reduction of emission, adaptation in view of preventing damage caused by heating, etc. But most importantly, all these actions are to be followed by geo0engineering, which would both simultaneously use and held nature in an ecological manner, so that renewable energy sources are sued more and more. These are solar

energy, the energy of wind, water, high and low tide, the energy of waves, geo-thermal energy, oxygen energy, as well as biomass.

MATERIAL AND METHODS

The Energy of Sea Waves

Waves are created by effects of wind, and wind by effect of the Sun. The basic characteristics of waves are height and length. Time interval between the two amplitudes is proportionate to the second square root of the wave length. The wave energy is proportionate to the square of the wave height and inversely proportionate to the time interval between two amplitudes. The energy abruptly decrease with the depth, so at the depth of 20m it is approximately 20% of the energy, and at the depth of 50m approximately 25 of the energy. The strength of wave can be up to 10kW/m2. For example, for the area of North Atlantic, at the open sea between Scotland and Ireland50% of the time the energy of waves is 3.9kW/m2 of higher. The strength of waves can be calculated per meter longitudinal at the sea surface [8].
Thus defined strength of waves changes with the speed of wind and depends on season and weather conditions. At the referred part of Atlantic 50% of the time during summer the strength is 10kW/m or higher, and in winter 95kW/m or higher. The length of the shore on all the five continents (without the Poles) is approximately 100 million meters, so if the calculation is made with an average strength of 10kW/m, the average annual strength of 1TW is obtained, i. e. the average energy of approximately 9000TWh, which is around 60% of nowadays produced electrical energy.
In deep water, where the depth of water is higher than half of the wavelength of the wave, the energy is calculated by using the following formula:

$$P = \frac{\rho g^2}{64\pi} H^2 T \approx \left(0,5 \frac{kW}{m^3 s}\right) H^2 T \tag{1}$$

where:

P – *the wave energy flux per unit of wave-crest length [W/m],*
ρ – *the water density* ρ=1025 kg/m^3,
g – *the acceleration by gravity* g=9,81 m/s^2,
π –*mathematical constant* π=3.1415926...,
H – *height of waves [m],*
T – *time period of waves [s].*

For example, in dep water, the waves with the length of 3m and period of 8s would have the energy:

$$P \approx 0.5 \frac{\mathrm{kW}}{\mathrm{m}^3 \cdot \mathrm{s}} (3 \cdot \mathrm{m})^2 (8 \cdot \mathrm{s}) \approx 36 \frac{\mathrm{kW}}{\mathrm{m}},$$

While during strong storms, the waves of the height of 15m and with the period of approximately 15s, would have the stregth of approximately 1,7 MW/m. The picture 4.3.1 respresents a map of the Earth with the average energy of waves.
It is certain that, due to more easy transmittion of the energy to users on the shore, iy would be more simple to expolit the energy at the proximity of the shore, even though the energy of waves at the open sea is much higher [2]. Usage of the energy of waves would be limited by factors of geography and economy, primarily caused by issues to transmit energy thus produced [7].

The Energy of High and Low Tide

Tide moves an immense amount of water twice per day, and if used, could give a lot of energy – taking the example of the Great Britain, that would be the approximate usage of energy of the country. Even though the electricity power supply is reliable and plentiful process, turning the energy into usable electricity is not an easy. Only about 20 locations in the world have been identified as possible tide-power plants (Fig. 1).

Figure 1. Collecting the energy of high and low tide, graphic representation

The power of waves as energy sources

The energy collected from water, i. e. its immense power, represents a source of pure and renewable energy. 71% of the earth surface consists of water. The World Energy Council (WEC) estimates that the electrical energy obtained from all the oceans would be twice the amount of the total amount of the currently produced electricity in the world.
The increased energy demand, as well as striving to reduce the emission of harmful gases into the atmosphere, encourages introducing new ways to obtain energy. The world's scientific circles direct towards renewable energy resources. The amount of energy obtained from oceans, through using the energy of waves, as well as the energy of high and low tide, is more than sufficient and can be obtained in a manner which is ecologically acceptable and economically viable [8].

Pelamis - Weave Power

Pelamis Wave Energy is a manufacturer of a unique system for generating electrical energy for renewable sources, ocean waves. Pelamis Wave Energy Converter is a result of long year's development of engineering of PWP. This was the world's first commercial machine for generating electrical energy into the network from offshore wave energy, and the first one to be used commercially. Pelamis Wave Energy Convertor (Fig. 2a) is half-submerged structure consisting of joints and cylindrical parts mutually connected. Wave causes movement of these joins, and the resistance to this movement is created by hydraulic frames through which liquid floats under high pressure. This movement pushes the liquid not hydraulic engines which use this mechanic energy to work generators producing electrical power.
The energy collected is via a cable connecting the convertor with the shore is transmitted to the network. Several devices can be connected together and to the shore over a single cable which is laid at the sea bottom (Fig. 2b). The machines currently produced are 180m long, 4m in diameter and with 4 Power Conversion Modules per single machine. Each machine is marked at 750kW. The energy produced by Pelamis depends on choice of location. Depending on height of waves, the machines would produce per average 25-40% of the maximum capacity. For generating electrical power the waves of at least 1m in height are required, and for achieving the nominal strength the waves of 5-6m in height. Each machine can provide sufficient energy to satisfy the demand per electrical energy of approximately 500 households [4].

a)

b)

Figure 2. Pelamis machines

Oyster - Wave Power

Oyster Wave Energy Converter is a hydro-electric device developed by the energy company Aquamarine Power. The device for "capturing" the energy of waves is situated at the vicinity of the shore and it turns this energy into electrical one (Fig. 3). The system consists of a mechanical "wing" tied by joint and connected to sea bottom up to approximately 10m of depth. Each wave moves buoyant flap, which sets in motion the piston under high pressure of water over pipelines on the shore, a turbine generates electricity. In November 2009, the first complete converter started producing energy when launched at European Nautica Energy Centre (EMEC) [2], [9].

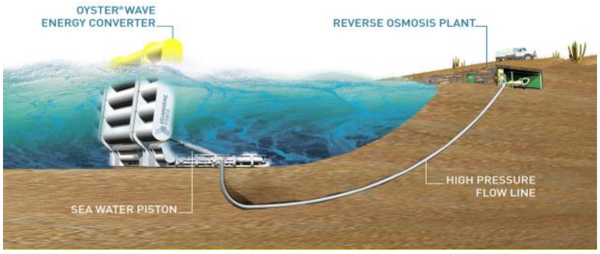
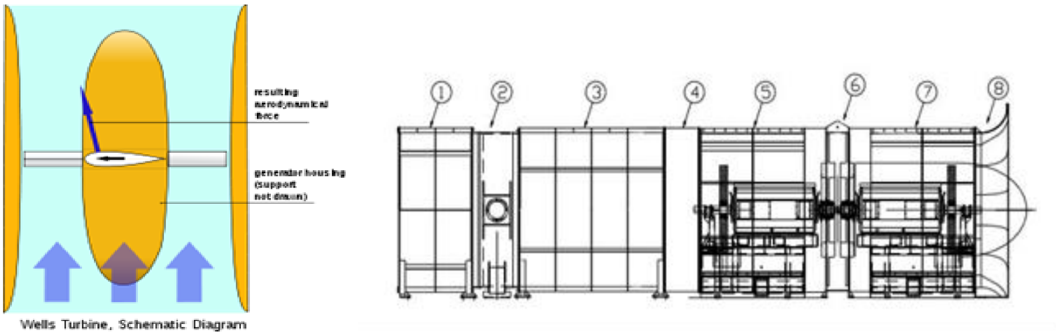


Figure 3. Oyster, graphic representation

Technological characteristics of OWC

The technology of using wave power to move turbines for obtaining electrical energy is quite "young" compared to wind generators or the turbines set to "collect" the power of water currants. The whole process is based on the Oscillating Water Column – OWC. The turbine moved by the air, pushed by water that enters through the opening at the lower part of the station submerged into water, is always rotated in the same direction, no matter the direction of air movement [1]. This manner of operating is possible since the blades of turbine are not fixed and can adjust in position to the air movement. In this manner, the maximum exploitation of each wave, i.e. each oscillation is achieved. The technology of Oscillating Water Column is connected with Wells Turbine and a highly functional system is obtained [1], [6].

The Wells turbine is a low-pressure air turbine that rotates continuously in one direction independent of the direction of the air flow (Fig. 4a). Unlike the conventional turbines, it is of symmetrical aero-dynamic airfoil, which implies that the angle at which air hits the blade is much higher. Its efficiency is lower than that of a turbine with constant air stream direction and asymmetric airfoil. One reason for the lower efficiency is that symmetric airfoils have a higher drag coefficient than asymmetric ones, even under optimal conditions. Also, in the Wells turbine, the symmetric airfoil runs partly under high angle of attack (i.e., low blade speed / air speed ratio), which occurs during the air velocity maxima of the oscillating flow. The efficiency of the Wells turbine in oscillating flow reaches values between 0.4 and 0.7 (Fig. 4b). By using this bidirectional turbine the necessity to correct the air flow with delicate and expensive air vent systems is avoided. This simple and yet high-quality device was developed by professor Alan Arthur Wells of Queen's University Belfast in the late 1970s [6].



a) graphic representation b) schematic representation

Figure 4. Wells turbine

OWC system with the Wells turbines can be applied in different locations and different operating systems:

- By the shore
- As breakwater (installation is performed at the already existing breakwaters or the new ones are constructed with the Wells turbine)
- In the vicinity of the shore
- At the open sea

According to research on renewable energy, in ocean waves there is sufficient energy to allow the production of 3 billion watts of electric energy [5].

Examples of applications of OWC technology

The project LIMPET 500 originated from Professor Trevor Whittaker from Queen's University in Belfast. With the support of the university, the professor set a prototype of the machine for collecting the power of waves OWC of the capacity 75 kW (Fig. 5). It was set in 1991, and in 1999 its usage was ended, as foreseen by the programme in accordance with which this experimental prototype was executed. It proved the principle and manner to use the power of waves as well as its application in the production of electrical energy (oscillating wave power).
The most important conclusion was that this kind of structures for "capturing" the power of waves at the rocky shore of Scotland were possible to be built. Later a question was raised whether the stations set on the shore were efficient enough and if it were better to place them at the open sea, where the power of waves is much stronger. Namely, waves lose their power as they approach the rocky grounds and their power is thus wasted [8]. Therefore the choice of an appropriate location is very important in setting of such a system. Due to costs of construction and problems of logistics, it was found that it was better after all to set the stations on the shore, rather than at the open sea, despite the advantages at the open sea.

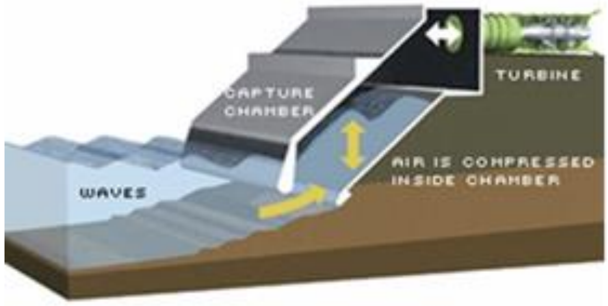


Figure 5. Limpet 500, schematic representation of the manner of operation

The first commercial plant for collecting the power of waves, set at the breakwater, would be constructed by the technology Voith Siemens Hydro Power Generation at the coast of Spain, on the Atlantic Ocean (Fig. 6). The new plant in Mutriku, in the northern Spain, would work by the principle of the Oscillating Water Column (the OWC technology). It was executed by Voith Siemens Hydro, a branch of Scottish company Wavegen, where this system has been tested for more than seven years in situ.
"Mutriku is groundbreaking in the history of waves' energy. We are proud that the first breakwater wave energy plants would lean on Wavegen technology," said dr. Hubert Lienhard, the president and CEO of LG Voith Hydro.
The new design would integrate 16 Wells turbines in the new breakwaters of Mutriku build by the local authorities. This would allow supply of green electric energy to 250 households with the estimated nominal power of almost 300 kW. The plant was put to service in winter 2008/2009. With this innovative concept, the plants for production of green energy would be integrated into the construction of a marine with the minimal costs of construction [8]. "This project represents a big step towards the commercialization of the waves' energy, while we continue to develop technologies and demonstrate their reliability in application under commercial circumstances," said Mr. David Gibb, the general manager of Wavegen, "And we have already negotiated additional projects in other countries."

Figure 6. Mitruku plant on the coast of Spain

RESULTS AND DISCUSSION

The conventional sources of energy are limited. The reserves of the conventional sources of energy are estimated to several decades. In more developed countries of the world there are sufficient reserves of nuclear energy, but due to safety during operating, as well as depositing nuclear waste, these have been seldom used.
Due to the above stated facts, the renewable sources of energy are more and more present. All these causes force mankind to consider more seriously the alternative sources of energy. The renewable sources of energy are permanently gaining significance, and though various funds and subsidies the further development is increase.

CONCLUSION

The capacity of deep water waves is truly immense, between 1 and 10 TW, but it is not practical to be used at once. It is estimated that it would be best not to use more than 2 TW of these resources. The locations with the highest potential for using the waves' energy are the west coasts of Europe, the north coast of the Great Britain and the coasts of North and South America, Australia and New Zealand. Waves are highly predictable. Waves caused by winds can be predicted five days in advance. The currents, caused by the natural phenomenon of high and low tide, due to the position of the Moon, are known 100 years in advance.
The power of waves in inexhaustible and pure way to obtain renewable energy. It is currently not entirely used, but the world is for now heading in the right direction as far as this kind of renewable energy is concerned. It has an immense potential which has still not be entirely used and there is plenty of room for progress.

Acknowledgments

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Session 5.

Designing and maintenance

ETHYLENE PYROLYSIS FURNACE TUBE DAMAGE INSPECTION

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Abstract: This aim of this study is to identify failure mechanism of ethylene pyrolysis furnace tube after five year of operation.The tubes were manufactured from centrifugally cast heat resistant steel HK 40. Failure analysis of the radiant tubes was performed by careful visual inspection of the failed tubes, scanning electron microscopy observation of crack region samples, hardness and micro-hardness measurements. Selected specimens were prepared from the four samples, measurements was carried out at inner, middle and outer sides of the samples. The experimental results showed that the mode of tube failure was a combination of high temperature carburization attack and creep damage leading to intergranular cracking. Maximum hardness is associated with internally carburized zone where the amount of carbides is maximum in this region. The hardness of the radiant tubes decreases as the distance moves from the inner surface to the middle section.
The metallurgical background of the combined action of carburization and creep ductility exhaustion have been investigated and are explained. Pyrolysis tube failures can be prevented by a combination of proper furnace operation, materials choice, regular inspections and good design.

Key words: ethylene pyrolysis; furnace; tube; damage; inspection

INTRODUCTION

Ethylene is a key product in the petrochemical industry, and it is produced by the thermal cracking of complex hydrocarbons in pyrolysis furnaces.The furnace coils are formed from the tubes by welding. The tubes used in thermal cracking furnaces in an ethylene manufacturing process are usually made of HP and HK grades of heat resistant stainless steel.These alloys exhibit excellent properties in terms of oxidation resistance, carburizationresistance, high temperature creep and thermal expansion. These tubes are exposed to high temperature (approximately 1100 °C and internal pressure of about 1 bar). Normal service life of these coiled tubes is approximately 100.000 h, but does depends on the service condition and could vary from 30.000 to 180.000 h [4].
Ethylene pyrolysis furnace tubes which are made of high Cr-Ni alloys often become difficult to weld after few years in service due to carburization and creep damage. The presence of carburization, often attempted to detect by magnetic permeability, can escape detection due to high Cr-Ni content of the alloy. Based on optical microstructural analysis and supported by scanning electron microscopy, this paper establishes that carburized material becomes difficult to weld due to carburized internal layers of the tube and cause hot shortness. To provide a practical way out for ethylene furnace operators, a solution annealing heat treatment is recommended to have a successful weld.
Pyrolysis coils in ethylene cracking furnaces (Fig. 1) are exposed to very severe conditions, e. g. high temperatures up to 1150 °C, severe start/stop and decoke cycles, oxidizing and nitriding flue gases at the outside and carburizing atmospheres at the tube inside surface. Therefore, high-alloyed centrifugal cast Ni-Cr-Fe alloys with adequate high temperature corrosion resistance, good high temperature strength, good machinability and weldability (even after years of service) are required.
Radiant coils have a limited life and failure is caused by a variety of factors, many being related to furnace operation. However, each pyrolysis plant experiences specific operational conditions and operational philosophies. Therefore, each plant has typical causes for radiant coil failure and it is of importance for operators to analyze and to understand the typical failure mechanisms. This will enable

them to consider the material grades, which would be best suited for those particular conditions and also to keep failures within limits by proper furnace operation.

Damages of the furnace coils may be produced by creep, carburization, thermal shocks and accidental overheating [9]. Any failure in these tubes results in shut-down of the cracking furnaces and wasting both cost and time. Replacement of these coils is expensive and difficult. Carburization and creep are the main causes of failure in the heat resistant tubes of ethylene cracking furnaces, leading to a decrease in ductility and embrittlement of the cracking tubes.

The radiant coil assembly (fig.1) of the ethylene furnace was investigated at Stock Company for Production of Petrochemicals, Raw Materials and Chemicals „HIP-Petrohemija" Pančevo - Republic of Serbia. The furnace tubes were fabricated from HK40 steel casting with an internal diameter of 63.5 mm and wall thickness of 16 mm. A section of failed tube was analyzed to determine the cause of failure.

It is the purpose of this paper to investigate the main failure mechanisms for tubes and outlet parts of pyrolysis furnace coils. In most cases there is a combination of factors which ultimately lead to the failure, e.g. carburization and creep ductility exhaustion. This results in bulging, bending and vocalization of the tubes. Also, brittle fracture during furnace trips can result in large, longitudinal cracks on many tubes in the furnace.

MATERIAL OF FURNACE TUBE

The radiant coils used in our cracking furnace are made by centrifugal casting process. They have appropriate ductility and weldability in as-cast conditions, and lose their ductility and weldability after being used in service. As normally produced, the HK alloy type is stable austenitic over its entire temperature range of application. The austenitic matrix in this kind of high-temperature alloy provides a great mechanical resistance at high temperatures.

Extended exposure at the normal operating temperature of 1093 °C have three detrimental effects in these microstructures: grain boundary voids and cracking of the protective oxide scale due to creep, carburization attack and the evolution of intermetallic compounds [1]. All these reduce both mechanical strength and ductility during service life.

Chemical composition and mechanical properties of the steel are presented in tables 1 and 2, respectively [Kubota Metal Corporation].

Table.1. Chemical composition of HK40 (wt%)

Comp.	**C**	**Mn**	**Si**	**Cr**	**Ni**	**P**	**S**
Min. %	0.35	0.4	0.5	23	19	-	-
Max. %	0.45	1.5	1.5	27	22	0.03	0.03

Table. 2. Mechanical properties of HK40

Mechanical properties		**Centrifugal castings**					**Static castings**
		21° C	760° C	870° C	980° C	1090° C	21° C
U.T.S. Rm	[MPa]	579	262	165	103	38	324
Y.S. Rm	[MPa]	303	165	110	62	34	310
El.	%	20	13	16	42	55	17

CARBURIZATION

During service, hard deposits of carbon (coke) build up on the inner wall of the tube, reducing heat transfer and restricting the flow of the hydrocarbon feedstock which requires that the furnace must be periodically taken off-line and "decoked" by burning out the accumulated carbon. Carburization is the carbon enrichment and carbide formation in the tube material under influence of the presence of carbonaceous gases and high temperatures. This accelerates carbon diffusion in tube material, especially during the decoking period. Carburized material in the inner wall of the radiant tube has a higher thermal expansion coefficient and tends to increase in volume and place stresses on the tube. These thermal stresses make the tube more susceptible to creep failure [9].

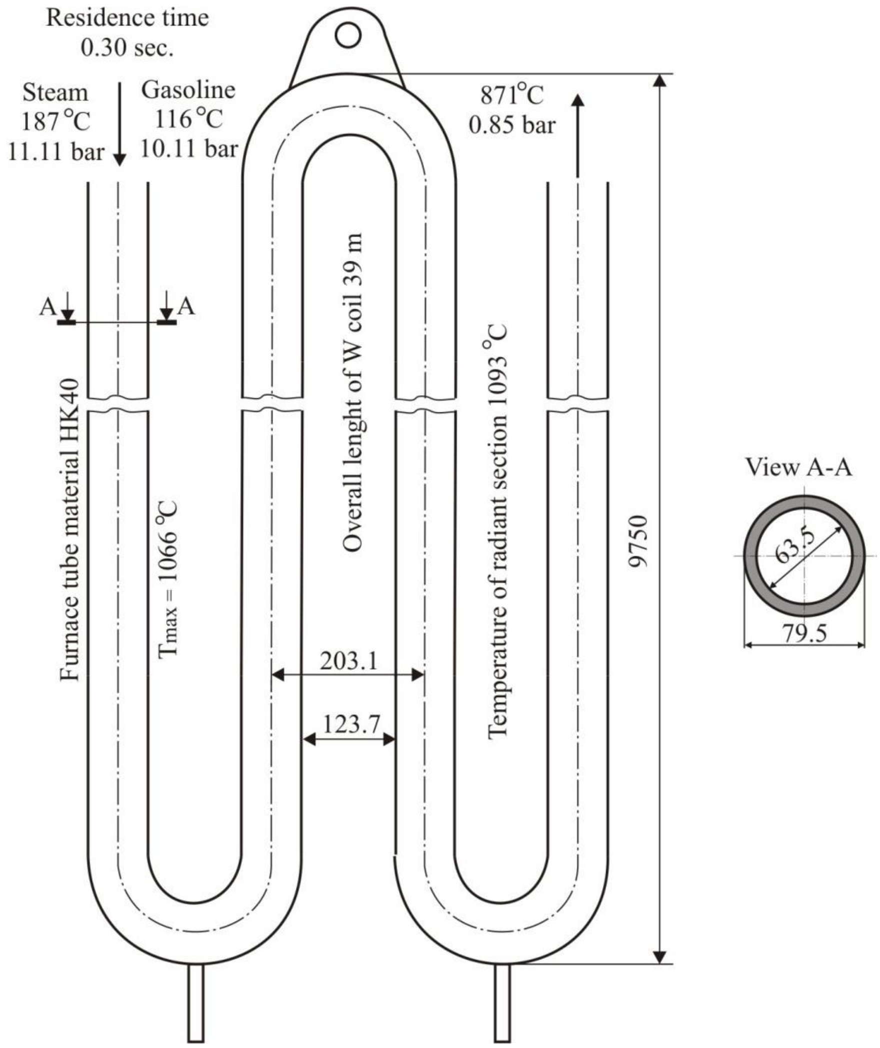


Figure 1. The radiant coil assembly

The deposition of the coke at high temperature is generally inhibited by the presence of a chromium oxide (Cr_2O_3) layer on the inner surface of the tube. When this film in present carbon diffusion into the tube is retarded. However, during decoking, the tube may be subjected to severe thermal shock that results in removal of the chromium oxide layer, so the carburization attack is increased [10]. Because of exposure of tube at elevated temperature, carbon diffusion could promote formation of continuous and/or separated carbides in grain boundary and matrix [1, 10,]. These carbides decrease the creep resistance and ductility at high temperature. Figure 2. Pyrolysis furnace radiant zone - consequence of a high creep rate Metal dusting is a catastrophic form of carburization that can result in rapid metal wastage in both ferritic and austenitic alloys. This damage mechanism typically has the appearance of localized pitting, or grooving, along the inner walls of pipe and tubes [10].
The ethylene cracking reaction releases free carbon that can deposit on tube surfaces accelerating carbon diffusion and hence carburization in tube material [8].One of the main problems with pyrolysis furnaces is carbon deposition on inner wall of the tubes and creation of a porous layer of coke. Coke formed in the pyrolysis furnace tubes is classified as catalytic and pyrolytic. Adherent coke can have two detrimental effects. First, it acts as a thermal insulator which requires a higher tube wall

temperature in order to maintain the same gas temperature. Secondly, it accelerates carburization attack of the tube material.

Carburization leads to the formation of metal carbides in the grains and grain boundaries that consequently reduce the mechanical properties, creep resistance, service life time and weldability of the tubes. The non-magnetic (austenitic) microstructure of these tubes becomes ferromagnetic due to carburization reaction.

Coke is normally removed using decoking technique which consists of shutting off the hydrocarbon feed and passing a mixture of air and steam through the coil. During decoking cycles because of sapling the oxide scale, carburization was accelerated to inner surface that results in an increase of inner surface hardness with respect to outer. Tubes can be subjected to a severe thermal shock where the temperature is increased above normal leading to creep which results in sagging of the tubes. In practice, the need for decoking is dictated by the process parameters particularly gas temperature, flow rates and conversion ratio [4].

CREEP

Creep is the primary cause of the furnace tube damage. It usually initiates within the tube wall some two-thirds of the way through from the outer surface, making it impossible to detect by in situ metallography [7]. This is opposite to boiler super heaters and headers where creep damage initiates at the outside surfaces, making it much easier to detect.

Creep elongation (also called stretching) occurs because of creep by the self-weight of the tube and the coke layer present in the tube and is influenced by temperature, the load carrying cross section of the tube, and the material used. A consequence of a high creep rate is the need to shut down the furnace and to shorten the coils (some end-users have lowered to bottom floor). Failures can occur if tubes are not shortened before they reached the heater floor (fig. 2). The coils are warped and bowed, resulting in higher tube stresses and creep rates.

Figure 2. Pyrolysis furnace radiant zone - consequence of a high creep rate

LIFE ASSETMENT

Predicting the life of furnace tubes has long been a problem for petrochemical and refinery industry. Even though failure of heater tubes is not a major safety issue, the prediction of remaining life is important because of cost savings resulting from the optimization of process parameters or reduction of inspection frequency and avoidance of unscheduled outages.

INSPECTION

The tube coils should be inspected closely for bulging, cracking, bowing, sagging, splitting, scaling, corrosion, and deposits from fuel gas. Fittings may show signs of damage, distortion or corrosion.

In order to investigate the mechanical properties, tensile, hardness and micro hardness tests were performed. Microstructures were characterized by using optical microscopy and scanning electron microscopy (SEM). Examinations are focused on three regions, namely inner surface marked I, middle section (region II) and outer surface (region III).

SAMPLES PREPARING

Samples (fig. 3) were machined from the as-received tube section for evaluation, one unused piece, one used but not cracked piece (one year in use), one piece showing sagging and different degrees of cracking (five year in use) and one piece which was not sagged but contained cracks (five year in use) at the inner surface that did not penetrate the entire thickness. Cutting was performed by using a precision sectioning machine with direct water-cooling of the specimen.

Figure 3. As received samples

The specimens were ground with SiC papers of the grades 180, 220, 320, 500, 1000 down to grit 2400 (Struers Standard 43-GB-1984, DIN69176, Part 1,2,4) with a pressure of 70-80 N and water as a lubricant. Polishing was done on nylon cloth with 0.3-lm alumina paste. Then, the specimens were etched in Kalling's etching reagent (1.5g $CuCl_2$ in 33ml H_2O, 34ml ethanol and 33ml HCl) to determine the size and location of precipitates in the matrix. For more investigation, the specimens were electrolytically etched with KOH solution.

HARDNESS AND MICRO HARDNESS TESTS

Brinell hardness measurements (HB 5/750/20) were performed on the tube wall cross section to evaluate mechanical strength and to determine a possible carburization /decarburization. The hardness of unused, unfailed and damaged tubes is presented in table 3. It is found that the longer service time results in the higher hardness value which can be attributed to the formation of metallic carbides due to carbon diffusion into the matrix of material at elevated temperature.

Table 3. Brinell hardness of analyzed samples

Sample	**Time in use**	**[$HB_{5/750/20}$]**			
		Inner surface	**Middle section**	**Outer surface**	**Average**
1	new	186	185	186	186
2	1 year	191	187	188	188
3	5 year	258	237	223	239
4	5 year	284	261	248	264

Micro hardness measurements were performed by Vickers method applying a load of 25g ($HV_{0,\ 025}$) for hardness determination of the particular micro constituents. Measurements was carried out at inner, middle and outer sides of the samples. In the as-cast condition (tube never used in service), the micro hardness of the austenite at the inner tube surface was measured to be HV 246 (average of three readings).

Microhardness measurements showed a significant increase in thehardness at the tube's internal surfaces (tab. 4). The hardnessdecreases as the distance from the tube's internalsurface is increased, suggesting a decrease in the carburizationdensity.

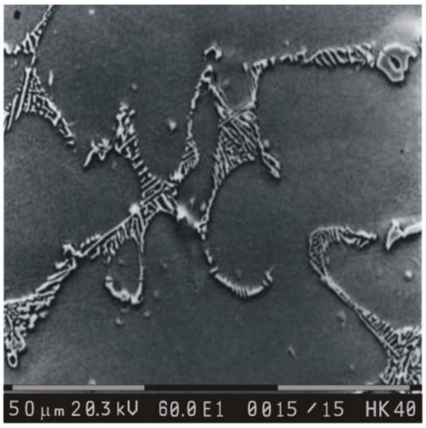
Table 4. Micro hardness of analyzed samples

Sample	Location	$[HV_{0.025}]$			
		Inner surface	**Middle section**	**Outer surface**	**Average**
1	grain boundary	250	242	247	246
	grain	102	96	98	98
2	grain boundary	267	246	250	254
	grain	149	97	101	115
3	grain boundary	362	308	269	313
	grain	202	176	106	161
4	grain boundary	401	340	297	346
	grain	224	192	147	187

MICROSTRUCTURE

Microstructure of the samples from the tubes analyzed by optical microscope and scanning electron microscope. The microstructure of as-cast HK40 alloy consists of an FCC gamma matrix and a cellular structure, which involves $M_{23}C_6$ carbides on the dendrite boundaries (Fig. 4). This structure was altered in all of three samples due to prolonged exposure to high temperatures, and it was observed that a continuous network of coarse carbides decorated the dendrite boundaries. Across the used tube wall, the materials were observed to have formed three distinct zones with different microstructures: the zones beneath the inner and outer surfaces and the region in between. The microstructure of this centrifugally cast tubular material consist of dendrite grains aligned in the direction of tube diameter and a protective oxide scale is usually present on the inner and outer surfaces.

a.)

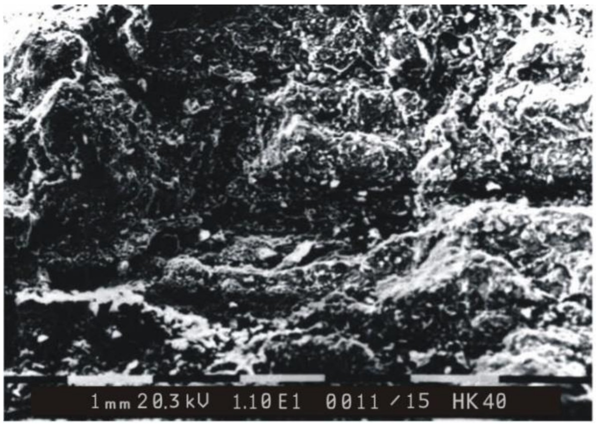


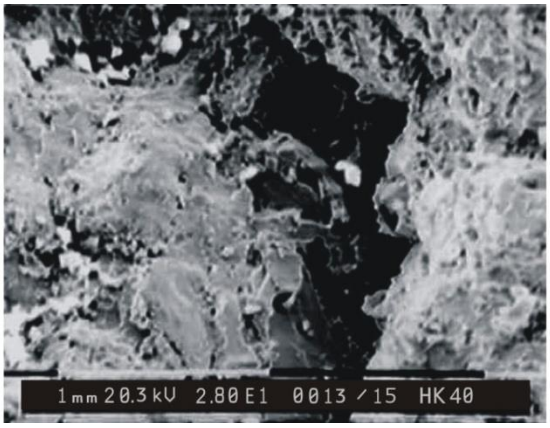
b.)

Figure 4. As-cast structure of the alloy HK40, a.) optical - x 150, b.) sem - x 600

The sample 2 material that presumably had been exposed to less severe service conditions displayed only coarse $M_{23}C_6$ type carbides.In sample 3 and 4, $M_{23}C_6$ eutectoid carbides of the as-cast condition were observed to have coarsened and transformed into M_7C_3 carbides with a heavily faulted structure. This carbide transition was observed to have occurred via an in-situ mechanism and also resulted in γ precipitation in M_7C_3.

The crack in sample 3 and 4 was visible to the unaided eye, and its propagation appeared to be associated with the carburization and oxidation phenomena. It is evident that the cracks are propagated along the grain boundaries of the austenite grains (Fig. 5).





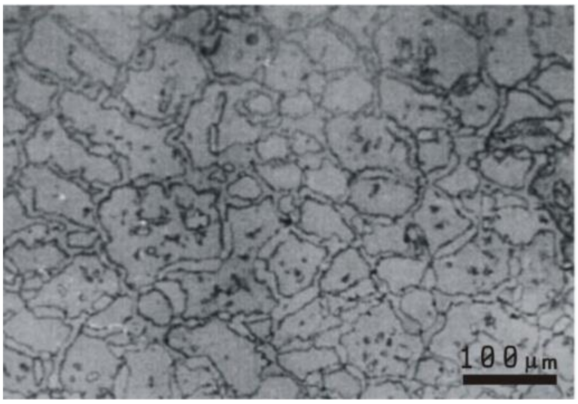
a.) *b.)*

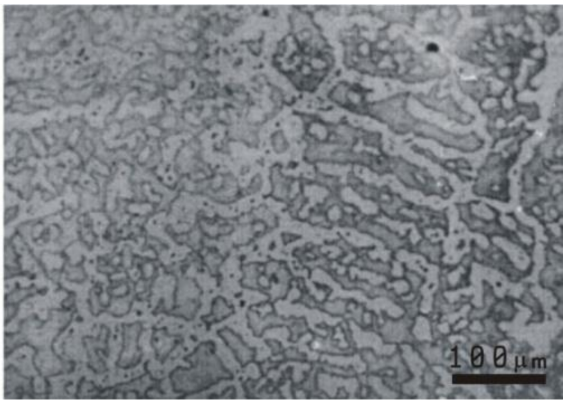
Figure 5. SEM images of sample 3 - a.) Surfaces with crack extended along dendrite grain boundaries – intergranularly, b.) Area with the presence of secondary cracks

The results of the fractured surface analysis presented in figure5 could be used for explanation of the fracture initiation and propagation mechanisms. The fracture was initiated on oxidation/corrosion products from the inner side of the tube wall. The crack propagates intercrystally, i.e. along the grain boundaries of fine dendrites. Secondary cracks were also identified.

In sample 3, the volume percent of carbides varied across the tube cross-section (fig. 6), gradually increasing from the outer to the inner surface, being 36.2% and 44.7%, respectively. Sample 3 also contained, unlike sample 2, circular intra granular carbides in addition to a macrocrack.

Sample 3, which had been removed from the same furnace as sample 4, showed more severe microstructural degradation to approximately Stage IV in the model of Petkovic-Luton and Ramanarayanan [5]. In both samples, the carbides appeared to have coarsened and become continuous along the grain boundaries during service. This was more pronounced in Sample 3, suggesting that it had experienced more carburization than Sample 4.





a.) *b.)*

Figure 6. Light micrographs from areas beneath: (a) the inner and (b) the outer surfaces of sample B.

CONCLUSION

In this study, ethylene pyrolysis furnace tube damage inspection was performed. The experimental results showed that the mode of tube failure was a combination of high temperature carburization attack and creep damage leading to intergranular cracking. Analyzed cracks in the failed tubes have their origin in the inner side of the tube walls, and propagating across their thickness.

Brinell hardness measurements were performed on the tube wall cross section to evaluate mechanical strength and to determine a possible carburization/decarburization. This maximum hardness is associated with internally carburized zone where the amount of carbides is maximum in this region. The hardness of the radiant tubes decreases as the distance moves from the inner surface to the middle section.

To avoid such degradation it is necessary to check the operation and decoking temperature and to ensure that the temperature is less than the design temperature. All heater tubes should be inspected, preferably early in life, to establish base-line conditions for tube diameter, wall-thickness, microstructure, and metal hardness.

Acknowledgements

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THE FRICTION THEORY FOR ESTIMATING VISCOSITY OF SOLVENTS

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Abstract: In this study, applicability of the friction theory for the viscosity estimation of binary liquid mixtures, used in regenerative flue gas desulphurization processes, was investigated. Theory was tested on the selected solvents that have already found commercial application, TEGDME, NMP and DMA, in combination with 1-butanol. The results were compared with experimental viscosity data for the systems: 1-butanol+ TEGDME, DMA+1-butanol, and NMP+1-butanol. In the calculation procedure friction theory was coupled both with the Soave-Redlich-Kwong (SRK) and Peng-Robinson (PR) equations of state. Almost identical deviations, under 2% with both EoS, were obtained for pure compounds. For viscosity of mixtures slightly better results, around 3% deviation, were obtained with SRK.
Key words: Flue gas desulphurization, Solvents, Mixtures, Viscosity, Friction theory

INTRODUCTION

Sulphur dioxide (SO_2), produced as a result of burning coal with high sulphur content, is one of the main environment polluters. Also, he is the main cause of acid rain problem, land degradation and "dying forests". Among the many methods for desulphurization of power plants flue gases, regenerative processes with organic solvents recently gain in importance [1-3]. The advantage of this method is that solvent regeneration can be relatively easily carried out by increasing the temperature or by lowering the pressure. Processes based on dimethyl aniline (DMA) and tetraethylene glycol dimethyl ether (TEGDME) have already been patented and industrially applied [4,5]. The main disadvantage of DMA is its high toxicity, while TEGDME, has shown relatively low selectivity to SO_2. As an alternative 1-methyl-2-pyrrolidone (NMP) has been proposed [6]. Lurgi Purisol process is the example of NMP commercial applications. On the other hand, alcohols favorable absorption and desorption characteristics, low vapor pressure, low toxicity, high chemical stability and low melting point, are well known. Number of literature sources present the possibility of applying the binary system with alcohols in the process of removing SO_2 [7,8].
Modeling and simulation of industrial processes in thermal power plants, as well as the design of appropriate flue gas treating facilities, require using of thermophysical properties of the applied solvent, as input data. Since, it is not always possible to carry out experimental measurements, and often there are no available experimental data for the specific process, it is useful to understand the correlative and predictive methods for calculation of thermophysical parameters.
This article presents the friction theory as a method for viscosity estimation of liquid solvents and their binary mixtures. The friction theory was tested on selected systems (1-butanol+TEGDME, DMA+1-butanol and NMP+1-butanol), with potential application in the regenerative flue gas desulphurization processes.

MATERIAL AND METHODS

Materials

All the chemicals were purchased from Merck with a stated minimum purity of 99.5 mass% for 1-butanol and 99.0 mass% for NMP, DMA and TEGDME. Experimental data are presented in our previous work [9,10]. The measurements were conducted in the temperature range from 283.15 K to - 333.15 K for systems 1-butanol+TEGDME and NMP+1-butanol, and in the temperature range 283.15 K to 323.15 K for mixture with DMA.

Apparatus

Densities of the pure substances and binary mixtures were measured on Anton Paar DMA 5000 densimeter and viscosities on a Stabinger SVM 3000/G2 viscometer. The procedures are described in our previous paper [9].

Mixtures were prepared gravimetrically on a Mettler AG 204 balance. The balance precision is $1\cdot10^{-7}$ kg and the standard uncertainty in mole fraction is evaluated as $\pm1\cdot10^{-4}$. The combined expanded uncertainty in density is within $\pm\ 8\cdot10^{-2}$ kg/m^3 with a 0.95 level of confidence (k~2) and in viscosity ±1.0%. The uncertainties of investigated properties were determined using the Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results [11].

Friction theory

The used theory [12] for viscosity modeling is based on friction concept of classical mechanics and the van der Waals theory of fluids. Theory separates the total viscosity into dilute gas term and residual friction term

$$\eta = \eta_0 + \eta_f \tag{1}$$

The dilute gas term is calculated from the equation

$$\eta_0 = 40.785\frac{\sqrt{M_W T}}{v_c^{2/3}\Omega^*}F_c \tag{2}$$

where M_W is molecular weight in g/mol, T is temperature in K and v_c is critical molar volume in cm^3/mol. Ω^* is reduced collision integral given by equation

$$\begin{aligned}\Omega^* = \frac{1.16145}{T^{*0.14874}} + \frac{0.52487}{\exp(0.77320T^*)} + \frac{2.16178}{\exp(2.43787T^*)} - \\ -6.435\cdot10^{-4}T^{*0.1487}\sin(18.0323T^{*-0.76830} - 7.27371)\end{aligned} \tag{3}$$

with

$$T^* = \frac{1.2593T}{T_c} \tag{4}$$

where T_c i critical temperature in K. F_c factor is empiricaly calculated from the equation

$$F_c = 1 - 0.2756\omega + 0.059035\mu_r^4 + k \tag{5}$$

with

$$\mu_r = \frac{131.3\mu}{\sqrt{v_c T_c}} \tag{6}$$

and

$$k = 0.0682 + 0.276659\left(\frac{17n_{OH}}{M_W}\right) \tag{7}$$

where ω is acentric factor, μ is dipol moment and n_{OH} is number of OH groups.

For mixture dilute gas term is calculated as

$$\eta_{0,mix} = \exp\left[\sum_{i=1}^{n} x_i \ln(\eta_{0,i})\right] \tag{8}$$

where n is number of components in mixture, x_i is mole fraction of component „i“, and $\eta_{0,i}$ is dilute gas term of component „i“.

Residual friction term, in quadratic friction model, is given by equation

$$\eta_f = k_r p_r + k_a p_a + k_{rr} p_r^2 \tag{9}$$

where p_r and p_a is repulsive and attracitive pressure contribution in equation of state in bar, k_r, k_a and k_{rr} are temperature dependent coefficients given as

$$k_r = a_1 \exp\left[\frac{T_c}{T} - 1\right] + a_2 \exp\left[2\left(\frac{T_c}{T} - 1\right) - 1\right] \tag{10}$$

$$k_a = b_1 \exp\left[\frac{T_c}{T} - 1\right] + b_2 \exp\left[2\left(\frac{T_c}{T} - 1\right) - 1\right] \tag{11}$$

and

$$k_{rr} = c_2 \exp\left[2\left(\frac{T_c}{T}\right) - 1\right] \tag{12}$$

where a_1, a_2, b_1, b_2 and c_2 are adjustable parameters in model.
For mixture, coefficients are given by equations

$$k_{r,mix} = \sum_{i=1}^{n} z_i k_{r,i} \tag{13}$$

$$k_{a,mix} = \sum_{i=1}^{n} z_i k_{a,i} \tag{14}$$

and

$$k_{rr,mix} = \sum_{i=1}^{n} z_i k_{rr,i} \tag{15}$$

with

$$z_i = \frac{x_i}{M_i^{\varepsilon} \overline{M}} \tag{16}$$

and

$$\overline{M} = \sum_{i=1}^{n} \frac{x_i}{M_i^{\varepsilon}} \tag{17}$$

where M_i is molar mass of component „i" in g/mol, $k_{r,i}$, $k_{a,i}$, $k_{rr,i}$ are coeficients of component „i", and ε is another adjustable parameter.

Viscosity modeling

In this work, the friction theory, coupled with the Peng-Robinson [13] equation of state (PR EoS) and Soave modification of the Redlich-Kwong [14] equation of state (SRK EoS), has been used to evaluate the viscosities of investigated pure components and their binary mixtures. The required EoS parameters are taken from the literature [15]. For mixtures, van der Waals mixing rule with three independent parameters was used with the friction theory and both EoS.
According to PR EoS pressure (in bar) is defined by the equation

$$p = \frac{RT}{v - b} - \frac{a(T)}{v(v-b) + b(v-b)} = p_a + p_r \tag{18}$$

where R is universal gas constant in cm^3bar/molK, v is molar volume in cm^3/mol, p_a and p_r are attractive and repulsive pressure terms. Coefficients b and a, for pure components, are given by

$$b = 0.077796 \frac{RT_c}{p_c} \tag{19}$$

where p_c is critical pressure in bar, T_c critical temperature in K and

$$a(T) = a_c \alpha \tag{20}$$

with

$$a_c = 0.457235\frac{R^2T_c^2}{p_c} \tag{21}$$

and

$$\alpha = \left[1 + m\left(1 - \sqrt{\frac{T}{T_c}}\right)\right]^2 \tag{22}$$

with

$$m = 0.37464 + 1.54226\omega - 0.26992\omega^2 \tag{23}$$

For mixture coefficients a and b is calculated from the equations

$$a(T) = \sum_{i=1}^{n}\sum_{j=1}^{n} x_i x_j \sqrt{a_i a_j}\left[1 - k_{ij} - l_{ij}\left(x_i - x_j\right)\right] \tag{24}$$

and

$$b = \sum_{i=1}^{n}\sum_{j=1}^{n} x_i x_j \sqrt{b_i b_j}\left(1 - m_{ij}\right) \tag{25}$$

where a_i and b_i are coefficients of pure component "i", and k_{ij}, l_{ij} and m_{ij} are adjustable parameters.

According to SRK EoS pressure (in bar) is calculated as

$$p = \frac{RT}{v-b} - \frac{a(T)}{v(v+b)} = p_a + p_r \tag{26}$$

where R is universal gas constant in cm^{3}bar/molK, T is temperature in K, v is molar volume in cm^3/mol, p_a and p_r are attractive and repulsive pressure terms. Coefficients b and a, for pure components, are given by

$$b = 0.08664\frac{RT_c}{p_c} \tag{27}$$

where p_c is critical pressure in bar and

$$a(T) = a_c\alpha \tag{28}$$

with

$$a_c = 0.42748\frac{R^2T_c^2}{p_c} \tag{29}$$

and

$$\alpha = \left[1 + m\left(1 - \sqrt{\frac{T}{T_c}}\right)\right]^2 \tag{30}$$

with

$$m = 0.4805 + 1.551711\omega - 0.176\omega^2 \tag{31}$$

For mixture, coefficients a and b are calculated from the equations

$$a(T) = \sum_{i=1}^{n}\sum_{j=1}^{n} x_i x_j \sqrt{a_i a_j}\left[1 - k_{ij} - l_{ij}\left(x_i - x_j\right)\right] \tag{32}$$

and

$$b = \sum_{i=1}^{n}\sum_{j=1}^{n} x_i x_j \sqrt{b_i b_j}\left(1 - m_{ij}\right) \tag{33}$$

where x_i are mole fraction of component "i", a_i and b_i are coefficients of pure component "i", and k_{ij}, l_{ij} and m_{ij} are adjustable parameters.

RESULTS AND DISCUSSION

For each pure substance, the corresponding model consists of five adjustable parameters, given in Table 1 along with the obtained absolute average deviation (*AAD*), calculated from the following equation:

$$AAD(\eta) = \frac{100}{m}\sum_{i=1}^{m}\left|\frac{\eta_{\exp} - \eta_{cal}}{\eta_{\exp}}\right|_i \tag{34}$$

where η_{exp} and η_{cal} denotes experimental and calculated values of dynamic viscosity. For pure substances, both EoS gives almost the same results. Better results, below 1% deviation, were obtained for the NMP and DMA.

Table 1. Parameters for the f-theory with PR EoS and SRK EoS along with absolute average deviations for pure components.

Component	a_1/(μP/bar)	a_2/(μP/bar)	b_1/(μP/bar)	b_2/(μP/bar)	c_2/(μP/bar^2)	*AAD*/%
	f-theory + PR EoS					
1-butanol	-2.7704	20.362	35.490	-99.997	-5.8863 x 10^{-3}	1.73
DMA	-11.075	37.259	-8.3241	-99.858	1.0276 x 10^{-2}	0.70
TEGDME	9.3324	-5.4242	36.389	-76.129	5.2370 x 10^{-4}	1.10
NMP	-29.905	-27.807	-30.269	-28.728	1.4826 x 10^{-2}	0.11
	f-theory + SRK EOS					
1-butanol	-7.0175	17.429	-2.3126	-99.881	-5.0501 x 10^{-3}	1.73
DMA	0.70606	42.200	-6.2023	-93.372	2.7011 x 10^{-3}	0.71
TEGDME	5.7296	-9.8892	-1.4601	-73.348	2.5049 x 10^{-3}	1.12
NMP	-3.7226	-5.1859	2.4219	-12.107	3.5136 x 10^{-3}	0.15

For each mixture, van der Waals (vdW) mixing rule [34] with three adjustable parameters was used. Values of interaction parameters are presented in Table 2 along with *AAD*, calculated by eq. (34), for both investigated EoS.The best results were obtained by using ε = 0.15 with the regular van der Waals mixing rule, with binary interaction parameters k_{ij}, l_{ij} and mij. The values of interaction parameters are optimized for every mixture and over the entire investigated temperature range. The values of absolute average deviation are acceptable for all analyzed mixtures and for both EoS. Better results are obtained with SRK EoS. The best results are obtained for DMA-1-butanol mixture and the worst for NMP-1-butanol. Narrower temperature range (288.15-323.15 K) in the case of DMA-1-butanol mixture is one of the reasons for better results than in the case of two other investigated systems.

Table 2. Results for the friction theory viscosity modeling with PR EoS and SRK EoS coupled with vdW mixing rule for the binary liquid mixtures with 1-butanol.

Mixture	vdW			*AAD*/%
	k_{ij}	l_{ij}	m_{ij}	
	f-theory + PR EoS			
1-butanol (1) + TEGDME (2)	5.9539 x 10^{-2}	-0.39165	-23.275	2.80
DMA (1) + 1-butanol (2)	1.3593	-0.75482	-11.931	1.83
NMP (1) + 1-butanol (2)	0.40197	9.7576 x 10^{-2}	-10.392	3.48
	f-theory + SRK EoS			
1-butanol (1) + TEGDME (2)	0.16641	-0.31995	-9.9212	2.60

DMA (1) + 1-butanol (2)	0.76807	7.7333 x 10^{-2}	9.7427	1.63
NMP (1) + 1-butanol (2)	0.73624	4.8829 x 10^{-2}	7.8498	3.09

CONCLUSION

Based on this study, the friction theory can be used as a method for viscosity estimation of liquid solvents and their mixtures. For investigated pure substances deviations from experimental values are under 2% and both EoS are acceptable. For mixtures deviations are around 3%, and SRK EoS is recommended. Our results confirmed potential application of friction theory on solvents used in the regenerative flue gas desulphurization processes.

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TESTING ADHESIVE BOND STRENGTH AND FRACTURE MECHANISMS OF THICKER AND POROUS PLASMA SPRAY COATINGS

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Abstract: For the functionality of metal products protected with plasma spray coatings critical is the adhesive strength of the bond of the coatings with the substrate surfaces. For the working life of the coatings the cohesive strength is also very important, which is directly related to the strength of the inter-lamellar connections, share of pores, presence of cracks and residual stresses in the deposited layers of coating and at the interface with the substrate. To test the adhesion / cohesion strength the most frequently used were the standardized test methods, ASTM C633 and Pratt & Whitney (PN 582005). Access to control of deposited plasma spray coatings allows the development, mastering and application of new quality materials, powders at the micro and nano level for more effective performance of metal products in service. For this paper, selected for testing were coating systems $NiCrAlCoY_2O_3/ZrO_2CeO_2Y_2O_3$ deposited by plasma spray process at atmospheric pressure (APS). Tests were performed according to standard Pratt & Whitney (PN 582005) and shown were assessments of adhesive bond strength and fracture mechanisms. The results showed that the method is relatively easy and reliable for the assessment of bond strength and fracture mechanisms of thicker and porous plasma spray coatings.
Key words: adhesion, cohesive strength, plasma spray coatings, APS

INTRODUCTION

Adhesive bond strength is the basic characteristic of thermal spray coatings. It is very important for porous ceramic coatings such as organic bio-reactive ceramic hydroxyapatite $Ca_{10}(PO_4)_6(OH_2)$ and inorganic bio-inert ceramics ZrO_2, $ZrO_2Y_2O_3$, Al_2O_3, TiO_2 and Cr_2O_3 which have a wide range of applications. The method for testing coating bond strength is a method of tensile tests [1,2]. The control procedure for adhesive / cohesive strength of the plasma spray coatings is required for the functional part to be installed and thus approved for use in operation. According to the Pratt & Whitney standard (PN 582005) samples for testing adhesive bond strength are made of AMS materials depending on the type of substrate on which the coatings are deposited. For substrates based on Fe, Ni and Co alloys, samples are made from AMS steel 5504 (0.15%C, 13.0%Cr)X15Cr13(EN1.4024) [1]. Based on the standard for testing adhesive / cohesive strength of the coatings, the thickness of the coatings to be tested is directly related to the proportion of micro pores in the coatings. The thickness of the tested coatings is increased with the proportion of micro pores as to prevent the penetration of the adhesive through the layers of the coating to the substrate. For coatings with a proportion of pores below 2% a coating thickness of 250 μm is recommended. For coatings with a high proportion of pores thickness should be minimum 380 μm or to have a maximum thickness for the designed coating on the functional part [1,2]. It should be noted that the adhesion strength is not a constant in real conditions, it is a complex trait that depends on: roughness of the substrate surface, coating deposition parameters, residual stresses due to mismatches of thermal and mechanical properties between the coatings and the substrates and the load conditions on the thickness of the coating. Testing adhesion bond strength is done on the hydraulic tensile testing machine at room temperature at low and constant tension speed. Low tension speed and gradual loading is used because of the stress state in the coating layers and at the substrate / coating interface. Tensile load is normal to the surface of the substrate /

coating interface. During testing the load is increased from zero to the load level causing fracture. Depending on the quality of the coating (coating surface roughness, proportion and size of pores in the coating, stress state of coating layers) and the quality of the bond of the coating with the substrate surface, fracture of the specimen can occur in several unwanted places as shown in Figure 1 [3]. The coating bond strength $\sigma = F/A$ (MPa) is calculated as the maximum load (F_{max}) on the sample divided by the area (A) of the fracture of the coating. The fracture surface area of the samples (A) is calculated as follows $A = 3.14 \times R^2/4$, where R is the measured fracture diameter [1,2].

Figure 1. Undesirable possible fracture locations: a) through the bond coating, b) at the bond coating / ceramic coating interface c) through the ceramic coating and d) at the ceramic coating / glue interface [3].

This paper analyzes the adhesive / cohesive bond strengths, and fracture mechanisms of the $NiCrAlCoY_2O_3/ZrO_2CeO_2Y_2O_3$ plasma spray coating system using tensile testing according to most commonly applied standard test methods, Pratt & Whitney (PN 582005) and (ASTM C 633), for testing adhesion / cohesion bond strength of thermal spray coatings. The examination tests belong to the group of mechanical methods in which the adhesion is determined by using a force on the coating / surface system [4-6]. Coating materials used for the deposition are two different plasma spray coatings. Adhesive bond strengths were measured in the bond coating / ceramic coating system, whose values and fracture mechanisms were discussed.

MATERIALS AND EXPERIMENTAL DETAILS

In the experiment two spray powders were used, Sulzer Metco 461 ($NiCr/Al/Co/Y_2O_3$) and Metco 205NS ($ZrO_2CeO_2Y_2O_3$) [7,8]. The $NiCrAlCoY_2O_3$ bond layer was deposited with a plasma gun speed of 250 mm/s and the $ZrO_2CeO_2Y_2O_3$ ceramic coating layers at plasma gun speeds of 250 mm/s, 350 mm/s and 500 mm/s on cold and preheated substrates with temperature of 160-180ºC. The specimen for tensile testing consists of two paired samples, Ø25x50mm in size, on one of the samples a plasma spray coating was deposited and on the other adhesive was applied, Figure 2. Before pairing and gluing of the samples a control and quality check of the deposited coatings on the substrates was performed, because for testing, the coatings in deposited state should not peel off, separate at the edges of samples or have cracks. In order to increase adhesion surface, the paired samples were roughened using the same parameters used for roughening the samples on which the coatings were deposited. Samples with the deposited coatings are not roughened. For gluing of the sample an adhesive (glue) was made based on resin and additives. Components of the adhesive were: resin LY 556, herter NT 972 and additive Al_2O_3 TiO_2. Resin LY 556 was mixed with component NT 972 in a weight ratio of 100:27 and then the additive Al_2O_3 TiO_2 was added in weight percent of 20% of the total weight of the resin. The prepared adhesive was applied in a thin layer on the roughened samples. Fixation and gluing was done in a tool, made according to the Pratt & Whitney standard, of aluminum alloy so that five sets of specimens were glued in it at once [1,9]. After alignment and clamping of samples, the tool was put in a chamber furnace heated to a temperature of 80°C. During gluing the tool with the samples was held at an angle of 30 degrees in the furnace. Parameters for gluing of samples were: gluing at 80°C for 1 hour, gluing at 140°C for a period of 2 hours and 20 minutes, and cooling of the tool with glued specimens in the furnace to room temperature. Before the tensile testing the excess adhesive was carefully removed from each set of specimen joints. For tensile testing of specimens adapters were used designed so that during the tests they ensure elimination of shear forces. Figure 2 shows the scheme of the adhesive tensile test [1,9].

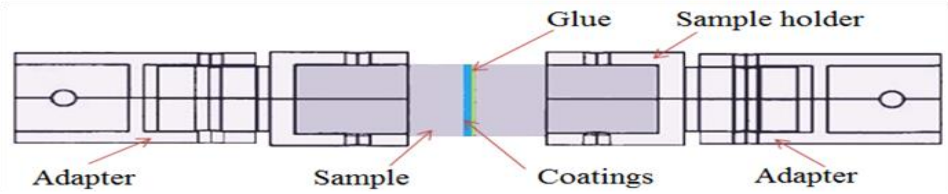

Figure 2. Schematic representation of the adhesive tensile test

Testing of specimens was done at room temperature with tension speed of 1 mm/min. Five specimens were used for testing each time. The paper presents the mean values of adhesive bond strength.

RESULTS AND DISCUSSION

Table 1 shows the rate of deposition of coating layers, the mean values (of coating thickness, porosity in the ceramic coatings and adhesive bond strength) and fracture mechanisms. In all test samples the crack fracture extended horizontally along the substrate / bond coating interface. There was no fracture through the bond layers at the bond coatings / ceramic coatings interface and through the layers of ceramic coating in any of the samples. The fracture mechanism for all deposited coating systems was adhesive at the substrate / bond coating interface. Figure 2 shows a representative example of a broken specimen. For all deposited coating systems high levels of adhesive bond strength were measured. The measured values were directly related to the stress states of the deposited layers and the proportions of porosity in the oxide lamellae. The stress states and porosity of the coating layers were controlled by the substrate temperatures and deposition rates of plasma spray layers.

Table 1. Adhesive bond strength, and fracture mechanisms of plasma spray $NiCrAlCoY_2O_3$ / $ZrO_2CeO_2Y_2O_3$ coatings

Plasma gun speed (mm/s)	Metal substrate temperature (°C)	Coating thickness (mm)	Ceramic coatings porosity (%)	Adhesive bond strength (MPa)	Fracture mechanism
250	21-23	0.557	17.89	40.9	Adhesive fracture at the substrate / bond coating interface
	160-180	0.543	15.11	47.5	Adhesive fracture at the substrate / bond coating interface
350	21-23	0.552	16.34	46.2	Adhesive fracture at the substrate / bond coating interface
	160-180	0.535	13.45	53.1	Adhesive fracture at the substrate / bond coating interface
500	21-23	0.567	15. 9	48.7	Adhesive fracture at the substrate / bond coating interface
	160-180	0.549	12.63	54.3	Adhesive fracture at the substrate / bond coating interface

Figure 2. Fracture mechanism at the substrate / bond coating interface.

The highest values of adhesive bond strength have the coatings deposited with a plasma gun speed of 500 mm/s on preheated substrates, which enabled the deposition of layers with the lowest stress condition and proportion of micro pores.
Higher plasma gun speed deposits thinner layers of coatings which introduce less heat and reduce the temperature differences in depth of the deposited coating and the substrate, and thus input less residual stress into the coating and at the interface with the substrate [3,10].

CONCLUSION

Based on the obtained values of adhesive bond strength and fracture mechanisms of the $NiCrAlCoY_2O_3/ZrO_2CeO_2Y_2O_3$ plasma spray coatings system the following conclusions may be drawn:

- Measured adhesive bond strengths between the coatings and the substrate surfaces, which are crucial to the functionality of the coated working parts, showed that the deposited coatings system meets all the criteria set in the standard Pratt & Whitney (PN 582005).
- Small amounts of heat input and uniform heat distribution in depth of the coatings in the ceramic coatings and on substrates surfaces influenced the formation of a smaller proportion of residual stresses and their more uniform distribution, as confirmed by the high values of adhesion strength.
- Examinations of the coatings systems have shown that the cohesive strength of all the deposited layers is good and that it is greater than the adhesive bond strength.

Impeccably obtained test values of adhesive / cohesive bond strength of the $NiCrAlCoY_2O_3$/ $ZrO_2CeO_2Y_2O_3$ coatings ensures their durability and justifies their use on functional working parts in exploitation.

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MAINTENANCE AND EFFECT OF MACHINES WORKED ON CONSTRUCTION SITE

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Abstract: The paper explained meaning and importance of the impact of construction machinery due to the specifics of their use. Describes how organization of maintenance activities of machines on construction sites and points to the impact this has on their performance. Accent was placed on possibilities of improving existing practice of building contractors and emphasized need for monitoring of achieved results, development and continuous updating of internal databases which are basis for planning and decision-making on implementation of mechanized work.
Key words: construction machinery, costs, maintenance, planning, effect

1. SPECIFICS OF USE AND MAINTENANCE OF MACHINES WORKED ON CONSTRUCTION SITES

Machine performed processes are often critical for deadlines and have a lot participation in implementation of construction projects, especially in engineering and new construction (up by earth and concrete works). Construction machinery has a number of important special features in relation to use and maintenance of machines in industrial plants, and there are certain similarities with machines in other industries (e.g. mining, forestry and shipbuilding). Usage of machines on building sites most is characterized by:

- Various characteristics of completed tasks over lifetime of a variable operating conditions (each project is unique);
- Work in workplaces temporary (change of work - from site to site, and at one site often more places of work);
- Use of machines that are not always optimal choice for a type of tasks (because of existing amount of work is not worth bringing another machine);
- Work mostly outdoors (exposure to different weather conditions);
- Disparity amount for implementation over a long operating time (often and downtime);
- Dislocation of works of the central places of machines, and consequently need for transport to any construction site (sometimes requires assembly and disassembly) and organization of maintenance activities of machines at each site.

For reliable cost planning work and for scheduling implementation is necessary to know impact of machines intended to be used, and that effect of specific site conditions of work. Unit labour costs of machines are direct costs and are calculated in the unit price analysis as the product cost hours of work a particular machine (how much contractor) and the norms of time, which should be inversely proportional to size of average realized performance. The duration of each activity expressed in working days deterministic is calculated as the quotient of product of amount of work and norms of time and the product of number of planned resources and number of working hours per day. Similarly it can be for a given operating time determined by required number of machines for a particular activity. Knowledge of effect it is necessary to realistically determine tasks to be implemented with available resources, in particular conditions at a given time, and to be able to harmonize the work of machines that work related.

2. PLANNING PERFORMANCE AND RELIABILITY OF CONSTRUCTION MACHINERY

Effect of one or more machines can be defined as amount of work satisfactory quality, or product, expressed in adequate accounting units (m^3, m^2, m, pc, t), which is performed per unit time, which is usually one hour. In construction practice more common problem are lack of knowledge on impact needed for planning costs and time, or lack of appropriate norms. Before 30-40 years there are general, national norms for construction machinery (e.g. [12]), but today – the state is not interested in making such norms, and considering a lot of different machines used, it would be an extremely extensive venture. Therefore, every company should create their own, internal norms for work performed by machines that use and/or have relevant data for calculation of their planned performance.

Because of the introductory mentioned reasons, planning the impact of construction machinery is not easy. Usually there are some data from the manufacturer of the basic technical effect, i.e. theoretical effect (E_t), but not on the performance that can be achieved in concrete terms on a construction site, so-called planned or practical effect (E_p). The theoretical effect arises from the structural characteristics of machine, such as power, speed in operation, capacity and size of tool. However, this effect can actually be achieved only with a new machine, in almost ideal conditions and for a short time (up to 1 hour).

Planning effect depends on technical characteristics of each machine (i.e. E_t), but also of various specifics of working conditions at each site. Studies have shown that greatest impact on performance are technical parameters of machines, organization and experience, fatigue, health status and motivation of workers, but at least weather conditions [13]. If plan was good and there were no unforeseen impact on execution of work, then they realized effect should be approximately equal to the planned effect.

Although there are stochastic models for determining size of the impact of construction machinery (based on principle of equilibrium statistical series relating to quantitative characterization of random events over random variables) [7] [8], they are applied only to the various theoretical, and in civil engineering practice "maximum range" is a deterministic calculation of impact. Stochastic models are more specific, but give almost identical results and are quite complicated [8]. Deterministic calculation implies multiplication hour theoretical effect (for machines that run cyclically this effect is calculated as product of the number of cycles per hour with the amount of work to be done on average in one cycle) with a series of correction coefficients ($E_p = E_t$ x k_1 x k_2 x to x .... k_n) whose dependent of machine type and of application characteristics. [4] [6] [9] [10] [14] [15].

There are more similar methodology for calculating performance machines (with different coefficients of correction and their value), of which those of known machine manufacturers give greater effect sizes calculated. For example, in relation to article presented procedure, budget *Fiatallis* for excavator with bucket of 1.0 m^3 gives 20%, 36% of budget of *Komatsu*, *Caterpillar*'s 48%, a *Liebherr* 53% more performance, while *Handubuch BML* gives 11% lower calculation impact. [9]

The usual correction coefficients to determine the impact of construction machinery are listed in Table 1, according to limits of their range in size can be seen that up can be more than ten times smaller than Tues. The maximum number of coefficients and largest reduction effect is at earthmoving. When calculated effect of operating time is longer than one hour is necessary to take into account higher percentage of unused working hours in these long periods of use of the machines. As amount normally expressed without taking account of material plus soils (clay material in a fused state) effect should be even cheaper by multiplying coefficient of friability whose size is inversely proportional to percentage of soils.

For all machines for safety may not always be in perfect condition (vehicle travelling on public roads, cranes) calculated effect is reduced due to anticipated failure or deterioration of k_{dm}. As seen in Table 1 of this reduction can be up to 29% of theoretical performance and amount of impairment effect may be even larger than size at the end of calculated planned effect. However, such a calculation was arbitrary because it is based solely on the current number of operating hours. In general, if machines have not had extraordinary damage new are those with up to 2000 hours and for them there is no impairment effect, machines with 2000-4000 hours of operation are considered to be preserved and their effect is reduced by 9% due to deterioration, machines with 4000 - 6000 hours of operation are considered worn out and their effect is reduced 20%, and machines with more than 6000 hours of some of literature [12] declared as "totally worn out" and their effect is reduced by 29% - correction coefficient k_{dm} includes assumption of age or condition, and of maintenance of machines and allows planning values individual performance of machine in terms of assumption of reliability. Reliability, depending on the use of machines and operating conditions, can have multiple meanings and characteristics, for example, trouble-free operation, durability, flexibility and others. Reliability single machine as a technical system depends on reliability of functioning of its assemblies, subassemblies and parts, and determination of their interactions and relationships between them, and this is a direct effect of preservation. [9]

Failures in machines are often the result of wear, tear or aging, but their performance declining constantly and gradually. Only numerical assessment of damage degree in worn parts solves the issue of evaluating and calculating reliability of parts, and this requires knowledge of the law to wear and tear. External factors (nature of body rubbing, initial play, kind of friction, at partial load on surface friction velocity, environment, and in particular oil and ambient temperature) significantly affect interaction of internal (plastic deformation and release of heat exchange surface roughness, structure, mechanical properties and properties film, accumulation of energy in material under cyclic load may) and output factors (rate of removal, intensity of spending, linear wear). However, this relationship is very difficult to express in analytical form, but on basis of empirical data defined range limits for certain types of damage, under certain conditions. [6]

Table 1. The most commonly used ratios to correct the theoretical impact of construction machinery with the usual border sizes. [9] [12] [14] [15]

Coefficients of correction - kind of influence on effect	Limit size	Remark
$\mathbf{k_{ut}}$ – utilization of working time	0,75 – 0,92	Taken into account in all machines
$\mathbf{k_{ow}}$ – organization of work on construction site and management	0,5 – 0,83	
$\mathbf{k_{dm}}$ – deterioration (according to the previous number of worked hours)	0,71 – 1,00	
$\mathbf{k_{ft}}$ – average filling of working tools	0,40 – 1,20	The effect of working conditions and the task (characteristics of the material, terrain, etc.) on the amount work performed in one cycle of work, or the work speed - for machines that run continuously.
$\mathbf{k_{km}}$ – knife of machine (for machines with a knife no k_{ft})	0,40 – 1,20	
$\mathbf{k_{ak}}$ – blade pitch angle to direction of machine movement	0,60 – 1,00	
$\mathbf{k_{lm}}$ – loss of material sliding along section (dozers)	0,50 – 0,95	
$\mathbf{k_{st}}$ – slope of terrain travelled by it full machine (dozers)	0,40 – 2,20	
$\mathbf{k_{at}}$ – altitude	0,90 – 1,00	
$\mathbf{k_{mm}}$ – moisture of material (earth) with which to manipulate	0,30 – 0,95	
$\mathbf{k_{ws}}$ – convenience of working space for maneuvering of machine	0,95 – 1,00	
$\mathbf{k_{ar}}$ – angle rotation about an axis in working cycle (only a crawler)	0,71 – 1,26	
$\mathbf{k_{hf}}$ – average height of working face at work	0,80 – 1,00	
$\mathbf{k_{lv}}$ – suitability of transport vehicle loading (1.00 if unloading on pile addition processing machine)	0,83 – 0,91	

Because of many influences it is difficult to predict exact border between state of work and dismissal. More realistic solution provides introduction degree of belonging to state of the elements in work or dismissal. These balances represent Fuzzy events that describe the elements Fuzzy sets. Failures happen by accident, but are probabilistic events for which applies probability theory Fuzzy events. Several authors have in their papers applied this theory to determine reliability and maintenance management of technical systems [11] what are considered construction equipment.

3. MAINTENANCE MACHINES ON CONSTRUCTION SITES

In the 21st century, developed advanced strategies maintenance of technical systems, but they are as yet not applied in machinery on construction sites.

In relation to occurrence of faults, maintenance of construction machinery could be corrective and preventive. Corrective maintenance is intervening in order to eliminate unexpected failures. It is always important to remove causes that led to their creation. It can be by replacing individual parts of machine or repairs (adjustment, lubrication, cleaning and other processes).

Preventive maintenance works according to an established plan. Planning maintenance of machines based on knowledge of all relevant data about them (on application, functioning and management, carried out repairs, mode of transport, preservation, accessories and spare parts, instructions for setup, maintenance and lubrication, test records machinery, norms for maintenance, etc.). They plan to check-ups, cleaning and lubrication, search and elimination of weak points and small, medium and major repairs and capital repairs.

One-shift maintenance procedures (e.g., visual inspection and lubrication performed alone machine operator) are performed before or after each work shift, periodic maintenance is carried out by manufacturer of the machine (checks without disassembly, cleaning and small repairs, lubrication, replacement and amendment of certain elements and settings in which along with machine operator and mechanic participate and associate - usually after 50, 100 or 200 or 250, 500 and 1000 or 2000, or 3000 hours of operation, and always includes all necessary actions to maintain for a short period containing) [16] and seasonal maintenance is usually performed twice a year (preparing machine for work in autumn-winter and spring-summer). Before storing machine needs to be carefully cleaned, paint the affected area, etched metal parts protect corrosion protection, rinse system and fill it with new operating fluids, and conduct regular operations of periodic maintenance and preservation. Greater complexity of machines and higher intensity of use in severe operating conditions (harder materials) requires more maintenance time, greater expertise and procedures that are performed in specialized workshops. Capital repair involves completely dismantling machine, review and selection of elements to those that can still be used, those who repair and those that must be replaced; significant savings with using modular units that were previously taken from other machines and renovated. [6] The decision on repair of such high returns are based on technical commission (established state machine) and economic indicators.

Preventive activities can be undertaken on basis of the time limit (where spending alike when it comes and when it does not work) or a specified number of hours worked mileage or consumed kWh. Studies have shown that the wear parts 37% more correlated with energy consumption than with hours of driving or km [6] or as early warning indicators of possible errors and delays. Such indicators are obtained by checking the current situation and the working performance of the machine which is characterized by predictive maintenance. Regular maintenance activities while there has been no failures in work of reducing cost of ownership and operating costs, [5], since it avoids damage that occurs when work is interrupted due to a malfunction. Preventive and predictive maintenance, especially in various activities showed that leads to a significant reduction in required quantity of spare parts and reducing downtime and increasing productivity and profits. [1] Possible ways of organization of the maintenance of machines in construction companies (according to [16]) and their characteristics are listed in Table 2.

Table 2. Models of organization maintaining machinery on construction sites

Org. model	Characteristics of maintenance and suitable cases for application
Centralized	Only one maintenance department with workshop and tool room (usually in the central drive companies) that operates very well (good equipment, quality experts, facilitated the collection and processing of data), but the problem is worse in connection with all sites and places of machines on them (poor monitoring and responding to sudden failures).
Individually (decentralized)	At each site with machines is service maintenance with a workshop, appropriate to the type and number of used machines. Problem is that construction companies rarely have enough for professionals, but multiplied equipment is generally less utilized. Therefore, such maintenance, generally, organized only for larger, separate site.
Combined (centralized with remote groups to maintain)	Small maintenance services are organized at each site (well aware of the condition of machines and react quickly), but in the case of complicated interventions work experts from the central departments. Current maintenance is carried out on the site (with mobile workshop), and investment maintenance is usually performed in the central workshop or service.
Cooperative (outsourcing)	Maintenance is partially or totally outsourced to specialized services, which may be the manufacturer of the machines. The situation is similar when it hired the machines, but on their maintenance care owner. This is good for small companies that do not have the specialists and equipment.

The organization of maintenance should always be consistent with - number, type and arrangement of machines and need to be flexible because of frequent changes of tasks to be fulfilled. Organization of maintenance should include planning and implementation of technology to link maintenance, planning, supply of spare parts and equipment, training of service and user machines, and organization of warehouses and workshops to support on high and low level of maintenance, all accompanying documents. In planning cost of using machines, as well as the cost-benefit analysis of their purchase, must be, to include maintenance costs. Quite simply rough guidelines determine size of maintenance activities on construction machine on annual basis in relation to accounting cost C (factory price plus the cost of procurement and delivery) according to the model: [10]

- For basic maintenance 0.06 x C in stationary machines, 0.09 x C at transport machines
- For medium maintenance 0.08 x C in stationary machines, 0.11 x C at transport machines
- To maintain a large 0.10 x C in stationary machines, 0.13 x C at transport machines

With this should be taken into account and the cost of the test run, which can be assumed in the amount of approximately 2% of the ex-works price of the machine and costs of procurement and replacement of wearing parts (proportional to the amount and heaviness of working conditions). [10] Orienteering can be assumed that total cost of hours of construction machinery cost of their maintenance is 9-10% [3]. In the opinion of Assakkafa [2] even up to 35% of the costs of construction machinery should focus on maintenance and repairs, because savings on it can only be short-term as it will lead to bad technical condition of machine, reducing impact of low-quality work and increased risk of injury and environmental disasters, protracted downtime due to failures on machines, etc. [8]

3.1. Possibility for Improved Performance and Reliability of Construction Machinery

It is important to know the usual time losses occurring in the implementation of construction projects in order to know to plan those to whom it cannot act, and to minimize or avoid (almost never completely) the negative effect on those who are in some way can act. Losses time that according to natural causes (most weather conditions) and technological nature (changes jobs at the site, changes haulage roads, uneven and partly of load, etc.) Cannot be avoided, but only good planning and organization (adaptation) reduced . Delays that can be avoided with better preparation, management and monitoring arise due to lack of materials, spare parts and driving energy, poor distribution on the construction site, inconsistent workflows, poor choice of machines and tools, machine failures, lack of training, lack of motivation and discipline employees etc.

It is difficult to act on the working conditions (characteristics of materials, space and time, and the availability of certain resources in company and in market), but it is always possible to have a positive effect on other factors that influence effect achieved. Such measures are listed in Table 3:

Table 3. Effect of possible measures on increase the impact of construction machinery

Measures to increase the impact	Action over:
- Selection of optimal machine (between available) for required tasks (in order to give maxim. effect)	T_C, speed
- Preparation and planning of work - number and spatial distribution of machines, compliance effects machines that work-related, path of action moving machine at work, backup in effect in accordance with the severity of working conditions (10 - 30%)	T_C , speed , k_{ow} , k_{ws} , k_{lv} , k_{hf} , k_{ar} and k_{ws}
- Appropriate preparing ground for the operation of machines (e.g. in earthworks optimum moisture)	T_C , v and k_{mm}
- Ensuring regular supply of necessary energy and auxiliary materials for machinery	k_{ow}
- Selection and training of workers who work with machines, and their motivation (duly rewarding and communication) in order to take advantage of more and kept machines	T_C , k_{ut} , k_{ft} and k_{dm}
- Timely preventive maintenance and rapid response in case of corrective action (with help of technical diagnostics, machine operators and maintenance of specialized mechanics)	k_{dm}
- Monitoring of work - to ensure discipline and collection of data on realized and actual operating conditions (for planning future work assignments)	K_{ut} & *reliability*

Based on analysis of the costs and impact on performance of machines should choose the most appropriate way of maintenance. You should also consider feasibility of investing in purchase of new, better machines, which provide opportunity to achieve greater effects, more suitable for maintenance (easier maintenance and self-maintenance, and embedded devices for technical diagnostics) and use IT to monitor job performance.

Monitoring work is important for performance evaluation work (reward - motivation of workers) and to determine the norms and weather data for planning effect machines (working cycle - T_C or speed, and correction coefficients). The coefficient of deterioration should be defined according to the actual situation and the reliability of maintenance of each machine at the construction site. To create norms uptime of machines operating in repeating cycles of shorter duration is the most suitable chronometer method (measured only productive time, but subsequently has to add other average spending of time), and, as a supplementary method, it is good to use the working reports in uniform patterns the water anyway due to the normal course of business sites and companies. It is vital to establish a rational system of storage and supply with spare parts, because it has a huge impact on the reliability and cost. Planning is always a process and the process for construction machinery shown in Figure 1;

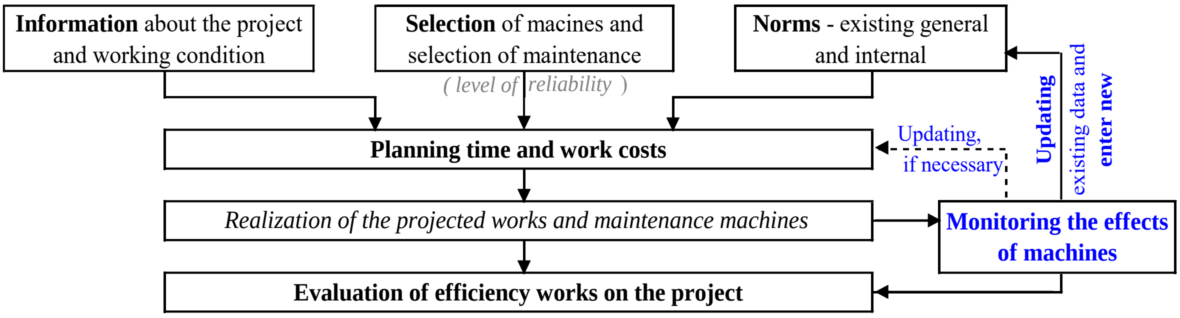

Figure 1. The process of planning the use of construction machinery

4. CONCLUSION

Achieving greater impact machines generally for contractors means lower costs and shorter deadlines. Data listed in article see importance of maintaining performance of construction machinery and share cost of maintaining - total cost of using machine. Maintenance affects safety of workers, and safety is one of factors of motivation. For all these reasons, economically works machines on site require prior well organize and plan their use and maintenance. Optimal choice of machines, as well as their use and maintenance, are among crucial problems and tasks of construction project management and organization of construction production. [12]

To plan a performance of machines recommended parallel use norms (primarily internal, and if there are adequate general norms and they should be taken into account) and budget provided for under influence of position and machine, calculated from actual sizes of correction coefficients.

Knowing positive and negative impact on performance of construction machinery in particular operating conditions it is important to be able to act on them in order to achieve higher productivity and that could be more realistically planned term and costs.

Positively can act from a position of leadership and the position of the machine operator and other workers, which is in the spirit of the totally productive maintenance (TPM).

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THE INTEGRATED SAFETY PERFORMANCE MODEL BASED ON SAFETY INDICATORS AND SAFETY LIFECYCLE

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Abstract: Systems approach in safety is applied during the analysis of complex safety systems and identification of key performance indicators. The integration of the safety system is necessary to enable efficient use of safety resources, and to take into consideration all technical, human and organizational aspects of safety. Safety lifecycle is an engineering process designed to optimize safety system and increase the level of safety. The main advantage of applying this model in real systems is increasing the effectiveness of the protection of employees and goods and the efficiency of safety resource use. In this paper, we describe the model for safety performance assessment of integrated safety systems, based on selected safety indicators and safety lifecycle.
Key words: safety, safety performance, safety indicators, safety lifecycle, integrated safety system

INTRODUCTION

Safety system is a complex combination of resources (people, materials, equipment, hardware and software components, data, information, knowledge, services) integrated with the aim to fulfill the specific needs related to the protection of human, material and immaterial goods. The system is human-made system, physical according to the form of existence, dynamic and open according to the relationship with the environment. Its main task is to achieve optimal conditions in working and living environment, which leads to: the effective discharge of duties in an appropriate work environment in which employees are protected from the harmful effects that can lead to injuries, occupational diseases or deaths; minimal impact of work processes on the environment from the point of pollutant emission, waste generation and use of non-renewable resources; taking into account the potential risk of natural disasters and catastrophes.
The essence of a successful safety system is to focus on the causes of adverse events, to prevent their occurrence, or to reduce to reduce negative effects of their appearance if they cannot be avoided. The safety system, its elements and interaction with the environment are presented in Fig. 1.

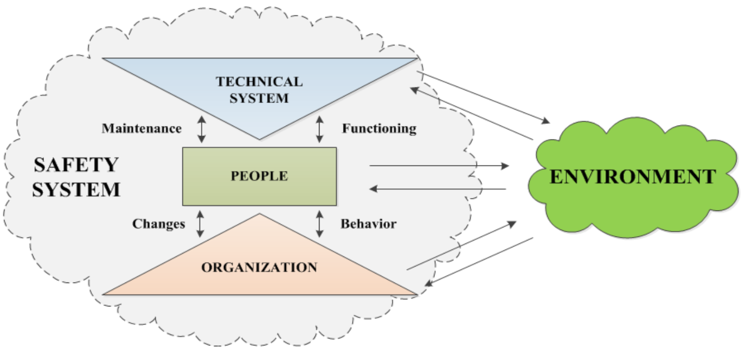

Figure 1. Safety system as an open system, and its environment

Many economic and social factors can influence decisions on safety, such as maintenance of devices and equipment and the implementation of certain measures. Therefore, the basic elements of the safety system are: technical and technological system, people (employees and employers), organizations and environment with which the system interacts (Fig. 1). Technical-technological system requires proper maintenance during the functioning. An organizational change and organizational safety culture influence the behavior of employees. The environment affects the safety system by certain norms and standards that must be applied in the safety system.

MATERIAL AND METHODS

Safety indicators

The level of safety is described by a set of indicators. These indicators describe the safety outcomes and some safety activities carried out with the aim of increasing the level of protection and education of employees, and preventing adverse events. A lot of indicators are used to describe the level of safety, general or special for a particular industry. These indicators describe human aspects in safety (e.g. human activities, human errors, etc.), technical aspects (e.g. system malfunctions, reliability, availability, maintenance, etc.), and organizational aspects (e.g. hierarchy of decision making in safety, organizational procedures, safety reporting, etc.). Also, there is also a significant impact of the environment in the form of standards that apply in a particular industry (e.g. ISO, OHSAS, ANSI, IEC or HACCP standards, etc.), that are in [1] included as environmental (external) indicators.
According to [1], the following factors are taken into consideration: technical factor, human factor, organizational factor, and environmental (external) factor. The most important indicators for every factor are presented in Table 1. Some other interesting indicators can be found in [2-5].

Table 1. Safety factors and indicators

The factor	The indicators	Type
Technical	The number of safety levels	Activity
	The number of failures of technical safety systems	Outcome
	The number of accidents	Outcome
	The intensity of maintenance	Activity
	Maintenance costs	Outcome
Human	The rate of injuries	Outcome
	An index of skills of employees	Activity
	The degree of compliance with operating procedures	Activity
	Employee satisfaction index	Activity
	The number of errors and omissions	Activity
Organizational	The efficiency of safety resource management	Activity
	The share of jobs with higher risk	Activity
	The number of controls of workplace safety in practice	Activity
	The annual average number of hours of employee training	Activity
	The number of guidelines for occupational health and safety	Activity
External	The level of safety technologies	Activity
	The level of implementation of legislation	Activity
	The number of implemented voluntary standards	Activity
	The number of available databases on accidents	Activity
	The amount of available funds	Outcome

Safety indicators by themselves, whether they describe safety activities, or safety outcomes, are not sufficient to improve the safety system or the level of safety. One of the solutions to increase the efficiency of the safety system is the integration of the system. The integration of safety systems increases the efficiency of safety resources consumption, and reduces cost and risks. The integrated safety system is important in organizations to efficiently use safety resources [6].

Lifecycle of integrated safety systems

The purpose of integrated safety system is to integrate technical systems with human resources, and to enable documented risk management. Integrated safety system conceptually means that safety is not treated as an independent entity, neither its technological nor human and organizational aspects. It requires a slightly different approach for safety interpretation, starting with the identification of activities and defining the concept of the system, its implementation or adaptation of the existing system, the continuous maintenance, improvement and development of the system.

To be able to achieve better efficiency of safety resources consumption and the highest possible level of safety, safety lifecycle was introduced. As safety system is usually treated as a complex socio-technical system, only its technical part was initially analyzed and described by means of safety lifecycle [7-11]. Safety lifecycle is and engineering process designed for systematic specification, development and optimization of a safety system. The most prominent standards that include description of safety lifecycle are IEC 61508, IEC 61511, ANSI/ISA S84 and EN 50126 [7-10].
Initially, it was applied for technical part of safety system. The lifecycle also includes the effects of the environment where this system is functioning, organizational structure that defines work activities, as well as people that perform certain activity, at least in the context of the operation and maintenance of safety instrument systems. Safety lifecycle of integrated safety system is presented in Fig. 2.

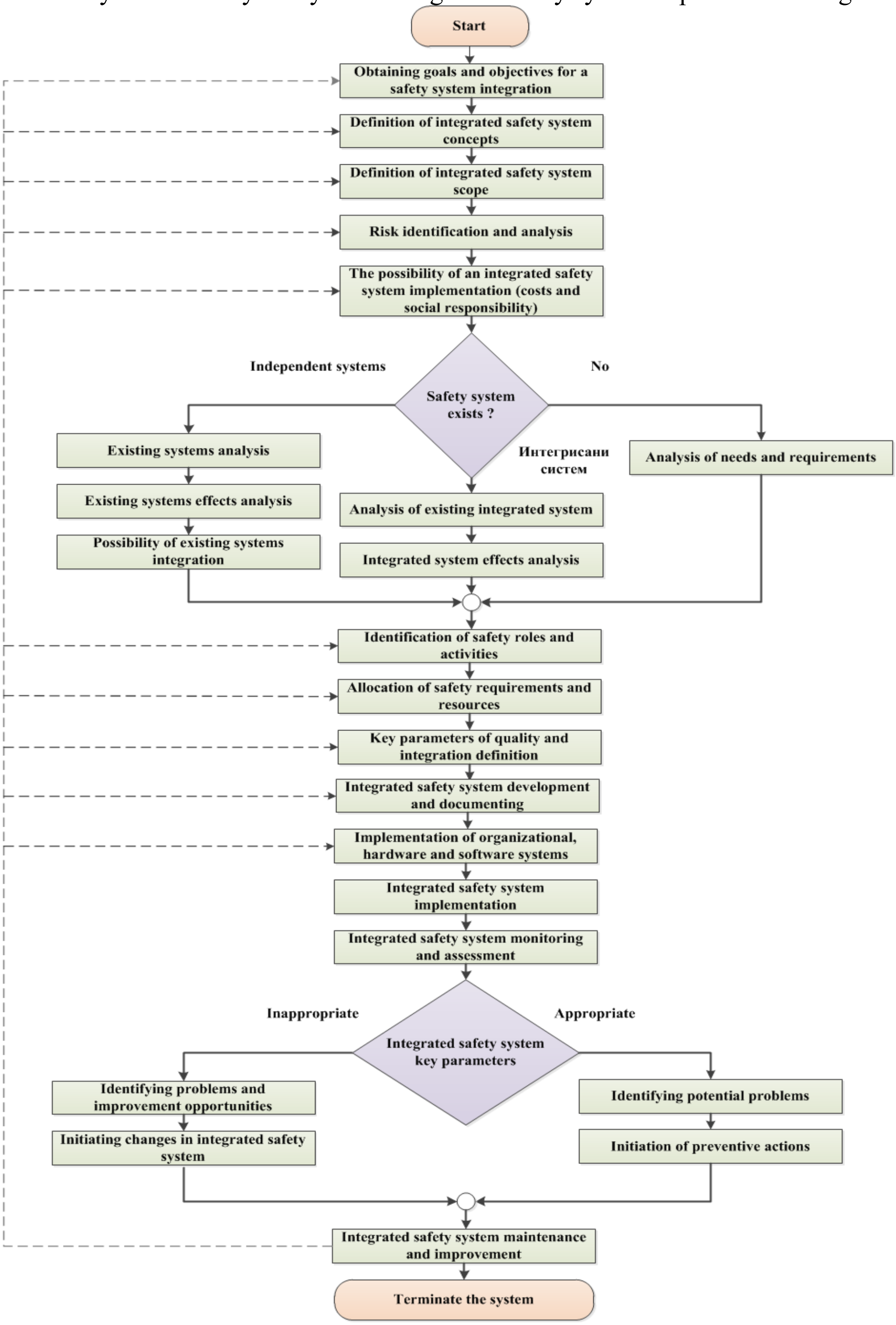

Figure 2. Safety lifecycle of integrated safety systems with safety performance assessment

The lifecycle starts with identification of goals and purpose of the system, and definition of concepts and the scope of the system. Identification of potential risks is the most important phase during the creation of safety system. The risks, cost and social responsibility are defined as the most important criteria for definition of integrated safety system [1].

Selection of key safety indicators

Analysis of the effectiveness of the safety system is based on several criteria. Multidisciplinary and interdisciplinary character of safety requires that more people participate in design, implementation, analysis and improvement of the safety system. These processes are based on the analysis of multiple criteria (attributes or indicators), so it is natural to employ methods of multi-criteria (multi-attribute) analysis. Among others, the analytic hierarchy process (AHP) and its fuzzy extension, fuzzy analytic hierarchy process (FAHP) are applied for occupational safety decision-making problems and for determining priorities of criteria and indicators in occupational safety systems.
It is recommended that the number of indicators is limited, so that each of the indicators could have a sufficient impact on the efficiency and effectiveness of a safety system. In [1], proposed number of key performance indicators is 20, or 5 indicators for each factor. In some situations, “less is more”. The complexity of the safety system sometimes requires a larger number of monitoring indicators than proposed, or an update of the number and types of indicators that are taken into consideration when deciding on the safety system.
It is recommended that the participation of a larger number of experts in the selection of indicators. Recommended minimum number of experts is 5, to cover all social, technical and organizational aspects of a safety system.
Method of selection of appropriate indicators for evaluating the integrated system of protection under the protection of the life cycle takes place in two steps:

1. Selection of key indicators using the experts’ ranking, where experts rank n indicators, assigning them ranks from 1 to n;
2. The ranking of key indicators using a method of multi-criteria analysis, by comparing the selected key indicators in pairs, or by using some other methods of identification of weights of indicators.

Table 2 shows some specific methods that can be used during the ranking of key safety indicators.

Table 2. Multi-criteria methods

Category	Weighting methods
Unique synthesizing criteria	Analytic hierarchy process (AHP), Data envelopment analysis, Fuzzy Analytic hierarchy process (fuzzy AHP), Grey relational analysis, Multi-attribute value theory (MAVT), Multi-attribute utility theory (MAUT), The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), Utility theory additive (UTA)
Outranking	Elimination and Choice Expressing Reality (ELECTRE), Preference ranking organization method for enrichment evaluation (PROMETHEE), Organization, Rangement Et Synthese De Donnes Relationnelles (ORESTE)

In [1], it is proposed the method for selection and ranking of occupational safety indicators based on the expert evaluation method and the fuzzy analytic hierarchy process (fuzzy AHP). Also, group decision-making based on aggregation of individual judgments or individual ranks is recommended.

DISCUSSION

Safety system is a complex system that needs an engineering approach for specification, development, assessment and optimization, and continuous improvement. The main goal of the improvement process is increasing the level of safety, reducing the number of accidents, occupational injuries and illnesses related to work, and at the same time using effectively all available safety resources.

Based on the described algorithm, the existing safety systems in organization are analyzed. They can be modified, and included as parts of integrated safety system. Based on defined requirements, new roles, models of management and control, and phases are identified. More precise definition of roles, processes and safety activities simplifies implementation of organizational mechanisms and safety instrumented systems, with improved safety requirements allocation and connection with unique work processes.
Detailed development and documentation of integrated safety system becomes the most important, and also definition of key performance indicators of quality of safety system, as well as the quality indicators of the process of integration. The next step is implementation of integrated safety system. The application of the system is connected with the adequate monitoring and assessment of the system, identification and benchmarking of key performance indicators.
Inappropriate values of key performance indicators of the system affect the occurrence of adverse effects. Identification of these problems can initiate improvement and changes in the system. Even when key parameters of the system are appropriate, some leading indicators can be used for identification of potential problems and for initiating preventive activities [12]. This double confirmation mechanism is the most important in maintenance and continuous improvement of integrated safety system.
Based on identified problems, expanding the scope and purpose of the system is initiated, additional concepts are defined, and scope of the system is expanded.
Further, the possibility of realization of a modified system is assessed, the analysis of the effects of the existing system is applied, and new roles and / or phase are introduced. Also, it can be proposed the introduction of new hardware and software solutions, allocated new requests for protection and defined additional key parameters of safety and integration quality.
The ranking of key safety performance indicators is based on the AHP or fuzzy AHP method. It can be also done by applying the other methods, such as interval-based AHP method, TOPSIS, VIKOR, ELECTRE, PROMETHEE, or the combination of several methods (e.g. AHP and goal programming, or AHP and TOPSIS).

CONCLUSION

Industrial development has demanded changes in the safety approach, is caused by a sudden increase in risk and the number of accidents. Thus, safety approach was changed in accordance with technological challenges, to enable use of new approaches and methods of risk management. Incremental development of safety is not enough good, because it is necessary to solve certain problems immediately, regardless of the lack of prior experience on them, with a broad understanding of the potential causes and methods of prevention of adverse events.
In this paper, the integrated safety performance model based on safety indicators and safety lifecycle is presented. It is based on systems analysis and continuous improvement of integrated safety system, monitoring of key performance indicators values (leading and lagging safety indicators). Safety indicators are not enough to make adequate decisions. Some decision-making procedures and methods, based on multiple available criteria, are needed.
The main problems in safety management are limited safety resources and the existence of multiple independent systems responsible for the quality and variety of forms of safety and security (occupational safety, fire protection, environmental protection, and safety instrumented systems). A lack of coordination between these independent systems leads to inefficient use of resources, and inadequate data exchange to ignore certain potential causes of adverse events. The problem can be eliminated by applying the systems approach supported by safety lifecycle and safety benchmarking based on indirect and direct safety performance indicators, as described in presented model.

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BACKGROUND OF A VIBRATION MEASUREMENT TO HAND-ARM VIBRATION, HEALTH SURVEILLANCE AND HEALTH RISKS

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Abstract: In this paper we will discuss obout undesirable human vibrations and the effect of over-exposure to human vibration. Health surveillance is about putting in place systematic, regular and appropriate procedures for the detection of work-related ill health, and acting on the results. The aims are primarily to safeguard the health of workers but also to check the long-term effectiveness of control measures.
Key words: Hand-arm vibration, Measurements, Health effects

INTRODUCTION

Vibrations arise when a body oscillates due to external and internal forces. In the case of hand-arm vibration, the handle of a machine or the surface of a work piece vibrates rapidly, and this motion is transmitted into the hand and arm. Hand-arm vibration (HAV) is vibration transmitted to the hand and arm during the operation of hand-held power tools and hand-guided plant, or while holding materials being processed by plant. HAV is commonly experienced by workers who regularly use power tools including jackhammers, chainsaws, grinders, drills, riveters and impact wrenches. The risks from hand-arm vibration affect people across many industries and occupations. The risks are greatly increased with use of higher vibration equipment and with prolonged and regular use of the equipment. However, investigations have shown that vibration hazards can be controlled and risks reduced by good management. Directive 2002/44/EC gives 'exposure limit values' and 'exposure action values'. It also specifies employers' obligations with regard to determining and assessing risks, sets out the measures to be taken to reduce or avoid exposure and details how to provide information and training for workers. Any employer who intends to carry out work involving risks arising from exposure to vibration must implement a series of protection measures before and during the work. The Directive also requires the Member States of the EU to put in place a suitable system for monitoring the health of workers exposed to risks arising from vibration.The Vibration Directive sets an exposure action value for daily vibration exposure, above which it requires employers to control the hand arm vibration risks of their workforce and an exposure limit value above which workers must not be exposed

• a daily exposure action value of 2.5 m/s^2
• a daily exposure limit value of 5 m/s^2

However, there is some risk of hand-arm vibration injury where exposures are below the exposure action value. The Vibration Directive places responsibilities on employers to ensure that risks from hand-arm vibration are eliminated or reduced to a minimum [1], [8].

BACKGROUND A VIBRATION MEASUREMENT SYSTEM

Since man began to build machines for industrial use, and especially since motors have been used to power them, problems of vibration reduction and isolation have engaged engineers. Gradually, as vibration isolation and reduction techniques have become an integral part of machine design, the need for accurate measurement and analysis of mechanical vibration has grown. This need was largely satisfied, for the slow and robust machines of yesteryear, by the experienced ear and touch of the plant engineer, or by simple optical instruments measuring vibratory displacement. Over the last 15 or 20 years a whole new technology of vibration measurement has been developed which is suitable for investigating modern highly stressed, high speed machinery. Using piezoelectric accelerometers to convert vibratory motion into an electrical signal, the process of measurement and analysis is ably performed by the versatile abilities of electronics.

In many situations it will not be necessary to measure vibration magnitudes. However, it is important to know when to conduct measurements. Sometimes it may not be possible to obtain adequate information (from equipment suppliers or other sources) on the vibration produced by a tool or work process.
It maythen be necessary to make measurements of vibration in the workplace. Vibration measurement is a difficult and complex task. You may choose to make the measurements in-house, or to employ a specialist consultant. In either case, it is important that whoever makes the measurements has sufficient competence and experience [1], [8].
Human exposure to hand-arm vibration should be evaluated using the method defined in European Standard EN ISO 5349-1:2001 and detailed practical guidance on using the method for measurement of vibration at the workplace is given in EN ISO 5349-2:2001.
Measurements should be made to produce vibration values that are representative of the average vibration for a tool or process throughout the operator's working period. It is therefore important that the operating conditions and measurement periods are selected to achieve this. Where tools are held in both hands, measurements must be made at both hand positions and the highest value used for determining vibration exposure [1].
For HAV the triaxial sum of the acceleration experienced by the worker in the three axes (x, y and z) as shown in Fig.5 is used in calculation of the daily vibration exposure A(8). This is different from whole-body vibration (WBV) where the axis with the highest average root mean square (RMS) acceleration is used in calculation of the daily vibration exposure A(8).

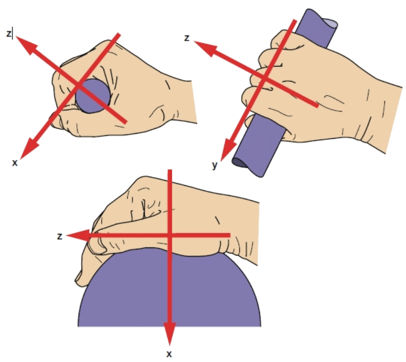

Figure 1. Axes of hand-arm vibration measurement [1], [8].

HEALTH EFFECTS OF HAV EXPOSURE

Workers exposed regularly to excessive hand-arm-transmitted vibration may be suffer in the long term with disturbances to finger blood flow and to the neurological and locomotor functions of the hand and arm. The term *hand-arm vibration syndrome* is used to refer to these complex disorders.
Hand-arm vibration syndrome has an impact on social and family life. Periodic attacks of impaired blood circulation will take place not only at work, but also during activities such as car washing or watching outdoor sports. Everyday tasks, for example managing small buttons on clothes may become difficult.
Vascular disorders, neurological disorders and bone and joints abnormalities caused by hand-transmitted-arm vibration are recognized occupational diseases in several European countries [6].

Vascular disorders

Workers exposed to hand-transmitted-arm vibration may complain of episodes of whitening (blanching) of the fingers (Vibration white fingers "VWF), usually triggered by cold exposure . This symptom is caused by temporary closing down of blood circulation to the fingers.

Various terms have been used to describe vibration-induced vascular disorders:
• dead or white finger,
• Raynaud's phenomenon of occupational origin,

• vibration-induced white finger
Initially attacks of blanching involve the tips of one or more fingers, but, with continued exposure to vibration, the blanching can extend to the base of the fingers. As the blood flow returns to the fingers (this is commonly initiated by warmth or local massage) the fingers turn red, and are often painful. The blanching attacks are more common in winter than in summer. The duration varies with the intensity of the vibration stimuli from a few minutes to more than one hour.
If vibration exposure continues, the blanching attacks become more frequent affecting more of the fingers. The attacks may occur all year around with quite small reductions of temperature. During a blanching attack the affected worker can experience a complete loss of touch sensation and manipulative dexterity, which can interfere with work activity increasing the risk for acute injuries due to accidents[6].
Epidemiological studies have demonstrated that the probability and severity of blanching is influenced by the characteristics of vibration exposure and duration of exposure, the type of tool and work process, the environmental conditions (temperature, air flow, humidity, noise), some biodynamic and ergonomic factors (grip force, push force, arm position), and various individual characteristics (individual susceptibility, diseases and agents such as smoking and certain medicines
that affect peripheral circulation)

Neurological disorders

Workers exposed to hand-transmitted arm vibration may experience tingling and numbness in their fingers and hands. If vibration exposure continues, these symptoms tend to worsen and can interfere with work capacity and life activities. Vibrationexposed workers may exhibit a reduction in the normal sense of touch and temperature as well as an impairment of manual dexterity [6], [9].

Musculoskeletal disorders

Workers with prolonged exposure to vibration may complain of muscular weakness, pain in the hands and arms, and diminished muscle strength. These disorders seem to be related to ergonomic stress factors arising from heavy manual work. Excess occurrence of wrist and elbow osteoarthritis as well as hardening of soft tissue (ossification) at the sites of tendon attachment, mostly at the elbow, have been found in miners, road construction workers and metal-working operators of percussive tools. Other work-related disorders have been reported in vibration-exposed workers, such as inflammation of tendons (tendonitis) and their sheaths in the upper limbs, and Dupuytren's contracture, a disease of the fascial tissues of the palm of the hand [6],[9].

HEALTH SURVEILLANCE TECHNIQUES

Health surveillance is about having procedures to detect work-related ill health at an early stage and acting on the results. The main aims are to safeguard the health of employees (including identifying and protecting people at increased risk), and also to check the long-term effectiveness of control measures. In the case of hand-arm vibration, one of the specific aims is to prevent employees developing an advanced stage of hand-arm vibration syndrome (HAVS) associated with disabling loss of hand function. It is possible that your employees who are exposed to vibration may have mild symptoms of HAVS. If they are not aware that they have the disease, healthsurveillance can help them to recognise that the first symptoms of HAVS have started to develop [5],[9].

When is health surveillance required?

Health surveillance should be provided for vibration-exposed employees who:

• are likely to be regularly exposed above the action value of 2.5 m/s2 A(8);

• are likely to be exposed occasionally above the action value and where the risk assessment identifies that the frequency and severity of exposure may pose a risk to health; or

• have a diagnosis of HAVS (even when exposed below the action value).

If you are self-employed there is no legal requirement for you to have health surveillance for HAVS. However, it is important for your well-being, and for your ability to remain in work, that you identify any early signs of HAVS and take appropriate action. It is therefore recommended that you follow this guidance if you think you are at risk from vibration [5],[9].

What do I actually have to do?

You need to ensure that you achieve an effective health surveillance programme in the workplace, including co-operation from employees. When you plan to introduce health surveillance, explain to your employees and their safety or employee representatives what you are proposing to do and give them the opportunity to comment on your proposals. Employees need to be given information about the reasons for carrying out health surveillance and they need to understand their roles and responsibilities.

What do I need to do about the results of health surveillance?

You need to make a decision about an individual employee if the doctor advises you that they are not fit for work with exposure to vibration. The employee is at risk of developing disabling loss of hand function if exposure is allowed to continue. You should consider assigning the employee to alternative work where there is no risk from further exposure to vibration. If you are informed that an employee has been diagnosed with HAVS but is still fit for work with exposure to vibration, it is good practice for you to consider taking further action to reduce that employee's exposure. Health surveillance results should be used to check the long-term effectiveness of your control measures. If the number of employees with HAVS has increased, or if the disease is progressing in affected individuals, you need to review your risk assessment and action plan [5],[9].

What if no symptoms are reported?

If no symptoms are reported on the screening questionnaire, there is no need to refer the employee for further assessment, but they should complete the simple questionnaire again on an annual basis (Tier 2). HSE recommends that after three years of a vibration-exposed employee reporting no symptoms they should be referred for a consultation with an occupational health nurse to provide an opportunity to explore more fully any possible symptoms that the individual may have overlooked.

What type of records should I keep?

You should keep a health record for each individual for as long as they are under health surveillance, although you may wish to retain it for longer. It is good practice to offer individual employees a copy of their health records when they leave your employment, if your business should cease trading or the employee ceases to be exposed to vibration. The record should be kept up to date and should include:

• identification details of the employee;

• the employee's history of exposure to vibration;

• the outcome of previous health surveillance in terms of fitness for work, and any restrictions required;

Health records should not contain personal medical information, which must be kept in confidence in the medical record held by the occupational health professional. The enforcing authority is entitled to ask to see your health records as part of their checks that you are complying with the Vibration Regulations [5].

Could an occupational health service provider carry out a complete health surveillance service?

Health surveillance may consist of an evaluation of the case history for a worker in conjunction with a physical examination conducted by a doctor or suitably qualified health-care professional[7],[9].

The case history
The case history should focus on:

• family history,
• social history, including smoking habit and alcohol consumption.
• work history, including past and current occupations with exposure to hand-arm vibration, previous jobs with exposure to neurotoxic or angiotoxic agents and any leisure activities involving the use of vibrating tools or machines.
• personal health history.

The physical examination
A physical examination should look in detail at the peripheral vascular, neurological, and musculoskeletal systems, and should be performed by a qualified physician [7]

Clinical tests
In general, clinical tests do not provide reliable proof of vibration injury, however, they may be helpful to exclude other causes of symptoms similar to those of hand-arm vibration syndrome or to monitor progression of injury. Tests for the peripheral vascular system include the Lewis-Prusik test, the Allen test, and the Adson test.
Tests for the peripheral nervous system include the evaluation of manual dexterity (e.g. coin recognition and pick up), the Roos test, the Phalen's test and the Tinel's sign (for carpal tunnel compression)[7],[9].

Vascular investigations
The vascular assessment of the hand-arm vibration syndrome is mainly based on cold provocation tests: assessing changes in finger colour, recording recovery times of finger skin temperature, and measuring finger systolic blood pressure. Other noninvasive diagnostic tests, such as Doppler recording of arm and finger blood-flow and pressure, may also be useful [7].

Neurological investigations
The neurological assessment of the hand-arm vibration syndrome includes several tests:
• Vibration perception thresholds
• Tactile sensitivity (gap detection, monofilaments)
• Thermal perception thresholds
• Nerve conduction velocities in the upper and lower limbs.
• Electromyography.
• Fingertip dexterity (Purdue pegboard) [7],[9].

Muscle strength investigations
The evaluation of muscle force in the hand can be performed by means of a dynamometer to measure grip strength and a pinch gauge to measure pinch strengths.

Radiological investigations
X-rays of the shoulders, elbows, wrists and hands for a radiological diagnosis of bone and joint disorders are usually required in those countries in which vibration-induced osteoarthropathy in the upper limbs is recognised as an occupational disease.

Laboratory tests
Blood and urine analyses may be necessary in some case to distinguish vibration injury from other vascular or neurological disorders [7],[9].

CONCLUSION

The evaluation and assessment of risks arising from exposure to vibration and the implementation of protection measures can be complicated.The risks from hand-arm vibration affect people across many industries and occupations. The risks are greatly increased with use of higher vibration equipment and with prolonged and regular use of the equipment. However, investigations have shown that vibration

hazards can be controlled and risks reduced by good management. The purpose of the hand-arm vibration risk assessment is to enable you as the employer to make a valid decision about the measures necessary to prevent or adequately control the risks from exposure of workers to hand-arm vibration.
Health surveillance is about putting in place systematic, regular and appropriate procedures for the detection of work-related ill health, and acting on the results. The aims are primarily to safeguard the health of workers (including identifying and protecting individuals at increased risk), but also to check the long-term effectiveness of control measures. Health surveillance may consist of an evaluation of the case history for a worker in conjunction with a physical examination conducted by a doctor or suitably qualified health-care professional. Complete health surveillance is: the case history, the physical examination, clinical tests, vascular investigations, neurological investigations, muscle strength investigations, radiological investigations and laboratory tests.

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INVERSE KINEMATICS ANALYSIS OF A PUMA ROBOT BY USING MSC ADAMS

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Abstract : This work presents a different approach to inverse kinematics analysis of a PUMA robot. PUMA robot is an industrial robot arm with open chain mechanism that is used in different purposes. PUMA robot has a complicated inverse kinematics expressions that needs to be solved. In this paper, the inverse kinematics problem is solved by using MSC ADAMS instead of knowing inverse kinematics expressions and calculating this expressions. PUMA robot multi-body dynamics model is built by MSC ADAMS and joint angles are derived for a circle-shaped trajectory. Used trajectory and derived joint angles are given in the form of the graphics.
Keywords: robot, robot arm, puma robot, multi-body dynamics, inverse kinematics

INTRODUCTION

PUMA (Programmable Universal Machine for Assembly) robot is an industrial robot arm with open chain mechanism that is used in different purposes like welding, surgery, laser tracking systems, etc [1-3]. Inverse kinematics is to obtain the joint angles for a desired trajectory or position of the end point the robot [4]. PUMA robot has a complicated inverse kinematics expressions that needs to be solved. There are several numerical and experimental studies in literature about solving inverse kinematics of PUMA robot by using different algorithms or softwares [5-7]. In this paper, the inverse kinematics problem is solved by using MSC ADAMS instead of knowing inverse kinematics expressions. PUMA robot multi-body dynamics model is built and joint angles are derived using MSC ADAMS. Inverse kinematics analysis is the first step of trajectory tracking control studies. PID control and adaptive fuzzy logic control are some of the control methods of trajectory tracking [8-9].

MODELING AND INVERSE KINEMATICS ANALYSIS

In this section modeling and inverse kinematics analysis of the PUMA robot is described. Model of the PUMA robot is built by MSC ADAMS that is a multi-body modeling software to build and simulate mechanical systems dynamic analysis. PUMA robot has six degrees of freedom with a spherical wrist. In this paper only first 3DOF is studied without wrist that shown in Figure 1. Modelled PUMA robot joint angles and component dimensions of the robot is shown in Table 1.

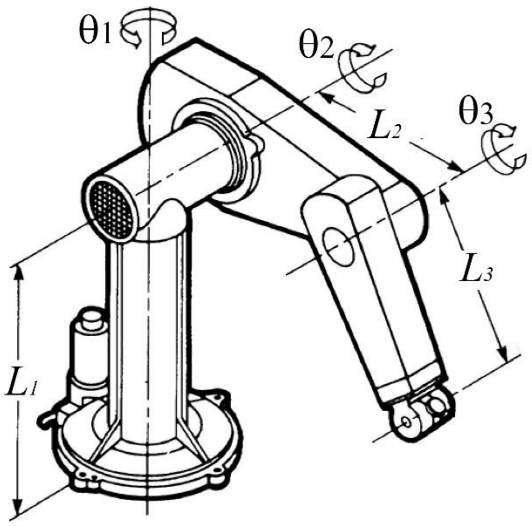

Figure 1. PUMA Robot dimensions and joint angles.

Table 1. Joint angles and component dimensions

θ_1	Waist angle	0 deg
θ_2	Shoulder angle	0 deg
θ_3	Elbow angle	-45 deg
L_1	Trunk length	0.180 m
L_2	Upper arm length	0.120 m
L_3	Forearm length	0.125 m

Inverse kinematics (IK) is to obtain the joint angles for a given trajectory or position to end point the forearm. PUMA robot has a complicated inverse kinematics expressions that needs to be solved. The inverse kinematics problem is solved by using MSC ADAMS and simulated by using MATLAB co-simulation instead of knowing inverse kinematics expressions and calculating this expressions. A circle-shaped trajectory is given to end of the forearm with using MSC ADAMS capability of giving motion to the points and joint angles are derived for the trajectory. X and Y coordinates of circle generated and used as an input by MATLAB shown in Figure 2. and Figure 3. Circle-shaped trajectory is shown in Figure 4 created with X and Y coordinates.

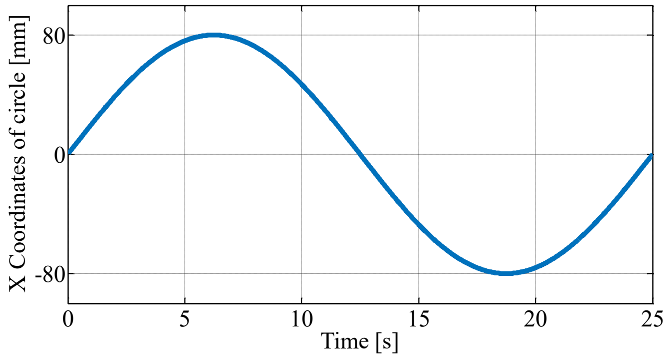

Figure 2. X Coordinates of the circle-shaped trajectory

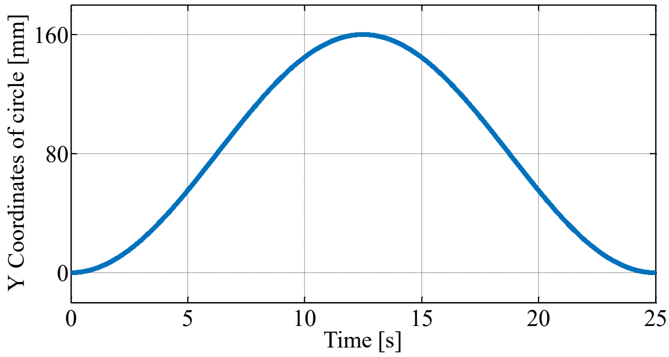

Figure 3. Y Coordinates of the circle-shaped trajectory

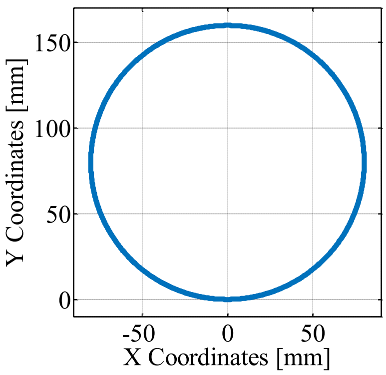

Figure 4. Circle-shaped trajectory created with X and Y coordinates

RESULTS AND DISCUSSION

Inverse kinematics problem of PUMA robot is solved by using MSC ADAMS and MATLAB co-simulation capabilities and joint angles are derived for the circle-shaped trajectory. As a result of inverse kinematics analysis Derived waist angle θ_1 is shown in Figure 5, derived shoulder angle θ_2 is shown in Figure 6 and derived elbow angle θ_3 is shown in Figure 7. Moreover, simulation of inverse kinematics analysis gives visual animations as a result. Snapshots from the animation of analysis are given in Figure 8. From this results, it can be said that using MSC ADAMS is a successful and effective method for solving inverse kinematics of a PUMA robot and dynamics of other mechanical systems.

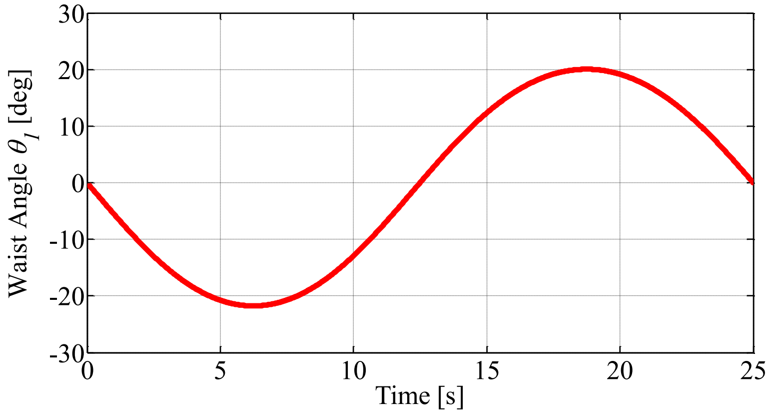

Figure 5. Waist angle

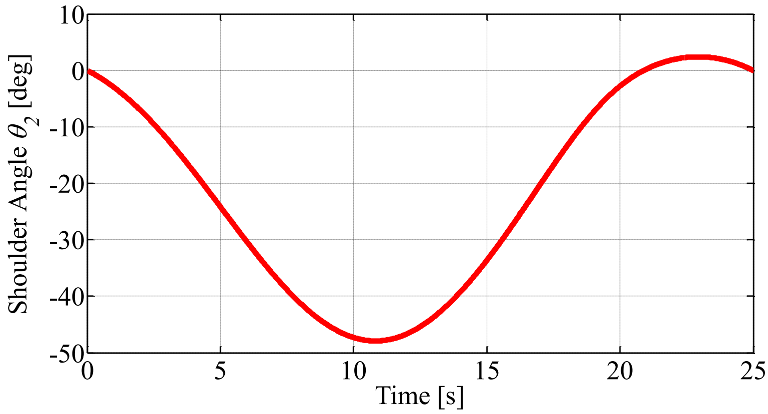

Figure 6. Shoulder angle

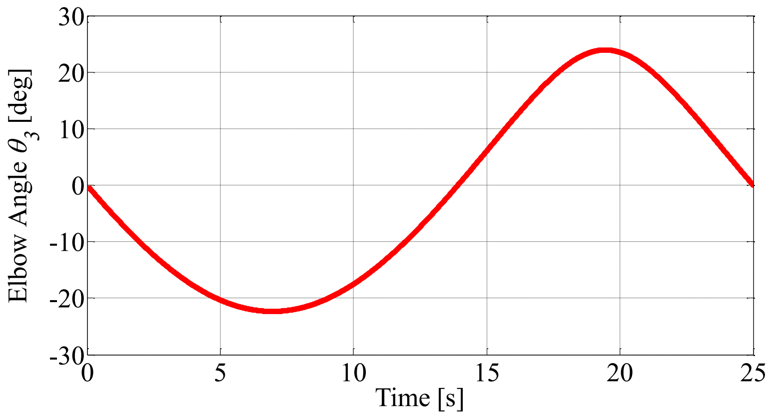

Figure 7. Elbow angle

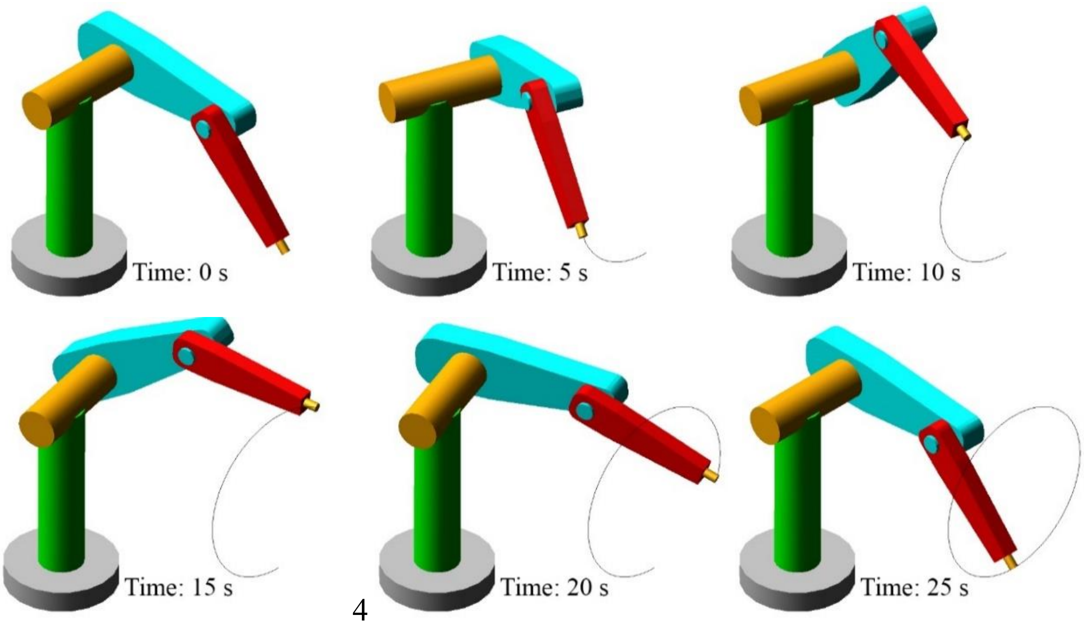

Figure 8. Snapshots from the simulation

CONCLUSION

This paper presents a different approach to inverse kinematics analysis of a PUMA robot that is an industrial robot arm with open chain mechanism. Inverse kinematics problem of PUMA robot is solved by using MSC ADAMS and joint angles are derived for the circle-shaped trajectory. Thus, these types robots and mechanical systems can be modeled and analysed without mathematical model by using an engineering software. As a result of the paper, proposed analysis method verified by simulations and derived joint angle results are given in the form of the graphics. The main contribution of the paper to the literature is that different type inverse kinematics analysis approach is implemented. Furthermore, this paper can be a reference to the trajectory control studies of the robots for the future works.

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OPTIMIZATION OF DRIVE MECHANISM OF MOBILE MACHINES MANIPULATOR USING TRIBOLOGICAL CRITERIA

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Abstract: In paper is defined the optimization tribological criteria of the manipulators crank driving mechanisms of mobile machines. Criteria indicator is mechanical efficiency of driving mechanisms, which reflects the tribological losspower of machines driving system due to friction between the elements of kinematic pairs (joints) manipulator's driving mechanisms.
Key words: driving mechanisms, optimization

INTRODUCTION

Manipulators of mobile machines (Fig. 1) represent multisegment kinematic chains with segments, in the form of lever, which are connected rotary or translational joints of the first class. The last segment in the kinematic chain of manipulators are different tools by which perform the basic functions of the machine. Drive mechanisms of manipulator built kinematic pairs of manipulators who connected with hydrostatic actuators (hydro cylinders and hydro motors).
Most common mechanisms of manipulator of mobile machines are kinematic pairs, with relatively mobile L_i (Fig. 1) and fixed segment L_{i-1}, and with two-way hydrocylinder c_i which is directly linked for segments of the kinematic pairs of mechanisms. With their transfer function, the drive mechanism of manipulator, input hydrostatic parameters of forces (flow and pressure) machine drive system, are transformed into outputs parameters of mechanical power in the form of angular velocity ω_i (Fig. 1) and the required driving moment M_{pi} with which the mobile segment L_i becomes executive segment of the mechanisms with rotating motion.
The total transfer function mechanism depends on transformation and transmission parameters. Transformation parameters of the mechanism are diameter of the piston and diameter of the piston rod hydro cylinder. Transmission parameters of the mechanism are: initial and final kinematic length of the hydro cylinder and position coordinates of the center of joints in which the hydro cylinder linked for segments of the kinematic pairs of mechanisms.

CRITERIAS OF OPTIMIZATION

The procedures synthesis the mechanisms of manipulators show that for the same given input hydrostatic parameters forces can define more variant solutions of mechanisms which have the same output parameters but different transformation and transmission parameters of their structural material. For example, the same range angle θ_{io} (Fig. 1) motion and drive moment M_{pi} executive segment of the mechanism can be achieved with the same transformation parameters (hydro cylinder same size) but different transmission parameters (Fig.1 a,b,c), where, in principle, an executive segment of the mechanism may be in the form of single arm lever (Fig.1 a,b) or the two-arm lever (Fig.1 a,b). Besides, variant solutions of mechanisms are possible with lower transformation and higher transmission parameters(Fig. 1c) and vice versa, with more transformational and less transmission parameters (Fig. 1d).
For selection the optimal solution driving mechanisms of mobile machines manipulators, from set of possible variant solutions, set up the basic objective function:
max . performance - *min* . power of machine, expressed the following criteria optimization [2][3]:

- $K_1=max(F_m)$ - criterion of maximal functional dependence of all of the driving mechanisms manipulators, which expresses efficiency of machine functions through estimate harmonious mutual activities possible drive moments of mechanisms at negotiation the external loading of manipulator in the in the whole working area of machine,

- $K_2=max(\eta_m)$ - tribological criteria defined on the basis of mechanical degree of usefulness drive mechanisms ηm, which reflects the tribological loss of power driving system machine because of friction between the elements of kinematic pairs (joints) of driving mechanisms manipulators,
- $K_3=max\ (m_i)$ - the criteria of minimum mass *mi* segments of kinematic pairs driving mechanisms of manipulators expressed by general conditions factor of nominal mass, which is defined according to the criteria stress state segments of mechanisms,
- $K_4=max\ (m_{ci})$ - criteria of minimum mass *mci* actuator (hydrocylinder) driving mechanisms of manipulators,
- $K_5=max\ (m_{si})$ - criteria of minimum mass *msi* segments of kinematic pairs (joints) driving mechanisms of manipulators.

TRIBOLOGICAL CRITERIA

The primary function of the machine following, among others, are and tribological appearances - friction and wear between the elements of kinematic pairs - joints, of kinematic chain of machine. The consequences of tribological appearances are loss of effective power of driving mechanisms and reducing the lifetime of elements of kinematic pairs.

Generally, friction is defined as resistance to relative motion between two surfaces in contact. During the manipulation task of machine comes to explicit relative motion of elements of manipulator's kinematic pairs and under the loading. From these reasons, setting up tribological criteria of optimal determining the parameters of driving mechanisms manipulators based on the loss of energy due to frictional resistance in the joints of mechanisms. For determining tribological criteria of optimization, first are defined the general tribological factors and then is analyzed the impact of parameters of driving mechanisms on their size.

Tribological factors

According to the general tribological settings, the joints of manipulator's driving mechanisms make tribomechanical subsystems, which parameters of structure transform the function parameters in the effective parameters of driving mechanisms with the occurrence of energy loss and materials expressed by tribological parameters.

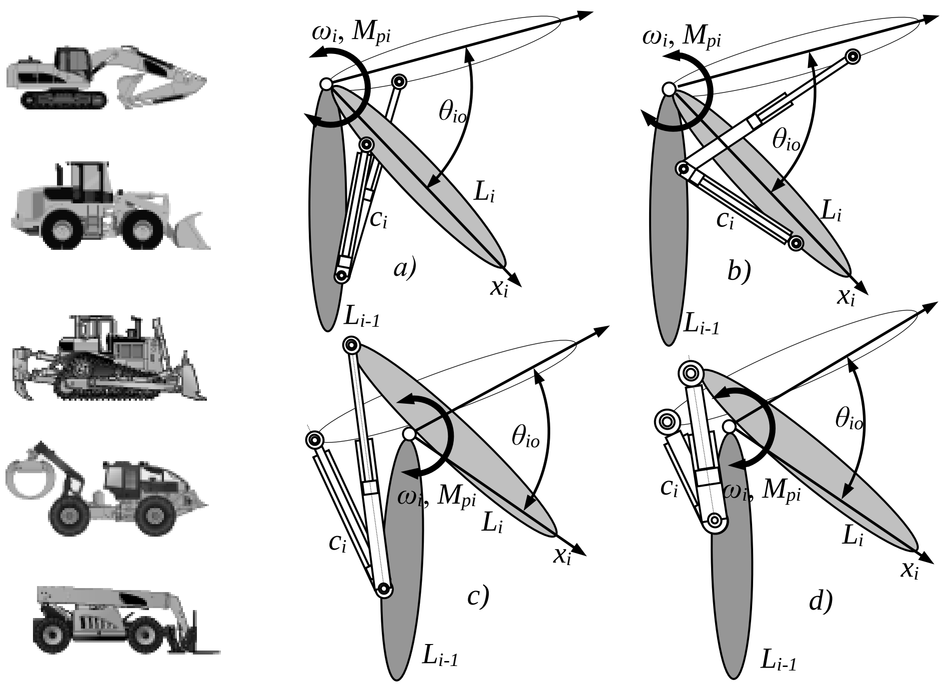

Figure 1. Possible variant solutions of the drives manipulators mobile machines

Parameters of joint function of machine's manipulator are: range δ_{ij} and relative motion velocity ω_i and loading F_{ri}, M_{ri} elements of the joint. Range and relative motion velocity elements of joints represent the kinematic values determined with manipulation task. Loading elements of joint O_i (Fig.2a,b) are determines with fictive interruption of manipulator's kinematic chain in same joint, and reduction at the center of the joint of all external resistance W, M_w and internal (inertial and gravitational) loadings F_{ju}, M_{ju} separated part of the chain $j>i$, including force F_{ci} and moment M_{pi} of drive ci (hydro cylinder) of joint [4]:

$$\vec{F}_{ri} = \vec{F}_{ci} + \vec{W} + \sum_{j=i}^{n} \vec{F}_{ju} \tag{1}$$

$$\vec{M}_{ri} = \vec{M}_{pi} + \vec{M}_{w} + \left[\vec{r}_w - \vec{r}_i, \vec{W}\right] + \sum_{j}^{n} M_{ju} + \sum_{j=i}^{n} \left[\vec{r}_{tj} - \vec{r}_i, \vec{F}_{ju}\right] \tag{2}$$

Loading elements of the joint can be decomposing (Fig.2v) on the components collinear and normal to the axis $\boldsymbol{e_i}$ of the joint:

$$\vec{F}_{ri} = \vec{F}_{ni} + \vec{F}_{zi} \tag{3}$$

$$\vec{M}_{ri} = \vec{M}_{ni} \tag{4}$$

During the manipulative task drive moment of mechanism M_{pi} (Fig. 2c) overcoming the moment's components of loading collinear with the axis of the joint $\boldsymbol{e_i}$, so that, according to the equation 2, the resulting moment for axis of the joint is: $M_{zi}=0$.
Other components the joint loading F_{ni}, F_{zi}, M_{ni} strained theconstruction of the joint, but particular cause friction between its of elements.

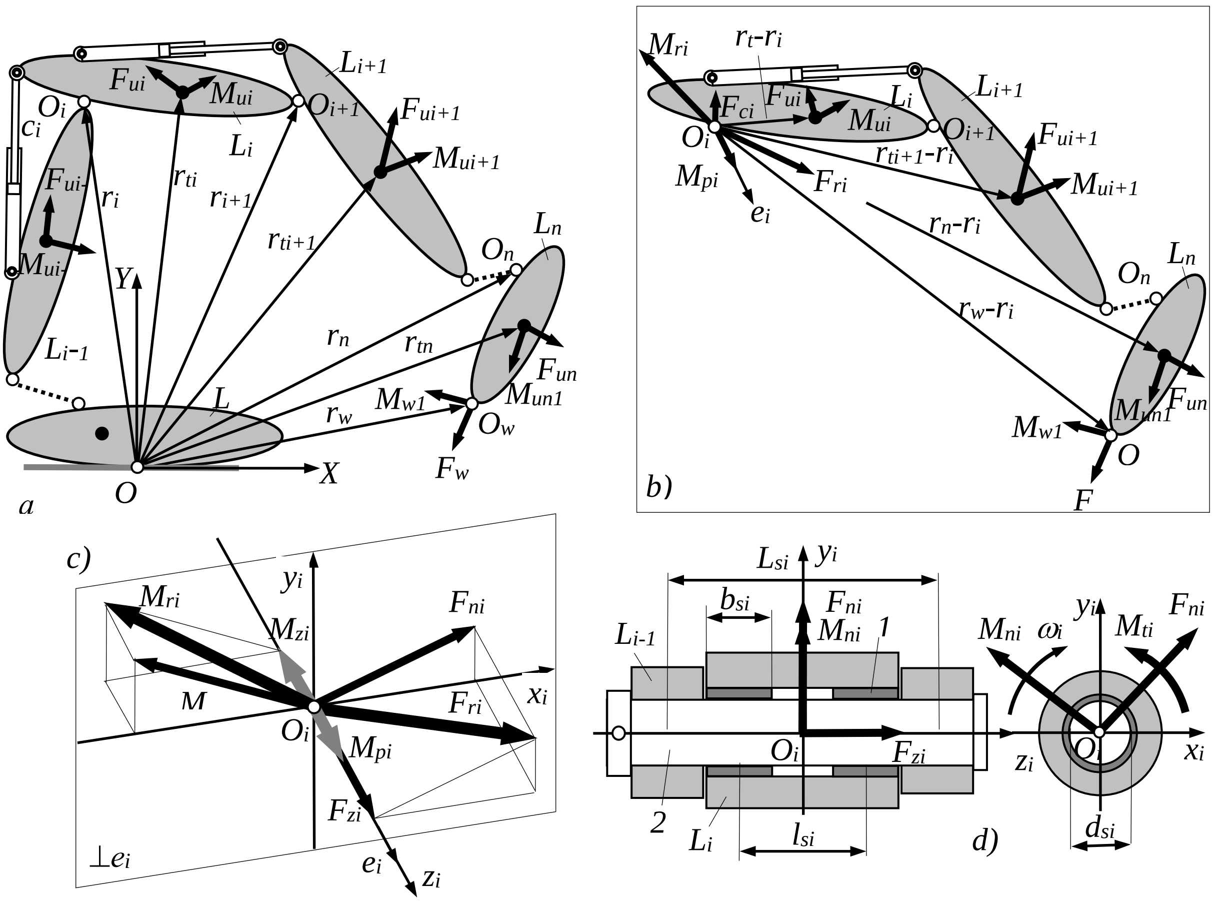

Figure 2. Tribological criteria of driving mechanisms optimization - Loading analysis of the joint kinematic pair of mechanism

For the plane configuration of manipulator's driving mechanism, according to equation 3, only the normal force F_{ni} that burdens the joint, depends among other loading and from reduced force F_{ci} of drive (hydro cylinder), apropos of parameters of driving mechanism.
On the other loadings of the joint F_{zi}, M_{ni}, parameters of driving mechanism have no effect because the reduced force of drive operates in a plane of manipulator normally on the axis of the joint. Therefore, from loading of the joint, as one of tribological criteria factors of optimization of manipulator's driving mechanisms, taking only the normal force F_{ni}. This force is besides being burdening the construction of the joint causes and friction between its relatively movable elements.

ANALYSIS

How much are the impact parameters of driving mechanisms on the joints of loading show the following analysis. Observing are two comparative mechanisms, one with smaller transformational (smaller diameter piston D_1 and connecting rod d_1 of hydro cylinder c_1) (Fig. 3a) and larger transmission parameter (larger connection length r_1) and second with larger transformational ($D_2>D_1, d_2>d_1$, of hydro cylinder c_2) but smaller transmission ($r_2<r_1$) parameters (Fig. 3b).
Mechanisms have the same overall transfer function of drive moment and executive segments with the same kinematic lengths s on which ends act the same vector of external loading W. Because the simpler analysis are considered the position of mechanisms when the directions of activities forces in the hydro cylinders parallel to the directions of the resistance movement forces. With the introduced assumptions, forces in the hydro cylinders of mechanisms have value (Fig. 3):

$$F_{c1} = \frac{W \cdot s}{r_1} \tag{5}$$

$$F_{c2} = \frac{W \cdot s}{r_2} \tag{6}$$

Forces F_{o1} and F_{o2} in the joints kinematic pairs of mechanisms are:

$$F_{o1} = F_{c1} + W = W(\frac{s}{r_1} + 1) \tag{7}$$

$$F_{o2} = F_{c2} + W = W(\frac{s}{r_2} + 1) \tag{8}$$

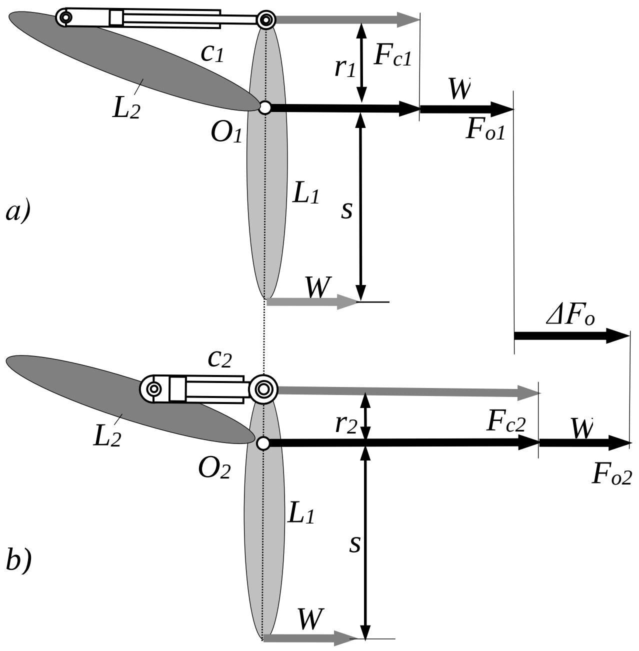

Figure 3. Comparative analysis of loading of the joint mechanism

The difference of forces *ΔFo* in the joints exists and is:

$$\Delta F_o = F_{o2} - F_{o1} = W \cdot s(\frac{1}{r_2} - \frac{1}{r_1}) \ \forall \ r_2 < r_1 \Rightarrow \Delta F_o > 0 \tag{9}$$

Obtained results of performed analysis shows that variant solutions of driving mechanisms with smaller transformational, and larger transmission parameters, have smaller loading of the joint elements, and vice versa.

Structure parameters of the joint define: shape, macro and micro geometry and material elements of joint, as an agency and method for lubrication of the joint. Elements of rotating joins, fifth class of manipulator's driving mechanisms, are performed in the form of one pair of sliding sleeve 1 (Fig. 2g) embedded in the hub of a relatively movable segment L_i and bolt 2 linked to a relatively fixed segment L_{i-1} of kinematic pair.

Macro-geometry was determined basic dimensions of the joint: diameter of bolt (shaft) d_{si}, width of sliding sleeve b_{si}, diameter of hubs D_{si}, range of sleeve l_{si} and range of hubs L_{si}.

Micro-geometry refers to the quality of surfaces and type of overlap elements of the joint. As an indicator of parameters impact of driving mechanisms on the structural parameters of the joint is determined based on loading and mechanical characteristics the elements of joint, shaft diameter (bolt) of joint:

$$d_{si} = max \begin{cases} (F_{nmi} / 2 \cdot e_{si} \cdot p_{sm})^{1/2} \\ (2 \cdot F_{nmi} / \pi \cdot \tau_{sm})^{1/2} \\ [8 \cdot F_{nmi}(L_{si} - l_{si}) / \pi \cdot \sigma_{sm}]^{1/3} \end{cases} \tag{10}$$

where: F_{nmi} - maximum value of force which burdens the elements of joint, acting normal to the axis of joint, e_{si} - ratio of width sliding sleeve l_{si} and shaft diameter d_{si} of joint (Fig. 2g), $p_{sm}, \tau_{sm}, \sigma_{sm}$ - allowed stresses of the surface pressure, shearing and bending the elements of joint.

Equation 10 shows that for the same materials of elements of joints, variant solutions of driving mechanisms with smaller transformational and larger transmission parameters have, due to smaller loading, smaller sizes elements of joints, and vice versa.

Tribological parameters of joint are related to friction and wear between elements of joint. The consequence of friction between elements of joint of driving mechanisms is the loss of energy during its transfer with occurrence of the thermal loading of joint. Due to wear caused the loss of materials and changes microgeometry elements of the joint.

According to the function parameters and structure of the joint, tribological parameters are:

a) Moment *Mti* of friction between elements of joint:

$$M_{ti} = -sign(\omega_i) \frac{d_{si}}{2} \mu_{tz} \cdot F_{ni} \tag{11}$$

b) Power *Nti* lost due to frictional resistance between elements of joint:

$$N_{ti} = M_{ti} \cdot \omega_i \tag{12}$$

where: ω_i – angular velocity of executive segment of mechanism, μ_{tz} - coefficient of friction between the sliding elements of the joint.

The last two equations show that, for the same material of elements of the joints p_{sm} and same lubrication conditions μ_{tz}, variant solutions of driving mechanisms with smaller transformational but larger transmission parameters have less power losses due to the occurrence of frictional resistance between of elements of the joints and vice versa.

CRITERIA OF OPTIMIZATION

Based on the above performed analysis sets up tribological criteria of the optimal determining parameters of machine manipulator's driving mechanisms with the aim that power loss due to frictional resistance between the mechanism's elements of joint would be minimal:

$$K_2 = min\left(\sum_i^n N_{ti}\right) \tag{13}$$

where: n - number of manipulator's driving mechanisms. As a relative indicator $kr2$ of tribological criteria of optimization takes are mechanical efficiency η_m of driving mechanisms for the certain position of the manipulator:

$$k_{r2} = \eta_m = \prod_i^n \frac{N_i}{N_i + N_{ti}} = \prod_i^n \frac{M_{pi}}{M_{pi} + M_{ti}} \tag{14}$$

where: N_i, M_{pi} – power, apropos driving moment, of mechanism without friction in the joints [5].

CONCLUSION

Defined tribological criteria shows that the syntheses of driving mechanisms crank manipulators of mobile machines should aim choosing smaller transformation and larger transmission parameters of mechanisms. Because with smaller forces of hydro cylinders and larger connection lengths - which hydro cylinder binds to segments of the mechanism, it provides less loading of joint mechanism for the same external loading. Lower loading of joints mechanisms cause less frictional resistance and wear between the elements of joints which increases the total mechanical efficiency and lifetime of the mechanism.

ACKNOWLEDGMENT

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STATIC ANALYSIS OF GEARBOX DRIVE SHAFT

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Abstract: In this paper, the structural analysis of the drive shaft of manual six-speed gearbox DMB 6.80.235 manufacturers Famos was performed. Static analysis was done in Ansys Workbench software, with the previously modeling of the mentioned shaft and the definition of boundary conditions and generating a finite element mesh. At the supports site, or bearings, springs are set and are presented by the final element COMBIN 14 whose stiffness is equivalent to stiffness of the supports.
Key words: static analysis, drive shaft, Ansys Workbench, COMBIN 14

INTRODUCTION

Elements for rotational movement play a very important role. Elements of rotary motion are shafts, axles, couplings and bearings [1]. Shafts are machine elements with rotation and serve as elements cantilevers for torque transmission, such as wheels, drums, gears, pulleys, etc. So, in addition to its own weight and the weight of rotating parts to wear and to load them, shafts, also, need to transfer torque. Therefore, the shafts are exposed to torsion and bending moment. The main difference between the shaft and the axle is that the shafts are loaded to the twisting and bending, but axles only to bending. In other words, the shaft transmits power, while an axle transmits only rotary motion [1]. In this paper, the structural analysis [2] of the drive shaft of manual six-speed gearbox DMB 6.80.235 manufacturers Famos was performed (Fig. 1).

Figure 1. Drive shaft

The drive shaft is separated from the gearbox assembly (indicated by a red in Fig. 2), and is manufactured together with the gear to second gear.

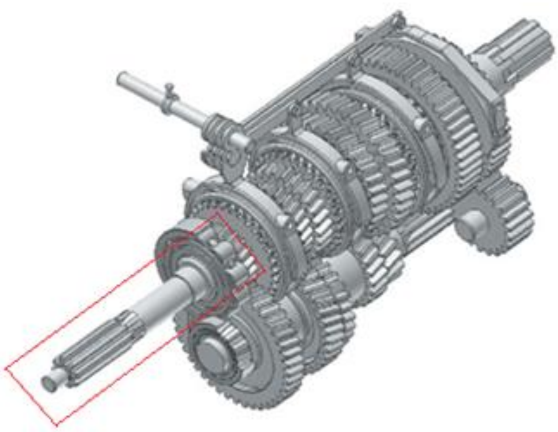


Figure 2. Gearbox DMB 6.80.235-downloaded from [3] and modified

The front part of the shaft enters the engine flywheel flange through the connecting plate and relies on ball bearing, while the rear part of the shaft relies on the roller bearing which is located in the front part of the housing [3]. The back of the drive shaft is an opening of bearing upon which the main shaft relies. The front part of the shaft is toothed to achieve strong links with the disc couplings hub. Static analysis was done in Ansys Workbench software, with the previously modeling of the mentioned shaft and the definition of boundary conditions and generating a finite element mesh. At the supports site, or bearings, springs are set and are presented by the final element COMBIN 14 whose stiffness is equivalent to stiffness of the supports, whereby each spring represents a roller body, and the total stiffness is divided by the number of rolling bodies by linear model of distribution. There are numerous examples of the static analysis of drive shafts, axles and the like [4,5].

APPLIED METHODS

Static analysis

The effects of static structure loading are calculated by the static analysis [6], while the inertia and damping effects are not taken into consideration. Static analysis may, of course, include inertial forces unchangeable in time (gravity or constant angular velocity) and loads variable in time that can be approximated by static load. Static analysis is used to calculate the displacement, stress and strain resulting from static loads. In a static analysis are defined:

1) Boundary conditions

The boundary conditions are used for limiting the translation and rotation of certain parts of the structure depending on the structure. They occur as the effects of neglected parts of the structure in a symmetric load of symmetric parts. Limit of one of the degrees of freedom can be in some interval or absolute (e.g. in the supports).

2) Limitations of one or more degrees of freedom
3) Planned (required) movements of certain parts of the structure that are different from zero
4) Temperature

The effects of temperature changes, as the structure load, provide for a result the thermal expansion or contraction, which allows the calculation of stress and strain in the static analysis.

5) Loads

Forces are concentrated loads, usually applied to the outside of the model, while pressure is a surface load, also applied to the outside of the model. Fixed inertial forces affect the entire structure and do not change in time or can be approximated by a constant forces. As an example the force of gravity may be given.

In this paper, analyzed shaft is loaded to bending and twisting. The twisting loading occurs because of the transfer of torque from the engine flywheel (526,7 Nm) [3] and bending occurs due to the force of the gear components (radial and tangential). The radial force bends the shaft in the vertical plane, while tangential force bends the shaft in the horizontal plane. Given that a pinion with straight teeth is located at shaft, the axial component of the force is equal to zero.

Static analysis is the most frequently used form of structural analysis, and it can be said that almost all software packages meet all analysis requirements, so, for static analysis, it is very important to define the problem properly, to have knowledge of finite element method and knowledge of software package that is used.

Static analysis of DMB 6.80.235 gearbox drive shaft

The first step which was essential for the structural analysis of shaft in this paper was the modeling of the shaft (Fig. 3) based on the workshop drawing and selection of materials (Table 1) and other properties of geometry (Table 2).

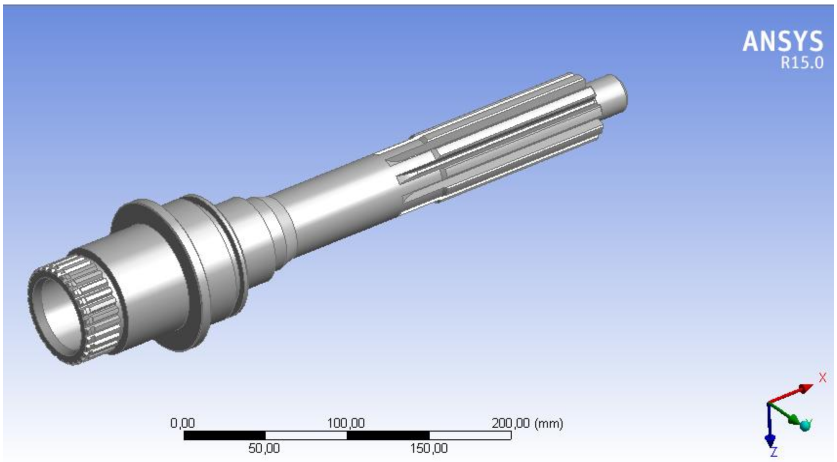


Figure 3. Shaft model

Table 1. Material properties

Density	7,85e-009 tonne·mm^{-3}
Coefficient of Thermal Expansion	1,2e-005 C^{-1}
Specific Heat	4,34e+008 mJ·tonne^{-1}·C^{-1}
Thermal Conductivity	6,05e-002 W·mm^{-1}·C^{-1}
Resistivity	1,7e-004 ohm·mm

Table 2. Geometry properties

Object Name	Geometry
State	Fully Defined
Definition	
Length Unit	Meters
Bounding Box	
Length X	420, mm
Length Y	98, mm
Length Z	98, mm
Properties	
Volume	7,6015e+005 mm^3
Mass	5,9672e-003 t
Scale Factor Value	1

At the supports site, or bearings, springs are set and are presented by the final element COMBIN 14 whose stiffness is equivalent to stiffness of the supports, whereby each spring represents a roller body, and the total stiffness is, by linear model of distribution, divided by the number of rolling bodies, in this case by the number of springs. The outer bearing is a single row roller bearing NU1016-M1 (Fig. 4). The total stiffness of the support at the outer bearing place is 418·103 N/mm, respectively 17433 N/mm per roller body.

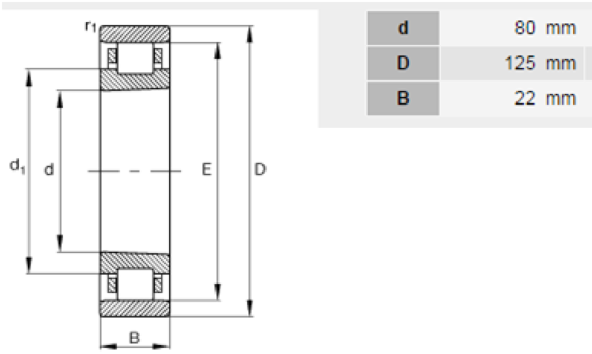


Figure 4. Roller bearing NU1016-M1[7]

The inner bearing is a single row roller bearings NU1005-M1 (Fig. 5). The total stiffness of the support at the inner bearing place is 290·103 N/mm, respectively 20757 N/mm per roller body.

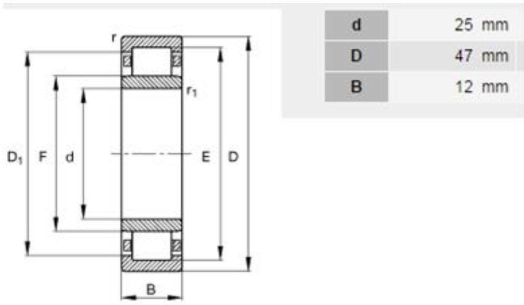


Figure 5. Roller bearing NU1005-M1[8]

After modeling the shaft, finite elements mesh was generated (Fig. 6). Mesh properties are shown in Table 3.

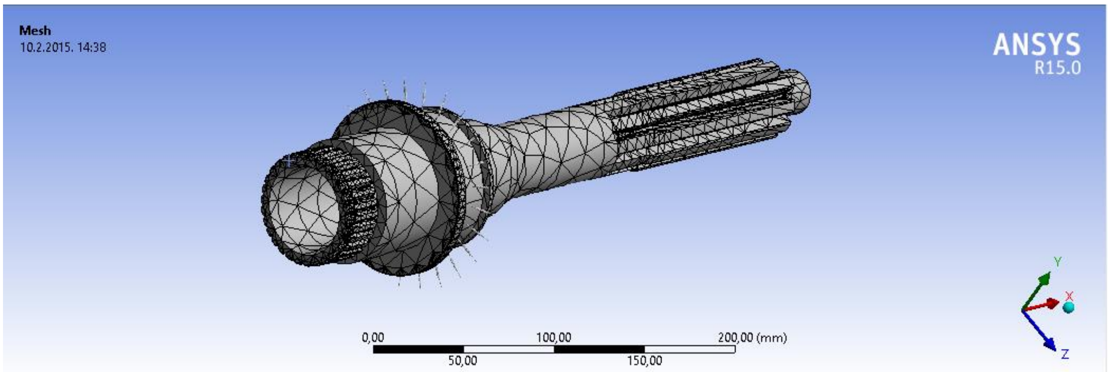


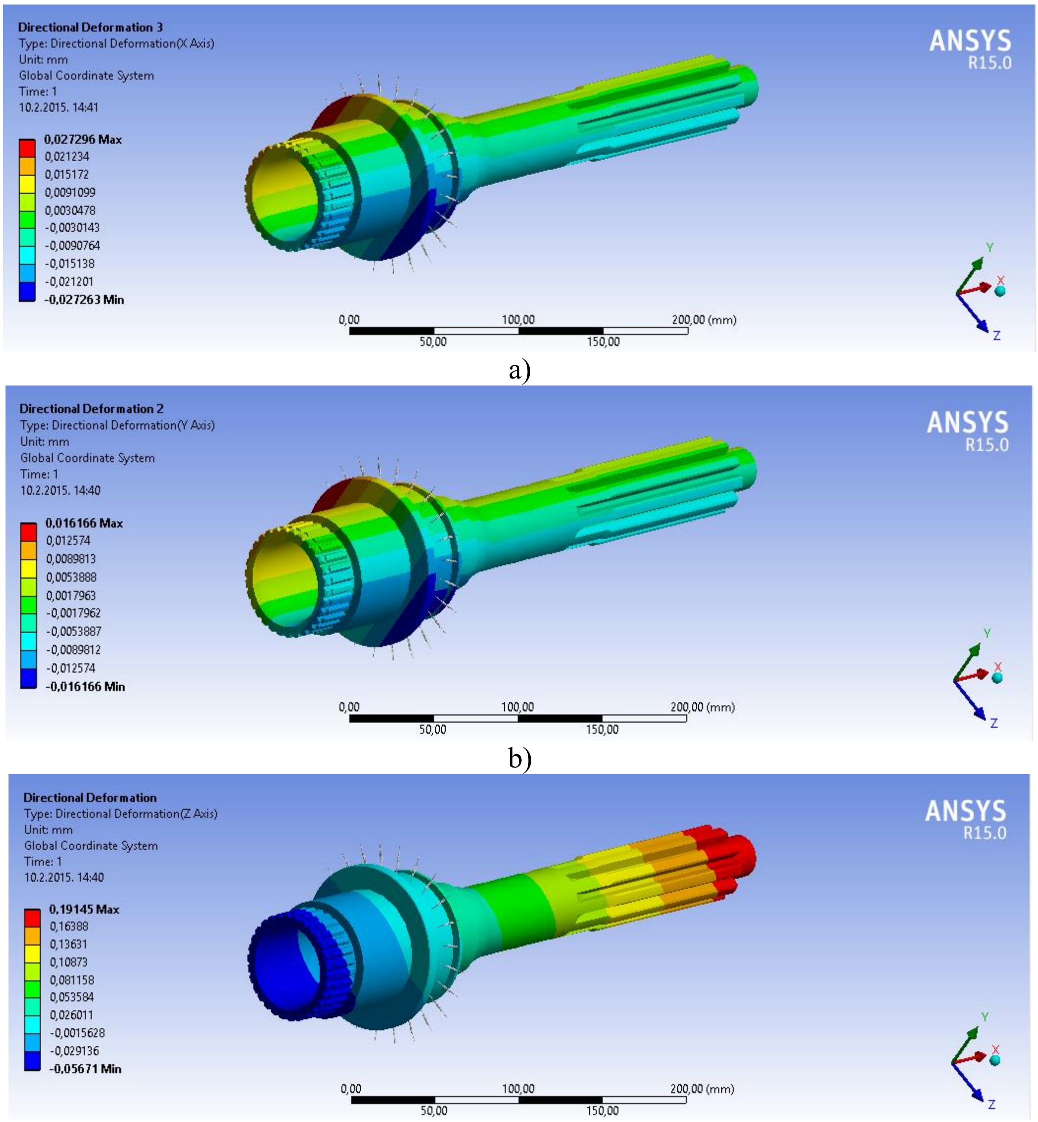
Figure 6. Shaft finite elements mesh generating

Table 3. Finite elements mesh properties

Object Name	Mesh
State	Solved
Sizing	
Element Size	Default
Smoothing	Medium
Transition	Fast
Minimum Edge Length	0,200740 mm
Statistics	
Nodes	39562
Elements	22381

RESULTS AND DISCUSSION

With the known supports stiffness represented by the system of springs using finite element COMBIN 14 and with known load, deformations of the x, y and z axis directions are obtained (Fig. 7). The results are shown in Table 4.



a) b) c)

Figure 7. Deformations in the direction of: a) x axis; b) y axis; c) z axis;

Table 4. Results of drive shaft static analysis

Object Name	Directional Deformation	Directional Deformation 2	Directional Deformation 3
State	Solved		
Definition			
Type	Directional Deformation		
Orientation	**Z Axis**	**Y Axis**	**X Axis**
Results			
Minimum	-5,671e-002 mm	-1,6166e-002 mm	-2,7263e-002 mm
Maximum	0,19145 mm	1,6166e-002 mm	2,7296e-002 mm
Minimum Value Over Time			
Minimum	-5,671e-002 mm	-1,6166e-002 mm	-2,7263e-002 mm
Maximum	-5,671e-002 mm	-1,6166e-002 mm	-2,7263e-002 mm
Maximum Value Over Time			
Minimum	0,19145 mm	1,6166e-002 mm	2,7296e-002 mm
Maximum	0,19145 mm	1,6166e-002 mm	2,7296e-002 mm

CONCLUSION

In this paper, the structural analysis of the drive shaft of manual six-speed gearbox DMB 6.80.235 and the use of software Ansys Workbench in the analysis of the same were shown. Static analysis is the most frequently used form of structural analysis, and it can be said that almost all software packages meet all analysis requirements, so, for static analysis, it is very important to define the problem properly, to have knowledge of finite element method and knowledge of software package that is used. After the static analysis, from the table with the results, it can be concluded that the maximum deformations are in the direction of the shaft z axis, which was to be assumed, because the load is centered exactly in the direction of z axis. Minimum deformation of 0,056 mm in the z axis direction of the shaft is close to the inner bearing. In this part, the distance between the two shaft bearings is very small, so that the obtained deformation is in accordance with that. The maximum deformation of 0.19 mm in the direction of z axis is at the top of the shaft (the side opposite the bearings), which is a very realistic and expected data. In contrast to the deformations in the direction of the z axis of the shaft, the deformations in the direction of the y axis and the longitudinal x axis are considerably less. Deformation in the direction of the shaft y axis is 0,016 mm, while the deformation of 0.027 mm in the direction of the longitudinal x axis is minimum, which is, of course, to be expected.

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STUDY THE DYNAMIC BEHAVIOR OF THE BOX OF PRECISION MEASURING EQUIPMENT, ATTACHED BY CONTAINER TO VIBRATING BASE

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Abstract: This report explores the dynamics of the box of measuring equipment for non-mechanical measurements, which in certain cases performs high-frequency vibrations. The vibrations with larger amplitudes and accelerations and related with them inertia forces may influence to the measurement precision. To determine the limits of change of these characteristics and to recommend measures for their limitation was done study of the system box measuring equipment, container for storing and vibrating base. The dynamic model for study of the system consists of two mases, modelling respectively the box and container, with elastic-viscous connection between them. The link between first mass and vibrating base is elastic-viscous, too. The mathematical model of the vibrating structure is a system of two inhomogeneous differential equations with two unknown accelerations, derived by the method of Lagrange of the second order. The solution of the system of the differential equations is realized in geometric environment for solving of such systems MATLAB/SIMULINK. Finally has been conducted experimental research of the problem. This was done through use of Stand for modular dynamic testing of the construction, subjected on seismic impact. The stand is part of the experimental base of the Lab for numerical and experimental dynamic modelling, one of the big labs at the UACEG, Sofia, Bulgaria. Based on the combined study were made recommendations on and variability of the characteristics of connections, depending on the magnitude of the masses and characteristics of the external impact.
Key words: dynamic model, mathematical model, simulation model, experimental set.

INTRODUCTION

Much of the mobile building construction and equipment – construction cranes, construction machinery (Fig. 1) and others are equipped with precise measuring technology. Part of the equipment intended for mechanical tests - displacement, acceleration, inertia is hard connected to the moving parts of the equipment for the purpose of precision measurements. For equipment intended for non-mechanical measurements - temperature, humidity, light, etc. The hard connection is not always appropriate. Large as amplitude and frequency vibration of the equipment can affect of the precision work of the last and accuracy of measurements, performed with them.

Figure 1. Constructional installations and technics with measuring equipment on them

With purpose protection from direct mechanical damage to the measuring equipment is placed in special containers (Fig. 2), attached to a movable, most often vibrating part of the constructions. The attachment of the containers to the vibrating structure can be hard or elastic. The attachment of the measuring technique to the container also can be hard or elastic. The elastic attachment elements - rubber pads, elastic ropes [2], springs and almost always possess certain dissipative properties, related to the vibrations of the system.

In the report, the system - vibrating base, container and measuring equipment are modeled based on certain simplifications such as vibrating system of two bodys with a viscous-elastic connections between them. To make relevant analytical, numerical and experimental research to refine the characteristics for connections based on the external impact and requirements of equipment for the maximum value of the kinematic and power characteristics in them.

Figure 2. Storage containers for measuring equipment

Discussed was forced a damped vibrations of the system, caused by cinematic interferences, modeled in sinusoidal or random form.

ANALYTICAL, NUMERICAL AND EXPERIMENTAL PROCEDURE

Dynamic model

The steps of modeling of the real system are shown in (Fig. 3).

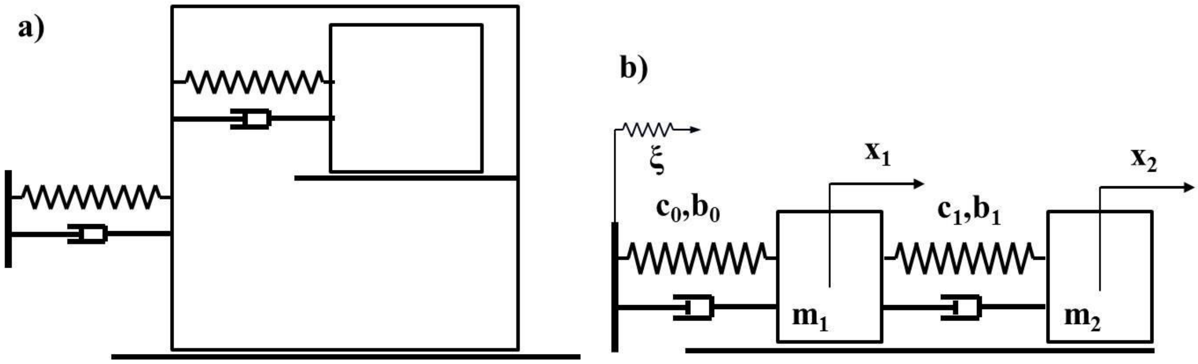

Figure 3. Dynamic model of vibrating system

The dynamic model consists of two bodies vibrating in a horizontal direction (container and a measuring instrument). It is assumed vibrations on one axis, container performs horizontal translation about the vibrating structure and measuring techniques performs translation about the container (Fig. 3a).

The external and internal forces of dry friction between the components of the vibrating system are ignored.

It has been recorded dissipative forces of internal friction as a result of viscous nature of some of the links.

In the dynamic model (Fig. 3b) the motion of the bodies is accepted in one axis without this to change the mathematical law of motion of the system from Fig. 3.a. The masses of the bodies are respectively m_1 – simulating the weight of the container and m_2 – simulating the mass of the measurement techniques. The link between the first body and the vibrating platform is modeled with elastic-viscous pair with coefficients c_0 и b_0, and connection between two bodies, respectively by a pair with coefficients respectively c_1 и b_1.

The motion of the vibrating structure is given in two ways – like a sine wave and a uniform random signal.

$$\xi = \xi_0 \bullet \sin(\theta \bullet t) \tag{1}$$

$$\xi = \xi_0 \bullet \text{rand}(1, \text{length}(t)) \tag{2}$$

The recording of the random function in formula (2) is given based on the recording in Matlab programming system [3].

Mathematical model

Mathematical model of the two-bodies vibrating system is created by Lagrange equations of the second order

$$\frac{\partial}{\partial t}\left(\frac{\partial E_k}{\partial \dot{x}_j}\right) + \left(\frac{\partial \Phi}{\partial \dot{x}_j}\right) + \left(\frac{\partial E_p}{\partial x_j}\right) = 0 \tag{3}$$

where j=1,2.
The kinetic energy, expressed by the velocity of the two bodies of the system has the following quadratic form

$$E_k = \frac{1}{2} \bullet m_1 \bullet \dot{x}_1^{\,2} + \frac{1}{2} \bullet m_2 \bullet \dot{x}_2^{\,2} \tag{4}$$

The potential energy, expressed by the displacements of the two bodies and the kinematic interference from the vibrating base has the form

$$E_p = \frac{1}{2} \bullet (c_0 + c_1) \bullet x_1^{\,2} + \frac{1}{2} \bullet c_1 \bullet x_2^{\,2} + c_1 \bullet x_1 \bullet x_2 - c_0 \bullet \xi \bullet x_1 + \frac{1}{2} \bullet c_0 \bullet \xi^2 \tag{5}$$

In the expression of the potential energy is observed elastic connection between the two generalized coordinates, while in the expression of the kinetic energy inertial connection between the respective velocities misses.
Expression for dissipative function as structure looks like a Formula 5, as the coordinates are replaced by the velocities and elastic coefficients with the dissipative ones.

$$\Phi = \frac{1}{2} \bullet (b_0 + b_1) \bullet \dot{x}_1^{\,2} + \frac{1}{2} \bullet b_1 \bullet \dot{x}_2^{\,2} + b_1 \bullet \dot{x}_1 \bullet \dot{x}_2 - b_0 \bullet \dot{\xi} \bullet \dot{x}_1 + \frac{1}{2} \bullet b_0 \bullet \dot{\xi}^2 \tag{6}$$

After substitution of the derivatives in Equation 3, is obtained the system of two differential equations with two unknowns – the accelerations of the two bodies.

$$\begin{aligned} m_1 \bullet \ddot{x}_1 + (b_0 + b_1) \bullet \dot{x}_1 - b_1 \bullet \dot{x}_2 + (c_0 + c_1) \bullet x_1 - c_1 \bullet x_2 &= c_0 * \xi \\ m_1 \bullet \ddot{x}_2 - b_1 \bullet \dot{x}_1 + b_1 \bullet \dot{x}_2 - c_1 \bullet x_1 + c_1 \bullet x_2 &= 0 \end{aligned} \tag{7}$$

Simulation model

The solution of the system of differential equations is realized in the area of the symbolic modeling SIMULINK [3].
For this purpose, equation 6 is decided in respect of the accelerations

$$
\begin{aligned}
\ddot{x}_1 &= -\frac{(b_0+b_1)}{m_1}\bullet\dot{x}_1 + \frac{b_1}{m_1}\bullet\dot{x}_2 - \frac{(c_0+c_1)}{m_1}\bullet x_1 + \frac{c_1}{m_1}\bullet x_2 + \frac{c_0 * \xi}{m_1} \\
\ddot{x}_2 &= +\frac{b_1}{m_2}\bullet\dot{x}_1 - \frac{b_1}{m_2}\bullet\dot{x}_2 + \frac{c_1}{m_2}\bullet x_1 - \frac{c_1}{m_2}\bullet x_2
\end{aligned}
\tag{8}
$$

The general appearance of the simulation model is shown in Fig. 4.
The input signals are stimulated by generators of sine wave and uniform random impact. Should be carefully selected the frequency and amplitude of the forced interferences, depending on the motion of construction. Graphs of the interference at equal amplitudes and approximately equal frequencies are given in Fig. 5.
The solution of the equation is simulated by system of sum blocks, integrators, multipliers. It is accepted zero initial conditions. Elastic and viscous characteristics of the links are accepted depending on the type of fixing elements.
All numerical values are set in linked with the model text file in the area of Matlab. This allows for an easy change of their values.
Dynamic behavior of the bodies is shown on a scope block.

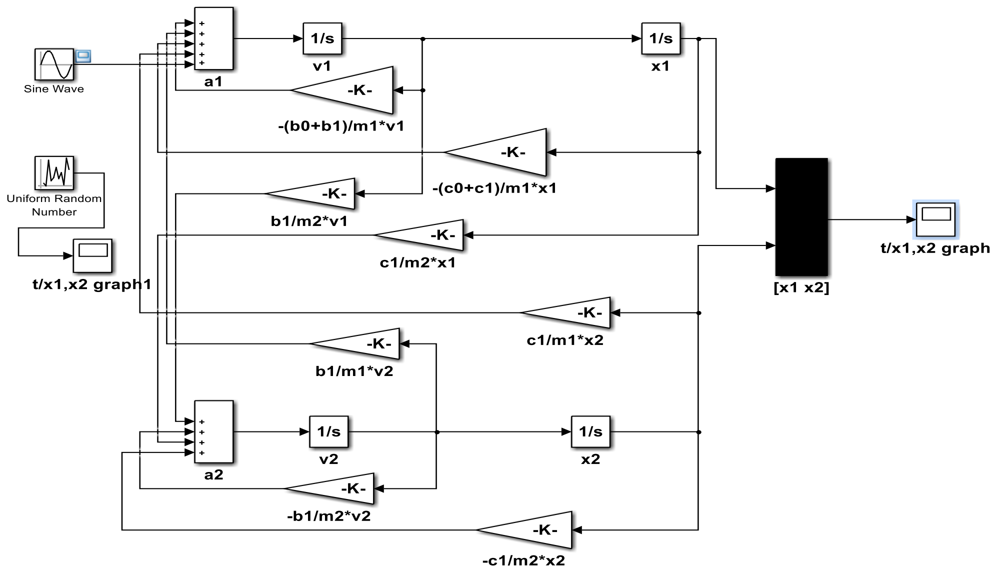

Figure 4. Simulation model of vibrating system

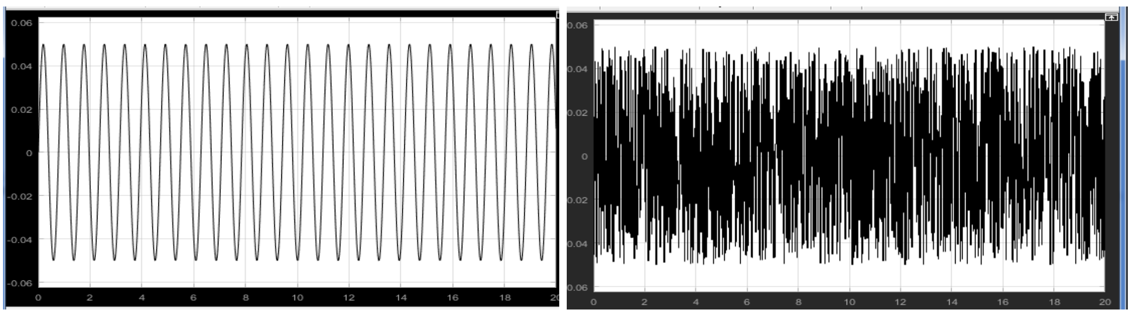

Figure 5. Input signal as sine wave and random impact

In Figure 6 are given graphs of the vibrations of the the bodies coused by the above described inpacts. It is accepted some average values for the mass of the bodies. Elastic-viscous charachteristics of the link with index 0 are relatively high, suggesting close to hard connection. As regards the second connection - there are accepted once large, once relatively smaller values. As result of the last are reduced vibrations of the second body - measuring equipment.

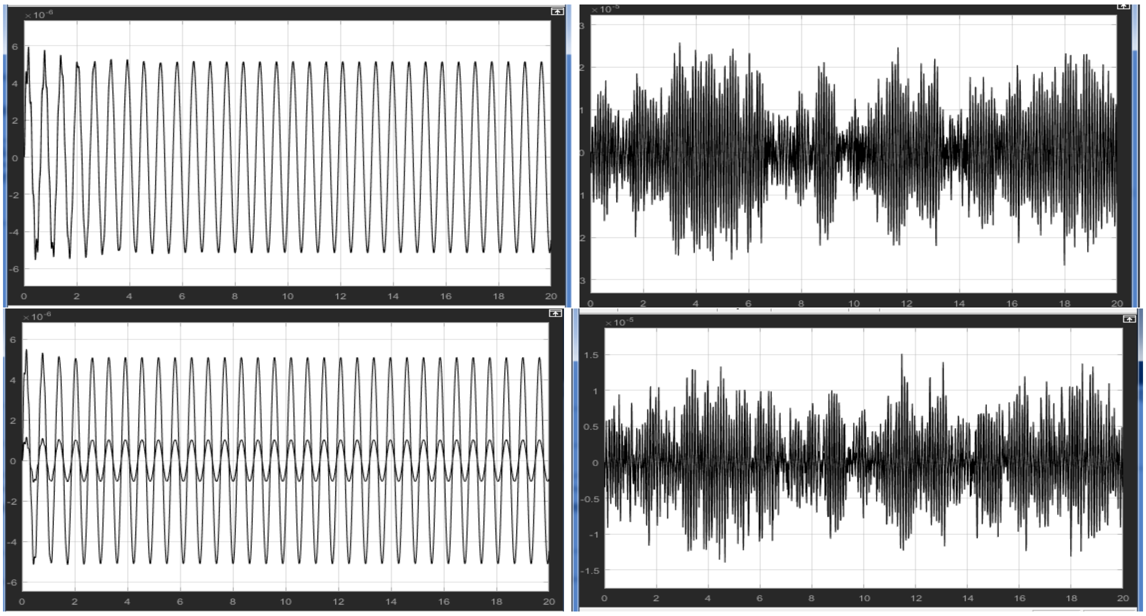

Figure 6. Dynamic behavior of the two bodies

Experimental study

Experimental study is realized by Stand for modular dynamic testing of construction subject on seismic impact [1,2,4,6] – Fig. 7.
The impact on the moving system is realized by horizontal vibrating table. The system for controlling the movement of the table allows realization of each of the interference by formulas 1 and 2 shown in Fig. 5.
As in the numerical study, the relationship between the container and the moving table is accepted rigid. In some of the experimental trials, connection between the container and the measurement equipment is accepted rigid with infinity values of the elastic-viscous characteristics. In the other experiments for the last was accepted elastic-viscous with an average characteristics. With suitable selection of the latter can be reduced amplitudes of the accelerations and displacements of the body modelling the measurement equipment.

Figure 7. Photos of experimental study

The measurements of the motion of the bodies is performed by specially designed innovative measuring system of light diode lamp and photo resistor. The latter by special Arduino board and program developed in the area of Matlab converts the electrical signal in a digital for visualisation and processing.
For the complete experimental study, were used and components from other stands [5] of the Lab for numerical and experimental dynamic modelling.

DISCUSSION

The combined study indicates that in order to obtain optimum kinematic characteristics of the moving equipment, must vary with characteristics of the both elastic-viscous couples.
In more stiff connection of first body with the second (container with a measuring equipment) was observed movement of the latter with an amplitude similar to that of the external impact. By reducing the stiffness of that connection is reduced and the amplitude of accelerations and displacements of the body.
In deterministic interferences more precisely can be defined the range and variability of stiffness to obtain the admissible values of kinematic characteristics.
During the test should be careful the forced frequency of the interference not to be close to that of the vibrating system, due to the risk of resonance. Especially dangerous is that in experimental research, because the latter can result to unforeseen stresses on the experimental set.

CONCLUSION

Basic numerical and experimental studies were conducted mainly on the influence of the elastic characteristics of the internal and external connections of the links.
Subject of the further work is determination of the influence of the dissipative characteristics on the motion of the bodies.

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MONETARY UNION IN THEORY AND PRACTICE

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Abstract: Monetary union is the highest level of economic integration, which is defined as an area in which there are no restrictions on payments, exchange rates of member states are permanently fixed, while the non-member countries to request flexible fluctuations. Monetary union is established as a zone in which monetary policy and exchange rates of member states managed in a way that leads to achieving the objectives of economic policy. The European Union has opened "the road to the country's debt high taxes". So today in Germany's public debt per capita is about 36,000 euros, which amounts to 153% of annual salary or close to 100% of disposable annual income of the average family. The new borrowing is financed over 10% of budget expenditures in the hope that "the economy in the future miraculously recover and that the situation will reverse."
Key words: Monetary union, economy, economic trends, industry, investments

INTRODUCTION

Full liberalization of capital movements, the integration of banking and financial markets of member states of the same and the elimination of fluctuation in the movement of foreign exchange rates through the irrevocable fixing them, are prerequisites for its formation [2].
The currency union is one of the forms of monetary union in which member states adopting a common currency waive their own, and as such, is appointed as a full monetary union and common currency area. The basic components of the monetary union are: the integration of the capital market (absence of control conversion of current or capital transactions within the scope Union), which will lead to a full convertibility of capital transactions. Certainly, there are times when countries decide to mutually fixing of exchange rates, and that doing so does not allow complete freedom of movement of capital, and One possibility is the establishment of so-called pseudo Union in exchange rates, or complete union of foreign exchange rates, depending on the degree of integration for which they are defined. The central bank provides a relatively floating exchange rate against the currencies of non-member countries, which is not the case with pseudo Union. The mechanism of the common foreign reserves automatically solves the imbalance of payment system between Member States, so that the surplus countries are helping shortage.
In the sixties of the twentieth century Mundell promotes the theory of optimal currency areas, which focuses on finding the optimal currency regime, considering the choice between pure floating and a fixed exchange rate. According to this theory, exchange rates are an instrument that can respond to numerous upheavals in the economic trends in the country. From these facts follows the necessity of finding a real choice between two modes of exchange rates policy taking into account, in various stages of development of this theory, factors such as the degree of openness of the economy, diversification of products, the management of state policy, the similarity rate of inflation, the level of integration policy level flexibility of prices and wages, and the variability of the real exchange rate.
The implications of the theory of optimum currency areas we looked at were in the context of the adjustment of exchange rates in terms of the balance of payments imbalances, as well as in the context of the development of the theory of monetary integration, which has been fundamental to the design of the European Monetary Union[4][10]. In addition, the theory of optimal currency area explains the link between countries, regions and currencies [4].
The key question is whether such a range and optimal and whether the country had more benefits of integrating into a wider currency area. The answer to the second part of the question, among others, that

McKinnon points out that small and open economic system more profitable accept currency wider currency area, but use your own. The optimum currency area is one that can simultaneously achieve full employment, low inflation and balance of payments. If the state is not able to achieve at the same time these three goals, then for it not to say that it is an optimal currency area. In the context of the EU member states more optimal currency area would be one in which the welfare of one Member State cannot increase, and to do so at the expense of the welfare of another EU member currency area. From this follows the conclusion that the purpose of entering into an optimal currency area increase welfare of the citizens of the area above the level enjoyed outside. The introduction of a common currency by Mundell-in was motivated by the following:

a) The role of money as an accounting unit is less adequately filled with the higher number of currencies;
b) A large number of currencies, foreign currency market for a currency would very likely become closer.

What is less currency area, the greater the share of imported goods and services in the consumption**.**

MATERIAL AND METHODS

Fiscal policy and the theory of optimum currency areas

The traditional theory of optimum currency areas, quite clearly shows that we should implement national fiscal policies in a monetary union.The analysis in this section should provide answers to the following questions:

1. What is the role of fiscal policy in a monetary union?
2. How many national policies able to be independent?
3. Do monetary union increases or reduces fiscal discipline?
4. What rules, if any, can be used to restrict national fiscal policy?

In order to provide answers to the question: What theory of optimum currency the field stayson fiscal policy management? [8]; the starting point is of assumptionsthat European consumers change their demand for the benefit of the product state "D", to the detriment of the product states "F" [9] (Fig 1.). Now the question arises: what are the implications of these developments (disorder) on fiscal policy? The assumptions of which the analysis is based are:

a) That the state "D" and "F" belong to the group of highly developed countries,
b) That as members of the same monetary union centralized good part of their national budget through central European authority,
c) That the social protection system is organized at European level and
d) That the tax revenue are collected over European governments.

The foregoing assumptions lead to the conclusion that a centralized budget work as a shock absorber. In the state of "F" output is falling and unemployment is continuing to rise. This has a double effect on the European budget. Country "F" records:

- Fallof tax revenues, which are collected over European governments, but because
- Increasing the payment of benefits to employees over the European authorities.

Fiscal multipliers differ across countries [1].The opposite effects are in the state "D". Their output rises and unemployment falls.The current result is that from 'D' tax revenues, which gathers European government increased, while spending by European governments in the state "D" decreases. It is clear that a centralized European budget performs automatic redistribution of income from the state "D" to the state "F", thereby smoothing out the social consequences of the changes in demand. This can be understood as a system of insurance in which country (and individuals) affected by negative shocks receives compensation through automatic transfers from countries that have a positive shock. There are important differences between countries that are not going to disappear in a monetary union [4].

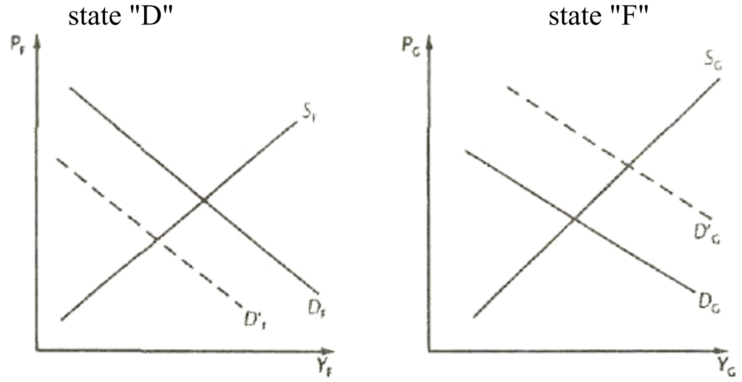

Figure 1. Asymmetric shock in the State, "D" and "F"

The next question is what happens if it maintains "F" and the state "D" form a monetary union without centralizing their budgets. It can be shown that in the state of "F" negative demand shocks lead to growth the budget deficit, because tax belong to, while benefits paid to the unemployed are growing.
In the state "D" is going the opposite: the budget surplus will increase (or reduce the deficit). In the event that there is an efficient capital market, the government needs the state "F" to borrow can be easily met by supply growth of savings that comes from the state "D".
However, in the case of decentralized budget, the state "F" will increase its external debt to be serviced in the future. There is a regional system of security, because those who receive the transfer in the days of the crisis, that is, citizens of the state "F", should return to the country "D" in a future.
Thus, the payment is made the future. As a result, this decentralized system is a system of insurance in which future generations of citizens of the state "F" to pay for the difficulties that have today's citizens. In addition, this decentralized system reduces the degrees of freedom of future fiscal policy of the government of the state "F". This contrasts with the case in which national budgets are centralized in such a system, the state "F" will not have to face the problems of external debt, because citizens of the state "D" on the principle of automation to transfer income to the state "F".
The theory of optimum currency areas in the monetary union takes the following implications for fiscal policy [4].It is desirable to centralize a significant portion of the national budget to the European level. The centralized budget allows countries (and regions) that are affected by the negative shock to realize automatic transfer, reducing the social costs of a monetary union.
This, too, was the main conclusion of the influential MacDougallovog report, which was published in 1977. The compilers of the report argue that monetary union in Europe should involve the centralization of budgetary powers in Europe (more precisely, the centralization of the system of benefits to the unemployed). If this is not done, there would be a major social tensions and endanger the monetary union.
If such a centralization of the national government's budget in the monetary union is not possible (as demonstrated in the context of the European Monetary Union), national fiscal policy should be used in a flexible way. Then the country, when they hit negativnimšokovima, should allow the budget deficit to grow through embedded (or automatic) budgetary stabilizers (reduction of government revenue, increased social spending).
This requirement that fiscal policy responds flexibly to negative shocks also means that these national fiscal policy should have considerable autonomy. Following the logic of the theory of optimum currency areas, when they join the EU, countries are losing one policy instrument (the exchange rate). If there is no centralized budget automatically redistributes income countries do not have at their disposal an instrument to absorb the effects of negative shocks. It remains only an instrument of fiscal policy.
This theory about how we should manage fiscal policy in a monetary union enough to criticize. The criticism is not directed at the first conclusion, IE, that it is desirable to centralize a significant portion of the national budget in the monetary union. Criticism is formulated in relation to a different conclusion, which calls for flexibility and autonomy of the budget of the national government in a monetary union, when the degree of centralization of the budget is limited. The government sets fiscal policy independently of monetary policy and the latter adjusts [7].

RESULTS AND DISCUSSION

The required level of centralization of government budgets in monetary union

The theory of optimal currency areas emphasizes that the desired high level of centralization of national budgets to adjust to asymmetric shocks in different regions (states) [4]. The question is what are the limits of such centralization?
To answer this question, it is important to understand that the budget transfers should be used in case of temporary shocks or used only temporarily, when shocks are permanent. Country or region, which faces the permanent shocks. A permanent decline in demand for output VAT) should it adapt to changes over wages and price or moving factors of production. Budget transfers can be used only temporarily alleviate these problems of adjustment.
The various reform processes must be given the time and confidence needed to display they effects [5]. However, experience with regional budget transfers within nations (Italy and Belgium, for example), indicates that it is very difficult to use the transfers temporarily. Very often, when the region is faced with the negative shocks (Wallonia in Belgium), transfers through centralized social protection system more difficult to obtain a permanent character. The principal reason for this is that transfers of social protection reduce the need for adjustment.
They tend to keep real wages in the region where the depression is too high and to reduce the motive of the population of the region to go to the prosperous regenerate. As a result: transfers weight to become self fulfilling. This is illustrated through the fact that Mezzogiorno receives, transfers (from the rest of Italy) which represent 20% - 30% of the Regional outputs Mezzogiorno for most of the past 25 years.
Although less significant in size, similar regional transfers there and in other countries (Belgium). It follows that a large and permanent regional transfers create new political problems when citizens prosperous regions are increasingly opposed to paying for others. In some countries, these political problems can lead question the unity of the nation. When the sense of national identity is weak, it can effectively lead the disintegration of the country. You can dream up some radical plots for changing the situation [3].
Experiences with regional transfers within the European nations should bear in mind when considering different limits that should be applied to the centralization of national budgets (including social protection) in Europe. Certainly centralization of the social protection system at the European level has created problems such as " Mezzogiorno " in most states. This would lead to a quasi-permanent transfers from one group of countries to another group of countries. The recession in the economies of the European Union from 2009 is shown in Table 1. GDP represents Gross Domestic Product.

Table 1. The recession in the economies of the European Union – 2009. (OECD, Economic Outlook, Interim Report, Paris 2000.)

	Economic growth	**public debt in % GDP**	**Budgetary deficit in % GDP**
Ireland *	-5.0	89,1	-7,1
Belgium	-1,9	122,8	-8,6
France	-1,8	66,8	-7,6
Portugal *	-1.6	86,9	-10,3
Spain*	-2,0	76,2	-9,9
Netherlands	-2,0	88,8	-4,0
Denmark	-1,0	86,6	-3,6
Finland	-1,2		-2,0
Sweden	-1,4	78,2	-9,9
Estonia *	-4,7		-6,0
Latvia *	-6,9		-4,0
Lithuania *	-4,0		-3,2
Germany	-2,3	84,2	-8,0
Hungary *	-1,6	51,2	-5,0
Austria	-1,2	78,4	-4,0

Italy	-2,0	121,6	-12,0
EURO-ZONE	-3.2	71,1	-6.2
Great Britain	-2,8	89,9	-13,2
USA	-2,6	94,0	-13,6
Japan	-5,8	125,0	-13,4

The sense of national identification is much less developed at the European level, rather than at the level of a country, which would certainly lead to big political problems. That would jeopardize the unity of the European Union. Therefore, although Europe needs some further centralization of national budgets (including social security systems) in order to obtain a functioning monetary union, the degree of centralization should be much lower than that achieved in current European nation states.
Some schemes limiting the centralization of the social security system (especially the system of benefits to the unemployed) propose and implement a significant number of economists. These proposals suggest that capped centralization, if we take into account asymmetric shocks (temporary), may be fully informed effective [8].

CONCLUSION

For a long time it was thought that the European financial system is stable and there is no need for intervention as in the United States. However, economists believed that the American scenario of a collapse of the financial system occurs in Europe. There is no economic model good for all [10].
Economic growth in the EU last two decades will be between 1% and 2%, which is extremely low. The average inflation rate ranged at around 2% (mainly due to prices of energy and raw materials), that is on the verge of deflation, while the rate unemployment constantly increases and exceeds the rate of 10%.
The total public debt of most developed countries (especially because of the great assistance from the financial institutions and businesses) will increase in 2010 by 30% and in 2011 for another 30%, thus reaching the fantastic sum of 45.000 billion dollars. To 2009, this amounted to "only" 35,000 billion. In doing so, the economies of EU countries in recession. the crucial role of the OECD in its dissemination and, above all, the role statistics have played in shaping science and innovation policies [6].
We are currently spending more than 20% of tax revenues on interest payments on public debt. And in other countries is the same situation, even in Spain, France, Italy, Greece, and even worse. It has grown to international debt and credit balloon.

Acknowledgments

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DESIGNING ONTOLOGY FOR ASSOCIATION BETWEEN WATER QUALITY AND KIDNEY DISEASES FOR MEDICAL DECISION SUPPORT SYSTEM

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Abstract: Never-ending research streams are directed toward the Water pollution danger, which may lead to abominable toxicity. Water concentration increases the deadly chronic kidney disease (CKD) risk. Individuals are threatened due to destruction and over-exploitations of the environment. Rapid urbanization, population growth, industries and agriculture expansion increase the demand for fresh water. Safe drinking water is an essential human right; however still about 2.0 billion individuals all over the world lack access to clean-safe drinking water. Poor sanitation and contaminated water claim more lives than a single disease. The CKD is geographically demarcated as it caused mainly by polluted water. This association between water and kidney diseases can assist physicians to predict certain disease such as existence of stones, gravels and cancer due to increased certain water element because of pollution. Consequently, finding such association was the target of the current work based on ontologies. In order to evaluate the proposed scheme, water samples that exposed to microbiological and physical investigations were gathered from five areas in Hail region, Saudi Arabia, namely Hail, Alkutha, Ugda, Qnaa and Twaran. Furthermore, hundred patients were subjected to clinical examination, urine analysis and kidney-urinary tract Utrasonography (US) to find association between the kidney diseases and drinking water quality. For example, the experimental results established that Qnaa water samples had the highest degree of alkalinity with a high incidence of kidney stone/gravels formation.

Key words: water quality, kidney diseases, ontology, association rules, data mining.

INTRODUCTION

Contaminated drinking water affects the environment as well as can cause severe chronic health diseases such as kidney damage, liver damage and cancer. One of these diseases is the chronic kidney disease, which causes a universal health problem that has gained global attention due to its rapid spread. Kidney disease (KD) occurs due to certain factors, such as hypertension, diabetes, aging and nephrotoxic drugs usage that affect the kidney's proper operation. This can lead to health problems including nerve damage, high blood pressure, weak bones, and poor nutritional health [1]. Consequently, water quality plays a major role in inducing several KD. Prior research has hypothesized a connection between KD and the drinking water [2-4].The chronic kidney disease prevalence can depend on the geographic area within the same country. Water quality has intimate relationship with its geological location as reported in earlier researches [5, 6].

Finding a relationship between water quality analysis and kidney diseases in certain geographical regions can assist proper diagnosis. Nowadays, advancement in the computer technology has helped emerge the possibility of finding such associations. The use of ontologies to automate extracting such associations between medical information has witnessed an explosive growth [7]. Ontologies have been effectively exploited in biology and medical science to explicitly describe entities and relationships among them.

Ontology can be considered as i) software implementations designed to capture some formal approaches, or as ii) theories of different types of entities (objects, processes, relations, functions) [8]. It indicates relationship of the most general/ essential features of objects and relations. Thus, the goal of ontology is to provide coherent, clear and rigorously basic structures to be found in reality [9]. The ontological method to solve problems of computer based biomedical information management, begins with human researchers/physicians attempting to identify exhaustively the information that is to be computer-implemented. Typically, ontologies are elaborated in various technological domains [10-12] such as multi-agent communication, web based applications as well as in to medical field [13, 14]. Additionally, various studies have been conducted to analyze the effect of the water on the kidney. This section explores the work done by eminent researchers in these fields. Lee *et al*. (2004) [15] developed an automatic scheme to build ontologies, especially in the medical area from a document collection using natural language processing methods for improving identification of the semantic relationship among concepts. The authors explored both manual construction and a semi-automatic linguistic pattern to identify treatment relations in the medical, abstracts for colon cancer treatment. Association rule mining was deployed to sample sentences including both the disease concept and a reference to the drug. This rule was applied to identify commonly occurring word patterns that can be used to recognize treatment relations in the sentences. Wei and Barnaghi (2007) [16] employed ontology-based knowledge depiction and semantic annotation technique for medical image data to provide well-defined meanings to data representation structures. This system can assist in improved medical diagnosis.

Numerous studies reported efforts towards associating human diseases with their causes. Gulbahce *et al*. (2012) [17] assembled a viral disease network of disease's relations to interpret the interaction between viruses and disease phenotypes. Alam-Faruque *et al*. (2014) [18] introduced collaboration between the renal biomedical research community and the Gene Ontology (GO) Consortium to improve the quality/quantity of GO terms describing the renal development. The authors produced a resource for data interpretation by investigating molecular mechanisms of kidney function, thus assisted towards alleviating renal disease.

Several researchers reported the relation between water quality monitoring and disease identification. Ceccaroni *et al*. (2004) [19] designed the OntoWEDSS decision-support system for wastewater management. This system enhanced the classic rule-based reasoning and case-based reasoning with ontology, which provided flexible management ability to the OntoWEDSS. The OntoWEDSS system assisted diagnosis improvement of faulty states of a water treatment plant. Chen *et al*. (2007) [20] presented a system prototype, which integrated water quality data from several sources and retrieved that data using semantic relationships between attributes. It allowed users to integrate water monitoring data across different sources and provided novel methods for information discovery. Wang *et al*. (2011) [21] proposed a semantic based scheme for emerging environmental information systems. It used ontology and integrated water data from different sources to enable pollution detection. This scheme identified the opportunity to connect different knowledge bases such as water quality and disease database. Mohamed *et al*. (2015) [22] studied the effect of tap water quality on the kidney and determined the renal health hazards.

The preceding reported studies highlighted the effect of quality of water toward many diseases. Further, researchers have been putting efforts towards ontology based automated water quality monitoring systems. However, none has focused on establishing association between the water quality and the symptoms of kidney diseases. In addition, the problem under consideration can be benefitted from data mining [10]. Automation of data mining has already leaded to construction of ontologies in this field. Consequently, the main contribution of the current study was finding the association between the water quality analysis and the diagnosis of different kidney diseases using ontology. The relations obtained from ontological analysis were verified by using SPARQL rules and confirmed by a physician. The water samples that subjected to physical and microbiological examination were collected from different five regions of Hail region in Saudi Arabia. In order to investigate and find association of the drinking water quality and the kidney diseases, hundred patients were subjected to clinical examination, urine analysis and kidney-urinary tract Utrasonography (US) in the primary health care centers of these five regions.

The structure of the remaining sections includes the methodology about the ontology concept, techniques/ tools and the used rules. Afterward, the results and discussion including the application of

Protégé and SPARQ (Simple Protocol and RDF Query Language) are addressed. Finally, the conclusion is introduced.

MATERIAL AND METHODS

This section provides overview of Ontology and proposed technique for establishing association between water quality and kidney diseases. In Artificial Intelligence (AI), ontology is defined as knowledge representation that captures the concepts and the relationships relevant to a specific domain [23]. Ontology requires embodying some sort of world view to represent the given domain. The world view is often conceived as a set of concepts (e.g. entities, attributes, and processes), their definition and their inter-relationships [24]. Good ontology offers a huge number of benefits that are not available in rational database schema or other standard ways to structure information. One of the key advantages of ontology is its ability to represent any form of information including unstructured information such as text and documents, semi-structured information (e.g. Extensible Markup Language (XML) or web pages) and structured information as the data stored in conventional databases. In addition, ontology allows concept matching, which enables matching different concepts that have a semantic affinity with a target concept. Ontologies also enable browsing and searching for domain-specific terminology and enable reuse of domain knowledge. Moreover, ontologies allow interoperability among different systems. The quality of ontology can be ensured using ontology reasoners. An ontology reasoned is used to make the consequences of a certain ontology design explicit, and thereby facilitates the evaluation of the ontology correctness without depending on concrete test cases [25]. As follows the employed ontology language, techniques and tools in the current work:

Web Ontology Language (OWL)

The World Wide Web consortium (W3C) created Ontology Web Language (OWL) for Ontology development that became a W3C recommendation in 2004. OWL is an important language in semantic web, which facilitates creating, modifying, linking and importing ontologies in different environments [26]. OWL is derived from description logics that use formal semantics and vocabulary to allow machines to perform automatic reasoning.

Protégé

Protégé is a free, open-source ontology editor and framework for building intelligent systems. Protégé [27] is known as a leading ontological engineering tool, which provides a graphic user interface to declare ontologies. Furthermore, it includes strong deductive classifiers to build the models and to produce new information based on the ontology analysis. Ontology reasoner is one of the most useful techniques in protégé platform. It is used to check the consistency of the ontology and automatically computes the ontology class hierarchy. There are many automated reasoners in Protégé such as Pellet, FaCT++, HerMiT and ELK. These reasoners help checking consistency and classification used in ontology. Further, domains, ranges and conflicting disjoint assertions can also be identified. They also calculate the resulting inferred hierarchy and other properties.

SPARQL

SPARQL stands for Simple Protocol and RDF Query Language. It has also been standardized by W3C and became one of its recommendations in 2008 [28]. It provides a standard way to query RDF data. It contains capabilities for querying optional graph patterns along with their conjunctions and disjunctions whenever required.

PROPOSED SCHEME

This section elaborates the constructing ontology process that can associate water quality with kidney disease symptoms by applying the protégé and SPARQL. The phases for building the required ontology are namely specification and knowledge acquisition, conceptualization, integration, implementation, evaluation, and documentation. The steps of the proposed procedure are demonstrated in Figure 1 as follows:

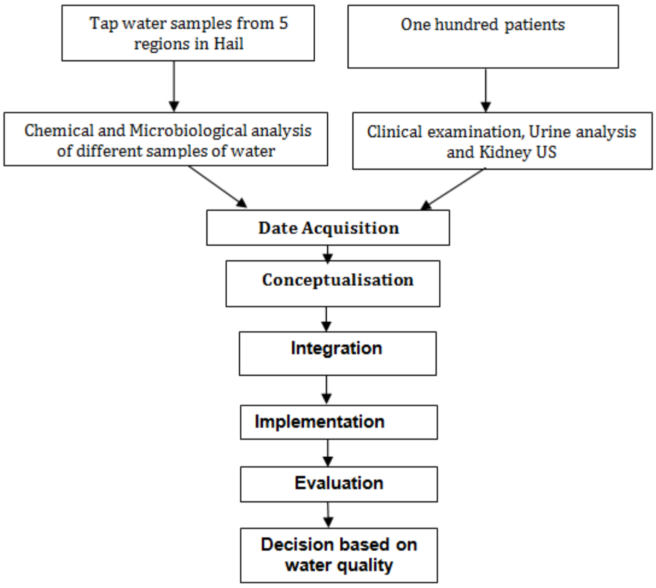

Figure 1. Ontology construction process using proposed technique

Detailed description of the proposed ontology construction scheme is given as follows.

Specification and Knowledge acquisition

In this stage, the ontology purpose, domain of use and users, and the ontology scope were identified. In the existing work, ontology was applied to assist researchers/physicians investigating the quality of tap water effect on the patients' health particularly for the kidney diseases. The knowledge required for developing the ontology was obtained from Tap water samples gathered from five regions in Hail, namely Hail, Alkhuta, Ugda, Qnaa and Tawaren. All water samples were subjected to physical tests, including the pH, electrical conductivity (EC), turbidity and total dissolved solids (TDS). Chemical analysis of these samples was also performed to analyze calcium, free chlorine, nitrate, magnesium, total hardness and alkalinity with trace element analysis (uranium, cobalt, zinc, cadmium, lead, nickel, copper, arsenic, and selenium).

Additionally, one hundred patients were examined in the primary health care centers in the previously mentioned five regions after taking their written consent. The patients suffering from diabetes mellitus, chronic renal diseases, hypertension, senile enlarged prostate or those taking nephrotoxic drugs were excluded from the study. A complete medical history of the patients were collected from the patients along with clinical examination, complete urine analysis and kidney urinary Ultrasonography (US) after an overnight fasting. The results of the water analysis and the patients' examination have been reported in [22].

Conceptualisation

This stage identified the concepts, relations and properties in the domain of interest (DoI). Afterwards, the concepts are represented using an appropriate representation and then relationships are established between the concepts. Figure 2 illustrated the three main concepts chosen in the current study, namely the Patient, City, and Water. *LivesIn* is a relation that links between the Patient and City whereas *ObtainedFrom* is a relation that links between Water and City.

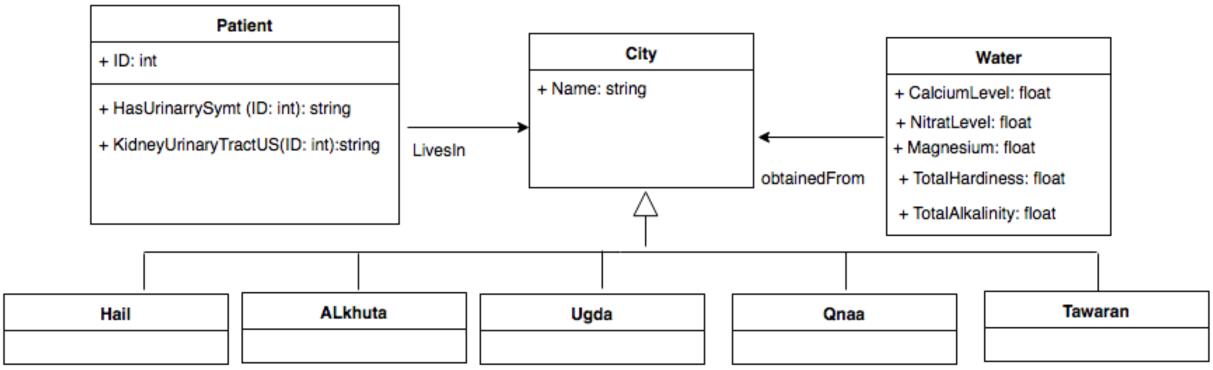

Figure 2. A class diagram indicating relationships between classes of proposed ontology

The Patient class has an attribute ID and has many operations, such as *UrinarySymptoms* that returns urinary symptoms and *Kidney-urinaryTractUS* that returns kidney problems which a patient suffered from (if any). The City class has *Name* attribute, while the Water class has many attributes such as *CalciumLevel* and *NitrateLevel, values of* which are obtained from the water analysis results. Hail, Alkuta, Ugds, Qnaa, and Tawaran are subclasses of City class.

Integration

It is possible to reuse other ontologies related to the domain and adapt them. The reused ontologies can be of benefit in extracting some concepts and extending them for preparing the proposed ontology. Since adequate knowledge was not already available in any existing ontology, thus none existing ontology could be reused. Thus proposed ontology has been developed independently from scratch. However, in future proposed ontology may be extended using other ontologies.

Implementation

In this step, a formal language was employed to code the proposed ontology. Coding means representing the concepts and the relationships captured from the previous phase using a programming language. The OWL was used to develop the proposed ontology in Protégé editor. Figure 3 demonstrated the hierarchies of the basic classes in the proposed ontology.

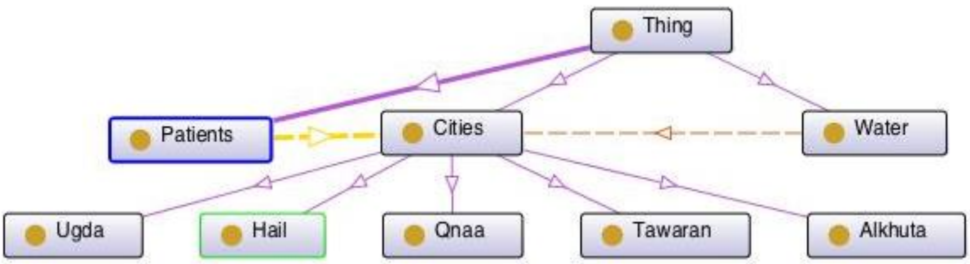

Figure 3. The proposed ontology classes

The OntoGraf is ontology graph visualization plug-in within the Protégé-OWL editor. It visualizes classes and individuals as nodes of a graph and relationships between them as edges. Different relationships are supported: subclass, individual, domain/range object properties, and equivalence. The dashed line between Patients and Cities indicated that there is a (domain-range) relationship between the Patients and Cities in which is (*LivesIn*). Similarly, there is a (domain-range) relationship between the Water and Cities which is *(ObtainedFrom*). The solid line indicates that there exist (has subclass) relationship between two classes. For instance, Ugda is a subclass from Cities.

Evaluation

In this step, evaluation of the developed ontology has been done to ensure completeness and validity of it. To verify the proposed ontology and test its accuracy and functionality, the SPARQL language has been used as addressed in the following section.

RESULTS AND DISCUSSION

This section includes some examples of queries and answers about the relationship between the water analysis and the kidney symptoms using SPARQL to report the relation between water quality and the kidney disease. The queries given by the physician and their answers by the current proposed scheme are:

Query 1. Which area has the highest value of calcium, and total hardness and higher degree of alkalinity?

Figure 4 illustrates using the SPARQL query to ask about the areas in Hail region that has highest value of calcium, and total hardness and higher degree of alkalinity, where the answer is included in Table 1.

SPARQL query:

```
PREFIX o: <http://www.semanticweb.org/user/ontologies/2016/9/WaterOntology#>
SELECT ?c ?cl ?th ?tk
            WHERE { ?c o:calciumLevel ?cl;
                       o:totalHardness ?th;
                       o:totalAlkalinity ?tk;
                     } ORDER BY DESC(?cl) (?th) (?tk)
```

Figure 4. The query to determine the area that has value of calcium, and total hardness and higher degree of alkalinity

Table 1. Answer of query 1

Region	Calcium level	Total Hardness	Total Alkalinity
Alkutha	108.16	317.6	75.64
Qnaa	90.72	294	215.7
Ugda	54.56	184.4	128.83
Twaran	51.04	165.2	143
Hail	23.84	70.8	43.43

Query 2. Which region (area) has high prevalence of kidney gravels and stones?

The SPARQL language is used to ask about the region in Hail that has high prevalence of kidney gravels and stones as illustrated in Figure 5, where the answer is included in Table 2.

SPARQL query:

```
PREFIX o: <http://www.semanticweb.org/user/ontologies/2016/9/WaterOntology#>
SELECT ?c (COUNT(?p) AS ?count)
            WHERE {?p o:Ultrasonography ?d;
                     o:LivesIn ?c;
                     FILTER (regex(?d, "stone", 'i')|| regex(?d, "gravels", 'i'))
                   } GROUP BY (?count)  ?c
```

Figure. 5 The query to determine the region that has high prevalence of kideny gravels and stones

Table 2. Answer of query 2

Region	Count
Hail	6
Alkutha	12
Ugda	6
Qnaa	**14**
Twaran	10

Query 3. Which regions have the highest value degree of alkalinity?
The SPARQL language is used to ask about the region in Hail that has the highest value degree of alkalinity as demonstrated in Figure 6, where the answer is included in Table 3.

```
PARQL query:
REFIX o: <http://www.semanticweb.org/user/ontologies/2016/9/WaterOntology#>
ELECT ?c  ?tk
          WHERE { ?c
                   o:totalAlkalinity ?tk;
                 }  ORDER BY DESC(?tk)
```

Figure 6. The query to determine the region that has the highest value degree of alkalinity

Table 3. Answer of query 3

Region	Total Alkalinity
Qnaa	**215.7**
Twaran	143
Ugda	128.83
Alkutha	75.64
Hail	43.43

Query 4. Which regions have the highest value of pH and turbidity with high calcium oxalate crystals?
The SPARQL language is used to ask about the region in Hail that has the highest value of pH and turbidity with high calcium oxalate crystals as illustrated in Figure 7, where the answer is included in Table 5.

```
SPARQL query:
PREFIX o: <http://www.semanticweb.org/user/ontologies/2016/9/WaterOntology#>
SELECT ?c ?cl ?th ?tk
          WHERE { ?c o:calciumLevel ?cl;
                   o:pH ?th;
                   o:waterTurbidity ?tk;
                }  ORDER BY DESC(?tk) (?th) (?cl)
```

Figure 7. The query to determine the region that has the highest value of pH and turbidity with high calcium oxalate crystals

Table 5. Answer of query 4

Region	pH	Turbidity	Calcium level
Qnaa	7.8	0.31	90.72
Twaran	**8.4**	**1.38**	51.04
Ugda	8.49	0.38	54.56
Alkutha	7.91	0.26	108.16
Hail	8.4	0.44	23.84

Query 5. Which region has high prevalence of kidney gravels?
The SPARQL language is used to ask about the area in Hail region that has high prevalence of kidney gravels as illustrated in Figure 8, where the answer is included in Table 6.

```
SPARQL query:
PREFIX o: <http://www.semanticweb.org/user/ontologies/2016/9/WaterOntology#>
SELECT ?c (COUNT(?p) AS ?count)
          WHERE {?p o:SufferFrom ?d;
                   o:LivesIn ?c;
                   FILTER regex(?d, "gravels", 'i')
                } GROUP BY (?count) ?c
```

Figure 8. The query to determine the region that has high prevalence of kidney gravels

Table 6. Answer of query 5

Region	Count
Twaran	**10**
Alkutha	9
Qnaa	8
Hail	6
Ugda	6

Query 6. Which regions have the lowest calcium and magnesium?

The SPARQL language is used to ask about the region in Hail that has the lowest calcium and magnesium as illustrated in Figure 9, where the answer is included in Table 8.

```
SPARQL query:
PREFIX o: <http://www.semanticweb.org/user/ontologies/2016/9/WaterOntology#>
SELECT  ?c ?cl ?tk
            WHERE { ?c o:calciumLevel ?cl;
                       o:magnesium ?tk;
                   }  ORDER BY Asc(?cl) (?tk)
```

Figure 9. The query to determine the region that has the lowest calcium and magnesium

Table 8. Answer of query 6

Region	Magnesium level	Calcium level
Hail	**2.69**	**23.84**
Twaran	9.02	51.04
Ugda	11.52	54.56
Qnaa	16.13	90.72
Alkutha	11.33	108.16

Query 7. Which region has Kidney free of stones and gravels?
The SPARQL language is used to ask about the areas in Hail region that has Kidney free of stones and gravels as illustrated in Figure 10, where the answer is included in Table 9.

```
SPARQL query:
PREFIX o: <http://www.semanticweb.org/user/ontologies/2016/9/WaterOntology#>
SELECT ?c (COUNT(?p) AS ?count)
            WHERE {?p o:SufferFrom ?d;
                       o:LivesIn ?c;
                       FILTER NOT EXISTS{
                          FILTER( regex(?d, "gravels", 'i') || regex(?d, "stone", 'i'))
}
                     }GROUP BY (?count) ?c
```

Figure 10. The query to determine the region that has Kidney free of stones and gravels

Table 9. Answer of query 7

Region	Count
Hail	**14**
Alkutha	8
Ugda	12
Qnaa	6
Twaran	10

The preceding results are matched with the results obtained by Mohamed et al. [22], which established the same relations between the water quality and the kidney disease. Consequently, it is suggested to apply the proposed approach on more associations using larger dataset of patients. In addition, several data mining methods can be used and formalized in SPARQL queries. In addition, as a future work, some complex SPARQL queries can be executed based on data mining methods to discover new information about association between water quality and kidney diseases and possibly some other diseases.

CONCLUSIONS

Presently, the CKD-prone covers wide areas, and affecting massive number of individuals. The CKD occurrence is thought to be cause by the polluted water consumption. Adverse environmental conditions, chemical fertilizer, agricultural habits, irrigation methods and agro-chemical use have a significant role in causing CDK disease; but no causality is demonstrated. In most countries, the CKD is an environmental disease. In the affected areas, the water is contaminated with cadmium, arsenic, toxic heavy metals, as well as nitrates, fluoride and toxic agro-chemicals. Though the precise cause for the CKD is unidentified, it is prospective to be multi-factorial and due to chemicals combination or toxins widespread in certain region/area. Therefore, an imperative solution is essential to find the specific association between water quality and kidney disease using ontology and data mining as proposed in the current study.

The experimental results established several associations such as high value of pH and turbidity with high calcium oxalate crystals lead to increased gravels number. Furthermore, kidney free of stones and gravels patients exists in areas having lowest calcium and magnesium. These results were confirmed and were compared by the results concluded clinically by Mohamed *et al*. [22].

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COMPUTER TOOLS IN ENGINEERING EDUCATION – EXAMPLE ON MACROMEDIA FLASH

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Abstract: The purpose of this study is to investigate the potential benefits of using computer tools in engineering education. Animations, visual cueing, and their combination in a multimedia environment are designed to support learners' acquisition and retention of scientific concepts and processes. The software used in the development of the animations is Macromedia Flash, a tool that allows very small vectorial graphics files to be created, thus facilitating their electronic transmission to any user connected to the network. The research was conducted on 75 students of the first year at the Faculty of Civil Construction Management of the Union "Nikola Tesla" University, Belgrade, Serbia. The course was followed by a 3-year study to assess the acceptance of the computer tools and multimedia animations for learning mathematics. This research clearly showed that students were highly interested in this way of teaching and learning.
Key words: computer tools, Macromedia Flash, animation, Engineering education

INTRODUCTION

Today, Internet has established a new model for providing information and services to all users throughout the world. Thus, the decision to use web technologies such as HTML, XML, Java and Flash is obvious [27]. FLASH is a very powerful graphics and animation development system that was introduced by Macromedia (now a subsidiary of Adobe Systems) in 1997. Over the past decade, it has become the de-facto standard for animation, gaming and multimedia applications on the World Wide Web. Many companies have web page that include animations created with Macromedia Flash, due mainly to the two most important characteristics of this application: creation of vectorial graphics and interaction of it user with the animations. We should add that Flash allows the user to interact with the animation being displayed, thus the user can control the visualization of the film, take decisions, write, press buttons, move, drag, etc.

The contribution made by Flash is clear: animation + interactivity, and we should remember that interactivity is the greatest advantage that multimedia contributes to teaching [11]. It is only necessary to select the content correctly and insert them properly in the program.

In most cases, Flash animations have become teaching aids [4] that are now common in many courses and universities and this represents a notable advance in teaching innovation achieved in recent years.

In the literature, there is of course no shortage of studies about the effects and the benefits of computer tools and animations in classroom instruction. Author [26] studied such effects long before the modern animations tools were introduced. Authors [11], [27], [3] and [19] discussed the use of interactive graphical tools in applications such as engineering education, computer science education and ecology. Authors [12] presented a study of the psychology of student interaction with animations. Authors [24] described some important concepts in the interactive learning process, such as the design principles of an interactive learning environment, the technology needed for gauging human performance, etc. Authors [13][14] published an extensive study of the cognitive and psychological aspects of multimedia learning. Authors [21] pointed out that multimedia applications have slowly transformed the typical university communication network to an education delivery system. Author [25] argued in a short article for the first time that the Macromedia Flash development system can be a serious instructional authoring tool (this is the view shared by the present author).

Authors [10][9][16][17][18] and recently [6] demonstrated some specific Flash examples for mathematics teaching.

MATERIAL AND METHODS

Overview of the experiment

One purpose of the current study was to investigate whether animations were more effective than static graphics to promote learning. Animations have the potential to facilitate knowledge construction with this type of learning content [7][22][29]. Therefore, we hypothesized that animations enhance retention of both concepts and processes. The study also investigated the potential cognitive benefits of adding visual cues to visualizations to enhance science learning in a multimedia environment. Based on the literature reviewed in previous section, we hypothesized that visual cueing is effective to enhance learning. In addition to learning, cognitive load and motivation were also investigated. By providing learner control over animations, the transitory nature of animations could be overcome. Therefore, we expected that when comparing animations to static graphics, animations would reduce extraneous load and consequently foster germane load. We also expected visual cueing to reduce extraneous load in multimedia learning environment, which is in line with [15] and [28]. Only a few studies have investigated learners' motivation in multimedia learning, e.g., motivation in an agent-based environment [20], and in an online animation-based environment [23]. As motivation impacts learning [5][8], this study explored the potential effects of animations and visual cueing on learners' intrinsic motivation in the multimedia environment.

Participants and questions of the Research

The research was conducted on 75 students (tree generations as per 25 of the first year students) at the Faculty of Civil Construction Management of the UNION University, Belgrade, Serbia. The course was followed by a 3-year study (2010, 2011. and 2012.) to assess the acceptance of the computer tools and multimedia - Flash animations for learning mathematics. In addition to the statistics collected about the test scores, the students who were tutored with the new techniques were also asked directly two questions after the conclusion of the study:

(1) 'Do you agree that the Flash animations contributed significantly to *lecturing* mathematics: I disagree, I agree, I totally agree?' and
(2) 'Do you agree that the Flash animations contributed significantly to *learning* mathematics: I disagree, I agree, I totally agree?'

Computer-based learning environment of mathematics. Example

Lectures of the mathematics courses included exactly the same information i.e. axioms, theorems, examples and tasks like on the traditional class of math, but the main information source was software created in Macromedia Flash 10.0, which is proven to be very successful and illustrative for creating multimedia applications in mathematics lectures [2]. Our multimedia lecturing material was created in accordance with methodical approach, i.e. cognitive theory of multimedia learning [13][14], as well as with principles of multimedia teaching and design based on researches in the field of teaching mathematics [1]. This material includes large number of dynamic and graphic presentations of definitions, theorems, characteristics, examples and tests from the area of mathematical geometry and analyses based on step-by-step method with accent on visualisation. Important quality of making one's own multimedia lectures is possibility of creating combination of traditional lecture and multimedia support.

a)

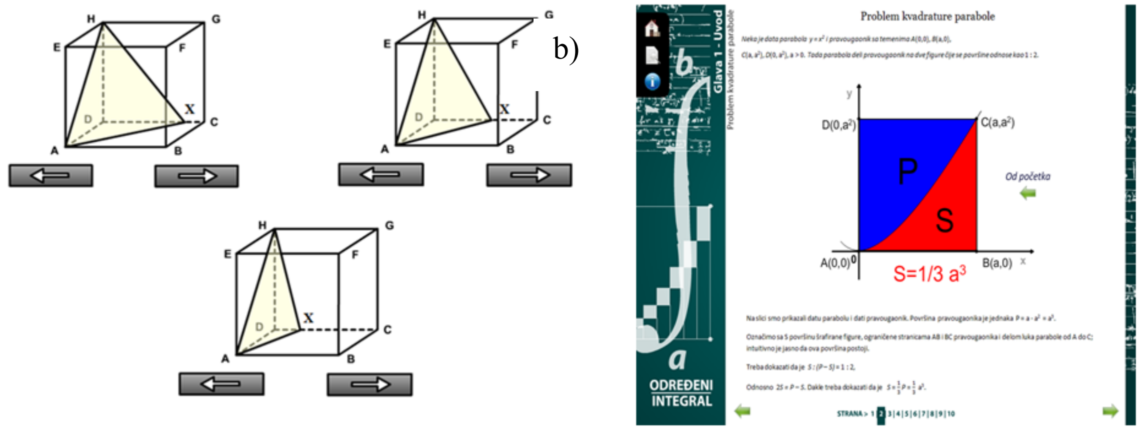

Figure 1. Examples of animations for teaching Geometry (a) and Analyses (b) created with Macromedia Flash.

RESULTS

In summary, multimedia learning helps to promote a better understanding of how to foster meaningful learning through the integration of words and pictures (printed or spoken text and illustrations, graphs, maps, animation or video).

Students' opinion

The students tested and worked with all the animations and subsequently responded to a series of surveys giving us, the teachers, their opinions, advice, comments and recommendations on the use of animations in the classroom.
The purpose of our first question is to go to the core of the issue concerning the use of animations in the classroom. We proposed to the students that the traditional explanations of theory given by the teacher should be replaced by animations, (Fig. 2). The students were not positively impressed by the idea of receiving a class of theory without the teacher, as, despite their interactivity, animations still do not have the same level of interactivity as a teacher. However, students mentioned that animations may be a great help for the teacher in the classroom.
In a second question, when we asked whether they prefer classical or multimedia way of individual learning mathematics, the students were answered multimedia - Flash animation, explaining it with the following reasons:

- ✓ ***Step-by-step***: The most frequent answer to the survey is directly related with the control students have over animations. Most of the animations have controls that allow the user to stop, resume, go to the beginning, go to the end, go one step forward or one step back. These devices allow the students to control the visualization and adapt the animation to their learning rate. Flash allows the user to control the animations, and although, in most cases, this is one of its most important properties, it may be counterproductive if the user progresses through the animation at a higher speed than the speed of the visualization itself [4].
- ✓ ***Amusing***: The students find animations amusing and they consider this a positive characteristic. As many of them pointed out, they are learning unconsciously, without being aware that they are visualizing three-dimensional concepts with quite a high level of complexity. This affective characteristic of learning is highly motivating as it attracts and holds the users attention – an essential aspect without which teachers will never be able to use with advantage any kind of educational resource [12]. This is why affective characteristics may play a very important role in the teaching–learning process.

- ✓ ***Availability***: Another of the strong points of animations is that, as they are located in a web server, they can be consulted at any time. Furthermore, the students consider that having material they can access as many times as they want constitutes an enormous advantage.
- ✓ ***Explanation***: The three characteristics mentioned above would be of no use if the teaching animations created do contain clear explanations with a well-defined structure that address the most important concepts of each lesson in a didactic way.

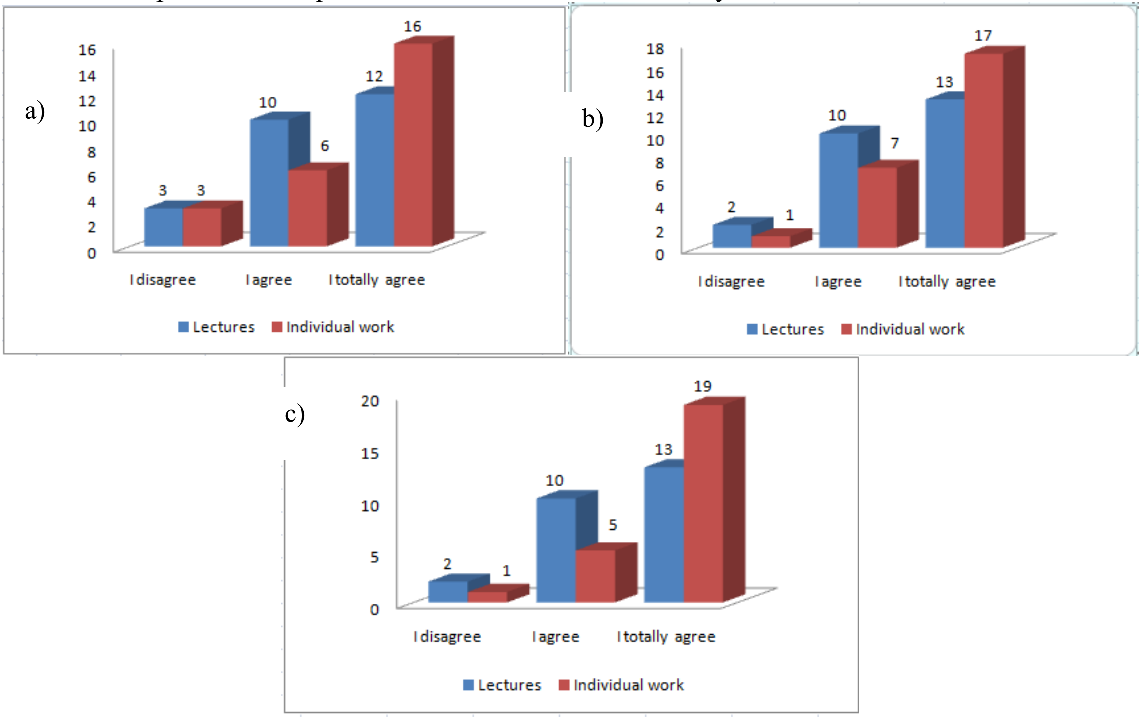

Figure 2. Students' answers to the question: Should Flash animations be used in lecturing and individual learning mathematics?
((a) – generation 2010, (b) – generation 2011, (c) - generation 2012)

CONCLUSIONS

Flash technology has revolutionized Internet. The generation of animations of a very small size, together with their interaction capacity and ease of use, has led to the spread of this technology among most creators of web pages, and many sites include animations or colorful presentations in their initial pages, thanks to Flash.

This technology opens a field with many applications for university teaching, since the theory content of the subjects can be converted to a greater or lesser extent into multimedia content, which students may consult and control at any time. But animations are not a solution to teaching problems since, if they are not correctly designed, they may be counterproductive for the learning process.

In the specific case of engineering education, the use of these animations is more enriching as, in many cases, it accelerates the development of the students' spatial perception – a basic objective in the training of any engineer. From experiments carried out with students who used animations created with Flash, a series of practical findings were obtained on how to create educational animations for educational teaching – learning process:

- ✓ Split up the content to be animated by Flash into basic learning units.
- ✓ Provide the animations with as much interactivity as possible.
- ✓ Hold the user's attention without recourse to unnecessary distractions.
- ✓ Allow the student to control the animation at all times.

The creation of these animations, together with their use in theory classes as a supplement to the work of the teacher, is guaranteed success among the students, as our experience shows. There was clearly a very significant improvement in the student's test scores as a result of introducing animations in traditional classroom instruction and great number of the students who believe that animations of mathematical concepts did contribute significantly to their understanding of mathematics.

Acknowledgments

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Session 6.

Student papers

THE IMPORTANCE OF APPLICATION AND MAINTENANCE OF BRAKING SYSTEM IN MODERN AUTOMOBILE

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Abstract: The authors of this work deal with the subject which is based on the braking system as one of the most important levels of security concerning automobiles. The focus is on the comparison between modern braking systems and the ones that were used before, on monitoring of system's development and on the use of modern and former braking systems in the car industry. Keeping in mind that braking is a process of vital importance, the elements of the system have to be projected thoroughly, produced, maintained and controled. The research and the development of new braking systems should be based on previous systems by testing their characteristics that, to a certain point, didn't satisfy the needs, as well as the reliability of the system itself, so that the development of some future system should be based on this experience, in order not to repeat the same disadvantages in the system's structure, but to strive to total quality and reliability.
Key words: braking systems, car industry, electronic control of automobiles

INTRODUCTION

Today in the 21st century there has been a sudden development of the system's automation, information technology, as well as enabling easier access to the knowledge about certain possibilities for progress. By development of that specific area, the level of automation, that is required for developing many other areas, such as medicine, mechanical engineering and other big branches of economy, has been risen. The main factors of traffic safety are: human-vehicle-road-surrounding. Traffic safety could be studied from the aspect of active and passive safety. Active vehicle safety is defined by possibilities which that vehicle provides to the driver in order to drive a vehicle reliably and with better control, and in that manner to avoid conflict situations on the road. Braking is a process that is carried out in order to slow down or stop the vehicle [6]. The development of braking systems can be perceived through three big entirities, or three periods, where every period is characterized by appropriate design solution and progress. The development of automation systems, as well as information systems, has contributed to great expansion, or to higher level of development of braking systems in the car industry in the modern age [9]. The main purpose of braking mechanisms is to accomplish necessary braking torque that has an influence on the wheel, causing its slowing down and therefore braking. That is why the braking torque is the main characteristic of these systems [7]. The reliabilty of the braking system, or any other technical system, is the ability to perform the requested function without cancellations and flaws. Regarding the car's braking system, the most important things are that the brake is safe, that the wheels and tires are correct and of certain quality, that the brake reacts at the moment of pushing the pedal or lever, and what is most important, that the vehicle stays stable after braking. Modes of use, as well as the vehicle maintainance, have a special influence on reliability and also on the vehicle's lifetime. The most common parameter of reliability is its lifetime that is usually expressed by the number of passed kilometres or hours of work. This parameter is commonly used to judge the quality of the vehicle [5].

METHODOLOGY OF THE RESEARCH

SUBJECT AND PROBLEM OF RESEARCH

In this work the subjects of research are braking systems in the car industry, or research of the characteristics of previous, as well as modern systems, and their mutual comparison. The problem that we examine is based on the comparison, in other words, on establishing the direction of developing new braking systems by improving the system's characteristics.

OBJECTIVES AND TASKS OF THE RESEARCH

The objective of the research could be defined as looking back on the braking systems that were used before and on those which are used today in the car industry, in order to come to a conclusion about the extent of progression of braking systems by using modern methods and techiques and also about the possibilities for further development and improvement of braking systems.

RESEARCH QUESTIONS

Regarding the implied and analysed theory, the following research questions have come up:
IP1: To what extent previous braking systems havent's satisfied traffic reliability?
IP2: What is the main task of development and usage of braking systems in the car industry?
IP3: How much have recent techologies and automation influenced the traffic safety?
IP4: Is the braking coefficient (prescribed by the law) satisfying, concerning safety of braking systems and also traffic safety?
IP5: Is maintainance and control of the braking systems in Serbia carried out on the required level?

JUSTIFICATION OF THE RESEARCH

Justification of researching this subject is reflected in the fact that there is a high level of flexibility while researching braking systems. Besides steering, one of the most important levels of safety of all vehicles is the braking system, that should be tested constantly and improved, on the basis of these tests, in order to reduce the possibilities for eventual cancellation within the system and to improve the characteristics. Also, the base of researching and improving of breaking systems is human security.

METHOD AND ORGANIZATION OF THE RESEARCH

The research in this work is based mostly on theoretical research of the braking systems from the time of their appearance until today, emphasizing the improvement and development in the future. The research is done in a way that a large number of practical examples in the theoretical research has been taken into account in order to base the work not only on the theoretical part, but also on the so-called „material" part which is actually a research of real phenomenona in these systems.

RESULTS AND DISCUSSION OF THE RESEARCH

Reliabilty as a security measurment of previous braking systems (*IP1)*

Previous braking systems, that were used in the mid 20th century, satisfied the needs of that time, but only in a certain domen which wasn't so flexible and was also too comfortable. Mechanical braking systems represented the basis, or a preventive solution, but there was a problem that occured at higher speeds, in difficult traffic conditions and other similar situations. Comfort and safety of those systems was on a very low level, although this type of system is applicable even today on trucks, e.g. tractors that have a presribed speed of maximum 25 km/h. Mechanical working brake hasn't been applied for a long time because of the development of the car industry, improvement of cars' characteristics, their speeds etc. The mechanical braking system has been widely used in vehicles as an extra, or an emergency brake. Reliability is according to all sciences an efficiency measurement of some system and that is also the case with the braking system, where reliability is reflected in the braking coefficient and the safety of the system itself. The previous systems haven't fulfilled this clause of efficiency and safety enough and for that reason there has been an evolution of braking systems followed by hydraulics. In the Table 1. percentage display of car accidents is shown, when the cause is the braking system.

Table 1. Percentage display of car accidents when the cause is the braking system (period 1976.-1981.)[2]

	Year						
Average	1976.	1977.	1978.	1979.	1980.	1981.	
Brake system	46,2	46,3	48,0	59,1	64,3	59,9	54,0

Development and application of braking systems in the car industry (*IP2*)

One of the main reasons and needs for developing braking systems, as mentioned before, is primarily human security, as well as reducing the number of car accidents, which are caused by braking systems and also by other reasons that are directly and indirectly connected with braking systems. For these reasons, in the mid-seventies of the 20th century started a global development of the new breaking systems that have hydraulics in their bases. As it turned out, those systems used to be implented for years, actually until 2016, and will still be present as a design solution of braking systems. In hydraulic brakes power transimission is carried out by fluids (oils). The power transmission through oils is convenient thanks to its characteristics that enable the power to be transmited simultaneously and continually, at the same speed and with the same intensity on the vehicle's wheels. During the flowing of oils, the frictional resistence is negligible. In the picture 1. it is shown a diagram of a hydraulic system of a passenger vehicle with the following components: *1- front wheel brake mechanism, 2- diagonal pipe „front left-back right" wheel, 3-the main cylindar, 4- diagonal pipe „front right-back left" wheel, 5- reservoir of a braking fluid, 6- servo device, 7-back wheel brake mechanism, 8- elastic lever of command pressure regulator, 9- pressure regulator, 10 – command lever of pressure regulator, 11- braking pedal, A- front brake hose, B – back brake hose.*

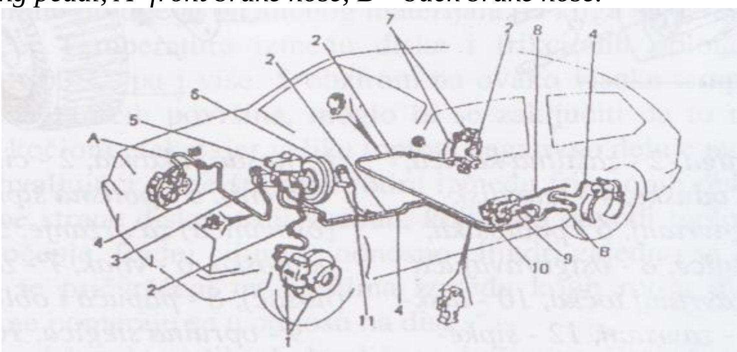


Figure 1. A diagram of the hydraulic system of passenger vehicles[1]

The advantages of hydraulic brakes are: the parts are small, easy installation, parts do not have to be lubricated because self-lubrication is carried out by using the oils of the braking system. In the world's car industry today, concerning the hydraulic braking system, there is a system of disk brake that is used in a design solution on both operating and driven wheels. This system is shown in picture 2.

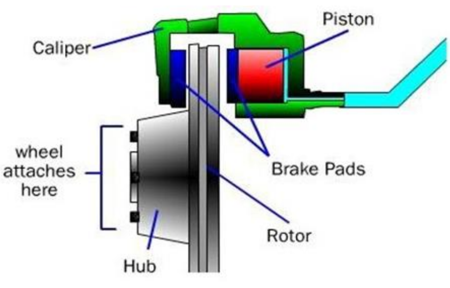


Figure 2. Disk brake [4]

In the table 2 it is given a percentage display of car accidents when the cause is the braking system.

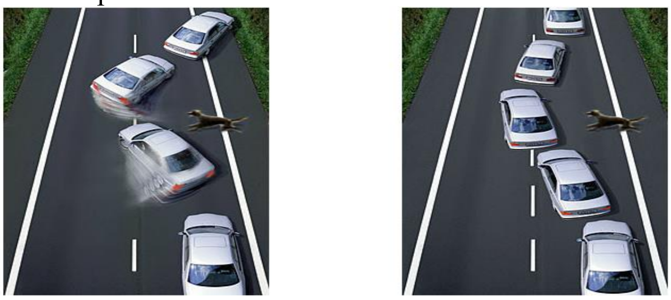
Table 2. Percentage display of car accidents when the cause is the braking system (period 1980.-1984.)[2]

	Year					
Average	1980.	1981.	1982.	1983.	1984.	
Brake system	30,40	30,66	26,44	30,89	29,79	29,64

In this table a clear picture is formed to what extent has the development of the new braking system contributed to reducing car accidents. A servo device which serves as help and supports the braking force, is added to the basic hydraulic system. The main reason of developing the servo device is stronger braking force along with the lower force effect on the braking system command.

Influence of new technologies on the traffic safety (*IP3)*

Development of new technologies has supported also the development of the braking system. By improving system automation, information technology and robotics, new spaces for the braking system's development have been opened. By the end of the 20th century, a new technology has appeared in the terms of the braking systems, that was called ABS system(Anti-block-lock systems). ABS systems are a result of the growing development of the system automation. Application of these systems, as one of the newest generations in the world of braking systems, has contributed, to a certain point, to reducing the number of car accidents caused by brakes. From 1995, when application and installation of these systems were noted for the first time, until today, there has been an evolution of this system. One of the greatest progresses is that the impulse of pedal recoil has been brought to the minimum, as it is shown in the pictures 3.



Picture 3. Vehicle behaviour: a-without the ABS system, b-with ABS system. [8]

Base	Withou ABS	With ABS
Dry	45	32
Snow	53	64
Ice	255	404

Braking coefficient as a safety measurement (*IP4*)

Braking coefficient as a main measurement or an indicator of brake regularity, is a very discutable factor of brake regularity in Serbia. The reason for such an opinion are low criteria that a vehicle and especially its braking system has to fulfill during the regularity check or regular technical inspection.
In the table 3 is given a an excerpt about the braking coeffients from the Auto-moto Association of Serbia.

Table 3. Braking coefficients [4]

VEHICLE CATEGORY	WORK BRAKING			ASSIST BRAKE		
	Coefficient of braking	Actuating forces		Coefficient of braking	Actuating forces	
		Foot activation	Manual activation		Foot activation	Manual activation
	z≥[%]	F≤ [daN]	F≤[daN]	z≥[%]	F≤[daN]	F≤[daN]
Bicycles with motor	**40**	**50**	**20**	**20**	**50**	**20**
Motorcycle	**45**	**50**	**20**	**20**	**50**	**20**
Passenger cars	**50**	**50**	**-**	**20**	**50**	**40**
Buses	**50**	**70**	**-**	**20**	**70**	**60**
Trucks	**45**	**70**	**-**	**20**	**70**	**60**
Trailer vehicles	**45**	p_m**≤6,5bar**	**-**	**20**	**-**	**-**
Tractors	**25**	**60**	**-**	**15**	**30**	**-**
Tractors trailer	**25**	**-**	**-**	**15**	**-**	**-**

Maintainance and control of the braking systems in Serbia (*IP5)*

Maintainance is one of the most important clauses of every dinamic, work system. Without maintainance there is no reliability, and in that case, no safety, as well. Conscience of constant need to maintain braking systems is not present among the drivers in Serbia enough. There are many solutions that could be subscribed by the Law of traffic safety. One of the main suggestions is to increase the frequency of controlling the braking systems, or to innovate a check of braking systems within the technical inspection that would be performed every 6 months. That is the only way for raising awareness about the importance of those systems' reliability.

CONCLUSION

In order to achieve modern industry, it is necessary to head for and accompany the development of previous braking systems. The reason for such a working principle is the fact that the basis of braking systems in modern industry is, after all, a mechanism that was used before, along with the modernization and improvement of that system. This work leads to various conclusions, but one of the most important is that previous braking systems, especially hydraulic braking system from the late '70, are even today the basis which is applied in the modern car industry, moreover, that is the case with almost every middle-class vehicle (automobiles) By developing automation systems, as mentioned before, there has been also a development of all systems in this type of industry, including the braking systems as well. Using a great number of modern devices for driving and control of vehicles is present today. It is noticable that electronics today support the mechanical systems to a large degree, which led to the increase of levels of safety while controlling the vehicles. The main task of the development and application of braking systems in the car industry is natural – prevention of numerous car accidents caused by these exact systems. From the beggining of the 21st century, until today, the number of accidents caused by braking systems has been decreased in a large percentage (more than 25%), thanks to the use of ABS and EPS systems and electronic car control. As one of the two most important vehicle systems, braking systems need to be innovated and improved regularly and for this purpose there is a wide platform of great quality that was created in the first decade of the 21st century by appearance and development of the IT sector, as well as by development of electronics through different softwares. However, software can never replace a human as a deciding and controlling factor, but with a higher level of automation systems' development, it could be possible to influence on that human factor to drive vehicles in an easier and safer way. The whole development of the braking system must be followed by the development of the system that maintain it, as well as the diagnostic, in order to diagnose the system's current state with high certainty. Reliability of the system depends most on its maintainance, which could be performed easily in the case of this system. It is also necessary to run some checks, for the reason mentioned at the very beggining of this work, and that is the fact that this system is one of the two most important safety factors while driving a vehicle.

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THE USE OF BIOFUELS AS THE PRODUCT OF BIOMASS ORIGINATED FROM ALGAE

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Abstract: The use of fossil fuels causes many environmental problems, such as atmospheric pollution, acidification of land and greenhouse gas emissions. Unlike fossil fuels, biomass combustion does not increase the amount of carbon dioxide (CO_2) in the atmosphere, and it, therefore, has a positive impact on the environment. The production of bio-fuel (biomass) from algae has a great potential, which can be achieved by using improved technology and by further development of the technology of obtaining bio-fuels. This paper presents the production and the importance of using bio-fuels from algae. And the essence of this paper is to highlight the importance of reducing the use of fossil fuels and turning towards cleaner and renewable energy sources.
Key words: bio-fuel, algae, energy efficiency, environment protection.

INTRODUCTION

The energy crisis in the early seventies, followed by numerous economic and environmental reasons, had made many countries to take appropriate measures for energy saving and its rational use [1]. The continued increase in global energy consumption generates an important challenge; non-renewable energy sources such as coal, oil, gas and nuclear energy, by the end of the 21st century, will be replaced by new, renewable, environmentally clean, natural energy sources such as sun, wind, water flows and biomass. In addition, the use of fossil fuels causes many environmental problems, such as atmospheric pollution, acidification of land and greenhouse gas emissions [2], [3]. The development of clean and renewable energy sources, today, is the crucial question for the solution of these problems. Biomass, which includes vegetation and trees, as well as biological solids, animal and agricultural residues, organic fractions of municipal waste and certain types of industrial waste, appears as a promising option because of its potential in the world in terms of availability, more efficient conversion and the ability to be produced and to use carbon dioxide (CO_2) on a neutral basis. Unlike fossil fuels, biomass combustion does not increase the amount of carbon dioxide (CO_2) in the atmosphere, and it, therefore, has a positive impact on the environment [4]. Also, the sharp rise in crude oil prices at the beginning of the 70's of the twentieth century has focused global attention to the need for more efficient use and finding new energy sources. In addition, a completely new approach to the production and the use of energy in the aim of security was developed; the result which causes the use (climate change) of certain types of energy and economic development. The consumption of energy is increasing dramatically in developed countries. In OECD countries, energy consumption is constantly increasing since 1985, while in other countries there is the growth of 50% in consumption during each decade. In general, it is expected that by 2030 the demands for energy will increase by more than 50%.

MATERIAL AND DISCUSSION

Biofuel

In general, bio-fuels can be defined as liquid or gaseous fuels used for transport and produced from biomass. As such, bio-fuels can be produced directly from plants or indirectly from industrial, agricultural waste, as well as from household waste. The goal of bio-fuel production is to reduce carbon dioxide (CO_2). Primarily, it is based on the fact that plants that bio-fuels are produced from absorb carbon- dioxide (CO_2) during their growth, which is then released during the combustion of bio-fuels. However, since the energy is needed for the growth and cultivation of plants and their conversion into bio-fuels and afterwards the distribution, it is clear that there is an additional release of carbon dioxide (CO_2).

By processing various types of biomass, bio-fuels that are applied mainly for transport purposes, in some industrial processes and for heating are usually produced. Depending on the raw materials from which they are produced, there are four generations of bio-fuels.

The division of bio-fuels can be presented as follows:

- ***The first generation of bio-fuels*** is produced from starch or sugar from corn, wheat, sugar cane, sugar beet and plants that contain a higher percentage of starch or sugar (the lack of first-generation of bio-fuel production has a negative impact on the price of basic foodstuffs and the country's economy). The products are: ethanol, biodiesel and biogas.
- ***Second-generation of bio-fuels*** is produced from lingo cellulosic biomass (wood, used paper, reed and grass) and agricultural remains; the production of the second generation of bio-fuels is still inefficient for commercial use, but some countries invested heavily in its research and development. (Product: bio hydrogen, bio-DME, bio methanol, HTU diesel, Fischer-Tropsch diesel and mixtures of alcohol).
- ***The third generation of bio-fuels*** is produced from algae or canola plants that do not threaten food supplies (The productivity of the third generation of bio-fuels is about 30 times greater per unit of surface area than the first or second generation of bio-fuels).
- ***The fourth generation of bio-fuels*** is produced from raw materials that are genetically modified to provide higher energy yields and/or their building macromolecules are subject to cost-effective decommissioning, and what is peculiar for them is to absorb large amounts of carbon dioxide (CO_2) from the atmosphere.

The main disadvantage of using *raw materials of the first generation* (edible oil seeds, cereals, etc.) to obtain biodiesel is a constant dilemma: food or fuel? –that is, the growth of food prices on the basis of edible oils due to their increased consumption in the production of bio-fuels [5]. Therefore, new researches are directed towards *the second generation raw materials*, which include non-edible and lingo cellulosic materials, such as: the remains from the treatment of sugar cane, wood and crops, municipal solid waste and other [6]. More recently, a growing number of researchers are studying the use of so-called *the third generation of raw materials*, which include micro-organisms, such as: yeast, fungi and algae, whose biomass can be used as the raw material for biodiesel.

The production and the importance of implementation of bio-fuels made from algae

The advantages of production and the implementation of bio-fuels made from algae can be seen through the following thesis:

- algae grow 50 to 100 times faster than traditional cultures that are used for the production of bio-fuels,
- algae do not need fresh water and land to grow,
- algae can be grown in separate water structures, even though water is not good enough to drink,
- algae can be grown both in salt and fresh water, as well as in polluted.

The very process of bio-fuel production can be presented through the reaction of fixation of solar energy to algae and the transformation of the same into the biomass (bio-fuel) and it can be displayed by the following reaction / formula (1):

$$6CO_2 + 6H_2O + \text{light} \rightarrow C_6H_{12}O_6 \text{ (sugar)} + 6O_2 \quad (1)$$

Sugars, formed through photosynthesis, convert all parts of the cell (lipids, carbohydrates, proteins) into biomass. The process of photosynthesis of algae is quite similar to the same process with all other

plants, however, it is quite simple due to the simple structure of algae; they represent a particularly effective convents of solar energy and carbon dioxide (CO_2) into biomass.
The convenience of the production and the application of algae is of wide range: they grow everywhere, in deserts, in salt and fresh water, even in the waste and polluted water, they reproduce rapidly. They apply carbon- dioxide CO_2 for photosynthesis and transform it, thereby reducing the concentration of carbon dioxide CO_2 by 40%. They are biodegradable and the biomass of algae is also applied to animal feed. From 2 kg of algae we can get about 1 kg of dry biomass. 2.5 kg of dry biomass is requires to get 1 kg of oil. They offer extremely high yields, from 10 to 100 times more than other bio-fuel sources. Bio-fuel from algae does not contain sulfur, it is non-toxic and biodegradable. Algae are the only natural resource that has the potential to completely replace fossil fuels.

The importance of the implementation

The biomass derived from algae can be applied in cosmetics by further manufacturing, as well as oil for food and other edible products, personal hygiene products, chemical industry and others, and algae can still be transformed in butanol [7]. The by-products and the remains of biomass can be used as fertilizers and animal feed [8]. The importance of algae implementation is a broad spectrum. The importance of algae for nature and man is manifested in different ways, through primary production, stabilization of atmospheric nitrogen, biological monitoring, economic impact...

The primary production - in such way, because the organic matter are a form of product generated as the result of photosynthesis, which is gathered in the algae, and algae as producers are the food to the primary consumers and allow the maintenance of food chains; the survival of primary consumers in the seas and oceans is directly related to the production of algae, while in smaller aquatic ecosystems vascular plants play a significant role; oxygen O_2 - one of the products of photosynthesis, is released into the environment, and oxygen O_2 is the condition for the survival of all aerobic organisms on the planet Earth.

The stabilization of atmospheric nitrogen–the atmosphere is extremely filled with nitrogen, by almost 80%, in the form of a very inert gas N_2; however, the algae and other plants are not able to use N_2 in that form in the process of photosynthesis, but in the form of various nitrogen compounds; the transformation of inert N_2into more complex forms of the compounds of the algae, is accomplished by certain bacteria that bind the amount of atmospheric N_2, about 20 million tons per year.

Biological monitoring - every organism has a reaction to certain environmental factors of the environment in which it is located. If the environment is, in extensive terms, narrower, the observed organism represents an adequate bio indicator of changes in the environment. The changes and pollution in aquatic ecosystems that are caused by human populations are important because algae found in those waters react in different ways. One of the important reactions is the change in their number (amount). The application of biological monitoring with the help of certain bio-indicators is an integral part of legislation to control water quality; the presence of certain types of algae indicates the level of water quality in the ecosystem, whether the water is contaminated or clean.

The economic impact - most marine macrophytes people use for nutrition. The industrial implementation of algae for the separation of certain substances of high priority; they are used in food and pharmaceutical industries, cosmetics, painting, various studies. The researches which have recently been given a special importance are driven by the assumption that in the 2025 bio-fuel from algae will be commercially applicable.

FARMING METHODS

The development of algae is feasible in areas where there are no possibilities for normal cultivation (desert areas, polluted waters, agriculturally exhausted land ...) [9]. Two types of algae cultivation can be distinguished, open and closed systems [10]. The most suitable species of algae for bio-fuel production was discovered 6 years ago in Thailand. It belongs to a family *Chlorella*, and its name is RRC-S2. Algae RRC-S2 is interesting because of the fact that it takes only two days for its population to double. The yield which it provides is 137,000 L / Ha, which is much more than some species applied in the production of bio-fuels, such as corn or soybeans [11]. About 1000 species were discovered which are very suitable for the cultivation and production of bio-fuels, while less than 100 species are currently being studied. From a variety of raw materials different fuels are created: from carbohydrates is produced ethanol, from lipids biodiesel and other [12].

As already shown, the cultivation of algae itself can be divided into two systems:
- The cultivation of algae in open systems (pools, lakes),
- The cultivation of algae in closed systems (photo-bioreactors).

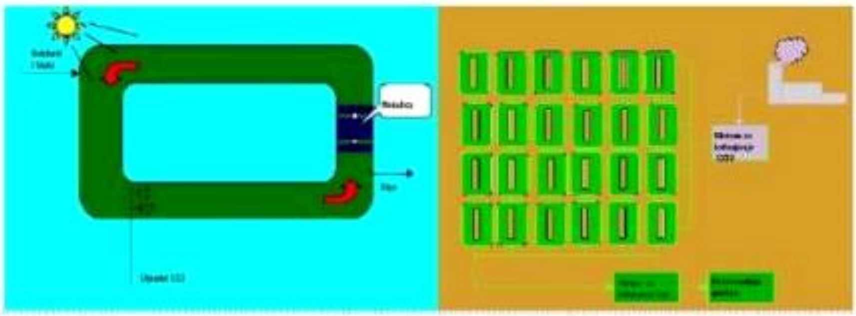

Figure 1. The cultivation of algae in an open system

These systems are simultaneously used as aerobic sewage and other waste water purifiers, as well as for the transformation of CO_2 resulted from power plants or heating plants. In this procedure, the algae provide the necessary dissolved oxygen in water, by which bacteria for aerobic decomposition, decompose other organic matter in the pool (Figure 1). A great disadvantage of this technology is a relatively small amount of the raw materials gathered from the lake / pool, which automatically draws the need to increase the number of lakes, and thus the greater the surface area required for production. Following this is the high cost of removing the cells of algae from pond water, as well as the contamination of lakes with other weed species of algae. But because of the access to the construction and the initial investment, this system is the most prevalent.

Due to the presence of great difficulties in ensuring high productivity in the open space (weather conditions, the light intensity, contamination with weed species of algae, and the need for larger areas), the need for closed systems to grow algae has developed. A particular success in this way of growing algae have countries like Japan, Germany and France, which have a band one the system of growing in the open space at the very beginning and have invested a significant amount of money in the closed systems of growing algae – photo-bioreactors. Today there are many types of photo-bioreactors which are used in the cultivation of algae; the most commonly applied is shown in the figure below (Figure 2).

Figure 2. Cultivation of algae in a closed system

A critical part in creating a closed system for growing algae – photo-bioreactor is the light, as the algae are photosynthetic organisms, for their proper development, they need as much surface area with better lighting as possible. As the result of this problem, the pipes become skewer, panels thinner, and neon lights and fiber optic cables are inserted inside the panel, in order to obtain the algae as much light as possible.

A brief comparison of open and closed system with algae cultivation can be seen in the following table (Table 1):

Table 1. The comparison between open and closed algae cultivation systems

	Efficiency	**Potential of CO_2 transformation**	**Investments and the costs of maintenance**
Open systems	Low	Low	Low
Closed system	High	High	High

CONCLUSION

The bio-fuel production from algae has a great potential, which can be achieved with better biotechnology and further development of the technology for obtaining bio-fuels. This technology, as well as many other good ideas (technologies), because of the ignorance and indifference of those responsible, is not yet in full swing in our country. This makes our country doomed to a long-term energy dependence on others. The demand for energy will not decrease in the coming years but will grow and alternative fuels will be needed regardless of how much of the dominant fossil fuels will remain. The production of bio-fuel from algae could be one of the most surprising things in the field of alternative fuels in not so distant future, especially if the prices of fossil fuels keep on growing.

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IMPORTANCE OF ENVIRONMENTAL WORK THROUGH ADEQUATE INDUSTRIAL PLANT

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Abstract: The development of technology and organization to the modern era was marked by ongoing efforts to systematize the level of development of technique and technology in certain periods and to justify the period of the historical development on the technological achievements and possibilities inherent for a given period. The Industrial Revolution has affected in many aspects; in this paper will be presented its impact on the environment. The industrial revolution has provided machinery manufacturing, contributed to the improvement and acceleration of the production process, or as a crucial consequence, has led to an increase in environmental pollution.
Key words: technology development, industrial revolution, environmental pollution

INTRODUCTION

The history of technological development of mankind and the intensive development of technology are recorded in the period of "industrial development", which runs from 1820 to 1900 year, which is characterized by the appearance of very important discoveries: the steam machine, machine for cleaning cotton, Besemer's process for obtaining steel, vulcanization of rubber and other [1]. According to some authors, the entire period of development until today can be described by the term industrial revolution that becomes informatics revolution in modern conditions, and the future belongs to bio-technologies and bio-engineering [2].

Today, the term industry is interpreted more broadly and this gives it more comprehensive sense for the following reasons:

- Its presence and activities in all forms of human activities, in material production and out of material production,
- The effects and impacts of industrial technology in all areas of human life and work.

Based on the above mentioned, we come to the complex relations within the system of nature - man - society - industry, where industry can be presented as the essence of that close relationship connection and interdependence in the modern world [3]. It is necessary that business organizations and industry balance their business and production activities and focus equally on three categories of importance [4]:

1. Humans – social consequences of activities,
2. The planet – ecological consequences of activities,
3. The profit – profitability of industry.

It is essential that a business organization has not only a responsibility for profit, but also to the social and ecological environment. The illustration above presented categories of importance can be displayed in the following picture (Figure 1).

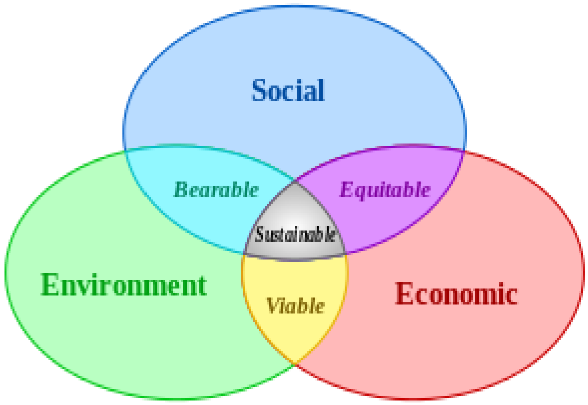

Figure 1. The illustration of relationship of the key categories with industry [4]

And that relation between the industry and the environment, as mentioned above is a part of broader relations of man - society - nature which possess the feedback as well. The main task of the industry is not only wage or profit, but at the same time the industry should have the social and environmental responsibility. Today special attention is paid to fighting climate changes. Many countries have begun to apply the basic principles of environmental policy, which include: precaution, prevention, combating pollution at source and the principle "the polluter pays". The increase in the use of green engineering is noted, which offers the possibility that the manufacturing processes are eco-efficient and to realize all the benefits to consumers through the entire processing cycle, whereby the assessments of the environment are economically alluded [5].

MATERIAL AND DISCUSSION

The prevention and the reduction of industrial impact on the environment

A generalized definition of sustainability which has been applied for years is to meet the needs of the present time, but without compromising the needs that will arise in the future. In the industrial process, which is made of associated processing units, a physical transformation of basic resources in end products is mainly performed. Basic resources are the most common natural resources, and the final products are created to meet the needs of the market. Today, the globalization, modernization and a steady increase in human population and the needs of the same, are leading to the increased industrial production. In this case, there is a growing consumption of basic resources and the greater use of natural resources. After the use of final products, created for the needs of the consumers, waste that is disposed of in the environment is usually produced. Also, in the technological process, which produces final products are generated the waste streams (solid, liquid, gas) that are released into the environment [6].
The waste streams that are exploited in the environment are generated by: technological process and the process industry, power and market generating systems and society. To protect the environment, it is necessary to reduce the amount of waste to a minimum.
In the following text, an overview of customized methodology for assessing the prevention of industrial pollution is represented, which means the modification of process, engineering design, apparatus and appliances, as well as additional automation.

A short review of the situation in Serbia

From the point of environmental and space protection, the basic problems of industry in Serbia are: the irrational use of existing industrial sites and facilities, with significant reserves for the expansion; the development and placing of new capacities within the existing industrial sites; the industrial production was mainly of material-intensive character, with a large extent of using raw materials, energy , water, land, with large impacts on the quality of the environment; the problems of relations with the environment, certain settlement structures; the excessive emissions of pollutants into the air, water and land, endangering the biological species; industrial waste, degradation of agricultural, forest and structural land; negative impacts on the quality of life, housing and health of residents and the rest [7].

The Republic of Serbia has adopted the first action plan for energy efficiency and sustainable development in 2010, which includes the following technical measures with the aim to save energy and to improve the sustainability in the industrial sector:

- the use of waste heat, which would create savings of more than 20% of current industry needs for energy in production,
- the improvement of the control and regulation, which would save up about 5% of energy consumption in industry,
- the replacement of existing electric motors with the ones of higher energy efficiency, which would save up about 0.6% of energy consumption in industry,
- the energy integration of the production process, which would increase the energy efficiency by 5%, especially in the chemical industry [8].

CONCLUSION

With the rapid development of industrial growth, the infiltration of the social system in working and living environment was enabled. As a result of exceeding the limits of endurance of the natural system was followed by the flare-up of the ecological crisis. The major problems of the world risk society include pollution of working and living environment, deterioration of natural resources, demographic boom, urban chaos, a huge discrepancy in the production and distribution of goods and services, etc. [9]. Today, many countries have found a solution to this problem in forming scientific and technological parks; this is an industry that does not pollute the environment, and is focused on the saving of resources and energy, and the creation of production which has no waste; it is actually a high-tech industry. This work had the aim to draw attention to those negative sides of industrial revolution which has brought the same with itself.

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IMPROVING PEOPLE'S AWARENESS ABOUT THE IMPORTANCE OF THE SAFE USE OF PLANT PROTECTION PRODUCTS

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Abstract: Plant protection products play an important role in achieving higher yields and in improving the quality of agricultural products. The most important objective in the production process of plant protection products is the safety of people and the environment. Together with the plant protection products on the market, we also have its packaging left behind after the use of these products which becomes waste. The packaging plays an important role in the safe delivery and in the use of plant protection products on the market, thereby reducing to a minimum level the risk of loss in the chain of investments and exposure to the user.
Key words: safety of people and the environment, packaging, waste.

INTRODUCTION

Issues such as the damage done to the human environment, the production which is the subject to objections, putting customers in an awkward position or risk, is gaining an increasing importance. The number of state regulations regarding the environment or social issues is increasing [1].Modern society has made significant progress in the development of environmental awareness, but also the development of ability to maintain a stable economic development [2]. After the use of plant protection product, its packaging becomes waste which can be seen in the following picture (Figure 1).

Figure 1. Packaging waste [3]

80% of containers of plant protection products are made of plastic, mostly from: High Density Polyethylene, HDPE. 20% of containers of plant protection products are a plastic film, PET, metal barrels or paper bags.

MATERIAL AND METHODS

The results of gathering pesticides' containers from individual customers in the PSS Sombor in the period 2013/2015

Sombor Agricultural Service in cooperation with the Association of producers of plant protection products Serbia has implemented the project "Establishing a system of collecting and disposing packaging waste from individual users of plant protection products". This is the first pilot project in Serbia, which was implemented in the municipality of Sombor, Apatin and Odžaci. The aim of the project was finding the best way for adequate collection and disposal of packaging waste.

The problem was the lack of a system which would support the takeover and the disposal of pesticides' containers from individual farmers. The significance of the project lies in the fact that there is no infrastructure for final disposal of pesticides' containers. The implementation of the project began by setting the mobile container by authorized operators at a predetermined location. Individual users of pesticides could safely dispose pesticide containers according to a schedule and time of the mobile container. Container had remained in a particular populated area for two hours.

For project realization, the following order of activities was implemented:

1. Obtaining the approval from local authorities in order to implement the project,
2. Locating the spot for the container,
3. Informing the individual users about the,
4. preparation of packaging for disposal,
5. Following the project realization,
6. The education about proper and safe handling of pesticides and pesticides' packaging,
7. The education about proper rinsing of containers,
8. The display of necessary protective equipment when applying pesticides during the packaging takeover,
9. The analysis of pesticides' containers disposal in agricultural holdings,
10. Project promotion.

The process of collecting pesticides' packaging is shown in the following picture (Figure 2).

Figure 2. Collecting the pesticides' packaging [4]

The pilot project indicates that individual users of pesticides' containers in 2013, as in previous years, not by their fault, have disposed the majority of packaging in places not intended for that purpose. In most cases, the packaging was not properly washed and was usually burned, buried, or left in the fields or disposed elsewhere. During the implementation of the project 14,340 kg was collected by agricultural producers from the municipalities of Sombor, Apatin and Odžaci. Because of environmental protection and safety of people, this action continues in 2016, in a period from 6th to 10th June, all in order to educate, raise awareness and habits of safe disposal of pesticide containers.

RESULTS AND DISCUSSION

Empty containers that are not properly washed and cleaned are the HAZARDOUS WASTE and as such may represent a potential danger to humans and contaminate the environment. The analysis of the project implementation indicates the need to raise awareness of individual users of pesticides and local authorities on the grounds that the amount of packaging waste has largely resulted from the activities of local communities. Within the project there were settlements which did not have any agricultural producers, even though these are active farming communities. On the other hand, cooperatives and other agricultural combined forces with experts have seriously approached handling packaging of pesticides and expertly prepared it for takeover in this action.

CONCLUSION

All individual users who have submitted empty pesticide containers indicate to the importance of this project, considering that this campaign is a good way to "liberate" themselves from potentially hazardous waste. The significance of this paper is to call for action in other municipalities across Serbia, to influence the national consciousness of the people, to implement education about the potential dangers of improper disposal of pesticide containers and to protect the environment in this area of economic activity. More such actions would assist agricultural producers in conditions where there is no systematic solution for disposal of containers of pesticides.

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FAMILY OF STANDARD ISO 9000 IN PRODUCTION ORGANIZATION

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Abstract: Countries in development usually find it hard to place their products on foreign markets, especially to more developed countries where life standard is a lot higher, unless they are certified by a certain quality standard. For that reason, it is crucial for them to implement Family of Standard ISO 9000, which is an ideal basis for basic mistake correction, while it's considered to be the base of upgrades of any additional standard.
Key words: ISO 9000, Countries in Development, Production quality, Quality management

INTRODUCTION

ISO (international standard organization) is an independent non-governmental organization with 161 bodies of national standard members. Through its members, this organization gathers experts to share their knowledge and develop voluntary, market based international standard which supports innovations and gives solutions for global challenges. ISO has more than 21000 standards (up until March 2016) and similar documentation covering almost all kinds of industries, from technological to food safety, throughout agriculture and health organizations.
Quality management and routing of organization is one really important factor, in organization as a whole, so in its private branches. New developments in 2015 gives the company freedom to create its own demands to adjust its standard to its needs and to the needs of its clients. Also, this version demands the company that implement it to know its processes well, and in that way decrease costs of production, which is very important in order to reduce spoilage and general loss. ISO 9000:2015 represents the basis of upgrade. It's upgradeable by other standards which regard saving the nature, worker safety, risk handling, and also a standard is being developed which handles corruption. This series of standards is ideal for companies in the countries in development which haven't implemented similar standards before.

ABOUT FAMILY OF STANDARD ISO 9000

Family of international standards referrals of management ISO 9000 has gained global reputation as a basis of establishment an efficient system of quality management. The need for international standards is very important, since more and more organizations do business on global economy level selling and buying products and services outside their own market. ISO technical committee ISO/TC 176 is responsible for development and maintaining the ISO 9000 family. Standard support for waypoints and other documents are being developed and updated continually to meet the demands and expectances of the users and the market itself. This chapter represents general picture of the ISO family of standard and explains how is it used to upgrade own systems of quality control. It gives a general insight in standards and shows how they are grouply formed into a basis for continual upgrade and business excellence.
ISO 9001 is giving precise demands for quality control system that the organization has to fulfill in order to show its capabilities of consistent quality and service control which skyrocket the satisfaction of the clients and fulfill applicable status and regulatory demands. Standard is used for certificatory and agree mental purposes from organizations who seek confirmation from their quality control system. ISO 9001 is organized into format which is adapted into format to easy understanding the user with the terms easily understood by the business sectors. The biggest advantage of the standard is achieved through usage and implementation of all standards in the family. It is advisable to use ISO 9000 to better understand the fundamental concepts, principles and normative vocabulary of the quality control system before applying ISO 9001 to achieve the maximum performance. Case studies explained in ISO 9004 can then be implemented as a system of quality, just like the system controls is applied to further the efficiency. ISO 9001 and ISO 9004 are written so to enable the user and connect them to other systems

of control, such is the environmental protection system or other sector demands, like ISO/TS 16949 in automobile industry, AS 9100/EN 9100 in aviation, space travel and protection, tL 9000 in telecommunications, and to help the gain of recognition through acional and regional awarding programmes.
ISO 9000, quality control system- basics and vocabulary, gives the fundamental concept, principles and vocabulary used in the entire ISO 9000 family of standards. It sets the conditions of understanding the basic elements of quality control explained in the ISO standards. ISO 9000 represents the users seven basic principles of quality control, just like the usage of possessive approach to achieve continual improvements.
ISO 9001, quality control system- demands, is used when the company wants to establish a system of management quality control which gives safety in the ability of the company to place its products that fulfill the demands and expectations of the users. ISO 9001 precises the demands which help the management quality control system can be certified by a third party. Standards recognizes that terms "Products and services" are worked materiel and software for the users.
ISO 9001, Quality management system - Requirements, is used when an organization wants to establish a quality management system that provides confidence in the organization's ability to deliver products that meet the needs and expectations of users. ISO 9001 specifies requirements with which a quality management system can be certified by a third party. Standard recognizes that the term "goods and services" refers to services, processed material, hardware and software intended for the user.
There are seven clauses in the standard that specify activities that need to be considered in the implementation of standards:

- The context of the organization;
- Leadership;
- Planning;
- Support;
- Realization poeraqtivnih activities;
- Evaluation performance;
- Improving.

Requests of all parts of the ISO 9001 are applicable. The organization should provide justification for all the requirements of this International Standard that the organization determines that are not applicable to their field of quality management system. Instructions or other information documents decide how to meet the ISO 9001 requirements for the organization.
ISO 9001 defines what needs to be taken to the organization continuously producing a product that meets customer expectations and applicable statutory and regulatory requirements. In addition, organizations should strive for continuous improvement of pleasures users improving the quality management system. ISO standards apply a process approach. Processes consist of one or more linked activities that require resources and which must be managed to achieve predetermined output. The output of one process may directly from the input for the next process and the final product is often the result of network or system processes.
Further instructions are contained in ISO 9001: 2015 and the introduction of a package of support that is saved subcommittee SC 2, Quality systems, ISO / TC 176, which provides the instructions:

- The list of changes;
- Implementation;
- Documentation required;
- Process approach;
- Reflection on the basis of risk;
- Frequently Asked Questions;
- Change Management;
- Correlation between ISO 9001: 2008 and ISO 9001: 2015

ISO 9004, management of sustainable success of the organization - Access to quality management, are used to get from the expanded range of ISO 9001 to all stakeholders in, or affected by, the operation of

the organization. The stakeholders include employees, owners, suppliers, partners and society in general. ISO 9004 gives guidance on a wider range of objectives of a quality management system ISO 9001, particularly in the management of long-term success of the organization. ISO 9004 is recommended as a guide for organizations whose top management wishes to extend the benefits of ISO 9001 in pursuit of systematic and continual improvement of overall organizational performance. But is not intended for standardization or contractual purposes.
ISO 19011, Guidelines for auditing management systems, covering part of the audit quality management system and environmental management system. Provide guidelines for auditing programs, the way relationships to internal and external auditors, and information about the competence revised. ISO 19011 provides a review of the handling of auditors and audit management systems need to be done. Effective auditors must ensure that the implemented QMS fortune requirements specified in ISO 9001 standard. Nature of the organization and its specific needs will determine how the standard applied in order to achieve the objectives. Useful advice and instructions for the conduct of audits were developed by the ISO 9001 group for the implementation of the audit (Auditing Practice Group). Information on the review of the third party also made a joint effort by the ISO-IAF (International Accreditation Forum (International Accreditation Forum)) accredited group for the implementation of the audit (Accreditation Auditing Practice Group).

ISO 9000 IN THE ORGANIZATION OF PRODUCTION

Implementation processes are important in achieving the full benefits of a quality management system (Quality Management System - QMS). Most new users will gain measurable results early in the implementation process.

- QMS is a dynamic system that eventually evolves through periods of improvement;
- Important is to determine which activities already exist and their subtlety within the context of the organization;
- The formal QMS presents a framework for planning, implementing, monitoring and improving the performance of the quality system is activated;
- In developing the QMS fundamental concepts and principles given in ISO 9000 can provide valuable advice;
- A successful QMS must correspond to the organization. Following sits, steps are useful guidelines:

1. Engage top management to:
- Agree regarding the reasons for the implementation of QMS;
- Do the context of the organization's strategic objectives and business processes;
- Determine the needs and expectations of customers and stakeholders;
- Understand the basic principles of the quality system as described in ISO 9000;
- Consider the implications of thinking on the basis of risk;
- It defines the objectives of the organization;
- Describe the scope of the impact of the QMS;
- Defines the business policy;
- Determine quality goals.

2. Identify key processes:
- Identifying the processes necessary to deliver products and services;
- Understanding the demands set by the standard ISO 9001;
- Determination of the risk and the nature applicable to the process of admission.

3. Planning a QMS, organizations:
- Identification of gaps in the existing system in comparison with the requirements of the QMS;
- Identification of the necessary process control;
- Defining the necessary working space;

- Defining the necessary skills and facilities.

4. Documenting the QMS, organizations:
- Documenting processes, activities and the necessary controls;
- Preparation of information documents (procedures and records) to the standard required in accordance with needs;
- Ensure that the QMS in accordance with the requirements of ISO 9001 standard.

5. Implementation of the QMS:
- process management
- Management of monitoring and measuring equipment;
- Training employees;
- Confirm the effective functioning of the process.

6. Management QMS:
- Monitoring and performance measurement;
- The audit process efficiency;
- Focus on customer satisfaction;
- Management system and operational changes;
- Review the management.

7. Training QMS:
- The request for certification / registration third party for QMS;
- Striving to improve referring to ISO 9004;
- Consideration of implementation of the model of business excellence within the company's operations.

CONCLUSION

As the implementation of the standards can be done in one segment of the organization, it is essential that in addition to the control of work and is certified production and to act according to the rules set by the ISO override. The production of such units may be subject to further certification standards such as ISO 14000 relating to environmental protection, ISO 45000, which refers to the management of health and safety, ISO 50000 - Energy Management, and many others. The options are not limited to, a more efficient production is the way these standards eased.

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USEFUL STANDARDS OF THE INTERNATIONAL ORGANIZATION FOR STANDARDIZATION THAT RAISE PRODUCTION TO A HIGHER LEVEL

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Abstract: In this paper are presented some of standards of International Standardization Organization that can rise the level of productivity. There are some standards that are universal for all types of production and there are some that are some that are specialized for specific industries. The key of success in the market is getting to know aspects of improvements in production that will most influence productivity and safety, as they are the most important factors of production.
Key words: Production, standardization, improvement, International Organization for Standardization

INTRODUCTION

An ISO standard is developed by a panel of experts, within a technical committee. Once the need for a standard has been established, these experts meet to discuss and negotiate a draft standard. As soon as a draft has been developed it is shared with ISO's members who are asked to comment and vote on it. If a consensus is reached the draft becomes an ISO standard, if not it goes back to the technical committee for further edits.
This way insures the the applicability of the standards in practice, particularly in manufacturing, where it is necessary to monitor and anticipate all situations. Worker safety and environmental security are one of the most important factors in the production and they are included in standards that Organization for Standardization ISO certified. One of the most important standards that ISO has issued is ISO 9001:2015 quality management system that became the basis for all other standards that can relatively easy be built on it.
Implementing this standards countries in transition, ensure the quality and safety, that are very important to the environment in which they work and all the stakeholders of great importance, and therefore the production rise to a higher level by providing a lower level of waste, lower risks and social responsibility.
ISO does not decide when to develop a new standard, but responds to a request from industry or other stakeholders such as consumer groups. Typically, an industry sector or group communicates the need for a standard to its national member who then contacts ISO.
ISO standards are developed by groups of experts from all over the world, that are part of larger groups called technical committees. These experts negotiate all aspects of the standard, including its scope, key definitions and content.
The technical committees are made up of experts from the relevant industry, but also from consumer associations, academia, NGOs and government.
Developing ISO standards is a consensus-based approach and comments from all stakeholders are taken into account.

ISO 9000 – Quality management system

The ISO 9000 family addresses various aspects of quality management and contains some of ISO's best known standards. The standards provide guidance and tools for companies and organizations who want to ensure that their products and services consistently meet customer's requirements, and that quality is consistently improved.
Standards in the ISO 9000 family include:

- ISO 9001:2015 - sets out the requirements of a quality management system
- ISO 9000:2015 - covers the basic concepts and language

- ISO 9004:2009 - focuses on how to make a quality management system more efficient and effective
- ISO 19011:2011 - sets out guidance on internal and external audits of quality management systems.

ISO 14000 –Environmental management

The ISO 14000 family of standards provides practical tools for companies and organizations of all kinds looking to manage their environmental responsibilities.
ISO 14001:2015 and its supporting standards such as ISO 14006:2011 focus on environmental systems to achieve this. The other standards in the family focus on specific approaches such as audits, communications, labelling and life cycle analysis, as well as environmental challenges such as climate change.
The ISO 14000 family of standards are developed by ISO Technical Committee ISO/TC 207 and its various subcommittees.
ISO 14001:2015 sets out the criteria for an environmental management system and can be certified to. It maps out a framework that a company or organization can follow to set up an effective environmental management system. It can be used by any organization regardless of its activity or sector.
Using ISO 14001:2015 can provide assurance to company management and employees as well as external stakeholders that environmental impact is being measured and improved.

ISO 45001 – Occupational health and safety

Over 6300 people die each day from work-related accidents or diseases - that's nearly 2.3million every year.
The burden of occupational injuries and diseases is significant, both for employers and the wider economy, resulting in losses from early retirements, staff absence and rising insurance premiums.
To combat the problem, ISO is developing a new standard, ISO 45001 *Occupational health and safety management systems - Requirements,* that will help organizations reduce this burden by providing a framework to improve employee safety, reduce workplace risks and create better, safer working conditions, all over the world.
The standard is currently being developed by a committee of occupational health and safety experts, and will follow other generic management system approaches such as ISO 14001 and ISO 9001. It will take into account other International Standards in this area such as OHSAS 18001, the International Labour Organization's ILO-OSH Guidelines, various national standards and the ILO's international labour standards and conventions.
ISO 45001 is intended for use by *any* organization, regardless of its size or the nature of its work, and can be integrated into other health and safety programs such as worker wellness and wellbeing. It also addresses many, if not all, legal requirements in this area.

ISO 26000 – Social Responsibility

Business and organizations do not operate in a vacuum. Their relationship to the society and environment in which they operate is a critical factor in their ability to continue to operate effectively. It is also increasingly being used as a measure of their overall performance.ISO 26000 provides guidance on how businesses and organizations can operate in a socially responsible way. This means acting in an ethical and transparent way that contributes to the health and welfare of society.
ISO 26000:2010 provides guidance rather than requirements, so it cannot be certified to unlike some other well-known ISO standards. Instead, it helps clarify what social responsibility is, helps businesses and organizations translate principles into effective actions and shares best practices relating to social responsibility, globally. It is aimed at all types of organizations regardless of their activity, size or location.
The standard was launched in 2010 following five years of negotiations between many different stakeholders across the world. Representatives from government, NGOs, industry, consumer groups and

labour organizations around the world were involved in its development, which means it represents an international consensus.

ISO 50001 –Energy Management

Using energy efficiently helps organizations save money as well as helping to conserve resources and tackle climate change. ISO 50001 supports organizations in all sectors to use energy more efficiently, through the development of an energy management system.
ISO 50001 is based on the management system model of continual improvement also used for other well-known standards such as ISO 9001 or ISO 14001. This makes it easier for organizations to integrate energy management into their overall efforts to improve quality and environmental management.
ISO 50001:2011 provides a framework of requirements for organizations to:

- Develop a policy for more efficient use of energy
- Fix targets and objectives to meet the policy
- Use data to better understand and make decisions about energy use
- Measure the results
- Review how well the policy works, and
- Continually improve energy management.

ISO 31000 – Risk Management

Risks affecting organizations can have consequences in terms of economic performance and professional reputation, as well as environmental, safety and societal outcomes. Therefore, managing risk effectively helps organizations to perform well in an environment full of uncertainty.
ISO 31000:2009, *Risk management – Principles and guidelines*, provides principles, framework and a process for managing risk. It can be used by any organization regardless of its size, activity or sector. Using ISO 31000 can help organizations increase the likelihood of achieving objectives, improve the identification of opportunities and threats and effectively allocate and use resources for risk treatment. However, ISO 31000 cannot be used for certification purposes, but does provide guidance for internal or external audit programmes. Organizations using it can compare their risk management practices with an internationally recognised benchmark, providing sound principles for effective management and corporate governance.
A number of other standards also relate to risk management.

- ISO Guide 73:2009, *Risk management - Vocabulary* complements ISO 31000 by providing a collection of terms and definitions relating to the management of risk.
- ISO/IEC 31010:2009, *Risk management – Risk assessment techniques* focuses on risk assessment. Risk assessment helps decision makers understand the risks that could affect the achievement of objectives as well as the adequacy of the controls already in place. ISO/IEC 31010:2009 focuses on risk assessment concepts, processes and the selection of risk assessment techniques.

CONCLUSION

In production there are many risks and unpredictable factors that can influence worker safety, safety of the environment, production expenses, and the like. With this standards we seek to carry all the relevant factors out in the light of the day, to manage them, and bring unpredictability to minimum. Saving energy reduces unnecessary costs, environmental protection keeps the ecosystem from harmful pollutants, social responsibility preserves the company in the face of public and ensures favor with the media. All of the above mentioned standards are designed to provide a healthy environment for the growth and development of production in general.
Implementation of one or more of the above mentioned standard provides not only safe high quality production, but also the sustainable development of the whole company, which is based on production.

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SIX SIGMA AS A SUPPORT IN THE PRODUCTION OF SUPERIOR QUALITY

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Abstract: This paper focuses on the advantages and disadvantages of quality management standards called "six sigma". This quality standard is noted as one of the best when it comes to for long term planning and development of quality and reduction of errors per unit of production. This work will shift the quality system and will bring it to the reader.
Key words: Standard quality, six sigma, statistical skills, creative approach

INTRODUCTION

The market is increasingly difficult to gain a competitive advantage and therefore it is necessary to create a superior quality with which to market the company can compete against strong competitors. Companies that begin to lag behind the market must be one of the first factors that affect its competitive advantage to examine their quality in relation to the market. High quality is not just a bit to achieve competitive advantage, but only for staying in the race for profit. The globalization of markets has provided an opportunity for companies to market their products independently of geographical location, and this contributed to the incredible jump in competition.
Six Sigma is a quality standard that delivers the best results and minimal manufacturing defects, as well as in the service business. Possibility of Six Sigma to reduce errors is such that when properly implemented, it can miss only a single-digit number of defects per million opportunities. This is one reason why they use the agency where passenger safety plays a major role, such as for example the agency for control and servicing of aircraft before takeoff.
There are multiple levels of Quality Coordinator within the six sigma system. The basic concept of this level ranged from yellow belt through green, to black, where black has two levels. Now the system is so modified and adapted to all colors are in use and a variety of color combinations. This supports the fact that quality control of creative work, as the statistical and that creative solutions must exist in order to achieve a greater impact.

Six sigma as the mainstay of superior quality

Six sigma is often mentioned in the literature as a system that enabled the business and financial renaissance of the world's largest companies. Using Six Sigma methodology dates back to the eighties of the last century and is linked mainly to large US corporations such as Motorola, General Electric, Boeing, Dupont, Raytheon or large companies around the world: Sony, Toshiba, etc. The fact that the listed companies significantly contributed to popularizing Six Sigma methodology is related mainly to the exorbitant cost savings realized through implementation. Therefore it is necessary to point out that the methodology Six Sigma is one of the most effective methods when it comes to continuous cost-cutting at all levels.
Six sigma can have several meanings of metrics, methodologies up to the management system. Each of these areas is equally important for organizations that wish to improve their business performance must be paid to all aspects of equal attention. The only rule at the same time it is worth mentioning is how the system should build on the foundation of metrics and methodologies. In other words, the mastering of basic statistical skills that are at the base of business process management, and after checking a number of improvement projects according to the standardized methodology are essential preconditions for the creation of a quality management system that carries the name of Six Sigma
One of the most popular requests of this methodology is the requirement according to which the key processes of the organization have functions at the level of 3.4 errors per million opportunities (eng.

Defects per Million Opportunities - DPMO). Satisfying the above requirement means almost perfect functioning of the process which eventually reflected in customer satisfaction, but also the realized costs and revenues. However, in practice the realization of the above claims often seen as a vision of the business, rather than the actual situation. The main reason for that is that often the process of bringing this level requires excessive investment and requires a very great effort and initiative of employees and management.
The rapid development of the market, the company imposed the obligation to introduce permanent improvements in their systems did not opt for the training of its experts, in order to be competent for establishing new methods in the area of quality improvement processes. Improving the process has become an important factor in gaining competitive advantage. In today's race for higher profits and the struggle for survival in times of global crisis, the available money and time for improvement is less and therefore need new ideas. Response to the new circumstances imposed by the market can be found in Lean Six Sigma concept. Lean Six Sigma concept demands constant change and constant improvement. The emphasis is on employee involvement and teamwork, measurement and systematization of processes, reducing variation, defects and shortening the duration of the process. Constant improvements are required for the project organization, or perhaps the only way to gain competitive advantage and survival in the market.
In short, the Six Sigma methodology is based on continuous improvement projects carried out by using an appropriate multifunctional teams at the same time clearly defined hierarchy of roles. Direct goal of each of these projects is to eliminate the variations of the basic processes and reducing them to a level of functioning that corresponds to the demand of 3.4 DMO, while indirect goal even more important and mainly based on cutting costs and improving overall business performance. When it comes to the goals of Six Sigma methodology, they do not differ from the common goals of quality management systems and are generally based on satisfying and delighting customers. One of the key aspects of Six Sigma system is the selection of appropriate projects and improve their relationship with the global strategy of the organization.
As a quality management system Six Sigma is its major goals is not significantly different from other quality management systems. However, what sets this system apart from the rest is the primary way in which its objectives are achieved.
Schroeder and his colleagues Six sigma quality management system define an organized, parallel structure of the organization targeted reduction of variation in organizational processes through the use of specialists, structured methods and performance indicators, and overall targeted achievement of strategic objectives.
Breyfogle Six sigma is defined as a methodology for achieving the continuous improvement of customer satisfaction and profits that goes beyond the reduction of defects and stresses successfully improved the business process.
Quack and his colleagues report that the six sigma project-oriented system management system focused on improving products, services and processes of the organization through continuous reduction of defects in the organization. It is a business strategy aimed at improving the understanding of customer requirements, operating system, productivity and financial performance.
Zu and colleagues point out three practices as key to Six Sigma concepts:

- Structured roles: Six sigma system uses a group of experts for improvement which include champions, master black belts, black belts and green belts. The hierarchy and the roles of individual participants in the process of improving the pre-specify and clear to everyone.
- Structured process improvement: Six Sigma uses the structured approach to achieving process improvement which is known as DMAIC (Define, Measure, Analyze, Improve, Control) and structured approach to product improvements and services known as DMADV (Define, Measure, Analyze, Design, Verify).
- Focus on metrics: Six Sigma emphasizes the use of the full range of quantitative indicators in the process of improvement, such as indicators of process sigma level, critical indicators of quality, defect rates and the rates of improvement, in addition to the above the usual quality indicators such as process capability indices.

Schroeder and colleagues (2008) have identified five principles underlying the Six Sigma system and they are:

- The involvement of management in Six Sigma functions such as: selection of a specialist, the selection of projects for improvement etc. One of the ways in which managers seek to be more involved in Six sigma projects is the requirement according to which they must become certified green belts.
- Specialists are trained to improve and develop different competencies (known hierarchy of roles based on the black and green belts).
- Metrics for measuring performance based on cost, quality and deadlines.
- Existence of systematic procedures to improve known as DMAIC.
- The prioritization of improvement projects is an important part of the six sigma system, a ranking determined by many criteria such as cost or the Pareto index importance.

Advantages and disadvantages of the concept of Six Sigma

In the literature it is possible to find a whole series of benefits that the implementation of six sigma method allows. Some of the most important advantages are the following:

- Six sigma utilizes a holistic and systematic multi-dimensional approach to understanding the problems and offer solutions to these problems. In this way, the close relationship between organizational competence, customer satisfaction and continuous improvement.
- The way to implement the Six Sigma represents a new approach to organizational improvements.
- There are authors who point out that the application of the concept of six sigma quality means a return to their roots since this methodology is very grounded in engineering and statistical analysis.

Although there is a whole series of large companies that stand out as Six Sigma has enabled revolutionary savings in their business, there are authors who highlight some of the shortcomings in the implementation of this system. Kumar and colleagues report that among the airlines that have implemented Six Sigma programs of less than 50% expressed satisfaction with the results, about 20% were partially satisfied, while as many as 30% of companies are not satisfied with the results achieved. Some of the disadvantages are:

- In general, Six Sigma insists on the return of selected financial indicators of projects highlighting both their short-term character. Although there are authors who claim that certain projects initiated solely because of the strategic objectives still dominated by a strict emphasis on short-time refund.
- Philosophy and the tools used by Six Sigma are identical to other quality management systems.

CONCLUSION

From enclosed can be concluded that the system of six sigma one holistic system that covers all aspects of the business in continuous progress. One of the important factors of six sigma is his approach to the problem of "mind set" (way of thinking, attitude) that those who implement it and later must be used. Although it has the same quality as tools and other quality management system and philosophy, the way of its implementation however, represents a new approach to organizational improvements.
Although it refers to short-term results of six sigma represents a long-term plan before the company and enables it to achieve phenomenal results in proportion to the effort expended for the establishment of quality standards. In the future, companies that implement this quality system are just the first to enjoy and profit from six sigma, for all who have anything to do with the company are also the winners of its stakeholders through clients, to social and geographical communities in which the company later.

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STUDIJSKI PROGRAM MAŠINSKO INŽENJERSTVO NA TEHNIČKOM FAKULTETU „MIHAJLO PUPIN“, UNIVERZITETA U NOVOM SADU

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Mašinsko inženjerstvo (traje 8 semestara). Svrha studijskog programa je obrazovanje studenata za profesiju – stručni naziv diplomirani inženjer mašinstva, u skladu sa potrebama privrede. Studijski program Master inženjer mašinstva traje jednu godinu, odnosno 2 semestara. Studijski program su akreditovani 2014. god.

Introduction
Study program Mechanical Engineering is made from study programs (adopted in 2006. And 2010.): Control of technical systems with modules: energetics, process engineering, maintenance, ecology; - Industrial engineering.
Mechanical Engineering (lasting 8 semesters). The purpose of the study program is to educate students for the profession - the professional title of graduate mechanical engineer, in accordance with the needs of the economy. Study Master program in Mechanical Engineering is one year, or two semesters. Study program accredited in 2014 god.

MAŠINSKO INŽENJERSTVO

Cilj i zadatak je upoznavanje, edukacija i osposobljavanje studenata za rad u oblastima mašinske tehnike: Mehanizacija, transportna sredstva, skladišta i mašinske konstrukcije i tehnologije, Termotehnike, termoenergetike, procesne i gasne tehnike, Održavanje mašina i opreme.

Ovo se postiže izučavanjem predmeta na studijskom programu „Mašinsko inženjerstvo“ – Osnovne akademske studije i Master akademske studije.

Na taj način stiču se teorijska i praktična znanja, tako da dipl. inž. kad završe fakultet, mogu odmah da počnu da rade u privredi. Iz tih razloga, nastavnici na svojim predmetima treba da prilagode i inoviraju nastavne sadržaje u tom cilju.

Treba u kontinuitetu stvarati uslove za razvoj Mašinskog inženjerstva, tako što će nastavnici biti u kontaktu sa privredom i pribaviti i deo opreme za Laboratorije iz saradnje sa privredom. Organizovati stručne posete studenata, proizvodnim preduzećima – fabrikama i upoznavanje sa tehnološkim procesima, mašinama i mernom opremom, pregledom tehničke dokumentacije i uvidom u stanje u fabrici.

Na taj način stvaramo bolje potencijalne mogućnosti zaposlenja diplomiranih inženjera u privredi. Fakultet treba da se prilagodi tržištu i da se studentima pruži praktično znanje, koje se može primeniti odmah. Na ovaj način osposobljavaju se diplomirani inženjeri, da kada završe fakulltet mogu odmah da rade u raznim granama privrede:

- Mašinskoj industriji
- Prehrambenoj industriji
- Hemijskoj industriji
- Farmaceutskoj industriji
- Petrohemijskoj industriji
- Agroindustriji
- Termoelektranama
- Toplanama
- Industriji nafte i gasa...

To su kompleksni poslovi značajni za kapitalnu investicionu izgradnju: inženjering, projektovanje tehnoloških procesa - fabrika, mašina i opreme, proizvodnja, montaža, izgradnja i održavanje. Poslovi vezani za kapitalnu investicionu izgradnju: inženjering, projektovanje i izgradnja, zahtevaju mašinske inženjere sa Licencom Inženjerske komore Srbije.

Iz tih razloga, velika obaveza nastavnika, je inoviranje nastavnih sadržaja, i implementacija programa mašinsko inženjerstvo, tako da se školuju mašinski inženjeri za rad pre svega u privredi. Diplomirani inž. mašinstva i Master inženjeri mašinstava, imaju mogućnost da apliciraju za Licence.

U podizanju i oporavku privrede i oživljavanju domaće industrije, mašinski inženjeri mogu da obavljaju značajne i odgovorne poslove. Naš zadatak i cilj je da školujemo kvalitetne mašinske inženjere, koji će kad završe fakultet, moći odmah da rade u privredi. Mašinski inženjeri mogu da rade gotovo u svim granama privrede, nauke i prosvete.

Pozivamo buduće studente iz svih mesta i gradova Republike Srbije, da upišu studijski program MAŠINSKO INŽENJERSTVO i studiraju na Tehničkom fakultetu "Mihajlo Pupin", Zrenjanin, kao matičnom fakultetu.

Prava odluka je studirati Mašinstvo. Mašinstvo je najperspektivnije zanimanje, pokreće svet i srpsku privredu. Mašinstvo se može svrstati u umetnost, sve što vidimo oko sebe je velika većina delo mašinskih inženjera.

MAŠINSKO INŽENJERSTVO – Diplomirani inženjer mašinstva

Studijski program Mašinsko inženjerstvo osnovnih akademskih studija traje 4 godine, odnosno 8 semestara i vredi 240 ESPB bodova . Svaka godina studija vredi 60 ESPB bodova.

Studijski program osnovnih akademskih studija Mašinsko inženjerstvo sastavljen je iz obaveznih i izbornih predmeta, čijim se savladavanjem obezbeđuju neophodna akademska znanja i veštine za sticanje stručnog naziva diplomirani inženjer mašinstva, (skraćeno: dipl. inž. maš.).

Osnovni cilj studijskog programa osnovnih akademskih studija Mašinsko inženjerstvo je da student stekne akademska znanja i veštine koje odgovaraju akademskoj tituli diplomirani inženjer mašinstva, kao i osposobljavanje studenta za primenu stečenih znanja i veština u naučno-stručnoj oblasti mašinsko inženjerstvo.

To uključuje i razvoj kreativnih sposobnosti razmatranja problema i sposobnost kritičkog mišljenja,ra zvijanje sposobnosti za timski rad i ovladavanje specifičnim praktičnim veštinama potrebnim za obavl janje profesije.

Diplomirani inženjer mašinstva je osposobljen da prepozna, formuliše i analizira probleme u oblasti mašinskog inženjerstva, kao i da ponudi rešenja za dati problem, a na osnovu stečenih fundamentalnih i aplikativnih znanja i veština, uvažavajući inženjersku etiku i koristeći standarde u mašinstvu, metode proračuna, projektovanja i konstruisanja, kao i savremene inženjerske alate. Kompetencije diplomiranih mašinskih inženjera uključuju i razvoj sposobnosti kritičnog mišljenja, analize problema, sinteze i projektovanja rešenja i donošenja odluka u realnom vremenu. Diplomirani inženjeri mašinstva takođe poseduju kompetencije za primenu stečenih znanja i veština u praksi i stalno inoviranje tih znanja i veština putem osposobljenosti za pristup stručnim i naučnoistraživačkim informacijama u sopstvenom području rada. Osposobljeni su za saradnju sa lokalnim i međunarodnim društvenim, javnim i stručnim okruženjem.

Specifikacija predmeta (Osnovne akademske studije)

Matematika 1
Tehničko crtanje sa kompjuterskom grafikom
Mašinski materijali
Informatičke tehnologije
Održivi razvoj
Teorija sistema
Matematika 2
Mehanika i mehanizmi
Osnovi mašinskih konstrukcija
Elektrotehnika sa elektronikom
Engleski jezik 1
Instrumentacije
Merne tehnologije
Otpornost materijala i konstrukcija
Engleski jezik 2
Termodinamika sa termotehnikom
Mašinsko inženjerstvo u praksi
Računarsko projektovanje
Verovatnoća i statistika
Industrijski dizajn
Mašinski elementi
Tribologija i podmazivanje
Mašine i aparati
Hidraulika i pneumatika
Tehnički sistemi u zaštiti kvalitetavoda i vazduha
Tehnička fizika
Upravljanje kvalitetom
Transportne mašine
Ekološko inženjerstvo
Menadžment održavanja
Pouzdanost mašina
Logički sistemi u tehnici
Baze podataka 1
Automatsko upravljanje

Tehnička dijagnostika
Parni kotlovi
Metode upravljanja i odlučivanja
Tehnologije montaže
Kompjuterski integrisano održavanje
Inženjerski materijali
Operaciona istraživanja
Upravljanje tehnološkim razvojem
Procesna postrojenja
Tehnologija mašinogradnje
Klimatizacija, grejanje i hlađenje
Projektovanje termotehničkih i procesnih sistema
Engleski jezik 3
Tehnologija održavanja
Projektovanje tehnoloških sistema
Konstruisanje mašina
Grafičko modeliranje
Upravljanje projektima
…………………………………………………

MAŠINSKO INŽENJERSTVO – Master inženjer mašinstva

Studijski program Master inženjer mašinstva traje jednu godinu, odnosno 2 semestara i vredi 120 ESPB bodova.

Na master akademskim studijama Mašinskog inženjerstva nastava je organizovana u dve oblasti. Studenti se, na osnovu sopstvenih sklonosti i želja, kroz izborne predmete, mogu opredeliti za jedan od ova dva modula:

1. ***Mehanizacija***
2. ***Procesna tehnika***

Mehanizacija

Cilj studijskog programa Master inženjer mašinstva je postizanje kompetencija i akademskih veština iz oblasti mašinskog inženjerstva. Nastavkom studija sa osnovnih i realizacijom dodatih naučnih disciplina kao i stručnih predmeta stepena master, omogućuje studentima razvoj kreativnih sposobnosti razmatranja problema i samostalnog kritičkog mišljenja, razvijanje sposobnosti za timski rad i ovladavanje specifičnim teorijskim, ali i primenom stručnih znanja iz oblasti mašinstva – mehanizacije, mašinskog projektovanja, transportnih sredstava, skladišta i mašinskih konstrukcija.

U okviru izbornog modula Mehanizacija *akcenat se stavlja na projektovanje i tehničku eksploataciju mašina i opreme, a naročito na projektovanje transportnih sredstava, skladišta i mašinskih konstrukcija i tehnologija. Završetkom studija, master inženjer mašinstva ima sposobnost projektovanja, organizovanja i upravljanja proizvodnjom iz oblasti mehanizacije, transportnih* *sistema, tehnologije obrade proizvoda, industrijskog monitoringa i razumevanje osnovnih principa iz oblasti mašinskog inženjerstva.*

Procesna tehnika

Cilj studijskog programa Master inženjer mašinstva je postizanje kompetencija i akademskih veština iz oblasti mašinskog inženjerstva. Nastavkom studija sa osnovnih i realizacijom dodatih naučnih disciplina kao i stručnih predmeta stepena master, omogućuje studentima razvoj kreativnih sposobnosti razmatranja problema i samostalnog kritičkog mišljenja, razvijanje sposobnosti za timski rad i ovladavanje specifičnim teorijskim, ali i primenom stručnih znanja iz oblasti mašinstva–procesna i gasna tehnika, efikasnost energetskih postrojenja, mehaničke i hidromehaničke operacije i oprema.

***U okviru izbornog modula Procesna tehnika** akcenat se stavlja na projektovanje, tehničku eksploataciju mašina i opreme, a naročito na projektovanje iz oblasti energetske efikasnosti, procesne i gasne tehnike, mehaničkih i hidromehaničkih operacija. Završetkom studija, master inženjer mašinstva ima sposobnost projektovanja, organizovanja i upravljanja proizvodnjom iz oblasti procesne tehnike, energetske efikasnosti, hidromehaničkih operacija, računarskog merenja i razumevanje osnovnih principa iz oblasti mašinskog inženjerstva.*

Specifikacija predmeta (Master akademske studije)

Metodologija istraživačkog rada
Računarsko merenje i industrijski monitoring
Mehaničke i hidromehaničke operacije i oprema

Tehnologije obrade proizvoda
Efikasnost energetskih postrojenja

Mašinsko projektovanje CAD/CAM
Mehanika fluida

Transportni sistemi
Priprema proizvodnje

Mašinske konstrukcije i mehanizacija
Procesna i gasna tehnika

Studijski istraživački rad MII

Članovi katedre:
Prof. dr Dragiša Tolmač
Prof. dr Miroslav Lambić, (u penziji)
Prof. dr Živoslav Adamović, (u penziji)
Prof. dr Slobodan Stojadinović, (u penziji)
Prof. dr Slavica Prvulović
Doc dr Eleonora Desnica
Doc. dr Ljiljana Radovanović
Doc. dr Jasmina Pekez
Doc. dr Vladimir Šinik
MSc Jasna Tolmač, asistent
MSc Ivan Palinkaš, asistent

U Zrenjaninu, 14. 10. 2016.

Šef katedre za mašinsko inženjerstvo
Prof. dr Dragiša Tolmač

SARADNJA SA PRIVREDOM

U kontinuitetu stvaramo uslove za razvoj Mašinskog inženjerstva tako što su naši nastavnici u kontaktu sa privredom. Organizijemo stručne posete studenata, proizvodnim preduzećima – fabrikama i laboratorijama. Studenti se upoznaju sa tehnološkim procesima, mašinama i mernom opremom, pregledom tehničke dokumentacije i uvidom u stanje u fabrici. Na taj način stvaramo bolje potencijalne mogućnosti zaposlenja dipl. inž. u privredi. Prilagođavamo se tržištu i studentima se pruža praktično znanje, koje se može primeniti odmah.

U tom cilju zahvaljujemo se sledećim preduzećima i ustanovama:

1. Ustanovi opšta bolnica „Đorđe Joanović“, Zrenjanin
2. Preduzeću – “Cimos Group” - Livnica, Sečanj
3. Firmi “Victorija Starch”, Zrenjanin
4. Visokoj tehničkoj školi, Zrenjanin
5. Firmi “Premitrade” – centar termovizije i vibrodijagnostike, Zrenjanin
6. Firmi “Um-ing”, Zrenjanin - preduzeće za projektovanje, konsalting i inženjering
7. AD “Tehnoradionica” – proizvodnja mašinsko tehnološke opreme, Zrenjanin
8. “SM Inženjering” – projektovanje, konsalting, inženjering, Zrenjanin.
9. LMV Alatnica – proizvodnja, montaža, servis alata, livačkih modela i mašinskih elemenata
10. "EVROBROD" D.O.O. Zrenjanin – preduzeće za projektovanje, proizvodnju i montažu procesne opreme

Zrenjanin, oktobar, 2016.

Šef katedre za mašinsko inženjerstvo

Prof. dr Dragiša Tolmač

VICTORIAGROUP

CIMOS

VTŠ

PETKUS

PETKUS BALKAN
Zrenjanin

Um-ing

M INŽENJERING
ZRENJANIN

PREMITRADE

1911
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TEHNORADIONICA
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OPŠTA BOLNICA
ĐORĐE JOANOVIĆ
ZRENJANIN