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UNIVERSITY "POLITEHNICA" TIMISOARA

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ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome VI (Year 2013) – FASCICULE 1 [January–March]
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Aims & Scope

General Aims:

ACTA TECHNICA CORVINIENSIS - BULLETIN OF ENGINEERING is an international and interdisciplinary journal which reports on scientific and technical contributions.

Every year, in four online issues (fascicules 1 - 4), ACTA TECHNICA CORVINIENSIS - Bulletin of Engineering [e-ISSN: 2067-3809] publishes a series of reviews covering the most exciting and developing areas of engineering. Each issue contains papers reviewed by international researchers who are experts in their fields. The result is a journal that gives the scientists and engineers the opportunity to keep informed of all the current developments in their own, and related, areas of research, ensuring the new ideas across an increasingly the interdisciplinary field.

ACTA TECHNICA CORVINIENSIS - BULLETIN OF ENGINEERING publishes invited review papers covering the full spectrum of engineering. The reviews, both experimental and theoretical, provide general background information as well as a critical assessment on topics in a state of flux. We are primarily interested in those contributions which bring new insights, and papers will be selected on the basis of the importance of the new knowledge they provide.

Topical reviews in materials science and engineering, each including:

- *surveys of work accomplished to date*
- *current trends in research and applications*
- *future prospects.*

As an open-access journal ACTA TECHNICA CORVINIENSIS - Bulletin of Engineering will serve the whole engineering research community, offering a stimulating combination of the following:

- *Research Papers - concise, high impact original research articles,*
- *Scientific Papers - concise, high impact original theoretical articles,*
- *Perspectives - commissioned commentaries highlighting the impact and wider implications of research appearing in the journal.*

ACTA TECHNICA CORVINIENSIS - BULLETIN OF ENGINEERING encourages the submission of comments on papers published particularly in our journal. The journal publishes articles focused on topics of current interest within the scope of the journal and coordinated by invited guest editors. Interested authors are invited to contact one of the Editors for further details.

ACTA TECHNICA CORVINIENSIS - Bulletin of Engineering has been published since 2008, as an online supplement of the ANNALS OF FACULTY ENGINEERING HUNEDOARA - INTERNATIONAL JOURNAL OF ENGINEERING.

Now, the ACTA TECHNICA CORVINIENSIS - Bulletin of Engineering is a free-access, online, international and multidisciplinary publication of the Faculty of Engineering Hunedoara.

ACTA TECHNICA CORVINIENSIS - BULLETIN OF ENGINEERING exchange similar publications with similar institutions of our country and from abroad.

Audience & Coverage:

Scientists and engineers with an interest in the respective interfaces of engineering fields, technology and materials, information processes, research in various industrial applications. It publishes articles of interest to researchers and engineers and to other scientists involved with materials phenomena and computational modeling.

ACTA TECHNICA CORVINIENSIS - Bulletin of Engineering is a good opportunity for the researchers to exchange information and to present the results of their research activity. Scientists and engineers with an interest in the respective interfaces of engineering fields, technology and materials, information processes, research in various industrial applications are the target and audience of ACTA TECHNICA CORVINIENSIS - Bulletin of Engineering. It publishes articles of interest to researchers and engineers and to other scientists involved with materials phenomena and computational modeling.

The journal's coverage will reflect the increasingly interdisciplinary nature of engineering, recognizing wide-ranging contributions to the development of methods, tools and evaluation strategies relevant to the field. Numerical modeling or simulation, as well as theoretical and experimental approaches to engineering will form the core of ACTA TECHNICA CORVINIENSIS - Bulletin of Engineering's content, however approaches from a range of environmental science and economics are strongly encouraged.

ACTA TECHNICA CORVINIENSIS - Bulletin of Engineering appear in four issues per year and is open to the reviews, papers, short communications and breakings news inserted as Scientific Events, in the field of engineering.

Mission:

ACTA TECHNICA CORVINIENSIS - Bulletin of Engineering is an international and interdisciplinary journal which reports on scientific and technical contributions. The ACTA TECHNICA CORVINIENSIS - Bulletin of Engineering advances the understanding of both the fundamentals of engineering science and its application to the solution of challenges and problems in engineering and management, dedicated to the publication of high quality papers on all aspects of the engineering sciences and the management.

You are invited to contribute review or research papers as well as opinion in the fields of science and technology including engineering. We accept contributions (full papers) in the fields of applied sciences and technology including all branches of engineering and management.
Submission of a paper implies that the work described has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis) that it is not under consideration for publication elsewhere. It is not accepted to submit materials which in any way violate copyrights of third persons or law rights. An author is fully responsible ethically and legally for breaking given conditions or misleading the Editor or the Publisher.
The Editor reserves the right to return papers that do not conform to the instructions for paper preparation and template as well as papers that do not fit the scope of the journal, prior to refereeing. The Editor reserves the right not to accept the paper for print in the case of a negative review made by reviewers and also in the case of not paying the required fees if such will be fixed and in the case time of waiting for the publication of the paper would extend the period fixed by the Editor as a result of too big number of papers waiting for print. The decision of the Editor in that matter is irrevocable and their aim is care about the high content-related level of that journal.
The mission of the ACTA TECHNICA CORVINIENSIS - Bulletin of Engineering is to disseminate academic knowledge across the scientific realms and to provide applied research knowledge to the appropriate stakeholders. We are keen to receive original contributions from researchers representing any Science related field.
We strongly believe that the open access model will spur research across the world especially as researchers gain unrestricted access to high quality research articles. Being an Open Access Publisher, Academic Journals does not receive payment for subscription as the journals are freely accessible over the internet.

General Topics:

ENGINEERING
- ☐ Mechanical Engineering
- ☐ Metallurgical Engineering
- ☐ Agricultural Engineering
- ☐ Control Engineering
- ☐ Electrical Engineering
- ☐ Civil Engineering
- ☐ Biomedical Engineering
- ☐ Transport Engineering
- ☐ Nanoengineering

CHEMISTRY
- ☐ General Chemistry
- ☐ Analytical Chemistry
- ☐ Inorganic Chemistry
- ☐ Materials Science & Metallography
- ☐ Polymer Chemistry
- ☐ Spectroscopy
- ☐ Thermo-chemistry

ECONOMICS
- ☐ Agricultural Economics
- ☐ Development Economics
- ☐ Environmental Economics
- ☐ Industrial Organization
- ☐ Mathematical Economics
- ☐ Monetary Economics
- ☐ Resource Economics
- ☐ Transport Economics
- ☐ General Management
- ☐ Managerial Economics
- ☐ Logistics

AGRICULTURE
- ☐ Agricultural & Biological Engineering
- ☐ Food Science & Engineering
- ☐ Horticulture

COMPUTER & INFORMATION SCIENCES
- ☐ Computer Science
- ☐ Information Science

EARTH SCIENCES
- ☐ Geodesy
- ☐ Geology
- ☐ Hydrology
- ☐ Seismology
- ☐ Soil science

ENVIRONMENTAL
- ☐ Environmental Chemistry
- ☐ Environmental Science & Ecology
- ☐ Environmental Soil Science
- ☐ Environmental Health

BIOMECHANICS & BIOTECHNOLOGY
- ☐ Biomechanics
- ☐ Biotechnology
- ☐ Biomaterials

MATHEMATICS
- ☐ Applied mathematics
- ☐ Modeling & Optimization
- ☐ Foundations & Methods

Invitation:

We are looking forward to a fruitful collaboration and we welcome you to publish in our ACTA TECHNICA CORVINIENSIS - Bulletin of Engineering. You are invited to contribute review or research papers as well as opinion in the fields of science and technology including engineering. We accept contributions (full papers) in the fields of applied sciences and technology including all branches of engineering and management.
Submission of a paper implies that the work described has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis) that it is not under consideration for publication elsewhere. It is not accepted to submit materials which in any way violate copyrights of third persons or law rights. An author is fully responsible ethically and legally for breaking given conditions or misleading the Editor or the Publisher.

5th Anniversary Celebration:

We are very pleased to inform that our journal ACTA TECHNICA CORVINIENSIS - Bulletin of Engineering completed its five years of publication successfully [2008-2012, Tome I-V]. In a very short period it has acquired global presence and scholars from all over the world have taken it with great enthusiasm.
We are extremely grateful and heartily acknowledge the kind of support and encouragement from all contributors and all collaborators!

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Editorial & Advisory Board

Review process & Editorial Policy

ACTA TECHNICA CORVINIENSIS - Bulletin of Engineering is dedicated to publishing material of the highest engineering interest, and to this end we have assembled a distinguished Editorial Board and Scientific Committee of academics, professors and researchers.
ACTA TECHNICA CORVINIENSIS - Bulletin of Engineering publishes invited review papers covering the full spectrum of engineering. The reviews, both experimental and theoretical, provide general background information as well as a critical assessment on topics in a state of flux. We are primarily interested in those contributions which bring new insights, and papers will be selected on the basis of the importance of the new knowledge they provide.
The editorial policy of ACTA TECHNICA CORVINIENSIS - Bulletin of Engineering is to serve its readership in two ways. Firstly, it provides a critical overview of the current issues in a well-defined area of immediate interest to materials scientists. Secondly, each review contains an extensive list of references thus providing an invaluable pointer to the primary research literature available on the topic. This policy is implemented by the Editorial Board which consists of outstanding scientists in their respective disciplines. The Board identifies the topics of interest and subsequently invites qualified authors. In order to ensure speedy publication, each material will be report to authors, separately, thought Report of the Scientific Committee. For an overview of recent dispatched issues, see the ACTA TECHNICA CORVINIENSIS - Bulletin of Engineering issues.
ACTA TECHNICA CORVINIENSIS - Bulletin of Engineering encourages the submission of comments on papers published particularly in our journal. The journal publishes articles focused on topics of current interest within the scope of the journal and coordinated by invited guest editors. Interested authors are invited to contact one of the Editors for further details.
The members of the Editorial Board may serve as reviewers. The reports of the referees and the Decision of the Editors regarding the publication will be sent to the corresponding authors.
The evaluated paper may be recommended for:

- ☐ *Acceptance without any changes - in that case the authors will be asked to send the paper electronically in the required .doc format according to authors' instructions;*
- ☐ *Acceptance with minor changes - if the authors follow the conditions imposed by referees the paper will be sent in the required .doc format;*
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- ☐ *Rejection - in that case the reasons for rejection will be transmitted to authors along with some suggestions for future improvements (if that will be considered necessary).*

The manuscript accepted for publication will be published in the next issue of ACTA TECHNICA CORVINIENSIS - Bulletin of Engineering after the acceptance date.

ACTA TECHNICA CORVINIENSIS - Bulletin of Engineering accept for publication unpublished manuscripts on the understanding that the same manuscript is not under simultaneous consideration of other journals. Publication of a part of the data as the abstract of conference proceedings is exempted.
All the authors and the corresponding author in particular take the responsibility to ensure that the text of the article does not contain portions copied from any other published material which amounts to plagiarism. We also request the authors to familiarize themselves with the good publication ethics principles before finalizing their manuscripts.
Manuscripts submitted (original articles, technical notes, brief communications and case studies) will be subject to peer review by the members of the Editorial Board or by qualified outside reviewers. Only papers of high scientific quality will be accepted for publication. Manuscripts are accepted for review only when they report unpublished work that is not being considered for publication elsewhere.

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Regional Associate Editors & Collaborators

The Editor and editorial board members do not receive any remuneration. These positions are voluntary.
We are very pleased to inform that our journal ACTA TECHNICA CORVINIENSIS - BULLETIN of ENGINEERING is going to complete its four years of publication successfully. In a very short period it has acquired global presence and scholars from all over the world have taken it with great enthusiasm. We are extremely grateful and heartily acknowledge the kind of support and encouragement from you.
ACTA TECHNICA CORVINIENSIS - BULLETIN of ENGINEERING is seeking qualified researchers as members of the editorial team. Like our other journals, ACTA TECHNICA CORVINIENSIS - BULLETIN of ENGINEERING will serve as a great resource for researchers and students across the globe. We ask you to support this initiative by joining our editorial team. If you are interested in serving as a member of the editorial team, kindly send us your resume to redactie@fih.upt.ro.

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2. *Stefan SCHMIDT – GERMANY*
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ABSTRACT: *Preventive methods are seldom used in logistics, although there is increasing awareness of their potential. This paper presents two examples of preventive methods currently in use, Poka-Yoke and FMEA (Failure Mode and Effect Analysis). The implementation of Poka-Yoke, the mistake proofing methodology, has been shown to drastically reduce the enormous warranty costs, including logistics costs, while FMEA, implemented for the purpose of assuring the smooth execution of industrial processes, has already been successfully applied during the early planning phase of a new packing centre under construction.*

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4. *Josip MESARIĆ, Zdenko SEGETLIJA, Davor DUJAK – CROATIA*
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ABSTRACT: *Energy supply chains are complex technological and economic structures that can be considered at different levels of their functioning. In this paper, energy supply chains are considered at the national economy level and in the context of wider supply chains of the region they belong to and that has precisely defined participants and relations within energy chains and their mutual relations. Trends in the development of energy supply chains were considered in the context of strategic development of other supply chains, whereby similarities and differences were detected. Evaluation of key development aspect and trend estimation of energy supply chains in the Republic of Croatia was performed. To get better insight in SC trends of analysed sector the analysis is spread out with SWOT analysis.*

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ABSTRACT: The work of modern measuring, manufacturing or other processes requiring reading of measurement data is based on the data provided by sensors located in the crucial - from the point of view of the process control and performance - places. Data obtaining, transmission and processing are accomplished within the measurement system which is defined as a set of devices, organizational means and information processing programs used to ensure correct performance of the production process. A characteristic feature of such a measurement system distinguishing it from the measurement setup is the presence of a system built-in device responsible for the information flow which is referred to as a controller. Usually it is a microprocessor controller or a computer. Architecture and configuration of the measurement system affect the way of information flow and the system's further expandability. The paper presents a description of the measurement systems in terms of their configuration and system components. The measurement system based on IEEE-488 interface is described and its advantages are pointed out. Examples of measurement applications are also given.

7. Marek MUŠÁK, Marek ŠTULRAJTER - SLOVAKIA
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8. Christos CHATZOPOULOS, Maria Mikela CHATZIMICHAILIDOU, Alexander TSIGKAS - GREECE
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9. Emilija RISTOVA, Valentina GECEVSKA, Zoran PANOV - MACEDONIA
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ABSTRACT: Worldwide globalization processes as well as rapid development of information and communication technologies (ICT) significantly determine modern business operations in each and every organization. The basic concept of mass customization as a new trend is to increase the variety of individually tailored products/services to meet customer needs without a large increase in production costs. It requires a highly flexible production technology though. Developing such technologies can be expensive and time-consuming. Clouds enable delivery of mass customized services/information in the "Data to Information to Knowledge" chain. The aim of this paper is to introduce the way how the mid-market can utilize Public Cloud computing in conjunction with a secure Private Clouds and further more to propose a framework for mass customization and its collaboration in Clouds.

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13. Slavka T. NIKOLIĆ, Slobodan MILADINOVIĆ, Jelena STANKOVIĆ - SERBIA
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15. Grzegorz BUDZIK, Jacek BERNACZEK, Bogdan KOZIK, Bartłomiej SOBOLEWSKI, Mariusz SOBOLAK, Mariusz OLEKSY, Mirosław GRZELKA, Anna DOBROWOLSKA - POLAND
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ABSTRACT: The paper presents the use of advanced integrated CAD and RP systems for the demonstrator of aeronautical planetary gear manufacturing. Contemporary methods of designing gear make use of computer aided designing systems (CAD), computer aided engineering (CAE) and computer aided manufacturing (CAM) including also rapid prototyping (RP). First stage of designing gear is always defining basic parameters of the gear work (among others: transmission ratio, rotational speed, power) determined by the gear destination. After carrying out the gear calculations it is possible to create 3D-CAD models of wheels and other elements of the gear. 3D-CAD systems are often equipped with a module for analyzing geometrical parameters and cooperation of its individual elements e.g. the track of cooperation. A detailed analysis of cooperation of gear wheels' elements allows for early detection of construction mistakes of models and for deleting the mistakes. If 3D-CAD models are made correctly, it is possible to record the geometrical data in an appropriate format of numerical data. The following stage of making the prototype of the gear is preparing numerical data necessary for making the demonstrator by means of rapid prototyping method. The accuracy of making physical prototype depends a lot on the accuracy of 3D-CAD/3D-RP model made by means of processing the numerical data. The demonstrator allows for analysis of constructional solutions of the gear based on physical model and for doing introductory stand tests. The paper presents the process of making the demonstrator of planetary gear applying 3D-CAD modeling and Rapid Prototyping. For making the physical prototype a Fused Deposition Modeling (FDM) method of Rapid Prototyping was applied.

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23. Valery Hambate GOMDJE, Thérèse Rosie Lauriane NGONO, Salah Eddine ELQOUATLI, Rachida NAJIH, Abdelilah CHTAINI - MAROC
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25. I. O. OHIJEAGBON, M. A. WAHEED, S. O. JEKAYINFA, O. E. OPADOKUN - NIGERIA
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- *THE 5th INTERNATIONAL CONFERENCE ON GEARS WITH EXHIBITION – GEARS 2013*
  7 – 9 October, 2013
  Technical University of Munich (TUM), Garching (near Munich), GERMANY
- *THE 11th INTERNATIONAL CONFERENCE ON ACCOMPLISHMENTS IN ELECTRICAL AND MECHANICAL ENGINEERING – DEMI 2013*
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- *The INTERNATIONAL CONFERENCE ON INDUSTRIAL LOGISTICS – ICIL 2012, organized in Zadar, CROATIA (14 – 16 June 2012), hosted by the Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb and International Centre for Innovation and Industrial Logistics (ICIIL). The current identification numbers of papers are # 1 – 4, in the content list.*
- *INTERNATIONAL CONFERENCE MANAGEMENT OF TECHNOLOGY – STEP TO SUSTAINABLE PRODUCTION – MOTSP 2012, organized in Zadar, CROATIA (14 – 16 June 2012), hosted by the Faculty of Mechanical Engineering and Naval Architecture and Faculty of Graphical Arts both from the University of Zagreb, CROATIA, Faculty of Management, University of Primorska, Koper and Faculty of Mechanical Engineering, University of Maribor, SLOVENIA, Faculty of Mechanical Engineering, Ss. Cyril and Methodius University, Skopje, MACEDONIA, and Politecnico di Torino, ITALY. The new current identification numbers of papers are # 11 – 12 and # 15 – 17, in the content list.*
- *The 9th INTERNATIONAL CONFERENCE (ELECTRO 2012), organized in Rajecke Teplice, SLOVAKIA (21 – 22 May 2012), by the Faculty of Electrical Engineering, University of Žilina. The new current identification numbers of papers are # 5 – 7 and # 18 – 20, in the content list.*
- *The 5th INTERNATIONAL CONFERENCE ON MASS CUSTOMIZATION AND PERSONALIZATION IN CENTRAL EUROPE (MCP-CE 2012), organized in Novi Sad, SERBIA (19 – 21 September 2012), by the University of Novi Sad, Faculty of Technical Sciences, Department of Industrial Engineering Management and Center for Product Development and Management. The new current identification numbers of papers are # 8 – 10 and # 13 – 14, in the content list.*

Also, ***ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering, Fascicule 1 [January-March]*** *includes, also, original papers submitted to the Editorial Board, directly by authors or by the regional collaborators of the Journal [papers # 21 – 25].*

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[1.] Matija MIKAC, [2.] Vladimir MIKAC

DRIVER ACTIVITY TRACKING SOFTWARE SUPPORTING ANALOGUE AND DIGITAL TACHOGRAPHS

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ABSTRACT: Adopting European Union legislative in Croatia and other countries in the region brought new rules for all professional drivers. Despite some existing tachograph software solutions being available, we decided to develop a completely new tool enabling simple collection of data about driver activities from both analogue and digital tachographs. The obtained data is archived, visualized on-demand and used to create required reports and make advanced analysis in order to find specific infringements.This article gives an overview of the main implementation steps, including both analogue and digital tachograph support. Some of the obtained results are shown and discussed.
KEYWORDS: tachograph, analogue, digital, AETR, driver activity, road transport, public and cargo transport

INTRODUCTION

Safety in public and cargo transportation has always been of utmost importance. Public transport safety regulations are directly related to driver capabilities that enable efficient and safe accomplishment of certain work activities (driving) and have prompted the development of devices that record work activities of mobile workers - tachographs. There are two types of tachographs available - analogue in older and digital in newer vehicles. Even though laws require all new vehicles registered in Croatia since January 1st 2009 [1] to be equipped with digital tachographs, in most transition countries, including Croatia, Bosnia and Herzegovina and other neighboring countries, fleets of many transport companies include older vehicles, so the share of analogue tachographs is quite high and must be taken into account when talking about data acquisition and collection.

EU legislative defines certain rules related to driver activities that should be fulfilled by all professional drivers and their companies - the goal of minimizing specific infringements is directly related to public and cargo road transport safety.

In order to track and analyze activities fulfillment in accordance with those rules, data from tachographs should be digitalized and archived using available software tools. Based on requests by transport companies, we decided to develop a completely new software solution featuring all the required tracking and analysis functions. Our tool supports simple collection of data from analogue and digital tachodevices, data archiving, visualization, reporting and activity analysis. Additional features related to driver activities like creation and record keeping of AETR agreement/attestations of activities is also implemented.

This article describes the development process of our tool for driver activity tracking supporting analogue and digital tachographs. It starts with an overview of driver activity definitions and a short description of tachograph devices. Main part of the article covers features of our software tool, including detailed descriptions of certain implemented functions. A rich and informative user interface is shown, visualizing all the required data. The article concludes with some remarks about future development and ideas.

DRIVER ACTIVITIES AND TACHOGRAPHS

In public and cargo road transport, drivers, co-drivers and crew members perform certain activities through day. Legislative rules define four types of driver activities - driving, availability, other work and rest. Driving activity is related to period of time when the driver drives his vehicle (co-driver activity in that period is usually set to availability). Availability is the time when the driver is not required to remain in his workplace but must be available to start or continue driving or do other work. It is also the time spent as a co-driver during driving, waiting at borders, time spent in vehicle when it is being transported by ferry etc. Other work relates to any activity by the driver, other than driving - for example loading, unloading, vehicle cleaning or maintenance, helping passengers get in or out of the vehicle, working on administrative formalities (police, customs etc.). Rest is the time the driver

spends outside of the vehicle or in a stopped vehicle, provided that it is equipped with a bed. [2]
There are limits defined in legislative rules - the maximum time of driving without a break is limited to 4.5 hours and to 9 hours daily. The weekly limit is 56 hours of driving. Rest has a minimum of 11 continuous hours within 24 hours time, or 12 hours if it is split in two parts, the first part being 3 continuous hours of rest and the second 9 continuous hours. Details in Croatian [1] and EU legislative [3].
During driving and work on their vehicles, driver and co-driver activities are recorded on special devices called tachographs. Each activity has a symbol related to it as shown in Table 1. A start and an end time of each activity period is recorded by the tachograph. This is the information that must be read from digital or analogue tachographs and then stored into the driver activity record by the driver activity tracking software.

Table 1 - Activity record

Activity	Symbol	Start	End
Rest		05:15*	06:24*
Driving		*the start and end of the activity period	
Availability			
Other work			

Digital devices that record information about work activities - digital tachographs - are being installed in all new cargo and passenger transport vehicles. Data storage and retrieval are standardized - a digital card which must be used during driving is given to each driver by an authorized agency - all the information is stored on that card and the card is an essential part of the control system. This article provides a description of the program solution which has been developed for downloading and interpreting data from the cards by using standard smart card readers.
An important issue in the logistics of transport companies is efficient tracking of driver activities. It is directly related to public transport safety regulations, and therefore all companies are obligated to provide required information. Since fleets of many Croatian transport companies include older vehicles equipped with analogue tachographs, digitalization of analogue tachocharts becomes highly important. This paper presents a process for tachochart digitalization and describes a few solutions used in our analogue tachochart digitalization tool.

ANALOGUE AND DIGITAL TACHOGRAPHS

Professional drivers and mobile workers perform certain activities while working. There are rules that are defined by law concerning safety in public transportation and transportation of goods and passengers. These rules define, for example, the maximum time duration of driving without stopping and resting, obligatory rest periods for drivers etc. Tachographs are devices which are used to record driver activities. There are two types of tachographs - analogue and digital. Both will be described in this chapter.

Analogue tachographs

Analogue tachographs are older types of tachographs which used to be installed into cargo and passenger transport vehicles. Figure 1 (left) shows one type of analogue tachograph - it is built into the dashboard of a vehicle and provides buttons related to different types of activities (in addition to the speed indicator). There are different models of analogue tachographs, as shown in Figure 1 (right) - a standalone device that can be installed into the dashboard of a vehicle.

Figure 1 - Analogue tachographs

Analogue tachographs record driver activity data on round paper forms which are 12.3cm in diameter - called tachocharts. The most used type of tachochart in Croatia is shown in Figure 2 on the left. However, lately, due to an obvious need for tachochart scanning and digitalization, a new type of a tachochart (shown in Figure 2 on the right) has been introduced to the market - one that has a clear center crown. This center crown is used to record driver activity and since it is clear (it does not contain any printed symbols) there is nothing to interfere with the reading of the tachochart. Drivers are required to manually write their name and surname, vehicle registration mark and the starting odometer state before inserting the tachochart. After tachochart removal the driver must write the current time (important in cases of night driving when the drive starts on one and ends on another day) and the current odometer state.

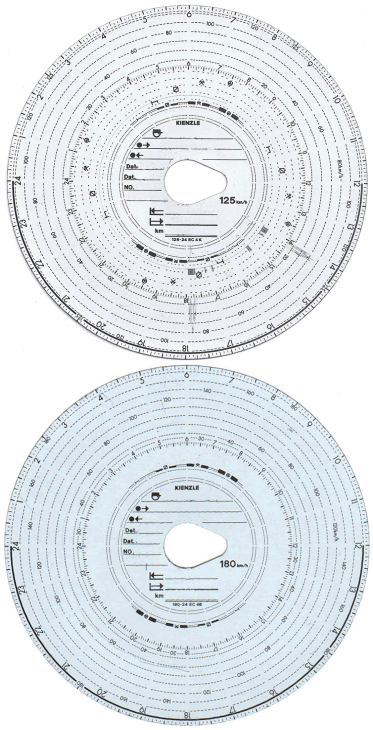

Figure 2 - Standard tachochart and tachochart with clear crown

Since the majority of tachographs in use in Croatia and neighboring countries are still analogue, the share of analogue tachographs is quite high and reading of the tachocharts should be made as simple as possible.

Digital tachographs

As previously stated, it is required by law that all new vehicles registered in Croatia since January 1st 2009 be equipped with digital tachographs. One model of a digital tachograph (manufacturer: VDO) is shown in Figure 3 (left) (downloaded from [4]).

For use with digital tachographs, an unique identification card [3] that has its own memory for storing driver activity is issued to every driver. The cards are issued for a period of five years. Figure 3 (right) shows an example card - as issued in Croatia (generic look, missing photograph, downloaded from [5]).

There are three more types of cards in use - transport company card (company/owner), workshop cards (for authorized workshops which service tachographs) and supervision card (for supervisory bodies such as police etc.). While driver cards are used only for storing data related to driver activity, other cards can be used to retrieve additional information from the tachograph (data on all drivers, locations and drive speeds, details on tachograph usage etc.).

Figure 3 - Digital tachograph and driver card

Each driver card must contain obligatory data fields and have minimum available capacity, as defined in [3].

AETR attestations of activities

Drivers are also required to have AETR attestations of activities in their vehicles. These are related to the times when they are not driving and have become obligatory in Croatia since January 1st 2010. They contain data about the driver (such as name, surname, date of birth, driving license or identity card or passport number) as well as the start and end of the period in which the driver was not driving and the reason why the driver was not driving (was on sick leave, was on annual leave, was on leave or rest, drove a vehicle exempted from the scope of Regulation (EC) 561/2006 or the AETR, performed other work than driving, was available).

It is now clear that all the input data is contained on analogue tachocharts, digital driver cards and attestations of activities. The goal then is to merge all this data into one record and process it. That is precisely what the software tool described in the next chapter does.

Software Tool Features and Implementation's

As stated before, we need to merge all the data (from analogue and digital tachographs and attestations of activities) into one record and process it. Each part of this procedure will be explained separately, key problems that arose during implementation will be stated and solutions for these problems will be provided. The procedure used for recording driver activity can be seen in Figure 4.

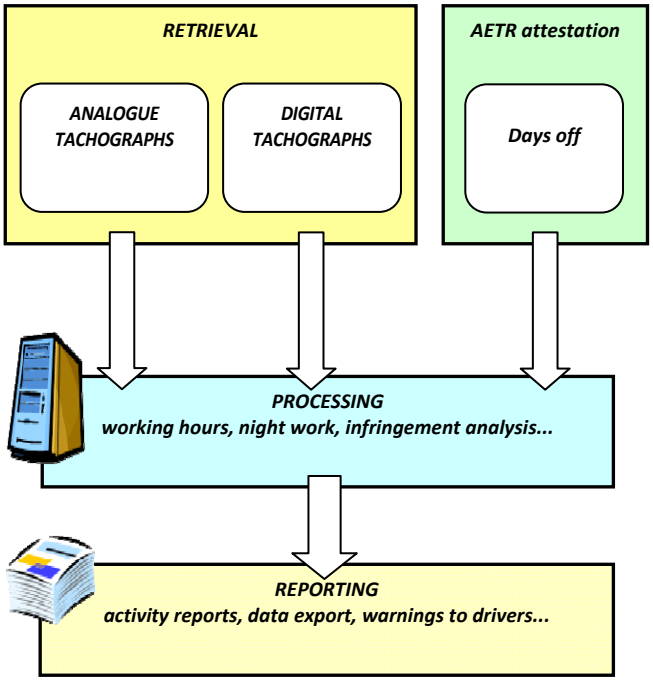

Figure 4 - Activity recording procedure

To start the collection of data we need to have the digital driver cards and/or scans of analogue tachocharts ready for use.

Chart digitalization module

Once the scans of analogue tachocharts are ready for use, the process of digitalization can begin. Prior to linearization and orientation detection, other algorithms [9] should be used to locate tachochart on the scan. All the algorithms were implemented in our tool, allowing detection of tachocharts being scanned one at a time or two charts per one A4 scan. The driver activities can now be retrieved from the tachochart, imported into a database and used with other data. Determining the type of activity is based on the width of the line used to record activities on the tachochart as shown in Table 2. Driving is recorded using the thickest line and rest using the thinnest line.

Table 2 - Activity record lines

Activity type	Symbol	Line width
Rest		
Driving		
Availability		
Other work		

To determine the start and end of the period of a single activity, it is necessary to determine which time of the day is recorded on a certain position within the crown of the tachochart. Since it is a circular record, the 24 hour period (a day) is recorded within 360 degrees, so 4 minutes of an activity can be represented within a single degree.

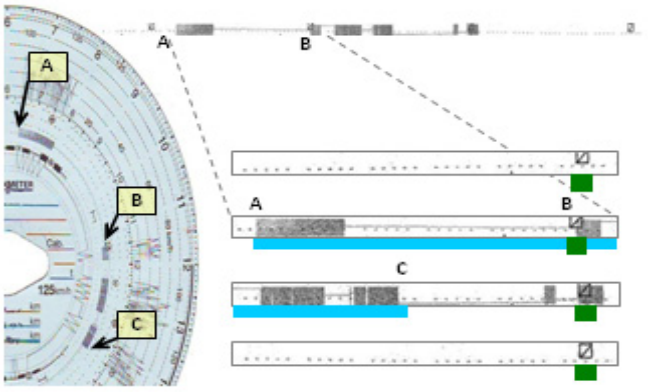

Figure 5 - Example of linearization of part of the crown of a tachochart

Retrieval of driver activities is done directly from the scanned image of a tachochart - the crown is linearized and converted into a rectangle - as modern digital tachographs do not offer retrieval precision below one minute [7], the crown is linearized into a rectangle which is 1440 pixels wide - in which case, every dot (line) of the linearized record represents one minute. The principle of this is shown in Figure 5 - three positions (A, B and C) that are marked on the tachochart can also be seen on the enlarged linearization view.

Once the linearization is complete, the retrieval of driver activities starts - for every minute (every column of dots) dark pixels are counted and categorized - if dark pixels are prevailing the activity is surely driving and if there is a small number of dark pixels, it is the rest activity. The remaining two activities are more precisely processed and categorized.

Every tachochart has a time scale (0-24 hours) on its edge. To correctly determine the time of a certain activity, an angle of rotation for the tachochart in question has to be determined. Once that angle is known, it is translated and applied to the time axis (which is a result of linearization) and the correct time can then be determined. The first part of this algorithm uses the central cavity of a tachochart - the peaked part of it always points to 12 hours, and opposite to that is the 24 hour point.

Figure 6 (left) shows this cavity and the angle marked β_0. This method alone was determined not to be precise enough.

Right beside the time scale on the edge of a tachochart, there are markings which can be used for a more precise determination of the angle of rotation. Shown on Figure 6 (right) is the edge of a tachochart and a circle can be seen - this circle is bolded on one half of the tachochart and can therefore be used to determine the start of the time scale. The angle β is found here. The search for this bolded circle break (which is the second part of the algorithm) is limited to the surrounding area of the angle β_0 which was determined by using the central cavity of the tachochart. The user is given the option to manually adjust the rotation angle, but since the algorithm was upgraded with this second part the need for user intervention has almost completely been eliminated. In depth coverage of most algorithms used in tachochart analysis is given in [9].

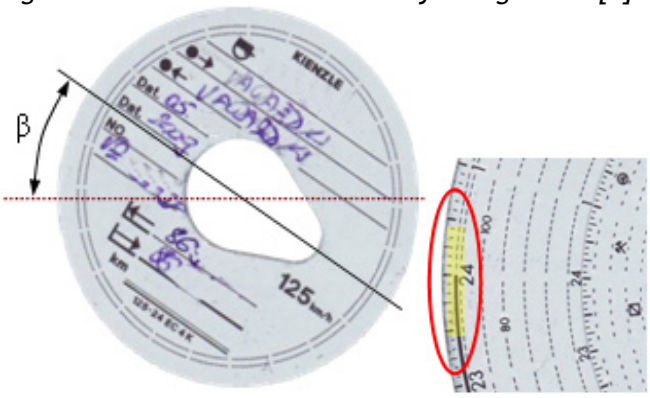

Figure 6 - Angle of rotation based on central cavity and bolded circle break

Driver card reader module

Data from the driver cards (which must comply with ISO/IEC 7816) used with digital tachographs can be retrieved by using standard smartcard readers, with the use of standard communication and transfer protocols.

The tool for this data retrieval only copies data from the driver cards into readable .ddd files. Once retrieved, the data is structured and binary coded in accordance to precisely defined rules [6] and has to be interpreted and shown in a more acceptable form. Figure 8 shows both a graphical and table view of driver activities for a selected date.

An unexpected problem has appeared during the development of the program for interpreting and showing data. Digital tachographs record time based on GMT0 time zone. Since Croatia and neighboring countries are in GMT+1 time zone and apply daylight savings time, an intelligent model has to be introduced to determine when the daylight savings time is applied. Even with that problem solved, there is still the question of what to do with one hour extra or one hour shortage on the day when the daylight savings is applied. Since it is only a single hour, it has been decided that it should be left in the calculation.

The digital tachograph system includes a security subsystem which prevents unauthorized manipulation and access to data. It also provides detection of subsequent change of activity data. A digital signature is used to insure data integrity (i.e. the data which was retrieved has not been changed). This security aspect was ignored during the development of the described software solution.

Vehicle unit reader module

Tachograph manufacturers usually offer devices (USB sticks and similar products) which can be used to retrieve the so called VU (vehicle unit) .ddd files which contain all data on vehicle activity for a certain period (drivers, infringements, speeds...). Our tool includes a module which can be used to retrieve and visualize such data, as well as to enable data exporting to .xls file format.

Visualization and software modules

The software offers a graphical and table view of driver activities as shown in Figure 7 (left), as well as a calendar view of driver activities as shown in Figure 7 (right).

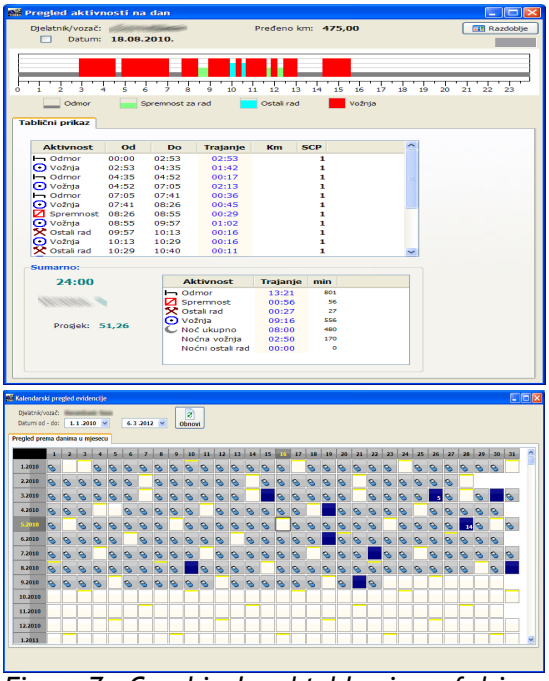

Figure 7 - Graphical and table view of driver activities for a selected date and calendar view of driver activities and data collections

A graphical view of driver activities for a selected period is shown in Figure 8 (left), showing integrated AETR attestations of activities visualization. Statistical analysis module is depicted in Figure 8 (right).

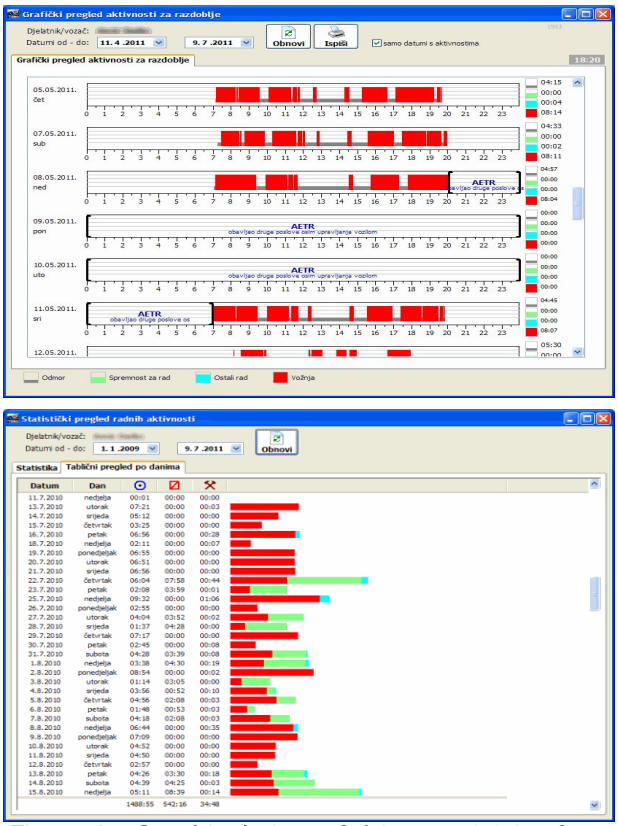

Figure 8 - Graphical view of driver activities for a selected period and activity analysis module

The latest implemented module in our software tool is used to analyze and detect driver infringements due to valid regulations [3]. It includes creation of reports delivered to drivers in order to inform them about potential infringements.

Conclusions

Our software was developed from scratch, in accordance to customer requests, and tailored specifically for the Croatian market and its requirements (the majority of tachographs in use are still analogue types).

The software is functional and enables simple retrieval, interpretation and showing of data. User reactions are very positive. A version of our software meant for use by companies which offer data retrieval and storage as a service is also available. The difference compared to the standard version is that it enables use for driver activity retrieval for an unlimited number of companies.

In future development, there are some things that could be improved. Reading more data from tachocharts (distances, speeds) could be implemented. The security aspect of driver card data retrieval, related to the digital signature control is also something that could be implemented in the future. Usage of web for data retrieval and delivery (primarily in cases when a company offers these as a service) is also being considered - in which case, the data would be read-only for users, and that data would remain property of the company.

Constant communication with our customers and further development based on their requests is one of our most important goals. Some even more detailed views of activities could be created and other ways to export data could be introduced. Increased interest in our software tools shows that transport companies are very well informed about new regulations and their obligations related to driver activity tracking.

Hopefully, that means that our custom made solutions could impact the market and find a place among other solutions developed by larger foreign companies.

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PREVENTIVE METHODS IN LOGISTICS POKA-YOKE AND FAILURE MODE AND EFFECT ANALYSIS (FMEA)

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ABSTRACT: Preventive methods are seldom used in logistics, although there is increasing awareness of their potential. This paper presents two examples of preventive methods currently in use, Poka-Yoke and FMEA (Failure Mode and Effect Analysis). The implementation of Poka-Yoke, the mistake proofing methodology, has been shown to drastically reduce the enormous warranty costs, including logistics costs, while FMEA, implemented for the purpose of assuring the smooth execution of industrial processes, has already been successfully applied during the early planning phase of a new packing centre under construction.
KEYWORDS: Preventive methods, logistics, FMEA, Poka-Yoke, industrial application

INTRODUCTION

In German industry, quality costs are estimated to be, on average, up to five to ten per cent of the turnover. This corresponds to 36 to 72 billion Euros. 70 per cent of these quality costs represent the costs involved in correcting defects, while only seven percent are prevention costs (quality inspection).
Preventive methods are seldom used in logistics and warranty generates huge costs for handling and transport. This paper shows, on the basis of industrial examples, that the mistake proofing methodology, Poka-Yoke, drastically reduces the enormous warranty costs including logistics costs.
In addition, a second preventative method, FMEA can be implemented for the purpose of assuring the smooth execution of industrial processes and has already been successfully applied during the early planning phase of a new packing centre under construction. In this way, possible failures and their causes and potential effects, as well as measures to be implemented for the avoidance and detection of such failures, can be analysed from the aspect of failure mode factors.

MISTAKE PROOFING METHODOLOGY POKA-YOKE

Poka-Yoke is a Japanese term that means "mistake-proofing or "fail-safing". This concept was formalised and the term adopted by Shigeo Shingo as part of the Toyota Production System [1, 2]. The target is to avoid missing parts, misassembled parts, incorrect processing and incorrect parts.
The definition of Poka-Yoke = Error Proofing:

- Poka-Yoke is a device, which prevents a process from making an error (**prediction**) or a defect from being passed on to the user (**detection**).
- When a defect is predicted or an error detected, the process is **shut down** or a **control** prevents the process from going ahead or a **warning** is sent.

Good Poka-Yoke devices, regardless of their particular implementation, share many common characteristics:

- They are simple & cheap. If they are too complicated or too expensive, their use will not be cost-effective.
- They are part of the process, implementing what Shingo calls "100%" inspection.
- They are placed close to where the mistakes occur, providing quick feedback to the workers, so that the mistakes can be corrected.

This paper shows, on the basis of industrial examples, that the mistake-proofing methodology, Poka-Yoke, eliminates the cause of an error at the source by detecting any error as it is being made or soon after it has been made, but before it reaches the next operation. Poka-Yoke helps to build quality into processes and products. As a result, the enormous warranty costs, including logistics costs, will go drastically down.

Poka-Yoke training programme

For the employees, the Target of the Poka-Yoke Training is to develop a Poka-Yoke mindset and gain practical experience in the implementation of Poka-Yoke. The Target group includes planning engineers, quality engineers, employees in problem solving process and „specialists in charge of Poka-Yoke solutions“.
The Training Concept is the communication, in an almost playful manner, of the Poka-Yoke theory and includes a high proportion of practical exercises. The exercises are based on real production problems and focus on Process-Poka-Yoke. The trainers conduct practical exercises during which they act as coaches. The results of these exercises are then presented to the management for their implementation. For the implementation of Poka-Yoke as a new methodology,

a training programme has been developed. Table 1 shows the agenda and table 2 the key lessons of a Poka-Yoke training programme.

Table 1 – Agenda Poka-Yoke training programme

DAY 1 – Theory:
- *Simulation: Poka-Yoke Training Station*
  - *Poka-Yoke Theory - Flip Chart Training*
  - *5 Shingo plants, product- & process-Poka-Yoke,*
  - *Attributes of good Poka-Yoke solutions etc.*
  - *Examples: videos and several solutions for production problems presentations*
  - *Poka-Yoke exercises (on paper)*
  - *Basics of the problem solving process*
  - *Organisation day 2: Formation of teams, introduction of several production problems*

DAY 2 – Practical experience:
- *Teams select 3 problems each (missing, wrong, loose), data acquisition*
- *Teams discuss each of these problems and then,*
- *Selection of one production problem and one solution for cardboard simulation*

DAY 3 – Practical experience:
- *Teams implement the solution in a simple cardboard simulation*
- *Preparation of a presentation for management*
- *Teams present results*
- *Agreement for the handover of results to the production line*

Table 2 – Key lessons of a Poka-Yoke training programme

- *Key lesson 1: Introduction to Poka-Yoke*
- *Key lesson 2: How three types of Poka-Yoke detect and prevent errors in a production system, the contact method, the fixed-value (or constant number) method and the motion-step (or sequence) method*
- *Key lesson 3: How Quality can be built into products by the implementation of Poka-Yoke*
- *Key lesson 4: How Poka-yoke helps build quality into processes*
- *Key lesson 5: How the growing relevance of Poka-Yoke improves warranty and reduces costs including logistics costs.*

Industrial Poka-Yoke examples

A Motor Company and Bosch Rexroth Corp. have implemented multiple error proofing applications to identify different sensors based on their torque signature:
- *Poka-Yoke#1:Torque Red/Green Light display*
- *Poka-Yoke#2:Screen Display*
- *Poka-Yoke#3:Sensor control for long/short sensor selection*
- *Poka-Yoke#4:Alarm signal if the wrong senor selected*
- *Poka-Yoke#5:NOK acknowledge*

The tool will be disabled if the wrong sensor is used. The operator then needs to press the acknowledge button to enable the tool. The Operator's full attention is required. The result of this automotive assembly project shows: reduced warranty and logistics costs by Poka-Yoke, no defects and better quality, which leads to higher customer satisfaction, see figure 1 [3].

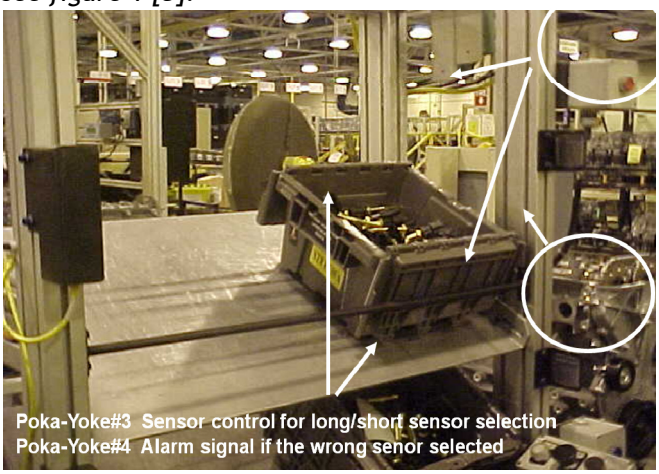

Figure 1 - Engine sensor installation with multiple Poka-Yoke applications

The expanding network size of logistical systems as a result of outsourcing and internationalization also leads to less reliable processes that are more prone to error. Increasing transport distances, network partners distributed throughout the world and the rise in the number of logistics interfaces lead to more unstable material flows. Error-tolerant logistic processes can, however, be achieved with the aid of Poka-Yoke solutions, as shown by the following examples (figure 2):
- *Poka-Yoke shelf in automotive final assembly line [4].*
- *Error-free order picking with Poka-Yoke: in this example, the Poka-Yoke concept is realized through the use of Pick-by Light or Put-to Light with sensor monitoring of the removal and storage places as well as RFID-monitoring of the conduct of the process. As a result of this implementation of Poka-Yoke, the number of order picking errors are reduced by 80% to 95% compared to paper-based systems [5]*
- *Increasing Efficiency of Warehouse Operations [6] by equipping forklifts with PCs: an affordable solution for many new and existing warehouses is to empower operators by installing an onboard computer on each forklift and connecting them to a Warehouse Management System (WMS) via a wireless local area network. This makes the location of items and empty storage space immediately visible, which instantly reduces the waste involved in transportation, human motion and waiting. This results in better response times (less waiting) for dependent production processes and customer satisfaction. A shorter lead time provides an improved service and can also result in a reduction of inventory and floor-space requirements. This represents a poka yoke solution, in which the incidence of retrieving and shipping the wrong item is dramatically reduced by matching the item with information on the item's location. The use of barcodes and RFID almost completely eliminates such errors and significantly improves inventory accuracy.*

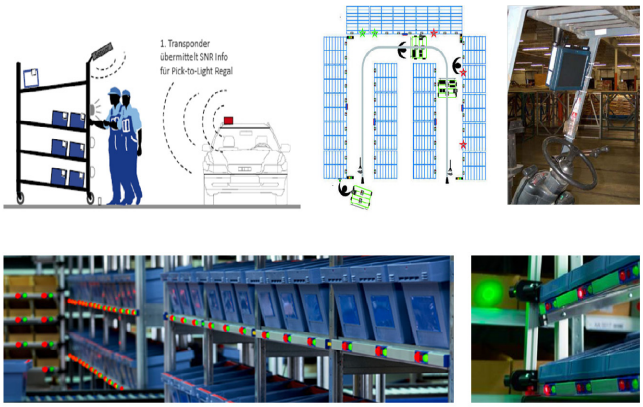

Figure 2 - Poka-Yoke applications in logistics [4, 5, 6]

RISK ANALYSIS FMEA - PLANNING OF A LOGISTICS PLANT

The Failure Modes and Effect Analysis (FMEA) is a development and planning accompanying system and risk analysis. It is integrated in the specialist departments and includes the optimisation of the system and risk reduction. As an important methodical instrument, the FMEA allows possible failures to be identified at an early stage, so that they can be prevented before they even occur. This is important in new concepts and developments as well as the further development of products and processes, see [7].

In quality assurance agreements for the assurance of delivery quality by suppliers, an FMEA is often mandatory. For example, according to the latest state-of-the-art technical requirements, a process FMEA is required to be carried out [8]. The results of an empirical study show that FMEAs are hardly ever used in project management for quality planning and assurance or for risk management, see figure 3 [9].

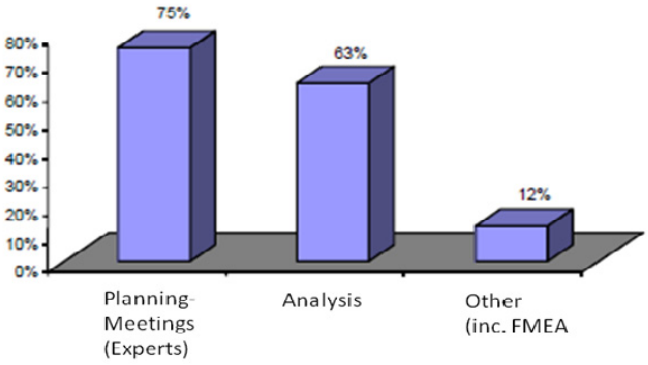

Figure 3 - Methods of risk planning

For the assurance of a smooth execution of the processes of a new packing centre under construction, a risk analysis was carried out with the aid of an FMEA performed in the early planning phase of this construction project, see [10]. This way, possible failures and their causes and potential effects, as well as measures to be implemented for the avoidance and detection of such failures, can be analysed from the aspect of failure mode factors, which includes man, machine, method, material and environment.

The FMEA is performed in 5 steps by a team comprising of members from all areas under the guidance of an experienced presenter. The 5 steps are as follows (see figure 4):

- *Representation of the system structures (hierarchical process structure),*
- *Representation of the functions and function structures (process flow),*
- *Failure analysis (possible failures, failure causes and failure mode),*
- *Risk assessment with respect to the severity of the failure mode as well as to the occurrence potential or detection potential of the occurred failure and its cause,*
- *Optimisation implementation. This involves the specification of the dead-lines and persons responsible and the coordination of the corrective measures (process sheets and operating instructions etc.).*

Figure 4 - Risk analysis packaging plant with FMEA

The potential failures can be subdivided into 2 groups during the risk assessment:

- *Refrain failures (omission of required activities, failures caused through ignorance etc.),*
- *Execution errors (mix up, unsatisfactory checks of the attribute, scan double etc.).*

The environment is also taken into consideration. In this context, it is the ergonomic conditions in particular, such as illumination, noise level, temperature etc., which can have an influence on the performance and motivation of the employees in a positive or in a negative regard. These conditions have been well-executed in the packaging plant, where much attention has been paid to avoiding the occurrence of refraining and executing errors on the part of the employees during the various manual tasks.

In the case of the aforementioned construction project, the possible risk of errors occurring during a variety of manual tasks could be reduced with the aid of remedial or avoidance measures. This mainly involved the provision of descriptions on how to carry out the individual processes (work instructions, descriptions of operational sequences, company rulings, maintenance timetables and programming SAP). An early preparation of these process descriptions is recommendable as they can then also be used for the training of the employees. If they are compiled simultaneously with the development of the process, they represent an up-to-date document of the process flow. The processes and the execution of the processes by the employees should be checked at regular intervals, in order to indicate where any improvements could be made.

An accurately timed use of a risk analysis is recommendable from both a technical and a business management planning perspective. Many functions are similar and can be transferred to other applications. In addition to a well-timed implementation of the FMEA, it is essential that the involvement of the operator is also favourable in terms of scheduling. At the start-up of the production, preventative measures are more difficult to set up. However, the FMEA can be used as a basis for follow-up planning from both a technical and a business management standpoint and can be maintained by the operator as a method for the continual improvement of the process after the start-up and during the stabilization phase.

Risk analysis with FMEA provides an early indication of the existence of potential failures and risks in the front-end of the process, thus allowing countermeasures to be already started in the early planning phase of this project. This way, the well-controlled execution of processes is guaranteed.

CONCLUSIONS

The expanding network size of logistical systems leads to material flows that are less stable. Error-tolerant logistic processes can, however, be achieved with the aid of Poka-Yoke solutions, which include the use of Pick-by Light or Put-to Light systems, barcodes, RFID-monitoring and the equipping of forklifts with PCs and connecting them to a Warehouse Management System (WMS) via a wireless local area network. Thus recent years has seen a significant increase in the implementation of Poka-Yoke, which, in turn, has led to a drastic reduction in the number of errors occurring during the actual logistics and production processes.

The Failure Modes and Effect Analysis (FMEA), on the other hand, allows possible failures to be identified already at the early conceptual phase of the process, thus enabling their prevention before they even occur. This is important in new concepts and developments as well as in the further development of products and processes. Therefore, an accurately timed use of a risk analysis with FMEA is recommendable from both a technical and a business management planning perspective, since it allows countermeasures to be already started in the early planning phase of projects. Since all major decisions concerning the complete process are already made in these early phases and any errors occurring then would be very expensive to correct at a later stage, the implementation of FMEA in the planning phases of projects, including logistics projects, would clearly be very beneficial, as these errors could then be prevented, thus guaranteeing a well-controlled execution of processes. However, in spite of these obvious benefits, FMEA is very seldom used in planning projects compared to Poka-Yoke solutions.

It can therefore be concluded that both Poka-Yoke and FMEA solutions are important tools in logistics and production processes and their combined implementation would enable a significant reduction in errors at all stages of the process from the early planning phase right up to product release. This would lead to a smooth functioning of the process and considerable savings in both time and money.

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THE LA LIBERTAD FOOTWEAR INDUSTRIES: LOOKING FOR COMPETITIVE ADVANTAGE

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ABSTRACT: The footwear industry in Peru is facing a new competitive scenario since the internalization of the economy and its integration to international markets. Many of the companies of La Libertad/Peru have an intensive use of labour and lack of technology compared to others worldwide. These companies need to establish logistics competitive strategies to differ from their competitors and aggregate value to their products. The aim of this paper is to show that Time-based competition represents a powerful and sustainable competitive advantage to the footwear industry in Peru as time has been outstanding as a prevailing dimension in a global competition.
KEYWORDS: time-based competition, logistics, competitive advantage, footwear companies, Peru

INTRODUCTION

The Peruvian footwear industry is mainly composed of small specialized firms that participate in different links of the production chain. According to [1], these firms have small outputs and produce a wide variety of items and suffer from a series of structural constraints producing mainly for the domestic market and requiring technological upgrading.

There are three major agglomerations of shoe firms stated by the mentioned author: 1) the districts of San Juan de Lurigancho, Rímac, San Martín de Porres and Comas, near Lima; 2) the districts of El Porvenir in La Libertad; and 3) the city of Arequipa.

The La Libertad region is considered one of the most important footwear production region in Peru with El Porvenir the main production centre, consisting of 68% of footwear manufacturing companies followed by Trujillo, with 16%. Many of the companies of La Libertad have an intensive use of labour and lack of technology compared to others worldwide, this means that these companies need to establish competitive strategies to differ from their competitors and aggregate value to their products [2].

As mentioned by [2], the footwear industry located in La Libertad region compared to other countries has a lack of technology in production processes, is intensive of labour force and mainly handcrafted. The companies believe that the implementation of new technologies would provide better productivity and competitiveness to the companies. On the other hand, the employees perceive technology as a factor of increasing unemployment.

[3] and [4] stated that time-based competition (TBC) is a competitive strategy that enables companies to develop a sustainable leadership in both domestic and international markets. Time-based competition involves compression of the time needed to perform a series of operational activities such as planning, design, product development, innovation, manufacturing, logistics, marketing and distribution according to customers' needs and expectations [5]. The success pattern in TBC is due to its characteristic of supplying the customer with the most aggregated value of product or service for the least cost in the least time [6].

The footwear companies are inserted in a competitive globalized market. [2] argued that the Peruvian footwear companies are facing a new pattern of competition mainly because of the augment of imports from Asian countries, which are jeopardizing the domestic companies as well employment.

The small and medium enterprises (SMEs) are mostly affected in this scenario. These companies have less productivity capacity and technological capabilities to compete both in domestic and international markets with quality products, competitive design and costs. According to [2] and [1], the Peruvian footwear companies need an intensive re-organization and modernization process in the whole productive chain aiming to improve competitive patterns.

This paper aims to focus on the aspects of TBC and logistics showing that Time-based competition represents a powerful and sustainable competitive advantage to the footwear industry in Peru as time has been outstanding as a prevailing dimension in a

global competition. Methodologically it can be considered a bibliographical, exploratory and descriptive research focusing in identifying TBC and logistics strategies that may enhance SMEs industries competitiveness.

TIME-BASED COMPETITION

The concept of time as a competitive advantage began with the Japanese industries' search for a leadership position among western companies [7, 3]. According to [8], the use of flexible factory systems introduced in the Japanese context has led to a sense of the importance of time in operations and the notion that its constant reduction leads companies to improve their capacity in developing a greater product variety in a shorter amount of time that is of high quality and a lower cost, according to customer needs.

[9] defined Time-based Competition as: "a strategy that firms try to gain competitive advantage by getting their product to market faster through all the phases of design, production and distribution". It also can be seen as a set of tactics which focus on compressing the time required for businesses activities [6]. The focus is reducing the cycle time in every phase from the product creation up to delivery cycle.

[10] contend that TBC competitive strategies involve the development of a holistic approach managing the internal and external supply chain as the result of a set of restructuring measures beginning with the changing of the organizational values, roles, responsibilities and processes aiming to align the entire supply chain and value chain according to consumers' needs. The authors stressed as a result of implementing TBC strategies, the companies gain a high performance and a competitive advantage in the consumer market, also a structure which facilitates intercompany integration, superior levels of co-ordination and material flow's synchronization.

There are several strategies for a company become time-based. [3] posit that for companies succeed the managerial focus must be on flexibility and fast response implementing the following strategies: determine time as the strategical parameter; use the fast response to be close to the customers; establish the innovation path; introduce a value chain focusing on time; make the necessary changes on business' processes and sustain the improvements.

According to [11], there are seven fundamental strategies to the implementation of TBC: 1) system simplification; 2) system integration; 3) standardization; 4) introduction of parallel activities; 5) variance control; 6) automatization; and 7) diminishing resources excess. These strategies deal with the lead time problems on product development, manufacturing and distribution.

On the other hand, [12] presented some managerial tactics to improve speed in business operations, such as: adopt time as an important factor; reduce the managerial bureaucracy; give more authority to the working teams; respect programming and scheduling; remember the important rule of distribution; and introduce the concept of speed and time in the organization's culture. On the other hand, [13] demonstrate operational strategies focusing on reducing time on ordering, delivering, product development, manufacturing and supplying network processes.

[14] also showed different authors' views and TBC strategies to reach competitive advantage. However, they did not discuss the focus adopted by the companies, namely: the focus on reducing time in product development cycle (innovation), the focus on reducing time in processes (order, production and logistics) or reducing time in both product and process.

The strategies taken into consideration intend to reduce the business' activities cycle time and as a consequence the total cycle time. The reduction cycle time basis the distinction of aggregate value processes and non-aggregate value processes [15]. The purpose is to diminish or eliminate the non-aggregate value processes or activities in order to create a linear flow from receiving an order up to its delivery in less time. [16] illustrate a case of a small furniture company that succeeds implementing TBC strategies obtaining competitive advantage compared to their competitors.

As showed above there are several strategies that can be implemented by companies aiming to become time-based. The question is how to determine which are the most effective one regarding the SMEs or large companies' goals. In this sense, what would be the best strategies for the Peruvian footwear industry to reach a sustainable competitiveness in a globalized world? We argue that the main targets for the companies that plan to adopt the TBC strategies are: 1) share the awareness that time is the main driven; 2) the implementing strategies must have the participation of all hierarchical levels; 3) less cycle time in respond to customers' needs should be in place (developing and introducing new products and services, ordering, manufacturing and delivering); 4) reduce non-aggregate time in business activities; 5) develop flexibility; 6) develop efficient logistics systems; and 7) provide integration with customers and suppliers.

THE PERUVIAN FOOTWEAR INDUSTRY

La Libertad region was characterized to be an agriculture region with large farms dedicated to sugar plantation in the beginning of XX century. After the land reform during the seventies, the large farms were converted into co-operatives producing rice, sugar cane and asparagus. Nowadays the La Libertad region is considered one of the most important footwear production centres in Peru, with El Porvenir consisting of 68% footwear manufacturing companies followed by Trujillo, with 16% [2].

[17] showed the reasons for migration in Peru and how the migrants established industries that became important sectors as the case of Trujillo which is known as an 'industrial district' formed of small-scale footwear manufacturers. According to [2], those Andean migrants have developed a production, supplying and commercialization network unique in Peru. In El Porvenir, the district which concentrates the majority of enterprises, it has been estimated that in each home there are among 1 to 2 persons

employed in this sector. Figure 1 [2] shows the localization of La Libertad region detached in the map of Peru.

Figure 1 - La Libertad Region Geographical Location - Peru

As presented by [1], leather and footwear production is a traditional and mature manufacturing sector in Peru. The Peruvian shoe industry produces mainly for the domestic market. Leather shoes (upper and soles) and shoes made of textile material (upper) are the most exported. Colombia has become the main export destination for Peruvian shoes, followed by Ecuador, Chile and the United States. According to the author, the importance of Andean countries in export may reflect the effect of lower tariffs.

Leather and footwear production in La Libertad is a conglomerate of over 2,000 small and micro footwear manufacturing enterprises, including 300 materials and components suppliers, close to 500 stores and specialized services. Also the sector employs thousands of people generating incomes to over 100,000 people considering the families. The shoes from this region are commercialized all over the country through an extensive network and it is estimated that the production in La Libertad represents 50% of the Peruvian footwear production [2].

The district of El Porvenir has the majority of companies in the Libertad region as can be seen on Table 1 [2]. At present, the districts of El Porvenir, Florencia de Mora and La Esperanza condense 37,3% of Trujillo's population. All the enterprises are small and micro, business family mostly and handcrafted. The manufacturers of Trujillo, El Porvenir, La Esperanza and Florencia de Mora intend to offer the best product as possible for the least price aiming the popular consumers [2].

Table 1 - Footwear Companies from La Libertad

Number of registered companies	*1,014*
Number of leather companies	*49*
Percentage of footwear companies in El Porvenir	*68%*
Percentage of footwear companies in Trujillo	*16%*
Percentage of footwear companies in Florencia de Mora	*10%*
Percentage of footwear companies in La Esperanza	*4%*

According to [1, p.17]: "Peruvian footwear companies are composed of small specialized firms that participate in different parts of the production chain. Firms in Peru are not specialized; they undertake multiple stages of production and are consequently inefficient. In addition, very few firms manufacture shoe components or provide services such as design". This lack of development and competitive strategies limit technological change, creativity and differentiation in the Peruvian shoe industry.

Peru as almost all Latin American countries has been facing huge transformations in production processes caused by the transferences of companies from the public to the private sector during the nineties. In consequence of the changes in economical policies, there have emerged a large number of micro and small enterprises absorbing the majority of labour force. The micro and small companies represent the second type of business in Peru [2].

[1] contends that 97.5% of all shoe firms in Peru have fewer than 10 workers, and 99% of firms have fewer than 20 workers. Fewer than 10 medium firms, most of them family-owned, export part of their production. As mentioned above, those firms show up limited technological capabilities which reflect in the low quality of their products mainly sold in the domestic market.

In Peru micro enterprises are considered as the ones that have from 1 to 10 employees and sales that do not exceed 150 unities of tributary tax per year. Small enterprises are considered the ones that have from 1 to 100 employees and sales that do not exceed 1,700 unities of tributary tax per year [18]. As mentioned by [6], classifying companies' size across the countries is a difficult issue. For instance, in Brazil, the patterns differ between government business agencies. Likewise in the production structure of European countries is heterogeneous, and the size of the companies is one of the elements that contribute to this heterogeneity. There are differences among countries according to those definitions, as well as relative to the number of employees and turnover.

The Peruvian government has settled a number of initiatives to foment the micro and small enterprises during the last years. These enterprises are responsible for 98,2% of all enterprises' employment [18]. The micro and small enterprises are an important factor in promoting employment and income for a great variety of families. Therefore, the Peruvian small and micro footwear companies need to establish competitive strategies so as to prevail not only in domestic markets but in global competition as well.

CURRENT SITUATION AND PERSPECTIVES

Peru like Latin American countries in general is facing new challenges in global competition after the commercial openings and economic activities resulting from globalisation and economical internalization. The footwear industry is not exempt from this new world context. Market changes are affecting the entire sector and the search for quality to satisfy customers is making enterprises even more

competitive. In terms of the footwear industry, the products must satisfy consumers, in terms of design, innovation, technology and flexibility.

The constant import increase from Asian countries has generated a search for new ways of production and technologies as it has been endangering a large number of companies that create jobs and income to the majority of population. On the other hand, footwear production from other Peruvian cities hardly competed to Trujillo's footwear, characterized, in large part, to develop shoes at low prices to a market segment with limited income. The products of higher quality and price from Trujillo supply Lima markets. This trend has strengthened in recent years because the best prices are available in Lima, where the market is basically geared by the footwear from Trujillo [2].

In addition, because of the economical recession, unemployment and lower incomes, there has been a change in the pattern of footwear consumption in Peru. Part of the population has chosen to buy cheaper goods like sandals and shoes imported made with synthetic material at the expense of traditional footwear produced in Trujillo. As a result of this process, smaller companies have been facing bankruptcy, while those with better organization and technology have more capacity and better business opportunities [2].

Therefore, an intense process of modernization has been required of the whole sector, including the supply chain, so as to enhance its capacity and to improve the quality of labour, production processes in both management and technology, as well as linking and articulating the changes in companies. All the contextual changes involve efforts far greater hitherto undertaken.

According to [2], the companies' modernization process should involve: a) a decisive transformation in selection, introduction and management of technology; b) an intensive process of training the workforce; c) a constant introduction of flexible production techniques and flexible organization and inter/business relationships to encourage specialization and complementation of the companies; d) a consistent strengthening of supply and services network; e) an aggressive trade policy focusing the foreign markets; and f) identifying strategic business alliances between producing, supplying and marketing companies.

For the Government support bodies and institutions:

a) a clear policy for local promotion strategically guided and with public/private participation in its formulation and implementation;
b) an active relationship between universities, research centers and companies to support and sustain the creative business environment and produce high competitive human capital;
c) development of modern rules capable of regulating the market and of creating mechanisms for standardization;
d) a medium-term financial policy to support the modernization process.

We also argue that together with the modernization process and policies listed above the TBC competitive strategy focusing on reducing time spent on product innovation, development, manufacturing, commercialization, distribution and logistics cycles can be seen as a path to enhance the Peruvian footwear companies´ competitive advantage.

Total time cycle compression is accomplished if the non-valued time in different business areas, such as engineering, design, production, manufacturing, information, innovation, marketing and distribution, is reduced in the business processes so as to attend to the customers' needs and expectations. This enables companies to become more integrated with their markets, enabling them to launch better services and products than their competitors. Thus, the partnership between companies, suppliers and customers must become closer to facilitate a better awareness of the real needs of customers and improve logistical strategies.

[8] pointed out that in a survey conducted on furniture companies located in different countries most of time strategic factors were strongly geared towards seeking local partnerships as a way to improve cultural differences and logistical partnerships.

Seeking local partnerships, such as universities, research study institutes, suppliers and enterprises, was perceived by the respondents as a way to reduce time: to receive service information, manufacturing, distribution, trace information about services, order transmission and information, trace executed services, and satisfy customer needs. Partnerships are seen as an important factor in improving companies' logistics (manufacturing, distribution, information and services), and business partnerships, so they could be integrated and in tune with the needs of the markets. In addition, they can strengthen mutual relationships and communications.

[19] also expounded that in the city of Franca in Brazil, known as the footwear production worldwide, the success relies on the arrangement of enterprises' networks and clusters. This integration promotes processes, product and services innovation in addition to approximating enterprises, suppliers, distributors and partners. [20] developed a study in the small Brazilian footwear companies located in Vale dos Sinos' cluster and showed that design is also an important factor for the competitiveness of footwear small companies.

According to [2], the current industry conditions, growth and importance, as well as their new challenges, clearly indicate that the spontaneous growth has come to an end. It is necessary therefore to systematically strengthen the entrepreneurial efforts through the generation, systematization, dissemination of technological and organizational knowledge, which does not occur spontaneously. In order to do so, it is necessary to promote local knowledge and experience so as to create conditions to consolidate small and micro footwear companies.

TBC allied to logistics, supply chain strategies in addition to enterprises´ partnerships and clustering can be considered a competitive strategy and may be the cutting edge for the Peruvian footwear industries to obtain competitiveness in both domestic and

international markets. We emphasize that the companies will succeed inasmuch as are aware of the real expectations and needs of their consumers, taking into account that those needs and expectations are cultured oriented.
Organizations, especially in a competitive and globalized world, require an infrastructure compatible to their needs and demands, in order to get their products and services among the different producers and demanding centres situated in different places in the world. Apart from that, according to [21], the sensibility to the cultural dimension helps the understanding of many crucial factors concerning business around the world. This must be perceived by the companies integrated in global market, namely those in and partnerships as well as by suppliers and customers, who must become closer in order to promote awareness of their real needs and improve logistical strategies and competitiveness.

CONCLUSIONS

The primary aim of this investigation was to illustrate that Time-based competition strategies in addition to logistics and supply chain represent a powerful and sustainable competitive advantage to the footwear industry in Peru as time has been considered an important point in global competition. Peruvian footwear companies are facing new challenges to improve their competitiveness and sustain their position in both domestic and international markets.
The ingress of Asian countries as players in production and commerce of footwear has been endangering a large number of Peruvian companies, mainly small and micro enterprises, which are responsible for most part of job creation and income. Therefore, those enterprises require an intense process of modernization, as well as the whole sector relative to the supply chain strategies so as to enhance capacity, quality and production processes to achieve competitiveness.
We recommend that future studies investigate the application of time-based and logistical strategies in Peruvian footwear companies as a case study in addition to the primary investigation presented in this study. Companies may want to investigate and compare their performance after implementing and improving their TBC and cultural strategies. We also suggest following investigations on local partnerships and their roles in improving TBC and logistical strategies in improving companies' competitiveness.
The modernization process and the TBC competitive strategies focusing on reducing time can be seen a path to enhance the Peruvian footwear companies competitive advantage. However companies will succeed if they be aware of the real expectations and need of their consumers. Also, partnerships are seen as an important factor in improving companies' logistics (manufacturing, distribution, information and services) and business network, so as to foster integration and in connection to customers' needs and expectations. In addition, they can strengthen mutual relationships and communications.

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ENERGY SUPPLY CHAINS –TRENDS AND CHALLENGES OF GROWING ENERGY DEMANDS, ENERGY EFFICIENCY, ALTERNATIVE ENERGY RESOURCES AND ENVIRONMENTAL SUSTAINABILITY

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ABSTRACT: Energy supply chains are complex technological and economic structures that can be considered at different levels of their functioning. In this paper, energy supply chains are considered at the national economy level and in the context of wider supply chains of the region they belong to and that has precisely defined participants and relations within energy chains and their mutual relations. Trends in the development of energy supply chains were considered in the context of strategic development of other supply chains, whereby similarities and differences were detected. Evaluation of key development aspect and trend estimation of energy supply chains in the Republic of Croatia was performed. To get better insight in SC trends of analysed sector the analysis is spread out with SWOT analysis.
KEYWORDS: energy supply chains, trends, SWOT, Croatia

INTRODUCTION

Supply chains in the energy sector are complex technological and economic structures functioning as infrastructure to other supply chains for goods and/or services. Functioning of other supply chains is not possible without them. For this reason supply chains in the energy sector are of special significance at business, sector, national, regional and global level. Development of the energy supply chain has strong impact on the nature as well as the quality, efficiency, technological base and competitiveness of all other supply chains.

The fact that SCM as complex term is not firmly and widely accepted in energy sector has its historical origin. Namely, the key activities in energy supply chain (exploitation of primary resources, production, transmission (transport), distribution and supply of final consumer) in Europe (as well as in most other countries) were performed by one or two state owned companies (in Croatia HEP and INA) and those companies as well as state for itself, has no any interest to divide their processes and make them visible [1].

After the claims of private sector to participate in energy SC processes the restructuration (demonopolization) of those systems begun. Those systems that start earlier with reconstruction, has recognised the need to introduce new terms like are SCM in newly established partners and relationships [2].

A typical supply chain in the energy sector begins with the so-called primary forms of energy, that is, naturally occurring forms of energy for which there are acceptable technological systems for their gathering, transformation into other forms, transmission, distribution, storing and use.

From the aspect of the initial primary resource, there are several supply chains [3]. For example, hydropower, wind energy, solar energy, nuclear energy, wave and tidal energy are converted into electrical energy and used for different purposes by end users (economic operators, public sector and households for heating, cooling, power of stationary engines, lighting).

Energy from fossil fuels (coal, oil, gas, oil shale and biomass) is mostly used in two typical supply chains: energy originating from coal mainly ends up in the supply chain of electrical energy through technological systems of thermal power plants. To a lesser extent it is used by end users in direct production of heat (industrial and personal consumption).

Oil (petroleum) is not directly used in production of energy. Physical processes are applied to decompose it into components (gases, petrol, diesel fuels, bitumen…) that are mostly used in supply chains ending in a type of internal combustion engine that is mostly used to power transport systems.

Smaller part of the so-called heavy derivatives that are unsuitable for internal combustion engines is usually converted (through heat processes) into electrical energy and/or immediate generation of heat that is distributed to end users.

In the current technological systems it is most economical to convert natural gas into heat energy through transformation system at the place of end

users. In special condition (price of NG, demands for electricity, available technology) natural gas is used also in thermal power plant.

A significant share of oil and gas is used in petrochemical (non-energetic) processes as raw material base for production of numerous chemical products (greases, petrochemicals, artificial fertilisers...)

Energy supply chains face several challenges, including:

- *A constantly growing demand for all forms of energy and a constantly growing price of energy,*
- *New technological solutions in exploitation of natural forms of energy, transformation, transmission, distribution and consumption of particular forms of energy,*
- *Strong pressure on efficiency in exploitation, transformation, transmission and consumption of energy*
- *Pressure by means of demands for preservation of the environment which is endangered in all phases of the energy supply chain, and introduction of new forms of trade - trade in unused pollution rights in the global environment,*
- *Globalisation of energy supply chains resulting in a complex architecture of supply chain networks that have to be efficiently managed,*
- *Energy supply chains are strongly regulated by means of state (political) influence, and deregulation (liberalisation) is carried out in the way that new participants appear in the supply chain (especially in distribution and supply systems),*
- *Internationalisation of the energy sector is becoming more widespread,*
- *New participants and new roles in the supply chain appear to carry out deregulation and demonopolisation of the energy market, control and envisage consumption and ensure investment cycles in the energy industry,*
- *Increased visibility of processes and distribution of risk in the supply chain among all participants*
- *The key problem of harmonizing supply and demand for particular forms of energy is of dynamic character, changing at daily, weekly and monthly level as well as seasonal level (depending on weather conditions). Penalisation due to discrepancies among production, distribution and consumption tends to be fair, forcing participants to carefully plan consumption and stimulate expansion of production and distribution capacities as well as to open the market to international competition.*

The aim of this paper is to estimate future directions of development of the energy sector as a complex chain of energy procurement by providing synthesis of trends in energy supply chains and trends in SCM.

GENERAL TRENDS OF BUSINESSS SYSTEMS IN THE FIELD OF SCM

Trends in the development of SCM systems were evaluated from different aspects, depending on the area they belong to, participants included, the period that the trend evaluation refers to and the significance given to particular aspects of SCM. Parallel analysis of trends in the development of energy supply chains was carried out in relation to the trends of SCM companies presented in the paper Global supply trends 2010 -2012 [4].

Although energy supply chains have specific qualities in terms of participants, their activities, products, processes and cycles, some key patterns of behaviour of SCM systems in other fields can be also recognised in the energy supply chains. These patterns were used for evaluation of trends in the development of energy supply chain systems in the Republic of Croatia.

The following trends were investigated:

- *Increased supply chain uncertainty and volatility,*
- *Globalisation of supplier and buyer networks,*
- *Market dynamics and configuration of regional and cost-optimised supply chains,*
- *Risk management in the entire supply chain,*
- *The level of integration of SC participants in energy SC.*

Directions of development of SCM in energy supply chains were evaluated based on selected trends. Behaviour of SC chains in the energy sector in the past will be investigated below as well as trends expected in a relatively close period of their future development.

TRENDS EVALUATION

A set of chosen trends should provide an insight into key aspects of future development of energy supply chains.

Increased supply chain uncertainty and volatility

This trend is increasingly present in the energy sector, as deregulation introduces a significantly larger number of participants on the supply side [5]. In this way market becomes more transparent and sensitivity to product prices leads to reduced loyalty of buyers. These phenomena resulted in new prognostic methods providing forecasts on daily, weekly, and monthly level as well as new market models and new supply models.

Mutual requests of producers, transmitters and distributers as well as all listed participants toward their end users have produced new generations of buyers (privileged buyers, tariff buyers; large buyers, medium-sized and small buyers) and new types of competitive relations and contractual relations in energy supply chains.

Whereas the focus of dominant strategies was on internal organisation until recently, dominant practice in the future generation of energy SCM will be focused on key suppliers and key buyers [6].

Although it is considered that price sensitivity of energy in general is low, the share of energy consumption in the total household consumption is on increase in terms of value, but in material sense it stagnates or is mildly growing, which indicates the fact that small consumers are sensitive to price of energy-generating products [7].

Globalisation of supplier and buyer networks

Energy market is highly internationalized due to the distribution of natural energy resources. Every state or even state association will tend to provide as much as possible energy from domestic resources and all

surplus sell on world energy market. On the other side, energy importing economies will try to make such agreements with exporters that guaranty supply continuity and reliability and adequate prices. This is why energy supply chain need highly developed supply chain network.

Energy supply chains are internationalised systems with the largest multinational companies on the production and transmission side as well as the distribution and supply side, mostly private or state-owned companies with huge concentration of capital and power.

These business systems were restructured following demand for deregulation of the energy market and their restructuring was carried out with the primary objective to manage the entire energy supply chain as efficiently as possible. New companies appear in the sphere of distribution and supply that do not necessarily need to have large capital. They also do not need to have physical infrastructure in which supply chains take place and they take over the role of a trader in the supply chain. This means that in a limited period of time (but also permanently) and on limited area they can buy and sell energy, utilising benefits occurring both on the supply and/or demand side. In addition, intermediaries appear in the supply chain, selling information or other types of services to real participants in the supply chain.

To maintain balance between supply and demand in circumstances of high energy dependence (like is the European energy market, but also on the markets of most of the developed countries in the world) and fluctuation on the global energy markets in the long run, participants in the supply chain must have high financial and negotiating strength.

Managing a supply chain in internationalised energy markets makes it possible for participants with greater market strength (those with more complex and longer chain) to achieve higher competitiveness on local national markets and to expand to other local national markets.

Development of energy structure (building of new capacities and stimulation of new, so-called privileged buyers) has been envisaged in the price of energy-generating products, which means that participants in a supply chain that is expanding will also build infrastructure and capitalise it through their own future activities and concessions.

Market dynamics and configuration of regional cost-optimised supply chains

Participants in energy supply chains in the European energy systems define mutual contractual relations whose aim is to provide a stable, reliable, foreseeable and manageable energy system that will also be acceptable in terms of development.

In the circumstances where national markets depend on energy import, supply chains need to be optimised in terms of minimising total costs of energy supply for the entire supply chain. Cost minimisation on the side of end consumers reflects in:

- Accepting demands for building energy efficient facilities in which there will be no drastic changes in demand if environmental conditions change,
- Introducing intelligent electrical installations (for example, EIB - European Installation Bus [8]) that will rationalize consumption in private, public and industrial facilities,
- Introducing automated systems for regulation of fuel consumption (natural gas),
- Using devices and appliances that consume less energy and/or use it more efficiently,
- Using optimal transport routes, means of transport, and vehicles with reduced fuel consumption,
- Selecting the most energy efficient industrial plants,
- Electronic devices are used in electrical energy distribution systems to compensate reactive power,
- Process automation - Automated business rules are used to define the set of critical business events and to propose problem solutions to the owner in real time [9].

Regulations pertaining to the above requests are partially in place (energy performance certificates for facilities, energy performance certificates for appliances and equipment, fuel consumption and stationary engines tests), thus stimulating savings or penalizing irrationalities in final consumption.

Rationalisation of transmission systems in terms of savings is based on introduction of electronic and control and regulatory systems whose main purpose is to adjust and reduce losses in transmission. New technological solutions are expected in application of new conductors and transmission of higher power at lower costs.

In production, i.e. transformation of primary forms, considered in the short-term period, savings will be lowest, as the technological structure of production plants is relatively unchangeable. New generations of nuclear and thermal power plants are focused on more efficient use of primary forms of energy, but there are strong requests regarding their safety and environmental impacts.

Through the process of the energy market deregulation, complex energy systems (national energy companies) were decomposed into separate operators in the field of production, transmission, distribution and supply. Supply chains established after deregulation may appear fragmented and under-optimised. However, their real integration and necessary optimisation has started with consistent energy policy at the EU level and by accepting the agreed directives [10].

Risk management in the entire supply chain

Supply chains in the energy sector are exposed to various risks. These risks arise from:

- Inability to predict weather conditions and their instability, with risks both on the side of consumption and production,
- Inability to predict political circumstances in the countries supplying primary forms of energy (natural gas, oil),
- Relations with neighbouring countries
- Decreased purchasing power of final consumers in the economic crises

- *Drastic increase in the price of primary energy sources and inability of domestic primary producers to obtain sufficient quantities of required primary forms of energy,*
- *Introduction of new financial burdens due to environmental requirements.*

The above risks, as it can be seen, can appear in different parts of a supply chain and the problem of managing these risks has to be divided among supply chain participants in a way that is as fair as possible. Special attention in risk management of supply chains is given to the following strategies, on which also SCM systems in the energy sector will be focused:

- *Efficient management of reserves. In the energy sector this means that at the national level the so-called mandatory reserves are maintained in an amount corresponding to three months of consumption,*
- *Profitability and cash flow management,*
- *Reduced pollution in all phases of the supply chain (reducing CO2 footprint),*
- *Optimised management of incoming and outgoing receipts (by introducing complex ERP and SCM computer systems, for example, SAP in energy, gas and oil sector in the Republic of Croatia, providing fast retrieving and processing, which resulted in strong financial discipline on the energy market),*
- *Improved quality, safety and reliability of products.*

The level of integration of SC participants in the energy SC

Energy supply chains are internationalised systems with the largest multinational companies on the production and transmission side as well as distribution and supply side that are private or state-owned companies with huge concentration of capital and power. Energy supply chains in the Republic of Croatia comprise the existing organizations that are organized according to energy legislation packages. The key piece of legislation is the Energy Act [11], whereas a particular energy market (electricity, gas, oil) is regulated by separate regulations, bylaws and conditions for energy supply. Market is functioning according to selected models. Models determine participants, their activities and relationships in the supply chain.

Following deregulation processes, integrated, complex, monopolistic and very often inefficient state-owned companies in the European energy space were transformed and some new companies were founded in the private sector that take over some of the possible roles in energy supply chains. In addition, also companies were founded whose primary function is monitoring and regulation of energy supply chains as well as providing direction for energy development (HROTE, HERA [12]). Although energy supply chains are relatively firm organisational and technological structures with clear roles in supply, participants in the energy market still do not create a fully integrated supply chain.

On the side of end users transition should be completed toward the so-called smart grids, which will provide two-way communication between consumers and suppliers as well as their more active and more complete participation in the energy market. Increasing share of alternative energy sources in the supply system may increase system variability. Therefore some of the following adjustments should be made:

- *Introduction of "Fast markets" (fast markets - contracting delivery during the day, for example, three hours in advance) along with good forecasts;*
- *Building of flexible power plants (hydro power plants, reversible hydro power plants, gas power plants) that can quickly regulate changes in the power);*
- *Storing energy at the level of both transmission and distribution networks (batteries, fly-wheels, fuel cells, super-condensers);*
- *Consumption management;*
- *Interconnections contributing to system and market expansion, thus decreasing variability at the level of (larger) system. In addition to interconnection lines, to achieve the desired effects it is necessary to define market rules to allow optimal utilisation of interconnection lines [13].*

SWOT ANALYSIS OF CROATIAN ENERGY SECTOR

Analyses in previous parts highlighted Croatian energy sector as complex supply chain. In addition we give simple SWOT analysis to make this economic sector clearer in the context of its future development.

Strengths:

- *Potential of oil and gas explored and those already in exploitation*
- *Existing energy infrastructure (pipelines, electricity distribution and transmission systems, heating systems)*
- *Experiences in investigation of new oil, gas and thermal sites*
- *Experiences in projecting and managing complex energy systems*
- *Excellent climate and geographic potential for renewable energy sources (solar, wind and geothermal)*

Weaknesses:

- *Relatively old technological infrastructure of energy plants (hydropower plants, heating plants and cogeneration plants)*
- *Shortcomings in infrastructure needed for takeover of electricity made in small photovoltaic and hydropower systems*
- *Not completed regulation in energy sector*
- *Insufficient number and technically equipped SME-s for high quality distribution and maintaining of energy (electricity)*
- *Inadequate information infrastructure*
- *Low level use of unconventional energy resources*
- *Discrepancies in energy prices for home and industrial users and still active state price regulation*
- *Shortcomings in own investment potential for new resources exploitation and increasing energy efficiency*

- *Higher energy intensity then EU27 average (energy intensity is relation between total energy consumption and GDP)*

Opportunities:

- *Excellent climate and geographic potential for renewable energy sources (solar, wind and geothermal)*
- *Preservation of ecological environment due to small consumption per capita*

Threats:

- *Dependency on foreign energy resources is going to increase*
- *Electricity is dominantly based on hydropower which depend on weather condition*
- *Insufficient refinery capacity and their technology obsolescence*
- *Entry of new producers and distributors on the energy market*
- *Dependency on political relations in the oil export countries*
- *Priorities and interests of foreign owners of Croatian companies*

CONCLUSIONS / FINAL CONSIDERATIONS

Despite specific qualities of energy supply chains in relation to other supply chains, in strategic considerations they follow trends of other supply chains, i.e. companies with focus on SCM to a great extent. Deregulation of the energy sector has made energy supply chains more visible in their structure, functions and mutual connections, irrationalities and monopolistic characteristics. Deregulation has produced disintegrations, accelerated technological progress in all phases of the supply chain. Market characteristics of European, i.e. particular national energy supply chains have resulted in demand for plenty of innovations and rationalities in energy supply chains. Necessity of efficient management has evoked the need for integrations and collaborations on new technological bases and with new short-term and long-term goals. A clearer distribution of roles and tasks among participants in the supply chain has made their monitoring, control and directing possible already now, and this will become more pronounced in the future.

Growing internationalisation and globalisation of energy markets has lead to creation of new integrations, with the goal of strengthening negotiation positions of energetically dependent national and private energy systems.

Finally, it can be concluded that investigated trends of energy SCM correspond to trends of SCM firms. This is why principles of SCM firms will be accepted in energy sector, but it is also to expect that some principles (especially automation) of energy SCM will be outspread in other SC-s.

To get better insight in SC trends of analysed sector the analysis is spread out with SWOT analysis. SWOT analysis has only limited analytical strength and need to be broaden with links and relations of present and future state of analysed system.

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IMPACT OF REMANENT MAGNETIZATION IN THE AREA OF DISTRIBUTION TRANSFORMERS DIAGNOSTIC BY SFRA METHOD

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ABSTRACT: The paper deals with the influence of core magnetization on its frequency response analysis. Remanent magnetization is a characteristic property of ferromagnetic materials. The core cans acquire different value of remanent magnetization in the process of diagnostic measurements. This fact is very important from the point of view of good representation of results from measurements. In the past, we made a couple of measurements on 3-phase dry transformer (3000VA). Nowadays, we had the possibility to measured 25MVA distribution transformer by SFRA method. This transformer has been connected in the network before the measurement and we have also results of measurements they were done one year before. That time the transformer was out of the operation for 9 months, so we have an anticipation to see some differences.
KEYWORDS: SFRA, remanent, magnetization, transformer, diagnostic, core

INTRODUCTION

The principle of SFRA (sweep frequency response analysis) is recording of responses to an input signal. Input signal has a sinusoidal shape and a variable frequency. For each frequency, measured winding of the transformer has its unique impedance. The impedance of transformer consists of the net of many resistances, capacitances and inductances. The distances between the parts of the transformer have also influence on particular capacitances. Therefore, we are able to identify mechanical changes in the transformer by using the SFRA. It is an advance method of transformer diagnostic without its removal. It is convenient to apply SRFA analysis of distribution transformer during routine measurements, when it is disconnected from a network. The transformer should also be submitted to SFRA after its manufacturing, transport, or after some fault situations.

It is common to entitle SFRA as an impedance measurement. Is possible to detect following defects of the transformer with SFRA:

- deformation of winding and its dislocation,
- interturn short-circuits, open winding,
- fault in a tap changer,
- core movement or its bad grounding [1, 2, 3,7].

In order to evaluate results from a SFRA test correctly, it is necessary to know about any possible influences to impedance measurements. From a theory of an electromagnetic field it is known that state of core magnetization level should has an influence on the inductance of windings. The best way to confirm this theory is to compare results from two impedance measurements, which were made under different conditions of core magnetization.

THEORY. Transformer core magnetization

The inductance of winding can be defined as:

$$L = \frac{\psi_m}{i} \tag{1}$$

where Ψ_m is a magnetic flux linkage and i is a current flowing through the winding. In the case of the transformer, Ψ_m depends on number of turns, geometry of winding and core permeability μ according to:

$$\psi_m = \frac{N \cdot i \cdot S \cdot \mu}{l} \tag{2}$$

The basic equations are:

$$\begin{aligned} \mu &= \mu_0 \cdot \mu_r \\ B &= \mu . H \\ \chi_m &= \mu_r - 1 \\ M &= x_m . H \end{aligned} \tag{3}$$

where μ_0 is the permittivity of a vacuum, μ_r is the relative permittivity, B is a magnetic flux density, H is a magnetic field intensity, M is a magnetization and χ_m represent a magnetic susceptibility. From above equations we can easily write a formula:

$$B = \mu_0 . (H + M) \tag{4}$$

This relation is valid for linear isotropic magnetic materials. In case of transformers, μ becomes a tensor due to the anisotropic nature of steel cores

and it is also frequency dependent. In ferromagnetic materials, magnetic susceptibility varies with the magnetic field, because of hysteresis of ferromagnetic materials.

It is clear from the Figure 1, that μ_r varies in dependence of the operating point position on the magnetization curve. Therefore, inductance also depends on the operating point position on the magnetization curve. (the value of μ_r close to the saturation is lower than value of μ_r at the remanent magnetization M_r). M_r is directly proportional to a remanent magnetic flux density B_r, and it modifies equation (4) as follows:

$$B = \mu_0 (H + M) + B_r \quad (5)$$

Magnetic flux linkage is hence greater in the case when the remanent flux density is present. It results in a higher inductance.

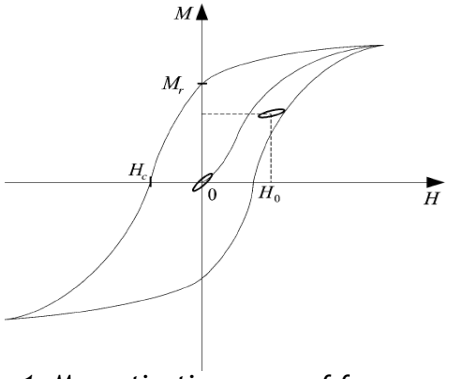

Figure 1. Magnetization curve of ferromagnetic material [5]

SFRA method uses an input voltage with small amplitude (up to 12 V) and it causes only small elliptical trajectory of M-H on the magnetization curve defined by magnetic field intensity H_0.

In the case when the magnetic field intensity is zero, inductance depends on the B_r and χ_{rev}. χ_{rev} is the reversible magnetic susceptibility and χ_a is the initial magnetic susceptibility. If the core is demagnetized, B_r is equal to zero, and $\chi_{rev} = \chi_a$, but if $B_r \neq 0$, $\chi_{rev} < \chi_a$. The relative inductance depends on the value of B_r and also on the value of χ_{rev} at a particular B_r value in comparison with the value of χ_a. [5, 8].

Magnetic viscosity

A magnetic viscosity is the time dependence of magnetization under the constant magnetic field. It is also called magnetic relaxation. The time dependent magnetization is described as:

$$M(t) = M_{irr}(t) + M_{rev}(t), \quad (6)$$

where $M_{irr}(t)$ is the irreversible component and $M_{rev}(t)$ is the reversible component of magnetization.

The magnetic viscosity occurs in magnetic material when the magnetic field intensity is suddenly increased or decreased or completely removed. A new steady state occurs after much longer time in comparison with eddy current effects. The magnetic viscosity can therefore be expected when a power transformer is suddenly switched off from the network.

Another possible case of the core magnetization is a diagnostic measurement with applied high voltage. It can be for example measuring of an insulation resistivity, or measuring of a dissipation factor [5, 7, 8].

PRACTICAL MEASUREMENT

In [6] we made a verification of a remanent magnetization phenomenon by the means of impedance measurements of 3 kVA-dry transformer in laboratory conditions.

In this paper we concentrate on a result from measurement of distribution oil transformer with its 25 MVA of power. It is a type of transformer on which the SFRA tests used to be exercised in a practice. The first SFRA test of this transformer was carried out in the year 2011. That time, transformer was out of operation for almost 9 months. Based on the theory of the previous chapter, a value of remanent magnetization was minimal.

In 2012 the transformer was again subjected to SFRA test. Now, transformer was out of operation only for 24 hours. According to theory connected with magnetic viscosity, the level of remanent magnetization has to be of higher value in the comparison with previous test. The card entry of transformer is in Tab. 1. The comparison of waveform from these two tests is in Figure 2 to Figure 7.

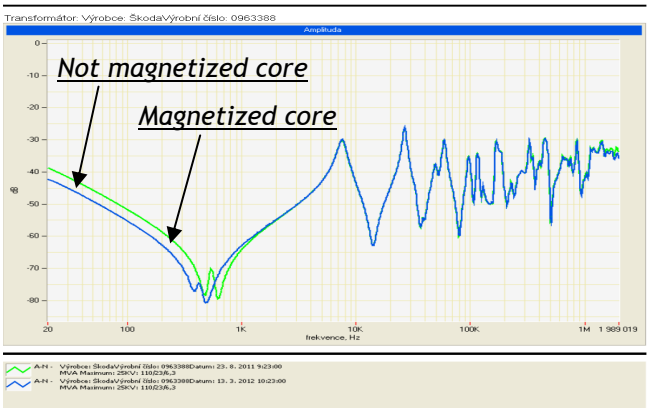

Figure 2. The comparison of phase A waveforms (open circuit test)

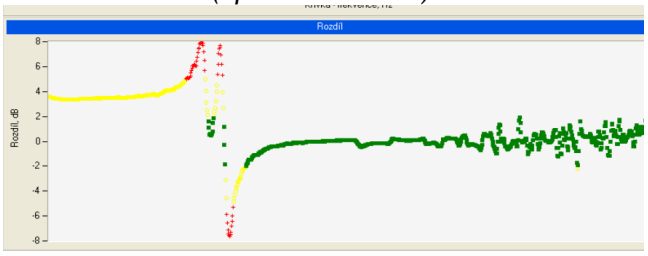

Figure 3. The cross correlation analysis of phase A waveforms (open circuit test)

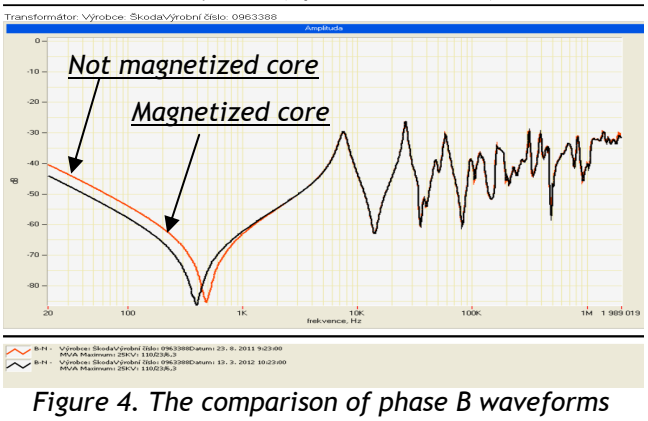

Figure 4. The comparison of phase B waveforms (open circuit test)

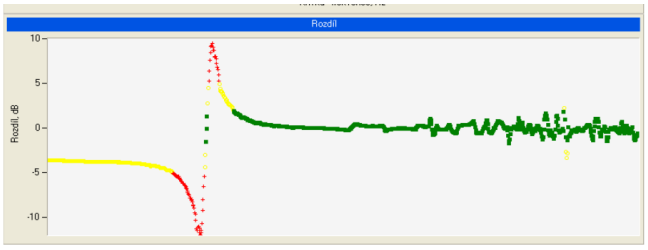

Figure 5. The cross correlation analysis of phase B waveforms (open circuit test)

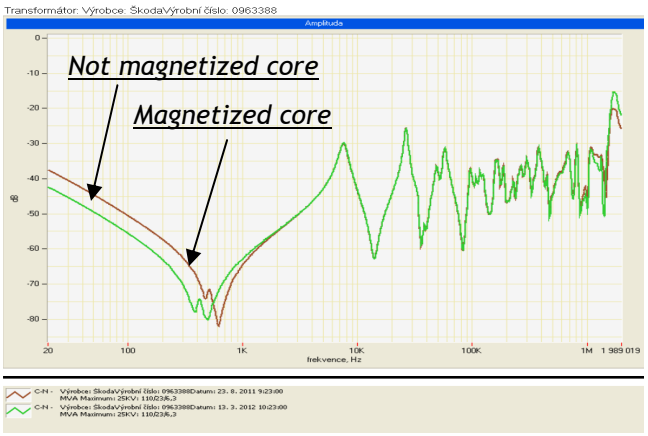

Figure 6. The comparison of phase C waveforms (open circuit test)

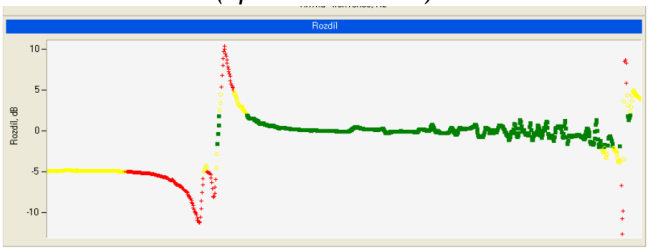

Figure 7. The cross correlation analysis of phase C waveforms (open circuit test)

We introduced only waveforms of primary phases in open circuit condition, because there is the major difference. It is known from the theory of SFRA tests, that core influence is sensible only at open circuit tests.

TABLE I. CARD ENTRY OF TRANSFORMER

Manufacturer	*Škoda, v.č. 0963388*
Year of manufacture	*1991*
Type	*8ERH 31M-0*
Connection	*YNyn0/d*
Frequency	*50 Hz*
Nominal voltage	*110/23/6,3 kV*
Nominal power	*25/25/8 MVA*
Position of tap switch	*14*
Temperature of transformer	*10 °C*

TABLE II. MEASURING METHODOLOGY

Open circuit tests		
Test n. 1	*Test n. 2*	*Test n. 3*
A-N	*B-N*	*C-N*

From Figure 2 to Figure 7 we can see that in waveforms for every primary winding, differences between two measurements are almost the same. In the case of three phase transformers, SFRA characteristics of phase A and C have to be the same and they have to be different from the phase B. This situation is caused by a geometrical alignment of a core and a winding. The cross correlation analysis shows a small difference between phases A and C. This should have many causations and it is probably very difficult to find it out. The important point is that there is a sensible difference between waveforms, which represent different states of the core magnetization. It is also known from the theory of SFRA, that core properties have an influence to SFRA characteristics only in low frequencies range (normally up to 1 kHz).

Figure 8. Measured transformer

CONCLUSIONS

The theoretical assumption about remanent magnetization is discussed in the introduction of this paper. The state of transformer core magnetization affects the comprehensive impedance of individual phases. This influence is sensible in a frequency range up to 1 kHz and only in the case of open circuit test. Our measurements confirm that the core magnetization depends on the time of the transformer disconnection from the network. This fact is caused by the phenomenon of magnetic viscosity.

The main aim of this paper was to advise of importance of correct SFRA test evaluation. In the case, if it this phenomenon is not considered, the shift between waveforms at low frequencies normally hints as core movement.

Acknowledgment

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INTEGRATED MEASUREMENT SYSTEM BASED ON THE IEEE-488 BUS

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ABSTRACT: The paper presents a description of the measurement systems in terms of their configuration and system components. The measurement system based on IEEE-488 interface is described and its advantages are pointed out. Examples of measurement applications are also given.
KEYWORDS: IEEE-488, GPIB, SCPI, VEE Pro environment, measurement system

INTRODUCTION

The work of modern measuring, manufacturing or other processes requiring reading of measurement data is based on the data provided by sensors located in the crucial - from the point of view of the process control and performance - places. Data obtaining, transmission and processing are accomplished within the measurement system which is defined as a set of devices, organizational means and information processing programs used to ensure correct performance of the production process. A characteristic feature of such a measurement system distinguishing it from the measurement setup is the presence of a system built-in device responsible for the information flow which is referred to as a controller. Usually it is a microprocessor controller or a computer.

Architecture and configuration of the measurement system affect the way of information flow and the system's further expandability. Three different types of the measurement system are distinguished - those of the bus, loop and star topology.

MEASUREMENT SYSTEM CONFIGURATIONS

Bus topology

In the bus topology (Figure 1) all the devices of the measurement system are linked to the common line of data transmission (data bus). None of the devices connected to it has a distinctive position and each of them can fulfill the function of the device reading measurement data as well as managing the system (controller) provided it has such an option. However, there is one restriction imposed, namely, that at the same time only one device fulfilling the managing function can be active. The aim of such a device is to control information transmission and reception between devices. It necessitates assigning unique addresses to all devices of the system and this is accomplished by giving permission for data transmission and reception, the so called transmission and reception addressing.

The advantage of the data bus system is its structural and functional flexibility in the field of the system's expansion and the ease of changing its configuration.

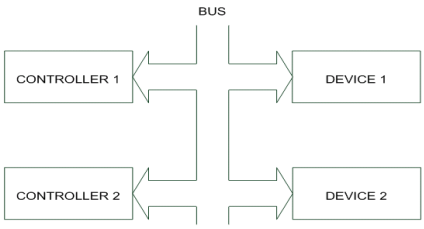

Figure 1. Data bus topology

Loop topology

A characteristic feature of the loop topology (Figure 2) is the uni-directional, set flow of information. In this system the controller has no special position and can be located at any place of the loop.

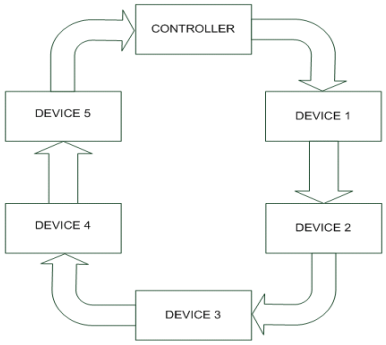

Figure 2. Loop topology

The transmission starts with sending information by the controller (controlling command or data) to the nearest device. If the information is not intended for this device it is immediately sent on until it reaches its destination. Such a transmission method requires addressing individual devices to transmit and receive. After the information has reached the targeted device (its destination), its content is analyzed and the command executed or, alternatively the data is received and then, sent further on in the unchanged

form. Sending the information on by a given device which it was to reach means that controlling commands have been executed or the data have been received. When the controller receives the information which was sent earlier it means that all the devices to which the information was sent confirmed its reception and it can send new information.

An advantage of the loop configuration is a small number of signal lines and its drawback is slow performance resulting from the fact that information has to flow through all the elements of the measurement system.

Star topology

In the „star" system (Figure 3) the controller has the central position and it is the only element communicating with other devices. Individual devices can communicate with each other only via the controller. Due to the difficulty in expanding such a system, it is used in simple measurement systems with a small number of devices.

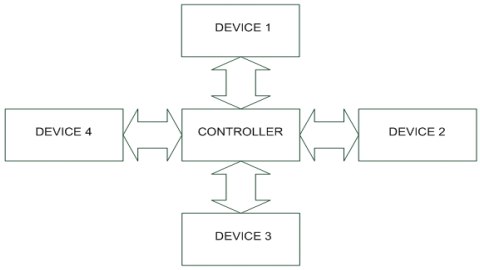

Figure 3. Star configuration

MEASUREMENT SYSTEM COMPONENTS

The structure and individual elements of the measurement system depend on its function. Nevertheless, the system always contains basic elements indispensable in the process of measuring the measured quantity. They are:

- *a device controlling the information flow in the system (controller) which is an appropriately programmed microprocessor or computer;*
- *a sensor converting the measured value into an electrical signal;*
- *an analog-to-digital converter converting the analog signal into its digital representation which can be interpreted by a digital device;*
- *an interface bus.*
- *Usually the measurement system also contains:*
- *signal conditioners - adjusting the input signal from the sensor to the form suiting the next element of the measurement system;*
- *model signal generators;*
- *devices visualizing measurement results (oscilloscope, computer monitor, printer, etc.);*
- *recorders.*

From the point of view of their functions, measurement system elements can be divided into:

- *the object of measurement whose parameters are read by the measurement system;*
- *measurement sensors processing the measured quantity into a signal which is readable for the measurement system;*
- *the controller, whose task is to coordinate the measurement process, in other words, to define/determine the conditions of the information flow, measurement time, the layout of devices, data acquisition, execution of the measurement data processing algorithms. It can be a microcontroller system with a written in program for controlling the measurement system or a computer with appropriate cards of the interface data bus connecting the measurement system devices and appropriate software;*
- *the block generating model signals and, less frequently, signals affecting the object of measurement and controlling its executive elements;*
- *the signal acquisition block collecting the measurement data;*
- *the data processing block executing set computation algorithms based on the measurement data;*
- *the block of communication with the user introducing information from the user into the system and taking the information out of the system.*

Division of the measurement system into functional units does not always overlap with their actual execution which, to a large extent, depends on the interface bus used and measuring devices. An example here can be provided by the modern measuring cards fulfilling the function of the data acquisition block and the block generating model signals. Moreover, the actual execution of the measurement system functional blocks can be carried out in the form of hardware or software. Currently both these methods are combined.

MEASUREMENT SYSTEM IN THE IEEE-488 INTERFACE

The pursuit of the ease of the measurement system configuration changes, its flexibility in the choice of the types of the quantity measured and expandability determines the measurement system chosen which the one of the data bus configuration is. The IEEE-488 is one of such types of interfaces.

The structure of the IEEE-488 interface known also as the GPIB (General Purpose Interface Bus) is based on the common data bus configuration to which all instruments are connected in a parallel manner (Figure1). Both interface messages (commands, addresses) and data from instruments are sent via this bus. Devices in this interface are divided into:

- *transmitters: sending messages and data to one or more receivers;*
- *receivers: receiving messages and data;*
- *controllers: monitoring connections and addressing the transmitter and the receiver with each other.*

Instruments can at the same time fulfill the roles of transmitters, receivers and controllers, e.g. a computer equipped with a GPIB interface card. At the moment, however, the device can fulfill only one of these functions.

Fifteen (15) devices including controllers can simultaneously be connected to the interface data bus. Each of them has the same access to the bus. The interface system is managed by the controller which organizes and manages the information flow (by sending addresses and commands). There can be

many controllers in the system but at a given moment only one controller can be active, the so called CIC (Controller-In-Charge). Controllers can pass control over the system to each other but always one of them must have the superior role in relation to others. Such a controller is known as the System Controller and is it's initiated as the active controller the moment the system is started. It identifies the device through individual 5-bit Device Addresses (DA) being the numbers from 0 to 30. These addresses are assigned to devices at the moment of the system setting up. This is accomplished by means of jumpers or switches on the device or by a program. The addressing method depends on the producer of a given device. Addressing is sending the TAD (Talk ADress) via the system bus received by the device as MTA (My Talk ADdress).

At a given moment of the system's work only one data transmitter can exist while there are many receivers. Activating the transmitter or receiver features is a result of appropriate addressing by the controller. In the case of the systems consisting of two devices where one is addressed as the transmitter and the other as the receiver direct communication between such devices is possible, for example, a multimeter configured to transmit and a printer configured to receive. In such a case the system does not need the controller.

The physical structure of the interface consists of 16 signal lines: 8 data lines, 3 handshake lines (NRFD, NDAC and DAV) and 5 control lines (ATN, EOI, IFC, REN and SQR).

Data transfer over the GPIB bus is an asynchronous operation with confirmation of the reception. The length of the cable between individual devices should not exceed 2 m, and the total length of all cables - 20 m. There is a possibility of extending the number of the devices used and making the length of cables longer with the help of the so called expander. The expander is a device which has two GPIB ports. You can connect 14 devices to each of them, including the controller which gives a possibility of connecting 28 instruments and extending the bus length to 40 m. Physically, the system consists then of two electrically separate networks that function as one logical network.

Easy configuration of the measurement system based on the IEEE-488 interface relies on clearly set standards of the interface hardware and software (in the form of the SCPI language) which is supported by the biggest companies manufacturing measurement equipment.

SYSTEM FOR MEASUREMENT OF DIFFERENT QUANTITIES

On the basis of the IEEE-488 bus the measurement system has been made which allows the measurement of: current, voltage, frequency, resistance and temperature and enables controlling of the arbitrary waveform function generator parameters (type of waveform function, frequency and amplitude) and programmable DC power supply (voltage and current).The system consists of:

- *a computer with the GPIB controller and software for creating applications;*
- *a multimeter - 2 pieces;*
- *programmable DC power supply;*
- *an arbitrary waveform function generator;*
- *a function generator;*
- *a programmable constant voltage source;*
- *a set of sensors.*

The measurement system software is based on applications written in the graphical programming environment of the VEE Pro software and on controllers of actual devices integrating this environment with the GPIB interface.

The VEE Pro is an object-oriented programming environment offering a possibility of developing an application controlling the measurement system, measurement acquisition, measurement data analysis, data processing and presenting as well as creating virtual tools supplementing or even replacing the object and measurement instruments.

The basic feature of the environment is representation of the program instruction in the form of the object's icon on whose input signals certain operations are performed. Instruction sequences are accomplished by connecting the object's output with the input of the following object. Graphically the program resembles a block diagram on which the directions of the information flow and control information are indicated.

The object may be a physical representation of the actual device functions (e.g. multimeter, function generator, etc.) together with their front panel and regulators/adjusters or typically program-related functions (e.g. if-then-else statement). One's own application can be provided with a graphical interface containing different types of ready-to-use indicators, regulators/adjusters and displays.

The VEE Pro built-in ActiveX mechanisms allow us to use external dynamic libraries and integrate the designed application with external software, such as Microsoft Excel, Word, etc.

Controllers dedicated to specific devices enable communication between them within the standards of the IEEE-488, VXI and RS-232 interfaces.

The VEE PRO packet is available for the systemic platforms of Windows, Linux, Unix and Sun.

EXAMPLES OF MEASUREMENT APPLICATIONS

The measurement of current, voltage, resistance and frequency was carried out with the use of the Picotest M3500A multimeter being in the IEEE-488 interface network. It enabled the measurement of such quantities as current, voltage, resistance and frequency. Figure 5 shows a sample solution of such an application with the use of the SCPI language and the VEE Pro environment.

Figure 5 shows the control panel of the remote control application for the Rigol DG DG2041A arbitrary waveform function generator. Application has an option of transmitting all its control commands to the device. To use it one must know the commands of the SCPI language. Commands are written from the command line field Read parameters or Set parameters depending on the type of the service command. In the Instruction field the manner of application service and an example of the command syntax are described.

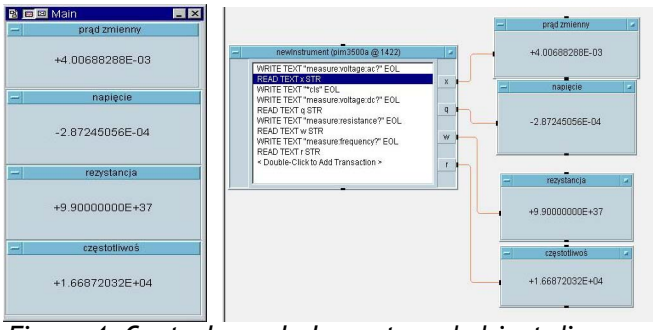

Figure 4. Control panel elements and object diagram of the application for measuring current, voltage, resistance and frequency (prąd zmienny - alternating current, napięcie - voltage, rezystancja - resistance, częstotliwość - frequency).

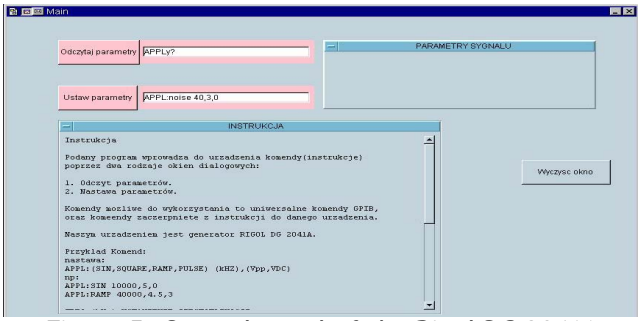

Figure 5. Control panel of the Rigol DG 2041A generator (instrukcja - instruction, parametry sygnału - signal parameters, wyczyść okno - clear, zapytanie o parametr - request parameter).

Figure 6 shows blocks of an object programming which the application is built of.

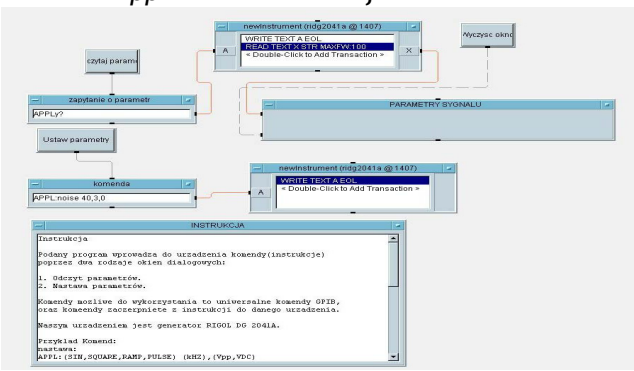

Figure 6. Control application for the Rigol DG 2041A generator

CONCLUSIONS

The unique contribution of the authors of this paper is an approach to measurement allowing the simultaneous measurement of several different quantities of the measuring system, or even its single device.

Typically, only one device is used to measure quantity even if it is a multimeter. The authors try to take advantage of measuring equipment to the "maximum". Figure 4 shows an example multimeter which measures four different quantities. In practice all terminals are connected to relevant units of measurement points and whether such a measurement is made depends only on the programming device by means of a computer. Measurements and device configuration is performed remotely. For easy handling of measurement the Agilent VeePro programme and IEEE-488 bus were used.

The above mentioned solutions make it possible to simultaneously applied to: 1) remote measurements, 2) using many capabilities of the device for the measurement of several different quantities in a single measurement, 3) using the IEEE-488 bus, and 4) controlling and perfoming measurement through the use of object-oriented programming of the VeePro Agilent environment.

The use of interfaces integrating numerous measuring devices for measurement purposes creates many possibilities of the measurement system architecture thanks to which measurements of various quantities are possible as well as controlling the devices in such a way that they can systematically interfere in the course of measurements. The standardised interface and programming language allow us to integrate the measurements of many devices in one application.

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NOVEL METHODS FOR PARAMETERS INVESTIGATION OF PM SYNCHRONOUS MOTORS

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ABSTRACT: The paper describes the unconventional methods for electrical parameters investigation of a Permanent Magnets Synchronous Motor (PMSM). Plenty of known methods have been using for the resistance and inductance measurement however the standard techniques do not support the estimation of inductances saturation curves. New approaches described in the paper offer a possibility to measure whole inductances characteristics which reflect to the behavior of electric parameters at different operational points of the motor. Based on the real measurement, the acquired parameters are compared and properly evaluated. Presented methods will be further processed and used for microcomputer implementation in order to determine the electric drive parameters.
KEYWORDS: synchronous motor, parameters, inductance, BH characteristic

INTRODUCTION

The information about motor parameter is very important for the machine designer however, is becoming important also for the operator of modern electrical drives. Electric drive represents a set of several systems such as electric motors, voltage source inverter, control unit and various types of sensors. The quality of motor control depends on the parameters of overall system but mainly on the parameters of controlled motor.

The PMSM motors are mostly controlled by employing the principles of Field Oriented Control (FOC) in a cascade control structure with relevant feedbacks. Despite the fact that the cascade control structure with PI controllers has the capability to eliminate various nonlinearities; there are still plenty of reasons why the topic of motor parameter determination is so hot.

For example the simulation purposes, implementation of various types of controllers or several motor control structures. However, there is also a special group of advanced motor control algorithms that are based on motor mathematical model and therefore the motor parameters are required as precise as possible.

Nowadays, there are various methods that can be used for the parameters evaluation [1, 2]. The parameters can also be measured by using of a proper device, for instance the RLC meter. This approach is sufficient for rough measurement and it is not recommended for very precise and complex measurement due to scale or range limitation, mid-level accuracy, low test current [3] and so on.

Very known and widely used methods for parameter investigation are methods based on principles of Ohm's law. The electric circuit of the motor is considered as a simple RL circuit that is excited by a voltage and current flowing through the winding is measured. In case of DC voltage excitation a standstill DC current is measured. Then the Ohm's law yields to a resistance of the motor. In case of AC voltage excitation the AC current's magnitude and phase response are measured. By utilizing Ohm's law it is possible to get an impedance of the motor and consequently the resistance and inductance. Such approach is also known as Standstill Frequency Response Test [1]. One of the most popular strategies for parameter estimation is a standstill DC step or DC decay test. These strategies can be used to determine both machine resistance and inductance, but they are mainly used for inductance calculation which is derived from the time electrical constant of the RL circuit.

Taking into account that PMSM motors are mostly operated at their operational point, the motor base parameters are supposed not to be changed and therefore the aforementioned techniques are enough precise for motor parameters determination. However there is lot of industrial applications where the motor runs out of ideal operational point and the parameter are then affected by a saturation phenomenon. Proposed approaches presented in the paper describe the way how to estimate the parameters in the wide operational region of the motor.

All described strategies have been verified on the real PMSM motor.

DQ Model in Stationary Reference Frame

The main objective of the paper is to describe unconventional methods to obtain dq model

parameters from physically measured data. Therefore, a two phase orthogonal dq model in synchronous reference frame has been used to analyze the synchronous reluctances of the machine. The mathematical model of PMSM motor is as follows:

$$\begin{bmatrix} u_d \\ u_q \end{bmatrix} = R_S \begin{bmatrix} i_d \\ i_q \end{bmatrix} + \begin{bmatrix} L_d & 0 \\ 0 & L_q \end{bmatrix} \frac{d}{dt} \begin{bmatrix} i_d \\ i_q \end{bmatrix} + + \omega_e \begin{bmatrix} 0 & -L_q \\ L_d & 0 \end{bmatrix} \begin{bmatrix} i_d \\ i_q \end{bmatrix} + \omega_e \psi_{PM} \begin{bmatrix} 0 \\ 1 \end{bmatrix} \quad (1)$$

where R_S is stator phase resistance, L_d, L_q are synchronous inductances in dq axes and ψ_{PM} represents a flux of permanent magnets.

All tests were executed at standstill or very slow rotary movement, therefore cross-coupling terms in both d- and q-axis as well as the back-EMF voltage component in q-axis are canceled and the PMSM model is linearized as follows:

$$\begin{bmatrix} u_d \\ u_q \end{bmatrix} = R_S \begin{bmatrix} i_d \\ i_q \end{bmatrix} + \begin{bmatrix} L_d & 0 \\ 0 & L_q \end{bmatrix} \frac{d}{dt} \begin{bmatrix} i_d & i_q \end{bmatrix} \quad (2)$$

From motor control perspective, the equation (2) describes the model of the plant for d and q current loop. Electrical torque in dq reference frame is developed by contribution of synchronous and reluctance torque, and is derived as follows:

$$T_e = \frac{3}{2} pp\left(\psi_{PM} i_q + \left(L_d - L_q\right) i_d i_q\right) \quad (3)$$

To establish a dq frame model of a given PM synchronous motor, there are four motor parameters that are to be determined. These are stator resistance R_S, inductances L_q and L_d, and PM flux linkage ψ_{PM}.

A. Connection scheme definition

Due to the mutual magnetic coupling between the three phases, for stationary tests with single-phase excitation, the inductance should be measured with all three phases excited as shown in Figure 1 [3]. In order to investigate the behavior of inductances in both d- and q-axis, the same scheme can be used, but the rotor has to be locked at two different positions. For d-axis measurement the rotor flux ψ_{PM} must be aligned with the resulting armature flux ψ_{ABC} and for q-axis measurement the angle between rotor flux and resulting armature flux must be 90 degrees, Figure 1.

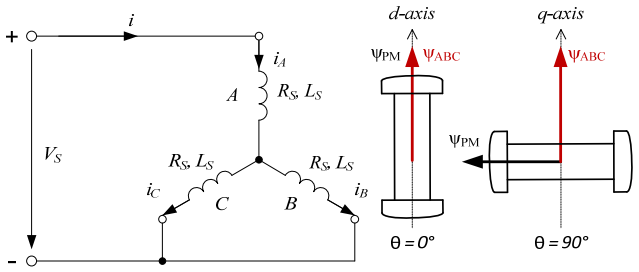


Figure 1. Connection scheme arrangement

B. D- and Q- axis rotor alignment

In order to locate the d- and q-axis in PMSM the easiest way is to apply DC voltage to the terminal of the motor. Using the connection shown in Figure 1, the rotor will follow the resulting armature flux ψ_{ABC} and consequently the rotor flux will align with it. Then the d-axis of the rotor is aligned with the center of stator phase A and acquired inductance of the circuit will be equivalent to L_d inductance [4].

Q-axis alignment requires a certain modification of the connection scheme according to Figure 2.

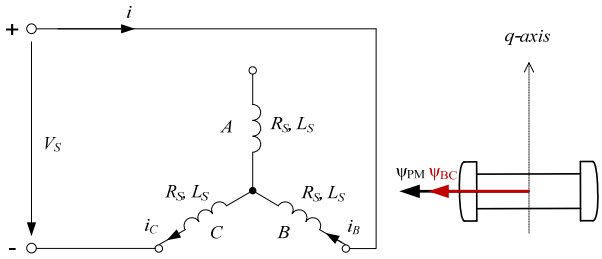


Figure 2. Connection scheme performing q-axis alignment

As it shown in Figure 2, the scheme considers only two motor phases energized and the phase A is disconnected. This approach causes generation of the armature flux ψ_{BC} that is 90 degrees shifted against the resulting armature flux ψ_{ABC} depicted in Figure 1. The rotor moves to the position of the armature flux ψ_{BC} and aligns with it. It means that the q-axis of the rotor is now aligned with the center of stator phase A and acquired inductance of the circuit will be equivalent to L_q inductance. Once the rotor is aligned, the shaft of the motor must be mechanically locked. Having the rotor aligned and properly locked, the connection for measurement purposes has to be changed to the one shown in Figure 1.

MOTOR PARAMETER CHARACTERISTICS

A. Stator resistance R_S

Generally, parameter R_S defines a phase resistance measured between line-to-neutral points. In the most common PMSMs, the midpoint of Y-connected winding is not accessible and therefore line-to-line resistance has to be measured. The measurement can be provided either according to the scheme in Figure 1 or scheme in Figure 2. In first case, the phase resistance will be two-thirds of measured line-to-line resistance, in second case the phase resistance will be half of measured line-to-line resistance.

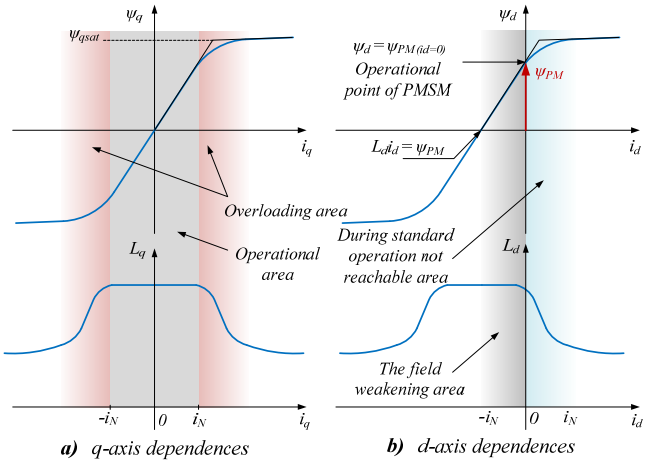
During measurement an attention has to be paid because winding resistance value is highly temperature-dependent.

B. Synchronous inductances L_d and L_q

Synchronous inductances measurement assumes the connection scheme shown in Figure 1. As it has been mentioned, the stator winding is Y connected without any neutral line for external access and the only line-to-line value can be measured. When the rotor's d-axis/q-axis are aligned with the stator phase A, the synchronous inductance L_d and L_q can be derived from equivalent line-to-line inductance $L_{L\text{-}L}$ as two-thirds of $L_{L\text{-}L}$, depending on the rotor angle θ. This assumption can be accepted only in case of simplification, where the mutual inductances are not taken into account.

Since inductance in the motor is also subject of saturation phenomena, the way to correctly monitor the inductances is to measure them at various current levels. The nonlinearity $\psi=f(i)$, $L=f(i)$ are caused by the saturation of iron parts of the stator

and has the same shape as magnetizing curve B=f(H). This dependency is described in Figure 3, where the relations ψ=f(i), L=f(i) in both axes are presented.



a) q-axis dependences b) d-axis dependences

Figure 3. The effect of saturation, ψ_{dq} and L_{dq} as a function of i_{dq}

To analyze the effect of saturation in q-axis, Figure 3a, the rotor q-axis has to be aligned with the stator phase A. If the motor is assumed to be under vector control, with no field weakening i_d=0, the increasing load will result in increased stator current in q-axis. When there is no load applied to the rotor, i_q=0, the linkage flux ψ_q =0. Increasing load results in an increase of i_q and ψ_q, and will cause saturation of the stator teeth around q-axis, which in turn decrease L_q.

To analyze the effect of saturation in d-axis, Figure 3b, the rotor d-axis has to be aligned with the stator phase A. To make the analysis easier, the effect of demagnetization or magnetization is studied without influence of the armature reaction, i_q is kept at zero. All the flux existing in the machine is created purely by the permanent magnets and therefore the area around d-axis is mildly saturated even if there is no current flowing through the stator winding.

In case that the stator current (i_d) increases and the direction of magnetic flux generated by the current is the same as the flux of permanent magnets, a magnetizing effect will occur. In this situation, the area of stator around d-axis will be even more saturated with increasing current, further lowering L_d. This operation area is not common for standard control techniques of PMSM.

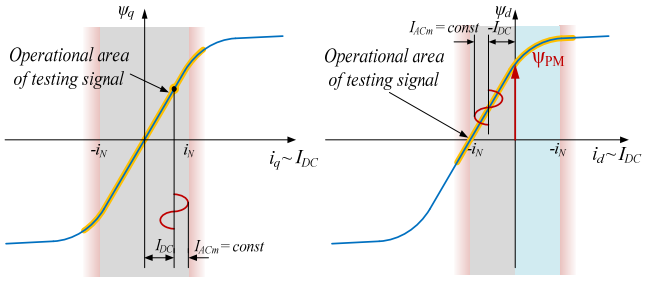
If the stator current (-i_d) increases and the direction of magnetic flux generated by the current is in opposite to the flux generated by permanent magnets, a demagnetizing effect will occur. Increasing the amplitude of the stator current will pull the area of stator around d- axis out of saturation. This phenomenon results in increase of stator d-axis inductance L_d. This is an important conclusion, since it will affect the design of the field weakening control loop, which is commonly used in controlling of PM synchronous motors [5].

To measure the inductances as precise as possible and to have a capability to cover also saturation region, several methods can be used. The rough division of suitable methods depends on the type of voltage exciting signal and subsequently on the signal processing. There are three different approaches presented in this paper.

MOTOR PARAMETER MEASUREMENT

A. Superposition of DC and AC excitation signal

The method utilizes compounded DC and AC voltages as an excitation signal. The major signal is DC voltage that will be adjustable during the test. The magnitude and the frequency of AC signal are set by a voltage source and will be fixed during the test. Such excitation signal is connected to the terminal of the motor according to the scheme in Figure 1. The idea of proposed approach is clearly visible in Figure 4.



a) q-axis dependences b) d-axis dependences

Figure 4. Impact of compounded excitation signal on the operational point on the BH curve

DC current I_{DC} has been changing in order to reach saturation area in both d- and q- axes. The DC voltage has been set such way, that the response of the current changed in a range I_{DC} = (-1,2I_N ÷ 1,2I_N). It has been expected that 20 percent higher current than its nominal value would allow reaching the saturation region during q-axis test, Figure 4a, and lowering L_q inductance will be seen. The same current range has been applied to the motor during d-axis alignment in order to see the whole knee of BH characteristic, caused by the saturation due to the flux of permanent magnets.

As seen in Figure 5, the excitation signal consists of DC value V_{DC} and AC value at certain frequency and magnitude V_{ACm}. The current response also contains two components, the first one is DC value I_{DC} and the second one is an alternating signal I_{ACm}. The DC current signal affects the operating point on magnetizing characteristic and moves it up and down as it is shown in Figure 4. By changing the position of operating point on BH characteristic the amount of saturation changes too.

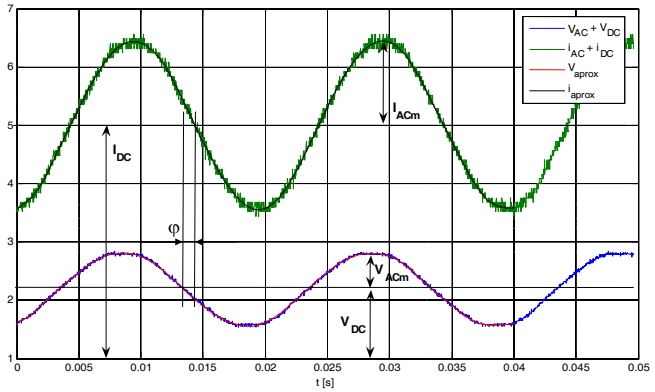


Figure 5. Excitation voltage and the current response

The DC values of voltage and current can be used for the resistance measurement.

$$R_S = \frac{2}{3} R_{L-L} = \frac{2}{3} \frac{V_{DC}}{I_{DC}} \qquad (4)$$

The peak values of the voltage AC component and current AC component and the phase shift between them is used for inductance calculation as follows:

$$L_{d(\theta=0)} = L_{q(\theta=90)} = \frac{2}{3}\frac{1}{2\pi f} R_S tg(\varphi) \qquad (5)$$

$$L_{d(\theta=0)} = L_{q(\theta=90)} = \frac{2}{3}\frac{1}{2\pi f}\frac{V_{ACm}}{I_{ACm}} \sin(\varphi) \qquad (6)$$

Equations (5) and (6) offer two possibilities to calculate the line-to-neutral inductances. The important information for both calculations is the phase shift φ. In order to extract this value from the waveforms shown in Figure 5 a proper modulation technique has to be used.

B. Instantaneous Flux Linkage

This method utilizes only AC voltage as an excitation signal for measuring the inductance saturation curves. The same test arrangement as shown in Figure 1 is used. Due to the fact that rotor is mechanically locked the voltage equations (2) is taken into account and used for linkage flux calculation. By applying mathematical rules to (2), a new set of equations can be derived:

$$\psi_d = L_d i_d = \int (U_d - R_S i_d) dt \qquad (7)$$

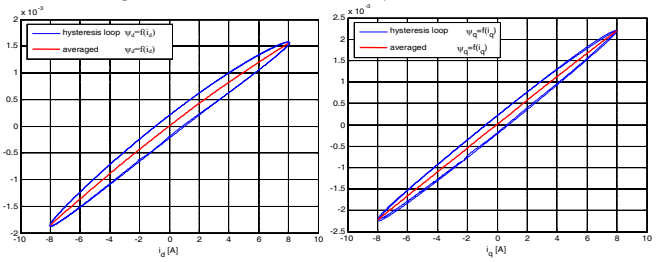
$$\psi_q = L_q i_q = \int (U_q - R_S i_q) dt \qquad (8)$$

Estimated linkage fluxes are shown in Figure 6. Then the inductances are calculated as follows:

$$L_d = \frac{\psi_{d\_avg}}{i_d} \qquad (9)$$

$$L_q = \frac{\psi_{q\_avg}}{i_q} \qquad (10)$$

The current and voltage waveforms were measured by an oscilloscope and processed in Matlab. In order to increase the accuracy of calculation, several periods of current/voltage waveforms were stored and averaged values were used for calculation.



a) b)

Figure 6. Flux linkage a) $\psi_d=f(i_d)$ and b) $\psi_q=f(i_q)$ determined by measurement

Averaged linkage flux values ψ_{d_avg}, ψ_{q_avg} from Figure 6 are then used for L_d and L_q determination based on (9, 10).

C. Partial current step changes - decay test

A method known as DC decay test has also been used for inductances investigation. The saturation curves can be acquired from several partial measurements at different level of saturation. The current difference during each measurement causes a transient that is characteristic by the time electrical constant. The test setup has been arranged according to Figure 7.

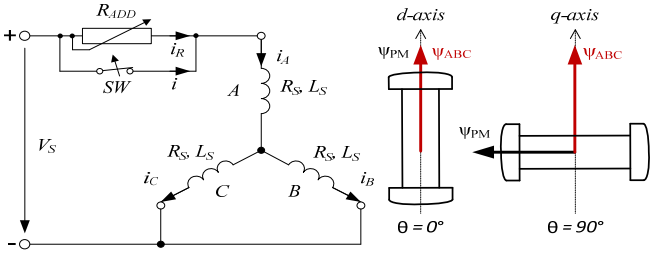


Figure 7. DC decay test connection scheme

The default state of the circuit shown in Figure 7 assumes the switch SW in the ON state and the current i flows through the winding. By switching off the switch SW, new current i_R will flow through the circuit. An additional adjustable resistance R_{ADD} allows setting the current i_R according to the required current step change Δi as it is described in Figure 8.

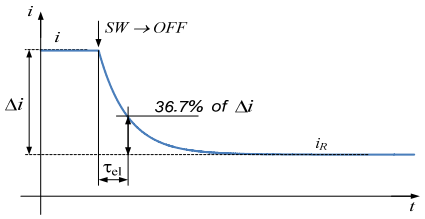
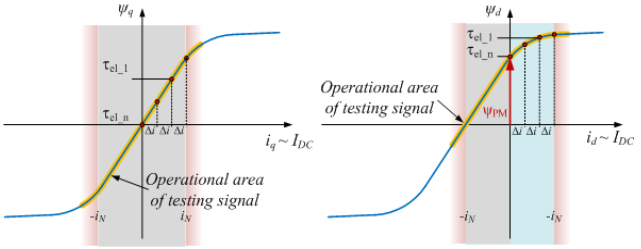


Figure 8. The current transient during DC decay test

The principles and effect of a partial current excitation is graphically described in Figure 9.



a) q-axis dependences b) d-axis dependences

Figure 9. Different levels of inductance saturation curves excited by DC current step change

It can be observed from Figure 9, that the particular regions of saturation curves relate to the particular time electrical constants due to changed inductance. This phenomenon is valid for both axes and can be used for synchronous inductances calculation. The current transient has to be plotted by the oscilloscope and by using cursors the time electric constant has be found for every step change. The data would be triggered on switch SW change from ON to OFF state.

Then the synchronous inductances depend on the rotor position and can be calculated according to an expression:

$$L_{d(\theta=0)} = L_{q(\theta=90)} = \frac{2}{3}\tau_{el}(R_{ADD} + R_{L-L}) \qquad (11)$$

EXPERIMENTAL RESULTS

The chapter offers the experimental results determined during the measurement on a real PMSM. The parameters of the PMSM given by manufacturer are shown in Table 1.

TABLE 1. MANUFACTURER PARAMETERS OF USED PMSM

TGT2 - 0032 - 30 - 24		TG Drives	
U_N	18V	2p	6
I_N	5,2A	Ke	3,6 V/1000rpm
M_N	0,3 Nm	R_{2ph}	0,594
n_N	3000 rpm	L_{2ph}	0,44mH

A. Compounded excitation signal

Equations (5, 6) were used for inductances and saturation curves estimation in d- and q-axis, Figure 10, 11.

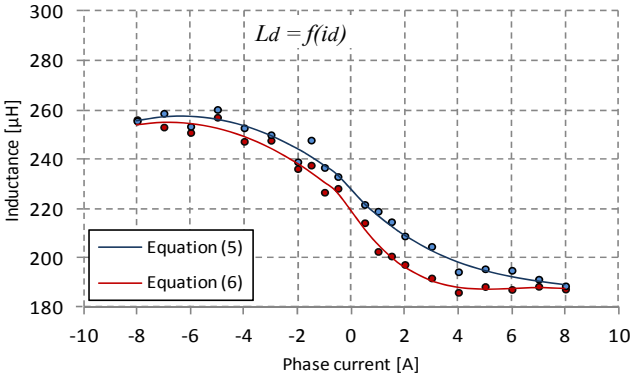


Figure 10. Measured d-axis saturation curves

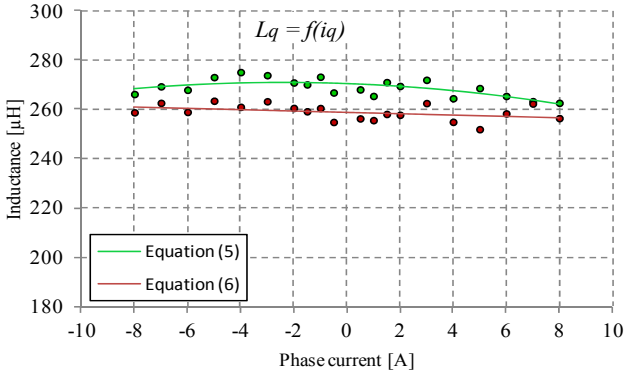


Figure 11. Measured q-axis saturation curves

The results plotted in Figure 10 and 11 are slightly deferent in depends on the approach (5) or (6) of final estimation. The reason of these differences is most likely caused by incorrect calculation, because approach with (5) utilized the same R_S value for whole current range calculation. On the contrary, the approach with (6) utilized instantaneous values of V_{ACm} and I_{ACm} for every current step. So the calculation with (6) can be considered as more correct and also the shape of saturation curve is nearer to the theoretical assumption shown in Figure 3.

B. Instantaneous Flux Linkage

The fluxes ψ_d, ψ_q estimated by (7, 8) are shown in Figure 6. A simple mathematical rule must be used to get averaged values ψ_{d_avg}, ψ_{q_avg}. Then the saturation curves, depicted in Figure 12 for d-axis and in Figure 13 for q-axis, are calculated by applying (9, 10).

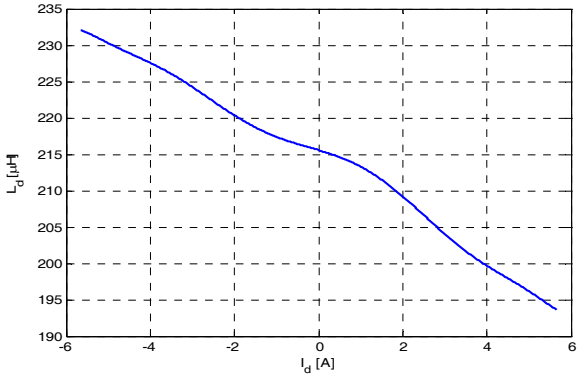


Figure 12. Measured d-axis saturation curve

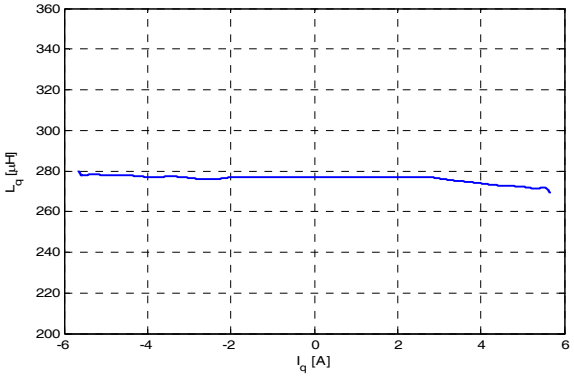


Figure 13. Measured q-axis saturation curve

The method is sensitive for correctly estimated fluxes. An issue can arise during the calculation, by using (7),(8), because of a DC offset that can appear in the current or voltage waveforms. This can be a reason why the saturation curves are slightly misaligned in comparison with the other methods.

C. Partial current step changes- decay test

For testing purpose, a current range from -7 up to 7Amps has been chosen with current step change Δi =1A. The resulting saturation curves for d- and q-axis can be seen in Figure 14.

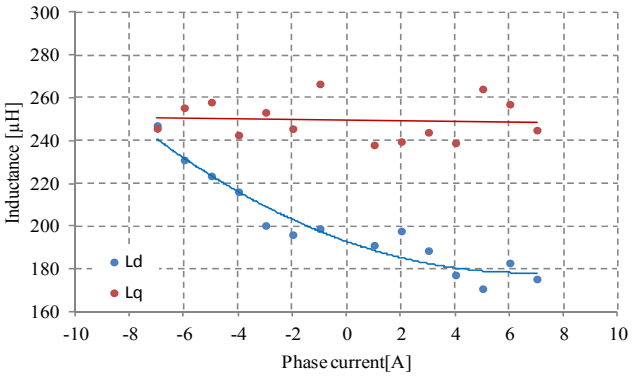


Figure 14. Measured d-and q-axis saturation curves

The shape of the curves has an expected behavior. The temperature of the winding plays significant role during the test, where the value of resistance can be changed. This can have a negative impact to the results, as it can be seen in Figure 14, where a certain misalignment can be observed in comparison with inductance curves depicted in Figure 13 and Figure 14.

CONCLUSIONS

The aim was to propose and verify the methods for PMSM motor parameters investigation that can be later used for microprocessor implementation. Three different approaches for inductance saturation curves measurement are presented in the paper. Comparing the results it can be seen, that the inductance curves taken from all methods are roughly similar. The small differences are caused by signal measurement and processing.

The method utilizing compounded AC/DC signals offers a possibility to estimate the resistance as well as both inductances in dq coordinates. A huge advantage of this approach is a variability that allows measuring and verifying the motor parameters and their behavior within a wide operational range of the motor. On the contrary, requirement of flexible AC-DC source and consequently complicated

demodulation method for phase shit estimation can be considered as a certain drawback.
Instantaneous flux method requires a very precise flux estimator. An issue can arise during the flux estimation process caused by integration. The acquired waveforms of motor quantities like current and voltage are affected by a small DC signal that is introduced by a measuring process (offset of ADC channels). Then the integrated offset generates the varying offset in the time which makes drift of the resulting fluxes. To avoid any drift in flux waveforms, the input signals of the estimator have to be pure sinusoidal waveforms without any DC offset. Due to this fact this method is quite laborious.
The last method, shown in the paper, is a simple current step change – decay test. The success and the final precision of this method is linked with the time electric constant. The more accurate the time constant is deducted from the acquired exponential waveform the more accurate parameters are reached. The modification of origin decay test to the partial step current changes allows investigation of the motor parameters in the wide operational range.
The PMSM motor has been chosen because of its popularity in servo-driven application. Respecting the trend that only few applications require neutral point to be accessible; the standard Y-connected PMSM motor without any access to the neutral point has been chosen and used during all tests. In such case, the only line-to-line inductances are measured and then converted to the phase inductance value according to the winding connection during the test. Such approach is enough precise for resistance measurement, but certain differences can be expected in inductances behavior, because the mutual inductances are not taken into account.
The same PMSM motor is planning to be used for further work. The proposed solutions for parameters estimation will be implemented into the microcontroller and used for parameters estimation of overall electric drive. The aim is to verify the influence of the voltage inverter to the system parameters and consequently to the quality of motor control.

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PRODUCTION LOGISTICS FOR MIXED-MODEL LINES: EMBEDDING MASS CUSTOMIZATION INTO DEMAND FLOW MANUFACTURING

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ABSTRACT: Production logistics include many aspects of materials management in a production process. Production process in Mass Customization Industries deals with mixed-model production lines, including assembly and fabrication lines. Great amount of various materials need to be organized by abiding economies of scope. Flow manufacturing is used in demand driven supply chain networks and Mass Customization seeks answers to such models. This paper represents effective material handling methods, such as Kanban Systems. Especially, eleven rules for Flow Mixed-model Manufacturing Implementation are described and analyzed on first sight. Appropriate production methods, algorithms and tools are described for Mass Customization Implementation. Designing, estimating, regulating, sequencing and sheculing problems are addressed from Mass Customization point of view. Approaches for solving these problems are also proposed.
KEYWORDS: Mass Customization, Demand Flow Manufacturing, Mixed-model lines, Production logistics

INTRODUCTION

A mixed-model line provides production flexibility by producing several end products during a shift. Several products bring on productivity fluctuations and the solution is to level the production loading. Load Leveling does not use large batches of one product, rather than several products following customer's demand. This necessitates demand-driven production system. If such a system could quickly adjust to the demand differentiation by an economical way, Mass Customization could be achieved. Machines and operators should decrease the setup times less than a single-digit minute in order to achieve Load Leveling in production scheduling. Small setup times signify an efficient production system that manufactures different products in one shift. Every workstation has its own setup times and they usually differ to each other. This craves for a flexible scheduling by conducting production factors such as setup times, cycle times, Takt time, resources reallocation, production planning and different logistic sequences with accurate capacity [1]. This work investigates subjects around production logistics that could help into Mass Customization implementation.

We introduce 11 steps that should be completed in order to achieve Mass Customization for Production:

1. Capture demand fluctuations and transform them into load-leveling production.
2. Define Key Value customizable Attributes and check production cost proliferation.
3. Define common components according with the economies of scope and subject the rest under special conditions.
4. Squeeze setup times into single-digit minutes and eliminate non-value adding time.
5. Induct JIT methods and consolidate the exact size of containers (Kanban System) for semi-finished components.
6. Reduce inventory levels of semi-finished products or components (Work-In-Process) and find suitable decoupling points (one decoupling point is more efficient).
7. Build a First In - First Out Supermarket in the decoupling point and flush costs backwards.
8. Reengineer the production scheduling and solve the makespan problem for mixed-model flow line.
9. Connect production sequence with replenishment sequence of materials.
10. Connect production sequence with supply chain sequence.
11. Provide exactly the right amount of end products, at the right time, every day.

SET OF PROBLEMS

This is not the perfection of Mass Customization, because perfection conceptually implies one of a kind product for every Takt time. To give an example, if the demand rate is very high, Takt time will be just a few minutes. The production flow line should be able to manufacture and/or assemble one of a kind product in every few minutes. The manufacturing

technology that is spread around was based on Mass Production System. Economies of scale are implemented on every workstation, but what about the whole production system and the asynchronous workstations? When productivity in each workstation is high, productivity of the whole production line does not considered to be also high. Economies of scale in asynchronous workstations cannot pay back. How can you build and deliver different products to many customers in such a system?

Kanban Systems are used in Just in Time (JIT), namely that production rate should follow the demand rate. The market expresses the required quantities of a specific daily product mix in decoupling points and production lines. Models that use algorithms in order to formulate the quantities of the Kanban containers, from optimization point of view, assist mostly on theoretical and experimental issues [2].

A logic model was developed in order to link all the production parameters that affect Kanban quantities and sequencing issues of production logistics systems [3]. Constraints of the model express stock-out situations in decoupling points which are used to outcome a daily production sequence of different products. Simulation test examine this model, concerning four parameters that influence the final results, which are Kanban quantities, number of Kanban containers, process time and setup times.

Supply chain systems can easily be expressed by mathematical models. The concept of the mixed-model production batch is analyzed by mathematical optimization procedures. A mixed-integer nonlinear programming (MINLP) problem is set on a supply chain including many assembly plants. Small size MINLP problems are optimally solved by branch and bound (B&B) methods. Moreover, heuristics are developed to decompose real life large size MINLP problems into several small problems. Logistics scheduling and production control issues are solved by Kanban systems [4]. The same problem exists in production logistics, translating assembly plants into production lines or unbalanced workstations of a production line. The accuracy to the real life is the main objective. What if the business policy looks for mixed-model flow manufacturing and not for batch manufacturing?

"Mixed model" production lines are often used in manufacturing systems based on just-in-time techniques (i.e. Kanban and sequenced Kanban Cards [5-14]. In these production lines, different product types are manufactured simultaneously by processing very small batches and sometimes batches are transformed into one single piece.

MASS CUSTOMIZATION IN PRODUCTION LOGISTICS

Capture demand fluctuations and transform them into load-leveling production

Every industry has its own production rate. This rate depends on market characteristics and a business strategy that industry follows. In such a way, the rate is theoretical. The rate could change from time to time due to unexpected reasons. Production defaults, maintenance absence, abnormal planning - scheduling, forecasting failure, unskilled workers, mixed up logistics, unstable tax system and many other factors. The real-life production is full of fluctuations. Daily declinations on stable productivity targets may exist.

Technical and human nature reasons can be overcome because they are inner-industry problems. On the contrary, outer problems call for solutions which push the exogenous factors to change its business culture. The opposite approach constitutes to adopt and bring the outer environment into the production line, namely inside the shop floor. The fluctuations should be leveled and smoothness on production rate could be established, see below Figure 1.

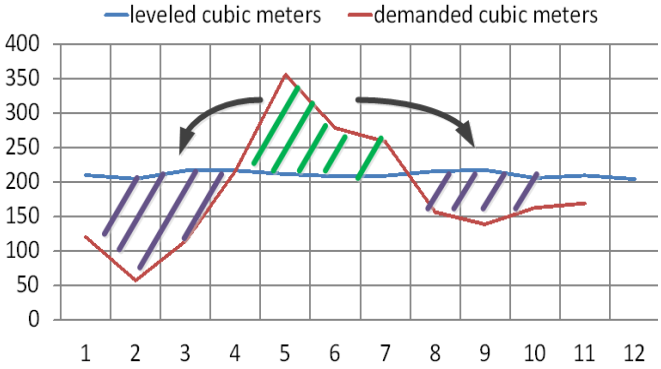

Figure 1. Production leveling

Let's assume that the red line is a normal demand curve and the blue line is a leveled production rate. It is mandatory to level the sales and pursue smoothness for completing orders. The success of this procedure depends on special attributes of each market. If customers are willing to purchase products by a leveled rate, production could be leveled as well. The target is also to redraw the red line as the blue one, namely to level the sales as good as the production rate. By a glimpse, the green sketched area should be moved into the blue sketched area, respectively.

Define Key Value customizable Attributes (KVAs) and check production cost proliferation

The attributes of a customized product are critical for the whole value stream. In which degree is the customer involved in product design and production process is determined by how many attributes and how much are they customized [15]. By defining the number of customized attributes, can be specified the number of decoupling points (one or more) in production stream. Decoupling points declare the production operations in which customers are involved and advanced directions need to be given.

These KVAs define also the competencies that are required in order to achieve Mass Customization [16]. Moreover, KVAs are distinguished into five types, concerning dimensional fitting, product's functions, aesthetics, materials' quality and packaging. Customers choose among many options for each KVA. These options are also correlated to each other. Every option may influence the others indirectly.

The economic point of view asks for economies of scope and two main concepts are assigned:

a) The matching of functional requirements to demanded specific attributes for every customer.
b) The sequence of attributes according to importance.

When the number of attributes increases, cost proliferates. As the number and the range of attributes increases, the returns decrease. It is suggested Pareto-type analysis to stall the law of diminishing returns [17].

Define common components according to economies of scope and subject the rest under special conditions

Commonality in components derives from feature standardization. Feature standardization refers to standard geometric design that is created by standard machine tools. Machine tools create geometrical characteristics in a specific range of variability. Machine tools must be standard in order to create standard part features. Standard part features create common parts or parts with low diversification to each other. Many factors are correlated to each other for commonality issues.

The commonality reduces material handling cost, enhances product quality, lower setup times, gives flexibility in manufacturing and higher responsiveness to customers. The variety of end products should be produced by common parts and standard processes in order to achieve cost effectiveness [18].

A design approach for Mass Customization (DFMC) was proposed and a Mass Customization oriented Product Family Architecture (PFA) is needed to be built for every industry in order to achieve cost effectiveness [19]. This formulation deals with commonality or reusability clustering methods in product design or process selection from product family perspectives.

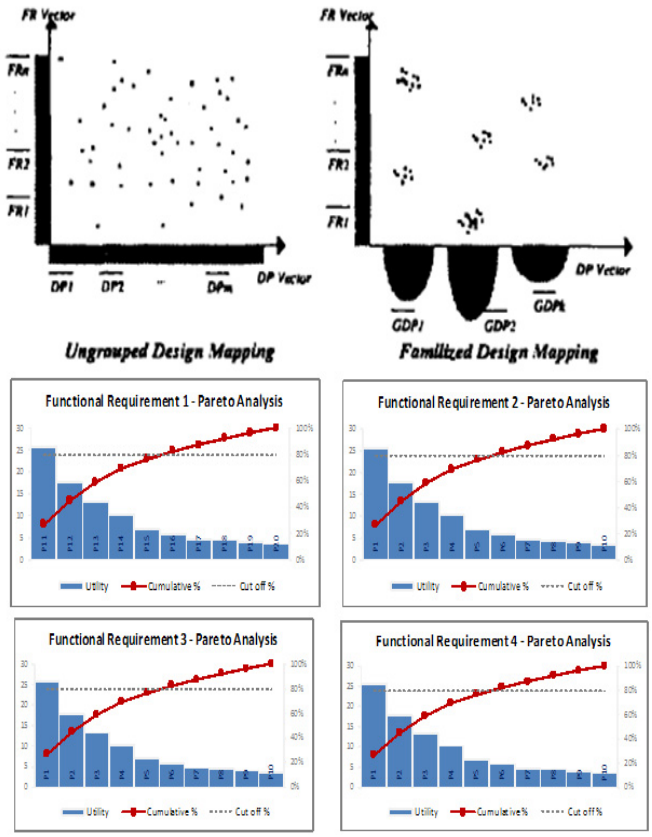

Figure 2. Hybrid strategy for parts commonality (clustering product spectrum and Pareto-type analysis for every Functional Requirement)

This rule refers to designing phase of customized products and highlights the critical point of common parts. The higher commonality degree does exist, the greatest cost effectiveness is achieved. To reduce the parts dispersity in a known market, Pareto-type analysis for design parameters is proposed. For future and unknown situations, approaches such as clustering design parameters are efficient. A hybrid strategy of clustering design parameters and a feedback control or assessment tool for design parameters on each functional requirement is also proposed, see below Figure 2.

Squeeze setup times into single-digit minutes and eliminate non-value adding time

Single Minute Exchange of Die (SMED) is a known method in manufacturing that radically decreases set up times, they should be no more than 10 minutes [20]. In Mixed-Model Production Lines, set up procedures occur many times during a shift, such as die casting or manufacturing systems reprogramming. This creates long downtime and therefore production rate decreases, see below Figure 2. For example, production process stops four times during a shift in order to build four different products. During a setup procedure, production loses potential quantities.

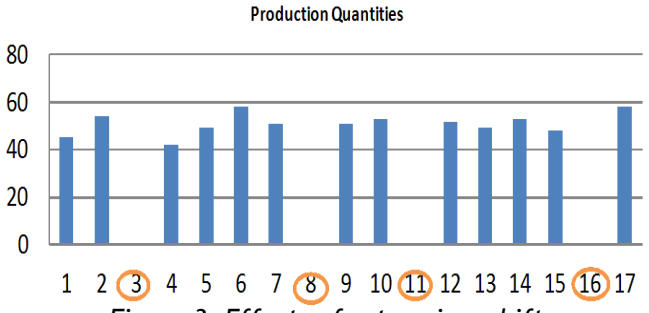

Figure 3. Effects of setups in a shift

SMED is a tool that is used in Total Productive Maintenance (TPM) and is capable to minimize the changeover time.

There are developed 10 advanced steps to achieve SMED, supported by 5S of Lean Manufacturing for real-life cases [21]:

1. *Implementation team forming.*
2. *Training.*
3. *Survey and screening of the situation prior to the method implementation.*
4. *Activity classification.*
5. *Transforming internal into external activities.*
6. *Improvement, internal activities minimization.*
7. *External activities improvement.*
8. *Standardization and forming the SMED procedures.*
9. *Save quantification of savings reached by SMED.*
10. *Continuous Improvement Process.*

When a setup activity runs in only one workstation of a production line, the successor workstations will be starved, because of the lack of materials. Predefined quantities of semi-finished parts, likewise buffers or Kanban quantities should feed the workstations that are in danger of starving.

Induct JIT methods and consolidate the exact size of containers (Kanban System) for semi-finished components

This step refers to calculation of containers that should feed the production line with materials. According with the manufacturing process, suitable amount of quantities could be estimated for a predefined production rate. The amount declares the size of containers for each component. As many customized products are manufactured from the line, even more components are needed to be available according with Bill of Materials (BOM) for each product. In many cases, products are assembled by more than one part and this proliferates the amount of components. Kanban System is based on signals (Kanban means signal) and moving containers. Containers should have a suitable amount of materials that normalize their move. Higher the amount of materials than the expected, less replenishment time for containers. On the other hand, less amount of materials means many replenishment times, see below Figure 4.

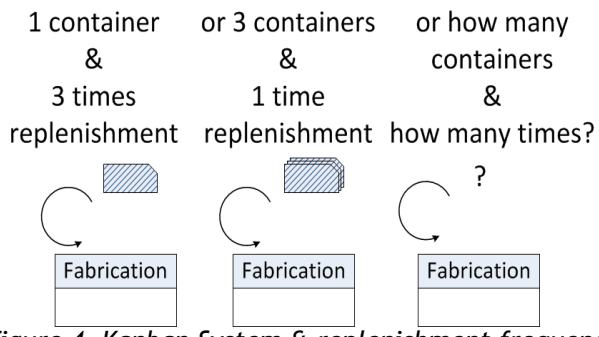

Figure 4. Kanban System & replenishment frequency

Accurate amount of materials is the key to normal flow and cost efficient production system. If the replenishment frequency is high, production rate will need to be also high. Production rate is usually predefined and cannot be higher than its limit. Such a situation may lead to starvation of workstations or even to overproduction. Production rate and materials replenishment frequency should follow the demand rate.

Reduce inventory levels of semi-finished products or components (Work-In-Process) and find suitable decoupling points (the fewer the better)

This step refers to bottlenecks, buffers and excessive inventory through the flow of production line. The reasons for such cases spread from technical and quality issues of semi-finished products to logistics or business strategy. It differs from the previous step on the stored items. The previous step indicates components and parts handling in contrast with current step that indicates semi-finished products handling. Inventories across the value stream are usually described as FIFO Supermarkets, namely as an excessive but also controlled WIP. FIFO Supermarket feed the successor workstations of a production line and withdraws materials from predecessor workstations, see below Figure 5. Also, there could be more than one FIFO Supermarket in a flow production line, in accordance with each production case.

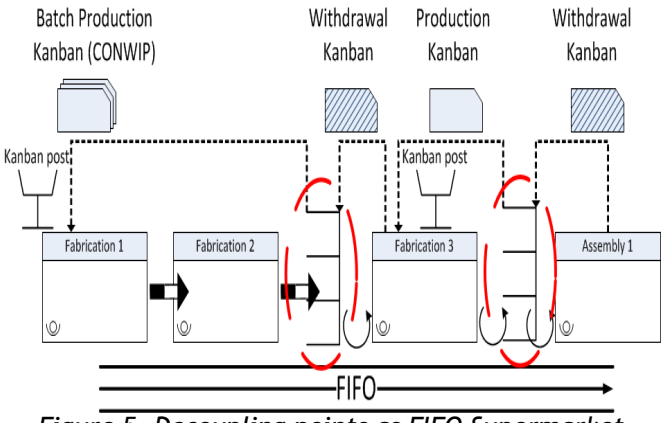

Figure 5. Decoupling points as FIFO Supermarket

The supply process is achieved by Kanban Systems. Predefined containers carry specific quantity of materials. As the previous step, size of all containers should follow the production rate in efficient replenishment frequency. Kanban Cards hanging on Kanban posts where they wait for transportation. Scheduling algorithms for solving pull sequence of the cards can be implemented, during waiting time on Kanban posts. Each card constitutes specific quantity of materials and also specific number of containers that carrying these materials.

The challenge is to reduce the inventory levels by reducing the number or the size of containers. This will give a boost to production by shortening the lead time and also the production cost.

Build a First In - First Out (FIFO) Supermarket in decoupling points and flush costs backwards

The term of Supermarket is used in Lean-Flow Manufacturing and connotes frequent replenishments of containers by Kanban Signals. Containers are moved from Supermarket to processes and backwards with Kanban Cards. A usual sequence is the first container it comes, the first should leave. By Kanban system in a FIFO Supermarket with predefined containers gives a real time inventory costing. This refers to backflush costing or backflush accounting. This approach of product costing is used mostly in Just In Time (JIT) production systems. The most significant attribute is that value of materials is issued on accounting system by its consuming time. It is an automatic and real time method to conduct material and product costing. Only when an end product is assembled or ready for sale, the consumed materials are issued for costing. By this way, a faster method of cost calculation assists on end product value estimation at the right time. Also, it gives real time numbers from the whole logistic system, suitable for inventory costing.

Reengineer the production scheduling and solve the makespan problem for mixed-model flow line

This rule refers to sequential jobs that should be done in a predefined duration, likewise in a shift of 8 hours. In Lean Production, the tool that defines the program planning is named Heijunka. This is a planning board that declares what task to do and when, concerning tasks duration, resources availability and other factors.

Time and cost minimization is the key solution for every, sequencing and scheduling problem, but also the business strategy plays a key role [22]. For example, it could be more essential to keep specific costs in higher levels, because of quality reasons.
Scheduling algorithms that continuously calculate optimized solutions concerning setup times, production rate, cost efficiency, delivery time and Kanban quantities run in every production round (every production round finishes by every changeover in order to produce a different product in the same line). A good time for this is when Kanban posts are above the semi-filled level.
The makespan problem gives scheduling solutions for Kanban Cards that are dedicated to specific materials and semi-finished products. The solutions are usually come from objective functions that deal with tasks' constraints, machines' constraints, sequence relationship, etc. Makespan is the total time for accomplishing a series of tasks by minimizing the total time duration. Job shop scheduling, Bin packaging problem, Genetic algorithm scheduling, Economic Lot Scheduling, Economic production quantity, Modified due date scheduling heuristic and Shifting bottleneck heuristic are some of the most common scheduling algorithms in production logistics that contribute to makespan problem solving.

Connect production sequence with replenishment sequence of materials

A radical algorithm for material sequencing is Evolutionary Production Sequencer (EPS) that was compared with two other known algorithms. The sequencer gives solutions, rapidly and efficiently, to sequencing problems for Mixed-Model Assembly Lines. In a previous work, one-card Kanban System with EPS, as pull sequence algorithm is simulated and assessed positively [23]. There are also many metrics that assess the smoothness of a sequence algorithm. An integrated procedure using these metrics can be followed in order to come up with a total scorecard assessment by comparing different sequence algorithms. The most suitable algorithm for providing the smoothest or in general, the best sequence could be revealed by such an assessment procedure [24].

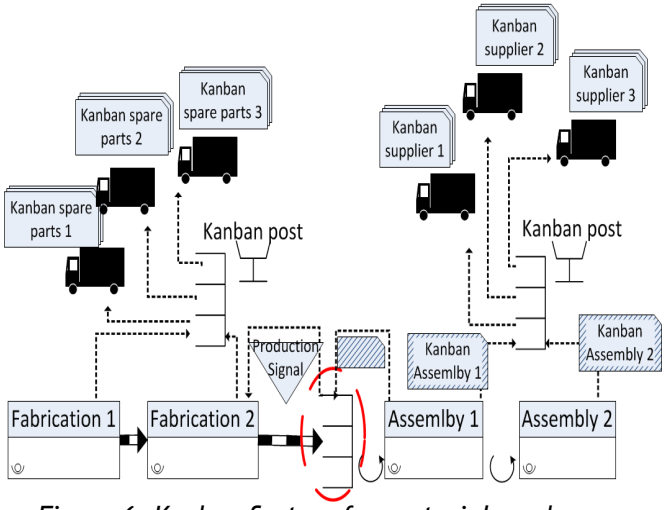

Figure 6. Kanban System for materials and spare parts handling

By the first rule, daily demand rate is calculated. By the eighth rule, production sequence is formed by Kanban posts and Kanban Cards of semi-finished products that are located in FIFO Supermarkets. In this rule, Kanban Cards are dedicated to specified containers that include materials or spare parts that could be handled by Kanban System, see below Figure 6.
Containers that are depleted in production line are replaced by full containers with the same material. The full containers come from FIFO Supermarkets. The empty containers in FIFO Supermarkets are replaced by full containers from suppliers. The whole system is conducted by Kanban Cards. Single Cards are replaced immediately and Batch Cards are replaced after sequence planning.

Connect the production sequence with the supply chain sequence

Mixed Model lines produce many different products for different customers that are located in different places. Every transportation vehicle should carry mixed model cargo that should be delivered in different places to different customers. As an example, we assume a cargo of 20 pieces. The 17 of them are different to each other and they will be delivered to 10 different customers in 5 different locations.
The mixed cargo and its quantities came from the mixed demand that came from a mixed model production and a mixed model replenishment sequence of materials. The market defines the customization degree of a cargo and its mixture.
Moreover, the sequence of production, as well for replenishment of materials and supply chain is the same with the demand sequence. The sequence of demand should synchronize all the other sequences of production, material replenishment and the whole supply chain in a Mixed Model Production Line [25]. Attributes of costing for sequence forming are also significant.
The algorithm for makespan problem should concern also the mixture of market, the due dates, the cost factors of customization and the production pace.

Provide exactly the right amount of end products, at the right time, every day

The demand is adapted to production process by the Takt time. Takt time is the time needed to complete work in each workstation, by following the daily mixed demand rate. It is the time span during the last workstation should complete its work for building a product. This implies that a product is finished every Takt time. Because of this, the last workstation is the pacemaker of the production line. The real Takt time should be smaller than the calculated Takt time in order to overcome unexpected daily pitfalls and to satisfy unexpected daily fluctuations in demand and customization process. The same pace is followed by materials replenishment and supply chain frequency. One sequence with one pace for all can produce and deliver customized products at the right time, in the right quantity, see below Figure 7.

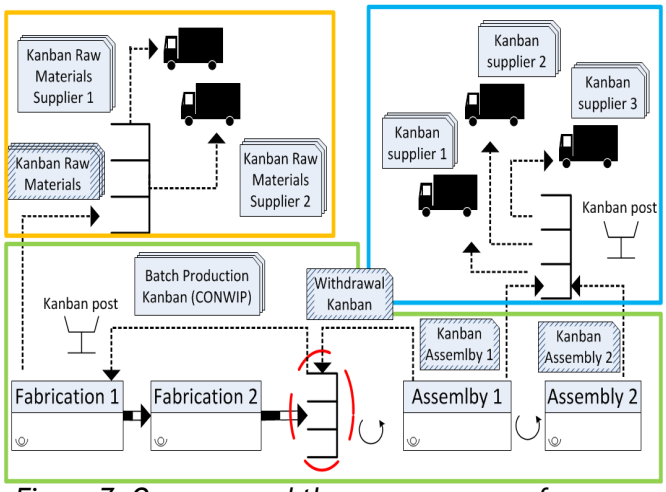

Figure 7. One pace and the same sequence for every factor of production

The upper left area with orange margins displays Kanban Cards sequence for raw materials replenishment. The upper right area with blue margins displays Kanban Cards sequence for materials replenishment and the supply chain. The lower area in green margins displays a production line with one FIFO Supermarket in a red dashed eclipse. The same method could also be established for spare parts replenishment. Kanban posts gather Kanban Cards in batches and scheduling algorithms for the sequence, providing solutions for supply chain planning.

A continuous flow production of customized products can be faster or slower in order to deliver goods at the right time. The pace of the flow is defined by Takt time. High Takt time gives small pace and small Takt time gives high pace. When production is overloaded, Takt time should become smaller in order to become faster.

Rebalancing of production line and sometimes reallocation of resources is needed. Many algorithms for this purpose were developed for Mixed-Model Production Lines. The same situation has effect on customization process. Rebalancing of designing phase and reallocation of designing resources are also needed. This is called leveling or balancing the design process.

CONCLUSIONS

Every system has its own limits, such as limits of production logistics, setup time, lead time, Kanban quantities, production sequence and replenishment turns.

Batch manufacturing for mass production is analyzed by mathematical algorithmic optimization procedures. The flow manufacturing in a mixed-model production line needs further fathoming.

This paper tries to explain the situation of production logistics in Mass Customization industries. Industrial environment consists of many interconnected factors. All the steps that are described above, deal with these industrial factors. Each step is described and their connections to production logistics are highlighted in this work.

Accuracy in logistics is inevitable. Not only production rates and replenishment frequencies should be accurate, but also the amount of materials and semi-finished products should be estimated.

The rules of eleven are challenges for production lines and not only actions that should be taken in a production case. The term "steps" instead of "rules" could also be used, but in some industries the aforementioned sequence of rules could change and the "step" could be collapsed. Known methods to reach the desired targets are briefly described. They should be tested and assessed by real-life cases, including fabrication and assembly processes as well. Any related future work could propose updated methods of Production Logistics in a Mass Customization Implementation procedure. It is also necessary for real-life case studies to implement and assess other relevant implementation methods. The comparison between the eleven steps and other relevant techniques will be crucial for the future.

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HYBRID CLOUDS AND MASS CUSTOMIZATION STRATEGY A MID MARKET UTILIZATION

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ABSTRACT: Worldwide globalization processes as well as rapid development of information and communication technologies (ICT) significantly determine modern business operations in each and every organization. The basic concept of mass customization as a new trend is to increase the variety of individually tailored products/services to meet customer needs without a large increase in production costs. It requires a highly flexible production technology though. Developing such technologies can be expensive and time-consuming. Clouds enable delivery of mass customized services/information in the "Data to Information to Knowledge" chain. The aim of this paper is to introduce the way how the mid-market can utilize Public Cloud computing in conjunction with a secure Private Clouds and further more to propose a framework for mass customization and its collaboration in Clouds.
KEYWORDS: Hybrid Cloud Computing, Mass customization, SME's

INTRODUCTION

The magnitude of change that is affecting industries today is unprecedented. Difficult economic conditions, a broader set of business imperatives, and evolving technology requirements are presenting midsize companies with as many threats as opportunities. At the same time, fundamental shifts are taking place in the way people everywhere live, work and interact. It's becoming increasingly clear that innovative, forward thinking companies can do more than survive in this environment, they can thrive.

There is no common definition of what the mid-market company is. Depends on the purposes of the survey conducted, some researches want to ensure that the IT department is large enough, without being so large as to skew issues to those of the Fortune 500 so relate on the annual revenue from the IT offerings and others relate to the number of the employees. There are several indicators of mid-market including [7]: the number of employees, annual sales and market position. Mid-market companies, typically have 100-499 employees, according to a study done by Ipso in 2006 in Canada. In the US mid-market, companies are sometimes defined as having sales of $5 million to $100 million, but other US studies use a more wide range. For an instance, IBM used between 100 and 1,000 in a 2009 study of mid-sized businesses and SAP used a definition of sales of between $30 million and $500 million which represents 1% of the number of all US companies and nearly 30% of corporate revenues. In the UK, the Department of Trade and Industry defines mid-sized firms as having 50-249 employees and 16% of the annual sales. In Europe regarding mid-marked definition, the Economist Intelligence Unit conducted a survey considered firms with €200 million or less in annual revenue. In this paper we accept definition that mid-market are companies with 50 to 500 employees but can be as high as 1,000 employees that generates annual sales of somewhere between $5 million and $100 million with a few definitions stretching the range to $500 million.

In a survey [5], where selected CIO's and CFO's were involved in companies and the IT department budget ranged from $1 to $10 million per year and meanwhile they were counted as mid-market organizations, results indicated that mid market companies have unique characteristics that are causing their IT development needs to go unaddressed. Mid market companies have drastically reduced headcount and yet need to address new business requirements. In the survey was found that CIOs and CFOs are very interested in realigning business goals and IT. They have realized some of the power that IT initiatives have given them, such as more efficient and easy migration into the production phase supply chain management and integrated services.

A survey conducted by Opinion Research Corporation and information technology decision makers at midsize businesses (100-1000 employees) among 17 countries across various industries (banking, retail, healthcare, consumer products, manufacturing) state that they need a technology partner who can help them work smarter, build an infrastructure to

support their growing business, and identify ways to use the information they have to make better business decisions. The study reveals distinct mindsets that are actively shaping the business strategy and related IT priorities at midsize companies [4]. Roughly half (53%) of surveyed companies are concentrating their efforts on increasing efficiency and lowering costs-strategic imperatives that can be supported by virtualization, energy efficiency, process optimization, IT standardization and other initiatives focused on reducing complexity and expense [10].

In this paper, an attempt has been made to introduce the way how the mid- market can utilize Public Cloud computing in conjunction with a secure Private Clouds, or so-called Hybrid Cloud Computing as a new IT paradigm within the testing and demo phases of business cycles at vastly information system software packages and its easy migration into the production phase. Cloud Computing can play an important role among mass customization and its collaboration in Clouds, driven by preference of funding sources, sharing of resources and expertise, division of labor/separation of concerns and it is enabled by advances in communication and collaboration technologies [10].

MASS CUSTOMIZATION STRATEGY

Mass customization is the capability, realized by companies, to offer individually tailored products or services on a large scale. Mass customization systems have three key capabilities: elicitation, process flexibility and logistics. Any company considering a mass customization strategy should carefully analyze its ability to deliver on the three key capabilities: elicitation (a mechanism for interacting with the customer and obtaining specific information); process flexibility (production technology that fabricates the product according to the information); and logistics (subsequent processing stages and distribution that are able to maintain the identity of each item and to deliver the right one to the right customer) [11]. Mass customization systems have three those elements that are connected by powerful communications links and thereby integrated into a seamless whole.

Elicitation is hard, customers often have trouble deciding what they want and then communicating influence on their decisions. That creates problems for any company aiming to serve those customers. There are situations in which customers clearly articulate their requirements. More commonly, however, customers are unsure. They are easily overwhelmed by too many selections on a store shelf or a Web page. Any elicitation process is an artful means of leading customers through the process of identifying exactly what they want. The difficulty of eliciting customer-specific information varies with the information required. Deeper levels of customization, however, require more information. Thus mass customization often requires an elaborate enabling mechanism (sometimes called a configuration). Improvements will no doubt be aided by progress in customer relationship management (CRM). CRM collects information about customers, aims to predict their individual desires and behaviors, and targets marketing messages accordingly. Although a targeted marketing message is different from a physical product or a customized service, the goals and technologies of CRM are somewhat similar to those of mass customization.

And again, the question of IT deployment model arises. What about CRM deployment models, what about different sizes of companies and sensitivity of data they managed? What is the role of Cloud computing model?

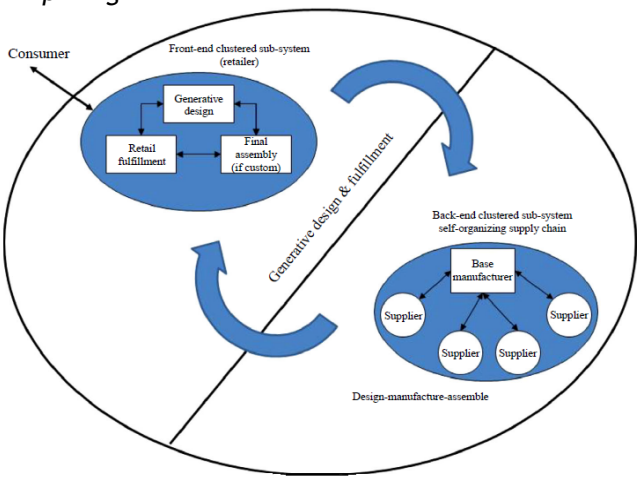

Figure 1: Generative customization – self organizing supply chain (Source: Buffington & McCubbrey, 2010)

Factors driving Mass customization

The success of the mass customization concept depends on several elements, which may represent strategies and support for development of the system. Theory mentions six different factors, out of which the first two are connected to the market while others represent parts of the organizational structure.

***1**. Customer demand for variety and customization must exist*

The basic justification for the mass customization is a need to satisfy a greater number of customers. Success depends on a balance between production and delivery of innovative products within a reasonable period of time. This factor is very much related to the one of the previously mentioned three key capabilities - elicitation.

***2**. Market conditions must be appropriate*

Organizations need to have the ability to respond to different market conditions. In an increasingly competitive environment, the advantages are based on the time needed to develop the mass customization system. In other words, the development of mass customization system can provide a significant advantage over competitors, since the organization is then viewed as innovative and able to respond to all consumers` demands. This factor is very much related to the one of the previously mentioned three key capabilities - process flexibility.

***3**. Value chain should be ready*

The success of mass adjustment of products or services greatly depends on the efficiency of the organization and its suppliers, distributors and vendors to take part in responding to consumers' demands. This factor is very much related to the one

of the previously mentioned three key capabilities - logistics.

***4**. Technology must be available*

Implementation of advanced manufacturing technologies represents the basis for enabling the development of the mass customization system. There are certain claims that this concept emerged after some companies were able to successfully integrate a wide range of information and flexible technology processes. Mass customization is one of the best systems that coordinate a work of advanced manufacturing technologies and information technologies within the value chain.

***5**. Products should be customizable*

Successful products need to be modular, flexible and focused on creating additional value. Although modularity is not a basic feature of mass customization systems, it leads to simplicity and reduction of expenses. Mass customization requires innovations and rapid product development due to a shorter product life cycle.

***6**. Knowledge must be shared*

Mass customization is a dynamic strategy and it depends on the ability to transfer consumers `demands onto new products and services. In order to achieve this, companies have to follow a culture which emphasizes the importance of knowledge and the creation of new values. This requires the development of production, technology and engineering.

Mass customization and its collaboration in Clouds

The core capabilities is to provide full product space for customers with low cost and high efficiency in customized manufacturers, and ultimately to meet the individual demand of customers [2]. A cloud based platform for mass customization, as a framework given bellow for an instance, by advantages of Clouds might effectively achieve the company's core capabilities and integration of resources and meet the supply and demand between the fluctuation in orders and the long lasting manufacturing capabilities.

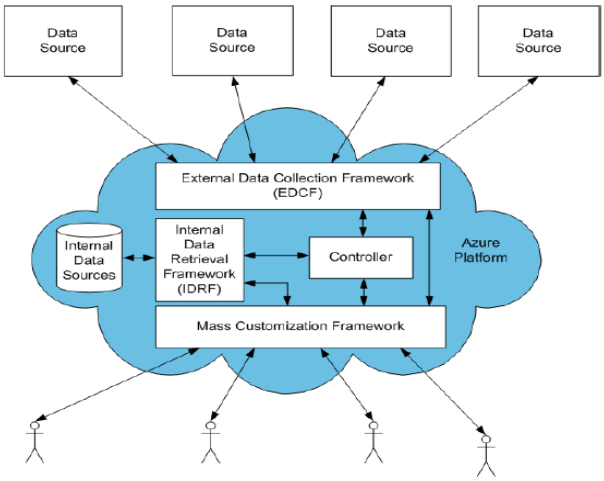

Figure 2: A framework for mass customization and its collaboration in Clouds [10]

HYBRID CLOUDS

The evolution of Cloud Computing over the past few years is potentially one of the major advances in the history of computing. Cloud Computing might be one of the alternatives for strategic investments in information technology and infrastructure due to the information systems adoption having in mind the following: companies have to increase innovation and flexibility in meeting the requirements of the market/customers (so they should focus on innovation, not solving problems associated with the infrastructure implementation and its maintenance), „start-up" companies as well as small and medium enterprises cannot afford large investments in information technology and infrastructure, greater flexibility and speed up launching new products on the market offering the opportunity to access and use of already defined data, etc. [8,6,9].

The basic notion of the Cloud computing refers to the technology infrastructure model that enables several types of computing tasks to be performed over a network. The network can be a local area network or a wide area network like the Internet. As mentioned before, the Cloud computing model promotes availability and it is composed of five essential characteristics, three service models, and three deployment models - Private, Public or Hybrid Cloud computing service.

Private cloud services enable IT departments to do more with the infrastructure that they already have. In a typical private cloud deployment, companies undertake the consolidation of distributed IT resources and apply virtualization to those resources in the data center. This enables IT to provide more cost-effective management while spinning up services faster. However, private cloud deployments can put significant strain on existing resources and work processes. As IT departments consolidate resources, applications and data are typically moved further away from many end users. Branch office employees and mobile workers now are required to go further across the wide-area network (WAN) to get the information they need. The resulting latency can often dramatically reduce performance, and make the business less productive overall. At the same time, the consolidation will put more strain on the available bandwidth connecting branch offices to the data center. With consolidated resources, many more user requests will go back to the data center. The WAN will be responsible for carrying significantly more traffic, which could lead to bandwidth congestion, or even force the enterprise to purchase more bandwidth.

Utilizing a service provider's infrastructure or platform allows companies to integrate the public cloud into their IT infrastructure. A public cloud service allows the company to rent compute power and storage, and is usually billed on a discrete basis. Public cloud services are compelling because of scale and elasticity - a service provider supporting thousands of businesses can drive lower costs than any one business alone, and can provide adaptability for changing workloads as an operating expense rather than a capital expense. One of the major challenges with the adoption of public clouds is performance. Moving services to a public cloud means that companies must accept that their applications can potentially be run from anywhere in the world -

wherever the data center of the service provider happens to be. Most public cloud services do not specify data center locations in their terms of service, maximizing their freedom to migrate work to reduce their operating costs. In essence, the distance (and latency) in accessing applications may significantly increase for everyone in the company. More surprisingly, those distances may change unpredictably.

Concerns about privacy and security of data have contributed to many companies' interest in developing private cloud environments, where company data remains inside the firewall or to consider hybrid cloud environments, which incorporate some elements of a private cloud and some elements of a public cloud [3].

While many business executives are attracted to the idea of the public cloud, just as many are interested in achieving the benefits of the cloud but on an internal basis. There are different reasons why companies investigating a cloud might want a private cloud instead of using a public one. The most obvious reason is privacy and security of data. Another reason that some companies are considering the private cloud is that they have already invested in a lot of hardware, software, and space and would like to be able to leverage their investments, but in a more efficient manner.

In most situations, a hybrid environment will satisfy many business needs. Here are some examples:

- *A company likes a SaaS application and wants to use it as a standard throughout the company; top management of the company it is concerned about security. To solve this problem, the SaaS vendor creates a private cloud just for the company's needs inside their firewall. They provide the company with a virtual private network (VPN) for additional security. In this manner, the company has both public and private cloud ingredients.*
- *A company offers services that are tailored for different markets. For an example, a company might offer to handle claims payments for insurance agents, shipping services for manufacturers, or similar. The company may want to use a public cloud to create an online environment so each of the company's customers can send the requests and review their account status. However, the company might want to keep the data that they manage for these customers within their own private cloud.*

AN APPROACH TO THE MID MARKET UTILIZATION OF HYBRID CLOUDS

Despite its critics, cloud computing technology has successfully transitioned from a "trend" to a trusted technology source relied upon by company's of all sizes, from start-up's, to the mid-market, to enterprises. Its proven benefits such as including cost-effective, accelerated provisioning in protected environments, etc., can no longer be ignored.

Understanding of Cloud Computing paradigms

Cloud computing has been driven to the forefront of technology and business by companies such as Amazon.com, Salesforce.com and Rack space. Although these large-scale cloud providers are leading the way in this space, their approaches are fundamentally identical: they offer the same public cloud solution to all of their customers. While this solution is favorable for some cost conscious businesses, it is not tailored for the business processes and unique needs of the mid market. Every company maintains vastly different IT infrastructures.

Therefore, it is important for implementers to understand the distinction between these cloud infrastructures, known as public clouds, and the solutions and services that comprise a private cloud model, a custom configuration built from the ground up with dedicated hardware including clusters of servers, storage area networks, firewalls, databases and load balancers.

While the public cloud is highly economical and can be utilized to meet company utility computing needs, the option a "one size fits all" approach, often introducing risks such as reduced availability of critical applications, or potential data compromises. These weaknesses are among the most common concerns cited by cloud computing cynics who are quick to overlook its overwhelming benefits.

As mentioned before, private clouds offer the counterpart. In the private cloud, computing resources and applications can be provisioned on-demand using virtualization and workload balancing, while simultaneously providing a secure environment for proprietary data and software.

While both have their benefits, we tout that the hybrid cloud, a combination of public and private, is the best solution for the mid market. For an example, by utilizing public clouds, service providers can create demo environments for multiple customers in a matter of hours, rather than weeks. From there, customers can easily be accommodated by quickly moving them from a demo environment into development, quality assurance and testing, and finally production with a private cloud. This entire process can be managed in a secure environment, backed by zero down-time.

Reliability in the Private Cloud

Virtualization is an easy solution for limiting expansive growth of physical IT infrastructure, which often wastes vital resources due to vast server sprawl. Installing applications on virtual machines greatly reduces the amount of physical assets needed, which introduces significant cost savings and eliminates unnecessarily complex IT infrastructures. Additionally, applications running on virtual machines are protected from downtime and disruption via scalable, high-class enterprise servers, enabling to company to increase their ability to maintain data integrity security controls. These solutions have all of the logging, auditing, and prevention mechanisms of traditional operating models to determine who has access to information, and how that information is stored, processed, or transferred.

A new approach can be preconfigured within hybrid cloud solution that is tailored to the client's business needs. In that way, the full visibility into operational and development areas and the power to control

availability at all times through dynamic resource scheduling, as well as workload balancing (a capability especially key for multi-tenant environments) is available.
Data, applications, and development projects can be monitored constantly (24/7), migrated from one virtual machine to another without downtime, or automatically re-allocated according to your business needs.

Scalability in a Hybrid Cloud Computing

It is evident that the time consuming process of procuring hardware, testing and securing it, then rolling it out, can delay sales. Typically, when conducting demos and navigating clients through an application lifecycle, companies can be restricted to a equal ratio between applications layers and servers (an expensive setup that impedes the ability to swiftly prepare services for customers). Once up and running, these dynamic testing environments can often become inactive, posing additional challenges for users.
The cloud solves each of these issues by eliminating hardware dependency, allowing service providers to manage multiple customers in one environment at any given time. Service providers can quickly and easily provision new stand alone test environments on demand for themselves, current clients, and prospective clients with little fuss.
Those challenges aside, developers struggle with additional obstacles after clients move forward with the next phase for a project, ranging from burdensome, data intensive applications that are difficult to migrate, to real time operations, to evolving project requirements.
However, within a virtualized cloud environment, resource intensive applications can be easily moved, enabling users to move clients from development to production, and meet the demands of projects that are constantly in flux.

Customized Private Clouds depend on the vendor

As businesses continue to move toward on-demand service models to operate their IT infrastructures, infrastructure providers must evolve with them. Finding the perfect fit to support a developer's IT needs depends on operational environments that enable companies to develop and test comprehensive, turnkey services that can be managed or handed over to clients.
Hosted at multiple top tiers, world class data center facilities, vendor's hybrid cloud solutions should be protected by the highest levels of security.
What do these partnerships mean for company's business? To surpass competitors, vendor's public cloud features a group of pre-defined virtual machines, allowing service providers to create a grouping of custom virtual machines that mimic any given test or demo environment being pushed out. By replicating a pre-configured VMware Apps, rather than a cluster of applications, deployments are made faster and more efficient, saving hours of time and eliminating manual tasks.
How to overcome dependability? Vendor's private clouds ensure that data and resources are protected by completely redundant servers, providing high-availability and 100% uptime; all supported by customizable file level backup and restoration capabilities.
What about security issue? Vendors of the cloud solutions should offer the ability to conduct development within a segregated environment. In this way, separation provides a secure area that can be used for demonstration, training, development, and testing purposes without jeopardizing enterprise information resources.
New approach created to help meet company's growing business demands, the unified management portal can seamlessly shift workloads to and from the private cloud to the vendor public clouds without reloading data, changing IP addresses, or encountering DNS (Domain Name System) issues.

CONCLUSIONS

When it comes to information systems (for an instance, Product Lifecycle Management software packages or SAP or even CRM systems), in today's complex business environment, companies are beginning to focus more and more on the individual productivity, application productivity and IT productivity. These three factors must be balanced and optimized at moderate cost. This is particularly challenging for small and medium sized companies who don't want to tie up their investment resources in major IT systems particularly within the testing and demo phases of business cycles. The proven success of cloud-based solutions, coupled with the promise of a less expensive and more responsive business solution infrastructure, is prompting many companies of all sizes, from micro, to the mid-market, to enterprises to give the cloud a closer look. The benefits such as including cost-effective, accelerated provisioning in protected environments can no longer be ignored.
As businesses continue to move toward on-demand service models to operate their IT infrastructures, many providers of on-demand and custom cloud solutions are paving the way for companies to better serve customers by combining the reliability, scalability and flexibility of the cloud. The burden of short scheduling requirements within the testing and demo phases of business cycles at vastly information systems is eliminated through swift provisioning of resources. The expensive hassles of dealing with aging hardware, server refresh, and the need to quickly adapt to unexpected frequent changes can all be offloaded and managed by cloud services. By relegating these tasks to the private cloud, businesses can focus on innovation, rather than keeping the lights on.
In that manner, reliability in Private Clouds as well as scalability that Public Clouds offer, ensure the future of Hybrid Cloud Computing in conjunction with SME's. As previously emphasized, Cloud computing can play an important role among mass customization and its collaboration in Clouds, the most driven by preference of funding sources, sharing of resources and expertise, division of labor/separation of concerns and it is enabled by advances in communication and collaboration technologies. The service platform architecture and the core

technology can improve the service capacity of mass customization business through the integration of resources, demand integration and optimal configuration.

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OPEN INNOVATION, SOCIAL EMBEDDEDNESS OF ECONOMIC ACTION AND ITS CULTURAL DETERMINATS

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ABSTRACT: The paper concerns the position of the economy within a socio-theoretical conception as a part of the economic sociology, in the context of its influence of the economic action, especially in the macroeconomic view. Based on the secondary research we review and challenge the primacy of economy in the contemporary society and we focus on the cultural determinates for social embeddedness by using of examples.
KEYWORDS: Social Embeddedness, Open Innovation, Economic Action, Cultural Determinats

INTRODUCTION

By analyzing the literature related to the socio-economical issues, the questions as why did a propagation of market logics take place during the last thirty years as a social control form? Or why did the political system lose the structural leverage on the economy which it had in the Keynesianism? may arise. Explanation attempts refer to crisis-like phenomena in organized capitalism, on globalization processes, as well as to the ideological reorientations of economic policy and economic theories since the seventies years with a accompanied change of economic action settings. Some of the changes within the economic action settings can be explained with the concept of embeddedness (Polanyi, 1944, 1957, 2001, 2010) and social embeddedness (cf. Granovetter, 1985) of the economic action. In the paper we take a deep look on the different theories trying to explain value of the economy in the society theory. In the first part of the paper we clarify the term of the New Economic Sociology and its main issues and changes compared to the classical Economic Sociology. Further, in the second part we explain the embeddedness as a part of economic geography and its relevance for economic action. In the subsequent part we focus on the cultural determinates for social embeddedness by using of examples.

NEW ECONOMIC SOCIOLOGY AND ITS MAIN ISSUES

The economic sociology as a sub-discipline belongs to an important research area of the social science (sociology) as a science in the modern, globalized society. Max Weber, a significant founding father of the sociology, dealt in the late 19. and early 20th century with the consequences of the economy on the society. His book Economy and Society, written by using of by comparative analyses, counts to the groundwork for further economic-sociological and ruling-sociological research. According to him, there is existing so called "the interest concept" which observe the economic actors as an exchange partner who act rationally to maximize the own profit. Based on it, he has concerted so called ideal types of the economic actions and classifies them regarding so called purpose (goal)-rational and value-rational action. He defines four types of the social action: (1) purpose (goal)-rational action, based on rational weighing and balancing between purpose, targets, means, consequences, (2) value-rational action, based on deliberate belief and confidence, in ethical, aesthetic or religious value of the own action, (3) affectional (emotional) action, based on the present emotional situation and emotions, (4) traditional action, based on the settled down, traditional custom. On this observation rests also the economic neoclassical research which considers the person as a so called homo oeconomicus. Homo oeconomicus is in the economic science the theoretical model of a so called „maximizer of the profit" used for the abstraction and explanation of more elementary economic connections. In contrast to the homo oeconomicus concept, so called homo reciprocans concept exists, which states that human beings are above all, forced by the desire to be helpful and to improve and look up at their environment. Other (newer) models of the social action use the concept of the reflection, the concept of the rational decision (rationally choice theory), or the concept of the "Autopoiesis" defined by Luhmann (1984). According to Luhmann (1986, p.269) „ A social system develops, whenever an autopoietic communicational interconnection which originates and differentiates itself by restriction of the suitable communication against an environment. Therefore, social systems do not exist out of the persons, also not out of the actions, but out of the communications". According

to Beckert (2009) from the perspective of a huge number of societal theories it appears to be not plausibly, to grant the economy with paradigmatic meaning in the understanding of the structures and dynamism of modern societies. In particular, sociological differentiation theories deny just the primacy of a certain social function system prior-ranking to the other one. They argue that different functions must be fulfilled at the same time, so that social order can be stabilized. Societies must not only generate material resources, but they need compellingly the political control, cultural orientation, institutional procedures for the conflict solution as well as also the socialization of its members. According to Luhmann (1984) societies differentiate in functional subsystems. The possibility of a hierarchical order of the functional subsystems with which a system could steer the others or to become the model in its function for other social subsystems is denied categorically by him. Luhmann's concept has been criticized with the arguments by the social-democratic control theories which however suggest the primacy of the political system, which can steer the configuration of social order about rational and democratically legitimized planning also in the case of the economic structures. Finally, the control theory by the political system had its background of experience in Keynesian theory and with it in the "adjusted economy". The realized own logic of capitalistic utilization processes via competition markets was narrowly enclosed in the post-war period by political defaults. Markets were politically limited, what enabled to oblige the economy in strong degree on the conversion of politically articulated social purposes and values. This horizon of experience has changed during the last thirty years drastically. Looking back on the years after the World War II, we can differentiate specific general orientations of the macroeconomic policy. According to Bieling (2009) those stages related mostly to Germany and some other industrial developed countries as in the USA are:

***1**. Postwar years - rules of "constrained" liberalism*
Specifics: "embedded (in context integrated) liberalism". Parties, trade unions, employers and other decisive social forces represent the view that capitalism is to be constrained by numerous institutions.

***2**. The late 1960th and early 1970s years - Keynes' welfare state.*
Specifics: for the first time the state pursued an active economic situation control, well-being-state benefits were expanded.

***3**. The late 1970s - criticism of the welfare state.*
Specifics: the demand was: instead of the bureaucratic, achievement-hostile welfare state a slender competition state ("slim-state") should step ahead, which concentrates exclusively upon its nuclear tasks without of the interventions on the market (self-healing forces of the market needed to be used).

***4**. In the 1980th to middle of the 1990s - period of the slim-state.*
Specifics: it lasted more than a decade, until the new general principle of the "slim-state" asserted itself against well-being-state institutions and corporation networks, union protests and remonstrance as well as in the federal system invested opposition. The cooperative relation between state and civil society which stresses the own responsibility of the citizens has been supported.

***5**. The late 1990s till this day - guarantee state.*
Specifics: the role of the state changed from the public care monopolist to the public care manager. The result of it is competition-politically and socio-politically enclosed, but continuous denationalization policy of the state in economic matters.

***6**. Indications for a trend turn.*
Specifics: the slim state which adjusts possibly many tasks to the market and only a little part of it becomes regulated, has recently lost to acceptance. The social problems like the poverty or have edged out the "reform traffic jam" of the political agenda of some states.

***7**. The results of the financial crisis.*
Specifics: attempts to establish a new finance market regulation and state programs of economic measures show increased readiness for intervention of the state stronger in the capitalistic economy.

But as stated by Beckert (2009) today we can speak at least about the control of competition markets only by political interventions for the realization of non-economic purposes but not of the serious re-definition of the market regulations and the role of the state. This opinion we share also today. Moreover the massive state interventions in connection with the financial crisis in 2008 do not contradict it. Thus just at the preservation of the market structures in an acute crisis situation and not a changed economic model, even in the case of the Greek crises, can be observed. The current position of the national states of industrialized western states can be described with the time limited interventions in the role of the state as a protector against the catastrophes in the competition market. It shows that Luhmann's theory of differentiated functional systems as for example function of the politics separated from economy seems to be valid. The markets steer social exchange processes today in a more comprehensive manner than thirty years ago.

If we compare the economic sociology of the classical authors with the today's so-called „New Economic Sociology" (NES), a significant difference can be found out. Against to the theoretical drafts and empiric researches to the economic theory of Marx, Weber etc. NES faces as a type of economic-sociological research. It concern consists rather in showing that the stability of markets and organizations can be not explained only by economic condition factors and a "natural inclination" (Adam Smith) of the people to the use maximization of the profit, but is extremely socially and culturally interlinked. The NES shows in persuasive manner how capitalistic economists depend on an ingenious institution system, which are based on network relations between the actors, have moral action conditions and go back on culturally anchored

knowledge supplies. In this context markets, enterprises or industrial districts are investigated in each case against the background of the question which importance the social context of economic action comes up for the coordination of extremely complicated and with varied risks afflicted economic exchange relations.

Embeddedness as a Part of Economic Geography and Its Relevance for Economic Action

Primary only the solution of the central coordination problems in the market exchange, of the competition, the cooperation and the value assessment allows the forming of reproducible role structures and with it forming of stable markets. Coordination problem can be considered as the "situation in which the interests of negotiators coincide, and the aim is to try to reach an outcome in which those interests are satisfied. Informally, this is a situation in which each person has an interest in doing something that chimes in with what the others do" (Blackburn, 2012). More officially, a clarification necessitates finding a balance and symmetry, meaning that no negotiator can do better by unilaterally doing something else given the options of the others. A good balance is one which each negotiator likes better than any other balance. Much societal action, including maybe inventing verbal communication and the social order, requires solving co-ordination problems. Institutional rules, social networks and cognitive or general principles allows, on the one hand, the solution of central coordination problems of economic action and to the other hand to adjust the distribution of economic wealth and lead with it to the stable orders. New Economic Sociology explains the most relevant coordination problems of today, which are i.a. linked with the term of embeddedness. Embeddedness is in the relational economic geography used concept for the imbedding of economic activities in socio-cultural respect systems or imbedding of an enterprise in his socio-cultural sphere.

According to Beckert (2009), three important coordination problems today are:

1. *Institutionalization of work as a paid labor (wagework).As stated by Polani (1944) like as it was in similar way stated by Karl Marx or Adam Smith, the work power is defined as "fictive commodity" (fictive goods) which can't be separated from the matching person. But the market acts, nevertheless, in such a way, as if the work power was any product like anyone. It leads to the regulations and institutionalization which are again different "constellations of forces" if we consider different national economies. It leads to the uncertainty in penetration of the capitalistic economic system.*
2. *Social risks based on defection of an exchange partner. With the exchange of commodities linked social risks, which originate from the possible defection of an exchange partner, constitute another coordination problem. The capitalistic economic system is characterized by a (discontinuous) process of the expansion of market relations. Hence, the division of labor processes must be integrated over bigger and bigger social and geographical distances. The bigger distance of the actors entails that, during the economic action, the expectation security of the exchange partners decreases; it signifies more insecurity for the contracting partners by which cooperation problems anew position themselves. The historical consideration reveals here systematic changes of forms of the embedding of economic action. The security of the relation between the contracting partners can be also analyzed by historical and cross-cultural perspective in order to find indicators for potential of cross-national contracting defection.*
3. *Valuing of the goods offered on the markets. Economic actors must value the goods offered on markets, in order that demand for them can originate. The appreciation and evaluation of the goods is connected, if it not determined by biological necessities, in connection with the cultural and social sphere. An example for it is described by Zelizer (1979) which exemplarily clearly describes the problem, mentioning the cultural limitation of market demand in the historical beginnings of the market for life insurances in America, to whose origin at first the religiously reasonable view had to be avoided, according to, life insurances have been declared to be "immoral" because with it, one is making a profit on account of the death of a beloved person. Similar examples are also today to be found in South Korea in regard of the chaebols and government interaction or in the case of Chinese Guanxi networks, which implies mutual obligations, assurance and understanding even when doing business, so that such social relationships have in those cases primary consequences in valuing of the goods. By exemplifying the coordination problems it becomes obvious that economic actions are linked with the socio-cultural sphere. It means that socio-cultural sphere can't be observed as separated societal functional unit but as embedded action within the economic action. Also in this case so called „double movement" is established, for example in form of institutionalization and global regulation as a reaction for contracting problem, in order to diminish the cases of defection. Similar movement can be observed in the role of the money which creates the primacy of economy (cf. Beckert, 2009). According to Schimank (2008), money exercises economical pressure on the other social subsystems in which the whole-social primate of the economy manifests itself. So, only money provides a complete access to society, indeed, not in regulating manner, but as available or missing "energy", which is allowing impacts everywhere - or just makes things impossible. Therefore politics depends on economy (money), conditions of the politics are friendly to economy and wage demands of the private household as a consideration (equivalent) for the working*

achievements made available to the economic system, remain limited.

Examples of Cultural Determinates for Social Embeddedness

The attempt to link the social embeddedness with the cultural determinants based on the cultural values and anthropological sources of the societal behavior, is a imputed venture which requires extensive research. It is also still a quite unexplored field of cross-cultural and social studies. We refer in this paper on two examples related to the cultural implication on social embedded economic actions. As stated by Rooks and Matzat (2010, p.45) "embeddedness theory stresses the importance of concrete personal relations and networks of relations in economic life. Recent sociological research shows that effects of embeddedness may differ between social settings, and recent experimental anthropological findings reveal that levels of cooperation and norm-enforcement differ between cultural settings". As the result of the research author state that "in Germany sharing a history of previous transaction and the existence of alternative partners had a larger effect on trust than in the Netherlands" (Rooks and Matzat 2010, p.45). Also Rai et al. (2009, p.617) addressed the gap between the cultural determinates and social embeddedness by "integrating the social embeddedness perspective and the culture literature to theorize how and why relational factors affect the success of offshore information system (IS) projects that are strategic in nature". Because of the argumentation the organization of the exchange connection has a important impact on economic action, embedded relationships in contrast to atomistic live-and-let-live interactions, display collective norms and values, decrease the need for observing and control, and make easy the transfer of information and incorporation of particular knowledge and capability. The economic inference of such embeddedness is accepted to be particularly significant in a circumstance such as strategic IS project improvement, where implicit knowledge has to be incorporated and characteristic problems have to be addressed. Explicitly, authors found that information exchange, joint problem solving, and trust, which are culturally based characteristics as for example project leader cultural values or shared norms between partnering firms, would influence the success of offshore project and would have effects of the reduction of the project cost overruns and improvement of client satisfaction.

CONCLUSIONS

In this paper we show different perspectives of the reasoning for economic actions and take a closer look at the earlier and contemporary view of value of the economy in the society theory. We explain that the concern of the New Economic Sociology consists rather in showing that the stability of the markets and organizations cannot be explained only by economic condition factors and by a natural inclination of the people to the use maximization of the profit, but that it is enormously socially and culturally depended. The new economic sociology shows in persuasive manner how capitalistic economists depend on an ingenious institution system and at least on money, so that primacy of economy can be indicated. It lead to the institutional reactions and partially re-use of the earlier used and during the last 30 years temporarily rejected instruments in macroeconomic policy, however following the sense of the denationalization policy of the state in economic matters. At least embeddedness theory highlight i.a. the importance of real personal relations and networks of relations in economic life, which are based on the cultural settings which impacts the relations on the individual level, important for the economic outputs. In further studies we aim to start the analysis in regard of the social embeddedness of economic actions in Balkan countries and to have a closer comparative look at the cultural implications at the organizational-cultural level.

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TOPOGRAPHY MEASUREMENTS USING SPIRAL SAMPLING

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ABSTRACT: In the paper surface topography measurements were presented. Collecting data using rectangular grid is rather slow in tactile profilometry. To avoid this problem sampling on a spiral was investigated. For this reason it is possible to use a conventional profilometer or a form tester, which offers much more versatile solutions, what was presented in the paper. Differences between results obtained with rectangular grid and spiral sampling were presented. Some problems emerging while sampling on a spiral were also shown.
KEYWORDS: topography, surface, spiral

INTRODUCTION

A traditional 2D surface profile analysis is - for some years now - still more often replaced with 3D topographical assessment [1]. It was reported by a many authors, including both - research problems and practical applications for various kinds of surfaces. Among many different methods of surface characterization stylus profilometry seems to be the most commonly used one, especially for engineering surfaces. It is based on multiprofile data tracking, giving as a result a set of points in three dimensions. There was quite a number of papers presenting surface images obtaining (both axonometric view and topographical map) and amplitude topography parameters, as well as full three - dimensional parametric analysis [2,3,4].

The aim of the project was to elaborate fast sampling methods enabling for a quick surface topography measurements by means of stylus profilometers. These devices are the most commonly used ones for assessment of surface asperities. Thus the surface is represented as a set of coordinates of grid points, basing on a grid constructed in a certain way. Most of the instruments work on a parallel multiprofile base, though some trials with concentric profiles were conducted as well. It is than sampling on a rectangular grid, and its benefit is that of simplicity in measurement execution. However, on the other hand its demerit is a large time of measurement resulting from a necessity of collecting a great number of measuring data. In order to obtain a reliable surface representation, the tracing speed must be low enough. If it is not than the stylus may lose a contact with the surface being inspected and a flight may occur [5]. A number of papers were devoted to this phenomenon [6,7] as its influence on the results of topography measurements is significant. If and when the flight occurs, depends not only on drive kinematic system but also on the stylus and surface geometry. The errors caused by the stylus not being in contact with the surface are the biggest obstacle in enlarging the scanning speed in multiprofile topography analysis. Thus still more and more often are the efforts to modify dynamics of the drive system in order to enable a fast scanning of the assessed surface.

One of the possibilities of reducing the time consumption in multiprofile topography measurement is to apply a non-rectangular grid [8,9]. The most popular grids are triangle one and hexagonal one, and especially the latter gives a nice time reduction as well as a smaller database. However, the benefits are not very significant (time reduction up to 15 %) while a sampling system has to be more complicated.

For this reason a spiral sampling was proposed as a potential solution of the problem. The solution is a novelty and does not exist in references neither in practical applications nor even in theoretical considerations. It should give a several times faster measurement, maintaining a good surface representation. For the sake of analysis it was necessary to create a mathematical base, an algorithm of data collection, transmission and converting as well as a construction of a device for a precise sample rotation and software for control and parameters calculation. This method was elaborated for nominally flat elements. It is based on a sampling that is a combination of two movements in the same time: a linear one and rotational one, giving a spiral as a result.

Spiral sampling is for some time now used as one of the strategies in NMR [10,11]. Also authors of [12] called this technique a spiral sampling, acknowledging it as a one of the fast method of image capturing. In work [13] authors pointed out its efficiency and continuous wave signal. Similarly like

during spiral sampling in surface metrology, also in NMR points on the spiral are translated to nodes of rectangular grid. There are some further research works on this topic still going on.

SPIRAL SAMPLING

Let us start with a short description of a spiral in general. Spirals (not fully properly) are two dimensional curves for which in polar coordinates their leading radius depends on an angle of rotation (increasingly or decreasingly). In case of Archimedean spiral of radius is proportional to the angle. This means, that - for example - if a body will move with constant velocity starting from the center of a record rotating on a record player to an edge, it will certainly follow an Archimedean spiral. Apart from this spiral few other are also known: logarithmic spiral - where radius depends on angle exponentially and Fermatian spiral (parabolic), where radius is equal to the square root of angle. Mathematically, a spiral is known from ages, and it was used e.g. to solve one of the famous Deli problems, a square with an area equal to area of a circle.

An Archimedean spiral is a set of points on a plane determined by a point moving with a uniform motion along the half-line rotating around its origin with a constant angular velocity (Figure 1).

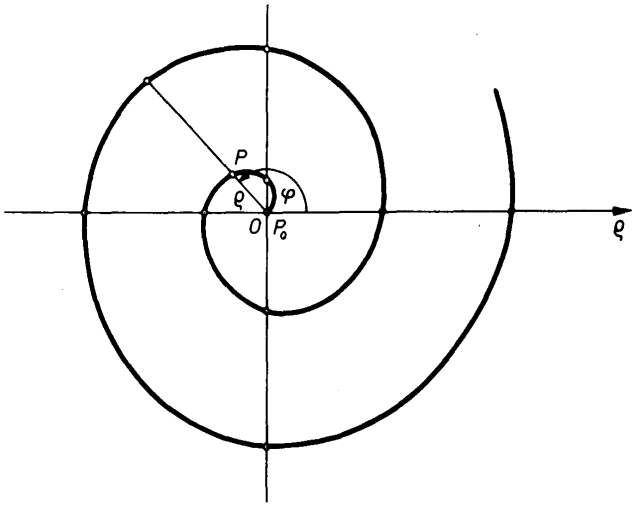

Figure 1 - The shape of Archimedean spiral

Assuming that initially a point P_0 moving along a half-line is in the pole, and the half-line is on the pole axis. Let the speed of the moving point be equal to c (expressed in mm/s or mm/min). A path ρ expressed in length units (e.g. mm or μm) covered by the point during a period of time denoted by t (in seconds or minutes) is equal to:

$$\rho = ct \qquad (1)$$

Let the angular velocity of the rotating half-line be equal to ω. The angular path covered by the half-line during the same period of time t is: $\varphi=\omega t$. Thus, eliminating t one can obtain a polar equation of Archimedean spiral in a form of:

$$\rho = \frac{c}{\omega}\varphi \qquad (2)$$

or:

$$\rho = a\,\varphi \qquad (3)$$

where: $a = \frac{c}{\omega}$, $a \in \Re^+$, $\varphi \in \Re_0^+$

The Archimedean spiral has got some important properties [14]. The most important for spiral sampling is the one stating that every half-line that has a beginning in the pole of spiral crosses this spiral in certain points. Distances between this points form an arithmetic sequence.

Sampling on that line gives in a topographical analysis of a surface as primary benefit a much less time necessary to cover a certain area comparing with a rectangular grid. Furthermore, with a rectangular grid it is necessary to withdraw a measuring pick-up to a starting point after every single profile. Although this motion is normally much faster than a measuring run, from a point of view of efficiency it is only a waste of time. There are only a few devices that can collect data in both directions, but than a problem of hysteresis appears. After every profile it is also necessary to move the whole setup in a perpendicular direction at a certain distance, to collect the next profile.

This motion, though a very small one is relatively slow, and has to be repeated normally more than a 100 times during the whole measurement. With every single profile - from dynamic or filtration point of view - it is also necessary to have one or two cut-offs more than these taken into further evaluations. The first one takes place at the beginning of every trace and the second (appearing in some devices) at the end of a profile. With spiral sampling there is only one cut-off at the beginning of the whole spiral and one (depending on the device) at the end because the pick-up is all the time in the motion. Only thanks to eliminating these segments the time consumption can be up to 30% smaller, comparing with a rectangular grid.

One of the problems appearing in spiral searching is the fact, that during a measurement the distance between a pick-up and the geometrical center of spiral grows constantly. This leads to a continuous growth of the tracking speed (Figure 2).

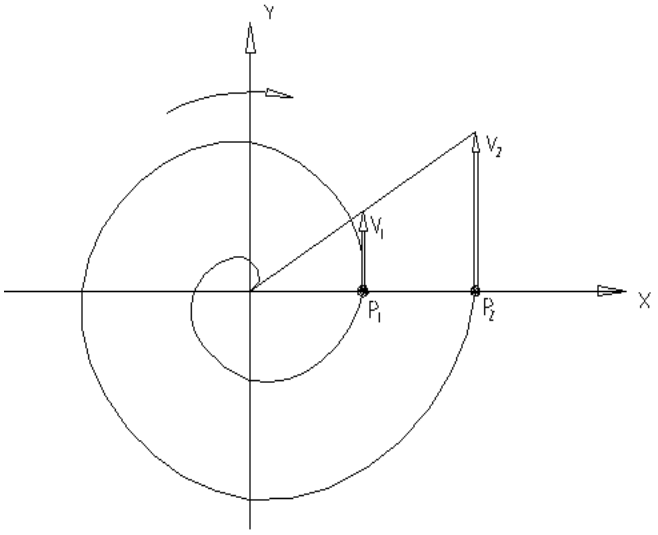

Figure 2 - Growth of the tracking speed during measurement in spiral sampling

If the whole measurement is to be performed at a constant angular speed, it must be chosen in such a way that a tracking speed at the end of a measurement will not be too big. Otherwise this may lead to destruction of a pick-up or at least distortion of a measuring signal due to a flight. Thus a measurement with a constant angular speed becomes quite inconvenient, as tracking is too slow at the beginning and too fast at the end.

During the initial phase of a measurement the table could rotate much faster and it wouldn't negatively influence the measuring conditions. Furthermore the time of measurement could be much shorter if the tracking speed was close to the certain optimal speed during the whole measurement.

Thus a concept of angular speed corrections was elaborated. The plot on a Figure 3 shows a measuring time change (regarding to 100 % with only one speed and no corrections) depending on the number of corrections. It is clearly visible that 3 to 5 changes of the angular speed can save about 40% of a measuring time. When a number of corrections reaches infinity the time save will reach as much as 50%. In this case the angular speed would have to be corrected continuously. In the elaborated prototype device the whole procedure with changing rotational speed is pretty straightforward to implement for control unit.

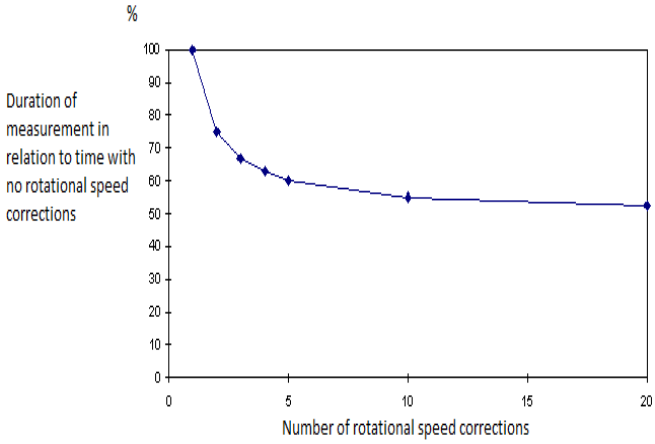

Figure 3 - Effect of corrections in angular speed on the total time of measurement

Another problem appearing when spiral sampling is applied is a special adjustment. For a proper measurement it is necessary to align the center of table rotation with the pole of Archimedean spiral. If the two points are not aligned, the pole of spiral is unknown what makes the calculation of points coordinates impossible. For this sake a special construction of a master can be used. Thus before the measurement takes place the whole setup is adjusted and the two points are aligned. In the described device this procedure is fast and done in automatic mode.

Similarly as for rectangular grid sampling conditions play an important role for measurement fidelity. For rectangular grid we have two sampling distances - in x and in y (Δx and Δy respectively), for spiral sampling very important is distance between convolutions k. An example of spirals with different convolutions was shown on figure 4 [15].

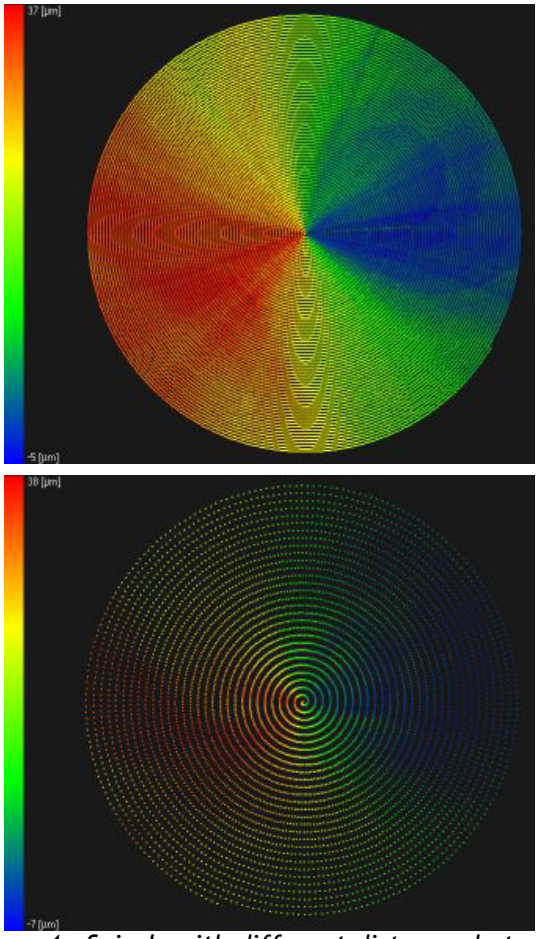

Figure 4 - Spirals with different distances between convolutions

MEASUREMENT SETUP

First trials with an application of spiral in surface metrology were mentioned by Mollenhauer [16], and a device enabling for that measurements was described by Nelle in his Ph.D. thesis [17]. He used two connected inductive gauges and a rotary table what made it possible to obtain profiles even as long as 30 meters. But the whole system was very complex and remained solely in a phase of prototype and initial tests, despite the fact that big number of points made it possible to get very stable results.

In the system proposed in this paper data points for topography analysis were collected by means of a stylus profilometer. The device was equipped with traverse drive on which rotary table was mounted. The output data were fed into a computer used for calculations. A scheme of the whole setup was shown on figure 5 while a picture of the device on figure 6.

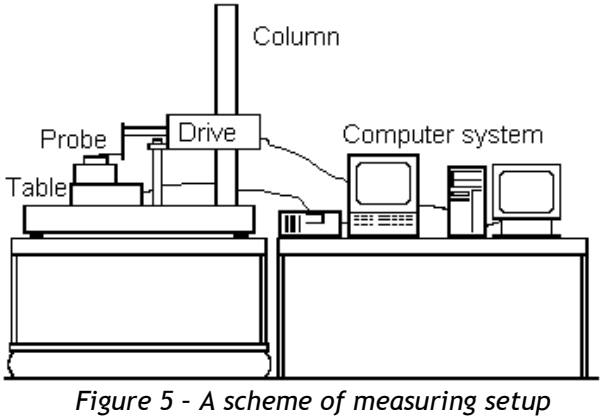

Figure 5 - A scheme of measuring setup

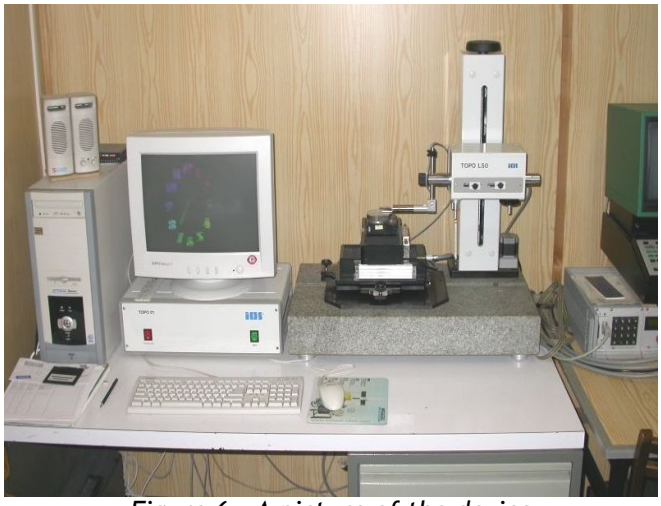

Figure 6 - A picture of the device

Measuring process is controlled by special software where all the conditions are programmed. There all the setup parameters for profilometer are defined: number of cut offs, number of measurement points etc. The program includes also commands sent to profilometer and to controller of linear and rotary drives. Collected data are transformed by software into coordinates, after calculating spiral radius in every point. Sampling points from spiral were transformed into net points of the rectangular grid using polynominal interpolation. Thanks to this, the same software was used for both grids to compute reference plane, parameter values and to present graphical image of the surface. It is also possible to extract a single profile from spiral grid in the direction corresponding to the one from rectangular grid. A comparison of these profiles - ensuring proper relocation - enables to observe similarities and differences in profiles obtained from both grids. From the sampled data points the following parameters were computed: Sq, St, Ssk, Sku, SΔq.

Comparison measurements were taken for both grids on surfaces after typical machining to get information regarding fidelity of representation [18]. They were performed with similar sampling density for both grids - about 84000 points per mm^2. Bearing in mind that square is included in spiral, the number of points from spiral sampling was a little bigger.

The measurements were taken on three flat samples machined by EDM, milling and grinding. Surface topography was measured on each of them using both: rectangular grid and spiral sampling. Creating a spiral it was assumed that the rectangular grid is included in the circle with a radius equal to the greatest radius of spiral.

RESULTS

Measurements were taken on different surfaces, respectively with determined, random and mixed lay. For determined structure a milled surface was chosen, for random an EDM one, while for mixed a ground plane. Sampling was made in two ways: either the biggest radius of spiral was inscribed in rectangular grid (Figure 7) or vice versa - a rectangular grid was inscribed in the biggest radius of spiral. Thus two different rectangular grids were created.

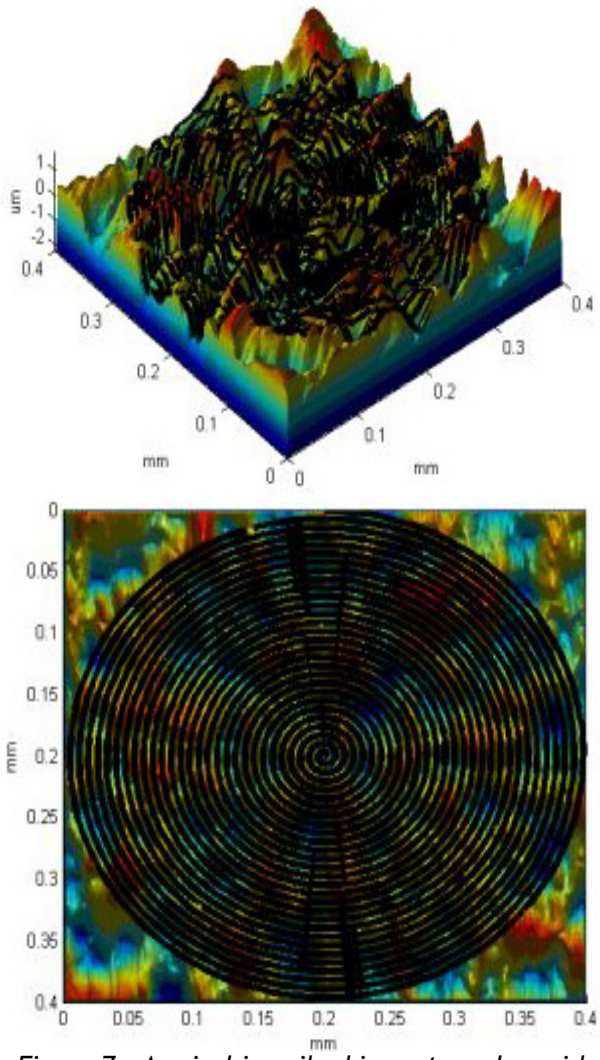

Figure 7 - A spiral inscribed in rectangular grid

As it turned out the values of surface topography parameters for both grids were pretty close to each other. The biggest differences were observed for milled surface while the smallest ones took place for surface obtained by grinding. For this surfaces not only height parameters were very similar (from 3,2% for St to 9,8% for Sq), but also the ones connected with shape of irregularities, e.g. SΔq (7,5%) which in other cases tend to differ between grids. For EDM surface the same differences were bigger: 9 - 11% for height parameters 40% for wavelength and over 80% for slope. The biggest differences in height parameters took place for milled surface (15 to 50%), though wavelength is quite similar. There were no significant differences between skewness and kurtosis for all inspected surfaces, what means that spiral grid managed to maintain and represent surface characters very well.

Steep irregular slopes and pitches are the features of EDM surface. This can be an effect of different approach to slope representation for both grids (difference in direction of movement through slope). The results of slope measurements for other surfaces were much closer as in these situations asperities are much more regular. In most cases the differences between height parameters were rather small. For spiral grid Sq and St values were greater what may be caused by different nominal surface orientation.

A comparison of profiles obtained in the same direction from both grids showed their compatibility as far as character of asperities is concerned.
In most cases results of parameters measured by means of spiral sampling were a little smaller than for rectangular grid. This is most probably due to the fact, that spiral has a bit more averaging effect for high peaks, as with this strategy a pick up tends more to slide down on them than with straight lines constructing rectangular grid. For determined or mixed surface direction of climbing peaks using rectangular grid is perpendicular to general lay, whereas for spiral sampling it is different. For the same reason in spiral sampling pick up a little more traverses slopes resulting in smaller values of SΔq. Another effect of different way of attacking slopes is a certain flattening of peaks observed in spiral sampling.
A cause of possible difference is also converting points from spiral to rectangular grid for calculations. This is due to interpolation procedure applied after measurement. Different algorithms cause - which seems to be understandable - different results, and the bigger is distance between convolutions of a spiral, the bigger are these differences.
Yet, all these differences - using proper sampling density and interpolation algorithm - can be minimized to a level smaller than 10 - 15% (depending on type of machining and magnitude of asperities), what is not a significant value bearing in mind, that traditional measurements in various areas on the same surface can give much higher discrepancies. A topographical image obtained by means of spiral sampling for a milled surface was shown on figure 8.

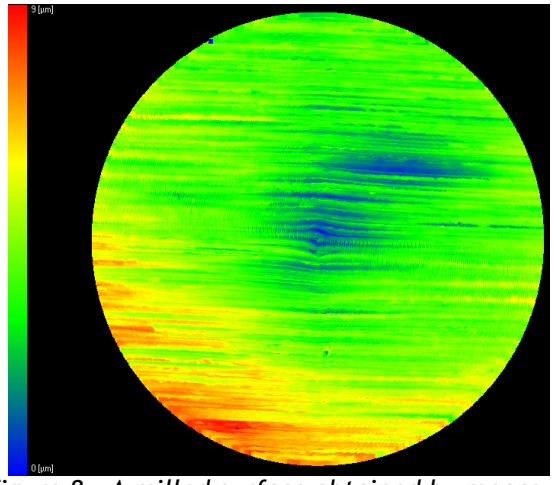

Figure 8 - A milled surface obtained by means of spiral sampling

On this figure one more problem appearing while using spiral sampling is visible. It is a small area of instability around a starting point. There, linear velocity of pick up is relatively small and main force component comes from rotation. Assuming, that at a starting point a pick up tip is on the slope (probability of that is close to 1) all backlashes and imperfections in mechanics may cause big interferences.

CONCLUSIONS

Basing on the above mentioned research a number of conclusions can be drawn:

- *Application of spiral sampling for surface topography measurements can be a good solution to a time consuming measuring process.*
- *A measuring method with all the algorithms and construction of a stand was worked out.*
- *With a spiral sampling the whole measuring process is fluent and is performed with no pauses.*
- *The considerations show a possibility of a further time reduction by means of angular speed corrections.*
- *Before the measurement it is necessary to aligned center of rotation with the spiral pole, using a special master.*
- *Spiral sampling is very interesting from theoretical considerations and proved to be successful in practical applications.*

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WASTE METALLURGICAL MATERIALS - POTENTIAL ADSORBENTS FOR REMOVAL Cr^{6+}

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ABSTRACT: Chromium is a common pollutant introduced into natural waters due to the discharge of a variety of industrial wastewaters. On the other hand, chromium based catalysts are also usually employed in various chemical processes, including selective oxidation of hydrocarbons. This paper describes the use of three metallurgical waste materials (electric arc furnace slag, waste mould sand and waste steel shot after cleaning of castings) as adsorbents for removal of Cr^{6+} from aqueous solutions. All mention waste materials were potential low-cost effective materials for Cr^{6+} removal. The removal of Cr^{6+} was studied by batch tests. The obtained results show that the analyzed metallurgical waste materials are effective adsorbents for the removal of Cr^{6+} from aqueous solutions within the range of working concentrations. The rate of Cr^{6+} adsorption increased rapidly during the initial 60 minute. Comparing the all isotherms, electric arc furnace slag was shown higher adsorption of Cr^{6+} than other used waste metallurgical materials.
KEYWORDS: waste metallurgical materials, adsorption, efficiency

INTRODUCTION

Chromium is a toxic metal and widely used in the industry (electroplating, leather tanning, metal finishing and chromate preparation, etc.). Of its two oxidation states, Cr^{3+} and Cr^{6+}, the hexavalent form is considered to be a group "A" human carcinogen because of its mutagenic and carcinogenic properties [1, 2].

Chromium is a common pollutant introduced into natural waters due to the discharge of a variety of industrial wastewaters. On the other hand, chromium based catalysts are also usually employed in various chemical processes, including selective oxidation of hydrocarbons. According to the World Health Organization (WHO) drinking water guidelines, the maximum allowable limit for total chromium is 0.05 mg/l. Hence, it becomes imperative to remove Cr^{6+} from wastewaters before discharging them into aquatic systems or onto land [3].

Adsorption is a well-established technique for heavy metal removal. Activated carbon is a widely used adsorbent material. In fact use of activated carbon can be expensive due to the regeneration required and loses in the application processes. A variety of natural, synthetic materials and industrial waste materials has been used as Cr^{6+} inexpensive adsorbents [4].

This paper presents the use of three metallurgical waste materials (electric arc furnace slag, waste mould sand and waste steel shot after cleaning of castings) as adsorbents for removal of Cr^{6+} from aqueous solutions. All mention waste materials were potential low-cost effective materials for Cr^{6+} removal.

MATERIALS AND METHODS

Electric arc furnace slag, steel shot and waste mould sand, as non-toxic waste materials, was used as adsorbents. The electric arc furnace slag is a waste material generated from the steel making process. The steel shot is waste material from castings cleaning process. The waste mould sand is residue from gray iron foundry.

The chemical composition of adsorbents was determined with classical chemistry analysis, according to Standard Methods [5] (Table 1-3).

Table 1. Chemical composition of electric arc furnace slag

Components	CaO	FeO	MnO
wt, %	36.1	27.2	18.0
Components	SiO_2	Al_2O_3	MgO
wt, %	17.0	1.4	0.3

Table 2. Chemical composition of steel shot

Components	Fe	C	Mn
wt, %	98.05	0.85	0.60
Components	Si	S	P
wt, %	0.40	0.05	0.05

Table 3. Chemical composition of waste mould sand

Components	SiO_2	Al_2O_3	Fe	Ca	Mg
wt, %	90.0	1.6	6.8	0.55	0.08
Components	Mn	Ni	Cr	C	
wt, %	0.04	0.004	0.01	0.916	

The removal of Cr^{6+} was studied by batch tests. The mixtures of 1 g samples (adsorbents) and 50 ml of prepared chromium solutions of differential initial concentrations (100, 200, 300 mg/l) were shaken at 60 rpm during 180 min at a temperature of 20°C in the closed vessels. Chromium ion solutions with different initial concentrations of chromium were prepared by diluting chromium standard solution. After filtration of the suspensions, the concentrations of chromium ions in the filtrate were determined by atomic adsorption spectrometer (ZEEnit 650, Analytic Jena).

Adsorption capacity of metallurgical waste materials was compared with adsorption capacity of commercial activated carbon (Merck, Deutschland), which was tested in identical adsorption condition as waste metallurgical materials.

RESULTS AND DISCUSSION

Figure 1 shows adsorption isotherms of Cr^{6+} ions on electric arc furnace slag, waste steel shot, waste mould sand and commercial activated carbon.

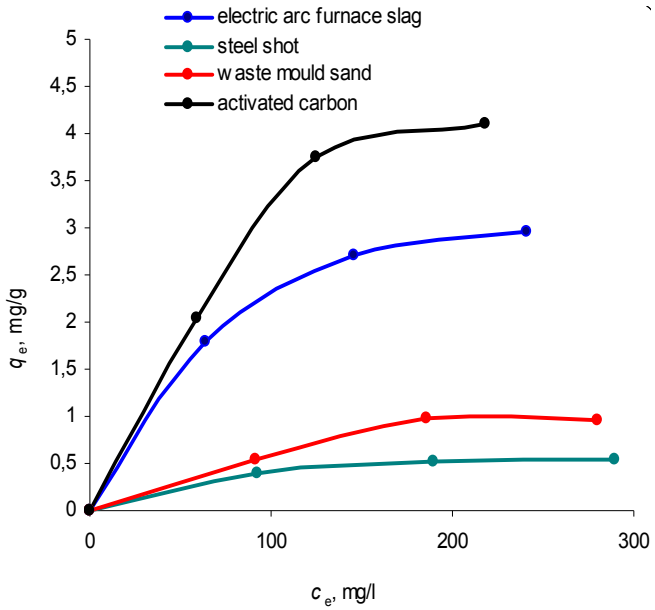

Figure 1. Adsorption isotherms of Cr^{6+} on electric furnace arc slag, waste steel shot, waste mould sand and commercial activated carbon

Figure 1 shows that the adsorption capacity increased with an increase in the initial Cr^{+6} concentrations for all using adsorbents. This is because an opportunity existed for increased reaction between the adsorbent and the adsorbate [6].

Comparing the all isotherms, Cr^{6+} adsorption of electric arc furnace slag was higher than adsorption capacity of other waste materials used as adsorbents. For electric arc furnace slag, equilibrium adsorption of Cr^{6+} was 2.95 mg/g when initial concentration of Cr^{6+} was 300 mg/l. The uptake of Cr^{6+} on waste steel shot and waste mould sand was much lower (adsorption capacity was 0.53 and 0.99 mg/g, respectively), for the same initial Cr^{6+} concentrations.

Figure 2 shows the amount of Cr^{6+} adsorbed on used adsorbents versus time.

It can be observed from Figure 2 that the rate of Cr^{6+} adsorption increased rapidly during the initial 60 minutes. After that, the removal of Cr^{6+} ions was decreased.

During the initial stage of adsorption, a large number of vacant surface sites were available for adsorption. After a lapse of some time, the remaining vacant surface sites were more difficult to occupy due to repulsive forces between the adsorbed molecules on the solid surface and in the bulk phase or desorption [7 - 9].

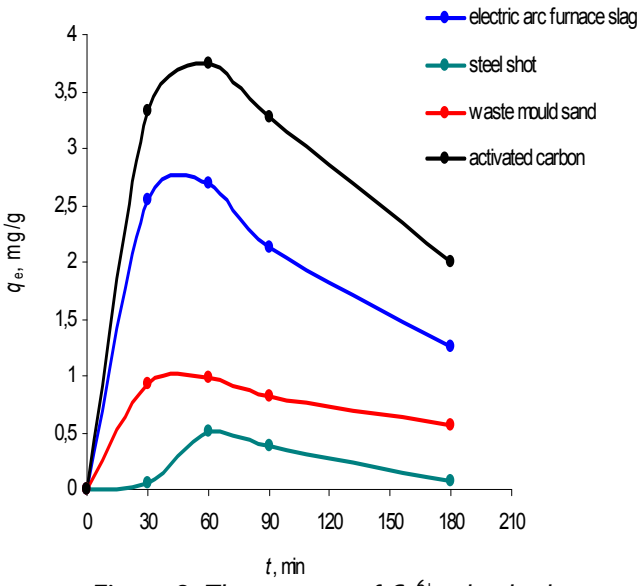

Figure 2. The amount of Cr^{6+} adsorbed on used adsorbents versus time (initial concentration is 300 mg/l)

Figure 3 shows the removal efficiency of Cr^{6+} as a function of initial adsorbents concentration (100, 200 and 300 mg/l).

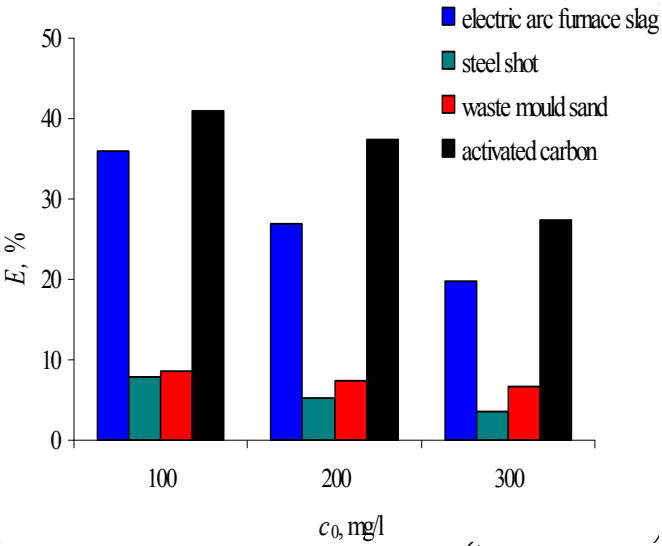

Figure 3. The removal efficiency of Cr^{6+} as a function of initial adsorbents concentration

It can be observed from Figure 3 that the removal efficiency of Cr^{6+} decreases with the increase of concentration of Cr^{6+} in solution. The cause may be the aggregation/agglomeration of adsorbent particles at higher concentrations, which would lead to a decrease in the surface area and an increase in the diffusion path length [10].

All results indicate that the electric arc furnace slag was the best low-cost adsorbent for removal of Cr^{6+}.

This research also proves that the removal efficiency depends on chemical composition of adsorbents [11].
Electric arc furnace slag composed of different oxides, mostly iron oxide (Table 1). Waste mould sand (Table 2) is mixture of silica sand, clay binder and organic carbon source (typically coal dust) [12, 13]. Adsorption medium was probably the iron particles and the coal dust [14].
Examination of different adsorbents shows the connection between their composition and adsorption capacity [15 - 18]. Carbon, metal oxides and SiO_2 in metallurgical wastes contribute to their adsorption ability (Tables 1-3).
Activated carbon adsorption seems to be an attractive choice for chromium removal, both for its exceptionally high surface areas, well-developed internal micro porosity structure, as well as the presence of a wide spectrum of surface functional groups like carboxylic group. For these reasons, activated carbon adsorption has been widely used for the treatment of chromium containing wastewaters [19].
Recently the market price of activated carbon for industrial grade is considered to be very expensive, depending on the quality of activated carbon itself [4]. Although a significant number of low-cost adsorbents from various materials have been found, commercial activated carbon has still been used intensively today.
Comparison of used waste metallurgical materials with commercial activated carbon shows that are good adsorbents for adsorption Cr^{6+}, especially electric arc furnace slag.

CONCLUSIONS

- *The metallurgical waste materials (electric arc furnace slag, waste steel shot and waste mould sand) were effective low-cost adsorbents for removal Cr^{6+} from aqueous solutions in concentration range from 100 to 300 mg/l at a temperature 20 °C.*
- *The rate of Cr^{6+} adsorption increased rapidly during the initial 60 minutes.*
- *The electric arc furnace slag was much better adsorbents for removal of Cr^{6+} than then waste mould sand and waste steel shot.*
- *Commercial activated carbon was the best adsorbents for removal Cr^{6+} from aqueous solution.*

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CO-CREATION CHALLENGES OF MODERN MARKETING

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ABSTRACT: Nowadays, interaction between customers and companies is taking new forms and shapes that go beyond almost all aspects of traditional exchange. Thus, both companies and customers are initiators of the new ways to support each other's value creation, based on customization, developing new co-creation mechanisms. The authors' opinion is that consumers 'innovators' as a relatively small group of consumers, who tend to buy the first new product, are potentially significant source of so-called "customized" consumers. The interrelationship (innovator-customized consumer) is reflected in the context of social capital and the dominant cultural pattern, as a catalyst of the creation of consumers which key feature is active participation in the production of its own (consumer) experience. Therefore, our focus will be on the co-creation process and the modern challenges associated with it.
KEYWORDS: Co-creation, Consumer Innovator, Social Capital, Cultural Pattern, Modern Marketing, Virtual Communities

INTRODUCTION

Consumption as a social and symbolic act becomes an increasingly important segment or hallmark of culture; it can be interpreted as an indicator of social and cultural differences and overall social relations.
Nowadays, the market is increasingly becoming a mediator of both economic and social activities. It affects the "human relations at work and at home, in public, as well as in the most intimate and private areas"[1]. Given that we are living in a society of consumers, their "natural habitat" has become the market, i.e. the place of purchase and sales.
The key fact is the emergence of new consumer logic that becomes the hallmark of the postmodern culture of developed societies of the West, contributing to the general "marketization" of society (or the penetration of market paradigm in various segments of social relations). Therefore, consumption has got the status of one of the basic elements and integrating factors on society; it has become the central research subject in the area of marketing and management, shaping the daily lives of people to a large extent.
Rather than adopting the traditional and accustomed lifestyle, the new "heroes of consumer culture" have made it a lifestyle-project, expressing their individuality and the sense of style through particularities (of goods, clothing, behaviour, experience, appearance and body) based on which they design their own lifestyle [2: 67]. Identity in consumer society is increasingly associated with style, image and appearance.
The (postmodern) consumer is featured by the paradigm of hyper reality, providing him/her with the properties of creator of change. As suggested by postmodern sensibility, "production and reproduction, image, simulation and meanings are no more the matter of accident or the result of fortunate circumstances,"; instead, they are "deliberate and organized"[3], opening new areas of challenges of marketing theory and practice. The contemporary (postmodern) consumer increasingly participates the "customization of his/her own world," affecting the final appearance of the product [4].

CO-CREATION PHENOMENON

Recently, the term co-creation has been established to denote special methods and strategies applied by firms to engage customers and users into their innovation process [5]. Customer co-creation describes set of methods that establish an active, creative and social collaboration process between producers and customers (users) in the context of new product development[6][7]. It denotes a paradigm shift from a manufacturing-active paradigm to a customer-active paradigm [8]. Customer's participation in a product development process increases. His or her active role represents a great challenge for modern marketing.
Customer co-creation is an open innovation with customers. It is a product or service development approach where users and customers are actively involved, providing ideas and take part in the design of a new offering [9][10][5]. More specifically, customer co-creation is an active, creative, and social process, based on collaboration between producers (or retailers) and customers (users)([7] building on [6]). The idea of co-creation is to actively involve customers in the design or development of future offerings [11], often with the help of tools that are

provided by the firm. These tools are usually based on digital and Internet technology, because they provide an easy access. Also, Internet-based co-creation process make customer's experience more relevant, useful and fun.

Co-creation activities are performed in an act of company-to-customer interaction which is facilitated by the company. The manufacturer is either empowering its customers to design a solution by themselves or is implementing methodologies to efficiently transfer an innovative solution from the customer into the company domain. Examples for methods include ideation contests, lead user workshops, consumer opinion platforms, forums, blogs, social networks, toolkits for user innovation, or communities for social product development.

(UN)EMPTY 'TANKS' OF SOCIAL CAPITAL

The first serious theoretical analysis of social capital is given by Pierre Bourdieu [12] in his theory of capital. Bourdieu considers that social capital is made up by combination of relationships, obligations and social contacts which individuals, families and social groups realizes and it may be under certain conditions converted into economic capital. At the organizational level, the social capital of individuals associated in the organization is connecting into the social capital of the organization and it is relatively easy to convert it into economic capital in a favorable moment.

Putnam, the most important theorist of social capital, was initially determined the social capital as features of social organization, such as trust, norms and networks that can improve the organization of society through the implementation (supporting or facilitating) of coordinated engagement [13: 167]. In later papers he recognizes participants as beneficiaries of social capital [14: 664-665], and finally social capital is defined as the relationship between individuals, as social networks based on norms of reciprocity and trust built on it [15: 19] which makes the legitimate point that social capital becomes directly linked to long-term personal interests.

Social capital comes to the fore when based on common values individuals realize social interaction, and on the basis of them build social networks which have a value not only on the emotional level but rather in a very concrete benefits resulting from the trust, reciprocity, information exchange and cooperation related to social networks. Thus, social capital is usually understood as a system of social networks (and norms) caused by regular social interactions that facilitate the action of individuals and groups within the wider community or society or as a social (common) resource that makes easy/difficult access to other resources and, potentially increases the comparative advantage over those who are not members of the network. Social capital, in principle, is disposed of the individuals linked to the different social networks. Ultimately this concept of social capital is an expression of personal (and social) trust and it represents a link that allows group coordination and cooperation for achieving individual (or group) benefits.

According to Putnam, social capital has three components: reciprocity, network connections and trust. Under reciprocity Putnam implies continuous cooperation and exchange relations involving mutual expectations that what we give today it will be returned in the future. When we talk about network connections, we should emphasize the importance of horizontal relationships of individuals of equivalent status and power. On the other hand, the vertical relationships involving individuals of different status are not considered significant for the formation of social capital. If mutuality and horizontal networks are placed in the same place then it has created a fertile ground for the development of mutual trust.

In general we can conclude that the key provisions of the social capital is that it includes all types of relationships between individuals, that all private networks and relationships with friends and family are important to it and that the emphasis is put on abstract normative and value aspects of mutual trust. In this sense various forms of solidarity can be the basis of trust: family, political, ideological, religious, interest, professional, intragroup in any sense of the word. This means that the social networks that individuals build can simultaneously represent a social capital for their institutions and other organizations and for linked individuals.

One of the biggest challenges for marketing today is phenomenon of virtual world and all of its characteristics - good and bad. Technology development and widespread use of the Internet, are bringing great advantages and benefits in private and business environment. The huge growth in computer, communications and other digital technologies has had a major influence on the communication. Considering that communication is the basis of building social capital, new ways of communicating are pointing to modern ways of building social capital. Technology has become an integral part of our lives. Creating social networks in the online environment, thus creating virtual communities can be one of the challenges of modern marketing. Digital technology brings, among the other benefits, a new way of online communication, relationship building tools, online advertising, online social networks etc. As technology has emerged, co-creation is a viable contemporary solution.

Internet environment enables the connection of a large number of people, transcending geographical and time barriers. With the connectivity and interaction, buyers and consumers have the opportunity to express their opinions, to tailor products and services to their needs and desires, and so actively participate in the production process. Online co-creation, as one of the challenges of the modern marketing, are product of creating virtual communities, customer's lack of time and sometimes of their spoiled. But, at the same time, online co-creation is one of the best ways for customers to create an unique product to satisfy their specific desires. Participating in online discussions and interaction with other consumers and organizations, consumers are building new reservoirs of their social capital.

"Customers can get a clearer impression on firms' activities and products by e.g. visiting a firm's Facebook page, but the firm in return gets additional valuable information about the visitor's social network profiles. Further, it is not only the customer-firm relation, but also the customer-customer relation that is affected. Customer can communicate, share knowledge, and find people with similar interests far easier." In turn, social media usage could have a great impact on relationships within each method of co-creation [16].

THE CULTURAL PATTERN AND A WORLD OF VIRTUAL COMMUNITIES

Since culture is "an integral part both of the structure of society and the structure of personality", it should be viewed from both angles. "Culture can be thought of as a 'building' others have built for centuries," says Z. Golubovic [17: 79], "that we find at birth, outside of which we would not be able to live a human life, but while living in it we feel the need to participate in its modeling and shaping...". All the above speaks in favor of the thesis of interdependence of culture, man and his behavior.

Behavioral tendencies can be explained through the characteristics of the prevailing cultural pattern. "Regardless to their incompleteness, people realize themselves through culture..." [18]. What is the cultural pillar of human behavior in Serbia made of? The answer can be found in clues on the ruling cultural matrix (cultural pattern) in Serbia, based on research of G. Hofstede [19], who believes that culture is a multidimensional concept. Based on the research from the 1970's and 1980's, Hofstede et al. have concluded that countries are resolving the same problems differently, establishing five key dimensions based on which it is possible to distinguish between national cultures: power distance (PDI), uncertainty avoidance (UAI), individualism/collectivism (IDV), masculinity/femininity (MAS) and the long-term/short-term orientation in time.

Cultures with the strongest resistance to change [20] are characterized by a high power range index, low individualism index and high uncertainty avoiding index. The cluster of countries with the strongest resistance to change (Portugal, Latin America, and Korea) had included also the former Yugoslavia. However according to a later repeated research [19], countries established by the disintegration of 'second' Yugoslavia have also retained (or rather maintained) these characteristics.

It is easy to conclude that cultures with low power range and uncertainty avoidance index and high individualism index, are expressing openness and readiness for change (England, USA, Sweden, Finland, Norway, The Netherlands). Of course, generally speaking, we can rather say that high uncertainty avoidance and power range levels are resulting with increased resistance to changes, while high level of individualism 'encourages' changes.

However, with a emergence of the Internet, citizens of Serbia and former Yugoslavia initially resisted the use of new technology, but in a short time they showed a high degree of adjustment to changes. Namely, the number of Internet users in Serbia tripled in four years (2006-2010) [21] and the number of Internet users worldwide is constantly increasing. Now, there are more than 1.8 bilion users worldwide. The digital era has brought many challenges to today-s cultural patterns. Some of traditional aspects have turned off, and some of new aspects have appeared. Lifestyle and consumer behavior have changed. Web 2.0 has overcome a simple information exchange. Now, people are connected worldwide, using different technologies such as blogs, social networks, forums etc. With the exchange of opinions and experiences, using online communication, people become closer to each other, creating virtual communities. Buyers and consumer of certain products, which have Internet access, are able to participate in co-creation and development of products, adapting it to their needs and desires. This leads to consumer empowerment. In context of virtual communities, empowerment refers to how the new technologies enable people to interact with the world on different levels (personal, dyad, group, or community) and to do or to achieve things that they found difficult to do or to achieve before [22].

THE ROLE OF CONSUMERS INNOVATORS IN CO-CREATION

Considering the characteristics of consumer innovators as a consumer group with a strong tendency towards being the first to buy a new product, the authors argue that this group has a significant capacity of influencing the final appearance of the product that they want to buy. In this way, consumer innovators indicate the consumer preferences that can be identified as an explicit preference for participating in the "customization of their own world" and creating their own consumer experience. All this supports the view that the identification of consumer innovators is the key concept to the development of businesses that root their differential advantage in the strong synergy of creative consumer and producer inputs while creating the desired product. Online environment provides a huge number of creative and interesting possibilities for innovative consumer to express themselves, quickly and to an enormous number of people.

Consumer preferences are explained by the consumers' personality traits. Innovativeness, the low level of dogmatism, the high optimum stimulation level and thus, the readiness of assuming higher levels of risk are all the key characteristics of consumer innovators. As characterized by the absence of prejudice, their innovative behaviour is an expression also of a strong need for uniqueness [23], and of the tendency to special offers. All this supports the thesis that consumer innovators are the potential core of 'customized consumers', having also the potential of recruiting new consumers who belong to the group called non-innovative consumers. A higher level of social acceptance and social integration of consumer innovators makes them effective opinion leaders, increasing their impact on consumers of different consumer preferences.

Internet provides information, connectivity, remote access, applications, networking sites and so on.

Innovative consumers are using a large number of digital technology's tools. They are empowering themselves with all of benefits that Internet provides. Passing on their experiences, they are creating a new cultural pattern and increasing their social capital.

Considering the properties of consumer innovators, it is not difficult to see the significance of the level of social capital and the prevailing cultural pattern as indicators of the innovative consumer capacity.

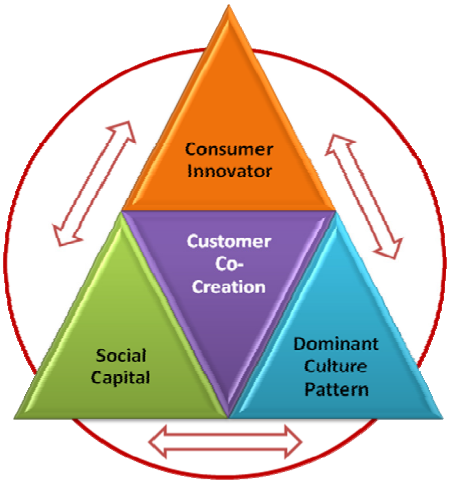

Fig. 1. The interrelationship: Co-innovator & Cu-Co-creation & Soc.capital & Cultural Pattern [24]

The key concern of marketing professionals is finding and recruiting new customers. Regarding the target group that has a high capacity of consumer preferences of participating in the creation of the own products, they are reasonably found among the consumer innovators. On the other hand, it is highly important to ensure the critical mass of such customers in order to ensure the cost-effectiveness of the co-producing strategy, both in terms of profitability, and in terms of less tangible values (image, brand, etc...). However, it is necessary to be familiar with the prevailing cultural pattern and the status of social capital. In societies with a high level of risk avoidance and power distance and low levels of individualism indicated by the cultural pattern, it is difficult to expect a significant level of presence of consumer innovators and 'customized' consumers. On the other hand, societies with empty or low reservoirs of social capital are characterized by high levels of distrust towards both the individuals and institutions, making the inclusion of processes of creating consumer experiences more difficult.

CONCLUSIONS

Consumer innovators are expressing consumer preferences that can be identified as the preference for participating the "customization of the own world" and the creation of the own consumer experience. All this supports the view that the identification of consumer innovators is essential for the development of businesses establishing their differentiated benefits on the strong synergy of consumer and manufacturing inputs in the creation of the desired product. Considering the characteristics of consumer innovators, it is not hard to perceive the significance of the level of social capital and the prevailing cultural pattern, as an indicator of innovative consumer capacity. The higher level of social acceptance and the better social integration of consumer innovators make them effective leaders of opinion, increasing their impact on consumers of different consumer preferences.

The role of the Internet in these processes is huge. New type of communication through Internet channels provides people to participate in online discussions, exchange opinions, developing and creating product that are custom-made. Co-creation is a process that provides a wide array of options to consumers innovators. By providing them so much freedom, for modern marketing is very difficult to balance the needs between customers and companies, especially whit the strong influence of social capital and cultural pattern.

In societies the cultural pattern which indicates high levels of risk avoidance and power distances and low levels of individualism, it is difficult to expect a significant presence of consumer innovators, and hence 'customized' consumers.

Today's business conditions forced companies to reconsider their customers' roles in current business practices. Companies need to pay more attention to the co-creation process, all its advantages and disadvantages, especially the challenges that brings. However, not all companies necessarily benefit from value co-creation, which makes it even more important for them to carefully assess the opportunities that it entails.

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COLORIMETRIC DIFFERENCES ON WOOD SUBSTRATE DUE TO VARNISHING INFLUENCE

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ABSTRACT: Digital printing machines with ink jet technology allow printing on wood substrate and varnish can be used as final process in wood finishing. Although varnish is protecting printed ink and increasing mechanical properties of wood surface it is also changing hue and saturation of printed color. The aim of this study is to quantify that difference in color value printed on a wood substrate with and without varnish layer. For that purpose, standardized colorimetric methods were taken based on CIE L*a*b* values using the equation for color differences CIEDE2000.
KEYWORDS: wood substract, varnish, ink jet, CIALAB space, color gamut, color differences CIEDE2000

INTRODUCTION

Digital ink jet printers can print directly on: glass, metal, stone, wood, plastics, etc. They are using solvent ink based on alcohol gel. Wood products as print substrates are characterized by great thickness and specific structure that achieves different surface properties (great absorption, surface roughness and possibility of different surface textures).

For easier maintaining the wood surface the varnish is used. Varnish is a transparent and protective film with glossy or semi-glossy reflection. It is used for increasing mechanical properties of wood surface and for protecting printed ink.

However, in the contact with wood surface, varnish is changing the hue and saturation of the printed color. Colorimetric differences, with and without varnish on the printed wood surface, can be measured with standardized colorimetric method based on CIEL*a*b* values.

L*a*b* (CIELAB) and L*u*v* (CIELUV) color space were designed to be device independent and perceptually uniform. They were introduced in the 1976 by the Commission Internationale de l´Eclairage (CIE - the primary organization responsible for standardization of color metrics and terminology). The CIELAB color space is widely used in color imaging and printing industry while CIELUV is commonly used in the display industry. These spaces are defined in terms of transformations from CIE XYZ tristimulus values to these spaces [1].

Based on CIE L*a*b* values the gamut of reproduction can be also constructed. Color gamut is the range of a set of colors and can be represented as location in a three-dimensional color space. For the gamut of reproduction the ICC profiles are necessary.

The ICC (International Color Consortium) is a consortium of those vendors founded in the year 1993 with the aim of developing a universal color management solution. The ICC profile format, defined by the ICC Profile Specification, consists of various data structures, which provide a mechanism for color transforms [2].

METHODOLOGY

The research was carried out on an ink jet printer DTS (direct to substrate).The printer driver takes RGB values as inputs. A standard X - Rite profile 343 Patches test chart was printed on three different wood surfaces -chipboard, MDF board and spruce board. After the chart was printed and dried on each board, L*a*b* values were measured using a spectrophotometer i1 Pro with 45°/0° measuring geometry, under conditions 50D illumination and 2° observer.The obtained data consisted of values of RGB inputs and their corresponding spectral reflectance.

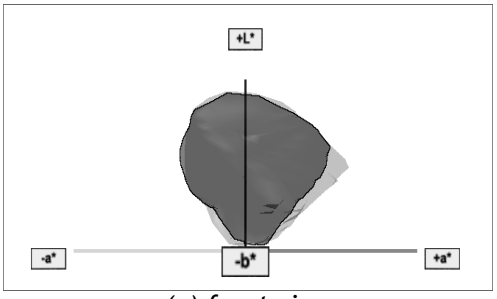
As a wood finishing the varnish was applied, two layer of basic varnish and one waterborne. When varnish was dried the L*a*b* values were measured again under equal conditions.The evaluation was carried out by the values with and without varnish for each of the 343 test chart patches using the equation for color difference CIEDE2000 [3].

$$\Delta E_{00} = \sqrt{\left(\frac{\Delta L'}{k_L S_L}\right)^2 + \left(\frac{\Delta C'}{k_C S_C}\right)^2 + \left(\frac{\Delta H'}{k_H S_H}\right)^2 + R_T \left(\frac{\Delta C'}{k_C S_C}\right)\left(\frac{\Delta H'}{k_H S_H}\right)} \quad (1)$$

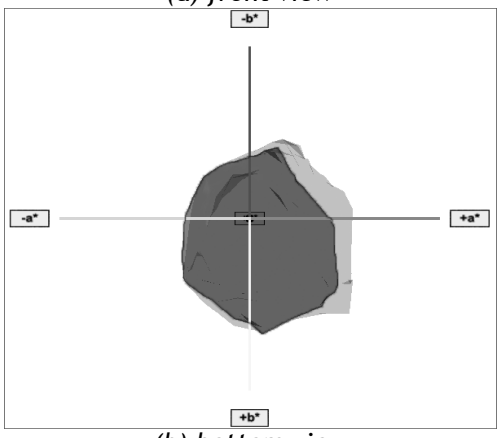
The obtained ΔE errors are Euclidean distances in the L*a*b* space. The minimum, mean, median and maximum of errors were calculated and the results are displayed in Table 1.

Table 1. Evaluation results

	Min ΔE	Mean ΔE	Median ΔE	Max ΔE
CHIPBOARD	0,6686	5,3392	4,8394	15,2802
MDF	0,8630	4,1760	3,1186	32,0223
SPRUCE	1,9271	6,2595	6,2434	9,9459

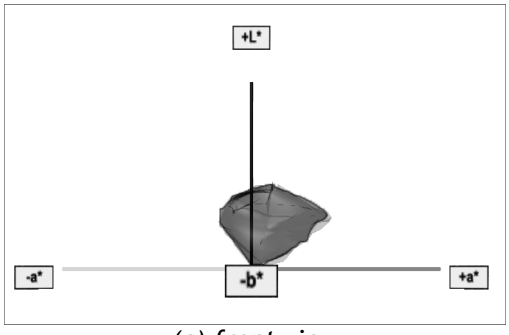


(a) front view

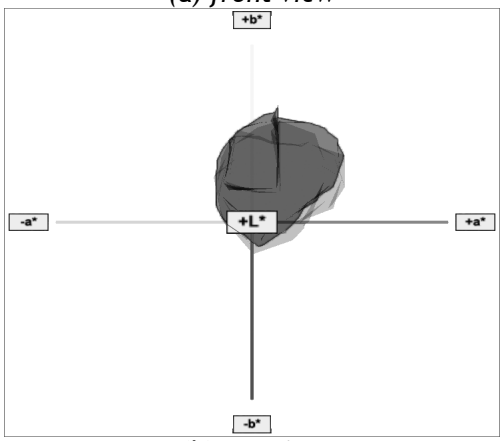


(b) bottom view

Figure 1.(a) front view and (b) bottom viewofcolor gamut without varnish (shown as light gray color) and with vanish(shown as dark gray color) on chipboard

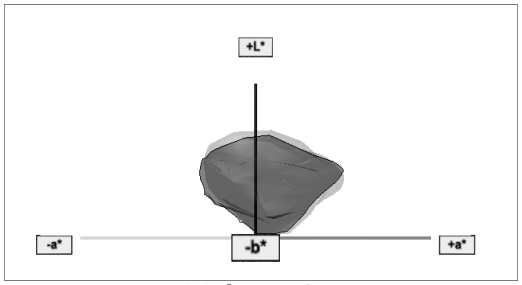


(a) front view

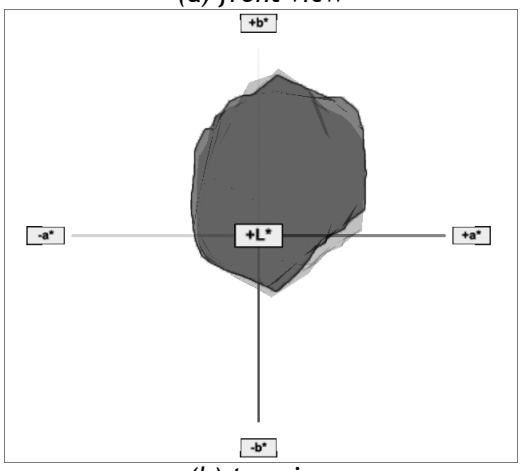


(b) top view

Figure 2.(a) front view and (b) top viewof color gamut without varnish (shown as light gray color) and with varnishing (shown as dark gray color)on MDF board



(a) front view



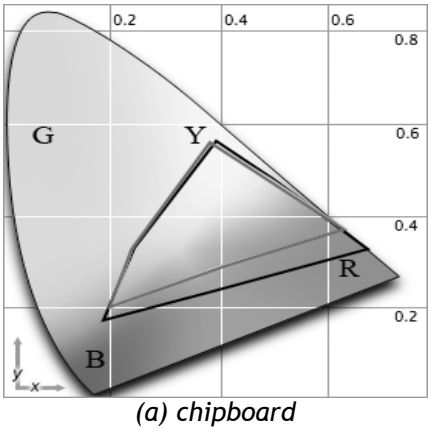
(b) top view

Figure 3.(a) front view and (b) top view of color gamut without varnish (shown as light gray color) and with varnish (shown as dark gray color)on spruce board

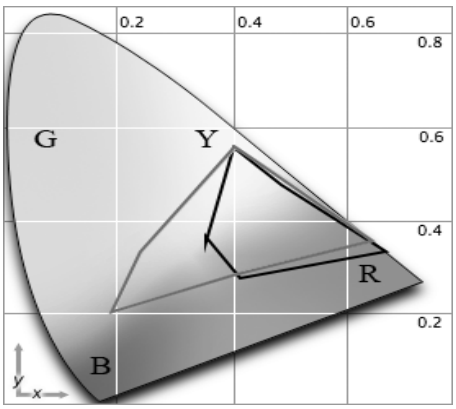
Once the L*a*b* values were measured the ICC profiles were made using Profile Maker 5.0. ICC profiles are required for construction of color gamut. In Color Shop X application the reproduction of gamut were made. Color gamut can be represented as a volume in three-dimensional color space. Therefore, the comparison in 3D color space of color gamut with and without vanish can be seen for chipboard on Figure 1; for MDF board on Figure 2; and for spruce board on Figure 3. in various views.

In the L*a*b* color space: L* represents the lightness, a* encodes the red - green sensation and b* encodes the yellow - blue sensation. Positive +a* indicates a red color and negative -a* a green color; and positive +b* indicates a yellow color and negative -b* a blue color [4].

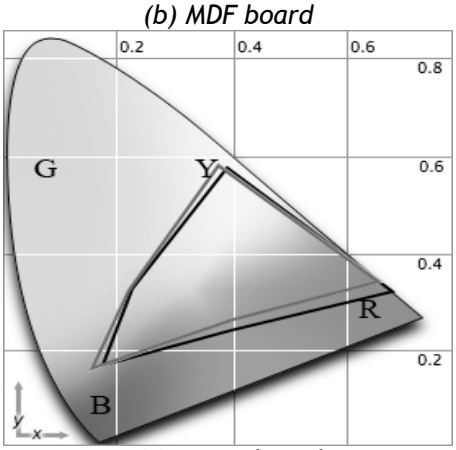
Furthermore, color gamut can also be represented as a vector in two-dimensional space as a unit plane known as spectrum locus in chromaticity diagram (Diagram 1.) [5].



(a) chipboard



(b) MDF board



(c) spruceboard

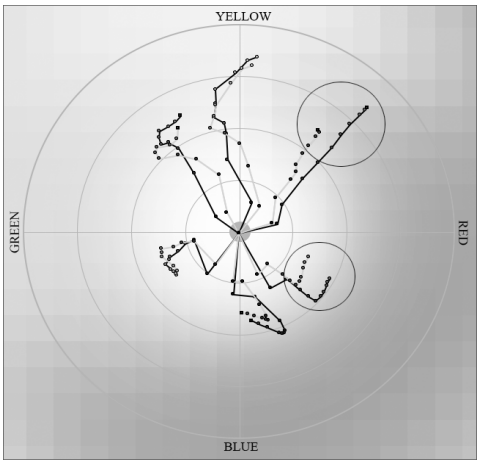
Diagram 1.CIE xy chromaticity diagrams for (a) chipboard, (b) MDF board and (c) spruce board (black stroke shows gamut without vanish, gray with) G = green, B = blue; Y = yellow, R = red

RESULTS

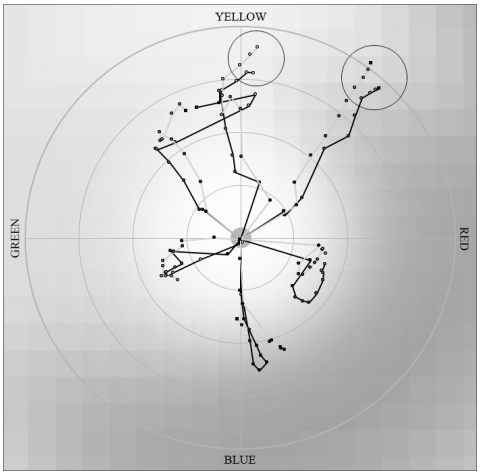
For these research three different wood surfaces were tested -chipboard, MDF board and spruce board. As can be seen from Table 1.the mean error of around ΔE 6is the highest for spruce board, but it is also interesting to note that thespruce board has the highest minimum error of ΔE 1,9 and smallest maximum error of ΔE 9,9. This indicates that the entire color amount after varnishing changed linearly which is nicely shown on the Diagram 1c. However blue tones went to green after varnishing which can be seen on Figure 4c. and the saturation of red color increased which can be seen on Figure 3a.

The smallest mean error of around ΔE 4 is for MDF board although Diagram 1b. shows desaturation of green and blue tones on unvarnished surface. That indicates that MDF board has great absorption properties and that the green and blue tones merged with the surface. Use of varnish not just increased the saturation of these twocolors but also the saturation of yellow color. Desaturation of red can be seen on Figure 2b; and Figure 4b. indicates that red went to yellow.

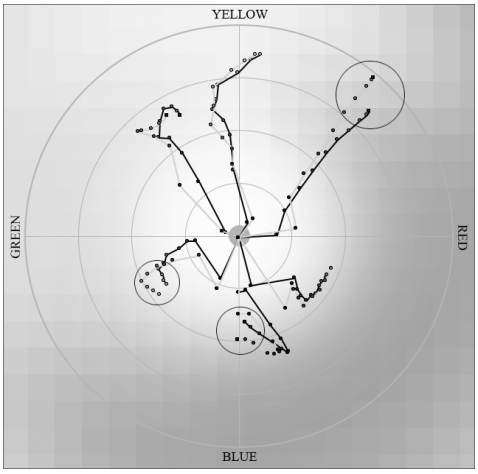
It is noticeable on the Figure 4a. that the saturation of red color on chipboard with varnish fall drastically which also indicates the maximum error of high ΔE 15,2. This is indicated also by Figure 1a. and Figure 1b. where we can see from bottom view the missing area in a+ zone which represent the red color.



(a)



(b)



(c)

Figure 4.Color gamut in 2D without varnish (shown as dark gray line) and with varnish (shown as light gray line) for (a) chipboard, (b) MDF board and (c) spruce board

CONCLUSIONS

As it was expected, hue and saturation of color printed on wood surface were affected by the addition of varnish. There were no significantly changes in lightness. Wood surface has a yellowish tone and varnish stimulated it more. As the results showed increasing the yellow, green color was increased too. The reason is in fact that green color contains yellow. On the other hand, blue and yellow are complementary color which means that they are opposite and one does not contain the other. That is why blue color failed the most.

The results of this research showed the way of colors changing, therefore, possible solution could be in modified prepress which should be investigated.

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ADVANCED INTEGRATED CAD/RP SYSTEMS IN MANUFACTURING PROCESS OF PLANETARY GEAR DEMONSTRATOR

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ABSTRACT: The paper presents the use of advanced integrated CAD and RP systems for the demonstrator of aeronautical planetary gear manufacturing. Contemporary methods of designing gear make use of computer aided designing systems (CAD), computer aided engineering (CAE) and computer aided manufacturing (CAM) including also rapid prototyping (RP). First stage of designing gear is always defining basic parameters of the gear work (among others: transmission ratio, rotational speed, power) determined by the gear destination. After carrying out the gear calculations it is possible to create 3D-CAD models of wheels and other elements of the gear. 3D-CAD systems are often equipped with a module for analyzing geometrical parameters and cooperation of its individual elements e.g. the track of cooperation. A detailed analysis of cooperation of gear wheels' elements allows for early detection of construction mistakes of models and for deleting the mistakes. If 3D-CAD models are made correctly, it is possible to record the geometrical data in an appropriate format of numerical data. The following stage of making the prototype of the gear is preparing numerical data necessary for making the demonstrator by means of rapid prototyping method. The accuracy of making physical prototype depends a lot on the accuracy of 3D-CAD/3D-RP model made by means of processing the numerical data. The demonstrator allows for analysis of constructional solutions of the gear based on physical model and for doing introductory stand tests. The paper presents the process of making the demonstrator of planetary gear applying 3D-CAD modeling and Rapid Prototyping. For making the physical prototype a Fused Deposition Modeling (FDM) method of Rapid Prototyping was applied.
KEYWORDS: CAD, Rapid Prototyping, FDM, aeronautical planetary gear demonstrator

INTRODUCTION

Epicyclic gears have numerous advantages and above all the possibility of getting big transmission ratio in spite of quite small size and generally greater efficiency than other gears.

All these factors cause huge popularity of this kind of gear in aeronautical constructions. Implementing gear into a driving unit must be preceded by a process of calculations and three-dimensional 3D-CAD models must be created on the basis of the calculations. This kind of models can undergo kinematic analysis and an analysis of cooperation of meshings in CDA/CAE environment.

Then one can create, using Rapid Prototyping, testing models which will undergo stand tests. This kind of tests makes it possible to verify the calculations' results and the created 3D-CAD models [1-7].

PLANETARY GEAR MODELS - 3D-CAD AND 3D-RP

As a result of an analysis of constructional solutions of aeronautical gear we chose an exemplary model of planetary gear with a transmission ratio i=12.

The calculations were made in Mathcad program and were founded on a methodology applied in calculating this type of gear [4-6]. Then 3D-CAD models of the gear parts were created on the basis of the calculations. Subsequently the parts were put together (fig. 1).

The following stage of the designing process was an analysis of individual gear parts' cooperation [11]. An analysis of the meshing was made as an intersection of teeth in subsequent angle positions of gears.

The 3D-CAD solid models of all the elements of the gear were then recorded as a data read by Rapid Prototyping devices' software. The most widely used format of recording and reading data in RP systems is STL format [7] so this format was used in the numerical data processing. The STL format describes the surface of 3D-CAD model via a network of triangles. Figure 2 shows 3D-CAD and 3D-STL models of one of the gears' case elements.

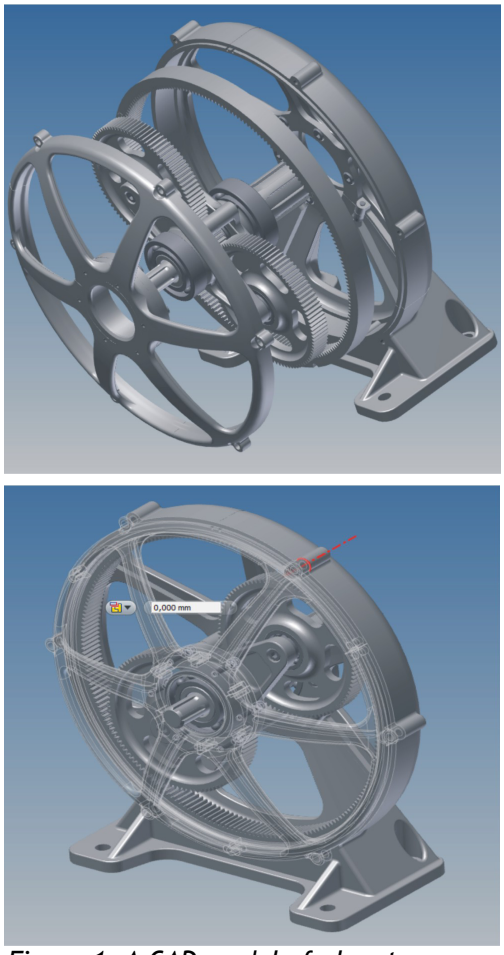
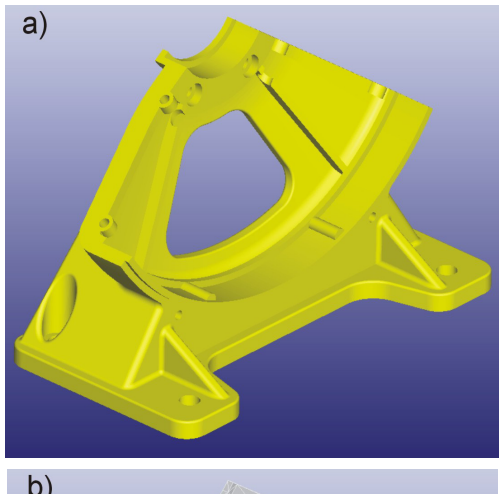


Figure 1. A CAD model of planetary gear



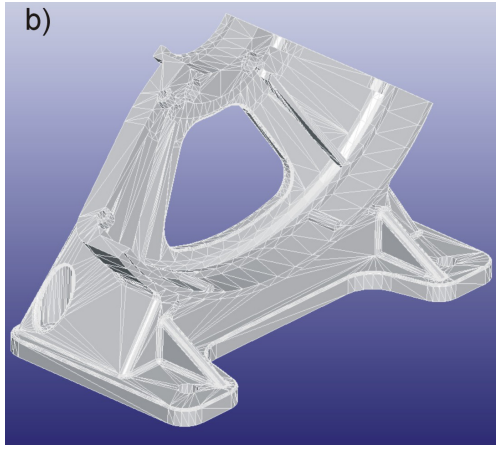


Figure 2. A 3D-CAD and 3D-STL model of the gears' case element

SOFTWARE DEVELOPMENT OF THE FDM PROCESS FOR PLANETARY GEAR PROTOTYPE

The basis for making the research prototypes were models recorded in STL format which later underwent a program processing - a division into 0,254mm thick layers using CatalystEX program on FDM machine - Staratasys. In this program the models were placed on a working platform's surface of U-Print device (fig. 3 and 4). In FDM a model is built of a material forced through a nozzle. The nozzle is fixed to shears which enable it to move horizontally.

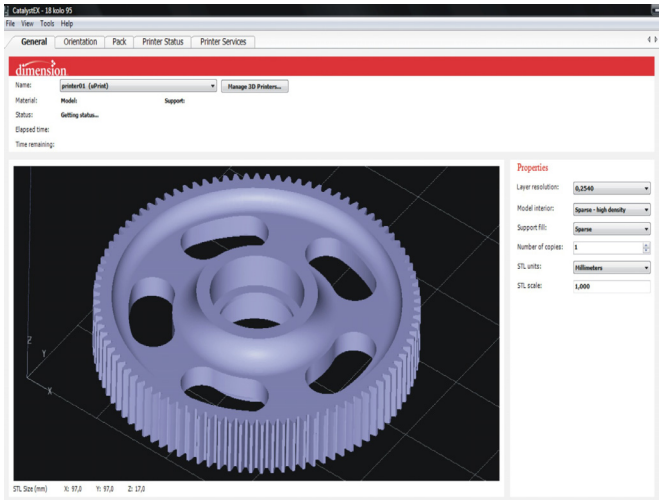


Figure 3. The gear on the working platform in CatalystEX program

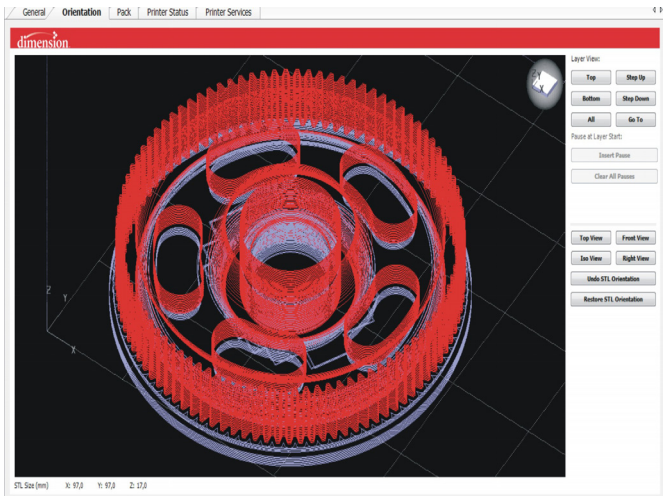


Figure 4. The gear divided into layers with supports in CatalystEX program

Vertical moves following y axis are made by moving the working platform. Putting all the movements together allows for arranging individual layers of material on a working space in accordance with the assigned geometry of the model (fig 5).

The put on layer of material solidifies and unites with a layer put on earlier [8-10]. In the process of creating the model a material for making the model is forced through one nozzle and the material for supports is forced through the other nozzle. This material is also supposed to combine the model with the working platform. The supports are made simultaneously with the model. For removing the supports easily they are often made of a material dissolving in water solution.

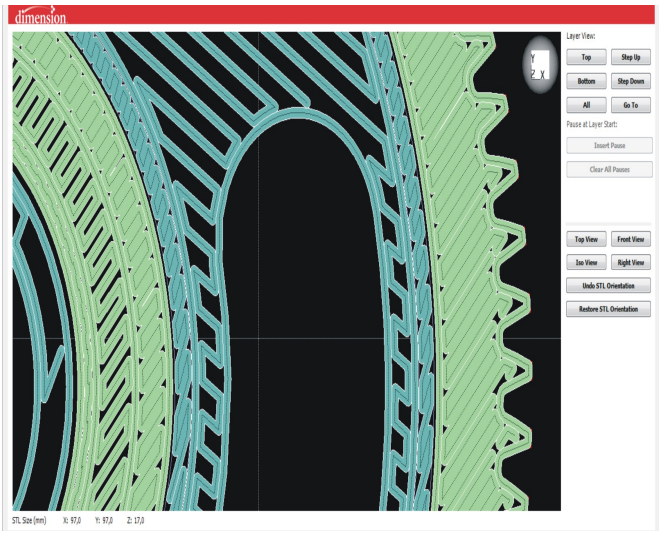


Figure 5. Slice layer of gear in CatalystEX program

A few kinds of materials are used in FDM including waxes, ABS and polycarbonates [9-11]. The models of the research gear were made of ABS (fig. 6) using U-Print device by Stratasys.

Figure 6. FDM models of gears the planetary gear's

Then the individual elements of the gear were combined in a unit (fig. 7) ready to be installed on a test stand.

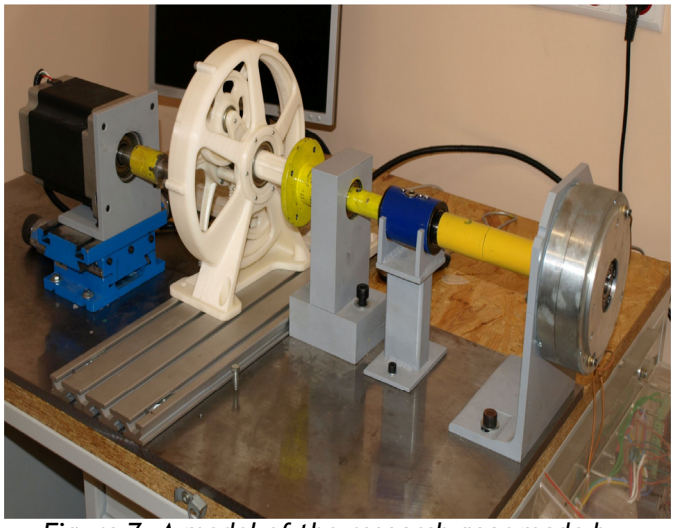


Figure 7. A model of the research gear made by means of FDM

CONCLUSIONS

Methods of computer aided designing CAD and computer aided engineering CAE together with Rapid Prototyping technologies allow for quick and that is why relatively cheap making research and demonstrative prototypes of aeronautical gears.

The research prototype presented in this paper was made by means of FDM and the material used was ABS. The properties of ABS and the applied mode of model construction (SOLID) make it possible to directly use the model for stand tests. The carried out introductory tests on models of this kind allow for analysis determining correctness of the applied designing methodology and the constructional solutions of planetary gear received on the basis of the above. In case of using other constructional materials than the material of the real gear, it is necessary to determine the modeling criterion of similarity to the target materials.

The next planned stage of making a prototype of aeronautical gear will be creating the gear's elements out of materials which have properties close to the target ones and then creating a prototype of planetary gear for testing in conditions complying with real loading.

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MEASURING THE QUALITY

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ABSTRACT: The paper presents the path towards quality, based on measurement. Monitoring, based on facts, is the founding concept of any total quality management program. Quality means stability in meeting customer expectations. Measurement is the road to TQM. Each company must apply appropriate methods of monitoring, and, as applicable, quality management system process measurement.
KEYWORDS: monitoring, process measurement, quality, quality management, improvement, TQM

INTRODUCTION

In order to survive and succeed in contemporary competitive business world, and undoubtedly even more competitive world of tomorrow, we need all managerial tools that we can acquire. One of the strongest will most certainly be total quality management, and in order to achieve TQM thorough measurement is required. Changes in market are nowadays extremely rapid. New technologies, new information and communication possibilities, direct growing communication, new distributors, new regulations and various technical barriers, constant customer need and expectation growth, are all conditioning new management style that needs to find rapid answers to these new challenges. It has recently been revealed that only companies that continuously invested in modern technology and enhanced their capabilities, remained on the market and improved their business [1].

Path of measuring the quality, as a program of high-quality business, will provide advice, tools, and techniques necessary for increasing the level of customers satisfaction, keeping the existing customers and gaining new ones; it will improve our relations with distributors and directs us towards profitable partnerships; it will make our activities more efficient and help us in finding means to eliminate wasting, avoiding errors, and reducing inconsistencies.

All measurements, in both service and production industry, conducted in all areas, have experienced progress, since conditions and criteria that products and services must meet have changed. Continuous narrowing of tolerances dictated completely new constructions of measurement and controlling devices and instruments, as well as their applications. European market demands this control to be in accordance with Standard ISO 9001:2008, point 7.6.

Therefore, it is necessary to plan, construct, use and manage measurement instruments, standards, etc. It is important to be familiar with the methods, physical work principles, certain errors, their size and means to avoid them. The important part of measurement devices and measurement instruments is software, which contains increasing number of devices and measurement instruments as an indispensable part.

Knowledge of measurement is a resource that is a base for all measurement. In order to conduct measurement in production, there has to be capacity for knowing the following:

1. *Instruments for production measurements and also dynamic measurements during the production, all of which affects the measuring piece.*
2. *Standards and artifacts, managing, maintaining and directing according to regulations that are increasingly becoming determinants of international character, without which it reduces to work market limited to the narrow national area.*
3. *Software and algorithms that are a part of measurement devices and are subject to changes and improvements, have limitations, and are provided for special purposes. Nowadays, even the software influence is considered to be an important source that affects measuring results accuracy.*
4. *Measurement strategies in production measurements are increasingly present in planning and conducting measurement, since they affect the end result of measurement and product prices.*
5. *Operating pieces or measuring objects are subject to measurement, and all production measurements imply that all information about the product must be known, if quality measurement wants to be achieved.*
6. *Special strength in the functioning of each system presents measurement and quality, under which is process quality and total system quality. That can be achieved in companies that have, in fact,*

approached to quality management system implementation, model ISO 9001.

COST OF QUALITY

In each process, certain activities are conducted, and as a result of process implementation of all activities, products and services occur that can be material and non-material in nature. Quality testing includes a set of different activities and implementation of secondary processes in the system, which enable assessment of the obtained process results. These secondary processes in the system are measurement, testing and control. Total quality system does not imply the measurement of everything. Instead, it directs you to measurement of correct facts, so as to maximize quality and productivity. Quality means to satisfy customer expectations. For us, the cost of quality is equal to costs directed towards fulfilling these demands in combination with costs that occur when we fail to meet the demands. In this case, it must be kept in mind that cost of quality presents measurable amount, and that by application of TQM tools we can reduce the cost. In addition, TQM method itself, such as cross-functional team work, reduces costs and increases business efficiency. If we want to achieve quality by way of measurement, we should always evaluate the percentage in relation to the quality and use it for further cost budget through the following:

- Prevention,
- Inspection and assessment,
- Internal failure costs,
- External failure costs.

It is estimated that 80% of the lost customers have stopped doing business with some company due to lack of quality. Attraction of new customers is 5 times more expensive than keeping the existing ones. Research has confirmed that 5% decrease in errors with users results in 25% to 85% increase of business profit.

Each company should establish a plan for the cost of quality analysis and apply it on the whole company. In this way we can move toward raising awareness on costs of managers and all employees. Through the plan, it is necessary to conduct the following activities:

- to establish cost of quality workgroup,
- to interview managers (how they measure the processes),
- to consider financial budget and customer data,
- to select monitoring parameters for cost of quality components,
- to establish cost of quality monitoring program,
- to monitor impact of total control management systems on cost-effectiveness.

Continuous analysis of the activities results in more precise distribution. Measurement process demands application of selected measurement system and certain measurement procedure, in order to determine the obtained measurement result. Measurement system consists of set of elements that are connected in whole, for the purpose of showing or registering measurement results. These elements are: measurement object, measurement instruments, secondary devices, measurement machine, measurement management and surroundings [2, 3].

MEASUREMENTS, ANALYSES, AND IMPROVEMENTS

Measurement in general

We continuously control product/service quality, customer satisfaction, achieved business performance and objectives, and other planned business results, as well as operationally and systematically monitor, measure, gather relevant data, analyze and assess achieved actions, and based on obtained indicators/facts we initiate appropriate improvement actions, in cases when needed and convenient.

These fundamental commitments are clearly stated through our policy and general objectives. Thereby, management is continuously developing necessary awareness of the employees, and is personally participating in the implementation of the mentioned actions, through planning and process management.

Data and information resulting from these processes are basis for review of QMS (quality management system) by the management, and making decisions and conclusions necessary for further improvements.

Monitoring and measurement (customer satisfaction)

Our basic commitment is to fulfill accepted/specified customer demands each time and on time, striving towards overcoming their expectations, when possible.

Information on customer satisfaction/dissatisfaction is continuously collected in different appropriate methods, the most convenient being:

- customer feedback in direct communication,
- customer complaints,
- customer surveys,
- customer refund in the sense of new orders of our products/services.

Primary responsibility for gathering and processing of information is on head manager, head of technical procedures and heads of processes of the contracted work implementation. All other employees have the responsibility to deliver customer satisfaction information to the head manager and/or other responsible staff, which they collected through contacts with customers (or their representatives), or any otherwise collected information.

Customers' surveys are conducted once per year through the established survey form, with the responsibility for it being on the head of the process of marketing, offer, and contracting. Processed information from the surveys, as well as those obtained from other sources, is the required item of the agenda during the QMS review by the management. Key indicators of customer satisfaction are:

- keeping existing customers and scope of cooperation expanding,
- gaining new customers,
- level of the expressed customer satisfaction assessed on the basis of gathered information (as described earlier).

a. Internal audit

One of the basic chapters of QMS planning is continuous planning and implementation of internal audits of all processes stated in the objective:

- determining implementation of planned activities prescribed by QMS documents,
- determining whether QMS is efficiently implemented and improved, according to business needs and relevant standard demands
- determining level of achievement of quality objectives, i.e. implementation of determined quality policy,
- determining areas where improvements are possible and necessary, and starting necessary correction and/or prevention action.

Annual program of internal audit consists of:

- type of audit (scheduled and unscheduled),
- determining work documents, as well as documents that are subject to audit,
- term for audit implementation,
- determining services/processes covered by the audit,
- determining audit team members,
- duration of internal audit and ways of reporting audit results.

Detail instructions for internal audit execution are described in systematic procedures for conducting internal audits.

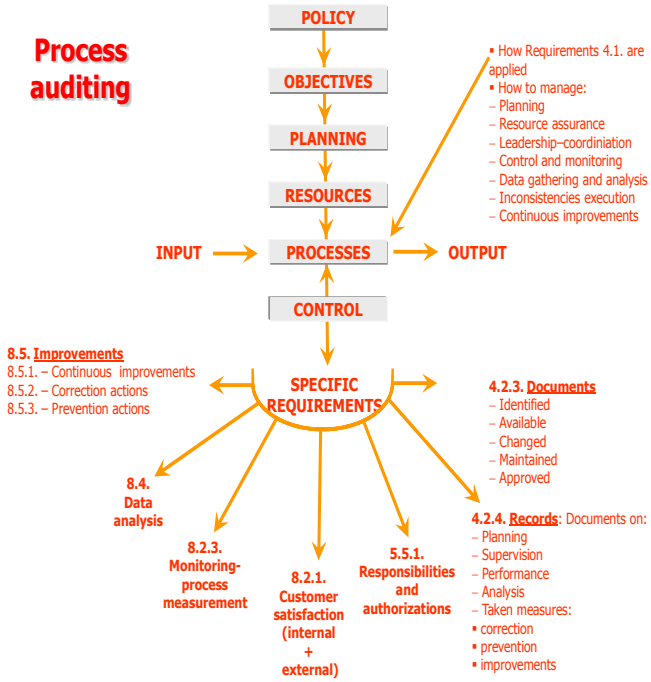

Figure 1. Process auditing

b. Monitoring and process measurement

Process managers, based on plan of implementation/monitoring and measurement processes, continuously implement planned activities, and based on gathered data realize assessment of the achieved results or objectives. If required they identify and implement corrections, and, if necessary, correction actions. They present the results of quality performance achievement on regular meetings of company's management, such as review of QMS by the management.

Specific indicators of process quality are quality and quantity of the implemented products/ services, maintaining planned terms, costs, whereas specific performance indicators are safety and health protection all of employees, and environment protection, which are determined by the corresponding programs of QMS management.

By relating achieved and planned values of certain indicators, we assess the effectiveness of the process, monitor trends, and determine possible and necessary improvements.

c. Monitoring and measurement of products/services

In the stages of planning and preparation of realization of individual contracts, we plan quality control and testing of our products/services.

Requests for specific characteristics of products/services are defined in the corresponding technical and technological documentation and contracts/orders on the delivery of products. When considered necessary or when the customer requests, we make a plan of control and testing which contains:

- type of control/inspection,
- required measurement and testing,
- acceptability criteria,
- required operational documentation and records,
- phases, steps or activities in which control or testing is conducted.

During the procurement process, we especially implement control of purchased products and materials, as described in the procurement procedure. Managers of implementation and procurement processes are responsible for conducting activities of monitoring and measurement of products/services, for which they must take into account the competence of personnel carrying out certain activities, safety of control - measurement and testing equipment, and where necessary appropriate microclimatic conditions. Appropriate records are kept on the implemented activities that clearly indicate the persons responsible and authorized for release of products/services in the next stage, that is, delivery to the buyers. All inconsistencies of product/service shall be treated in accordance with the procedure for inconsistent products control.

Control of inconsistent products/services

Documented procedure is established whose effective implementation ensures that the product/service, performance activity or indicators that do not comply with the relevant requirements are identified, stopped and marked, with the appropriate procedure for resolving its status initiated. This is decided by the process manager, which can be:

- to correct determined inconsistency,
- to initiate immediate corrections for correction of inconsistencies,
- to deliver the product, as it is, to the buyer with prior consent/agreement with the buyer.

Repaired or upgraded product/service is again controlled/tested and verified, of which an appropriate record is composed. If the deviation is such that requires taking correction action, that action is initiated and conducted according to the procedures of correction action.

The treatments of inconsistent products/services after delivery to the customer, i.e. the indicators

that are above legal regulations, have the priority over all current activities in the company.

Data analysis

Process managers gather and analyze appropriate data for the purpose of proving efficiency of process and quality management system, and continuous improvement of the same. The following activities are analyzed:

- *monitoring and process measurement results of products/services,*
- *customer satisfaction,*
- *achieving business results,*
- *achieving quality policy, i.e. determined objectives,*
- *information on distributors of products/services.*

Continuous improvement

In accordance with our Quality Policy we continuously initiate and implement process improvement actions based on facts (information, data, analyses, measurements, internal audits, etc.) from our everyday practice, as well as based on customer needs, our objectives and business plan, and positive legal regulations.

Process managers and quality management representative are specifically responsible for initiating and beginning improvement actions, and coordinating their implementation and assessment of their efficiency. Results of constant improvement process are the required item of the agenda during the QMS review by the management.

a. Correction actions

In order to determine causes of certain inconsistencies and prevent their repeating, we take corresponding correction actions, after which we assess their efficiency. The procedure is prescribed by the documented procedures, which determines procedures of initiation, defining, implementation and assessment of correction action efficiency, as well as associated responsibilities and authorizations. Representative of quality management keeps record of process in relation to individual correction action, and, as needed, coordinates necessary activities for interventions in all related processes. He also keeps up to date records of status of all initiated actions, of which he prepares reports for QMS review by the management.

b. Prevention actions

We continuously raise awareness, and develop culture and motivation of all employees to ensure their proactive approach in everyday work, in order to prevent the appearance of any inconsistencies beforehand. Documented procedures of prevention actions determine process elements, respectively responsibilities and authorizations for process activities, such as:

- *identifying potential inconsistencies and their causes,*
- *assessing the need for action to prevent inconsistencies,*
- *defining and implementation of actions,*
- *recording results of taken actions.*

By managing (review) status of all initiated actions, quality management representative coordinates all other processes in relation to running actions and initiates actions to be effectively implement in all related processes, as convenient/needed [4,5].

CONCLUSIONS

The objective of any company is to achieve and sustain competitive advantage. One good way for company to realize this is to satisfy customer needs in faster and better way than the competition. In order to achieve this, the company must find a way to accomplish this objective. In doing so, the objective should not only fulfill customer expectations, but also excel them, so as to create the impression in the eyes of customers that competition is not able to meet their needs in better way. To achieve this goal it is necessary for the company to introduce and implement a quality management system. Quality monitoring, and constant review by the management is a good way to TQM; the TQM is a guarantee of any company success. In all of this, it is management that plays the leading role, since it is responsible for the moral and physical support. The role of management in modern companies is increasingly changing and going in the direction of shifting the emphasis from leadership and management of staff towards facilitating presentation and implementation of ideas that employees have in relation to improving business processes. Management is responsible for monitoring and measurement of the process. By monitoring, measurement and analysis through the quality management system we achieve business excellence, which is often identified with the world's most prestigious award for quality.

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ASSESMENT OF ENERGY CONSUMPTION BY MACHINE TOOLS

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ABSTRACT: The aim of the study was to determine the energy required to perform the machining of selected parts, and then to assess the quality of the machine tools from the point of view of their energy consumption. A method for determining and assessing energy consumption was developed. Test workpieces, tools and cutting parameters for lathes and milling machines were proposed. Specific cutting tests for different cutting speeds, feed rates and depths of cut were carried out. On the basis of the instantaneous values of the power consumed by the machines in idle operating conditions and during the cutting process, their cutting energy consumption indices were determined.
KEYWORDS: machine tool, energy consumption, cutting tests, assessment

INTRODUCTION

Despite the fact that problems relating to energy consumption by machine tools are investigated by many research centres [2-3,5-10], the introduction of energy consumption indices encounters difficulties arising from the peculiar nature of such machines. Machine tools are highly complex and consist of a large number of different modules of different size, performing different functions. Since machine tools are universally used in manufacturing processes, measures aimed at introducing energy-efficient solutions can lead to a reduction in manufacturing costs.

The European Machine Tool Industry Association (CECIMO) has undertook action to develop high and competitive standards for energy-efficient machine tools [1] according to EU directive [4]. As a result, procedures and methods enabling machine tool manufacturers to determine environmental impact on the basis of energy consumption will be developed. Both relative and absolute energy-saving values are used to show clients that the additional investment into energy-efficient machine tool solutions can be profitable, particularly in the context of the increasing prices for energy carriers. Also in Poland almost 90% of the manufacturers declare that they make attempts to minimize energy consumption [5]. This means that this problem is perceived as crucial for reducing production costs and for the proper operation of industrial enterprises.

The aim of this research was to determine the amount of energy required to machine selected parts and to assess the quality of the machine tools with regard to energy consumption. The research was limited to the assessment of the energy consumption by selected types of cutting machine tools (milling machines and lathes) in idling conditions and during the machining of test workpieces. The advantage of this paper over other similar studies is the application of instantaneous power to the calculation of the energy consumption during the processing of the test workpieces, instead of average power of machine tools. For the assessment of the energy consumption by machine tools, energy consumption index was introduced as the relative average measure.

FACTORS HAVING BEARING ON ENERGY CONSUMPTION BY CUTTING MACHINE TOOLS

Constant factors, which are independent of the particular machining process, and variable factors, which depend on the type and course of the manufacturing process have a bearing on energy consumption by machine tools (Figure 1).

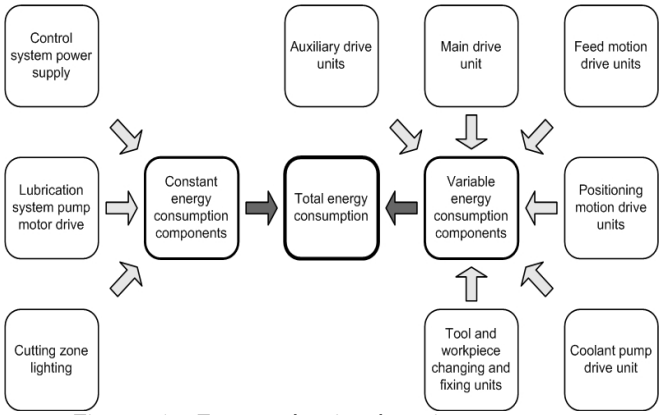

Figure 1 - Factors having bearing on energy consumption by machine tools.

Most of the energy consumed by a machine tool is consumed by its drive system. The latter usually consists of several drive units ensuring the execution

of the motions involved in the shaping of a product. Such a drive system incorporates:

- drive units for main motions (e.g. of lathe spindles),
- feed drive units,
- tool and workpiece changing and fixing units,
- positioning drive units,
- auxiliary drive units (for, e.g., the chips conveyor and the coolant pump).

Regardless of the type of machining, energy is also needed to power other systems, such as the control system, the cutting zone lighting, the lubrication system pump motor drive and so on.

ASSESSMENT OF ENERGY CONSUMPTION BY MACHINE TOOL

The amount of energy consumed to remove machining allowance is considered to be independent of the machine tool which is used for this task. In the literature one can find theoretical relations for calculating the amount of this energy [6]. However, this is only a part of the energy actually consumed in the manufacture of a product - the other part of this energy depends on the machine tool used in the machining process. In order to take the latter part of the energy into account it is proposed to the determine the average power used for the machining of a representative workpiece by a given machine [9,10]. Then energy E_{mt} consumed to perform a single machining operation is:

$$E_{mt} = E_c + P_{av} t_g \qquad (1)$$

where: E_{mt} [J] - the total energy consumed during machining, E_c [J] - cutting energy, P_{av} [W] - average power of the machine tool, t_g [s] - the main machining time.

The definition of a representative test workpiece and how to use the average power determined in this way as a representative power remain an open question. It should be noted that the total energy calculated in this way does not take into account many auxiliary operations.

Electric power P_{el} drawn from the mains is not only used to overcome the machining resistances and the resistance of all the units along the power transmission path from the motor to the executing unit, but also to power all the peripheral devices. It is assumed that this power can be divided into three components: effective power P_{ef} needed to perform machining work, power ΔP_{bo} consumed by the machine tool when running idle and additional power losses ΔP_o under drive system load. Thus the electric power is the sum of the three components, as formulated below:

$$P_{el} = P_{ef} + \Delta P_{bo} + \Delta P_o \qquad (2)$$

where: P_{el} [W] - electric power, P_{ef} [W] - effective power, ΔP_{bo} [W] - power consumed during idle runing, ΔP_o [W] - additional power lost under load.

In this research an attempt was made to analyze energy consumption E in turning and milling, by discretely measuring, at constant time intervals Δt, instantaneous power P_i drawn from the mains by a machine tool not loaded with cutting forces and during the machining of selected test workpieces. The energy was calculated from the relation:

$$E = \sum_{i=1}^{n} P_i \Delta t \qquad (3)$$

where: $\Delta t = 1/f_p$ (f_p - power signal sampling frequency), $n = t_g/\Delta t$.

For assessing the energy consumption by machine tools, energy consumption index W_e expressed as the ratio:

$$W_e = \frac{E_{el} + E_{bo}}{E_{el}} = 1 - \frac{E_{bo}}{E_{el}} \qquad (4)$$

where: E_{el} - total energy calculated on the basis of power P_{el} consumed during machining, E_{bo} - energy determined on the basis of power ΔP_{bo} consumed during idle running,

is proposed. Its value may range from 0 to 1.

INVESTIGATIVE METHODOLOGY

For the assessment of machine tools with regard to their energy consumption three lathes (one conventional - TUR50 and two numerically controlled - TUR MN560 and HAAS) and two milling machines (one conventional - FWD32J and one numerically controlled - HAAS Mini Mill) were selected. Two different test workpieces were proposed for the machines and proper tools and machining parameters were chosen.

The choice of a shaft as the workpiece for the lathes was dictated by the possibility of attaining proper cutting speeds. The shaft diameter of 125 mm (Figure 2) and steel C45 (commonly used in machining tests) were adopted. Two grooves were cut in the shaft so that at least two surfaces could be machined in one clamping. The grooves enabled machining at three different depths of cut. For example, the shaft's right segment was machined at a cut depth of 0.4 mm, then the tool was brought back to its initial position and the same segment was machined at a cut depth of 1 mm. Subsequently the middle segment was machined at a cut depth of 1.4. A short workpiece (L/D<3) required only one-sided clamping in the lathe chuck without lathe centre support.

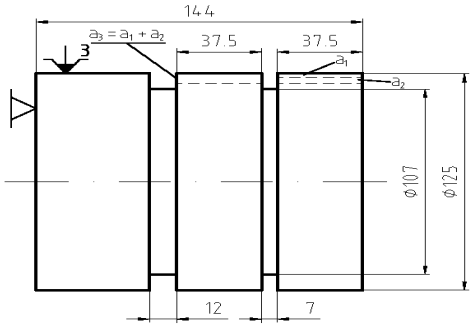

Figure 2 - Test workpiece used in turning operations

The choice of lathe tools was dictated by the possibility of fixing them in the engine lathe's tool block or in the tool head of the NC lathes. Also the possibility of setting a spindle rotational speed which would make it possible to attain the recommended cutting speed was taken into account. Lathe tool MWLNR 2020K06 with a WNMG060408N-GE insert made of carbide AC820P met all these requirements whereby the shaft could be machined on all the three lathes. The recommended cutting speeds ranged from 210 m/min for roughing to 440 m/min for finishing.

Power on the TUR-50 lathe was measured at a spindle rotational speed of 900 or 1120 rpm, whereby a cutting speed of 350 m/min or 440 m/min could be attained. In the case of the other lathes, the speeds were attained using an infinitely variable drive. Depths of cut a_p and feed rates f are shown in Table 1.

The consumption of power P_{el} during milling was studied for the face milling of a 170 x 100 x 40 mm prismatic workpiece (Figure 3). The workpiece's dimensions were such that it could be secured in a precision vice fixed to the milling table. In conformance with the tool manufacturer recommendation, the milled surface width was about 1.6 smaller than the cutter diameter. Machining was done at longitudinal milling table feed parallel to the workpiece's longest edge while the face milling cutter axis was perpendicular to its longitudinal axis.

Table 1. Machining parameters used for shaft turning

	n = 900 rpm			n = 1120 rpm		
f [mm/rev.]	a_p [mm]			a_p [mm]		
0.1	0.4	1	1.4	0.4	1	1.4
0.22	0.4	1	1.4	0.4	1	1.4
0.4	0.4	1	1.4	0.4	1	1.4

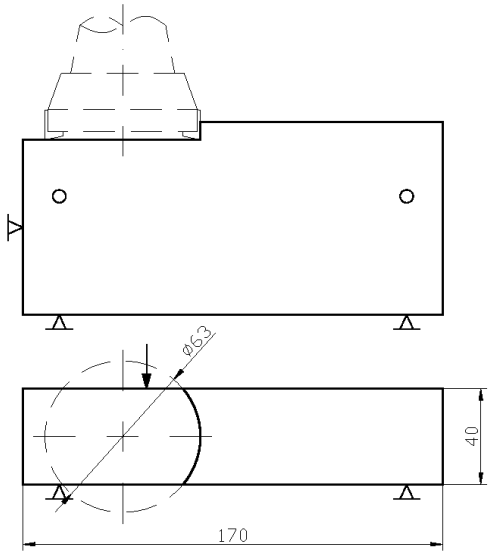

Figure 3 - Test workpiece used in milling operations

Face milling cutter 20.699-063/R610.21-063 (63 mm in diameter) made by DOLFAMEX, with six APKT 160416ER-46 SP6564 inserts (bit material SP6564) was used for milling. The choice of the cutter and the cutting parameters was based on the milling machine capability determined by the power of the machine's motors and its stiffness. In the case of the HAAS Mini Mill, power P_{el} was measured at milling rates v_c=80, 140 or 200 m/min.

Similar milling rates were used for the FWD32J miller. The rates in this case were determined by the sequence of spindle rotational speeds and amounted to 90, 140 and 220 m/min. The machining parameters are shown in Table 2. The differences in feed rates f between the conventional miller and the NC miller are due to the fact that in the former only feed rates expressed in mm/min can be selected, whereas in the latter there more options available.

Table 2 - Machining parameters used for flat surface milling

	FWD32J miller		
depth of cut a_p [mm]	cutting speed v_c [m/min]		
	90	140	220
	feed rate f [mm/min]		
0.5	112	224	355
1.0	112	224	355
1.5	112	224	355
	HAAS miller		
depth of cut a_p [mm]	cutting speed v_c [m/min]		
	80	140	180
	feed rate f_z [mm/tooth]		
0.5	0.04	0.08	0.12
1.0	0.04	0.08	0.12
1.5	0.04	0.08	0.12

MEASURING SETUP

In order to asses the energy consumption by the machine tools it was necessary to measure the electric power drawn by them during the different stages of the machining process. Wattmeters connected into the Aron circuit, forming the measuring set made by LUMEL, were used for this purpose. The measuring set was equipped with a digital display of consumed power and the latter could be recorded as a function of time (at a programmed measuring signal sampling frequency) by a PC. A scheme showing the location of the wattmeter between the power supply and the machine tool, and the transmission of the measuring signal via a converter to the PC is shown in Figure 4. The measuring setup enabled the measurement of a.c. active power from -50 to + 50 KW at a supply current frequency of 45-65 Hz.

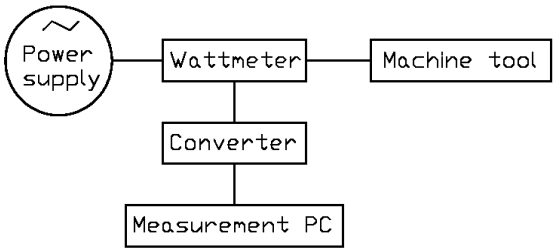

Figure 4 - Wattmeter-converter-PC connection scheme

Consumed power P_{el} was recorded as a function of time by the PC in order to determine the energy consumed by the machine tool during no-load operation and while carrying out the machining tests. The averaged energy value was calculated from relation 3.

TEST RESULTS

In order to determine machine tool energy consumption the electric power take-off from the mains was determined for the different machine operating conditions. A typical work program consisted of turning machine tool power on, turning spindle rotational motion on, no-load feed motion and machining at different speeds, feed rates or cut depths. Typical power waveforms recorded for the HAAS lathe according to the above scheme are shown in Figure 5.

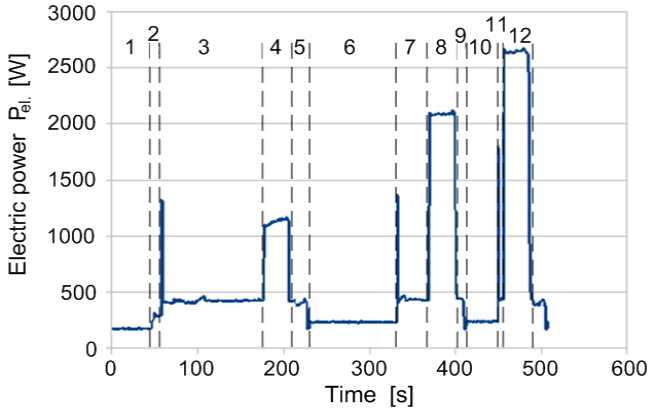

Figure 5 - Course of the power consumption P_{el} for straight turning on HAAS NC lathe at cutting speed v_c = 270 m/min, feed rate f = 0.1 mm/rev. and depth of cut a_p = 0.4, 1.0 or 1.4 mm (MWLNR 2020K06 tool with WNMG060408N-GE insert).

In the above figure, the following stages in the operation of the lathe can be distinguished: 1 - only the machine tool supply circuit switched on, 2 - the spindle rotational motion drive switched on, 3 - the feed drive motor additionally switched on, 4 - machining at depth of cut a_p = 0.4 mm, 5 - the feed and the spindle drive remain switched on after machining, 6 - the spindle drive switched on, the tool brought back to the initial position, 7 - feed switched on, 8 - machining at depth of cut a_p = 1.0 mm, 9 - the same state as in pt. 5, 10 - only the spindle drive switched on, 11 - the feed additionally switched on, 12 - machining at a cut depth of 1.4 mm. The instantaneous increases in power consumption between, e.g., stages 2 and 3, or 6 and 7 are connected with the starting currents and are due to the inertia of the machine's mechanisms whose speed had to increased to the speed required in the given machining stage.

Similar measurements of the power drawn by machine tool drive units were carried out for machining on the FWD32J and HAAS Mini Mill milling machines. Figure 6 shows the results obtained for the FWD32J miller at a cut depth of 0, 0.5, 1.0 and 1.5 mm.

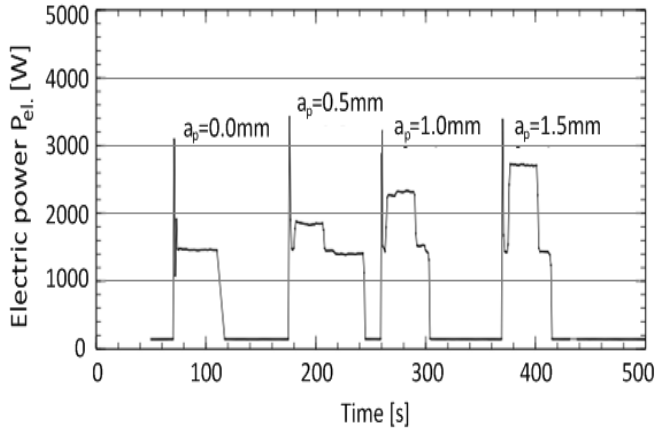

Figure 6 - Power P_{el} measured for flat surface milling on miller FWD 32J at cutting speed v_c = 140 m/min, feed rate f = 355 mm/min and depth of cut a_p = 0-1.5 at every 0.5 mm (milling cutter 20.699-063/R610.21-063 with six inserts APKT 160416ER-46 SP6564)

In each of the three diagram parts for milling at depth of cut a_p other than zero one can notice an instantaneous increase in power consumption, due to the switching on of the feed drive, an increase in power consumption until the milling cutter begins cutting along the full workpiece width, an almost constant power value during machining along the full workpiece width, a decrease in power as the tool leaves the workpiece and a constant power value as the tool moves above the already machined workpiece. A similar pattern of power consumption was obtained for the HAAS lathe. But the power values for machining were in this case much lower despite the same machining parameters and only slightly different feed rates. The differences were mainly due to the much lower power consumed by the HAAS lathe during idle running.

The recorded power measurement data were used to determine the energy consumed in order to remove a material allowance from the workpiece. For the turning of the shaft, the energy was calculated assuming that straight turning proceeded along a length of 37.5 mm. For machining along this length one had to determine the tool-workpiece contact time and multiply it by the average measured power. In the case of facing, especially at a constant cutting speed, one had to determine the area under the power graph through integration since this power was subject to considerable variation. Exemplary values of energy [in Wh] consumed for turning using the HAAS and TUR MN 560 lathes are shown in Figure 7.

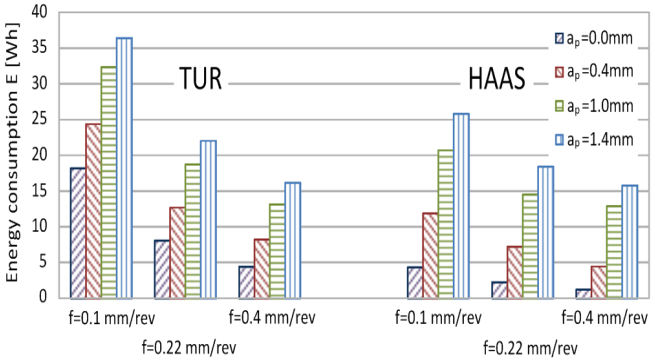

Figure 7 - Energy consumed during straight turning of shaft on TUR MN 560 and HAAS lathes (at different feed rates f and depths of cut a_p) at cutting speed v_c = 270 m/min

From the above diagrams one can draw some conclusions about turning using the TUR MN 560 lathe and the HAAS lathe. As the depth of cut increases so does the amount of energy consumed for removing of a material allowance. This is obvious since the greater the depth of cut, the larger the cross section of the material layer being removed. The cutting forces are then greater and the machining power is higher whereby at the unchanged machining time, energy consumption increases. However, when one increases the feed rate, this results in a reduction in energy consumption. Although as the feed rate is increased, power P_{el} drawn by the machine tool also increases, the time of the operation is then shorter and consequently less energy is consumed for removing the material allowance. Also cutting speed

has a beneficial effect on energy consumption. As the cutting speed increases so does the feed per minute whereby the time of machining the given part of the shaft is reduced. Thus in order to reduce the amount of energy consumed for removing a given material layer one should use the parameters recommended for roughing, i.e. large depths of cut and high feed rates. Although lower feed rates are recommended for roughing (because of tool durability), high-speed machining is advantageous from the energy consumption point of view.

The power consumption coefficient increases with the depth of cut and the feed rate. Therefore as more energy is consumed for machining work, the index also assumes higher values when the machine drive system consumes less power during no-load operation. In the presented cases, W_e assumes higher values for the HAAS lathe and lower values for the TUR MN 560 lathe. As it appears from the bar charts shown in Figure 8, the values of power ΔP_{bo} drawn during no-load operation are lower in the former case. Generally speaking, the higher the power consumption coefficient W_e, the less energy-intensive the cutting process executed using a machine tool.

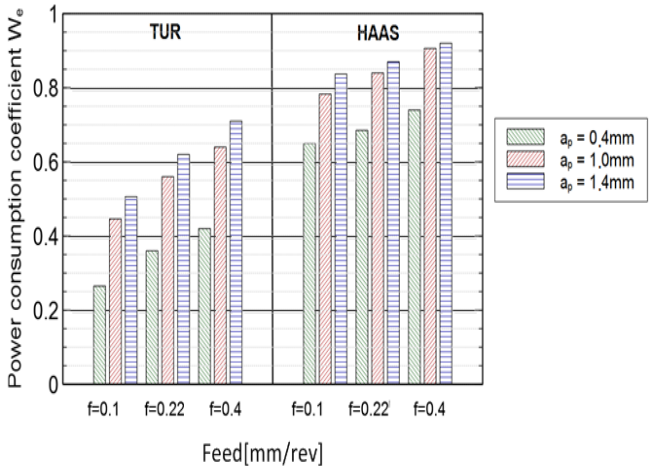

Figure 8 - Energy consumption coefficient for straight turning of shaft on TUR MN 560 and HAAS lathes (at different feed rates f and depths of cut a_p) at cutting speed v = 180 m/min.

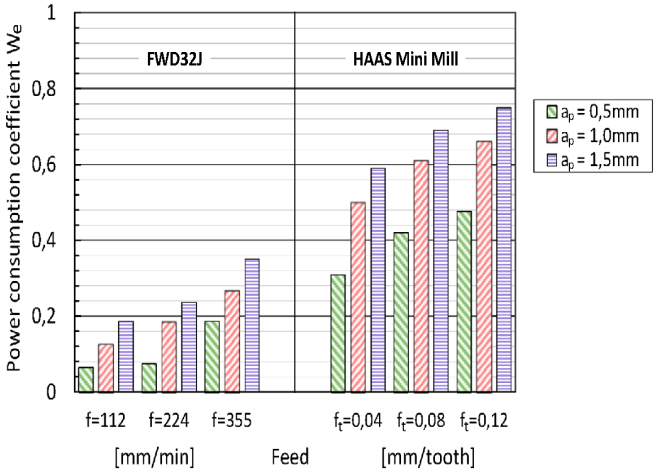

Figure 9 - Energy consumption coefficient for flat surface milling on FWD32J and HAAS Mini Mill millers (at different feed rates f and depths of cut a_p) at cutting speed v = 140 m/min

Conclusions similar to the turning process can be confirmed for the milling process, analyzing characteristics from Figure 9. Energy consumption coefficient W_e value increases with milling depth and feed rate, just like in the turning process. When milling on CNC miller - HAAS Mini Mill, its value is considerably larger than on conventional milling machine FWD32J. The main reason for differences in both millers energy consumption is the extensiveness of the FWD32J main and feed drive systems. This machine tool draws more power when running idle due to the greater power loss in both drive systems. This results in higher energy consumption.

CONCLUSIONS

The costs of energy consumption in the production process become an increasingly critical component of the total production costs. Therefore attempts at reducing them are economically imperative. One should also take into account the fact that electric energy is usually produced by combusting natural fuels, which is one of the main causes of environmental degradation. The above factors make it necessary to economically manage the national energy resources. Also in the sphere of machines production and operation one can find possibilities of reducing energy consumption.

The preliminary studies presented in this study show that even in the case of simple machining operations performed on manually or numerically controlled universal machine tools there are possibilities of reducing energy consumption. The amount of energy consumed for the turning of a cylindrical surface using the TUR MN 560 lathe and the HAAS lathe differs significantly between the two lathes.

The following conclusions (which need to be verified by further research) emerge from the studies:

- *the amount of energy needed to perform the same machining operation to a large extent depends on the design of the drive units of the machines on which the operation is performed;*
- *the differences in the amount of energy consumed for performing the same machining operation are mainly due to the differences in power ΔP_{bo} consumed by the machine during no-load operation;*
- *the process parameters have an influence on the amount of energy consumed for machining: the amount of this energy decreases as the cutting speed and the feed rate increase and increases with the depth of cut;*
- *having in mind energy consumption, one should use large depths of cut and single-pass machining instead of a larger number of passes at a smaller depth of cut;*
- *dimensionless index W_e is recommended to be used for assessing machine tool energy consumption; the magnitude of the index depends on the amount of energy consumed during the no-load operation of the machine and during machining;*
- *in order to determine the energy consumption index one should determine the course of the power consumed by the machine tool during no-*

load operation and during machining and measure the machine tool operation time;

- the energy consumption index may assume values from 0 to 1. The higher the index, the less energy will be consumed for the machining process.

The studies have an exploratory character. They were carried out on machine tools with simple drive units, performing only simple machining operations. Nevertheless, it emerges from the obtained results that the energy consumption by a machine tool can be assessed on the basis of the power drawn by it during machining and during no-load operation. The energy consumption can be expressed by dimensionless energy consumption index W_e.

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ANALYSIS OF LCTLC RESONANT CONVERTER QUANTITIES FOR DIFFERENT OUTPUT

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ABSTRACT: The paper deals with design analysis, simulation, synthesis and verification of power resonant converter integrated with LCLC filter, HF transformer and rectifying output. The output voltage of LCTLC in the basic AC direct mode is sinusoidal one with harmonic distortion roughly 5% in the whole range of the load with possibility of non-symmetrical control of the converter. A novel detailed analysis of over-loaded rectifying mode with DC output is given, as well as transfer and transient properties analysis, non-linearity including. Simulations based on Matlab/OrCad models confirmed by experimental results of both modes are given in the paper.
KEYWORDS: resonant-mode power supplies, DC/AC converters, LCLC resonant filter

INTRODUCTION

One of the progressive alternative, by which it is able to reach requested parameters of high power density, high efficiency and with low EMI/EMC influence, is LLC resonant converter topology ([13]-[15], [7]). These converters are developed and manufactured since 90's and their topology has many advantages [13], [14].

Nowadays, targeting increase of power density and efficiency, the new topologies of resonant converters are being developed [1], [2], [6], [7], [13]-[16]. Even those topologies consist of more resonant components compared to LLC converter. The magnetic components can be integrated and can have small dimensions as well as low consumption. These structures, upgraded with parallel resonant circuit and with synchronous MOSFET rectifier operated in inverse regime, can achieve efficiency of 95,5 % with power density of 95W/in3 and switching frequency up to 2,3 MHz [1], [13]. A LCTLC resonant converter can provide both types of AC or DC power supply, and it is usually used as power supply for either HV rectifiers (vacuum displays and CRTs, [2], X-ray devices [8] or fluorescent lamps [1], or HF cycloconverters or matrix converters [11]).

BASIC TOPOLOGY OF LCTLC INVERTER

The basic scheme of LCTLC resonant inverter is shown in Figure 1.

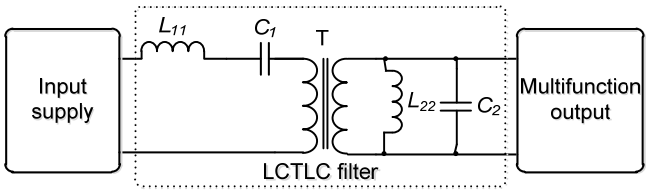


Figure 1. Block scheme of LCTLC resonant inverter

It consists of input supply, LC series resonant filter (with parameters L_{11} and C_1), HF transformer (HV or normal MV), and LC parallel resonant filter (L_{22} and C_2) and multifunction output. The HF transformer can also be connected after the LCLC filter, if necessary.

A. Input supply possibilities

Basically, input supply of the LCTLC can be considered by three ways, i.e.:a) full-bridge DC-AC inverter, b) half-bridge one with centre type of the DC source,c) DC-DC buck converter.

B. Multifunction output possibilities

Output of LCTLC can be loaded by simply RL load - direct AC output or rectified RL load - rectified DC output, respectively, Figure 2a, b or AC output with variable or constant frequency LV, Figure 2c. Other possibility is connecting of cycloconverter or matrix converter to the LCTLC.

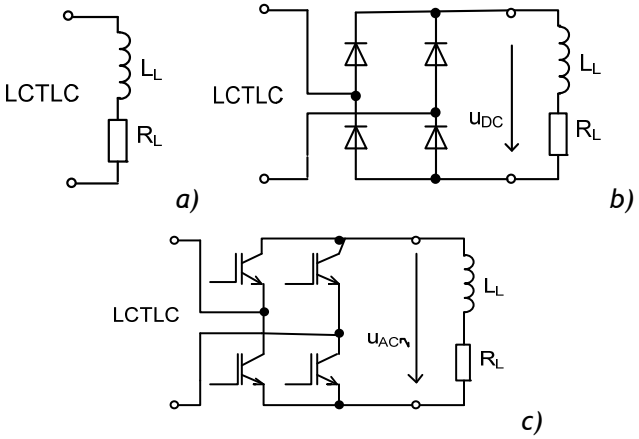


Figure 2. Basic connections of LCTLC output

C) Proposed connection of LCTLC resonant inverter

The basic scheme of proposed LCTLC resonant inverter is shown in Figure3. It consists of DC/DC buck converter, LC series resonant filter (with

parameters L_{11} and C_1), HF transformer (HV or normal MV), and LC parallel resonant filter (L_{22} and C_2). The HF transformer can also be connected after the LCLC filter, if necessary.

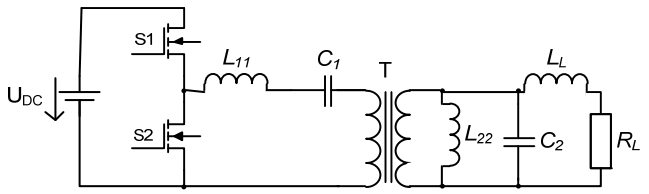


Figure 3. Basic scheme of proposed LCTLC resonant inverter

DIRECT AC OUTPUT MODE ANALYSIS OF LCTLC INVERTER

The following analysis is oriented, contrary to [2], [17] on design analysis of LCLC components, investigation of transfer- and transient properties, and also influence of non-linearity of inductors. Since the input voltage of LCTLC $u_1(t)$ involves certain DC component voltage this component has been omitted due to series capacitor, and investigated circuit are sup-posed to be supply by AC rectangular voltage Figure4.

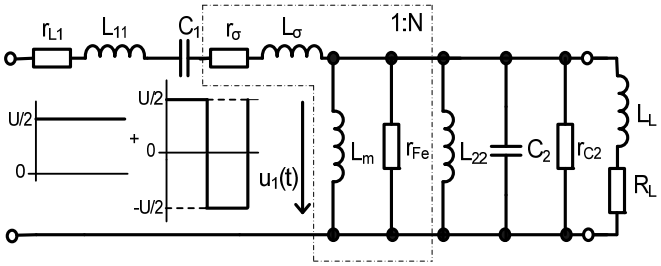


Figure 4. Equivalent scheme of LCTLC circuit with R-L load

The parameters of the HF transformer [2], [17] are included into resulting component parameters, and then:

$$R_1 = R_{11} + R_\sigma \qquad (1a)$$

$$\frac{1}{R_2} = \frac{1}{R_{Fe}} + \frac{1}{R_{22}} \qquad (1b)$$

$$L_1 = L_{11} + L_\sigma \qquad (1c)$$

$$\frac{1}{L_2} = \frac{1}{L_m} + \frac{1}{L22} \qquad (1d)$$

State-space model equation

$$\frac{di_{L1}}{dt} = \frac{r_1}{L_1} i_{L1} - \frac{1}{L_1} u_{C1} - \frac{1}{L_1} u_{C2} + \frac{1}{L_1} u_1; \qquad (2a,b)$$

$$\frac{di_{L2}}{dt} = \frac{1}{L_1} u_{C2}; \frac{du_{C1}}{dt} = \frac{1}{C_1} i_{L1};$$

$$\frac{du_{C2}}{dt} = \frac{1}{C_2} i_{L1} - \frac{1}{C_2} i_{L2} - \frac{1}{r_2 C_2} u_{C2} - \frac{1}{C_2} i_{LL}; \qquad (2d,e)$$

$$\frac{di_{LL}}{dt} = -\frac{R_L}{L_L} i_{LL} + \frac{1}{L_L} u_{C2}$$

Using suitable numerical method or directly Matlab functions the time waveforms of the quantities of LCTLC inverter can be obtained, Figure 5.

When input U_{DC} voltage is varying then RMS value of fundamental harmonic will be also varied. To be constant the asymmetric control of duty cycle of S1, S2 has to be provided [9], [12].

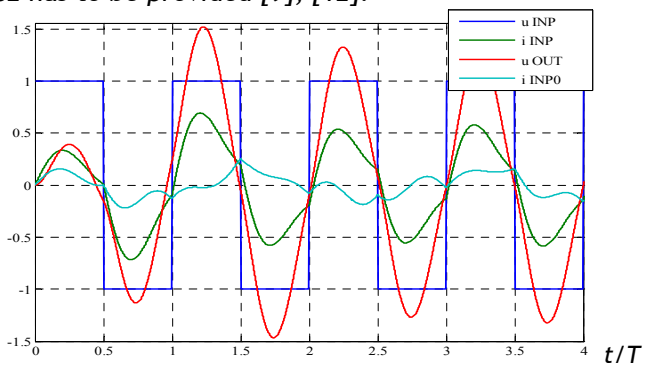


Figure 5. Simulated waveforms of LCTLC inverter (p.u.)

A) LCLC Elements Design Synthesis Criteria

From the different point of view one can obtain:

- *minimum voltage and current stress of the storage elements in the steady-state $|Z_{L1,2}| = |Z_{C1,2}|$; $q = 1$*
- *minimum total harmonic distortion: THD< 5 % (we need to know the impedance frequency characteristic)*
- *minimum voltage and current stress of the accumulate elements in transient states (we need transient analysis).*

Resonant frequency of L_1, C_1 and L_2, C_2 should be the same as basic fundamental frequency of the converter and is requested by load demands. So, based on Thomson relation [18]

$$\omega_{res} = \sqrt{\frac{1}{L_1 C_1}} = \sqrt{\frac{1}{L_2 C_2}}$$

or, respectively

$$L_1 \omega_{res} = \frac{1}{\omega_{res} C_1} = L_2 \omega_{res} = \frac{1}{\omega_{res} C_2} \qquad (3)$$

where ω_{res} is equal 2πtimes fundamental frequency of the converter. Theoretically, $\omega_{res} L_1$ and other members of (3) can be chosen from wide set. Not to exceed nominal voltages and currents of the accumulative elements we take value of the nominal load $|Z_L|$. Then where q_1, q_2 quality factors are ratio of impedance of components L_1, C_1 or L_2, C_2 to the nominal load impedance.

$$L_1 = \frac{U_1^2}{\omega_{res} P_1} q_1, \quad C_1 = \frac{P_1}{\omega_{res} U_1^2} \frac{1}{q_1}$$

$$L_2 = \frac{U_2^2}{\omega_{res} P_2} \frac{1}{q_2}, \quad C_2 = \frac{P_2}{\omega_{res} U_2^2} q_2 \qquad (4)$$

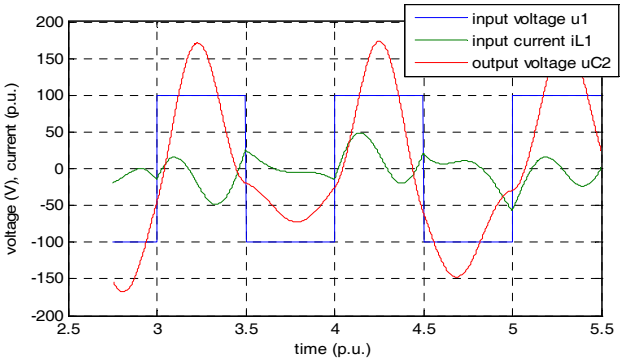


Figure 6. Output voltage of LCLC under load disconnection in the middle of half period [18]

B) Transient analysis of LCTLC

Analysis was done in works [4], [9]. Transient phenomena were simulated for two sets of filter parameter values: basic values of the filter parameters (i.e. quality factor q (Q) of the filter equal one), and for quality factor equal two, when resonant reactances ($\omega_{res}L$) and capacitances ($1/\omega_{res}C$) are equal 2-multiply of the nominal load $|Z_N|$, Figure 6.It is possible to simulate transient phenomena with considering non-linear function $L = f(i_L)$ as is shown in [5].

As can be seen in Figure 6 for $q_1 = 0.6$ and$q_2 = 1$ the over voltage during load disconnectis+7.5 % regarding to maximum value of output voltage in steady-state only. By selecting appropriate values of quality factorsq_1, $q_2$the voltage stresses can be minimized ($<U_{Mnom}$+5 %).

Voltage transfer characteristic of LCLC filter U_2/U_1 (Bode diagram) is shown in Figure 7.

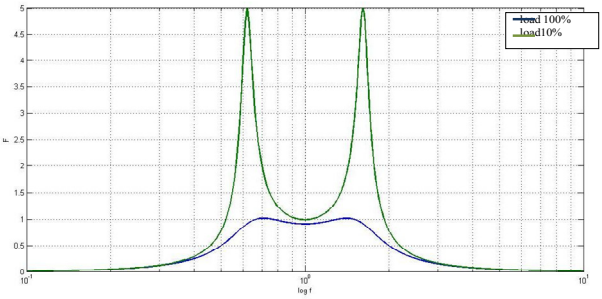


Figure 7. Voltage transfer characteristic of LCLC filter U_2/U_1

The output voltage at equality of ω_{res} andω_{sw} is almost constant; small difference is caused by voltage drop on passive resistances of inductor L_1 and capacitor C_1.

C) Experimental verification of direct AC output mode

Basic measurement of input and output voltages of the LCTLC under no load are shown in Figure 8, with following parameters:$L_1 = 14.61$ μH; $L_2 = 14.61$ μH; $C_1 = 99$ nF; $C_2 = 99$ nF; $U = 6.00$ V; $r_1 = 0.1$ Ω ;$r_2 = 20$ kΩ; $f = 132$ kHz; $R_L = 12.25$ Ω (full load); $L_L = 174$ μH

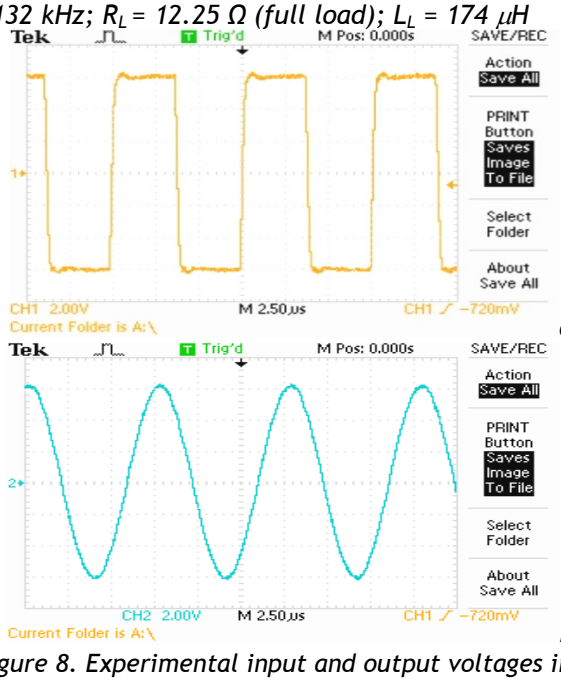


Figure 8. Experimental input and output voltages in no-load operation. a) input voltage; b) output voltage

Used apparatus and devices:
Signal generator Agilent 33521 30 MHz;
Power linear amplifier Krohn-Hite 7500;
Transformer used: Type Flyback;
$P_{out} = 2$ W;$f_T = 132$ kHz; $L_\sigma = 0.6$ μH;
$U_{1,2} = 5$ - 15 V_{rms}; $(N_1/N_2 = 1:1)$
Settings: $U_1 = 6$ V; $f_{SW} = 132$ kHz.
Results of measurement of input and output voltages and input current of the LCTLC are shown in Figure 9.

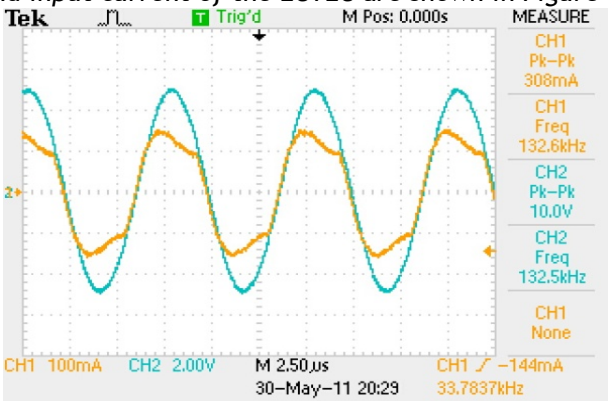


Figure 9. Experimental results: input and output voltage under full load

Since the output quantities are in good agree with simulation ones, the input voltage is due to non-zero impedance of DC source only 4.4 V (average value) under full load instead 6 V at no-load.

CURRENT RECTIFYING DC OUTPUT MODE

There are four different topologies for LCTLC with output rectifier A); B); C); D), Figures 10, 11, 12, 13 for extended analysis in overcurrent loading rectifier mode.

Topology for positive half-period of input voltage and positive rectified output

***A) U_{C2} is positive and grater than threshold voltages of D_1, D_4 diodes**, Figure10.*

Since u_{C2}voltage is positive ($> 2U_{Th}$) then all equations (2a) - (2e) are valid. As a consequence of resonant phenomena in the circuitry the u_{C2}voltage will cross zero level when current i_{C2} charges capacitor having negative polarity:

$$i_{C2} = i_{LL} - (i_{L1} - i_{L2}) \qquad (5)$$

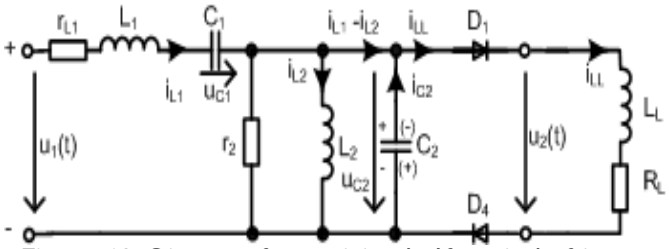


Figure 10. Diagram for positive half-period of input voltage and positive rectified output

***B) UC2 is negative and greater than diode threshold voltages of D2, D3 diodes**, Figure 11*

When the u_{C2}voltage becomes negative the D_2, D_3diodes are opening and therefore Eqs. (2d), (2e) will be changed into (6a,b):

$$\frac{du_{C2}}{dt} = \frac{1}{C_2} i_{L1} - \frac{1}{C_2} i_{L2} - \frac{1}{r_2 C_2} u_{C2} + \frac{1}{C_2} i_{LL} \qquad (6a)$$

$$\frac{di_{LL}}{dt} = -\frac{R_L}{L_L} i_{LL} - \frac{1}{L_L} u_{C2} \qquad (6b)$$

That means the C_2 capacitor will be overcharged by inductors energy back to positive polarity.

$$i_{C2} = i_{LL} + (i_{L1} - i_{L2}) \qquad (7)$$

To be negative again (and voltage too) sum of the currents i_{L1}, i_{LL} and has to be negative one. When the sum on the right side is zero, the capacitor current i_{C2}becomes zero (and voltage u_{C2} too).

$$\text{if} \quad i_{L2} \geq i_{LL} + i_{L_1} \quad \text{then} \quad i_{C2} \leq 0 \qquad (8)$$

The process can be repeating periodically until fulfilling of above condition or can be finish after one period depending on inductors energies. These circumstances are depicted in Figure 12.

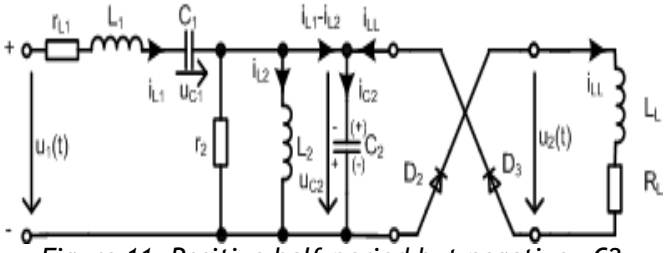
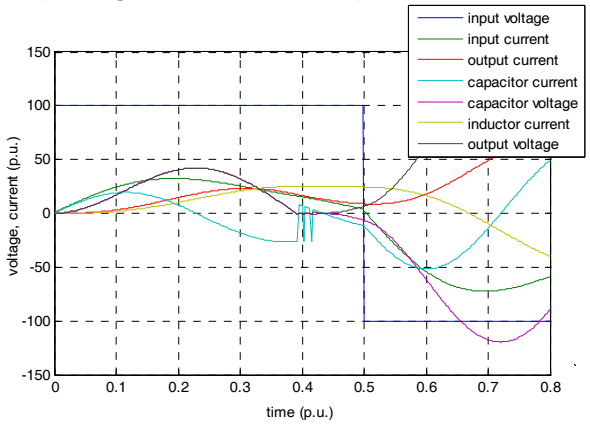


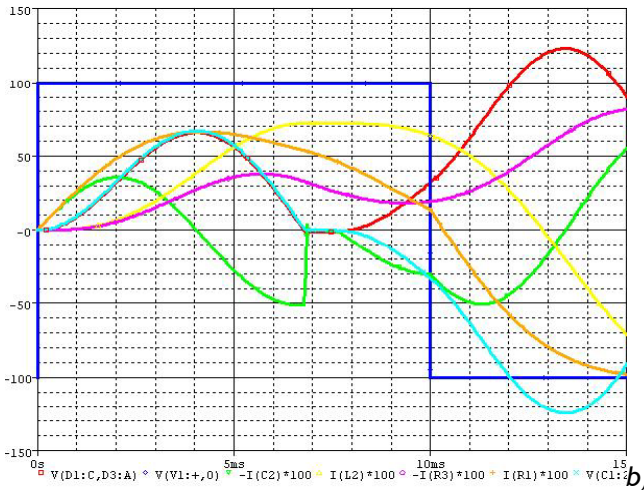
Figure 11. Positive half-period but negative uC2 voltage

After fulfilling of condition (8) the i_{L2} current stays nearly constant (see both Figures 12a and 12b).

Interesting is that during steady-state the 'zero voltage' period will be placed symmetrically to T/2-axis (see Figures 15a,b and 16b).



a)



b)

Figure 12. Time waveforms during u_{C2} crossing zero a) using MatLab, b) using OrCAD environment

Topology for negative half-period of input voltage and positive rectified output

The similar processes will be doing during negative half-period of input voltage.

C) U_{C2} is negative and greater then threshold voltages of D_2, D_3 diodes

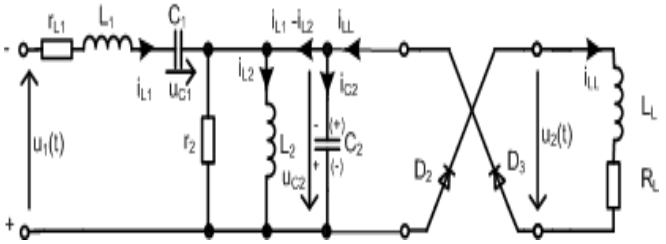


Figure 13. Diagram for negative half-period of input voltage and positive rectified output

D) U_{C2} is positive and greater then diode threshold voltages, Figure14.

The length of zero rectified voltage depends on following factors:

- loading of the rectifier; greater load cause longer zero voltage
- ratio of L_L and L_2 inductances (parameter of LCTLC circuit)
- value of i_{L1} at instant of u_{C2} voltage zero crossing
- time constant of the load (ratio L_L/R_L)

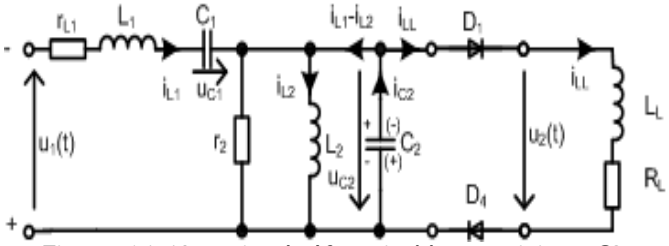


Figure 14. Negative half-period but positive uC2 voltage

Note that 'zero voltage' period can also occur under normal operation of LCTLC depending on its parameters, and almost always during overloading. On other hand, the mechanism causing 'zero voltage' has also a benefit: it restricts overcurrent due to decreasing of output rectified voltage average value as shown in Figures 15a,b and 16b.

Experimental Verification of Extended Analysis in Overcurrent Loading Rectifier Mode of LCTLC

Following parameters have been used for simulation and experimentation: $L_1 = L_2 = 14.60\ \mu H$; $C_1 = C_2 = 99$ nF; $R_L = 12.25\ \Omega$; $L_L = 174\ \mu H$

Transformer used: Type Flyback $P_{out} = 2$ W; $f_T = 132$ kHz; $L_\sigma = 0.6\ \mu H$; $U_{1,2} = 5$ - 15 V_{rms}; $(N_1/N_2 = 1:1)$

Signal generator type of: Agilent 33521 30 MHz

Power linear amplifier type: Krohn-Hite Model 7500

Schottky diodes BAT 41: 0.45 V/Tj = 25°C(1V/200 mA)

Settings: $U_1 = 5$ V, $f_{SW} = 132$ kHz, $R_L = 12.25\ \Omega$ (full load) - 6.15 Ω (2-fold overloading).

There are shown overloading waveforms in Figures 15a and 15b - simulation, and in Figure 16b - experimental verification, at steady-states with nominal R-L load ('cosφ' = 0.8).

Verification of rectifier mode at steady-states with pure resistive load is presented in Figure 16a.

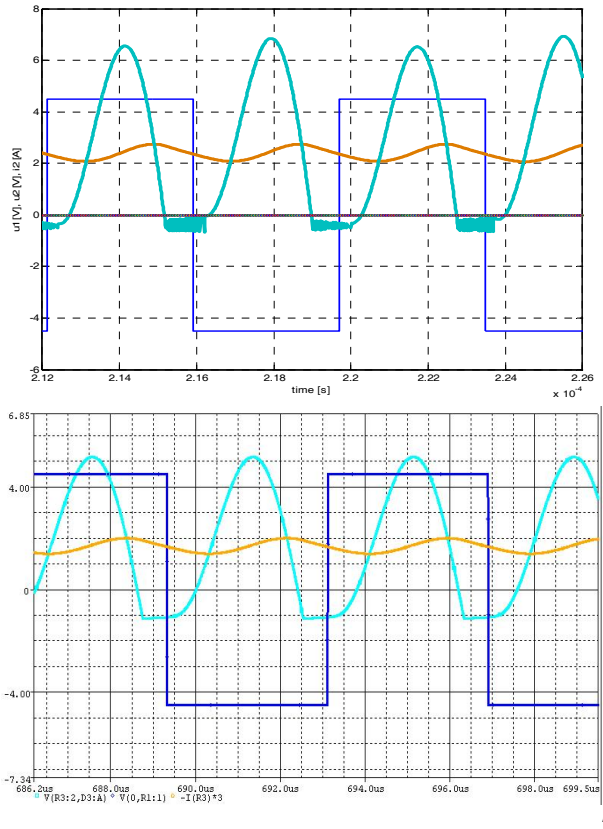


Figure 15. Simulation experiments for overloaded rectifier mode: in Matlab (a) and OrCad (b) environment

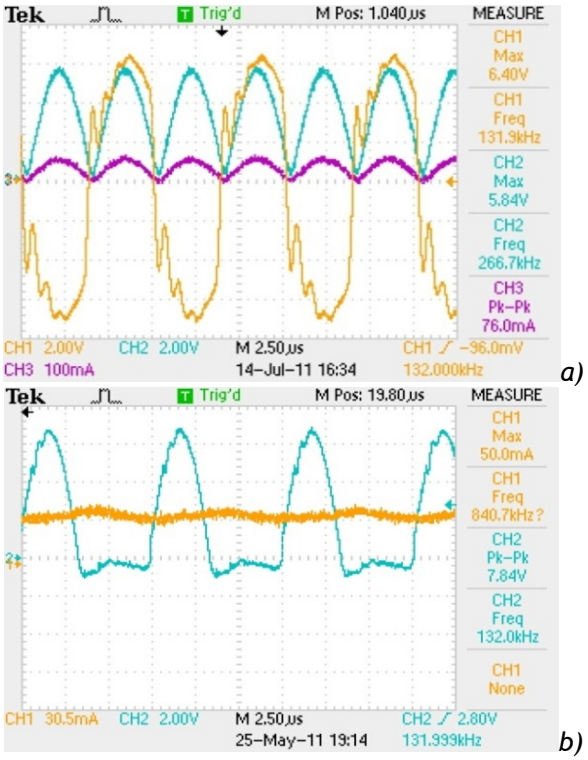


Figure 16. Rectifier mode under R load (a)- and overloaded rectifier mode under R-L load (b) of LCTLC - oscilloscope view

As one can see from achieved results the output voltage is not constant but depends on value and character of the load. Using asymmetrical control [9], [12] is possible to control of output voltage or to hold it on constant value. Dependency of fundamental harmonic of $u_1(t)$ input voltage on control angle β or duty cycle, respectively is given by relation:

$$\frac{U_1(\beta)}{U} = \frac{\sqrt{2}}{\pi}\sqrt{1-(\cos(\beta)} \ldots\ldots (= \frac{2}{\pi}\sin(\frac{\beta}{2})) \quad (9)$$

where control angle β is equivalent to the width of pulse.

The voltage (its fundamental harmonic) is then transformed throw the resonant LC circuit to the output of LCTLC convertor. Using simply control voltage loop the output can be regulated in the range from zero up to maximum value ($2/\pi \cdot U_{DC} \cdot N_1/N_2$; where N_1/N_2 is transformer ratio).

Using controlled rectifier with MOSFETs instead of Schottky diodes could be also possible a classical phase shift control.

Another way how to control of output voltage is to use voltage transfer function of LCTLC which gain depends on used switched frequency - that means: frequency control.

CONCLUSIONS

There has been described in the paper two modes of LCTLC converter:

- *direct AC (HF) mode,*
- *rectifying DC mode (with output SD or MOSFET rectifier).*

At the first one the LCTLC converter with HF output mode is used as power supply source of high frequency voltage for industrial applications (e.g. hardening of materials, demagnetisation in bearing production). Quality of the output voltage is very high, total harmonic distortion can be lesser then 5%.

The second mode of LCTLC uses Schottky diode or MOSFET rectifier for DC output. This mode with Schotky diode was intensively analysed in the paper mainly regarding to overloading when occurring 'zero voltage' period in output voltage.

Both modes are verified by Matlab 'equational' simulation, OrCad circuital simulation, and by experimental testing with good results. The analysis results showed very good transfer and also functional properties of LCTLC:

- *output voltage is stable and constant, practically independent on the loading,*
- *during overloading a 'zero voltage' period is gene-rated; output voltage decreasing, and consequently output current is restricted.*

Acknowledgment

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NOVEL TRENDS AND TECHNIQUES USABLE FOR SOPHISTICATED APPLICATION LAYER DENIAL OF SERVICE ATTACKS DETECTION

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ABSTRACT: As increasing number of security threats and attacks continuously appear and security in the network has become a basic requirement, the need of developing flexible, reliable and automated security mechanisms that can detect and respond to threats in real time has posed a big challenge for researches. This paper focuses on description of Application layer Denial of Service (DoS) and Distributed Denial of Service (DDoS) attacks, which present a continuous critical threat to the Internet services. Over some period of time, researchers proposed many solutions to prevent the DoS/DDoS attacks from different OSI layers, but there has been done only a very small research on application layer. In this paper, we consider sophisticated attacks that utilize legitimate application layer requests from legitimately connected network machines to overwhelm Web server. In this paper we propose several known mechanisms to combat application layer DoS/DDoS attacks continuing with proposing most recent approaches and trends which are concurrently under the development.
KEYWORDS: denial of Service, application layer, Intrusion Detection System

INTRODUCTION

Network security and security policy is a frequently discussed topic in state of the art computer world. The obligation of protecting sensitive information, data and services placed on computer networks and Internet is a obvious question today.
There are lots of new threads appearing quite often and countermeasures against them have to be taken. Usually, computer threads can be categorized into four main classes, like: reconnaissance attacks, password attacks, denial of service attacks and malware. This paper will talk more about the third mentioned attack type, Denial of Service (DoS) attacks and problems associated with the appearing defense mechanisms to counter this kind of attack.

A. Denial of Service Attack Description

Several years ago when Denial of Service attacks started to appear quite frequently, the need of defending networks and servers against this kind of security threat became serious. This need to protect servers and other network systems is an important aspect in network security as it requires only a little effort to execute DoS attack.
Today plenty of application servers and network facilities may suffer from DoS and Distributed Denial of Service (DDoS) attacks and that is why it is needed to wide inform on what mechanisms these attacks work, in what manner are these mechanisms evolving and how to defend servers and network systems against this malicious activity. [1]

The main goal or purpose of DoS and DDoS attacks is to prevent authorized hosts from using a service. The service can be either for free or it can be paid, the attacker doesn't differentiate due to the service fee. It is important to notice that DoS and DDoS attacks differ from other classes of computer and security attacks with the purpose of the attack. The goal is not to steal or misuse the sensitive data, DoS/DDoS attacks aim at creating network congestion or overloading the application server by generating a large amount of traffic addressed to the victim. Usually, a malicious user blocks legitimate users from accessing network services by exhausting or depleting the resources of the victim's server. [2]
DoS and DDoS attacks are aimed at any network device but most often at application layer servers, like DNS servers, electronic mail servers or web servers to make the most popular services unavailable for users. This can be done by several approaches, but most usually either by consuming the network bandwidth, the CPU cycles or by consuming the RAM memory of the victim device. Due to the attack performance, DoS attacks can be categorized in the manner of what damage they cause into three main categories:

- Destructive DoS attacks
- Resource consumption DoS attacks
- Bandwidth consumption DoS attacks

It is evident that in the first case the device stops to work normally. In this case, the attacker can cause

power interruption or destruction of some configuration information. It can be said that this is the simplest way how to interrupt the accessibility to the service but on the other hand it can have most serious consequences. Second example of DoS attack impact is resource consumption where the principle of attack is to overuse resources of the victim's hardware. In the same manner bandwidth consumption attacks simply consume bandwidth capacity of a network by sending bogus requests to the victim server thus clogging the subnetwork of victim's origin with fake traffic. [2]

B. Distributed Denial of Service and Distributed Reflector Denial of Service Attacks

Distributed Denial of Service is a special kind of DoS which goal is to increase the attacks intensity by using a number of computers. DDoS attacks are considerably more effective than DoS because they allow increasing the attack intensity by simultaneous use of number of computers. DDoS attacks represent a frequent disturbance to services hosted on high-profile web servers such as banks, credit card payment gateways, insurance companies and others.[3] DDoS occurs when multiple systems flood the bandwidth or resources of a targeted system, what makes the attack more efficient and complicates searching out the originator of the attack. [4] Distributed Denial of Service is usually performed within a logical structure, which can be seen on Figure 1.

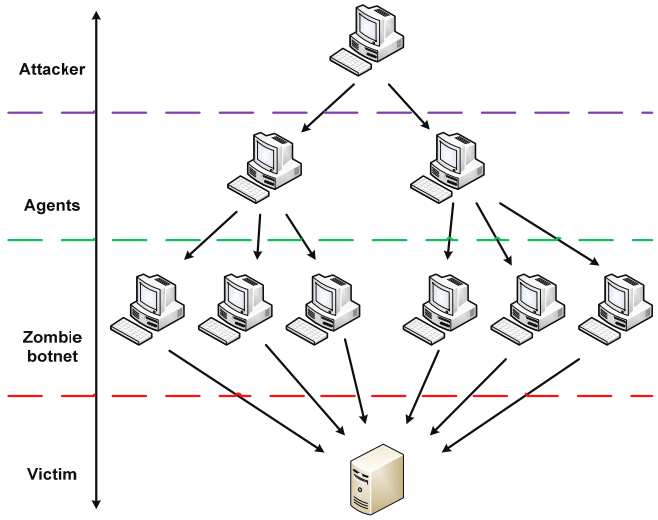

Figure 1. Structure of Distributed Denial of Service Attack

The layered structure consists of a client, who is an attacker and who connects to several compromised system called handlers. These handlers indicate commands to multiple zombie agents which in turn facilitate the DDoS attack on the target host or system. By the way, each handler can control up to thousand agents. The attacker usually uses in Internet Relay Channel for communication with the agents. Many systems can be compromised by an attacker using a variety of methods because operating systems and network protocols were developed without applying security engineering. This results in providing hackers a lot of vulnerable machines on Internet which can be misused by an attacker for building an army of attackers. The attacker usually misuses known vulnerability of a computer system and implements a malicious code into the victim. Created zombie botnet then simply attacks the victim with a large amount of traffic.

Distributed Denial of Service attacks can be divided into two main categories:

- *flooding attacks*
- *vulnerability attacks*

Flooding DDoS attacks consume resources such as network bandwidth by overwhelming bottleneck link with a high volume of traffic. DDoS flooding is basically a resource overloading problem. By the term of resource can be understood bandwidth, memory, CPU cycles, file descriptors and buffers etc. [5] Thus, service is denied to legitimate users due to limited bottleneck bandwidth. However, resources of distribution networks are not a problem in case of commercial servers if these are situated quite close to their backbone network with high bandwidth access links. But hardware resources of the server such as processing capacity, buffer limit etc., are put under stress by flood of seemingly legitimate requests generated by DDoS attack zombies. Each request consumes some CPU cycles and once the total request rate overlaps the service rate of a server, the requests start to be placed in a buffer of the server and after some time the buffer gets overfilled. Due to buffer over run, other incoming requests are dropped. The congestion and flow control signals then try to force legitimate clients to decrease their rate of sending requests, whereas attacking packets keep coming. Finally, there comes a state when there is only the attacking traffic reaching at the server. Thus, service is denied to legitimate clients. Moreover, in [6] Robinson highlights that as attack strength grow by using multiple sources, the computational requirements of even filtering traffic of malicious flows become an additional burden at the target.

Vulnerability attacks use the expected behavior of the protocols such as TCP and HTTP to the attacker's advantage. The computational resources of the server are then tied up by seemingly legitimate requests of the attackers and thus prevent the server from processing requests from authorized users.

Almost all of DoS and DDoS attacks are targeted at TCP based services.

DDoS attacks can result in a great damage to network services. Since they can rapidly degrade the network performance and are difficult to detect, they have become one of the most serious security challenges to the current Intrusion detection systems. However if DDoS attacks are detected in sufficient short time, the loss caused by this attack can be reduced to minimum. So far, effective and complex solutions to defeat all features of DDoS attacks haven't been found yet. Therefore, DDoS attack detection is still an attractive area for researches. [7]

An important goal for an attacker is to stay anonymous or to hide true source of the attack traffic. For these purposes attackers found out a novel methodology of attack called Reflector Denial of Service (RDoS). On the Figure 2 can be seen a principle of Reflective Denial of Service attack.

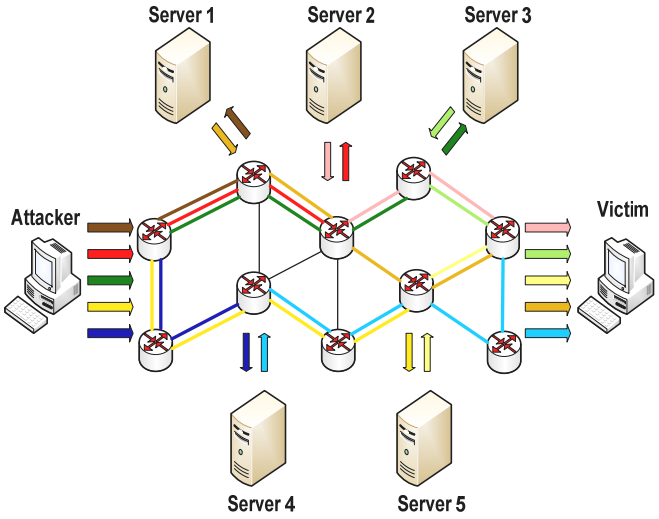

Figure 2. Principle of Reflective Denial of Service

This type of bandwidth attack aims to obscure the sources of attack traffic by using third parties (routers or Web servers) to relay attack traffic to the victim. These innocent third parties are also called reflectors. Any machine that replies to an incoming packet can become a potential reflector. In principle, the attacker sends packets with spoofed source addresses to the victims address to surrounded routers or web servers. These network devices then answer to incoming packets and address them to the address, received as a source address, which means to the victim. This way the victim receives a huge amount of traffic and start to be under Denial of Service attack. Reflective DoS attack can be executed either in a simple manner or in a distributed manner. The Distributed Reflecrot Denial of Service (DRDoS) attack consists of three levels. The first level is very similar to the typical DDoS attack, which was described in previous section, so that an attacker makes connections to several agents. However, in the second level, when agents of the attacker have control of a certain number of zombies there is a little difference. Instead of instructing the zombies to send attacking traffic to the victim directly, the zombies are ordered to send traffic to the third parties with spoofed source IP addresses to the victims address. In the third stage, the third parties called reclectors will then send the reply traffic to the victim, which leads to a DRDoS attack. In comparison to a traditional DDoS attack, the traffic from a DRDoS attack is further dispersed by using the third parties, which makes the attack traffic even more distributed and difficult to identify. [8] Moreover, the source IP addresses of the attack traffic are from innocent third parties, which make attack source traceback exteremely difficult.

RELATED WORK

Based on the literature survey, most DDoS detection related studies focus on three different layers:

- *Network layer detection*
- *Transport layer detection*
- *Application layer detection*

Most DDoS detection related research was focused on the IP layer, because there are a lot of parameters, which can be monitored. These mechanisms attempt to detect attacks by analyzing specific features like arrival rate or header information. For example in [9] Cabrera used the Management Information Base (MIB) data which include parameters that indicate different packet and routing statistics from routers to achieve the early detection. In [10] Yuan used the cross-correlation analysis to capture the traffic patterns and then to decide where and when a DDoS attack possibly arises. Other approach made Mirkovic in [11], who monitored the asymmetry of two-way packet rates to identify attacks in edge routers. Other statistical approaches for detection of DDoS attacks include for example IP addresses [12] and time-to-live (TTL) values [13].

Second very frequently monitored layer for DoS/DDoS attack detection is transport layer. For example, authors [7] mapped ICMP, UDP, and TCP packet statistical abnormalities to specific DDoS attacks based on MIB. Wang [14] for example monitored TCP SYN/FIN packets for SYN flooding attacks detection. In [15], DDoS attacks were discovered by analyzing the TCP packet header against the predefined rules and conditions and afterwards the difference between normal and abnormal traffic was distinguished. Noh [16] attempted to detect attacks by computing the ratio of TCP flags (including FIN, SYN, RST, PSH, ACK, and URG) to TCP packets received at a Web server.

However, only a little work has been done on application layer for DoS/DDoS attack detection because Application DDoS attacks appeared only a few times in the past. Ranjan [17] used statistical methods to detect characteristics of HTTP sessions and employed rate-limiting as the primary defense mechanism. Other researchers combated the App-DDoS attacks for example by puzzle [18]. In [19], there are used two properties to distinguish the DoS/DDoS and normal flash crowd:

1. *a DoS event is due to an increase in the request rates for a small group of clients while flash crowds are due to increase in the number of clients,*
2. *DoS clients originate from new client clusters as compared to flash crowd clients which originate from clusters that had been seen before the flash event.*

But none of these approaches can be thought as a complex and effective solution for Application DDoS attacks detection, which makes this area still attractive for researchers.

APPLICATION DOS/DDOS ATTACKS

DoS and DDoS attacks have caused severe damage to network devices and services. In the past it was most common to execute these attacks at network and transport layer such as ICMP flooding, SYN flooding, or UDP flooding. The intent of these attacks is to consume the network bandwidth or overleap the number of possible parallel connections and deny the service to legitimate users. Many studies have explored this type of attack and many different schemes how to protect the network have been proposed. Because of that, it is not as easy as in the past for attackers to launch the DDoS attacks based on network layer. This has led to uncovering a new, sophisticated strategy on how to overload network

devices, such as application servers. The main difference between Application DDoS and network layer oriented DDoS is in exploiting vulnerabilities of application protocols. This means that connections on network and transport layer have to be estimated correctly. This makes the detection of the attack much more complicated because it is difficult to differentiate attacking traffic from the legitimate one. [20] This performance of attack requires less number of attacking traffic because the goal is to reach resource limits of a concrete service, which is always lower than the total amount of possible TCP or UDP connections. This way can the attacker exhaust all the possible connections on application layer regardless to hardware limitations of the victim's device. Most times are targeted frequently used application servers like HTTP server, FTP server, SMTP server etc. A lot of application DDoS attacks target HTTP, in which case they aim to exhaust the resource limits of Web services.

If we are interested in HTTP or HTTPS service then there are two protocol weaknesses which are usually misused:

- HTTP GET
- HTTP POST

HTTP GET flood attack is performed with the misuse of the first mentioned weakness of HTTP protocol. In this type of attack, attackers send a large number of malicious HTTP GET requests to a target server [21, 22]. Since these packets have legitimate HTTP payloads, victim servers cannot distinguish normal HTTP GET requests from the malicious requests. Thus servers have to serve all requests as normal requests, and they exhaust their resources finally.

Another attacking approach is used when the attacker performs Slowloris attack. It is also based on HTTP GET request weakness, but the victim is not flooded with spoofed requests but it uses time delayed HTTP GET headers. In principle, the attacker doesn't sent HTTP GET request header on one time, but he separates the lines of the header and sends each line separately. The web server creates the connection with the attacker and simply waits until the end of the request header and this could take a long time. This way is the connection reserved for the malicious request for a long period of time. There is a default threshold, which indicates the maximum timeout when has the next line of header arrive, otherwise will be the connection closed. On Apache web servers it is usually 300s. This time is than set as a break time for sending next line of request header on the attacker side. An attacker can than exhaust web server resources with multiple connections created in this manner. [23]

Last most used attack strategy is to misuse weakness of HTTP POST request. A POST request includes a message body, which can use any encoding. The field Content-Length in the HTTP Header tells the web server how large the message body is. The attacker then completes HTTP Header portion and sends it in full to the web server. The attacker then sends HTTP message body in sequences for example 1 Byte per 110 seconds. Web servers will just obey the Content-Length written in the header field and wait for the remaining message body to be sent. By waiting for the complete message body to be sent, web servers can support users with slow or intermittent connections. When there is multiplied such type of connections, the web server gets under DDoS attack.

APPLICATION LAYER DOS/DDOS ATTACK DETECTION POSSIBILITIES

There are several reasons for attack detection. First, if a target can detect an attack before the actual damage occurs, the target can get more time to implement attack reaction and protect legitimate users. Second, attack detection can help to identify the attackers so that legal actions can be taken. Third, if attacks can be detected close to attack sources, attack traffic can be filtered before it wastes any network bandwidth. However, there is generally insufficient attack traffic in the early stage of an attack and in the links close to the attack sources. Consequently, it is easy to mistake legitimate traffic as attack traffic. Therefore, it is challenging to accurately detect attacks quickly and close to the attack sources.[24]

There has been done only a little research in the past about detecting application layer DoS/DDoS attacks because this type of attack is quite new and it wasn't executed that often in the past. Here are highlighted some older techniques used for application layer DDoS detection:

Client Puzzle Protocol

Client Puzzle Protocol (CPP) is an algorithm for use in Internet communication, whose goal is to prevent abuse of server resources. The idea of the CPP is to necessitate from all clients connecting to a server to correctly solve a mathematical puzzle before establishing a connection, during the time, when the server is probably under attack. After solving the puzzle, the client would return the solution to the server, which the server would quickly confirm or reject and drop the connection. The puzzle is made simple and easily solvable but requires at least a minimal amount of computation on the client side. Non malicious users would experience just a negligible computational cost but attacking clients that try to simultaneously establish a large numbers of connections would be unable to do so because of the computational cost (time delay). This method holds promise in fighting some types of spam as well as other attacks like Denial of Service.

Ingerss Filtering

In computer networks, ingress filtering is a technique used to make sure that incoming packets don't have spoofed source IP addresses in their headers. Generally networks receive packets from other networks. Normally a packet will contain the IP address of the computer that originally sent it. This allows other computers in the network to know where it came from, which is needed for things like sending a packet back to the sending computer. In certain cases, the sending IP address will be spoofed. This is typically done as part of an attack, so that the attacked computer does not know where the attack is really coming from. In ingress filtering, packets coming into the network are filtered based on previous gained information from the originating

network that the sending computer is not allowed to send packets with that IP address. The idea is to prevent computers on your network from spoofing (acting as another).

Treshold Values

The threshold value is the number of requests that a server can handle without straining its resources. It is defined as a predetermined percentage of the maximum number of requests that a server can handle.

These are some older methods which actually do not solve the DoS/DDoS problem. [25] Today, there is a novel approach for application DoS/DDoS attack detection based on two different principles, which are:

- Signature based attack detection
- Anomaly based attack detection

A. Signature Based Attack Detection

This method for DDoS attack detection is based on monitoring statistical changes. The first step for these methods is to choose a parameter for incoming traffic and model it as a random sequence during normal operation. All DoS signature-based detection techniques are based on one or more assumptions. For example one assumption could be that the incoming packet rate is proportional to the outgoing packet rate, which is not always the case, at least real audio or video streams are highly disproportional, and with the widespread use of online movies and online news, where the packet rate from the server is much higher than from the client, false positive rates, will become a serious concern for this scheme.

Another detection assumption can be based on the fact that a normal TCP connection starts with a SYN packet and ends with a FIN or RST packet. So when the SYN flood starts, there will be more SYN packets than FIN and RST packets. Different assumption is based on the fact that multiple attack sources use the same DoS attack tool. Therefore, the resulting traffic is highly correlated. Unfortunately, there is no theoretical analysis to support this assumption. Signature-based detection can identify an attack if the monitored traffic matches known characteristics of malicious activity. But in practice, bandwidth attacks do not need to exploit software vulnerabilities in order to be effective. It is relatively easy for attackers to vary the type and content of attack traffic, which makes it difficult to design accurate signatures for DoS attacks [26]. While signature-based detection can be used to detect communication between attackers and their zombie computers for known attack tools in many cases this communication is encrypted, rendering signature-based detection ineffective. This limits the effectiveness of signature based detection for DoS attacks.

B. Anomaly Based Attack Detection

Anomaly-based detection can identify an attack if the monitored traffic behavior does not match the normal traffic profile that is built using training data. Anomaly-based detection has become a major focus of research, due to its ability to detect new attacks, including DoS attacks. [27] Building a normal profile is most times the first step for all anomaly-based detection techniques. Since there is no clear definition of what is normal, statistical modeling plays a crucial role in constructing the normal profile.

Statistical anomaly detection includes two major parts. First part is to find effective parameters to generate similarity measures. The parameters can be IP packet length, IP packet rate, and so on. The second part is to calculate the similarity between the normal profile and new traffic. If the distance between the monitored traffic and the normal traffic profile is larger than a given threshold, a DoS/DDoS attack is detected. [28] The common challenge for all anomaly-based intrusion detection systems is that it is difficult or almost impossible for the training data to provide all types of normal traffic behavior. As a result, legitimate traffic can be classified as attack traffic, causing a false positive. To minimize the false positive rate, a larger number of parameters are used to provide more accurate normal profiles. This on other hand degrades the detection speed, which is actually very important.

Thus current research activities in the field of network intrusion detection of application oriented attacks focuses mostly on anomaly based intrusion detection and at the present, most approaches and techniques applied in the detection process are related to machine learning.

CURRENT TRENDS IN APPLICATION LAYER DOS/DDOS ATTACK DETECTION

A typical complex detection tool that also uses anomaly-based detection approach is Anomaly Based Intrusion Detection System (AB IDS). This system can be later classified into two different groups based on whether it analyses the features of each packet separately or if it analyses the whole connection. Concerning this feature, there is a distinction of IDS between

- Packet-oriented and
- Connection-oriented systems.

A packet-oriented system uses a single packet as minimal information source, while a connection-oriented system considers features of the whole communication before establishing whether it is anomalous or not. Theoretically, a connection-oriented system could use as input the content (payload) of a whole communication, which would allow a more precise analysis. But this would require a longer computational time, which could limit the throughput of the system by introducing extra latency time.

In practice, a connection-oriented system typically takes into account the number of sent or received bytes, the duration of the connection and transport layer protocol used. As written in [8], most AB IDSs in practice are packet-oriented.

Based on [29], there are two adequate measures for anomaly-based intrusion detection at the application layer: payload length and payload histograms. Main conclusion of their experimental work is that the payload length should not be used as an isolated feature for distinguishing between normal and anomalous traffic. However, its use in conjunction

with other features is shown to be a good choice, since it contributes information related to the normality of the payload.

The normality degree of a given payload could be evaluated with the use of conditional probabilities. Those probabilities can be achieved by using a Markov chain. In this context, [20] proposes an anomaly-based scheme to detect attacks against the HTTP service that follows the basic idea of modeling the payload as a Markov process.

The HTTP specification defines a common structure for every payload, which is composed of several sections each containing different information units. Since each section has its own set of allowed values according to its purpose and semantics, it is natural to suppose that the probability of occurrence of certain strings within each section of the payload is not uniform throughout the request.

Some proposals how to detect anomalies in application-layer traffic have been already made. As written in [30], features, or monitored parameters of an application query, that are usually considered as relevant for detecting application layer malicious activity are:

- *Attribute length*
- *Attribute character distribution*
- *Attribute presence or absence*
- *Attribute order*

Current research activities in the field of anomaly based network intrusion detection of application layer DoS attacks, as stated in [30] are focused on three different directions:

- *Statistical-based AB IDS*
- *Knowledge-based AB IDS*
- *Machine learning-based AB IDS.*

In statistical-based techniques, the network traffic activity is captured and a profile representing its stochastic behavior is created. This profile is based on metrics such as the traffic rate, the number of packets for each protocol, the rate of connections, the number of different IP addresses, etc.

The desired model for knowledge-based IDS is constructed manually by a human expert, in terms of a set of rules that seek to determine legitimate system behavior. If the specifications are complete enough, the model will be able to detect illegitimate behavioral patterns.

Machine learning techniques are based on establishing an explicit or implicit model that enables the analyzed patterns to be categorized. A singular characteristic of these schemes is the need for labeled data to train the behavioral reference model. At present, most approaches and techniques applied in the detection process are related to machine learning. Most important machine-learning schemes are:

- *Bayesian networks*
- *Markov models*
- *Neural networks*
- *Fuzzy logic techniques*

These are most recent approaches and trends concurrently under the development of Intrusion Detection Systems with the focus on application layer DoS attacks detection.

CONCLUSIONS

In this paper, we focused on DoS/DDoS attack description and consequently aimed the attention at the detection of Application Layer DoS/DDoS attacks and presented methodologies used for attack detection. While most current effort focuses on detecting DDoS attacks performed at network and transport layer with stable background traffic, we proposed two main detection architectures aiming at monitoring Web traffic on application layer in order to discover dynamic changes in normal burst traffic. Signature based DoS attack detection techniques generally use one or more features of DoS attacks, and can identify attack traffic effectively.

However, all these techniques are based on one or more assumptions, which are not always reliable. On the other hand anomaly based detection techniques are facing a dilemma of how to choose a tradeoff between processing speed and detection accuracy. Beside this we presented also most current methodologies used by anomaly-based Intrusion Detection System for application layer DoS attack detection.

Recent intrusion detection techniques combine and correlate information from different detectors while individual detectors are designed to monitor only a specific protocol or behavior.

At present, most approaches are related to machine learning by Markov models, anagrams and others.

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LMPM MASTER SLAVE POSITION CONTROL WITH LUENBERGER OBSERVER USING GENETIC ALGORITHMS

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ABSTRACT: Linear motors tend to be indispensable at present. Whether they are utilize in health service or in automation industry. It is certain that companies is always looking for something 'more' and linear motors have it. Therefore the aim of this paper is to find better solution for introduced task. How to achieve higher precision in LMPM position control? How to adjust optimal controller parameters? This paper contains answers for more than these questions and in addition compares in more detail Pole-placement method with genetic algorithm, as well.
KEYWORDS: Master Slave Control, Luenberger Observer, Linear Motor, Genetic Algorithm, Lead Compensator, Pole placement method

INTRODUCTION

Nowadays, linear motors types are still more and more preferred thanks to their matchless features. Although in comparison with rotary motors, they are henceforward financially demanding. It can be mentioned that a high speed trains, such as Maglev or Trans-rapid became famous by implementation these kind of motors. Linear motors however occur in various sectors, whether in electro-technical or electronic production (drives for operating and position engineering, drives into machine tools …).

This paper will be focused on position servo-drive control design of LMPM in consideration of control performance comparing Genetic Algorithm (GA) with Pole-placement (PP) method. It has to be mentioned as well that 3D Master slave control with Luenberger observer will be applied.

Observers are algorithms that combine sensed signals with other knowledge of the control system to produce observed signals. In some cases, the observer can be used to enhance system performance. It can be more accurate than sensors or can reduce the phase lag inherent in the sensor. Observers can also provide observed disturbance signals, which can be used to improve disturbance response. In other cases, they can reduce system cost by augmenting the performance of a low-cost sensor so that the two together can provide performance equivalent to a higher cost sensor. In the extreme case, observers can eliminate a sensor altogether, reducing sensor cost and the associated wiring [3]. Consequently among various observers, Luenberger observer was chosen to enhance the accuracy and reduce the sensor-generated noise.

Idea of evolutionary computing was introduced in the 1960s by I. Rechenberg in his work "Evolution strategies". His idea was then developed by other researchers. GAs were invented by John Holland and developed by him and his students and colleagues. This lead to Holland's book "Adaption in Natural and Artificial Systems" published in 1975. In 1992 John Koza has used genetic algorithm to evolve programs to perform certain tasks. He called his method "genetic programming". During reproduction, first occurs recombination (or crossover). Genes from parents form in some way the whole new chromosome. The new created offspring can then be mutated. Mutation means, that the elements of DNA are a bit changed. These changes are mainly caused by errors in copying genes from parents [8].

GA is one of the most famous and the most used representatives of evolutionary computing techniques with wide range of application [1]. Control performance possesses highly important function in servo-drives that is why we took advantage of GA to improve the overall performance. Finally results gained from the GA are compared to these learned from the controller designed by Pole-placement method with lead-compensator described in (Radicova, Zalman) [2]. Main idea of designing controller parameters using GA has been publicly adopted in the 1990's, but remains popular in the present as well, which is proven by number of papers in relevant journals [6],[7]. Interesting is also attempt of PI position controller design of SMPM drive by Khater and others [5].

3D MASTER SLAVE SERVO-DRIVE

A. Master slave control

Master slave control can be assign to the status control or model control [4.]. Its significant advantage is the inutility of knowing the exact mathematical model of controlled system S. The quality model of regulating system is highly

sufficient providing that you are familiar with the scale of main parameters.

Master serves as a generator of control state variables and surprisingly the control vector can be greater than number of measured variables. Its task is to generate desired state value curves - control vectors which shape can be rectangular, trapezoidal or sinusoidal either 3-dimensional or 4-dimensional. In this paper is used 3D master slave generator and it generates state values of the position, speed and acceleration (Figure 2).

Slave contains controllers of the state values.

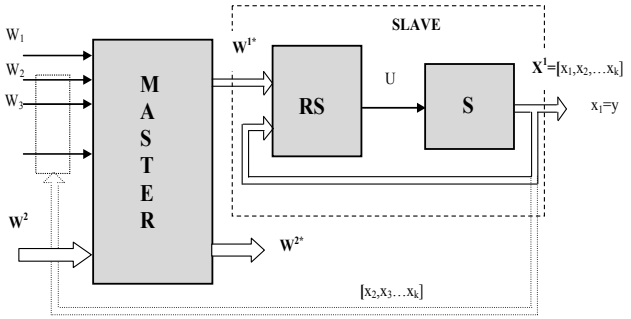

Figure 1. Master Slave control system structure

RS represents regulating system and S means controlled system.

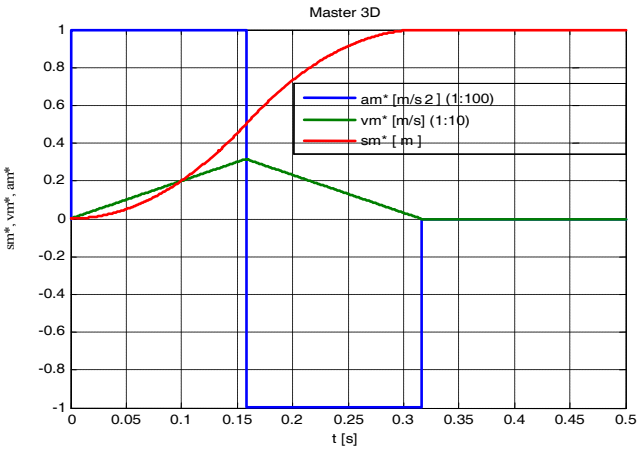

Figure 2. Time responses of Master slave output values

B. Precorrection constants

Undeniable parts in Master slave control are precorrection constants. Their task is to enhance position accuracy and consequently lower the position error.

Calculating precorrection coefficients (K_1, K_2) starts from the condition for feed forward control, however force generator GF dynamics is not considered.

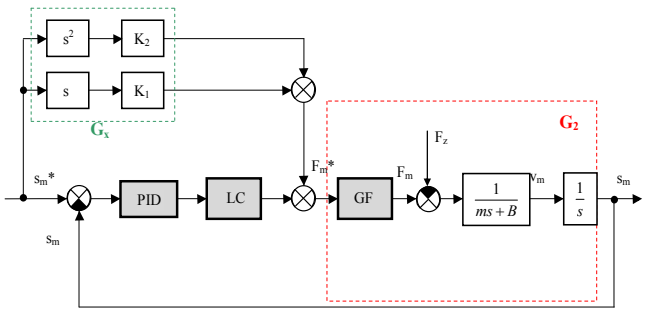

Figure 3. Force Position servo-drive block diagram with PID structure and marked precorrection Master-3D (PID-proportional-integral-derivative controller, LC-Lead Compensator, GF-Force generator,)

$$G_x(s) = \frac{1}{G_2(s)}$$

$$G_2(s) = \frac{1}{ms+B}\frac{1}{s} = \frac{1}{ms^2+Bs} \qquad (1)$$

$$G_x(s) = \frac{1}{G_2(s)} = ms^2 + Bs$$

$$K_1 = B;\ K_2 = m$$

POSITION CONTROL

A. Position servo-drive, implementation block scheme

Position servo-drive can be performed by various algorithms. PID algorithm with lead compensator is applied, referring to the article [9]. The main asset is to execute synthesis of PID algorithm with lead compensator and evaluate better parameters design method. Pole-placement method and GA will be used as was presented in introduction. The entire position servo-drive structure may be seen in the Figure 4.

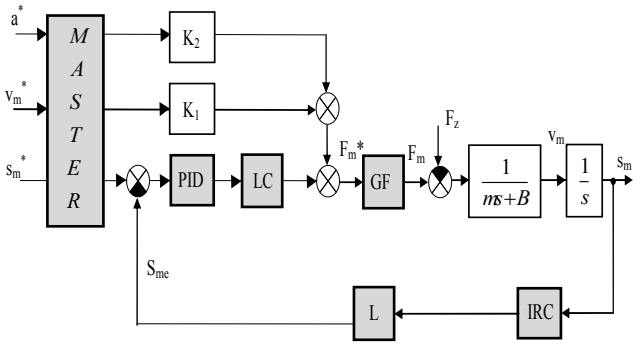

Figure 4. Entire diagram of position servo-drive (PID-proportional-integral-derivative controller, LC-Lead Compensator, GF-Force generator, L-Luenberger observer, IRC-Incremental sensor)

B. Force generator

Force generator GF (Figure 4) is the most important block of linear servo-drive control structure, which works on a principal of vector frequency-current control synchronous motor with PM control (Figure 5).

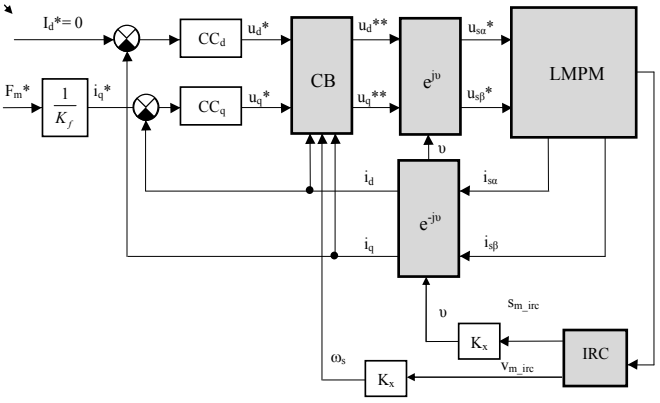

Figure 5. Force generator LMPM structure

As can be seen it contains blocks of Park's transformations, compensation block, IRC sensor, two current controllers (CC_d, CC_q) and block LMPM - particular servo-drive realized by equations

$$u_d = R_s i_d + \frac{d\psi_d}{dt} - \omega_s \psi_q$$
$$u_q = R_s i_q + \frac{d\psi_q}{dt} + \omega_s \psi_d$$
$$\psi_f = L_{md} i_f$$
$$\psi_d = L_d i_d + \psi_f \qquad (2)$$
$$\psi_q = L_q i_q$$
$$F_m - F_z = m \frac{dv_m}{dt}$$
$$\omega_s = K_x v_m \; ; \qquad \upsilon = K_x s_m$$

Equation (3) represents a relation between rotary and linear parameters issued from the physical interpretation.

$$v_m = 2\tau_p f_s \qquad (3)$$

τ_p - Pole spacing [m]
f_s - Power supply frequency [Hz]
Then generally holds the equation (4).

$$K_x = \frac{\omega_s}{v_m} = \frac{\pi}{\tau_p} \qquad (4)$$

C. Luenberger observer

Luenberger observer is the observer of velocity and acceleration. In general it may contain different algorithm structures for observing velocity and acceleration. In this paper is chosen PID algorithm for controlling the third order system however.

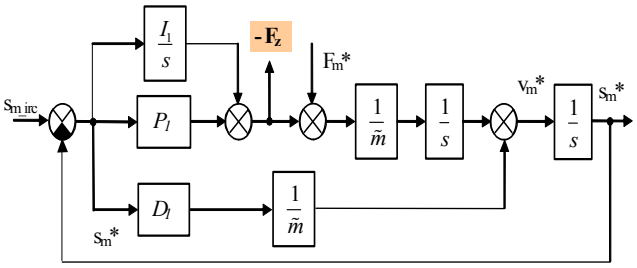

Figure 6. Luenberger observer block diagram

Pole-placement method is applied. It compares denominator of close-loop system N(s) with desired denominator $N_D(s)$ by equal power.

$$N(s) = s^3 + \left(\frac{D_1}{\tilde{m}}\right)s^2 + \frac{P_1}{\tilde{m}}s + \frac{I_1}{\tilde{m}}$$
$$N_D(s) = \left(s^2 + 2\xi_1\omega_{01}s + \omega_{01}^2\right)\left(s + k_1\omega_{01}\right) \qquad (5)$$
$$N(s) = N_D(s)$$
$$P_1 = \tilde{m}\omega_{01}^2\left(2\xi_1 k_1 + 1\right)$$
$$I_1 = \tilde{m}k_1\omega_{01}^3$$
$$D_1 = \omega_{01}\left(2\xi_1 + k_1\right)\tilde{m}$$

Parameters setup variables ξ_1, k_1 and ω_{01} are further explained in the Table III.

CONTROLLER DESIGN METHODS

The comparison of two controller design methods will be presented.
PID controller is the most used controller in praxis and it contains 3 parallel connected sub-circuits. The first sub-circuit is proportional, which multiply controller input value with adjustable coefficient. The second parallel sub-circuit integrates and the third parallel sub-circuit derivates controller input value.
The dynamics of force generator is not considered in the synthesis of PID controller. Pole placement method is suitable for PID controller design, but it is more or less impossible to design parameters of PID with lead compensator together. According to that genetic algorithm is applied.

A. Pole-placement method

Pole placement is one of the most widely used methods of controller design. It compares denominator of close-loop system N(s) with desired denominator $N_D(s)$ by equal power. Accordingly, controller parameters are designed (P, I, D), however force generator GF dynamics is not considered.

$$N(s) = N_D(s)$$
$$N(s) = s^3 + \left(\frac{D+B}{m}\right)s^2 + \frac{P}{m}s + \frac{I}{m}$$
$$N_D(s) = \left(s^2 + 2\xi\,\omega_0 s + \omega_0^2\right)\left(s + k\omega\right) \qquad (6)$$
$$P = m\omega_0^2\left(2\xi k + 1\right)$$
$$I = mk\omega_0^3$$
$$D = \omega_0\left(2\xi + k\right)m - B$$

Parameters setup variables ξ, k and ω_0 are further explained in the Table III.
Lead compensator coefficients are design by well-known method using relation (lead - lag).

$$G_{LC} = \frac{aT_1 s + 1}{T_1 s + 1} \qquad (7)$$

The lead compensator design is not the main purpose of this paper and you can find it in (Radičová, Žalman) [2]. A task to design parameters for PID controller together with lead compensator by Pole-placement method led to analytically unsolvable problem. Therefore, another solution for this task had to be found.
However, the design of PID and lead compensator parameters were continuous, realization was discreet.

B. Genetic algorithm

GA is one of the mostly used representatives of evolutionary computing. This algorithm is based on finding optimal solution (optimal structure and controller parameters) for the given problem. Accordingly, the base rule for success is precise fitness function design. Hence the fitness function represents minimization of position error using the following

$$Fitness = \sum|e| + a\sum|dy| \qquad (8)$$

As a solving tool Genetic algorithm toolbox was used [10.]. It is not the standard part of MATLAB distribution. The Toolbox can be used for solving of real-coded search and optimization problems. Toolbox functions minimize the objective function and maximizing problems can be solved as complementary tasks as well.
The process of searching is adjusted very sophistically.

First of all, a random population is generated with a predefined number of chromosomes in one population within prescribed limits for controller parameters (for particular values see Table I).

TABLE I. USED PARAMETERS OF GENETIC ALGORITHM OPTIMIZATION

Number of generations	100
Number of chromosomes in one population	30
Number of genes in a string	3
Parameter "a" weight	0.6

Then two best strings according the fitness function were selected to the next generation. Bigger number of strings was selected to the next generation by tournament. Then number of crossovers and mutations are applied to the population to achieve bigger chances to reach the global optimum.
This algorithm, using methods mentioned above, is able to design 6 parameters for PID controller (P, I, D) and lead compensator (a_1, a_2, b_2), as well. Eq. 9 represents transfer function for lead compensator and PID controller.

$$G_{LC}(z) = \frac{a_1 z + a_2}{z + b_2} \qquad (9)$$

$$G_{PID}(z) = P + I\frac{Tz}{z-1} + D\frac{z-1}{Tz}$$

Figure 7 shows algorithm progress, how was fitness function searching for optimal results.

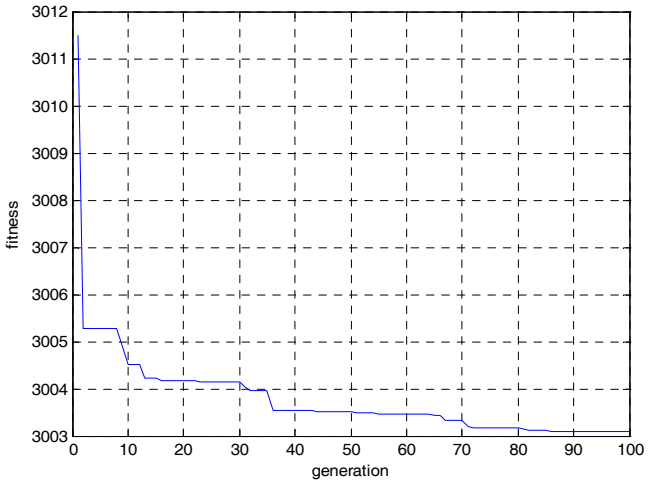

Figure 7. Convergence of genetic algorithm (GA)

RESULTS

Genetic algorithm is a powerful tool for parameters controller optimization purposes because it is able to find the solution where the other methods fail.
The main purpose was to find method how to design controller parameters as simply as possible. Genetic algorithm GA offered co-equal results as Pole-placement PP in 3D Master slave rectangular control (Figure 11). However, the major positive effect is that GA was able to design 6 parameters in discrete form at once.
In edition it has to be mentioned that following experiments were performed on the simulation model in Matlab Simulink environment using Luenberger observer and precorrection constants.

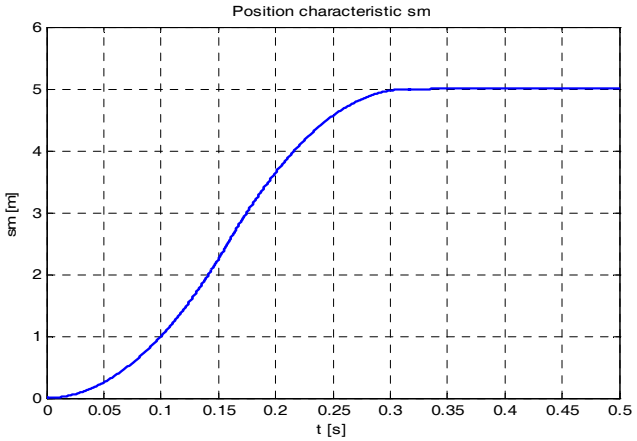

Figure 8. The time response of position

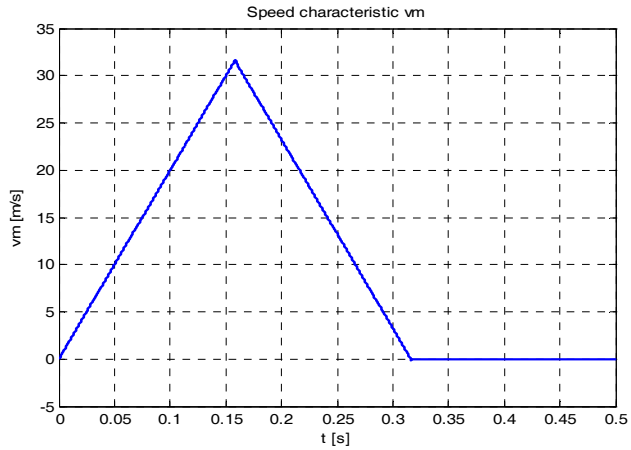

Figure 9. The time response of speed

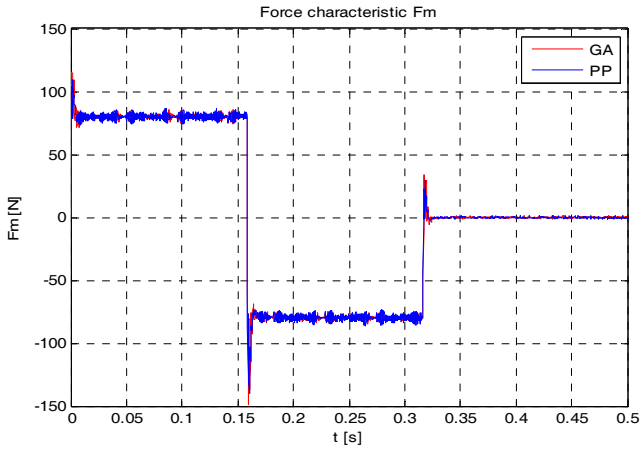

Figure 10. The time response of force

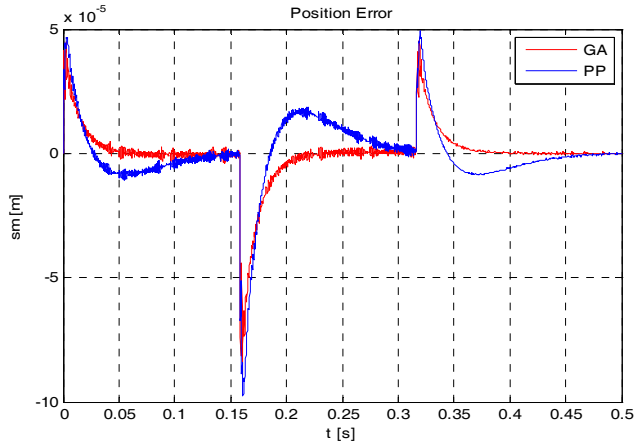

Figure 11. The time responses of position error comparing GA and PP approach

TABLE II. COMPARISON OF PARAMETERS OBTAINED BY TWO DIFFERENT METHODS

	P	I	D	a_1	a_2	b_2
GA	9487	2837	149	5.86	-0.81	0.61
Pole-placement	4737	99220	75.39	20	-0.07	-0.003

TABLE III. TABLE OF ACRONYMS

Acronym	Meaning	Value
T	Sampling period	0.2 ms
Parameters for PID controller		
ξ	Damping index	1
k	Shift pole index	1
ω_0	Bandwidth	$2\pi f_0$
f_0	Frequency	10 Hz
Parameters for Luenberger observer		
ξ_1	Damping index	1
k_1	Shift pole index	10
ω_{01}	Bandwidth	$2\pi f_0$
f_{01}	Frequency	10 Hz
Parameters for precorrection		
K_1	Precorrection constant	B = 0.01 kg.s-1
K_2	Precorrection constant	m = 0.4 kg
Parameters for IRC sensor		
N	Resolution	2 μm

CONCLUSIONS

Genetic algorithm toolbox in connection with MATLAB is a very powerful tool for optimization and search problems. The numerical results and provided figures show that within 100 generations, a solution better than analytical (Pole placement method) was found. At this point it can be said that genetic algorithm is capable to design more than 3 parameters in comparison with Pole placement method what is a significant contribution in this area. Using positive effect of precorrection and Luenberger observer led to the achievement of more precise positioning of LMPM (Figure 11). Eventually, it can be observed that PID controller with lead compensator parameters designed by genetic algorithm possess significant impact on positioning precision.

Acknowledgment

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EMISSION TESTING USED BIOGAS AND VEGETABLE OILS AS FUELS

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ABSTRACT: We made some environmental tests on different kinds of vegetable oils and biogas in a few projects so in this paper we describe exhaust emission measurements, in fact this paper introduces environmental dimension of renewable energy systems (utilizing biogas and vegetable oils in internal combustion engines). We deal with the biogas and biodiesel because producing and utilization of biogas and biodiesel help realize the strategic purpose and objects in the energy policy and the environment policy, too. Namely the European Union focuses on the promotion of renewable energy sources through its energy policy. Actually, our environmental obligations and supported tasks of renewable energy production came into view after our joining to the European Union because in the European Union the share of renewable energy must reach 20% till 2020. So we have to take advantages opportunities more and more in the renewable energy.
KEYWORDS: Biogas, Vegetable oils, Internal combustion engine, Emission testing

INTRODUCTION

The studying of possible renewable liquid and gaseous fuels - derived from different kinds of biomass or wastes - is not a new theme. Although in recent years, sustainable development and sustainable survival became actual global problems because it is needed to increase the rate of renewable energy sources to solve together the environmental and energy problems. Numerous studies examine biodiesel and biogas fuels because their properties are similar to conventional fossil fuels so can be used in internal combustion engines without any special modifications. Actually, the idea of the bio-fuels is as old as the engine itself.

There are various solutions to utilize the biogas and the biodiesel, one of the possible options is utilizing of them in internal combustion engines. Our daily lives there can be no firing. However it can not be given up the energy from burning, but environment pollution is not necessary to accompany development. In the operation and facilities management of heat engines in addition to machinery and equipment design there is key role composition and quality of the used fuel. Most of the air pollutants come from the combustion. The importance of renewable fuels - between the biogas and the biodiesel - is justified by environmentally, EU requirements and economic considerations besides energetic aspects. Conservation of state of our environment and efficient, economical satisfying of energy demands can be solved by harmonized application of traditional and renewable energy sources.

Accordingly, the objective of our research task is: testing of utilization of biogases and biodiesel for energy in internal combustion engines particularly the emission.

THE ENVIRONMENTAL EFFECTS OF BIOGAS FUELLED

We made emission tests on 24.6 kW power, 4 cylinder Wiscon Total TM27 type gas engine with biogases. We represented the biogases as mixtures of methane and carbon-dioxide.

In Figure 1 it can be seen that in case of λ >1.1 air access ratios the cooling effect of the surplus air results lower NO_x emission, however, NO_x formation depends on the temperature. The engine operation with increasing carbon-dioxide content of gas mixture - by reason of drawing-off of combustion and cooling effect of carbon-dioxide - results further decreasing.

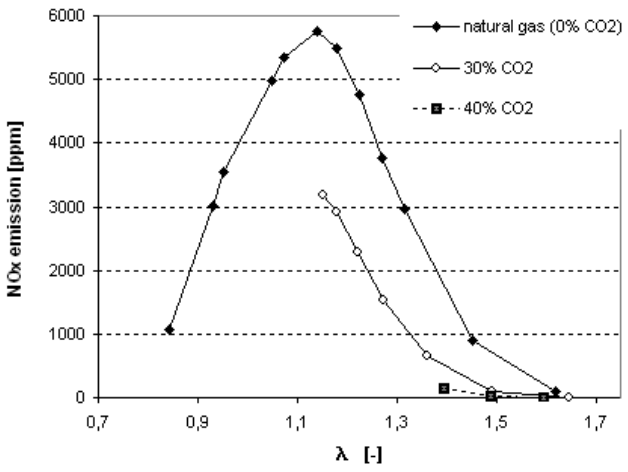

Figure 1. NO_x emission

With increasing of carbon-dioxide rate of the applied biogas, the circumstances of the combustion are getting worse.

Figure 2 illustrates the CO emission plotted against the air access coefficient. In case of λ<1.0 air access ratios CO emission increases by leaps and bounds, which can be explained by the increase of adiabatic flame temperature and production of getting rich mixture.

However, in range of λ=1.1-1.4 air access ratios CO emissions - independently of carbon-dioxide content of gas mixture-stabilized on lower values. In case of λ>1.4 air access ratios the dragging-on of combustion results increasing CO emission (and higher quantity of unburnt hydro-carbons). In terms of CO emission, unambiguously, it can be determined that the traditional gas engine is operated with gas mixture with low methane content, there is no effect on CO emission if the gas engine operates permanently in range of λ=1.1-14 air access ratios.

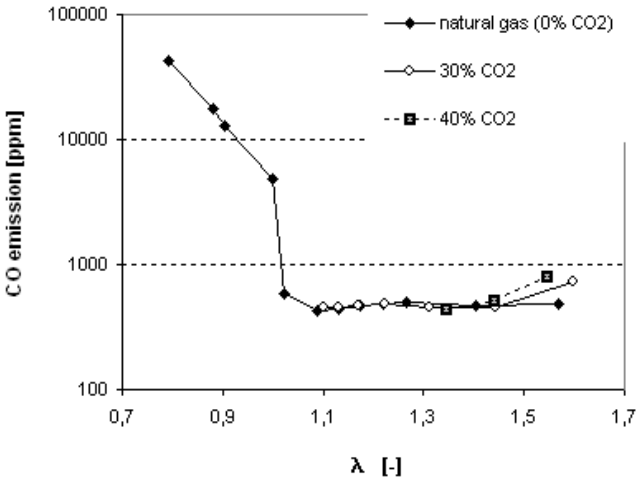

Figure 2. CO emission

Measuring of the methane content in the exhaust gas can give points of reference on the goodness of combustion process. Increasing the air absence and dragging-on of the combustion result similar tendencies considering the unburned hydrocarbons emission, too.

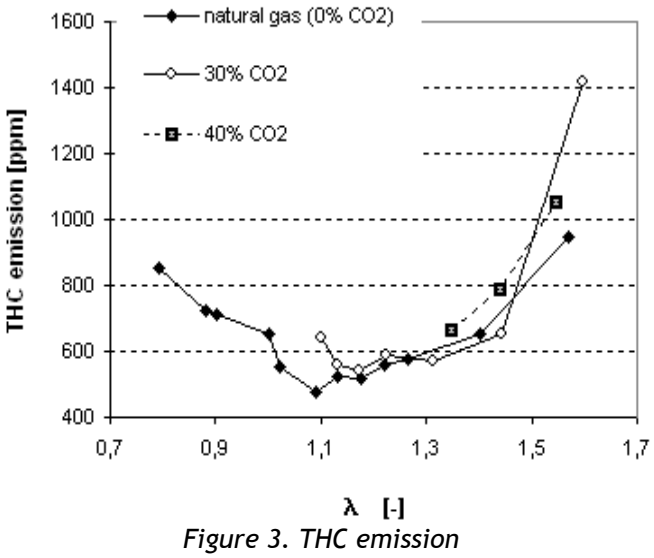

Figure 3. THC emission

In Figure 3 it can be discovered that considering the incombustible hydrocarbon content of the exhausted gases there is no significant deviation present between the operation of natural gas and gas mixtures with a higher carbon-dioxide content in the range of λ=1.2-1.4 air access ratio.

ENVIRONMENTAL EFFECTS OF VEGETABLE OILS FUELLED

We could test 10 types of vegetable oils which are suitable for use as diesel engine fuels. We investigated emission components used with as well 5 kinds of sunflower oils (NR, NB, NA, NA82, NA04), 4 kinds of rape oils (RT, RB, RE, RP), RME and RME mixed with diesel oil (RME 10%).

Application of vegetable oils as fuels in the internal combustion engine resulted different power and torque values than diesel oil, it can be explained with different heat values and viscosity, cetane number of vegetable oils.

Our tests were performed by taking into account the requirements of EU 49 standards with PERKINS 1104C engine type. In the course of our we established the amount of CO, HC, NO_x, CO_2 and O_2 components of exhaust gases and determined the rate of smoking, too.

Our measuring system realized the certification cycle which contains operating conditions like speed (idle speed, maximum torque speed, maximum power speed), load (10, 25, 50, 75, 100%) and load factors. R49 regulation requires a thirteen-step engine brake bench test in steady operation.

The emissions are measured step by step, and they are registered as a specific mass emission (g/kWh) per performance. The issue is an average number that is calculated per polluting components and also per operation modes. Among the thirteen measuring points (operation modes) the sixth and the eights measuring points are high load working points. This means high average exhaust temperature.

During the application of the 10 kinds of vegetable oil-diesel oil mixed fuel we measured higher NO_x values only on two cases than that of near diesel oil (Figure 4).

The samples with sunflower oil were slightly more favourable, than rape oil samples. Nine samples remained below the diesel fuel by 6.94% - 13.61%. Our further remark is that the values of pure RME exceeded the NO_x limit of diesel oil with 6.54% and the mixed fuel containing 10% RME also exceeded by 10.72%.

After the emission tests it was stated that among the 5 kinds of sunflower oil mixed with diesel oil the effect of 4 kinds of fuel fell back by 6.93%-24.94% compared to the CO value of diesel oil (Figure 5). Among 4 kinds of rape oil we noticed substantial falling (65% and 39.61%) in two cases and rising (9.52% and 4.56% twice).

The pure RME showed 26.42% less CO emission the mixed fuel containing 10% RME decreased by 73.57%.

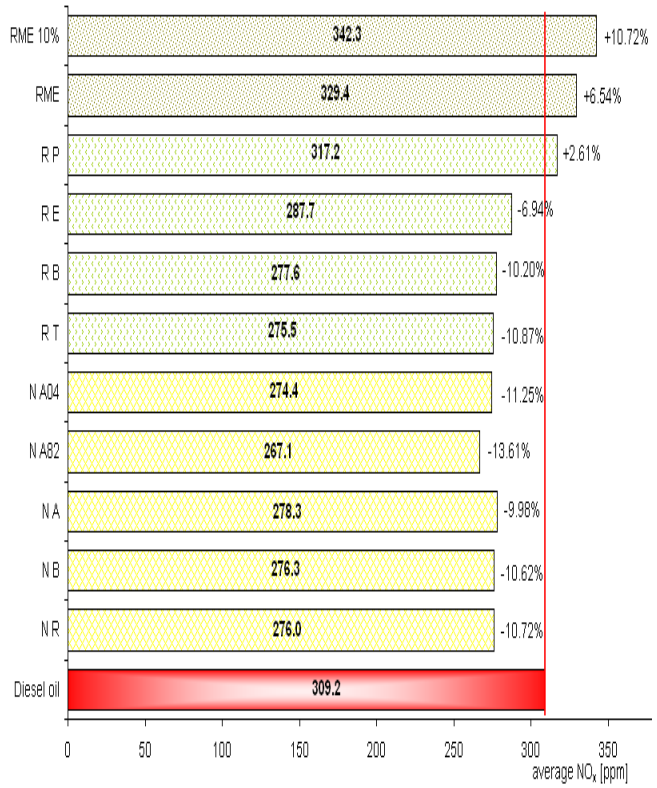

Figure 4. NO_x emission values

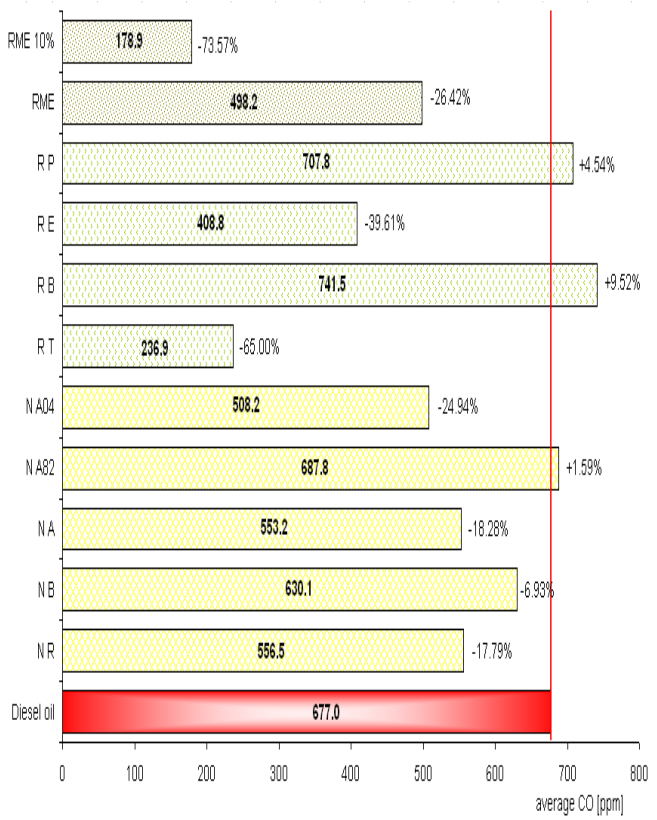

Figure 5. CO emission values

CH emissions of all the vegetable oils remained under CH values of diesel oil (Figure 6).

To compare the values of mixed fuel with sunflower oil that of there was diesel oil, drop of 18.6% - 34.88% and also a fall of 26.16% - 66.28% mixed fuel was used with rape oil. The pure RME resulted 5.23% less CH values, while the mixed fuel containing 10% RME dropped by 55.81%.

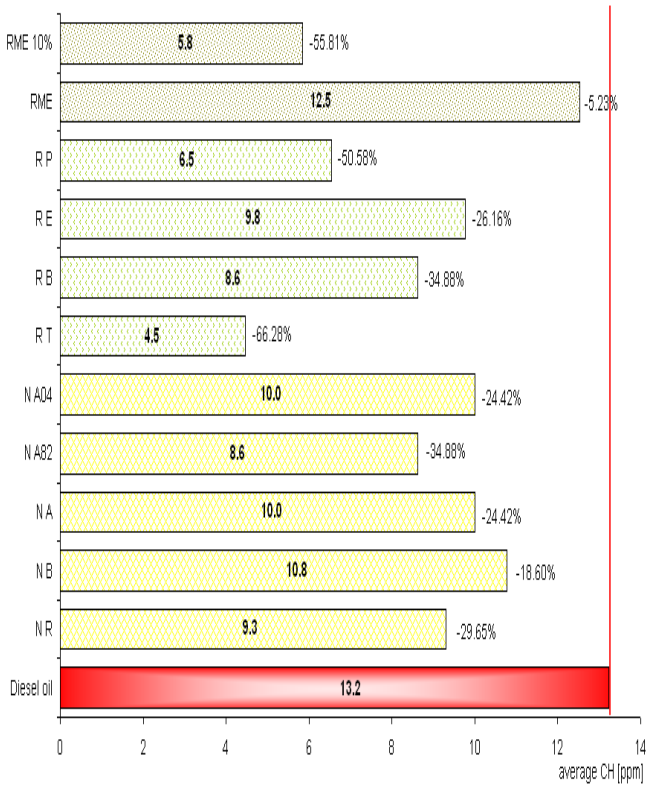

Figure 6. CH emission values

CONCLUSIONS

Today, all over the world, impacts of energy resources on the environment are global problem. The preservation of the environmental quality and providing of the necessary energy can be solved with the harmonized application of the traditional and renewable energy sources. Spread of energy carriers of biological origin can be promoted by continuous innovative activity. That is why nowadays the best perspectives are hidden in the utilization of biogas, biodiesel and vegetables oils for energy. They are universal energy sources, which have significant roles in the energy strategy.

Carbon-dioxide content of the biogas depends on the organic wastes or by-products and the production technology. The combustion takes longer time on the effect of carbon-dioxide, which can bring changes in emission.

It can be determined that that the 10 types of vegetable oil are suitable for use as diesel engine fuel but these promising results need to be completed by a more detailed study of the effect of parameters.

In conclusion, results of this study show that the biogas and vegetables oils have more and more important roles in the future.

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HEAT TRANSFER INVESTIGATION IN THE INTAKE PORT OF FOUR STROKE DIRECT INJECTION COMPRESSION IGNITION ENGINE

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ABSTRACT: Heat transfer is one important aspect of energy transformation in compression ignition engines. Fast transient heat flux between the combustion chamber and the cylinder wall must be investigated to understand the effects of the non-steady thermal environment. The objective of this paper is to present the development and application of heat transfer model to the intake manifold of four stroke direct injection diesel engine. One-dimensional (1D) gas dynamics was used to describe the flow and heat transfer in the components of the engine model. The engine model has been simulated with variable engine speed from 500 to 4500 rpm with increment of 500 rpm.
KEYWORDS: Diesel engine, computational simulation, heat transfer, 1D CFD, intake port

INTRODUCTION

In the last decades, the legislation on internal combustion engines (ICEs) has severely reduced the limits for pollutant and noise emissions. These requirements have established the research activity at design phase as a key stage in the engine production process. Therefore, an intensive investigation on ICEs has been carried out, focusing on the optimization of performances and fuel consumption. In particular, an important effort has been done seeking the improvement of the combustion and gas exchange processes, using tools such as Computational Fluid Dynamics (CFD).

Heat transfer is an important process in the intake manifold of engines. It increases the charge temperature which reduces the volumetric efficiency and also causes higher chemical reaction rates leading to increased NOx emissions. It also affects engine performance and emissions through enhancing the fuel evaporation and charge mixing process in cylinders. As a result, many experimental and theoretical studies have investigated heat transfer in the intake manifold of engines.

The heat transfer involved in the intake system occurs when air or an air-fuel mixture comes into the manifold. The intake manifold is hotter than the air-fuel mixture because of its proximity to the engine components or the design of the manifold. The intake manifold can be designed to heat the air-fuel mixture, so that the mixture can start to vaporize once it has entered the combustion chamber. One way of heating the manifold is to put it in close proximity with other hot components.

The manifold will heat through convective heat transfer. Electricity and hot coolant flow are other ways in which the manifold can also be heated. After the manifold is heated then the air-fuel mixture is heated through convective heat transfer. Equation (1) shows the heat transfer problem associated with the air-fuel mixture and the manifold walls.

$$\dot{Q} = hA(T_{wall} - T_{gas}) \qquad (1)$$

where, $\dot{Q}$ amount of heat transfer, h convective heat transfer coefficient, A inside surface area of intake manifold, T_{wall} wall temperature, T_{gas} gas temperature.

$$h = \frac{d}{k_f} C\,Re^m \qquad (2)$$

where, d cylinder diameter, k_f fluid thermal conductivity.

The classical, steady correlation are widely used for estimating the convective heat transfer coefficient in the intake manifolds of engines [1, 2, 3, 4], because of a correlations type easy to use as well as unsteady heat transfer model is not available. An equation (3) and (4) shows the classical steady correlations.

$$N_u = C\,Re^m \qquad (3)$$

$$N_u = C\,Re^m\,P_r^n \qquad (4)$$

where, C, m and n constants are adjusted to match the experimental data to account for unsteady heat transfer enhancements, surface deposits and surface roughness. The data of the steady state correlations constants was presented in Table (1).

Table 1. Steady state correlations constants

Reference of previous study	C	m	n
Dittus and Boelter (1930)	0.023	0.80	0.4
Bauer et al. (1998) for straight manifold	0.062	0.73	0.0
Bauer et al. (1998) for curved manifold	0.140	0.66	0.0
Depcik and Assanis (2002)	0.069	0.75	0.0
Shayler et al. (1996)	0.135	0.71	0.0

The frequencies based on valve events and pipe lengths, drastically alter the flow patterns and change the heat transfer relationship [3, 5]. The correlations provide good agreement with experimental data in fully-developed steady pipe flows and acceptable agreement with time-resolved experimental data in unsteady flows and slow velocity variation under the quasi-state assumption. It is important to indicate that these correlations can produce large errors in both phase and magnitude [6] for highly unsteady flows with rapid velocity variations. Different researchers suggest that the unsteady flow effect in the engine intake manifold enhances heat transfer by 50 to 100% over the prediction of the steady pipe flow correlations presented by Dittus and Boelter [1]. At different engine speed and load, the unsteadiness of the flow condition is different. Therefore, the constants C and m are usually optimized only for one operation condition of a given engine and hence compromised for other conditions.

FLUID DYNAMICS GOVERNING EQUATIONS

The flow model involves the solution of the Navier-Stokes equations, namely the conservation of continuity, momentum and energy equation. These equations are solved in one dimension, which means that all quantities are averages across the flow direction. There are two choices of time integration methods, which affect the solution variables and limits on time steps. The time integration methods include an explicit and an implicit integrator. The primary solution variables in the explicit method are mass flow, pressure and total enthalpy.

In broad terms, a model is created using two types of discritization. Firstly, the complete powertrain system is grouped into general components. These components consist of air cleaners, valves, piping, valves, fuel injectors, mufflers, resonators, catalytic converters, combustion chambers and resonators. The second aspect is separating each component into multiple control volumes. Each control volume is bounded by another control volume or wall. By discritizing the system into sufficiently small volumes, the properties of the fluid in that volume can be assumed to be constant. The scalar variables (pressure, temperature, density, internal energy, enthalpy, species concentration, etc.) are assumed to be uniform over each volume. The vector variables (mass flux, velocity, mass fraction fluxes, etc.) are calculated for each boundary. These type of discretization is referred to as a "started grid".

The conservation equation (5), energy equation (6), enthalpy equation (7) and momentum equation (8) are shown below.

$$\frac{dm}{dt} = \sum_{boundaries} \dot{m} \qquad (5)$$

$$\frac{d(me)}{dt} = -p\frac{dV}{dt} + \sum(\dot{m}H) - hA_s(T_f - T_w) \qquad (6)$$

$$\frac{d(\rho HV)}{dt} = \sum(\dot{m}H) + V\frac{dp}{dt} - hA_s(T_f - T_w) \qquad (7)$$

$$\frac{d\dot{m}}{dt} = \frac{dpA + \sum_{boundaries}(mu) - 4C_f\frac{\rho u|u|}{2}\frac{dxA}{D} - C_p\frac{1}{2}\rho u|u|A}{dx} \qquad (8)$$

where, $\dot{m}$ boundary mass flux into volume, m mass of the volume, V volume, p pressure, ρ density, A flow area (cross-sectional), A_s heat transfer surface area e total internal energy (internal energy plus kinetic energy) per unit mass, H total enthalpy, h heat transfer coefficient, T_f fluid temperature, T_w wall temperature, u velocity at the boundary, C_f skin friction coefficient, C_p pressure loss coefficient, D equivalent diameter, dx length of mass element in the flow direction (discretization length), dp pressure differential acting across dx.

MAIN ENGINE DATA

The development of the four cylinder modeling and simulation for four-stroke direct-injection (DI) diesel engine was described in [7]. The specific engine characteristics are used to make the model are shown in Table (2).

Table 2. Specification of the engine

Engine Parameters	Value
Bore (mm)	100
Stroke (mm)	100
Displacement (cc)	3142
Number of cylinder	4
Compression ratio	18
Connecting rod length (mm)	152
Piston pin offset (mm)	0
Intake valve open (0CA)	340
Intake valve close (0CA)	-137
Exhaust valve open (0CA)	127
Exhaust valve close (0CA)	376
Brake power (KW)	120.9
Brake torque (Nm)	384.8
Model : Four Cylinder, Four-Stroke, Turbocharged, Vertical, Air Cooling.	

It should be noted that the intake and exhaust ports of the engine are modeled geometrically with pipes. The intake port characteristics of engine are shown in Table (3). The intake and and exhaust ports on the engine are modeled geometrically with pipes and the air enters trough a bell-mouth orifice to the pipe. The discharge coefficient of the bell-mouth orifice was set to 1 to smooth transition.

Table 3. Intake port characteristics

Intake port parameter (unit)	Value
Diameter at inlet end (mm)	47
Diameter at outlet end (mm)	47
Lenght (mm)	95
Surface roughness (mm)	0
Wall temperature. (K)	340

RESULT AND DISCUSSION

The heat transfer steady state and transient simulation of the intake port of diesel engine model was running on any different engine speed in rpm, there are 500, 1000, 1500, 2000, 2500, 3000, 3500, 4000 and 4500.

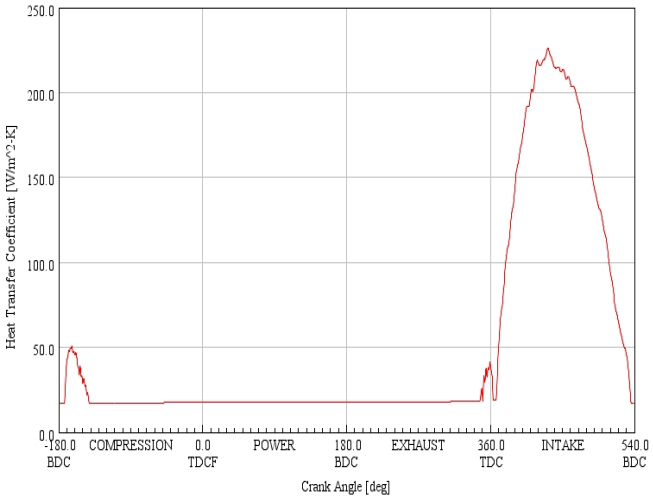

Figure 1. Heat transfer coefficient in intake port at 500 rpm

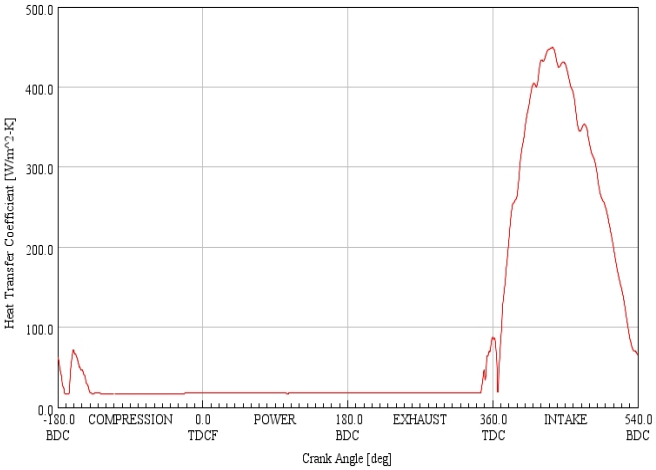

Figure 2. Heat transfer coefficient in intake port at 1000 rpm

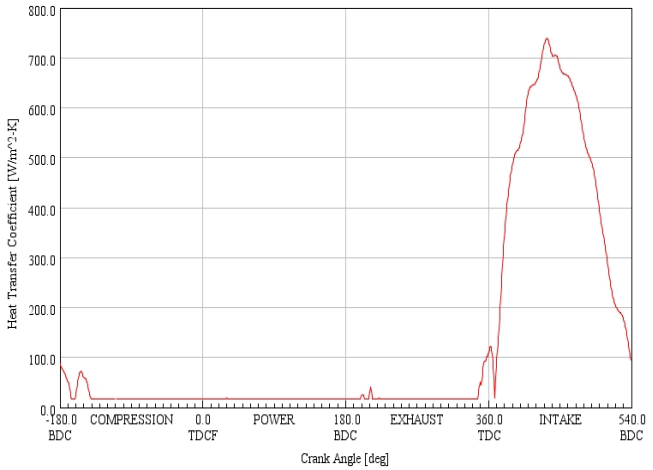

Figure 3. Heat transfer coefficient in intake port at 1500 rpm

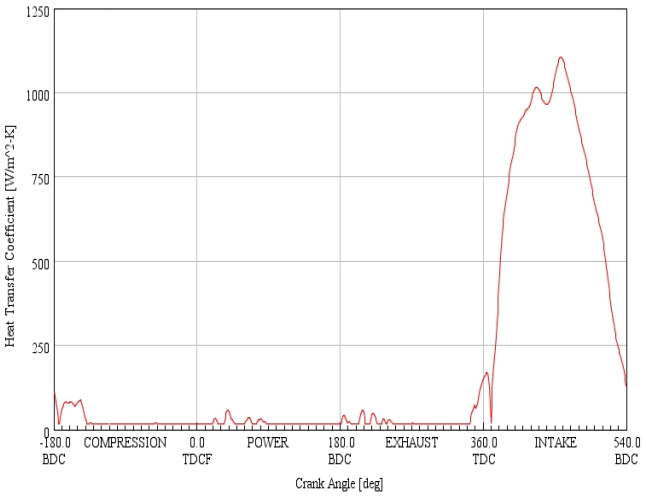

Figure 4. Heat transfer coefficient in intake port at 2000 rpm

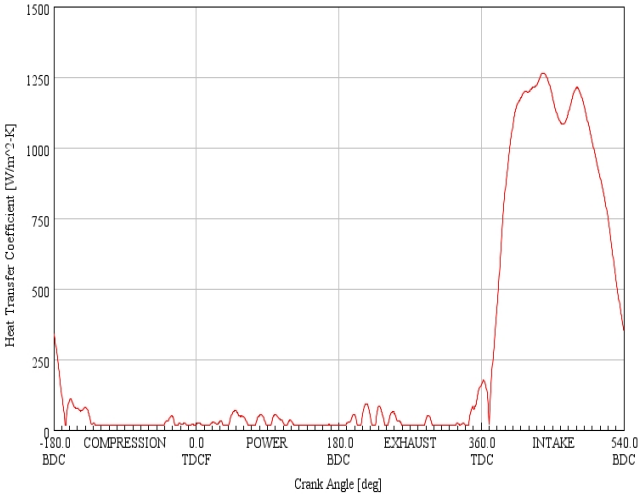

Figure 5. Heat transfer coefficient in intake port at 2500 rpm

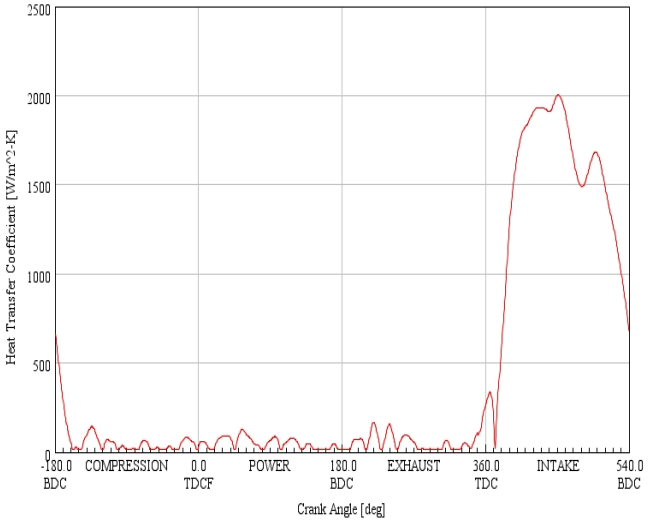

Figure 6. Heat transfer coefficient in intake port at 3000 rpm

The heat transfer coefficient in intake port simulation results are shown in Figure 1-9.
The fluid to wall heat transfer rate in intake port simulation results are shown in Figure 10-18.

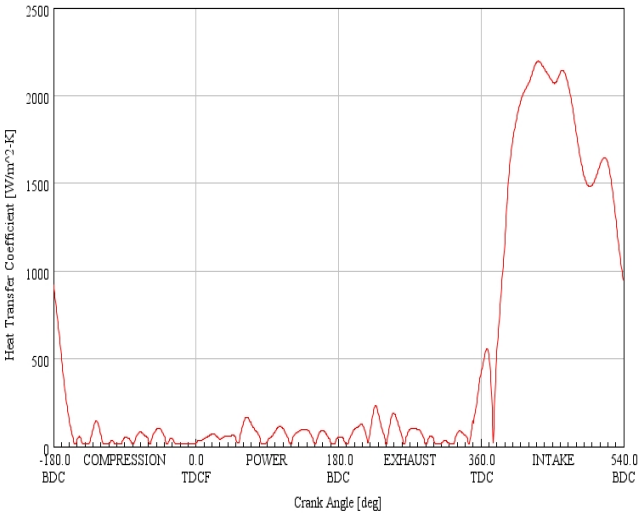

Figure 7. Heat transfer coefficient in intake port at 3500 rpm

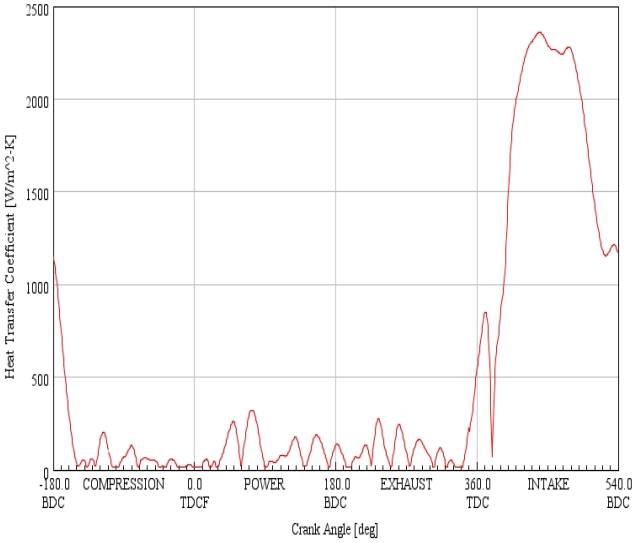

FIGURE 8. Heat transfer coefficient in intake port at 4000 rpm

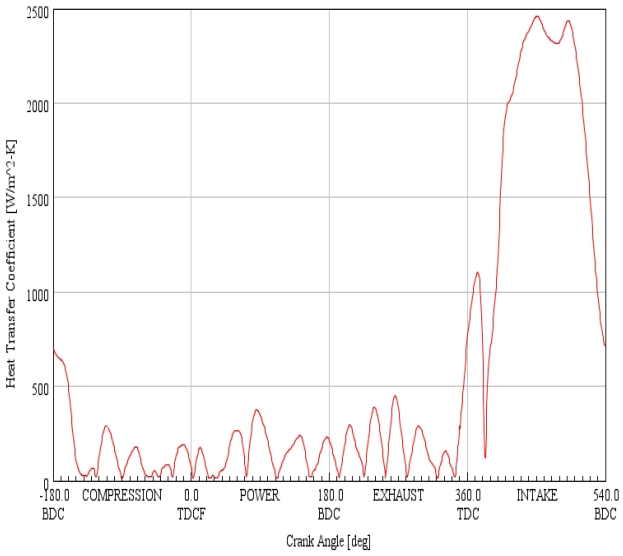

Figure 9. Heat transfer coefficient in intake port at 4500 rpm

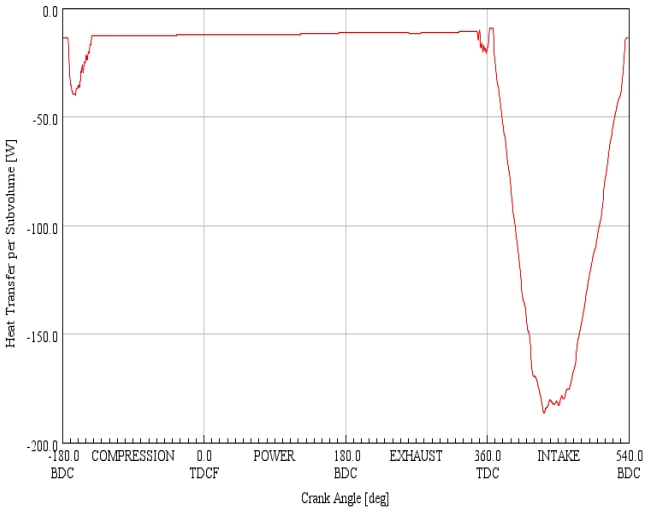

Figure 10. Fluid to wall heat transfer rate in intake port at 500 rpm

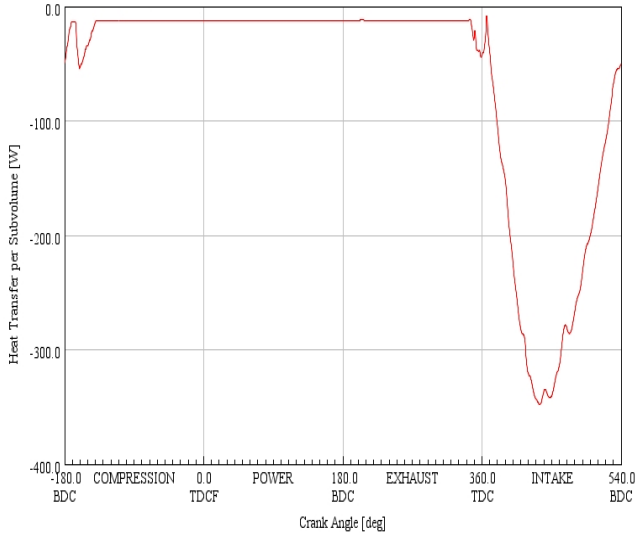

Figure 11. Fluid to wall heat transfer rate in intake port at 1000 rpm

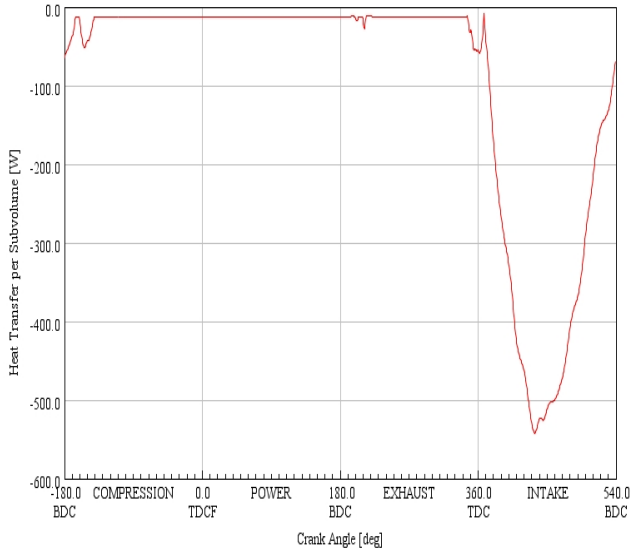

Figure 12. Fluid to wall heat transfer rate in intake port at 1500 rpm

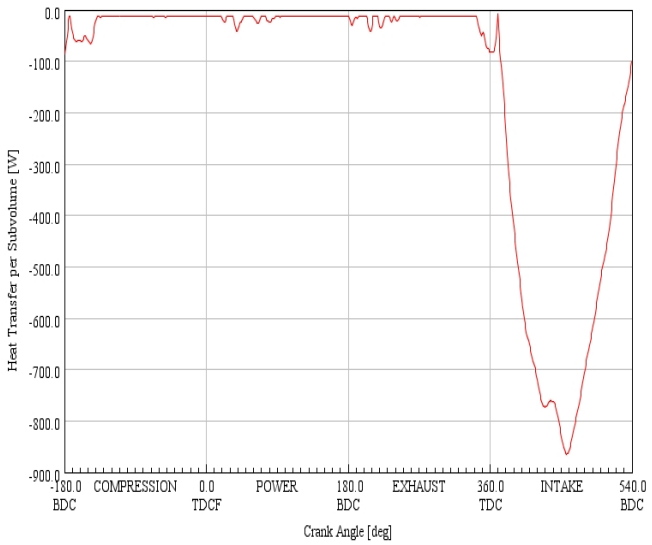

Figure 13. Fluid to wall heat transfer rate in intake port at 2000 rpm

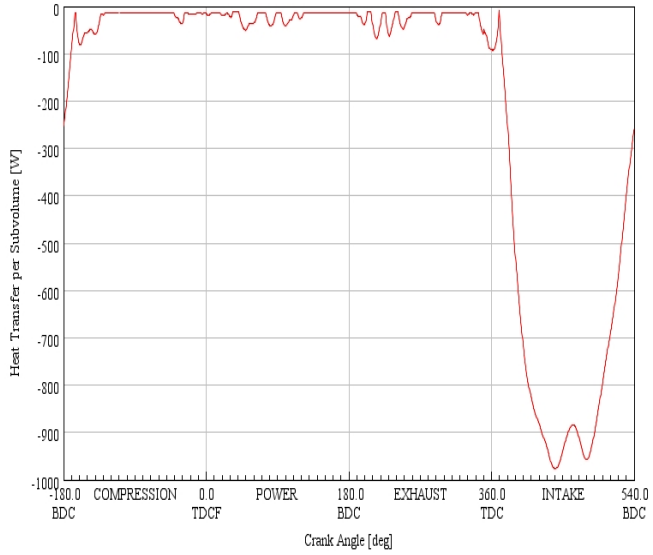

Figure 14. Fluid to wall heat transfer rate in intake port at 2500 rpm

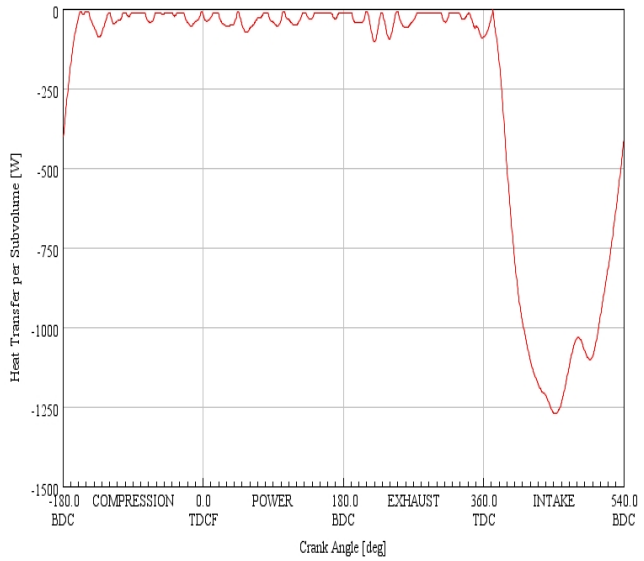

Figure 15. Fluid to wall heat transfer rate in intake port at 3000 rpm

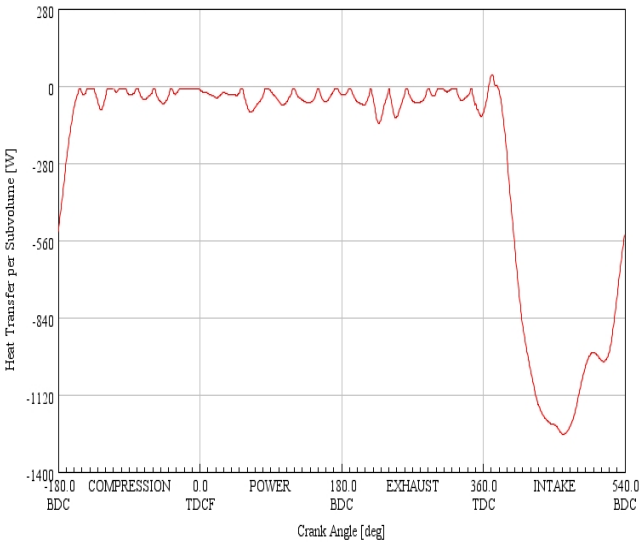

Figure 16. Fluid to wall heat transfer rate in intake port at 3500 rpm

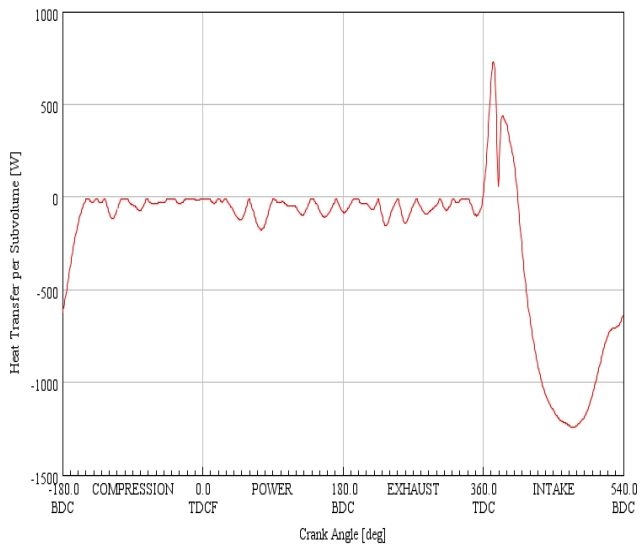

Figure 17. Fluid to wall heat transfer rate in intake port at 4000 rpm

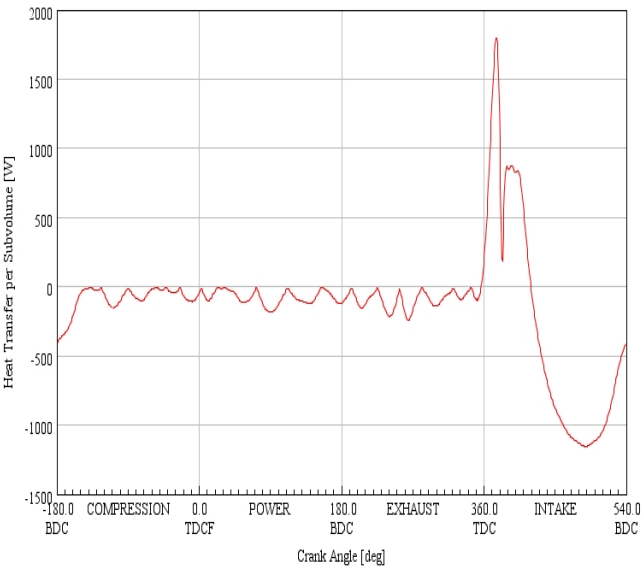

Figure 18. Fluid to wall heat transfer rate in intake port at 4500 rpm

The heat transfer coefficient obtained at different crank angle in intake port of engine in variation of engine speed shows that in turbocharged direct injection diesel engine, the values of heat transfer in compression stroke, power stroke and exhaust stroke is near to zero point at engine speed from 500 to 1500 rpm, because in this stroke the intake valve is closed. So, the heat from combustion process in engine cylinder is not interacted with intake port wall and heat gas from fluid combustion is not flow to intake port wall. The situation is quite different if the intake valve is opened, the heat from gas flow to exhaust valve is still in engine cylinder and quickly flows out to intake valve and intake port if the intake valve is opened. At engine speed over 1500 rpm, the values of heat transfer in the compression stroke, power stroke and exhaust stroke go to unstability (Fig. 13 - 18) to the down line and at engine speed from 2000 to 4500 rpm the values of heat transfer are only unstable during compression, power e and exhaust strokes. The probable reason for this effect of instability is increasing of the velocity and turbulence intensity of gas flow in intake port at high speeds. Heat transfer coefficient in intake port correlates with the engine speed - it is lowest at low engine speeds and highest at high engine speeds.

The fluid to wall heat transfer rate in intake port of engine versus crank angle degree at different engine speeds are shown in Fig. 10-18. It is evident that in turbocharged direct injection diesel engine, the nominal value of fluid to wall heat transfer rate in the compression, power and exhaust strokes is near to zero point at engine speed from 500 to 1500 rpm so the heat from combustion process in engine cylinder is not interacted with intake port wall and heat gas from fluid combustion is not flow to intake port wall. It is very different if the intake valve is opened. The heat from gas flow to intake valve is still in engine cylinder and quickly flows out to intake valve and intake port when the intake valve is opened. The trend result of the nominal fluid to wall heat transfer rate is shown that increasing of engine speed lead to increasing of fluid to wall heat transfer rate. The lowest fluid to wall heat transfer rate was obtained at 500 rpm and the highest - at 4500 rpm.

CONCLUSIONS

Heat transfer coefficient and fluid to wall heat transfer rate versus crank angle degree during the compression , power and exhaust strokes are stable at engine speed region 500 -1500 rpm. Its show that in these strokes the heat transfer is near to zero point and at engine speed region 2000 - 4500 rpm the values of heat transfer are only unstable. The probable reason for this effect of instability is increasing of the velocity and turbulence intensity of gas flow in intake port at high speeds. The heat transfer is maximal during intake stroke, because of interaction between gas in engine cylinder and intake port wall.

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ELECTROANALYTICAL DETERMINATION OF LEAD WITH CARBON PASTE MODIFIED STEEL ELECTRODE

[1-5.] EQUIPE D'ELECTROCHIMIE MOLECULAIRE ET MATERIAUX INORGANIQUES, UNIVERSITE SULTAN MOULAY SLIMANE, FACULTE DES SCIENCES ET TECHNIQUES DE BENI MELLAL, MAROC

ABSTRACT: We report a sensitive electrochemical voltammetric method for analyzing lead (II) using a carbon-coated steel electrode. Operational parameters have been optimized, and the stripping voltammetric performance has been studied using square wave voltammetry and electrochemical impedance spectroscopy. The peak current was linearly dependent on the concentration of lead ions from 1.5×10^{-5} mol/L to 3×10^{-5} mol/L.
KEYWORDS: Electroanalysis; Modified electrodes; Lead; Electrochemical impedance spectroscopy; Square wave voltametry

INTRODUCTION

Lead is a toxic heavy metal that appears in the environment mainly due to industrial processes, it is a microelement naturally present in trace amounts in all biological materials, it has no physiological function in the organism. Lead is absorbed by plants through roots where most of the lead is also accumulated. Lead enters the organism with food and air. In children it affects most the central nervous system [1]. Therefore sensitive methods must be established for the trace amounts of lead quantification in human's body fluids, water samples, plants and animals. Some of the methods used for the determination of lead are Atomic Absorption Spectrometry (AAS) [2-3], atomic emission spectrometry (AES) [4] and mass Spectrometry (MS). These methods, although highly sensitive, require relatively large volumes of sample for analysis, complicated operation, costly maintenance, expensive apparatus and low electrical power requirement [5].

Electrochemical methods are well known as very powerful techniques for determination of diverse range of metallic and biological targets in environmental, biological and industrial samples.

Modified electrodes are also attracting interest [6-7]. Recent works, reported in the literature, have shown several applications and electro analytical methodologies employing micro-electrodes as working electrodes [8-12].

Mercury based electrodes such as, mercury film electrodes and hanging mercury drop electrodes, has been traditionally used in stripping techniques because of their advantages such as high sensitivity, reproducibility, purity of the surface, high hydrogen over potential, and possibility of the amalgam formation and they have been recognized as the most sensitive electrodes for determination of heavy metals [14]. It has been shown that bismuth film electrodes maintain all the advantages of mercury electrodes and, at the same time, are environmentally friendly as the toxicity of bismuth and its salts is negligible. In addition to their lower toxicity, bismuth film electrodes resulted in compared to the performance of mercury electrodes were less sensitive to dissolved oxygen and had a wide potential window for analysis. However, the determination of copper using bismuth film electrodes has been relatively ignored due to the similar stripping potentials of copper and bismuth with only a few reports in the open literature [11-12].

Many researchers detected heavy metal ions at modified carbon paste electrode [12], but no researchers using deposited carbon paste onto steel as electrode for the detection of Pb (II) were reported.

In this work we prepared and characterized the carbon modified steel electrode, which successfully exploits the favourable mechanical and electrochemical properties of carbon paste electrodes.

EXPERIMENTAL

Reagents: Potassium nitrate was dissolved into Bi-distilled deionized water (BDW) to form 1mg.L^{-1} stock solutions. Working standards for calibration were prepared by diluting the primary stock solution with BDW. Carbon paste was supplied from (Carbon, Lorraine, ref. 9900, French). All chemicals were of analytical grade and used without further purification.

Substrat preparation and electrodeposition of carbon paste: The cathode electrode was a steel plate, with a dimension of 1 cm x 1 cm x 0.1 cm, was

polished on wet SiC paper (grade 600) and immersed in H_2SO_4 solution for 5 min to dissolve the air-formed oxide film on the surface and the anode electrode was a platinum plate. The current was maintained by a galvanostat with a function generator. Then, the electrodes were immersed in electrolyte of carbon paste gel contained glass chamber, and subjected to anodic oxidation by applying DC for 48h at room temperature. The deposit of carbon paste on steel surfaces was processed at 20 V.

***Substrat/carbon paste characterization**: All the electrochemical experiments were performed in a standard one-compartment three-electrode cell. The reference electrode was SCE and the counter electrode was platinum. All electrode potentials were referred to this reference electrode. The working electrode was steel/carbon paste.*

***Apparatuys**: Electrochemical experiments were performed using a voltalab potentiostat (model PGSTAT 100, Eco Chemie B. V., Utrecht, The Netherlands) driven by the general purpose electrochemical s systems data processing software (voltalab master 4 software).*

RESULTS AND DISCUSSION

***Voltammetric characterisazation:** The cyclic voltammograms of both unmodified steel and carbon paste modified steel (CP-S) electrodes are shown in Figure 1. The carbon modified steel electrode voltammogram (Figure 1b) showed that the modified electrode is electro inactive at a reasonable broad potential range of approximatively -1500 mV to 1000 mV. There was also some indication that the modifier (carbon paste) is effectively deposited into steel plate.*

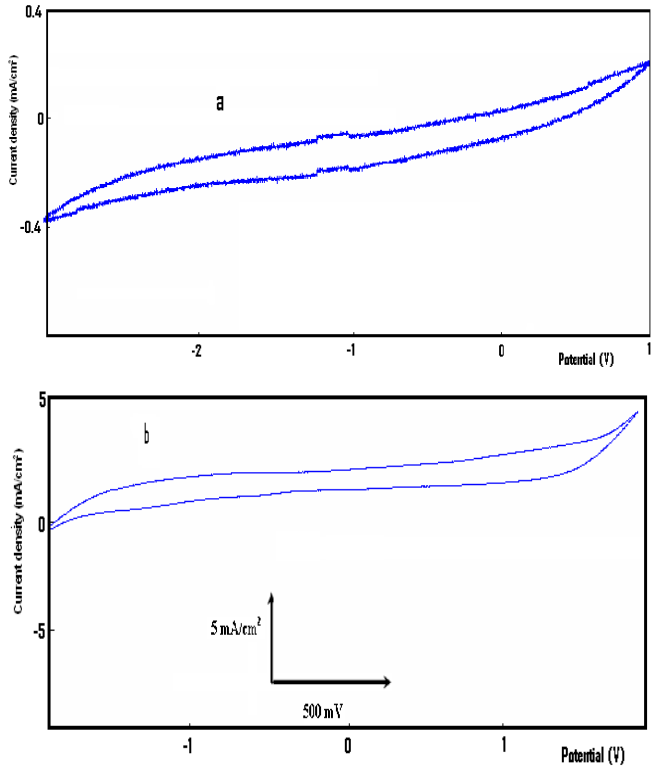

Figure 1. Cyclic voltammograms of unmodified steel (a) and carbon paste modified steel electrodes at scan rate of 100 mV/s in 0.1M Na_2SO_4 solution.

In the preconcentration step, the accumulated Pb^{2+} was found to be reduced at -1.05 V at which the lead ion is electrochemically deposited at the electrode surface. The deposited lead is oxidized at -0.5 V. The whole mechanism comprises of accumulation, reduction and stripping stages which can be represented, respectively, by the following:

$$(Pb^{2+})_{solution} + (CP\text{-}S)_{surface} \rightarrow (Pb^{2+} - CP\text{-}S)_{adsorption}$$

$$(Pb^{2+} - CP\text{-}S)_{adsorption} + 2e^{-} \rightarrow (Pb - CP\text{-}S)_{adsorption}$$

$$(Pb - S)_{adsorption} \rightarrow (Pb^{2+})_{solution} + (CP\text{-}S)_{surface} + 2e^{-}$$

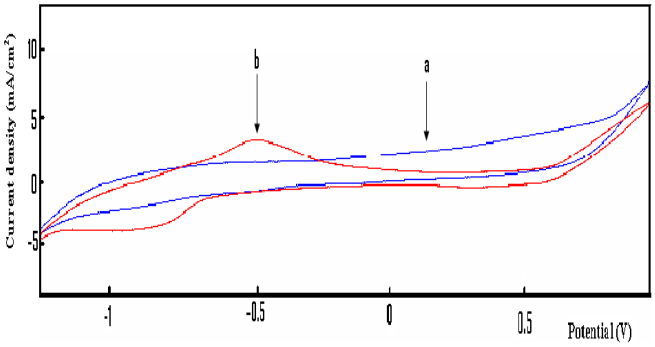

Figure 2. Cyclic voltammograms of carbon paste modified steel electrode at scan rate of 100 mV/s in 0.1M Na_2SO_4 solution (a) and in 0.1 M Na_2SO_4 solution container 10 mg/l Pb^{2+}.

The square wave voltammograms obtained for 10mg/L of lead ion present one peak at around -0.5V (Figure 3). This peak was associated to the oxidation of deposited Pb^{2+}. This peak can hence be used, with great success, for electroanalytical determination of lead ion in different samples.

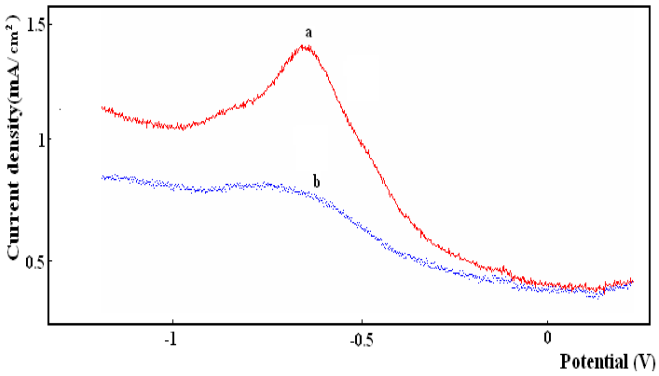

Figure 3. Square wave voltammograms recorded at CG-S electrode in a- 0.1M Na_2SO_4 solution containing 10 mg/L of lead (pH 7.0) and b- 0.1M Na_2SO_4 solution.

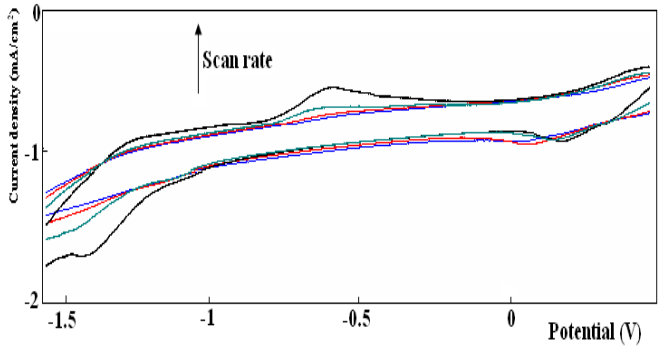

Figure 4. Cyclic voltammograms of carbon paste modified steel electrode at different scan rates in 0.1 M Na_2SO_4 solution container 10 mg/l Pb^{2+}.

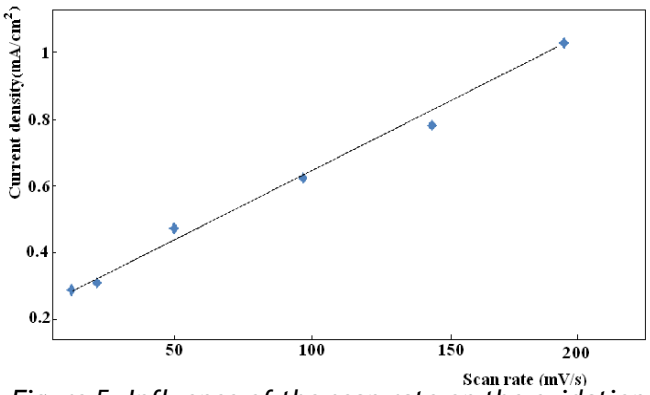

Figure 5. Influence of the scan rate on the oxidation peak intensity for 10 mg/L Pb^{2+} (pH 7.0) in 0.1M Na_2SO_4, preconcentration time 15 min.

Figure 4 shows the influence of scan rate was studied at CG-S electrode immersed for 15 min in 10 mg/L Pb^{2+}. The oxidation peak was found to vary linearly with the scan rate ranging from 10 to 200 mV/s (Figure 5). Lead ion diffused from the preconcentration solution towards the interstitial space existing in the paste carbon film.

***Optimization parameters**: The effect of accumulation time on the stripping peak currents of 10 mg/L de Pb^{2+} was shown in Figure 6. The stripping peak currents decreased gradually with the accumulation time in the range of 0 - 10 min. After 10 min of accumulation, amounts of lead ion on the surface of modified electrode increased with the increase of accumulation time, which resulted in the increase of oxidation peak currents.*

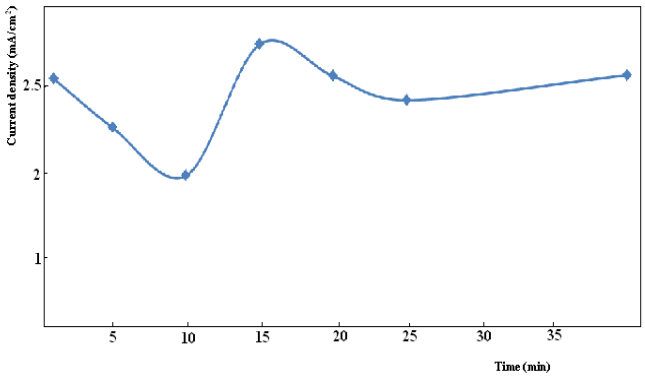

Figure 6. Influence of preconcentration time on the oxidation peak of 10 mg/L lead pH 7.0 on square wave voltammograms at CP-S electrode in 0.1M Na_2SO_4 solutions

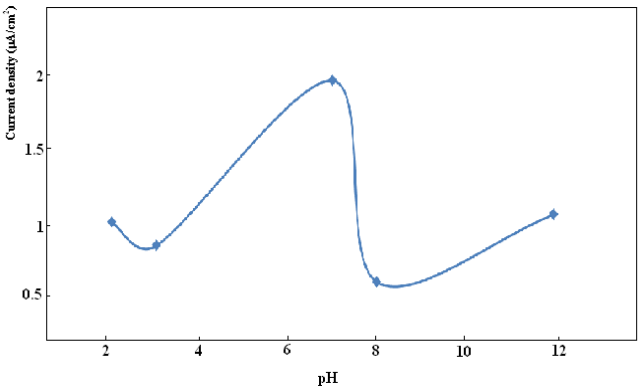

Figure 7. Effect of the pH on square wave voltammogram peak height of 10 mg/L Pb^{2+} in 0.1M Na_2SO_4, accumulation time: 15 min

With further increase of accumulation time, the peaks currents reached a flat caused by the complete coverage of active points on the surface of carbon paste modified steel electrode by lead. Taking account of the sensitivity and the efficiency, accumulation time was 15 min in the following experiments.

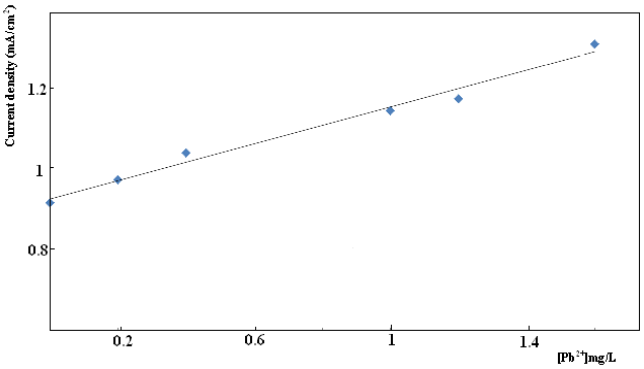

Figure 8. Influence of concentration of lead on the peaks intensity at CP-S electrode under the optimized conditions

The effect of pH on the preconcentration solution is shown in Figure 7. Results showed that the current peak decreased above pH 7. An increase in pH led to an increase in peak current up to pH 7. This is also the same with a study [18] which demonstrated that lead belongs to the first class of metals where metal ion can tightly bind and is rapidly bound at pH ≥ 5.0.

***Calibration plots**: The calibration graph of peak current vs lead ion concentration in the range 0.2 - 20 mg/L is shown in Figure 8. The calibration graph was linear. The regression straight line has the following equation:*

$$i_P = 0.4592\ [Pb^{2+}] + 0.64$$

where i_P is expressed in mA/cm^2 and the concentration in mg/L and the correlation coefficient was 0.9837.

***Interference studies**: Several other metal ions were examined for their possible interference in lead (II) analysis using the prepared electrode. The determination of a 10 mg/L Pb^{2+} using the optimized conditions was not affected by the presence of cadmium and copper ions.*

The voltammograms has been recorded after the preconcentration of CP-S electrode in aqueous solutions containing Pb^{2+}, Cd^{2+} and Cu^{2+} (Figure 9). The anodic oxidization of the cadmium occurs to the potential of -0.7 V, lower to the potential oxidation of lead -0.45 V. The oxidization peak of copper ion appears at a potential + 0.1 V superior to the potential oxidation of lead. The clean separation of the three potential peaks offers us the possibility of the simultaneous determination of lead, cadmium and copper.

PRACTICAL APPLICATION OF PROPOSED ELECTROANALYTICAL METHOD - In orange juice

The same methodology has been applied with success in orange juice under the optimized conditions. Interference is possible because of the complexity of the matrix. The presence of the organic substances in the matrixes of the orange juice has a considerable effect on the response of lead at the electrode surfaces. (Figure10).

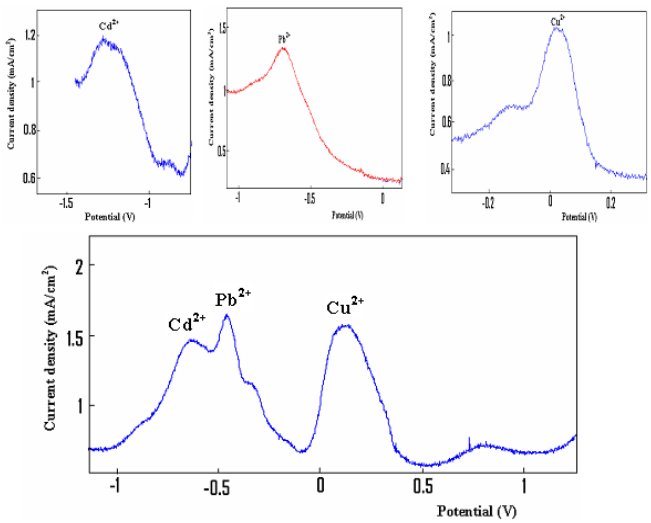

Figure 9. Cyclic voltammograms of 10 mg/L lead, 10 mg/L cadmium and 10 mg/L copper at CP-S electrode, pH 7.0, 15 min of preconcentration time in 0.1M Na_2SO_4.

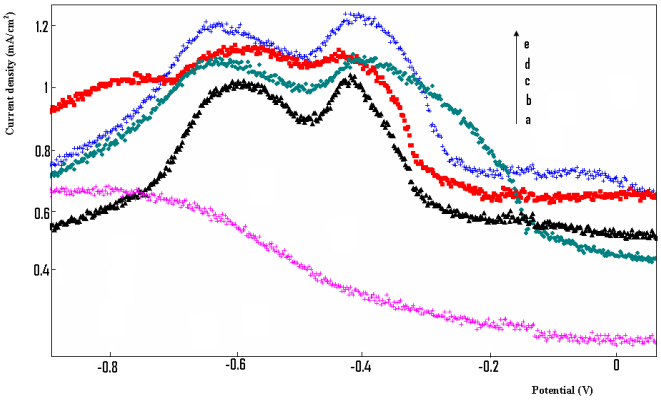

Figure 10. Square wave voltammograms in 0.1M Na2SO4 under the optimized conditions at CP-S electrode of lead (II): a- 0 mg/L, b- 5 mg/L, c- 8 mg/L, d- 10 mg/L and e- 20 mg/L.

CONCLUSIONS

An edge plane steel electrode was modified with an in-situ electro-deposition of carbon paste and was then successfully utilized for the simultaneous determination of Pb^{2+}, Cd^{2+} and Cu^{2+} in standard and real samples.

Under the optimal conditions lead ions can be detected in the concentration range from $1.0x10^{-5}$ mol/L to $3.0x10^{-5}$ mol/L.

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STUDY OF THE EFFICIENCY AND OTHER WORKING PARAMETERS OF SOLAR COLLECTORS

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ABSTRACT: The efficiency of a solar collector is the function of the solar irradiation intensity and the temperature different between the collector and the ambient air. By the measurements we wanted to determinate the efficiency function as in a wide range as we can. We did the measurements in outdoor conditions, we have not used artificial lights, so we could not control the intensity of the irradiation. During our experiments about solar collectors we have developed a unit that is capable for measuring the functions of the efficiency. We have analysed two own-designed experimental solar collectors simultaneously, so with changing a parameter we could do comparison measurements. Beyond the determination of the function of the efficiency our studies cover the analysis of the transient effects and the properties of the serial and parallel connection. By the operating of the unit we have several observations which could be important informations during the designing of a control system for solar collectors.
KEYWORDS: solar collectors, comparison measurements, control system, efficiency

INTRODUCTION

We have developed a unit for the measurement of the efficiency of solar collectors. During our study we have used our own-designed experimental solar collectors. The absorbers of the collectors have the typical tube systems: one of them is equipped with a single pipe (1), the other one has parallel pipes (2).

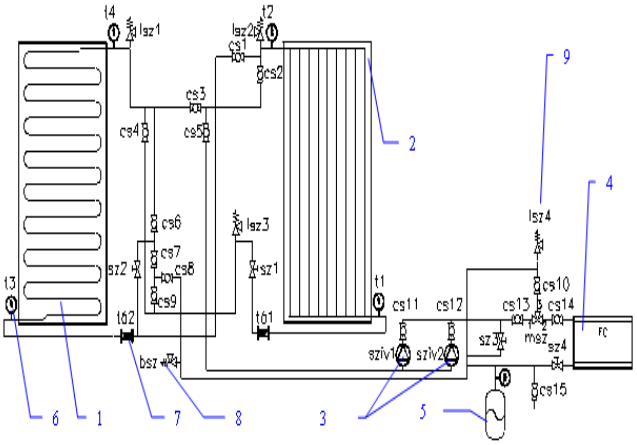

Figure 1. Experimental unit for the measurement of the efficiency of solar collectors
1 - solar collector with a single line pipe, 2 - solar collector with parallel pipes, 3 - circulation pumps, 4 - fan coil, 5 - expansion tank, 6 - thermometers, 7 - volume flow rate meters, 8 - safety pressure limiting valve, 9 - air-escape valve

The covering is removable, so we could study different polycarbonate sheets and the uncovered collectors as well. With the unit we can operate the collectors in parallel and in line connection. In case of in line connection we can change the order of the two collectors. We can lock out each of the collectors from the operation.

The efficiency of a solar collector is the function of the solar irradiation intensity and the temperature different between the collector and the ambient air. By the measurements we wanted to determinate the efficiency function as in a wide range as we can. We did the measurements in outdoor conditions, we have not used artificial lights, so we could not control the intensity of the irradiation. The other argument the temperature different between the collector and the ambient air in our system is well-controlled with the fan coil (4) which transfers the heat from the collectors to the ambient air. The number of revolution of the fan is continuously adjustable, and the cooling capacity can be further reduced by a valve and a bypass pipe. It is possible to lock out the fan coil from the circuit. With this construction we can change the temperature of the fluid at the intake of the collectors: as we reduce the cooling capacity the temperature increases. It supports the control of the temperature different between the collectors and the ambient air.

We have mounted two pumps, one of them controls the volume flow rate by the temperature of the fluid, and the other one is uncontrolled. The two pumps do not run simultaneously (3).

The volume flow rate meters (7) measure by displacement with rotary pistons. With this devices we can measure from 7,5 lh^{-1} which is an extremely low volume flow rate for the two collectors.

The accuracy is ± 2 %. The impulse relays mounted to the volume flow meters add impulses by liters. We have registered the impulses with a two-channel data logger.
We have measured the temperatures with K-type thermocouples and Testo 177-T4 data loggers. The accuracy is ± 0,3 °C.
Further the measuring points in the Figure 1 we have measured the temperature and humidity of the ambient air and by a Lambrecht 16131 pyranometer the intensity of the solar irradiation. The pyranometer is mounted between the collectors at the same plane. The response time our pyranometer is less than 18s, the accuracy is ±5 %, the non-linearity is less than ±1 %. The pyranometer conforms to ISO 9060 "First class" standard (www.lambrecht.net). The pyranometer used during the tests shall be placed in a typical test position and allowed to equilibrate for at least 30 min before data-taking commences. (ISO 9806-1).
During the measurements we have registered the values by 5 seconds. This rate enables the study of the transient effects.

SELECTING THE CLOUDLESS PERIODS

The momentary efficiency could be calculated only in sunny periods. In cloudy condition we can calculate average values for a term. In a diagram we can see the cloudy periods well, but because of the big amount of data we need to define a function to filter out the cloudy periods automatically.
The clouds make the intensity of the solar irradiation unstable. The response time of a solar collector is defined as the time taken for the temperature rise of the absorber plate to reach 90% of the final steady rise when the collector is subjected to a step change in the solar radiation level (N. E. Wijeysundera, 1976). The pyranometer senses the change of the intensity during less than 18 seconds. The mass - and so the thermal inertia - of the collectors is much higher than the pyranometer's, and the reaction is much slower. So during a period of a decreased irradiation that caused by a cloud rack the heat output of the collectors still high - caused by the higher irradiation of the previous minutes. If we calculate the momentary efficiency in this time, it will add wrong result. This error could be eliminated by two ways:

- *calculation of average efficiency for a longer period,*
- *filtering out the results of the cloudy periods.*

We have developed an algorithm for the filtering out of the cloudy periods. We have introduced this method in a scientific article (István Péter Szabó, Gábor Szabó, 2012).

CONNECTION IN LINE

Going ahead collector by collector the efficiency in serial connection is decreasing. Wrong control and too low volume flow rate result zero efficiency in the last collectors if the fluid reaches the maximum temperature before the output of the last collector. We have detected this effect in our unit and another solar collector system, too.
The second collector in line has a slower reaction to the changes of the weather (István Péter Szabó, Gábor Szabó, 2011).

EFFICIENCY DIAGRAMS

We can make the diagrams by queries from the database of the measurements. Figure 2 and Figure 3 represent the efficiency at 1000 Wm^{-2} solar irradiation in function of temperature difference between the collector and the ambient air.
With further queries we can define the function of the efficiency at different solar irradiation values for the two collectors (Figure 4, Figure 5).

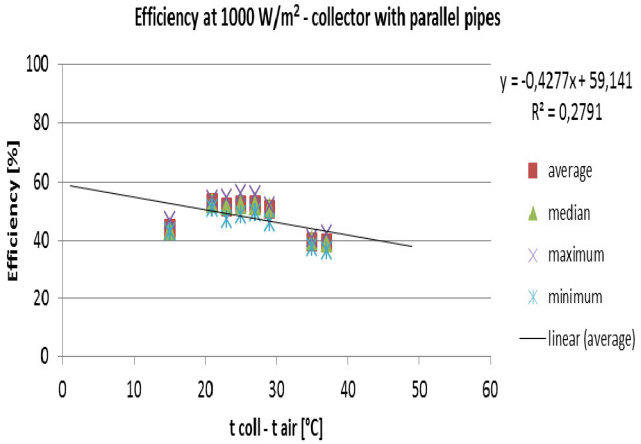

Figure 2. Function of the efficiency at 1000 Wm^{-2} - parallel pipes collector

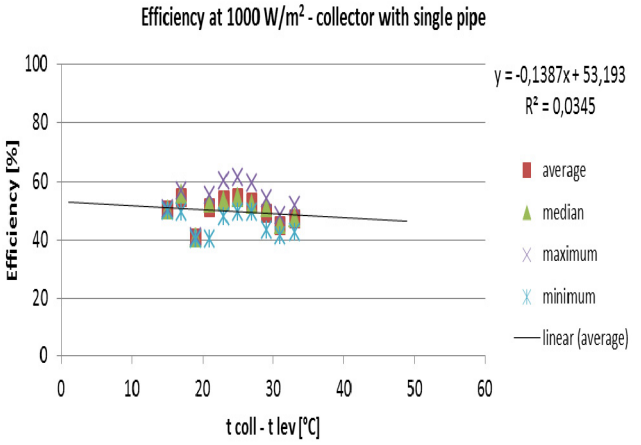

Figure 3. Function of the efficiency at 1000 Wm^{-2} - single pipe collector

We have used a tolerance of ± 1 °C for the temperature difference and ± 10 Wm^{-2} for the solar irradiation in every query. During a query at the chosen range of the temperature difference and intensity of solar irradiation we have hundreds of results with a deviation. The outliers mean measuring errors.
One of the filtering methods that most effectively diminished the outliers while retaining valid data was the removal of data where the global instrument's reading was less than 200 W (A. Lester et. al., 2006).
During the data process we also experienced that the low intensity of solar irradiation makes incorrect results, so we have removed this records from our database. By the ASHRAE standard the minimal intensity of the solar irradiation during the

measurements is 630 Wm^{-2} (ASHRAE, 1977). We also experienced that the deviation of the results starts to increase if the intensity of the solar irradiation is less than 600 Wm^{-2}.

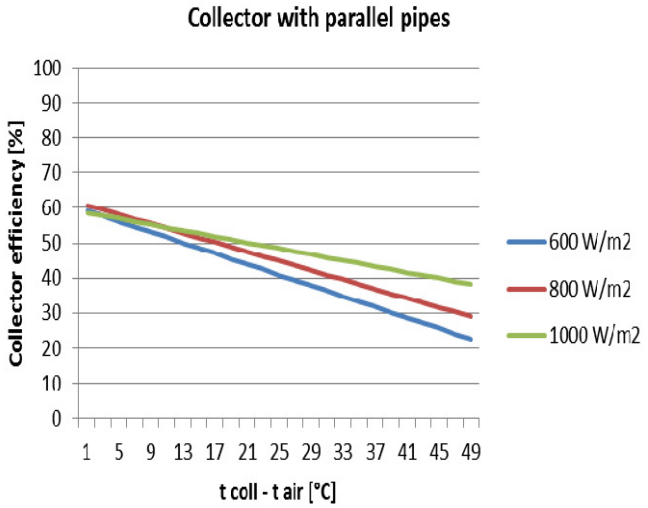

Figure 4. Functions of efficiency at different intensity of solar irradiation - parallel pipes collector

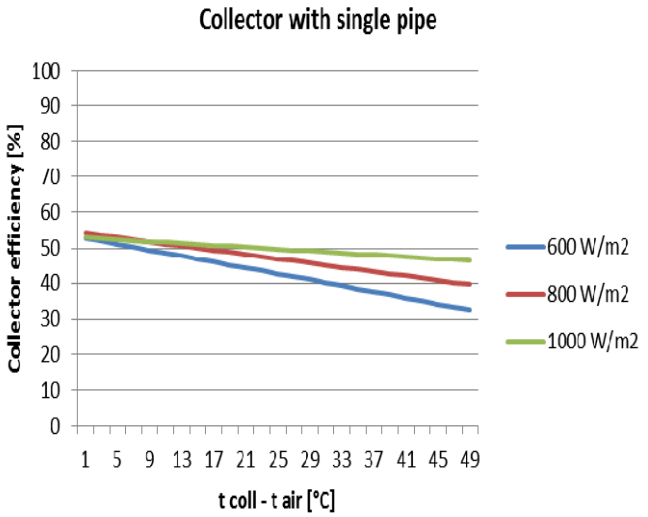

Figure 5. Functions of efficiency at different intensity of solar irradiation - single pipe collector

CONCLUSIONS

In our experiments we have developed a unit which is applicable for determining the function of efficiency of solar collectors with outdoor measurements. The calculated functions are well-fitted to the results and the characteristics are similar to the theoretical functions': increasing the temperature difference between the collectors and the ambient air the efficiency decreases, higher solar irradiation causes higher efficiency and at ambient temperature the efficiency is independent from the intensity of the solar irradiation: the maximum difference between the three intercepts is 2,36 % (parallel pipes collector) and 1,43 % (single pipes collector). The accurate fitting is representative in the range of 600÷1000 Wm^{-2} - from the solar intensity of the laboratory measurement to the minimal intensity specified by the ASHRAE standard.

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DEVELOPMENTAL DESIGN OF A LABORATORY FIRE-TUBE STEAM BOILER

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ABSTRACT: This paper presents the design of a laboratory fire-tube steam boiler for eventual construction and use as a teaching aid and for research purposes. Thermodynamics, heat transfer and strength of materials analysis were conducted to estimate dimensions of parts and 3D modelling process was used to draft the working drawings of the steam boiler. Operational, dimensional, and thermodynamic details of designed steam boiler were determined. The working drawings of designed boiler are also presented. The design enables the availability of portable and affordable steam boilers for steam generation in school laboratories and to enhance research and students' learning process in areas of thermodynamics, heat transfer and energy studies
KEYWORDS: fire-tube; steam boiler; thermodynamics; 3D modelling; laboratory

INTRODUCTION

Steam is a critical resource in today's industrial world. It is used in the production of goods and food, the heating and cooling of large buildings, the running of equipment, and the production of electricity. The system in which steam is generated is called a boiler or a steam generator (Woodruff et al., 2004). Steam generators may be of different shapes and sizes, depending on their applications. Steam generators have been in use for a very long time and over the course of time, various inventors and engineers have developed and modified them for the purpose of academic study, as well as to suit the needs of the modern man. As a result of their continuous success, many industries today depend greatly on steam for the operation of their equipment and the production of their goods. Steam boilers are closed vessels which are usually used to produce steam from water by combustion of fuel (Rajput, 2006). Steam is therefore important in engineering and energy studies.

In science and engineering laboratories, there is sometimes the need to utilize steam or hot water to generate power, to carry out tests or for other heating applications. This steam or hot water can be obtained using boilers. Therefore, the purpose of this project is to design a miniature fire-tube laboratory boiler that can be manufactured to meet the needs of schools for practical demonstrations and teaching aid.

A boiler is a closed vessel in which steam is produced from water by combustion of fuel. According to the American Society of Mechanical Engineers (ASME), a steam generating unit is defined as a combination of apparatus for producing, furnishing or recovering heat together with the apparatus for transferring the heat so made available to the fluid being heated and vaporized (Rajput, 2006). Steam boilers is made up of two major parts, that is, the combustion chamber, which provides heat by the combustion of fuel, and the heat exchanger which transforms water into steam through heat exchange in the medium (Saidur et al., 2010).

Boiler types comprises of fire tube, water tube, modular, coil tube and cast iron respectively. Steam boilers could be used for various services, such as, steam process and heating, hot water heating, power generation, petrochemical processes, chemical recovery, nuclear, just to mention a few (Lou Roussinos, 2010). Fire-tube boilers are safer to use, require less expertise, and operate under lower pressures than water-tube boilers. Thus, they are more suitable for small scale applications. Water-tube boilers on the other hand, have a higher rate of steam production and are easier to construct and transport (Rajput, 2006).

They are designed to withstand the stress induced in the boilers (Woodruff et al., 2004). In a boiler, water is heated, steam is generated or superheated, or any combination thereof, under pressure or vacuum by the application of heat resulting from the combustion of fuel (such as in a natural gas boiler), electrical resistance heating or the recovery and conversion of normally unused energy (Rawson, 2008).

Many different solid, liquid and gaseous fuels are fired in boilers. Sometimes, combinations of fuels are used to reduce emissions or improve boiler

performances. Fuels commonly fired in boilers include fossil, biomass, and refuse-derived fuel (RDFs) as well as others types of fuels and fuel combinations (Boiler Fuels and Emissions, 2009).
For effective teaching and learning, well equipped laboratories and subject rooms are needed. However, many educational institutions lack the necessary equipment for effective teaching and learning (Adeyinka, 1992). Science and engineering education is incomplete without practical demonstrations.
This study is aimed at the design of a laboratory fire-tube steam boiler for eventual construction and use as a teaching aid and for research purposes. A 3D model of the designed boiler with Autodesk 3ds Max Computer Aided Design (CAD) software technology for flexible sizing and standardizing of parts would also be conducted.

METHODOLOGY

The process of designing the laboratory fire-tube steam boiler involves developing a conceptual physical geometry, making necessary calculations from which dimensions and other deductions were made, and finally, developing a working drawing.

Conceptual physical geometry of the laboratory fire-tube steam boiler

The conceptual physical geometry of the laboratory fire-tube steam boiler was developed from the schematic diagram of a boiler shown in Figure 1 (Saidur et al., 2010; Ohijeagbon, 2012). The boiler consists fundamentally of the combustion and heating chambers and other parts such as: fire tubes, water container, steam trap, steam tap, exhaust pipe and boiler casing which are designed in the geometry of the laboratory fire-tube steam boiler.

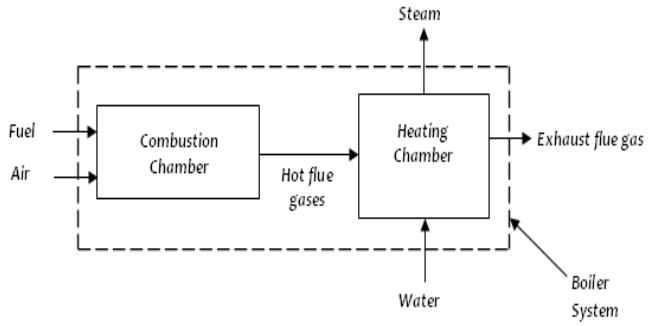

Figure 1: Schematic diagram of a steam boiler

Theoretical framework of the laboratory fire-tube steam boiler

For effective and efficient functioning of the boiler, important calculations to be carried out are enumerated as follows:

1. Operating temperature and pressure

The operating temperature and pressure of a boiler must be determined in order to make other important calculations required for effective functioning of the boiler.

2. Stresses in tubes and drums

Stresses are induced in different parts of an operating boiler by the temperatures and pressures of hot flue gases, feed water and steam respectively. The magnitudes of these stresses must be known so that the boiler will be operated under safe conditions.

3. Internal design pressure of a boiler is given by (Woodruff et al., 2004):

$$P = \frac{S_u \times t \times E}{R \times f_s} \quad (1)$$

where, P = internal design pressure on inside of drum or shell (N/m^2)
S_u = ultimate strength of plate (N/m^2)
t = thickness of plate (m)
R = inside radius of drum (m)
f_S = factor of safety (ultimate strength divided by allowable working stress)
E = efficiency of joints or tube ligaments (ultimate strength of joint or ligament divided by ultimate strength of plate)

4. Maximum allowable working pressure for pipes (Woodruff et al., 2004)

$$t_w = \frac{Pd}{2S_aE + 0.8P} + c \quad (2)$$

where, S_a = allowable stress (N/m^2)
t_w = minimum wall thickness (m)
P = design pressure (N/m^2)
d = tube outer diameter (m)
E = ligament efficiency
C = corrosion allowance

5. Minimum required wall thickness

The minimum required wall thickness of a boiler is a value beyond which the boiler wall cannot be easily damaged by the operating pressure in a boiler. The formula is given as (Woodruff et al., 2004):

$$t = \frac{PR}{SE - 0.6P} \quad (3)$$

where, t = minimum required wall thickness (m)
P = internal design pressure (N/m^2)
S = allowable stress of material at design temperature (N/m^2)
E = efficiency of weld joints or of ligaments between openings
R = inside radius of drum (m)

6. Efficiency of a joint or tube ligament

This is generally found by dividing the strength of the section in question by the strength of the solid plate. In the case of a drum that is drilled for tubes that are parallel to the axis, the efficiency of the ligament can be calculated as (Woodruff et al., 2004):

$$\frac{P - d}{P} \quad (4)$$

where, P = pitch of the tube hole (m)
r = radius of the tube hole (m)

7. Heating surface of a boiler

The heating surface of a boiler refers to the areas that are in contact with heated gases on one side and water on the other side. It is usually expressed in square feet (Woodruff et al., 2004).

8. Rated horsepower of a boiler

This depends on the type of boiler and the number of square feet of heating surfaces it has. It is calculated by dividing the square feet of heating surfaces by a factor corresponding to the type of boiler in question (Woodruff et al., 2004).

9. Boiler horsepower and steam generation

Boiler horsepower (BHP) refers to a steam capacity of 34.5 mm/s of steam at atmospheric pressure with feed water at 212°C. The formula for converting BHP to steam generation is given as (Ganapathy, 1994):

$$W = \frac{33{,}475 \times BHP}{\Delta h} \quad (5)$$

where, W = steam flow (m/s)

Δh = enthalpy absorbed by steam/water, expressed as:

$$\Delta h = (h_S - h_{fw}) + BD \times (h_f - h_{fw}) \quad (6)$$

where, h_S = enthalpy of saturated steam at operating steam pressure (kJ/kg)

h_f = enthalpy of saturated liquid (kJ/kg)

h_{fw} = enthalpy of feed water (kJ/kg)

BD = blowdown fraction

10. Water required for cooling gas streams

It is important to know the quantity of water required for cooling flue gas streams so that maximum heat is absorbed from the flue gases, hence increasing the efficiency of the steam boiler. The formula for obtaining the appropriate quantity of water is given as (Ganapathy, 1994):

$$q = 5.39 \times 10^{-4} \times (t_1 - t_2) \times \frac{W}{1090 + 0.45 \times (t_2 - 150)} \quad (7)$$

where, q = water required (litres/s)

t_1, t_2 = initial and final gas temperatures (°C)

W = gas flow entering the cooler (m/s)

11. Velocity of fluid inside tubes, pipes or cylindrical ducts

It is important to know the velocity of fluid flow in a boiler so as to control or determine other conditions of the boiler's operation. The formula is given as (Ganapathy, 1994):

$$V = 0.05 \times W \times \frac{v}{d_i^2} \quad (8)$$

where, V = Velocity (m/s)

W = flow (m/s)

v = specific volume of the liquid (m^3/kg)

d_i = inner diameter of pipe (mm)

12. Stoichiometric and actual air-fuel ratio

Complete combustion of a hydrocarbon with atmospheric air is written as (Ohijeagbon, 2011),

$$C_xH_y + a(O_2 + \frac{0.79}{0.21}N_2) \rightarrow xCO_2 + \frac{y}{2}H_2O + \frac{a0.79}{0.21}N_2 \quad (9)$$

where x,y and a are constant coefficients that characterises the hydrocarbon and combustion process. By balancing the number of atoms of O, this shows that

$$a = x + \frac{y}{4} \quad (10)$$

The stoichiometric air-fuel ratio (AFR_{st}) (by mass) is then given by

$$AFR_{st} = \frac{a(MW_{O_2} + 0.79/0.21 MW_{N_2})}{MW_{fuel}} \quad (11)$$

where, MW_{O_2} = mass weight of oxygen, O_2

MW_{N_2} = mass weight of nitrogen, N_2

MW_{fuel} = mass weight of fuel, C_xH_y

The actual air-fuel ratio (AAF) is given by (Ohijeagbon, 2011),

$$AAF = (1 + EA) \times AFR_{st} \quad (12)$$

in which, EA = excess air

The recommended excess air level for single fuel oil burners is 20% (Ohijeagbon, 2011).

13. Mass flow rate of material streams in boiler

$$\dot{m}_a + \dot{m}_f = \dot{m}_p \quad (13)$$

$$\dot{m}_p = \dot{m}_g \quad (14)$$

$$\dot{m}_w = \dot{m}_s \quad (15)$$

where, $\dot{m}_a$ = mass flow rate of air

$\dot{m}_f$ = mass flow rate of fuel

$\dot{m}_p$ = mass flow rate of hot products

$\dot{m}_g$ = mass flow rate of flue gas

$\dot{m}_w$ = mass flow rate of water

$\dot{m}_s$ = mass flow rate of steam

Hence,

$$\dot{m}(kg/s) = q_m(litres/hr) \times SG/3600 \quad (16)$$

where, $\dot{m}$ = mass rate of substance

q_m = rate of material stream

SG = specific gravity of substance

14. Combustion temperature

The temperature of combustion in a boiler furnace is given as (Ohijeagbon, 2011),

$$T_c = T_{ca} + \frac{h_f}{[c_{pp} \times (1 + AAF)]} \quad (17)$$

where, T_c = combustion temperature

T_{ca} = temperature of the combustion air before entering the burner

h_r = heat of reaction = lower heating value (LHV)

c_{pp} = specific heat of fuel at temperature of products of combustion

15. Enthalpy of hot products

The enthalpy of hot products is given as (Ohijeagbon, 2011),

$$h_p = \frac{m_f h_f + m_a h_a}{m_p} \quad (18)$$

16. Temperature of exhaust flue gases

The temperature of exhaust flue gases was estimated from the values of the hot product and exhaust flue gas temperatures given by Ohijeagbon (2012),

17. Enthalpy of exhaust flue gases

Enthalpies of most gases used in combustion calculations can be curve-fitted by the simple second order equation (Kitto and Stultz, 2005):

$$h = aT^2 + bT + c \quad (19)$$

where, h = enthalpy in Btu/lb

T = temperature in degrees, ^0F

a, b and c are coefficients with the following values for T {0-500 ^0F (260 ^0C)} given as:

a = 1.683x10-5; b = 0.233; c = -18.03

18. Entropy of exhaust flue gases

The entropy of exhaust flue gases is given as (Ohijeagbon, 2011),

$$s_g = c_p \ln \frac{T_g}{T_{0a}} \quad (20)$$

At $T_a = 200K, s_a = 1.29559 kJ/kgK$ (Cengel& Boles, 2006)
where, T_g = temperature of exhaust flue gases
c_p = the average of c_p of air and exhaust flue gases

19. Entropy of hot products (Ohijeagbon, 2012)

$$s_p = \frac{h_p}{T_p} \quad (21)$$

where, T_p = temperature of the hot products (^0C)

20. Entropy of combustion fuel gas (Ohijeagbon, 2012)

$$s_f = \frac{h_p}{T_f} \quad (22)$$

where, T_f = combustion fuel temperature (^0C)

21. Rate of heat transfer (conduction and convection) (DOE Fundamentals Handbook, 1992)

$$\dot{Q} = \frac{T_a - T_b}{1/h_1A + \Delta x/kA + 1/h_2A} \quad (23)$$

$$\dot{Q} = U_o A \Delta T_{overall} \quad (24)$$

where, $\dot{Q}$ = rate of heat transfer (kJ/hr)
T_a = temperature of flue gas (˚C)
T_b = temperature of water (˚C)
h = convective heat transfer coefficient (W/m^2K)
k = thermal conductivity (W/m K)
Δx = thickness of tube wall (m)
A = cross sectional area for heat transfer (m^2)
U_o= overall heat transfer coefficient (W/m^2 K)
ΔT = temperature change (˚C)

22. Heat energy

The heat energy is given by (DOE Fundamentals Handbook, 1992)

$$q = mC_p\Delta T \quad (25)$$

where, q = heat energy (kJ)
C_p = specific heat capacity (J/kg ˚C)
ΔT = temperature change (˚C)

23. Boiler efficiency

Boiler efficiency varies with different types of fuel. It is important to determine this value so as to know what to expect from boiler operation.
For fuel oils (Ganapathy, 1994),

$$\eta_{LHV},\% = 99.0 - (0.001383 + 0.0203 \times EA) \times \Delta T \quad (26)$$

where, EA = excess air factor
ΔT = difference between exit gas and ambient air temperatures
These and other necessary calculations are further discussed and implemented in the design chapter.

Determination of dimensions and 3D modelling process for the steam boiler

The size of a boiler determines other characteristics, such as temperature and pressure design limits. Therefore, in the design of a boiler, the first stage is to determine the size of the boiler, which is based on the intended use of the boiler. Since the boiler of interest is a laboratory fire-tube steam boiler, it will be relatively smaller in comparison with industrial boilers. Therefore, the design temperatures and pressures of operation will be within the operating capacity of the boiler. All other calculations are derived from the size and load of the boiler. The overall boiler dimensions are stated as: length (1 m), width (0.5 m) and height (0.5 m) respectively.
The required working drawings of the laboratory fire-tube steam boiler were derived from the application of the dimensions and calculations made, as the final stage of the design process. After the development of the working drawings, the laboratory fire-tube boiler will be modeled using Computer Aided Design (CAD) Technology. The software used in this project is Autodesk 3ds Max which is three-dimensional (3D) design software. It is preferred over other software because it provides comprehensive, integrated 3D modelling for designers, and is very flexible, and therefore aids exhaustive design and 3D modelling and speeds up the production process (Murdock, 2007).

RESULTS OF DESIGN ANALYSIS

A summary of the basic details and operational data of the designed steam boiler are presented in Table 1. Specifications for the fuel used for combustion are presented in Table 2. Also, a summary of the dimensional analysis is presented in Table 3.

Operational details of designed steam boiler

Determined operational details of the designed steam boiler are presented in Table 1.

Table 1: Summary of details and operational data of steam boiler

S/No	Details	Description/Values
1	Orientation	Horizontal
2	Type of tube	Fire tube
3	Type of firing	Internally fired
4	Type of circulation	Natural circulation
5	Type of pressure	Low pressure
6	Stationary or portable	Stationary
7	Single or multi-tube	Multi-tube
8	Number of fire tubes	3 (3 passes each)
9	Operating feed water temperature	80 ˚C
10	Operating steam temperature	151.8 ˚C
11	Operating steam pressure	500 kN/m^2 (5 bar)
12	Combustion fuel	Diesel
13	Operating steam capacity	5.65 tons/hr
14	Firing rate	483.84 kg/hr
15	Boiler capacity	18.87 GJ/hr
16	Material used for boiler shell Mild	Steel A36
17	Material used for boiler insulation	Brick

Specification of diesel fuel

Every fuel has a unique composition and energy content described by its fuel specifications presented in Table 2. Knowing the fuel specifications is essential for determining various combustion parameters (Ohijeagbon, 2012).

Table 2: Fuel Specifications for diesel

Property	Value
% Carbon (C)	85.54
% Hydrogen (H)	12.46
HHV (Gross Heating Value) (kJ/kg)	45,482.52
LHV (Net Heating Value) (kJ/kg)	42,790.21
CO_2 max	15.60
% Sulphur (S)	1.60
% Moisture (M)	0
% O_2 [100 - (C+H+S+M)]	0.100

Source: Ohijeagbon (2012)

Dimensional details of designed steam boiler

Determined dimensional details of the designed steam boiler are presented in Table 3.

Table 3: Summary of dimensional details

S/No	Details	Description/Values
1	Diameter of boiler shell	0.5m
2	Length of boiler shell	1m
3	Thickness of insulation	0.0625m
4	Diameter of fire-tubes	0.035m
5	Length of fire-tubes	0.6m
6	Thickness of fire-tubes	2.5mm
7	Thickness of boiler shell	6.25mm
8	Volume of fuel tank	$0.027m^3$

Thermodynamic details of designed steam boiler

Determined thermodynamic details of the designed steam boiler are presented in Table 4.

Table 4: Thermodynamic properties of material streams of the boiler

Substances	Mass flow rate (kg/s)	Temperature (°C)	Enthalpy (kJ/kg)	Entropy (kJ/kgK)
Air, m_a	2.2848	40.00	313.26	1.7446
Fuel, m_f	0.1344	1,051.31	42,790.21	2.0185
Hot products, m_p	2.4192	186.67	2,673.09	4.0922
Feed water, m_w	1.5692	80.00	334.90	1.0750
Steam, m_s	1.5692	151.80	2,749.00	6.8220
Exhaust flue gas, m_g	2.4192	150.10	225.77	2.0449

Working drawings of designed boiler

Determined parameters obtained in the design analysis were used to draft the working drawings of the boiler. The whole boiler was modelled in three-dimensional details using Autodesk 3ds Max. This presented a more detailed view of the different parts of the boiler and enables better visualization of what the fabricated product will look like.

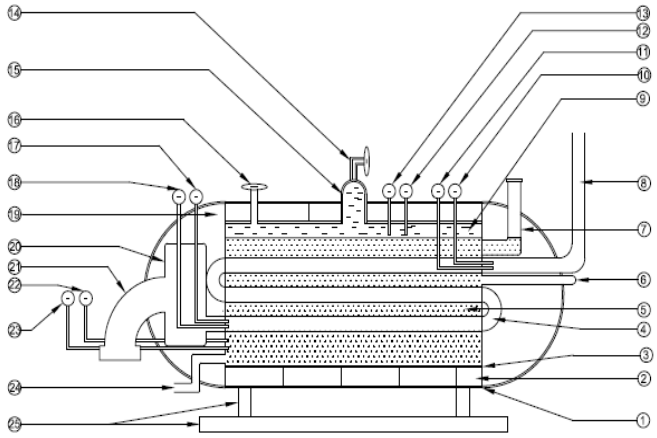

Figure 2: Cross-sectional view of the steam boiler

Figure 2 shows the cross-sectional view of the steam boiler with all the parts identified. The list of parts of the steam boiler is presented in Table 5. Figure 3 shows the major dimensions of the steam, Figure 4 gives the isometric view of fire-tubes showing the path travelled by flue gases, Figure 5 represent the cut-away image showing boiler wall, and Figure 6 is the isometric view of the steam boiler.

Table 5: List of parts of the fire tube steam boiler

S/No	PARTS	S/No	PARTS
1	Boiler casing	14	Steam tap
2	Brick lining	15	steam dome
3	Boiler shell	16	Safety valve
4	Fire-tube	17	Flue gas temperature gauge
5	Water	18	Flue gas pressure gauge
6	Water return tube	19	Boiler access door
7	Water level indicator	20	Combustion chamber
8	Exhaust pipe	21	Burner
9	steam	22	Feed water temperature gauge
10	Exhaust gas temperature gauge	23	Feed water pressure gauge
11	Exhaust gas pressure gauge	24	Feed water inlet
12	Steam temperature gauge	25	Boiler supports
13	Steam pressure gauge		

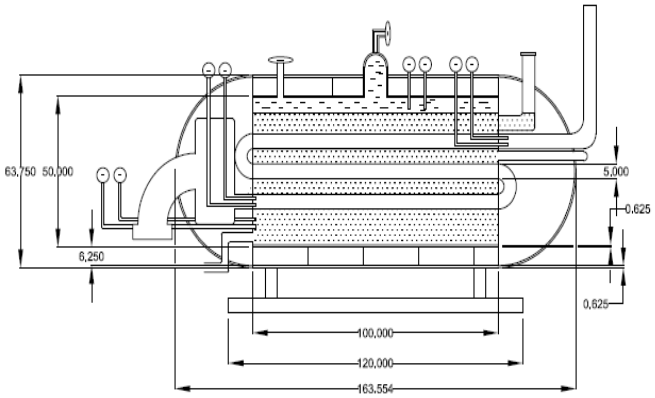

Figure 3: Major dimensions of the steam boiler

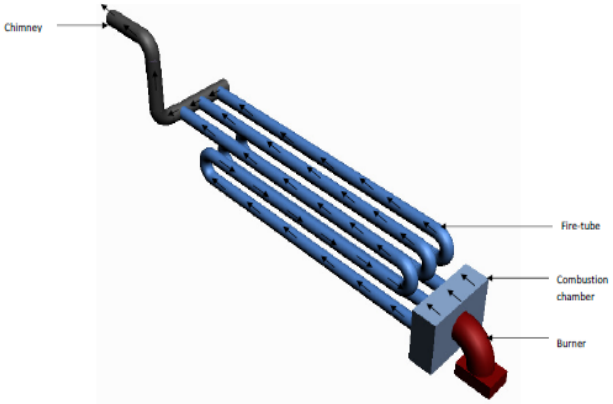

Figure 4: Isometric view of fire-tubes showing the path traveled by flue gases

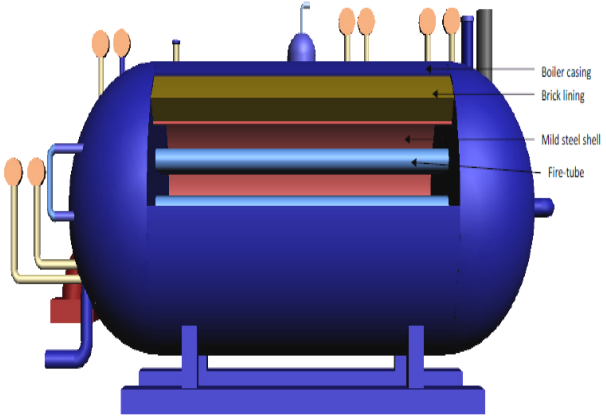

Figure 5: Cut-away image showing boiler wall layers

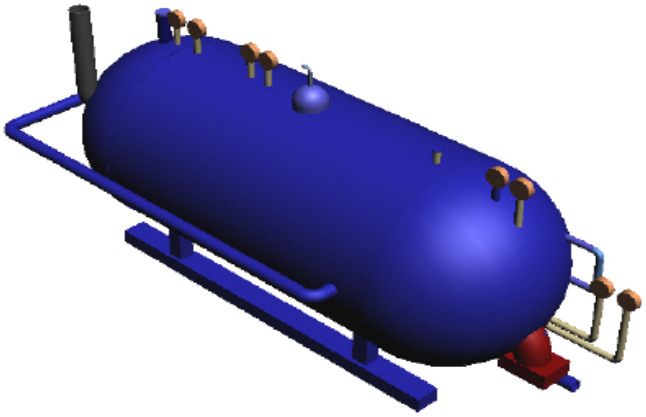

Figure 6: Isometric view of the steam boiler

CONCLUSIONS

The laboratory steam boiler designed was projected from the conceptual physical geometry of fire-tube boiler which elucidated the primary units making up a boiler. Thermodynamics, heat transfer and strength of materials analysis subjected to temperature and pressure variations were conducted in the theoretical framework of the laboratory fire-tube steam boiler. Dimensions of major and secondary parts were estimated from computations from the theoretical framework and 3D modelling process for the steam boiler was then carried out to present various working drawings of the steam boiler for possible construction. Conclusively, a simple laboratory fire-tube steam boiler is herein presented for fabrication, testing and further improvement. Production of a simple steam boiler of this sort will enable the availability of portable and affordable steam boilers for steam generation processes, especially in school laboratories. The availability of steam boilers in school laboratories will enhance students' learning process, especially in the area of thermodynamics, heat transfer and energy studies.

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Scientific Events in 2012

1. THE 7th INTERNATIONAL WORKING CONFERENCE TOTAL QUALITY MANAGEMENT – ADVANCED AND INTELLIGENT APPROACHES – TQM 2013 with 3rd SPECIAL CONFERENCE "MANUFUTURE IN SERBIA 2013"
4 – 7 June, 2013, Belgrade, SERBIA

The main objective of the 7th TQM Conference is to provide an international forum around the world for the exchange of knowledge, experience, research results and information about various aspects of the state-of-the-art and the future development of total quality management.
The scope of the Conference covers philosophical, scientific and practical concepts concerning research, development and application of TQM-based advanced approaches.
Topics of interest include, but are not limited to:
- *Business excellence models (applications and development trends);*
- *TQM & manufacturing management;*
- *World class performance;*
- *Attractive quality;*
- *Robust engineering;*
- *Six sigma model;*
- *Intelligent quality tools and methods;*
- *Virtual factory and virtual quality;*
- *Intelligent metrology in manufacturing;*
- *Intelligent and virtual CMM;*
- *Business process improvement;*
- *Breakthrough management;*
- *Organizational Excellence;*
- *Intelligent design for quality;*
- *Intelligent Business;*
- *Quality in Higher Education;*
- *Quality of the Public Services / health care;*
- *Advanced Quality approaches;*
- *Digital engineering/manufacturing;*
- *Manufuture* initiative *and Micro-nano manufacturing / Metrology*

Detailed informations here: http://cent.mas.bg.ac.rs/tqm/2013/index.html

2. THE 5th INTERNATIONAL CONFERENCE ON GEARS WITH EXHIBITION – GEARS 2013
7 – 9 October, 2013
Technical University of Munich (TUM), Garching (near Munich), GERMANY

The fifth international conference on gears and transmissions in Germany will become a broad platform for equipment manufacturers and producers and researchers of gear and transmission systems to present new solutions and their latest research results.
Climate change is one of the big issues in public discussion, in politics and industry. The conference will show, what the transmission and drive train industry can contribute to increase energy efficiency. Gears are vital in the efficiency of different applications. They transmit and vary torque between prime movers and applications.
There is still room for improvement, which will be demonstrated by the presenters. New concepts for drive trains of energy supply systems provide answers to the increasing demand for energy worldwide. These concepts must be introduced to global markets more quickly. Therefore, new designs are necessary and will be presented at the conference.
The state-of-the-art of industrial applications will be demonstrated at an exhibition beside the conference.
The conference will last three days, comprising keynote addresses and presentations in a series of plenary and parallel sessions. The official language of the conference will be English. No simultaneous translation will be provided. The conference program and the registration form will be available in June 2013.
Detailed informations here: www.vdi-gears.eu

3. THE 11th INTERNATIONAL CONFERENCE ON ACCOMPLISHMENTS IN ELECTRICAL AND MECHANICAL ENGINEERING – DEMI 2013
University of Banja Luka, Faculty of Mechanical Engineering
26 – 28 May, 2013, Banja Luka, BOSNIA & HERZEGOVINA

We are pleased to inform you that the Faculty of Mechanical Engineering Banja Luka will organize the 11th International Conference on Accomplishments in Electrical and Mechanical Engineering and Information Technology, DEMI 2013. The Conference will be held from 30 May to 1 June 2013 at the Faculty of Mechanical Engineering Banja Luka.
The aim of the Conference is to review the current state of research in the field of mechanical and electrical engineering as well as information technologies. We hope that results of scientific investigations obtained by research institutions and research results obtained by industry will significantly contribute to the implementation of new technologies in production processes and induce the competitiveness of domestic industry. The Conference aims to encourage new forms of cooperation between scientific institutions and manufacturing companies, which can help those companies overcome difficulties related to the transition process and the global crisis.
We would like to invite all scientists, researchers and experts from the industry to take part in the DEMI 2013 Conference, to exchange their experiences and to present the latest results of their research.
SCOPE AND TOPICS OF THE CONFERENCE:

- *Production Technologies and Engineering: Production technologies, conventional and unconventional processes, production systems and computer integrated manufacturing, metrology, quality, industrial management …*
- *Mechanics and Design: Mechanics of rigid and deformable bodies, Fluid mechanics, hydraulics and pneumatics, design methods, stability of structures, products design, analysis and synthesis of construction…*
- *Transport and Means of Transport: Engines, vehicles, railway vehicles, transport systems modeling, contemporary means and systems of transport, logistics…*
- *Energy and Thermal Engineering: Thermal Engineering, heating, air conditioning ventilation, refrigeration, energy efficiency, renewable energy sources …*
- *Maintenance of Technical Systems, Occupational Safety: Maintenance methods and techniques design and management of maintenance systems, maintenance versus new technologies, maintenance versus environment protection, occupational safety, ...*
- *Mechatronics: Industrial automation, automatic control systems, proportional and servo technology, robotics…*

The Conference organizer is planning marketing and commercial presentations of companies for conference participants. We would like to invite all companies to take this opportunity and present their products and services to the Conference participants.
Detailed informations here: http://demi.rs.ba

4. THE 6th INTERNATIONAL CONFERENCE FOR ENTREPRENEURSHIP, INNOVATION AND REGIONAL DEVELOPMENT – ICEIRD 2013
Program Theme: Regional Economic Resilience through Innovation and Enterprise
20 – 21 June, 2013, Istanbul, TURKEY

In the face of fragile economic recovery following the economic and financial crisis of 2008, many firms all around the world continue to invest in growth-enhancing activities to achieve a sustainable development.
While the crisis has heavily hit all aspects of business vested interests, investments in innovation, entrepreneurship and regional partnership have been the key priority to ensuring a strong and stable economic growth.
The objective of the conference is to gather decision makers (government, ministries and state agencies), innovation experts (universities, research and development centers, technology transfer centers, start-up centers) and practitioners (SME's, business incubators and business support organizations) to generate discussion and exchange on the potential of entrepreneurship promotion and innovation to national and regional competitiveness.
Researchers and practitioners are invited to submit workshop proposals addressing research on entrepreneurship, innovation, and regional development for ICEIRD 2013.
Detailed informations here: http://www.iceird2013.org/

5. THE 8th RESEARCH/EXPERT CONFERENCE WITH INTERNATIONAL PARTICIPATION – QUALITY 2013
6 – 8 June, 2013, Neum, BOSNIA & HERZEGOVINA

Organizing Committee invites all potential authors to submit abstracts (up to 100 words), not later than February 28th 2013. The official Conference languages are English, Bosnian, Serbian and Croatian. We remind authors that special section with presentations in English language will be organized at the conference.
The Research/Expert Conference will be performed as follows: plenary session (Key papers concerned global topics) and symposium (papers according to the conference topics).
Detailed informations here: http://www.quality.unze.ba/

6. THE 7th INTERNATIONAL SCIENTIFIC-PROFESSIONAL CONFERENCE – SB 2013
"CONTEMPORARY PRODUCTION PROCESSES, EQUIPMENT AND MATERIALS FOR WELDED CONSTRUCTIONS AND PRODUCTS"
23 – 25 October, 2013, Slavonski Brod, CROATIA

During last six meetings this conference had gathered number of experts and scientists who presented and introduced novelty in welding profession. Due to that, for the seventh time, organizers call everyone who can give their contribution to the area of welding technology and welding related techniques, automation and robotization in production of welded constructions, and all others that can, in any other way, give their contribution to development of welding practice, to present their scientific and professional knowledge and experiences.
This year, also, there will be the exhibition of welding devices, filler metals and equipment, and all presented papers will be published i the conference proceedings and CD media. We thank to all our present partners of this conference for their contribution and welcome you in Slavonski Brod.
TOPICS:

- *New technologies and materials*
- *Welding processes*
- *Robotization and automation*
- *Pressure vessels*
- *Welding related techniques*
- *Manufacturing of welded construction*

- *Quality control of welded products*
- *Reliability and safety of welded productions and constructions*
- *Weldability of materials*
- *Filler metals*
- *Equipment for welding and welding related techniques*
- *Personnel and education in welding*
- *Metallurgy*
- *Ecology and occupational health*
- *Economical aspects of welding*

Detailed informations here: http://www.sfsb.hr/dtzsb/

7. THE 13th INTERNATIONAL MULTIDISCIPLINARY SCIENTIFIC GEOCONFERENCE & EXPO – SGEM 2013 – SURVEYING – GEOLOGY & MINING – ECOLOGY – MANAGEMENT
Modern Management of Mine Producing, Geology and Environmental Protection
16 – 22 June, 2013, Albena Resort, BULGARIA

The Multidisciplinary GeoConference will bring together researchers, educators, and practitioners representing research and educational institutions, companies, government agencies and consulting organizations from all over the world to exchange of ideas, to define the research priorities and to propose potential solutions of problems related to the global changes. International Multidisciplinary Scientific GeoConference aims are:

- *To provide the best platform for knowledge and experience shearing in the field of geosciences;*
- *To incorporate and strengthen the capacity of geo-scientists for facing the challenges of our time;*
- *To give the opportunities for future co-operation;*
- *To emphasize the role of multidisciplinary approach in revealing and solving the environmental problems in local, regional and global scale;*
- *To outline research direction, identify, report, and disseminate issues and/or problems in geo-sciences applications;*
- *To discuss the new developments and technologies in surveying geology and mining, ecology, and management, in order to ensure the sustainable use of natural resources.*

SGEM International Multidisciplinary Scientific GeoConference and Expo is organized under the auspices of Ministry of environment and water, Bulgaria. Main organizers are the Academies of Sciences of the following countries: Bulgaria, Czech Republic, Iran, Latvia, Poland, Russia, Serbia, Slovakia, Ukraine, and also the Bulgarian Industrial Association.
Detailed informations here: www.sgem.org

8. FEDERATED CONFERENCE ON COMPUTER SCIENCE AND INFORMATION SYSTEMS – FedCSIS 2013
8 – 11 September, 2013, Kraków, POLAND

The 2013 Federated Conference on Computer Science and Information Systems cordially invites you to consider contributing an Event (conference, symposium, workshop, consortium meeting, special session). The FedCSIS multi-conference consists of a significant number of recurring Events, but proposals for new associated Events are welcome until January 14, 2013. The Events can run over any span of time within the conference dates, from half-day to three days.
The FedCSIS Events provide a platform for bringing together researchers, practitioners, and academia to present and discuss ideas, challenges, and potential solutions on established or emerging topics related to research and practice in computer science and information systems.
The Events will be selected based on the scientific/technical interest and/or their relevance to practitioners in their topics, the clarity of the proposal in addressing the requested information, the innovativeness of the Event topics, and the capacity in the FedCSIS multi-conference program.
Detailed informations here: www.fedcsis.org

9. THE 7th INTERNATIONAL CONFERENCE ON PHYSICAL AND NUMERICAL SIMULATION OF MATERIALS PROCESSING – ICPNS '13
16 – 19 June, 2013, Oulu, FINLAND

Following on from its six predecessors in Harbin (1990), Hainan (1997), Beijing (1999), Shanghai (2004), Zhengzhou (2007) and Guilin (2010), this conference will be held outside China for the first time. It provides an excellent international forum for those who wish to present their latest work on advances in the field of physical and numerical simulation methods and their applications in the processing of advanced materials. Oulu will provide an excellent environment for a highly enjoyable stay during the conference with among other things 24 hours of daylight.
The main topics of ICPNS '13 will be:

- *Physical simulation (Gleeble testing, torsion, dilatometry, thermal analysis, etc) of material processing: continuous casting, thermomechanical processing, hot rolling, forging, extrusion, forming, welding, heat treatments, etc.*
- *Numerical simulation and modeling of liquid metal processing, continuous casting, thermomechanical processes, and all phenomena occurring during metal processing.*
- *Metal surfaces: properties and behavior.*
- *Processing and characterization of advanced materials.*
- *Fabrication of advanced materials.*

Detailed informations here: http://www.icpns13.org/

10. INTERNATIONAL CONFERENCE ON MEMS AND MECHANICS – MEMSM 2013
15 – 16 March, 2013, Wuhan, CHINA

MEMSM 2013 will be the most comprehensive Conference focused on the various aspects of advances in MEMS and Mechanics. Our Conference provides a chance for academic and industry professionals to discuss recent progress in the area of MEMS and Mechanics.
The goal of this Conference is to bring together the researchers from academia and industry as well as practitioners to share ideas, problems and solutions relating to the multifaceted aspect MEMS and Mechanics.
Detailed informations here: http://www.memsm2013-conf.org

11. THE 3rd INTERNATIONAL CONFERENCE ON ENVIRONMENT AND INDUSTRIAL INNOVATION – ICEII 2013
19 – 20 May, 2013, Copenhagen, DENMARK

The 3rd INTERNATIONAL CONFERENCE ON ENVIRONMENT AND INDUSTRIAL INNOVATION (ICEII 2013) is the premier forum for the presentation of technological advances and research results in the fields of Environment and Industrial Innovation. ICEII 2013 will bring together leading engineers and scientists, academics and industrial experts in

Environment and Industrial Innovation from around the world.
The primary goal of the conference is to promote research and developmental activities in Environment and Industrial Innovation. Another goal is to promote scientific information interchange between researchers, developers, engineers, students, and practitioners working in India and abroad. The conference will be held every year to make it an ideal platform for people to share views and experiences in Environment and Industrial Innovation and related areas.
Topics of interest for submission include, but are not limited to:

- *Advanced Ceramic-porous ceramic*
- *Aerodynamics*
- *Application of Spatial technology*
- *Catalysis and Environment*
- *Environmental Biotechnology*
- *Environment management*
- *Environmental Chemistry*
- *Environmental engineering*
- *Environmental Planning of Mines*
- *Environmental Pollution Control*
- *Fermentation Technology*
- *Fermentation Technology*
- *Industrial Environment*
- *Industrial Microbiology*
- *Industrial Microbiology*
- *Industrial pollution*
- *Land resource utility*
- *Pharmaceutical Technology*
- *Renewable Energy*
- *Wastewater Quality Modelling*
- *Wind engineering*

Detailed informations here: http://www.iceii.org

12. *THE SECOND INTERNATIONAL CONFERENCE "MECHANICAL ENGINEERING IN THE XXI CENTURY"*
Mechanical Engineering Faculty of the University of Niš
20 – 21 June, 2013, Niš, SERBIA

It is our great pleasure to announce that the Faculty of Mechanical Engineering, University of Niš, is organizing the Second International Conference "Mechanical Engineering in the 21st Century". The Conference will take place in Niš on June 20-21, 2013. In recent years, the economic system has been changed in the direction of market economy, private property, and intensive creation of small and medium enterprises. The strategy and policy of the scientific and technological development of Serbia pays most attention to the innovative environment, which should assure the application of results from fundamental and applied research.
The Second International Conference "Mechanical Engineering in the 21st Century" aims to bring together researchers from scientific and industrial institutions to present and communicate their newest results, to create personal contacts, to promote research within the area of mechanical engineering, to find possibilities of cooperation in bilateral or multilateral projects, and to stimulate the participation of doctoral students.
You are cordially invited to attend and participate in the Second International Conference "Mechanical Engineering in the 21st Century".
Detailed informations here: http://www.masfak.ni.ac.rs

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Tome VI (Year 2013) – FASCICULE 1 [January–March]
ISSN 2067–3809

MANUSCRIPT PREPARATION – General Guidelines

These instructions are written in a form that satisfies all of the formatting requirements for the author manuscript. Please use them as a template in preparing your manuscript. Authors must take special care to follow these instructions concerning margins. The basic instructions are simple:

- *Manuscript shall be formatted for an A4 size page.*
- *The top and left margins shall be 25 mm.*
- *The bottom and right margins shall be 25 mm.*
- *The text shall have both the left and right margins justified.*

The original of the technical paper will be sent through e-mail as attached document (.doc, Windows 95 or higher). Manuscripts should be submitted to e-mail: redactie@fih.upt.ro, with mention "for **ACTA TECHNICA CORVINIENSIS – Bull. of Eng.**".*

STRUCTURE

The manuscript should be organized in the following order: Title of the paper, Authors' names and affiliation, Abstract, Key Words, Introduction, Body of the paper (in sequential headings), Conclusion, Acknowledgements (where applicable), References, and Appendices (where applicable).

THE TITLE

The title is centered on the page and is CAPITALIZED AND SET IN BOLDFACE (font size 14 pt). It should adequately describe the content of the paper. An abbreviated title of less than 60 characters (including spaces) should also be suggested.

AUTHOR'S NAME AND AFFILIATION

The author's name(s) follows the title and is also centered on the page (font size 11 pt). A blank line is required between the title and the author's name(s). Last names should be spelled out in full and succeeded by author's initials. The author's affiliation (in font size 11 pt) is provided below. Phone and fax numbers do not appear.

ABSTRACT

A nonmathematical abstract, not exceeding 200 words, is required for all papers. It should be an abbreviated, accurate presentation of the contents of the paper. It should contain sufficient information to enable readers to decide whether they should obtain and read the entire paper. Do not cite references in the abstract.

KEY WORDS

The author should provide a list of three to five key words that clearly describe the subject matter of the paper.

TEXT LAYOUT

The manuscript must be typed single spacing. Use extra line spacing between equations, illustrations, figures and tables. The body of the text should be prepared using Georgia or Times New Roman. The font size used for preparation of the manuscript must be 11 points. The first paragraph following a heading should not be indented. The following paragraphs must be indented 10 mm. Note that there is no line spacing between paragraphs unless a subheading is used. Symbols for physical quantities in the text should be written in italics.

FIGURES AND TABLES

Figures (diagrams and photographs) should be numbered consecutively using Arabic numbers. They should be placed in the text soon after the point where they are referenced. Figures should be centered in a column and should have a figure caption placed underneath. Captions should be centered in the column, in the format "Figure 1" and are in upper and lower case letters. When referring to a figure in the body of the text, the abbreviation "Figure" is used Illustrations must be submitted in digital format, with a good resolution. Table captions appear centered above the table in upper and lower case letters. When referring to a table in the text, "Table" with the proper number is used. Captions should be centered in the column, in the format "Table 1" and are in upper and lower case letters. Tables are numbered consecutively and independently of any figures. All figures and tables must be incorporated into the text.

EQUATIONS AND MATHEMATICAL EXPRESSIONS

Equation numbers should appear in parentheses and be numbered consecutively. All equation numbers must appear on the right-hand side of the equation and should be referred to within the text.

CONCLUSION

A conclusion section must be included and should indicate clearly the advantages, limitations and possible applications of the paper. Discuss about future work.

ACKNOWLEDGEMENTS

An acknowledgement section may be presented after the conclusion, if desired. Individuals or units other than authors who were of direct help in the work could be acknowledged by a brief statement following the text.

REFERENCES

References should be listed together at the end of the paper in alphabetical order by author's surname. List of references indent 10 mm from the second line of each references. Personal communications and unpublished data are not acceptable references.

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***Books**: Surname 1, Initials and Surname 2, Initials: Title, Edition (if existent), Place of publication, Publisher, year.*

***Proceedings Papers**: Surname 1, Initials; Surname 2, Initials and Surname 3, Initials: Paper title, Proceedings title, pages, year.*

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