ACTA TECHNICA CORVINIENSIS

– BULLETIN of ENGINEERING

fascicule 3
[July - September]
tome VII [2015]
ACTA Technica CORVINIENSIS
BULLETIN of ENGINEERING

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We are very pleased to inform that our international scientific journal ***ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering*** *completed its seven years of publication successfully [2008 – 2014, Tome I – VII]. In a very short period the* ***ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering*** *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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AIMS, MISSION & 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.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.

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.

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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.

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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.

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- ✓ Agricultural Engineering
- ✓ Control Engineering
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- ✓ Nanoengineering

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- ✓ Materials Science & Metallography
- ✓ Polymer Chemistry
- ✓ Spectroscopy
- ✓ Thermo-chemistry

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- ✓ Agricultural Economics
- ✓ Development Economics
- ✓ Environmental Economics
- ✓ Industrial Organization
- ✓ Mathematical Economics
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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.*

***ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering** publishes invited review papers covering the full spectrum of engineering and management. 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.*

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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.*

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 *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.*

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. The evaluated paper may be recommended for:

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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.*

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.

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TABLE of CONTENTS
Tome VIII [2015]
Fascicule 3 [July – September]

Abstract: *The information obtained from the camera image processing is used to increase the safety and comfort of parking users. Detection and tracing of the vehicles movement in open, large parking areas comes across problems with clear identification of the object from the image based on the primary character. The article describes the approach of vehicle tracking using the registration number that is recorded upon entrance and combining some secondary characters such as colour, size and way of movement. This solution has been tested with the created software which consisting of functional units providing an input, a passing and a stopping the vehicle. The provided services are based on assigning a unique identity character to each vehicle (EVN), which allows increased safety of vehicles and targeted monitoring.*

Abstract: *Conception, design and fabrication of agricultural machinery, in modern age, cannot be achieved in competitive conditions without including in these activities the one of experimental research through field and laboratory testing. Acceleration of tests is a way of hurrying up the information obtaining regarding products behavior in conditions of economic efficiency. By accelerated testing concept we understand time compression and acceleration of braking mechanisms in a reasonable amount of time so that the products reliability will be evaluated. This concept is also applied to agricultural machinery testing, especially of those high stressed in exploitation. The paper will present the stages which have to be passed for design validation of a resistance frame from a deep soil loosening machine by applying an accelerated testing program within a laboratory unit. For this, we will present the real solicitations spectrum at which the machine is subjected in exploitation and the synthesized accelerated test program obtained using a Rainflow counting algorithm. Then, the deep soil loosening machine will be mounted on a specialized stand and will be subjected to strains according to the obtained testing program, with the final purpose of its resistance frame design validation.*

Abstract: *The present paper represents a comparative analysis of the experimental results, observed by determination of thermal conductivity coefficient of environmentally friendly building materials made of clay (gray marl), sand and different quantity of straw. The thermal conductivity study was carried out by using of two different methods – method of infinite flat plate with "D-r Bok" stand and modified transient plane source method with thermal conductivity analyzer CTherm TCi. The comparative analysis of the results, obtained from the both apparatus, shows that there is a good repeatability of the thermal conductivity values and this is a reason to confirm the good thermal insulating properties of the tested materials. The experimental research established that the studied materials have thermal properties which could be compared with the thermal properties of common materials as lightweight concrete (k=0,1-0,3W/m.K) and ceramic bricks (k=0,6-1,31W/m.K).*

Abstract: *The determination of Silicon (Silica) in materials using the Molybdenum blue reaction was studied. The UV-Visible spectrophotometer scanning for the silicon molybdenum blue reaction was studied between a wavelength of 400nm and 800nm. The instrumental analytical procedure applied consists of four basic parts: the sample pretreatment, the instrument adjustment, the calibration and measurement and the calculations. The instrument was optimized using standard solution of $KMnO_4$ with conventional calibration method applied. The performance characteristics of the spectrophotometer at a wavelength of maximum absorption (λ_{max}) of 825 ± 5nm for the silicon-molybdenum blue analysis are observed. The procedure was applied to amorphous silica produced from glass sand and the findings were observed to correspond with existing standard.*

Abstract: *Hybrid power supply systems in the recent time are used in everyday life, primarily because humanity turns in exploitation of renewable energy sources, as well as the reduction of fossil fuel reserves, where most of the electricity produced is based. The hybrid power supply system in its most general form includes the following components: photovoltaic systems, wind generator, diesel generator, a system for energy storage (batteries), grid connection, and power converters through which is perform the conversion of electrical energy and power suppling. This paper will provide an analysis of the operation and viability of a hybrid power supply system, modeled in software package HOMER.*

Abstract: *Adoption of optimal teeth parameters for gerotor pumps is of great importance and it has a large influence on their operational characteristics. This is the reason why a lot of attention is directed towards their optimization. The working flow of a gerotor pump has been chosen as the topic of optimization in this paper. Taguchi method for ranking gearing parameters related to pump flow has been presented here. Based on teeth parameters influence rank, an optimization is performed by method of linear programming. As a result of optimization optimal teeth parameters are chosen.*

Abstract: *Before analysis, development or improvement of existing structure of drive unit or gearboxes, the load that appearing in exploitation must be known. This paper presents a method of load (torque) measurement, on the cardan shaft embedded in the freight vehicle, using strain gages. The aim of the study is to determine torque variation depending on the exploitation conditions (road surface, speed transmission, vehicle load, etc). The measurement was performed for different road characteristics (vehicle movement on flat terrain, up and down the slope). Results are presented using tables and diagrams, and percentage utilization of the power drive unit, embedded into freight vehicle, was calculated based on obtained values of torque. Obtained results have an important role for designers because they give a general insight in the load on the cardan shaft , which represent the basis for future development or redesign of power unit or gearboxes and basis for forming of specter of gear load and bearing embedded into gearbox.*

Abstract: *Life, in the form we all know, it exists because of air, water and earth, which are the main elements that underlie it. When one of these elements is disrupted by man and can no longer follow the natural cycles, the balance is destroyed, and we witness, without any right of reply, genuine environmental disasters. In the industrial sector, in most cases, in addition to the main product, there are one or more products which can be returned to the steel circuit after a quick processing. Reintroduction into the economic circulation of products/small and powdery ferrous wastes leads to reduction of water/air/soil pollution levels. Every tone of ferrous waste recovered and returned to steel production circuit leads to an economy of investments and operating costs. The paper approaches the problem of small and powdery wastes recovery from mining and steel industry in the western part of Romania. Research carried out shows that wastes can be used to produce pellets and briquettes.*

Abstract: *The article deals with the rating appreciation of the banking sector in Slovakia. It discusses the rating assignments beginnings for the Slovak banking. It is associated with the year 1994 when the first valuation was assigned by two major rating agencies, namely Standard & Poor's Rating and Investment Information. The article brings individual assessments based on positive and negative aspects that influenced them. The next section deals with the contribution of the further development of the rating to the present. It brings evaluations of the three top global agencies for each year that is generally reviewed in tabular and pictorial form with the appropriate commentary. The conclusion is devoted to the current situation in the banking segment in Slovakia with estimates of future development in this field.*

Abstract: *Rice husk ash (RHA) is an agricultural waste and is rich in silica. Silica gel was extracted from RHA by burning, thoroughly washed and dried rice husk into ash in an enclosed drum, the ash was thereafter conditioned in a muffle furnace at a temperature of 650 ^{0}C; the conditioned ash was leached with various concentrations (0.5, 1.0, 1.5 and 2.0M) of sodium hydroxide (NaOH) in a water shaker bath at 100 ^{0}C for 1 hour, the solution was filtered with ashless filter paper number 41 and the filterate was precipitated with concentrated hydrochloric acid (HCl) to obtain solution until pH 7and incubated for 48 hours to promote silica gel formation. The silica gel produced was separated from soluble salt solution by vacuum filteration and washed with deionized water. The silica gel was dried in an air blast oven at 150 ^{0}C for 48 hours and ground into powder. The presence of silica in the gel was confirmed with Energy Dispersive X-ray Spectrometer (EDX).*

Abstract: *The aluminium alloys become increasingly higher into the metallic materials category for transport, aerospace, electrochemical, electronics and microelectronics, chemical, industrial and civil construction industries and so on, mainly due to high ratio between mechanic strength and density, high corrosion resistance, thermal conductivity and electrical which were perfectly raised. The research of aluminium alloys can be done through direct physical and chemical laboratory methods, but also through indirect methods that highlights the research through simulation and physical or mathematical modelling. Autodesk Simulator is a programme for simulation which can help us determine physical characteristics, mechanical properties of certain processes, materials or complex installations so that we can give an overview and insight into the future in terms of the property of the element studied but also the economic benefits. The paper presents the authors' personal research over the significant qualitative characteristics of certain aluminium alloys through simulation and modelling using Autodesk Simulator CFD. The results have a major importance to establish the stress resistance and ductility of the alloy.*

Abstract: *The term biomechanics or bio engineering has become synonymous with high cost measurement apparatus. This contribution focuses on force plate devices and challenges the current high cost trends of this technology by designing a low cost alternative capable of obtaining comparably accurate results. The design uses a simple and unique configuration of beam elements measured through strain gauges. The contribution explains the alternative devices evolution from concept to FEA calculations of active structural members, to the realization and testing of prototype. The data obtained from the prototype are compared to those from an established force plate manufacturer. The comparison of results shows that the prototype force plate obtains data that are comparable to the results acquired from high cost technologies, proving that the low cost alternative is capable of providing similar levels of accuracy at a fraction of current prices.*

Abstract: *Measures for increasing of energy efficiency in buildings are closely related to Energy Audit. Faculty of technical sciences – Bitola (FTSB) is one out of five companies that were chosen as educating facilities for training of energy auditors. High School dorm "Mirka Ginova" in Bitola is the only state-owned dorm in the city. Preliminary energy audit for the nearby building of the dorm was performed as a part of the training for energy auditors. The calculations were performed by using of ENSI© EAB software.*

Abstract: *In many areas of business services has a major impact on the decision for any manufacturer to decide, often even higher than the price or features. So, the classical servicers meet the above requirements only partially. To meet the above mentioned requirements is necessary to develop new concepts and methods, and one of them is the teleservice. This paper presents a teleservice as the process of removing electronic failures on machines from a distant place. Service is explained in details as new service, who gives a new concept of maintaining the production. Also included are all the positive and negative features of this service. The aim of the study was to analyze the reasonableness of performing Teleservice compared with the conventional way of service. The paper will be justification of service execution teleservice show an example of a machine for filling water.*

Abstract: *This article deals with how gamification can open new ways in the education of cloud security. The new generation needs more exciting, more engaging tools at all stages of the flow of information – browsing webpages, reading news, using apps on mobile devices. This article focuses on those elements of gamification which can give a pleasant experience for the users, making them stay on the browsed pages and making them engaged for the downloaded applications. Cloud Computing is a widely used platform – and cloud security rules have to be kept by every user. But how can we make the users feel responsible for this security policy if they have no motivation to read at least the terms of use? A possible solution would be: gamification didactics tools.*

Abstract: *The compaction of agricultural soil is a phenomenon of degradation, occuring from natural or artificial causes and is defined by the increase in soil density and the decrease in soil porosity, with negative consequences for the environment and for agriculture. Artificial soil compaction is generated by the contact between soil and tires or tracks of tractors and agricultural machinery. This paper presents some general mechanical concepts regarding the behavior of soil under compressive stresses and a review of some mathematical models which can be applied to describe the behavior of soil at compaction, under the influence of various parameters.*

Abstract: *As demands on micro metal products increase significantly, micro forming becomes an attractive option in the manufacture of these products due to its advantages for mass production. Fundamental issues relating to materials, processes and analysis have been studied intensively in recent years and have been well documented in the literature. But still the application of metal forming to the manufacturing of micro parts is not widespread. One reason is that the knowhow of conventional forming cannot be simply transferred to the micro scale. Also the forming behavior mainly depends on the part's individual grain gathering leading to a rather unpredictable forming result and making a process design impossible. . It has become essential to develop a proper understanding which in turn could be used to develop dedicated processes for the manufacturing of metallic micro components. In this work, an attempt has been made to realize this special application of metal forming.*

Abstract: *Biomass continues to be investigated as an alternative resource to resolve the demanding consumption of petroleum-based gasoline and diesel fuel. In addition, biomass can be used to provide bio-oil, biogas, and hydrogen as well as electricity. The growing demand for alternative energy sources has contributed to increased biofuel production, but the effects on biodiversity of land-use change to biofuel crops remain unclear. As a result and in order to minimize impacts of biofuel crops on biodiversity, management practices that reduce chemical inputs, increase heterogeneity within fields, and delay harvests*

within wildlife areas are recommended. There is also the need to address the growing challenge of climate change by closer scrutiny of biofuels to assess whether they can be produced, traded and used sustainably. Criticism of biofuels has centered on the perceived negative impacts on the environment through deforestation, spread of monocultures, loss of biodiversity and possible higher GHG emissions under uncontrolled land-use change. The potential of biofuels to contribute to a shift into more sustainable energy systems has been contested, and scientists had to move away from emotional preferences and question the claimed environmental superiority of biofuels.

Abstract: *In this paper we present the results of experimental research performed using a Philips XL 30 ESEM TMP scanning electronic microscope, owned by UPB-CEMS, on a number of 6 samples taken from an iron-nickel-chromium special material, used for making high voltage overhead power lines, which were disc-shaped, with a diameter of 7mm and a height of 0,5 – 1,2 mm, electrically eroded. Inside a vacuum environment, using a 30 kV voltage for accelerating the electron beam, a spot dimension on the sample surface equal to 3 and a distance between the polar piece of the microscope and the surface of the sample of 10 mm, there have been obtained images of secondary electrons, which have helped morphologically characterize all the samples, at magnifications between 100x and 25.000x.*

Abstract: *It is essential that a sufficient level of protection of the information. The information security processes and activities of standardization could be applied by a single form. Compliance with the standards and certification audits, offer guarantees of the economic operators and public organizations as well. A number of government standards or recommendations developed along its own information security strategy. There are different kinds of standards, treated by different organizations. In the article below they are presented to the standardisation bodies, which European and the Hungarian economy has big a impact. We do all this in order to find your way to the right so that the client can compare a multitude of information security.*

Abstract: *The paper presents the design and construction of an autonomous mobile mini-sumo robot. The mobile robot is a combination of devices endowed with power drives and sensors, under the control of a hierarchical computing system operating in the real space, which has to plan the movements so as to perform a task depending on the initial state of the system as well as on the information received from the work environment. The robot was designed using Fritzing software and its programming has been done by means of Arduino programming language. In building the robot, the regulations of the sumo-type robot competitions were taken into account in order to allow it to take part in such competitions.*

Abstract: *Unmanned autonomous aerial vehicles have become a real center of interest. In the last few years, their utilization has significantly increased. During the last decade many research papers have been published on the topic of modeling and control strategies of autonomous multirotors. Today, they are used for multiple tasks such as navigation and transportation. This paper presents the development of a dynamic modeling and control algorithm - backstepping controller of an autonomous hexa-rotor microcopter. The autonomous hexa-rotor microcopter is an under-actuated and dynamically unstable nonlinear system. The model that represents the dynamic behavior of the hexa-rotor microcopter is complex. Unmanned autonomous aerial vehicles applications are commonly associated with exploration, inspection or surveillance tasks.*

Abstract: *Fundamental working element of the most robot and manipulator arms is needle-sized tentacle which moves straight-line. One end of the tentacle is fixed and the other is free, and the corresponding physical model is a clamped-free beam. Operation of the tentacle is in straight-line direction and axial vibration appears. As the material of tentacle is usually with nonlinear properties, the model of the system is also nonlinear. Axial vibration is described with a nonlinear partial differential equation. In this paper an analytical method is developed for solving the equation. It is based on separation of the partial differential equations into two uncoupled strong nonlinear second order differential equations. Using boundary and initial conditions, parameters of vibration are obtained. The procedure suggested in this paper is applied for a beam with cubic nonlinearity. Frequencies of free axial vibration are determined. It is proved that they depend not only on the type of boundary conditions, but also on initial conditions. At the end of the paper the numerical solution of the axial vibration of the clamped-free beam with cubic nonlinearity is calculated.*

Abstract: *Copper has outstanding electrical and thermal conductivity, brought about in both cases by electron transfer. The recycling of copper is, for example, in Europe, well-functioning with established business for collection, treatment and processing of highgrade scrap. Copper is a versatile metal with a variety of industrial and residential applications, such as in electronic products, construction, industrial machinery, transportation and as alloying element inbrass and bronze. This is shown in the rather large proportion of the copper produced originating from secondary sources. Various secondary sources and wastes containing copper-based alloys are generated in industries such as brass scrap, waste residue of electric arc furnace, automobile shredder scrap, rayon industry*

*The **ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering, Tome VIII/2015, Fascicule 3 [July–September/2015]** includes scientific papers presented in the sections of:*

- ***The 3rd INTERNATIONAL CONFERENCE INDUSTRIAL ENGINEERING and ENVIRONMENTAL PROTECTION – IIZS 2014**, organized in Zrenjanin, SERBIA (15th of October, 2014), jointly by the University of Novi Sad, Technical Faculty "Mihajlo Pupin", Zrenjanin, SERBIA. The new current identification number of the papers are the **# 13, 14** and **18**, according to the present contents list.*
- ***The 8th International Conference for Young Researchers and PhD Students – ERIN 2014**, organized by the Brno University of Technology, in Blansko - Češkovice, CZECH REPUBLIC (April 23rd–25th, 2014). The current identification numbers of the selected papers are **# 12** and **# 25**, according to the present contents list.*
- ***The 2nd INTERNATIONAL CONFERENCE on MECHANICAL ENGINEERING TECHNOLOGIES and APPLICATIONS – COMETa 2014**, organized in East Sarajevo, Jahorina, BOSNIA and HERZEGOVINA (December 2nd–5th, 2014), jointly by the University of East Sarajevo, Faculty of Mechanical Engineering, BOSNIA and HERZEGOVINA. The new current identification number of the papers are the **# 5 – 7**, according to the present contents list.*
- ***The 3rd INTERNATIONAL CONFERENCE and WORKSHOP – MECHATRONICS in PRACTICE and EDUCATION – MECHEDU 2015**, organized in Subotica, by Subotica Tech, SERBIA (May 14 – 15, 2015), in partnership with the Faculty of Technical Sciences Novi Sad , SERBIA, the Donát Bánki Faculty of Mechanical and Safety Engineering, Budapest, HUNGARY and the Faculty of Engineering – Szeged, HUNGARY. The new current identification number of the papers are **# 22** and **23**, according to the present contents list.*
- ***The STUDENTS ' SCIENTIFIC SYMPOSIUM – „45 YEARS OF HIGHER EDUCATION IN HUNEDOARA" – Doctoral Studies Section**, organized in Hunedoara (22nd – 23rd May, 2015), by Faculty of Enginering Hunedoara, ROMANIA. The new current identification number of the papers are **# 11, 15, 19, 20** and **24**, according to the present contents list.*

*Also, the **ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering, Tome VIII/2015, Fascicule 3 [July–September/2015]**, includes original papers submitted to the Editorial Board, directly by authors or by the regional collaborators of the Journal.*

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MONITORING OF PARKING LOT TRAFFIC USING A VIDEO DETECTION

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Abstract: The information obtained from the camera image processing is used to increase the safety and comfort of parking users. Detection and tracing of the vehicles movement in open, large parking areas comes across problems with clear identification of the object from the image based on the primary character. The article describes the approach of vehicle tracking using the registration number that is recorded upon entrance and combining some secondary characters such as colour, size and way of movement. This solution has been tested with the created software which consisting of functional units providing an input, a passing and a stopping the vehicle. The provided services are based on assigning a unique identity character to each vehicle (EVN), which allows increased safety of vehicles and targeted monitoring.
Keywords: car park occupancy, video detection, object tracking

INTRODUCTION

In the context of static traffic (parking, parking spaces on the street and parking areas) the camera systems are deployed which are primarily designed to monitor the situation around parked vehicles. They have a preventive effect and can record a critical incident (theft, accidents etc.).

The CCTV discourages some part of potential offenders. However, the presence of cameras on the parking area doesn't protect primarily the vehicle against theft and damage. The extension of surveillance camera within existing infrastructure it is possible to increase the level of service and security in parking areas [1].

The aim of such systems is to ensure the most reliability of the parking area, to provide a view of unauthorized (suspicious) movement of persons or to find a subsequent movement of the vehicle (exit from the parking lot) on the parking lot after the theft with possibility of identification of the perpetrators. Therefore, the research team were targeted in an internal pilot project ITS-USP (Intelligent Transport Systems – University Science Park) focused on the design of algorithms for the possibility of identifying and recording the subsequent trajectory of the vehicle and the recording time sequence of a motion, i.e. entering, stopping and leaving the parking lot.

The proposed approach and algorithms were tested on the premises of the campus of University of Žilina. The entry into the area of parking is realized through three input-output terminals equipped with barrier system. The existing technical infrastructure [2] allows a collection of parking fee at the exit or a pre-paid resident input simultaneously. Proposed and partially tested system is a software extension for the actual hardware implementation. The conceptual proposal covers the entire parking area; the system itself is implemented only on part of the parking lot [3]. The coverage of university campus by cameras to the state allowing fully automatic operation will implement during construction of technological infrastructure of USP. The actual verification of functionality of the proposed algorithms and the system is implemented only in part of the area (five cameras used). The black circles (Figure 1) represent three input-output terminals for parking lot.

Figure 1. The distribution of parking spaces in University campus, input-output terminals are marked (left), a design of deployed cameras showing the coverage of sectors (right)

Each vehicle shall be operated at these points at the entrance /exit getaway. This fact can be used to obtain information about vehicles which enter the parking area. Layout of cameras in the area of university campus should meet these requirements:

- *The location of cameras with a view to maximize the number of parking spaces;*
- *An ideal view of the parking places without smaller vehicles being covered by larger ones (e.g. a van covering a parking space for passenger cars).*

The placement requirements of cameras in parking areas will not allow determining the number plate (EVN) because the resolution of is not sufficient. The vehicle registration plate is only a universal unique identifier. Therefore, the requirements for placement of cameras at the input terminals are different and enable accurate capturing of EVN in sufficient quality. Cameras placement should be at an appropriate angle to be able to determine the EVN and other characteristics of the vehicle such length, width and color [4]. It is advantageous to combine the information about EVN captured as the vehicle enters the campus and the information about the vehicle movement recorded between sectors of parking lot covered by cameras.

Complex monitoring of static traffic within the campus of the University of Žilina enables a proposal of three functional units of the system. These are selected so as to achieve the necessary functionality with the lowest economic effort - particularly savings in the hardware part (the number of cameras, cables etc.). Functional units consist of: data processing at the entrance to the premises, data processing to track the trajectory of the vehicle and data processing in order to evaluate a pulled-up (parked) car in the designated area.

RECORD INFORMATION AT THE ENTRANCE

By installing cameras at the entrance on the parking lot to obtain primary information was obtained which is needed for basic identification data of the vehicle itself. The primary identification element of the vehicle is its number plate. Automatic number plate recognition supports several freely available algorithms collected in libraries for standard programming languages.

Used algorithms achieve high detection rate and low error text. Converting EVN into digital form is a standardized process and has been used as a black box system. The output is a number plate of the vehicle in digital form. That information shall be attached to elementary specific characteristics of the vehicle (the length, width, colour), which will be store in a database.

EVN is assigned to tracking moving object (usually a vehicle) so it is a primary identified which is carried forward in the detection of the vehicle. EVN detection is not primarily used in next part of proposed software. Other cameras (located on parking area) will be used for capturing secondary cognitive characteristics of the vehicle. Properties of used cameras increase the accuracy of the characteristics of the vehicle and the percentage of correct detection.

Figure 2 . Layout of cameras at terminal (left), an example of the vehicle and the number plate recorded at the entrance (right)

PASSING VEHICLES AND THEIR TRACKING

The main function of the designed system is to allow the identification of the vehicle within sectors in the parking area. The main aim of camera location is to cover the largest part of the parking areas and thus the number of parking spaces. This reduces the number of required hardware with the same functionality of the system. Such placement of cameras will not allow detecting and identifying EVN as the unique identifier of the object. The proposed approach allows the assignment of number plate of the vehicle based on secondary identifiers together with the monitoring of movement between sectors parking. It combines object detection method based on motion and color information. Detection process is described in the flowchart (Figure 3).

Block 1

Firstly, the number plate of vehicle which should be tracked is entered. The vehicle photo captured at the entrance is assigned to the number plate.

Block 2

One of the videos recorded in storage is loaded.

Block 3

The cycle is repeated until all frames are processed - from the beginning to the end of the video.

Block 4

Processing of frame to moving object detection using operations difference images, thresholding, dilation, erosion, and mask

Block 5

The decision whether the movement is detected in one of ROI or not.

Block 6
Differences between a moving and the search object. In this case, the color information is used.
Block 7
The decision whether the difference corresponds with the wanted object. Tolerance varies for each ROI.
Block 8
The movement trajectory is drawn in the reference frame of the place where the object was detected along with the time of detection.
Block 9
The last block is determined that the vehicle left the range of cameras.

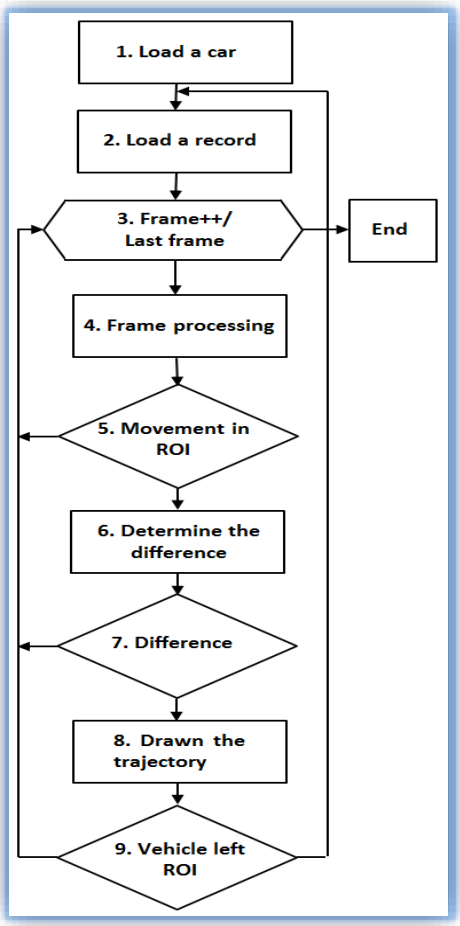

Figure 3. *The procedure of vehicle tracking among sectors from video data processing*

Program starts a processing of the next video if the vehicle occupies the boundary loops (ROI). That means the vehicle leaves the maximum possible view of the video camera and the next close record of video camera should be processed.
The proper definition of the region of interest (ROI) is important for correct functionality and correct handling of recorded sequences. ROIs are placed in the processed images; first the movement presence in ROI is detected. The idea of the ROI distribution is based on the coverage of boundary sections, where vehicles are moving and cameras monitoring. The transit of the vehicle between adjacent sections covered by cameras is monitored (Figure 4). It is based on the idea of transit of the vehicle in the desired direction. If the vehicle occupies an input ROI (entrance to actual sector covered by camera) then the camera in the scene is covering the actual section. If during the time interval the vehicle does not occupy an output ROI it can be assumed that it is parked in the area covered by a given camera. If the vehicle leaves the picture (occupy output ROI) algorithm is expected to arrive in the camera image according to the following practical possibilities movement in the parking lot. The vehicle can be tracked by combining the movement time information in the image and the color information (or other secondary characters) captured at the entrance where EVN was recorded. The vehicle information is retained this way, which cannot be directly obtainable from cameras designed to cover the surface parking spaces.

Figure 4*. Proposed deployment of ROIs among sectors (left); an example of ROIs deployment in the monitored sector, aimed at motion detection (right)*

DIFFERENT OCCUPANCY STATUS OF PARKING SPACES

A related service of the vehicle tracking on the premises of the campus is a record of the place where the vehicle was parked. To avoid incorrect identification of the vehicles that stop out of the prescribed places, it uses the information about moving objects among the sectors. Information about the EVN is taken (as indicated) from entrance as information of monitoring procedures for the tracking of the object to the final stopping point. For correct monitoring of occupancy of parking spaces two optical loops are placed at each parking space (Figure 5). The determination of the actual status between them is determined by the current state of occupancy [5].
The proposed algorithm is designed to evaluate the changes in occupancy of parking places, is resistant to the impact of weather conditions and the movement of people in the parking lot. The algorithm is based on the secondary characteristics (colour, size) of objects (vehicles) that need to be captured. The functionality of the program has been verified on a university parking lot. Percentage of

correct evaluation of occupancy has been compromised just too fast moving cars in the parking area. Implementation of the proposed approach allowed an authentication of functionality in real conditions. During the tests only a minor part of the campus was covered by cameras, it was sufficient to confirm the correct detection of vehicle in different camera records. Temporal information is recorded about detected occurrence in ROI along with the EVN based on secondary characters. Thusly recorded information is used to draw the route of a particular vehicle during the presence in the monitored areas. The processing of the recorded data is transferred into the application (Fig. 6) allowing basic operations on the structure of the data stored in the database using the approach presented in the article.

Figure 5. Detected movement of persons does not affect the change of parking space occupancy (left), a vehicle detected release a parking space (right)

Figure 6 . GUI using described algorithms for vehicle routing based on secondary characters on parking area where EVN is no visible. A route of single vehicle is marked.

CONCLUSION

The results of our tests confirm the applicability of the presented approach to vehicles tracing in open parking areas. Weaknesses of the system periodically occurred in non-standard behaviour of drivers of vehicles. Sudden deceleration rate in the monitored sectors of the first vehicle and current transit of another vehicle with similar secondary characters results in a confusion of these vehicles. This fact is subject of research, which should eliminate this scarcity.

The main advantages of this approach, compared with the traditional parking lots systems without image processing, are:

- *Automated monitoring of eligibility of occupancy rights at a designated place.*
- *Overview of the movement of particular vehicles usable for statistical purposes. The number of transits through the parking lot, parking time of each vehicle.*
- *Personal security parking. Mobile application allows informing the holder of the vehicle.*
- *Easy to re-trace the route of the vehicle, for example in the case of unauthorized movement.*
- *Services for registered employees as standard paying for parking usage.*
- *Blocking departure of vehicles in case of theft or unauthorized leaving of the area.*
- *Navigation to free parking sectors or places.*

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ACCELERATED TESTING OF DEEP SOIL LOOSENING MACHINE RESISTANCE FRAME

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Abstract: Conception, design and fabrication of agricultural machinery, in modern age, cannot be achieved in competitive conditions without including in these activities the one of experimental research through field and laboratory testing. Acceleration of tests is a way of hurrying up the information obtaining regarding products behavior in conditions of economic efficiency. By accelerated testing concept we understand time compression and acceleration of braking mechanisms in a reasonable amount of time so that the products reliability will be evaluated. This concept is also applied to agricultural machinery testing, especially of those high stressed in exploitation. The paper will present the stages which have to be passed for design validation of a resistance frame from a deep soil loosening machine by applying an accelerated testing program within a laboratory unit. For this, we will present the real solicitations spectrum at which the machine is subjected in exploitation and the synthesized accelerated test program obtained using a Rainflow counting algorithm. Then, the deep soil loosening machine will be mounted on a specialized stand and will be subjected to strains according to the obtained testing program, with the final purpose of its resistance frame design validation.
Keywords: accelerated testing, resistance frame, rainflow

INTRODUCTION

As a general rule, an agricultural machine design is based on the physical operations it has to perform during work. The design may be new, innovative, but also inspired by a similar operation performed by an existing machine. The bearing structure, the frame or the chassis are designed and sized appropriately to a reserve which ensures the good running of the activity (maximum strains not affecting the work quality and maximum stress applied on structure, which cannot determine failures). This primary structure is subjected to a structural analysis process for a better or even optimal dimensioning. This structural analysis process comprises the stages: structural modeling, static analysis, analysis of own frequencies, dynamic simulation, fatigue test [4]. Following these stages, the structure theoretical dimensioning can be decided. The structure physical building is followed according to theoretical process data, by the physical testing stage. This test is of two types: testing in the field, under different working regimes, respectively bench testing.

The field tests first aim to determine the quality of the work performed, as well as to determine favorable (maybe optimal) working regimes, but also the general behavior of resistance structures (strains, components stress, vibrations, resonances, fatigue, etc.). At the same time, there are monitored the operations the machine has to perform, namely the machine mission profile [5]. Following this identification and based on field tests the machine shock response spectrum, is defined. Based on this spectrum, the mechanical laboratory tests to which the machine will be subjected, are established [1,6].

The main mechanical tests are thoroughly performed on testing stands, in simulated and accelerated regime. Observations and corrections made in these stages can bring back the product at the design stage for improvements, after which the testing stages continue and the cycle keeps going on till all the machine problems are satisfactorily solved. When the machine is appropriate to designers, potential beneficiaries, users and testers, it can reach the stages of model, prototype and respectively production.

MATERIAL AND METHODS

The stages necessary to achieve an accelerated testing program at which the machine resistance structure be subjected based on a real stress spectrum, are the following:

- achieving the structural model of machine resistance structure; then, real excitation and supporting points of structure will be chosen in order identify the structure critical points;
- applying sensors (strain gauges) in critical points for registering the real stress in the filed;
- performing tests in transport and in exploitation and estimating their share out of the machine total operating period;ț
- processing the signals obtained in the field using a counting algorithm of rainflow-type cycles [3] and a program synthesizing the test signal;
- preparing a test stand in laboratory which should reproduce the real operation conditions;
- performing laboratory tests, on testing stand;
- results conclusions.

The structural model presented within the thesis for MAS-5 scarifier is probably the simplest structural simulator, made only of 1-dimensional finite elements. It was built starting from the MAS-65 machine experimental model, available for performing physical tests both in the field and laboratory. This way, the main components of machine resistance structure and their basic profiles, were identified and their dimensions were measured and after that, the structural model was built.

Figure 1. Machine MAS-65 in aggregate with New Holland TD80 tractor during the work in fallow laid field

In fig. 2 is given the map of stress state (Von Mises) equivalent in structural model of scarifier MAS – 65. Maximum value of equivalent stress is of 39.4 MPa and the bar which models the upper hydraulic cylinder and the bars connecting to tractor, are located.

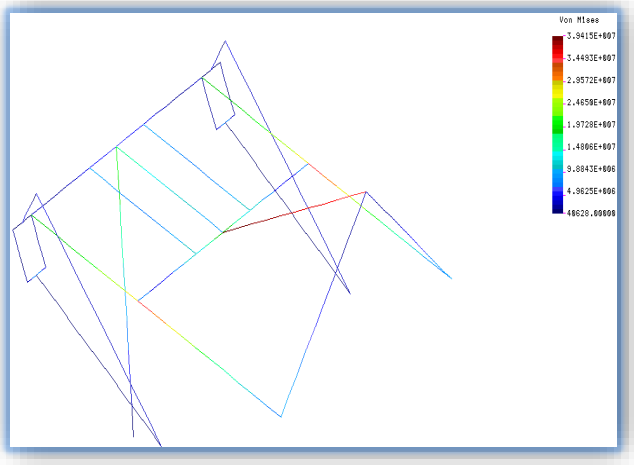

Figure 2. Map of equivalent stress in structural model of scarifier MAS-65 [N/m^2]

The main excitation source of resistance structure of soil deep loosening machine was identified as its working part which is the interface between resistance structure and soil. Therefore, in structural model, the excitation forces were directly applied on the beam simulating the machine's working part.

At the same time, 14 interest points situated on MAS-65 machine resistance structure were identified, in which strain gauges measuring the specific deformations registered during tests, were placed. A part of measuring points was empirically identified, being situated next to the welded joints between the resistance structure components. As it was used a structural model with unidimensional elements, the strain gauges measuring direction were along the components symmetry axis and where it was possible, an additional strain gauge perpendicular on this direction, was installed. In order to perform the tests in laboratory and in the field, a number of 14 LY11-6/350 strain gauges, manufactured by Hottinger company were applied, having the base of 6mm and resistance of 350 Ohmi, factor k=2.03 ±1.0%, transversal sensibility -0.1%. The amplifying modulus used for measuring the specific strains was of QuantumX 1615 type, with 16 amplifying channels. Results of measurements have been registered within ASCII-type files , representing by columns the time information and value of specific strain registered for each point.

In order to obtain the real stress spectrum of MAS-65 soil deep loosening machine, there were identified the machine usual operating conditions.

Thus, for taking the field samples, the following extreme working parameters were established:

- *Working depth 50 cm;*
- *Displacement speed 2 km/h;*
- *Working width 1.5 m*
- *Rotative speed at tractor's PTO: 540 rot/min*

After analyzing the seasonal operating conditions, an average productity of 150 ha/season, has been identified with an approx. transport distance of the machine of 10 km/day.

Experiments with MAS-65 machine were performed in INMA testing fields, using a 80 H.P. tractor.

RESULTS OF RESEARCH AND DISCUSSIONS

Strain gauges have registered the specific deformation on beams(bars) surface of machine resistance structure. As the structure permanently worked in elastic domain (resistance structure is made of OLT 45, with fatigue stress of 210 MPa), the specific strains turned to tensions according to Hooke law [2].

After processing the data recorded, the table 1 was obtained, where the values measured during work are statistically shown insurance of the air-seeds mixture homogenization.

The geometrical place of structure excitation points have been chosen being its working part and having mounted at its base the M5 gauge, so the signal registered by it is being used for buiding the packages of test signals in laboratory controlled regime. After applying the algorithm of counting the cycles of rainflow type and establishing the relevant characteristics, the data shown in table 2 and figure 3 were obtained. For the counting algorithm, the maximum domain of stress amplitude was divided in 12 intervals, for which the solicitation cycles were counted. Amplitudes shown in table 2 are related to average stress value of -57.392 MPa.

Table 1. The values measured during work

Gauge	Minimum value, MPa	Maximum, MPa	Average value, MPa	Mean square deviation, MPa	Kurt, MPa	Number of cycles/45 sec
M1	26.229	41.905	33.227	3.211	-0.727	1464
M2	-37.564	-8.543	-22.053	5.608	-0.483	1033
M3	-28.663	-11.514	-19.891	3.704	-1.058	1316
M4	-11.439	-1.466	-5.294	1.758	0.433	860
M5	-93.283	-36.913	-57.392	10.734	-0.244	907
M6	-6.758	-1.459	-3.584	1.073	-0.584	1178
M7	3.007	13.759	7.168	2.045	-0.618	1478
M8	10.188	28.61	16.355	3.424	0.283	758
M9	2.709	3.449	3.09	0.116	-0.043	1500
M10	3.351	8.38	6.408	0.707	1.829	1107
M11	-113.039	-44.772	-73.057	12.269	-0.479	1173
M12	5.574	14.094	9.782	1.831	-1.074	1213
M13	-14.154	-4.195	-7.783	1.524	0.838	733
M14	-44.806	-20.198	-28.572	4.718	-0.12	1298

Table 2. The relevant characteristics

In work, in fallow laid field, with vibration		
Number of cycles	Amplitudes	Frequencies
133	2.349	1.333
151	4.698	1.511
107	7.046	1.067
127	9.395	1.267
109	11.744	1.089
131	14.093	1.311
69	16.441	0.689
51	18.79	0.511
20	21.139	0.2
7	23.488	0.067
2	25.836	0.022
0	28.185	0

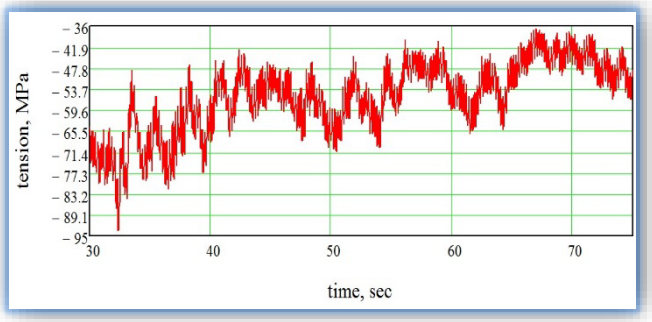

Figure 3. Time evolution of strain measured at machine working part and cycles distribution

Based on data obtained above testing signals packages have been built, which are shown in figure 4, as a sinusoidal sequence of different amplitudes and frequences, easy to reproduced in laboratory.

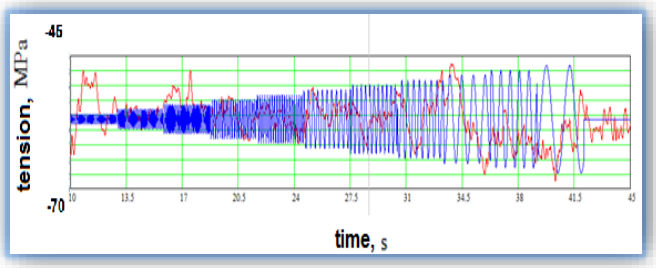

Figure 4 . Package of signals tested by hyropulse (with red -the original signal, with blue-the synthesized signal)

Signals for the command of hydraulic cylinder used for operating the resistance structure of the machine presented in figure 4 were introduced in a programme generated in programming graphical medium LabView , for physically generating as continous current levels, which served as referrence signal for hydraulic actuator used.

In figures 5 and 6 is presented the testing stand of MAS 65 machine resistance structure in simulated regime. It is made of device which simulates the three-points connecting to tractor, two props on which the supporting wheels and a hydraulic cylinder of 100kN, with 200 mm course, lean.

Figure 5 .Testing stand of deep soil loosening machine MAS 65, general view

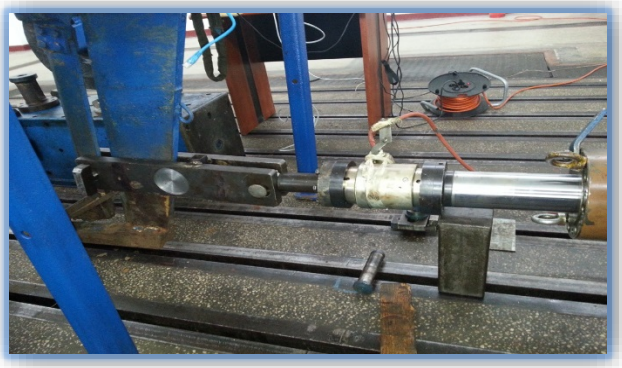

Figure 6 . Testing stand of deep soil loosening machine MAS 65, coupling detail of force cylinder to machine working part

The testing program package obtained for experimental measurements performed in fallow laid field was applied for evaluating the structure response to it. In order to cover the whole span of life of the machine, the synthetized testing program should be repeated 18000 times, which represents the field work of 150 ha.
Results obtained for M5 are shown in figure 7 where can be noticed 4 repetititions of testing program.

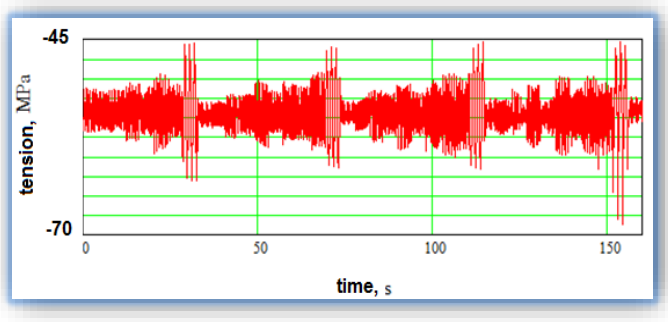

Figure 7. Voltage-time diagram obtained for M5 gauge, after applying the testing program

CONCLUSIONS

- *After analyzing the experimental data, it can be noticed that the strains appearing in measured points represent approximately half of the fatigue limit of material which the machine is made of, thus the material fatigue is very small. Though, the laboratory test should be done for validating a minimum span of life and verifying the quality of joints used.*
- *In order to obtain an optimal acceleration of tests, the testing packages simplified by eliminating the unsignificant cycles out of registered signals, in terms of material fatigue, should be achieved. This can be done by two methods: changing the characteristics of cycles counting algorithm or by directly removing them from testing programs by introducing certain passing thresholds.*
- *Continuing the researches, it will attempt to assess the share of field quality comparing to value of stress amplitudes registered, and if the case is, a combination of working packages will be achieved;*
- *The acceleration test will be chosen related to manufacturer requirements.*
- *The probable span of life of structure subjected to final testing packages will be checked by calculation;*
- *The time repartition of testing stages will be estimated;*
- *For achieving the tests in simulated and accelerated regime of a resistance structure, clear operating stages have to be respected: structural modeling, field tests and laboratory tests. When the structure stress spectrum is known,then the field test stage may be omitted. The engineer has to identify the leaning, fixing and excitation points of the structure so that the test does not determine abnormal behaviors of tested equipment. When these phenomena appear, then measures for diminishing them will be taken.*
- *Laboratory tests will not totally describe the field situation, because of constraints related to testing stand, testing equipment limitations, as well as the lack of certain factors (soil) or appropriate operating conditions (e.g.,speed, acceleration, elements in rotation movement). Though, they represent a valuable instrument for engineers due to precious information given in a short period of time on equipment structural integrity, its reliability, etc.*

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COMPARATIVE ANALYSIS OF THE THERMAL CONDUCTIVITY COEFFICIENTS OF ENVIRONMENTALLY FRIENDLY BUILDING MATERIALS

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Abstract: The present paper represents a comparative analysis of the experimental results, observed by determination of thermal conductivity coefficient of environmentally friendly building materials made of clay (gray marl), sand and different quantity of straw. The thermal conductivity study was carried out by using of two different methods – method of infinite flat plate with "D-r Bok" stand and modified transient plane source method with thermal conductivity analyzer CTherm TCi. The comparative analysis of the results, obtained from the both apparatus, shows that there is a good repeatability of the thermal conductivity values and this is a reason to confirm the good thermal insulating properties of the tested materials. The experimental research established that the studied materials have thermal properties which could be compared with the thermal properties of common materials as lightweight concrete (k=0,1-0,3W/m.K) and ceramic bricks (k=0,6-1,31W/m.K).
Keywords: thermal conductivity, environmentally friendly materials

INTRODUCTION

During the last few years the very topical theme is the refurbishment of old buildings and building-up of new energy efficiency buildings. Some of the reasons which provoke the humanity to start to think in that direction are the global warming of the Earth and as a result the unfavorable climatic changes. Huge part of natural resources is used for energy production and transmission, and this is always accompanied by loading of ecological system and potential risks for the future.

The main indicators that each advanced product designed for industry, transport and households must meet are price, energy efficiency and environmental friendliness. The energy efficiency is the most important since it determinates the possibilities and terms for payment of the product at its future using and the competitiveness of the manufacturing in which it participate.

The use of alternative building materials whose thermal characteristics are comparable with those of the advanced materials is one of the ways to increase the energy efficiency of buildings. A reason these materials to be environmentally friendly is that most of them come entirely from it, this means that they do not pollute it and could be used repeatedly thought working. Other advantages of the alternative building materials are: work with them is time-consuming and it is not needed special qualification to use them; often they could be extracted directly from the place which will be building up, so the transporting emissions are reduced; thermal characteristics of some alternative building materials show that they are applicable at different temperature ranges because they have very good insulating properties [1-4].

From the foregoing it is clear that the ever-changing conditions and requirements of the regulations impose continues search of new solutions [5-7]. According of various manufacturers of building materials, thermal conductivity coefficient of the offered by them products is in wide ranges [8-12]. Linked to the expected massive influx of the environmentally friendly building materials in the practice, it is necessary to control their declared parameters and especially the thermal conductivity coefficient [12-16].

A comparative analysis of the experimental results of thermal conductivity measurements of environmentally friendly building materials is represented. Two methods of measurements were used to determinate the thermal conductivity coefficient - method of infinite flat plate and modified transient plane source method.

METHODOLOGY OF EXPERIMENTAL STUDIES

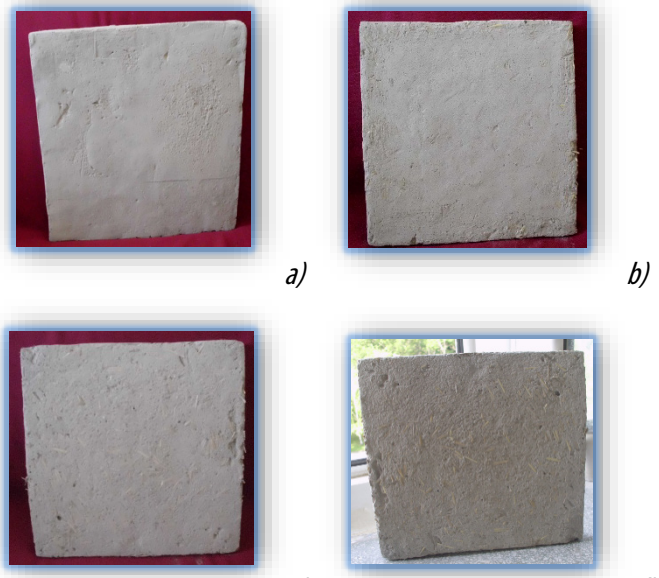
The formulated above problem was solved by measurement of the thermal conductivity coefficient of the environmentally friendly building materials made of clay (gray marl), sand and various amount of straw.

Sample preparation

For the research purpose four flat samples were made with composition as follows:

1st sample – clay with sand (1:2) (fig. 1a);
2nd sample – clay with sand (1:2) and 68 g straw (fig. 1b);
3td sample – clay with sand (1:2) and 102 g straw (fig. 1c);
4th sample – clay with sand (1:2) and 136 g straw (fig. 1d).

Samples were prepared as follows: The clay was dissolved in water, after that the sand was added and the composition was mixed to homogenous mixture. For samples 2, 3 and 4 the defined quantity of straw was added as well. The next steps were: the mixture was cast in wooden mould with length of 0,24m and height of 0,0245 m; the mould was "reversed" on a flat surface and after that removed; the sample was placed to dry at room temperature in ventilated area for 48 hours; the roughness was smoothed with sandpaper to reduce the errors in subsequent measurements.



a) b) c) d)

Figure 1. View of the samples: a) sample 1; b) sample 2; c) sample 3; d) sample 4

Method of infinite flat plate

"D-r Bok" stand was used (figure 2 and figure 3). The stand is used to determinate the thermal conductivity coefficient k in the range from 0,029 to 1,98 W/(m.K) (0.025÷1.7 kcal/(m.h.grad)) of natural and synthetic fine-porosity, porosity and fibre materials.

Figure 2 „D-r Bok" stand

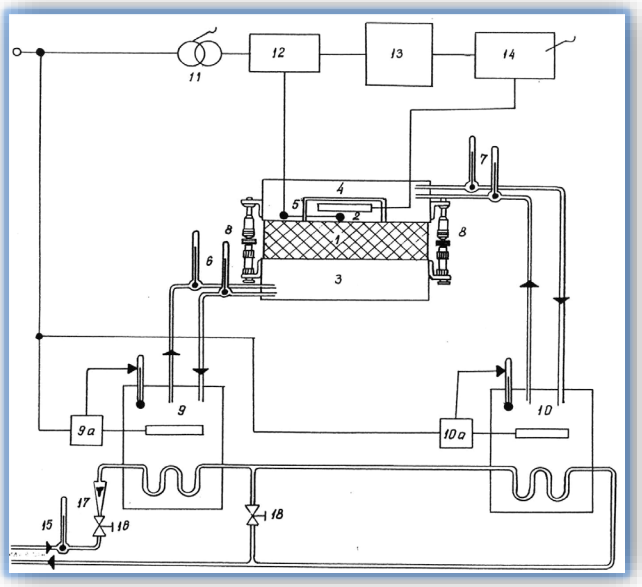


Figure 3 . Principle scheme of "D-r Bok" stand
1. Sample; 2. Hot plate; 3. Cold plate; 4. Protective plate; 5. Temperature sensor; 6. Thermometers on the cold plate; 7. Thermometers on the protective plate; 8. Micrometers; 9. Thermostat for the cold plate; 9a. Thermoregulator to 9; 10. Thermostat for the protective plate; 10a. Thermoregulator to 10; 11. Transformer; 12. Two-position regulator; 13. Electric meter; 14. 12-points potentiometer; 15. Thermometer for cooling water; 16. Valve for cooling water; 17. Rotameter for cooling water; 18. Bypass valve

Principle of stand operation – the sample (1) is put between two flat plates with different temperatures – hot plate (2) and cold plate (3). The hot plate keeps constant temperature by supplying electricity. The temperature of the cold plate is kept constant by heat removal through the water. The hot plate is covered by protective plate (4) with the same temperature and as a result the heat losses to the surrounding space are prevented and the heat flow is directed to the specimen. Thus, at quasi-stationary mode, the supplied electrical power to the hot plate is proportional to the heat flow to the specimen, figure 3.

Modified transient plane source method

A thermal conductivity analyser CTherm TCi was used (figure 4). The apparatus has a wide range of measurement of the thermal conductivity (k=0-220 W/(m.K)) at temperatures from -50 °C to 200 °C. It allows precise measurement with an accuracy of ±1%. The test time is in 5 seconds. Tested material could be in form of solids, fluids, creams or powders.

Figure 4 . Thermal conductivity analyzer CTherm TCi

Principle of analyzer operation – the sensor is placed on the specimen. Current is applied to the heating element of the sensor and the required amount of heat is produced. As a result, the temperature on the boundary surface between the sensor and the specimen is increased. This temperature increasing causes a change in the voltage drop on the sensor. The velocity of increasing the sensor's voltage is used to determinate the thermal properties of the tested materials. Thermal physical properties of the material are inversely proportional of the velocity of increasing the sensor's voltage. Specialized software is used to process the results of the measurements [17].

EXPERIMENTAL RESULTS

On the base of above described experimental procedures for both apparatus 5 experiments on the "D-r Bok" stand and with the thermal analyzer CTherm were carried out. The results are shown below.

According to the references [13-15], thermal conductivity coefficients for clay, sand and straw are as follows: dry to wet clay - $k_{clay} = 0,15 \div 1,8$ W/(m.K) [14]; sand with 10% humidity - $k_{sand} = 0,97$ W/(m.K) [15]; straw no matter direction of the stems - $k_{straw} = 0,048$ W/(m.K) [13]. It was concluded that the thermal conductivity coefficient of the new composite material - object of the present research, will be within the measurement range of the both apparatus.

Experiment № 1

For calibrating the "D-r Bok" stand an experiment with a glass specimen was made. Thermal conductivity coefficient of the glass is known – $k_{glass} = 1,15$W/m.K [14]. The glass probe was with thickness of 0,015 m (figure 5).

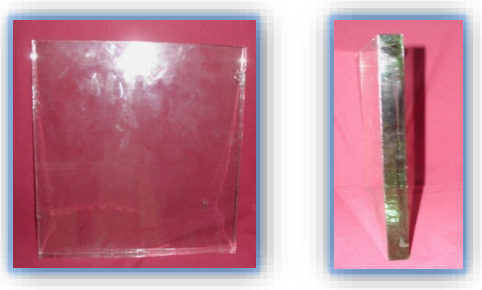


Figure 5. Sample - glass

The specimen was placed between the hot and the cold plates. All contact surfaces were properly cleaned beforehand. By using the micrometers (position 8, figure 3), the thicknesses in the fourth middles of the glass were measured. After that the protective plate (position 4, figure 3) was placed on the plates.

When the stand was in its established mode, it was performed reading of the ambient temperature, the temperature of the cooling water from the water-main, the stand electrometer and the temperatures on the inlet and outlet of the cold and of the protective plates on every 30 min. during period of 2,5 hours. According to the measured values the thermal conductivity coefficient of the glass was calculated. The obtained coefficient of thermal conductivity was $k_{glass} = 1,115$ W/(m.K).

Experimentally obtained value of the thermal conductivity coefficient of the glass is near to the table one (the difference is in 3%), therefore the stand is in proper working condition and the tests of the specimens made of the environmentally friendly mixtures could start.

Experiment №2

The object of study of the second experiment was a sample of clay and sand (figure 1, sample 1). The test was carried out following the same procedure as it was described in the first experiment. The result was k=0,561 W/(m.K).

Experiment №3

The object of study of the third experiment was a sample of clay, sand and straw (figure 1, sample 2). The test was carried out following the same procedure as it was described in the first experiment. The result was k=0,436 W/(m.K).

Experiment №4

The object of study of the fourth experiment was a sample of clay, sand and straw (figure 1, sample 3). This test was carried out following the same procedure as it was described in the experiment №1. The result was k=0,253 W/(m.K).

Experiment №5

The object of study of the fifth experiment was a sample of clay, sand and straw (figure 1, sample 4). This test was carried out following the same procedure as it was described in the experiment №1. The result was k=0,228 W/(m.K).

On the same specimens were carried out similar tests with thermal conductivity analyzer CTherm TCi.

For experiment №1, the glass specimen with thickness $\delta_{glass} = 0,015$ m was placed on the sensor of the analyzer. It is necessary the sensor and the specimen to be in thermal equilibrium, only then the contact resistance between them is zero. The measurements were made in 20 points and after software processing the results obtained were averaged. The result was $k_{glass} = 1,18$ W/(m.K). Experimentally obtained value of the thermal conductivity coefficient of the glass is near to the table one (difference is in 3%), therefore the analyzer is in proper working condition.

Experiments with numbers 2, 3, 4 and 5 on specimens from 1 to 4 were carried out similar to the first one.

The results obtained from the measurements by both methods were represented in table 1.

***Table 1.** Experimental results obtained from testing of environmentally friendly building materials made from clay, sand and different amount of straw*

Sample №	δ m	ρ kg/m^3	k_1 W/(m.K)	k_2 W/(m.K)
1	0,0240	2000	0,562	0,498
2	0,0241	1877	0,436	0,379
3	0,0245	1737	0,254	0,241
4	0,0247	1683	0,228	0,219
glass	0,015	2600	1,115	1,18

Symbols

δ – average value of the specimen thickness, m;

ρ - density, kg/m^3; k – thermal conductivity coefficient, W/(m.K);

The analysis of results shows that with increasing the quantity of straw the thermal conductivity decrease. That means that material

with greater quantity of straw has better thermal insulating properties.

CONCLUSION

On the base of the carried out experiments and obtained results for thermal conductivity coefficient of environmentally friendly building materials made of clay (grey marl), sand and various quantity of straw the following conclusions could be made:

1. The thermal conductivity coefficient of a specimen made of clay and sand is k = 0,562 W/(m.K) when "D-r Bok" stand was used and k = 0,498 W/(m.K) when thermal analyser CTherm TCi was used. The difference in results is caused by the using of totally different methods of measurement but they are comparable and commensurable.

2. Depending on the amount of the added straw to the clay and sand mixture the values of the thermal conductivity coefficient, obtained by "D-r Bok" stand, are: at the lowest amount of straw (68 g) - k=0,436 W/(m.K) and at the highest amount of straw (136 g) - k=0,228 W/(m.K). The same specimens, tested on the thermal conductivity analyzer CTherm, gave the following results: k = 0,379 W/(m.K) and k = 0,219 W/(m.K). The conclusion could be made is that with increasing the quantity of straw thermal conductivity coefficient decrease. That means that the tested materials become better insulating properties.

3. The comparative analysis of the results, obtained from the both apparatus, shows that there is a good repeatability of the thermal conductivity values and this is a reason to confirm the good thermal insulating properties of the tested materials.

The conclusions made above and the experimental study of the thermal conductivity coefficient are the basis for confirmation the possibilities for good application of the tested environmentally friendly building material on places where the advanced thermal insulating materials are not applicable.

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MOLYBDENUM BLUE METHOD DETERMINATION OF SILICON IN AMORPHOUS SILICA

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Abstract: The determination of Silicon (Silica) in materials using the Molybdenum blue reaction was studied. The UV-Visible spectrophotometer scanning for the silicon molybdenum blue reaction was studied between a wavelength of 400nm and 800nm. The instrumental analytical procedure applied consists of four basic parts: the sample pretreatment, the instrument adjustment, the calibration and measurement and the calculations. The instrument was optimized using standard solution of $KMnO_4$ with conventional calibration method applied. The performance characteristics of the spectrophotometer at a wavelength of maximum absorption (λ_{max}) of 825 ± 5nm for the silicon-molybdenum blue analysis are observed. The procedure was applied to amorphous silica produced from glass sand and the findings were observed to correspond with existing standard.
Keywords: Molybdenum blue reaction, Performance characteristic, Instrument optimization, Silicon

INTRODUCTION

Silicon analysis is of great importance in environmental and industrial monitoring application. Its presence in material is usually estimated by calorimetric (spectrophotometric) method. The overall high concentration and strong tendency to form stable silicides with many element makes silicon a very important material (as impurity) in high purity materials. For similar reason, its determination at trace levels have been documented to be difficult [6].

A very sensitive method in which silicomolybdic acid is formed and then reduced to molybdenum blue is now used for the determination of silicon in trace amounts in materials e.g. sea water, potable water, biological samples and other materials. Several procedures have been published for the determination of silicon in different materials using the molybdenum blue method as reported in literature [1,3,8,11,12]. The variations can be seen in the sample dissolution, conditions of the silicomolybdic complex formation and reduction, reducing agents and other reagents.

The molybdenum Blue Silicon method in conjunction with a UV-visible spectrophotometer is a standard analytical method [7] with Association of Analytical Chemist (AOAC) approval [12]. It is easy, especially after reducing the yellow molybdic acid to the blue thus forming a stable complex that allows for sample analysis and direct determination.

Methods suitable for detailed description in an analytical procedure are either non-instrumental or makes use of instruments that are easily adjustable. Methods for the determination of trace amounts of analyte, lack the necessary sensitivity that must be replaced by relative methods of analysis. This typically involves the measurement of a physical property that through comparison with known reference solution is then converted to a value for the concentration of the component to be determined in the sample [12].

UV-Visible spectrophotometer is a good example of a relative method of analysis. It requires an instrumental adjustment (optimization) that can be easily described and is usually not very critical consequently; the measured absorbance is nearly independent of the instrument used. Remaining minor variations between different instruments can usually be accounted for in the calibration graph prepared from reference solutions [12].

MOLYBDENUM BLUE METHOD

The acidification of solutions having molybdate ion and silicate form a yellow crystalline precipitate known as molybdosilicate (silicomolybdic acid) [1,9,11]. When there is selective reduction, using reducing agents such as hydrazinum sulphate , 1-amino-2-napthol-4-sulphonic acid [11] and others, a blue color is produced due to Molybdenum Blue of uncertain composition.

The intensity of the blue color is proportional to the amount of silicate initially incorporated into the heteropoly acid. This is the basis for the use of the Molybdenum blue method in quantitative and qualitative analytical technique [8].

This is peculiar to hetero atoms whose ion forms heteropoly acids such as tungstate, Phosphate, germante and arsenate. These heteropoly acids may be present as interferences and must be suppressed by introducing masking agents such as oxalic acid, citric acid and tartaric acid [3, 6].

This work presents the determination of the silicon in the amorphous silica produced from glass sand and characterized by a metallurgical

microscope, XRD & EDXRF [10]. Considering the fact that, a standard analytical method is needed for the determination, it was subjected to the silica-molybdenum blue reaction using ascorbic acid as the reducing agent and analyzed using the UV-Visible spectrophotometer. The UV-Visible spectrophotometer was optimized using $KMnO_4$ as a standard carried out with the normal calibration method [2].

MATERIALS AND METHOD

Safety

The Material Safety Data Sheet (MSDS) for the detailed information and safety precautions for all the chemical reagents used in addition to the appropriate safety sections in the instrument manual was reviewed and applied.

Reagents

Silicon Standard Solution was used in Atomic Absorption Spectrophotometer (AAS) Standard. Acidified Molybdate Solution of Analytical grade was formed by diluting Ammonium Molybdate $(NH_4)_6Mo_7O_{24}.4H_2O$ in HCl. This solution was prepared fresh each day. Ascorbic acid, Oxalic acid solution (5% $^m/_v$), Glycerin solution (1% $^v/_v$) .All the reagents used are of an analytical grade. The sand used in this work is the glass sand sourced from Igbokoda, Ondo State, Nigeria. Amorphous silica was produced from this sand by fluxing the acid-washed sand with NaOH at an elevated temperature in furnace specifically designed and developed for this work, which produced a yield of 82.5%.

Apparatus/Instrument

UV-Visible spectrophotometer, 1cm quartz cell and a wavelength range of 190 – 1100nm.

Procedure

All reagents having silicon was stored in a polyethylene container. Also all glassware was treated with acid to avoid introduction of silicon and all reagents were prepared using silicon-free deionized water.

Blank solution: The blank solution was prepared by pipetting 1ml of acidified ammonium molybdate solution, 5ml of oxalic acid solution. 1ml of ascorbic acid, 1ml of 1% ($^v/_v$) glycerin and made up to mark with silicon-free deionized water.

Standard working solutions: silicon molybdenum blue mixtures containing 0.1, 0.2, 0.4, 0.6, 0.8, 1.0 $mgdm^{-3}$ of the standard silicon stock solution was made by dilution method after pipetting appropriate aliquot of the stock for a 5 $mgdm^{-3}$ concentration and reacting with other reagents as in the blank.

Scanning of the spectrophotometer with silico-molybdenum reaction [Determination of λ_{max}]

6ml standard silicon stock solution was measured. 3ml of acidified ammonium molybdate (yellowish in color) was added. After 5mins, oxalic acid, ascorbic acid, and glycerin solutions were sequentially mixed in a predetermined order and proportion. The mixture was made up to 100ml mark with deionized water and immediately transferred into a polyethylene container and left for 20mins for blue color development.

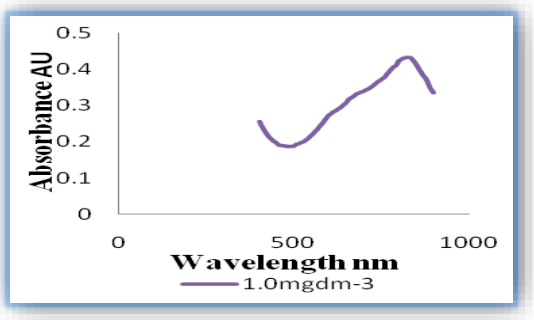

Figure 1: Spectrum of Molybdenum Blue reaction at 825±5nm

The mixture was introduced into 1cm quart curette of the spectrophotometer and scanned between 400 – 800nm wavelength. The blank solution was used to establish a baseline in the instrument. A fit of absorbance against wavelength gave the spectrum of the reaction as shown in Figure 1.

Spectrophotometric determination of silicon in amorphous silica using molybdenum blue reaction

0.1000g of the silica was weighed accurately into a porcelain crucible in a fume hood. 1ml of water and 2mls of hydrofluoric acid (HF) was introduced into the sample drop-wise. The mixture was gently swirled until dissolved in accordance to Vogel [8].

3ml of acidified ammonium molybdate was added to the dissolved sample. After 5mins, 5ml oxalic acid, 1ml of 0.04m ascorbic acid and 1ml of 1% glycerin solutions were added one after the other. The mixture was made up to 100ml mark with deionized water and immediately transferred into a polyethylene container and left for 20mins for blue color development.

The absorbance of the sample was measured at ≈ 825 ± 5nm against a reagent blank sample. The corresponding silicon concentration of the amorphous silica sample was deduced from the calibration curve by interpolation and the percentage silicon was calculated.

RESULT AND DISCUSSION

The absorption spectrum for the molybdenum blue reaction showed maximum absorption (λ_{max}) at 825 ± 5nm. The scanning of the instrument gave standard results as shown in Table 1.

Table1. Normal Calibration Data for Standard results at 825 ± 5nm

Absorbance (AU)	Concentration ($mgdm^{-3}$)
0.000	0.0
0.027	0.1
0.141	0.2
0.201	0.4
0.258	0.6
0.350	0.8
0.433	1.0
0.520	1.2
0.606	1.4
0.693	1.6
0.866	2.0
0.930	4.0
0.970	6.0

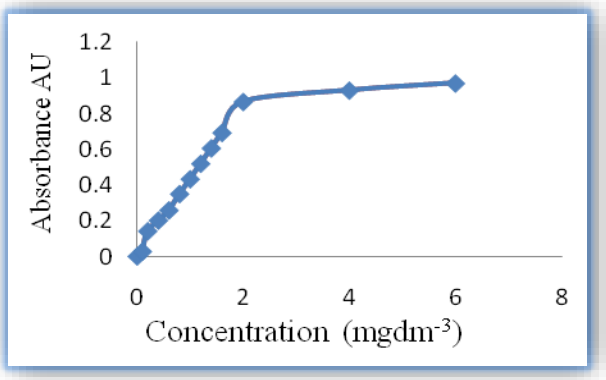

Figure 2 . Graphically illustrates of the normal calibration data for standard results at 825 ± 5nm

Microscopic analysis of the silica showed a resolved 2-D imaging at a magnification of 200x of a particle size of 1.5um agglomerates on drying (Figure 3a). X-ray diffraction pattern showed diffraction maxima 25⁰ and base width between 22⁰ and 30⁰ (2θ2) and the quantitative analysis of the elemental composition (Figure 3b) was done by using Energy Dispersive X-ray florescence model [XR–100CR] following a standard technique [10].

Figure 3(a): Optical Micrograph of the particles of silica gel at magnifications of 200X viewed using metallurgical microscope (AP2000 MTI). The micrographs showed that the particle sizes are on a micro particle scale of about 1.5um. The shape of the particle was found to be uniform and agglomerated.

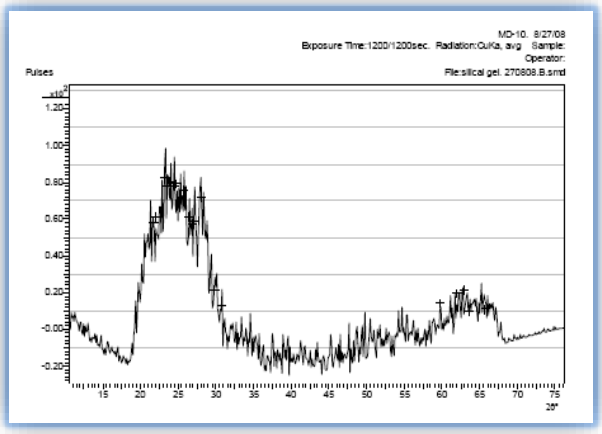

Figure 3(b): XRD diffractogram (MD 10) of amorphous silica

A linear correlation was obtained between concentration and absorbance giving a linear range of 0.00 - 2.00 mgdm^{-3} was observed from the plot in Figure 2 above. The slope of the calibration curve was determined to give the sensitivity of the instrument for silicon determination as 0.438AU mg^{-1}dm, with a molar absorptivity of 3.540 x 10^{-7} AU mol^{-1}dm^{3}cm^{-1}. The detection limit is calculated by analyzing a 0.4 mgdm^{-3} standard and reagent blank 8 times. Using 3 times the standard deviations D_L = (n, 3s.d) confident limit, giving a detection limit of 0.002 mgdm^{-3}. The concentrations of the standards were chosen such that their absorbance bracketed the absorbance of the sample. By interpolation, the concentration of the sample with absorbance 0.427 AU and 0.219 AU gave 0.99mgdm^{-3} and 0.49mgd^{-3} respectively.

The wavelength of maximum absorption (as shown in Figure 1) was taken as 825 ± 5nm. This was because the absorption peaks for the reaction appeared for some reaction mainly between 820 - 830nm and average was taken. It was also observed that with different Ammonium molybdate $(NH_4)_6MO_7O_{24}4H_2O$ having different assays, different points of maximum absorption can be obtained e.g. Fisher product gave 815nm and AVIS chemical gave 825±5 nm. This corresponds to reported range in literature. It changes color and throws down precipitate after 1 or 2days and so must be prepared fresh before use daily.

Preparations of the standard solution of the molybdenum blue are better done by dilution method. This is due to variations in the absorbance which could be caused by pH considerations and colloidal formations when direct preparations are made.

CONCLUSION

After thorough investigation in this work, it was observed and concluded that the UV-Visible spectrophotometer determination of silicon using the molybdenum blue reaction provides a standard method of confirming the presence of silicon in materials.

This work will therefore provide more literature for silicon determination and given a good understanding and behavior of the Ammonium molybdate produced by different sources.

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HYBRID POWER SUPPLY SYSTEM

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Abstract: *Hybrid power supply systems in the recent time are used in everyday life, primarily because humanity turns in exploitation of renewable energy sources, as well as the reduction of fossil fuel reserves, where most of the electricity produced is based. The hybrid power supply system in its most general form includes the following components: photovoltaic systems, wind generator, diesel generator, a system for energy storage (batteries), grid connection, and power converters through which is perform the conversion of electrical energy and power suppling. This paper will provide an analysis of the operation and viability of a hybrid power supply system, modeled in software package HOMER.*
Keywords: *renewable energy, hybrid power supply system, energy efficiency*

INTRODUCTION

The energy crisis, which is reflected in the increasing prices of fossil fuels, raises the question of ensuring the safety and operation of power systems ranging from small communities, cities, regions and even countries. The growing energy demand lead to the introduction of energy saving measures, implementation of energy efficiency policies and the need for renewable energy sources, which are the foundation of sustainable development in meeting energy demands.

The main energy sources in the twentieth century were nonrenewable energy sources: coal, oil, natural gas and nuclear energy. Two main problems of non-renewable energy sources are the facts that have them in limited quantities and that pollute the environment. The burning of fossil fuels releases large amounts of CO_2, which caused global temperature increase on Earth. Nuclear fuels are not dangerous for the atmosphere, but the resulting products of nuclear reaction remain radioactive for years, and should be stored in separate rooms. Renewable energy sources represent an inexhaustible natural form of energy that is all around us. The concept of renewable energy sources means energy sources that can be found in nature, and it can be renewed completely or partially. Natural and technical potential of renewable energy sources is sufficient to satisfy the overall energy requirements of the world's population, because their natural daily potential is 20 000 times higher than the daily consumption of nuclear and fossil fuels. Renewable energy sources there are in huge amount, but the current technology development does not allow complete reliance only on them.

Hybrid power supply systems, in the recent time, are used in everyday life, primarily because humanity turns in exploitation of renewable energy sources, as well as the reduction of fossil fuel reserves, where most of the electricity produced is based. The hybrid power supply system in its most general form includes the following components: photovoltaic systems, wind generator, diesel generator, a system for energy storage (batteries), grid connection, and power converters through which is perform the conversion of electrical energy and power suppling [1].

As an example of softwere/programe which can analyse all aspects of benefits/disadvantages of a hybrid power supply system, such as cost-effectiveness of the system, designing, electricity production, the losses in the system, is described HOMER, software that was developed by NREL-a (National Renewable Energy Laboratory) and represent a computer optimization model for distributed generation of electricity.

The paper describes a concrete example of a hybrid power system that aims to provide power consumers (residential units) at the site of Sarajevo. The system is designed as an "off-grid" configuration, providing the variant of analysis with connection to the distribution grid.

THE CONCEPT OF THE HYBRID SYSTEM

As it noted earlier, the most widely used configuration of the hybrid power system is one of a combination of electricity sources represented by blocks of wind generator, photovoltaic modules, diesel engine as an additional source of energy and the possibility of connection to the grid through a converter which provide electricity supply to consumers. Block diagram of such a system is shown in Figure 1.

Wind energy is the fastest growing segment of energy production from renewable sources. On a very windy locations, wind farms can produce energy at a cost that is comparable to those in the most economical traditional generators. Due to the advancement in technology, mass production and experience, wind energy is a form

of energy from renewable sources, which will over the next decade give the largest contribution to electricity production. As a good sides of using wind energy stand out the high reliability of plant operation, no fuel costs and no pollution. Bad sides are high construction costs and the variability of wind speeds (can not guarantee the delivery of energy).

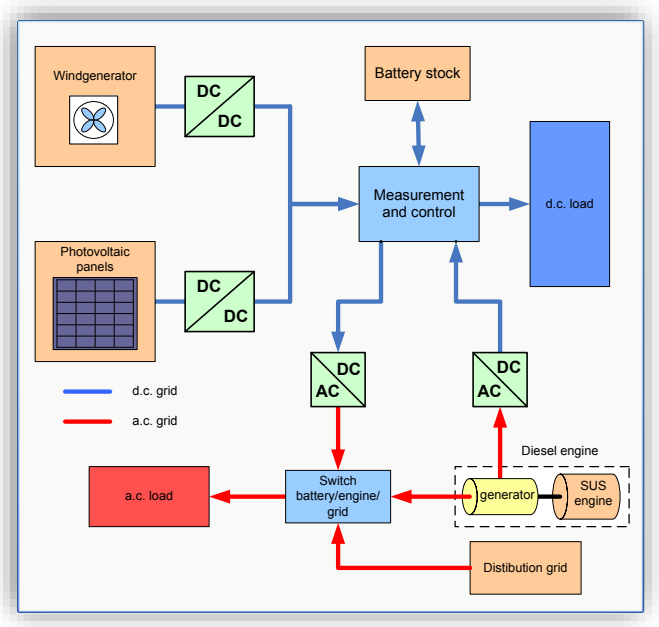


Figure 1. Structure of the hybrid power supply system

Wind generator consists of a wind turbine that converts the kinetic energy of the wind into mechanical energy, and electric generator which converts mechanical energy into electricity. Generators are set at a top of cylindrical or lattice pillar, wherein the rotor of wind turbine and rotor of electric generator mounted on a common shaft, with or without an appropriate gear. Wind generator is designed to give rated output power at the rated wind speed. For wind speeds below the cut-in wind speed, wind turbine is out of work since developed aerodynamic torque is not sufficient to overcome the losses due to friction engines, and to produces usable power. For wind speeds above the rated, power is aerodynamically controlled to maintain output at rated value until it reaches some limiting values of wind speed, known as the cut-off speed, at which point the wind turbine stops. The relationship between power and wind speed is known as the power curve [2,3]. A typical example of the power curve and the power factor of a wind turbine is shown in Figure 2.

The photovoltaic system is an integrated set of photovoltaic modules and other components, designed so that the primary solar energy directly transform into electricity which ensures the certain number of d.c. / a.c consumers are supplied. For photovoltaic systems connected to the distribution grid, direct current obtained in the photovoltaic modules is converted into alternating current by the inverter, which is connected to the grid, so that beside of supplying the consumers and performs energy exchange with the grid. Design of photovoltaic systems is usually done on the basis of their annual energy produced, which is also a good parameter for monitoring the long-term performance of photovoltaic systems. To predict annual energy production of photovoltaic systems are essential to have reliable models and methods with respect to the stochastic nature of solar radiation and the large number of influencing factors (environmental conditions and system performance).

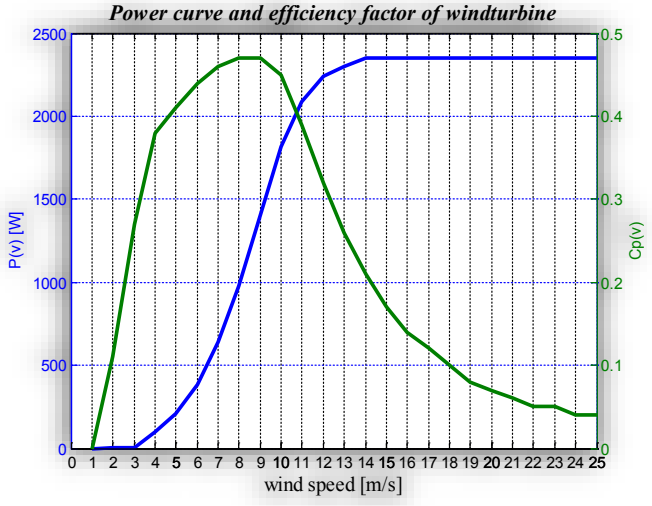
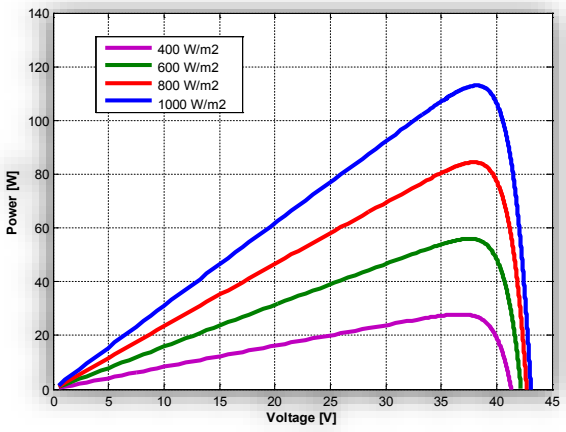


Figure 2. Power curve and efficiency factor of windturbine



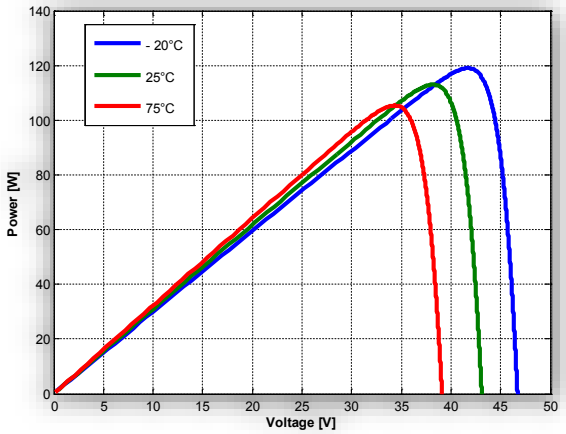


Figure 3. Photovoltaic power curve due to changing the solar radiation and changing the temperature

In order to design a grid connected photovoltaic systems, solar energy resources, environmental conditions, and characteristics of all elements of system must be well acquainted. Estimate of solar energy

resources is based on measurements and calculations based on solar radiation at the surface on which it is planned to set up the panel. In order to estimate system performance, the rated DC power output of an individual module under standard test conditions (irradiation of 1 kWh/m^2, air mass ratio AM 1.5, cell operating temperature 25^{o}C, modules completely clean) can be used at the beginning of process [3]. In real operating conditions, output power of photovoltaic system delivered to the grid is less than the d.c. output power of modules at standard conditions due to losses regarding conversion efficiency.

An example of the photovoltaic power curve due to changing the solar radiation and environmental conditions (temperature) is shown in Figure 3 [4].

APPLICATION SOFTWARE TOOL »HOMER« IN THE DESIGN OF HYBRID SYSTEMS

HOMER is the computer optimization model for distributed generation of electricity, which simplifies the task of self-assessment of cost effectiveness or grid modeled hybrid system composed of non-renewable and renewable resources. It is developted by NREL (National Renewable Energy Laboratory) at 1993. [5,8]

Over designing process of distribution grid (energy system), it is necessary to make many decisions about the configuration of the system itself. A large number of technology options and variations in technology, prices and availability of energy resources, make it difficult to choose from. Optimization algorithms and sensitivity analysis with HOMER make many possible configurations of the system. HOMER allows the definition of a model with inputs, which describe technology options, component costs, and resource availability. The program uses the entered data to simulate the system configuration, or a combination of component and generates results that are presented as a list of feasible configurations sorted by price. Simulation results in different tables and graphs help in evaluating and comparing configuration according to their economic and technical values. During the investigation of the impact/effects that make changes caused by factors such as the availability of resources and economic conditions on the cost-effectiveness of different system configurations, software performed a sensitivity analysis. When performing sensitivity analysis, HOMER requires information about the values that describe the extent of changes in the availability of funds and the price components. HOMER simulates each system configuration based on these inputs. The results of the sensitivity analysis to identify the factors that have the greatest impact on the design and operation of the system. HOMER calculates the energy balances for each configuration of the system under consideration. Specifies whether the configuration is feasible, ie. it can meet the requirements of the users, and estimates the cost of installation, operation and maintenance of the system in the lifetime of the project.

For most users, the hybrid system financial return on investment is an important indicator in the decision to invest in the project. Significant funding for the initial investment, and sometimes they are a major obstacle to the decision to invest. Therefore, optimizing the system is a key prerequisite for achieving financial viability of the hybrid system. Optimization procedure was carried out so as to form a model of the system in the software package HOMER who will be making a comparison or evaluation of small hybrid (energy) systems that can be connected to a grid or to work completely independently (stand alone) [6,7]. In the formed model it will be shown how can provide electricity from renewable sources to the consumer, and provide cost-benefit analysis if the resulting energy is used for the needs of consumers or sold to distribution companies.

For the use and formation of the model in HOMER, it is necessary to entered the input data describing the choice of technology, the price of available components, and energy resources into model. In this way it is possible to compare the economic and technical parameters of various combinations of the hybrid system with the aim of selecting the one that is optimal for specific purposes. For a concrete example, the designing the residential building supplying system on the site of Sarajevo were collected input data on available renewable resources shown in Fig. 4 and 5.

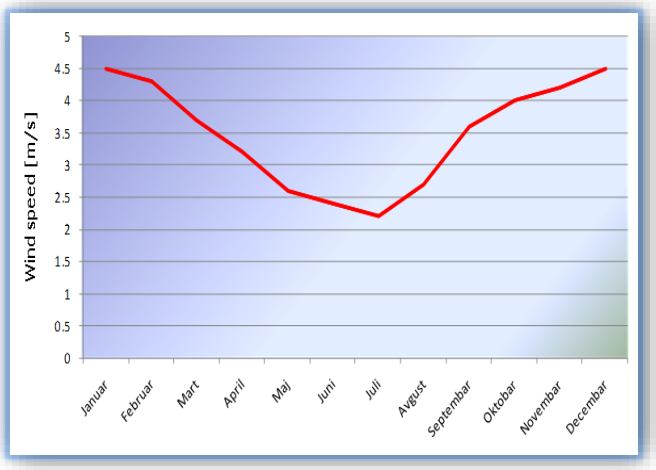


Figure 4. Average wind speed by months

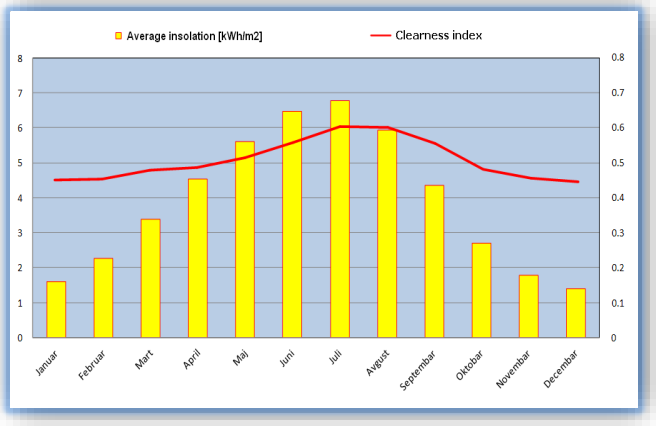


Figure 5. The data on solar radiation at the site of Sarajevo

The data on the average wind speed of 3.5 m/s shall decide on the selection of a low-power wind turbine, whose rated speed was as close as possible to the measured. Measuring height of the

anemometer is located is 10 m, and elevation of the location is 590 m. Height measurement is relatively low, which means that the rate under the dominant influence of surface roughness and facilities nearby. Wind speed at the vertical distance from the ground will bo growing which makes favorable setting up a small windgenerators on higher pillar. The values of mean daily insolation differ significantly in winter months (December 1.41 kWh/m^2) and summer (July 6.77 kWh/m^2), which results in the different production of photovoltaic systems.

Before choosing and sizing the appropriate components of system, it is necessary to know which load the system must satisfy, whether it's the connection object to the grid or on a standalone hybrid system. Depending on the consumer load and the available renewable energy sources are chosen corresponding components of the system. Figure 6 is a diagram presented daily load, which is used in this paper during the simulation of described system.

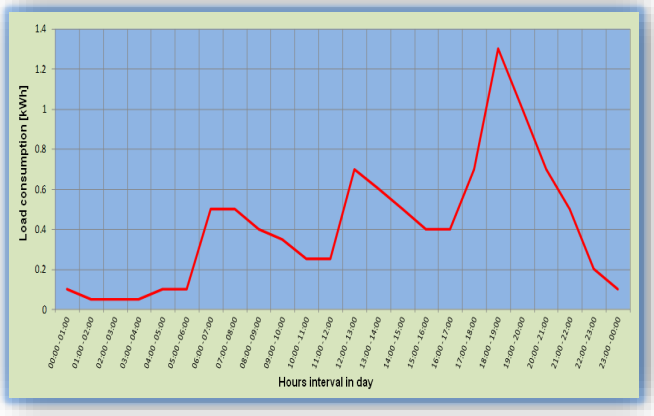


Figure 6. Diagram of the average hourly / daily load

RESULTS ANALYSIS AND DISCUSSION

Based on the analysis of the input data, it is established a model of the system in HOMER (Figure 7), which consists of the following components: photovoltaic panels, wind generator, battery pack, inverter and connected consumer.

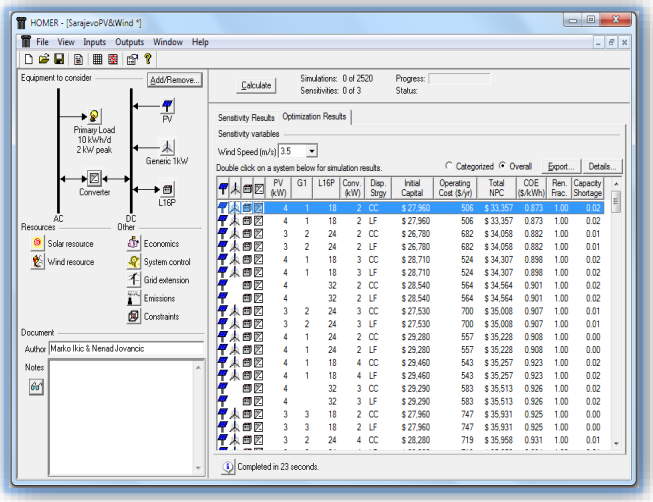


Figure 7. Results of optimization system configurations sorted by the total costs

In Figure 7, in addition to the formed models are presented and the results of simulation/optimization sorted by optimal selection of components in relation to the total cost of the system. As the best solution, ie the most cost-effective, software based on optimization model provides the configuration of the system consisting of the photovoltaic panel size 4 kW, a 1 kW wind generator, battery system of 18 batteries connected in parallel, the nominal capacity of 6480 Ah, rated voltage of 6 V and the inverter 2 kW (which in this case is only in inverter mode).

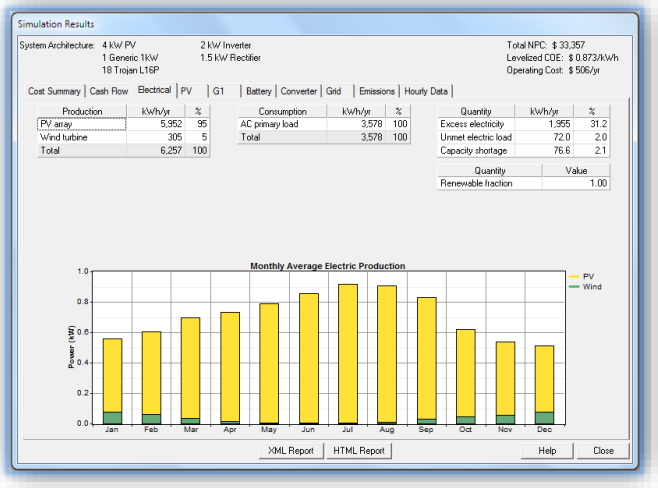


Figure 8. Total electricity generation of the hybrid system

Electricity production from this system, based on the given input parameters, is plotted in Figure 8. The total value of the electricity produced is 6257 kWh/year, of which photovoltaic panels produce 5952 kWh/year (95%) and a wind generator 305 kWh/year (5%). The required load of the system is 3578 kWh/year so it is obvious that this system meets in the provision of electricity consumers, and even has a possibility that excess energy to the distribution companies selling at prices that are subsidized by the state if there would be access to the distribution grid and thus reduce the time of repayment of formed system.

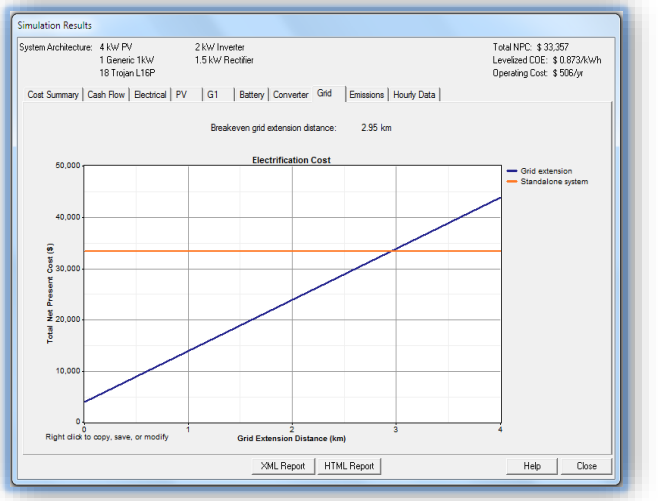


Figure 9. Graphic viability of the hybrid system and the grid connection in relation to the length of connector (fider)

If we look at the profitability of the hybrid system in relation to the possibility of connection of consumers to the distribution grid (where are previously entered data on the costs of connection and the grid price of electricity), as a result of the conducted analysis in the HOMER, is that the hybrid system is more cost-effective if the distance consumers from possible connection to the grid is greater than 2.95 km (Figure 9). In conclusion it can be said that such systems are suitable for power consumers who are more distant from the local distribution grid.

CONCLUSION

In this paper, the use of specific software HOMER in the analysis of work and the cost-effectiveness of hybrid power systems is shown. A brief overview of renewable energy, specifically the solar energy and wind energy, their exploitation and the parameters which are describe and measure them. It is described the configurations of the one hybrid system and its components as well as the benefits and disadvantages of the use in everyday life.

For the analysis of the hybrid system is described HOMER software, that carry out all analysis of the proper work of system, its viability and designing process of its components. From the general results of the system optimization model, it can be noted that this systems should also find their use in everyday life, especially in localities that are "enriched" with renewable energy sources ie. at sites with a high level of insolation and higher wind speeds as well as at the same time it is not anticipated consumer connection to the distribution grid or its implementation is more expensive than the cost of installing a hybrid system.

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ADOPTION OF OPTIMAL TEETH PARAMETERS OF GEROTOR PUMP

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Abstract: Adoption of optimal teeth parameters for gerotor pumps is of great importance and it has a large influence on their operational characteristics. This is the reason why a lot of attention is directed towards their optimization. The working flow of a gerotor pump has been chosen as the topic of optimization in this paper. Taguchi method for ranking gearing parameters related to pump flow has been presented here. Based on teeth parameters influence rank, an optimization is performed by method of linear programming. As a result of optimization optimal teeth parameters are chosen.

Keywords: gerotor pump, Taguchi method, optimization, linear programming

INTRODUCTION

One of the new types of teeth, which could largely replace the involute profile, is the trochoid tooth. The introduction of this type of gearing would greatly enhance functional features such as needed efficiency and service life with minimal weight and overall dimensions. This type of tooth may lead to a reduction in material consumption that would lead to big savings. Another big advantage is the simultaneous trochoidal tooth gear contact resulting in better carrying capacity compared to the gear pairs with involute gears.

Lately, due to the advantages of trochoidal teeth a greater interest of mechanical engineers for their implementation in mechanical systems has appeared. Applications of trochoidal teeth are present in a large number of rotating machines, which are used in a variety of applications: rotary pumps, rotary motors, rotary compressors etc. An excellent application of trochoidal gear teeth has been found in cycloid drives, which belong to a special group of gearing in planetary gears. Considering the characteristics of trochoidal teeth, their development is cost effective [1].

This paper will present the choice of optimal gearing parameters for gerotor pumps. The optimization criterion is the operational displacement of the gerotor pump. Optimal choice of parameters is performed by using the hybrid optimization method on two levels. The first level of optimization is performed by using the Taguchi method, which is determined by the most influential parameter for the teeth on the working displacement of the gerotor pump. The second level is derived by the method of linear programming, where the optimal gear parameters have been derived. At the end of this paper, conclusions and directions of possible research have been made. Both directions of research have been given, to improve the construction of the pump, and to develop a hybrid optimization method.

LITERATURE OVERVIEW

The optimization process is a way to obtain the best solution to the stated problem [2]. Selection of an optimization method for a specific problem involves a solid knowledge of optimization and its methods [3]. Through deliberation of specific methods on the problem of the operational displacement of a gerotor pump, it can be concluded that for the solution of this problem it is necessary to conduct optimization in two iterations.

In order to determine which parameters have the most influence on the operational displacement of the pump the Taguchi method is chosen. The wide spectrum of the Taguchi method's application on optimization problems are given in detail in [4] and [5]. By selecting the Taguchi method it has become possible to attain a hybrid method. In [6-7], the Taguchi method and the evolutionary optimization algorithm have been used on the problem of an automobile door bracket. In this paper, optimization is performed by the criterion of minimum displacement, in order to save on material. Paper [8] presents a procedure for the use of the optimization method that is based on a combination of Taguchi method and an evolutionary algorithm. This paper gives an explanation of why the hybrid method gives better results than the conventional optimization methods.

Hybrid optimization methods are one of the youngest optimization methods. In order to implement hybrid methods, a solid knowledge of the methods themselves as well as the possibilities of their efficient computerized utilization is paramount. Using the Taguchi method, these papers determined the influence of parameters on the objective function. Determining the influence of parameters significantly reduces the spectrum of solutions. By reducing the field of solutions and using another optimization method, the most correct solutions for a given problem can be obtained.

To solve the problem of maximizing the operational displacement of a gerotor pumps, unlike the aforementioned hybrid methods, in addition to the Taguchi method, a method of linear programming has been added [9]. In order to confirm the results of the applied hybridization an experimental comparison with existing data was performed [1].

IDENTIFICATION OF THE MOST INFLUENTIAL TOOTH PARAMETER

Identification of the most influential tooth parameter for gerotor pumps is very important. The reason is the ranking of parameters from the most to least influential on the operational displacement, for choosing a parameter variation degree from which a choice of optimal parameter values can be chosen by further optimization.

Setting the objective function for maximizing displacement

The objective function in finding the most influential tooth parameter of a gerotor pump is the formula for determining operational displacement:

$$q = be^2 \frac{z-1}{z}\left[s^2 - (\lambda z - c)^2\right] \quad (1)$$

Distances from the centers of circular profiles of the center of the trochoidal gears, are calculated using the ratio:

$$s = \frac{r_s}{e} \quad (2)$$

With all the figuring variables explained in the function for determining pump displacement, the next step is determining functional parameters from which the maximal operational displacement of the gerotor pump will be determined.

Determination of functional parameters

Determination of functional parameters that will be subjected to optimization depends on the parameters that will be chosen to be unchallengeable and predetermined before optimization. For fixed-parameter optimization selected values are given in the table 1.

These measures were selected as fixed input parameters because they define the dimensions of trochoidal gears. By defining them at the start the required gross measurements of the pump housing can be obtained. Other dimensions define the operational displacement of the pump, work-life, reliability and other pump parameters. Optimizing the other three parameters leads to a maximization of the operational displacement of the gerotor pump.

Table 1. Fixed parameters

Trochoidal gear width, b	16,46 [mm]
Pump eccentricity, e	3,56 [mm]
Distance of the center of the circular profile to from the center of the trochoidal gear, s	7,57 [mm]
The radius of the root of the external gear, r_S	26,94 [mm]

The table show parameters which will be optimized, are number of teeth and profile coefficient of the trochoid gear: z – number of teeth of the external gear, λ – trochoid radius coefficient, c – equidistant radius ratio.

The variation of the number of teeth z, trochoid radius coefficient λ, and equidistant radius coefficient depend on the limit function.

The methodology developed here can be carried out for optimization of the displacement of any gerotor pump. For the gerotor pump from the paper [1], with which our results will be compared, the restricting functions are as follows:

1. *Number of gear teeth will be included in the set of integers z = {4, 5, 6, 7}. Number of gear teeth is a discrete variable.*
2. *The trochoid radius coefficient, λ, will be in the interval 1 < λ < 2, and will be divided into five parts,*
3. *The equidistant radius coefficient, c, will also be placed at the interval of 2 < c < 6, and it's limit will be discussed later in this paper.*

After defining all the parameters that affect the gearing gerotor pumps, access to determining the type of orthogonal matrices.

Selection of an orthogonal matrix to maximize operational displacement

Selection of an orthogonal matrix for the Taguchi method is based on the number of effective parameters of the objective function. Since the objective function is affected by six parameters matrix selection is restricted to a choice between matrices L8, L18, L32 and L25. Because of the six influential parameters on the gerotor pump displacement a matrix of six parameters with five levels is chosen. This is the L25 matrix. By selecting these orthogonal matrix greater variations in relation to the matrix of lower rank is enabled, between trochoid radius coefficients, λ, and equidistant radius, c, and the number of teeth that was previously defined.

Application of Taguchi method to maximize the displacement

After determining all functional parameters and their limits, they form an orthogonal matrix L25. In an extreme case, a small variation of fixed parameters value can be performed within acceptable tolerances of trochoid. However, due to the nature of the objective function this would not have a significant impact on the result. In the case that the first three columns are not considered in the orthogonal matrix, due to the methods functioning reliable results would not be possible.

After the formation of the basic L25 orthogonal matrix, it is necessary to determine the value of the objective function to five levels of the Taguchi method. Once the objective function S/N ratio is calculated according to the formula that is used to maximize the objective function:

$$S/N_i = -10\log\left(\frac{1}{N_i}\sum_{j=1}^{Ni}\frac{1}{T_j^2}\right) \quad (3)$$

Parameter ranking according to influence

The final operation before finding the influence of variables on the objective function is completing the matrix for ranking parameters. Calculating the matrix elements for ranking parameters is done by calculating average values of elements compared to the position variation of matrix elements [4].

Table 2. Parameter ranking by the impact of gerotor pump operational displacement

Level	λ	c	z
1	45.95	42.61	65.28
2	51.98	48.58	56.27
3	46.21	51.28	47.99
4	55.40	53.55	36.56
5	52.21	55.74	45.66
Δ	9.46	13.13	28.72
	3	2	1

Since only three variables are included in, ranking the objective function of the matrix will be 3x5. The matrix with ranked elements is given in Table 2. Table 2 shows that the greatest impact on the change in displacement, when choosing gearing parameters of gerotor pumps, has the number of teeth of the trochoid gear, z. The following parameter, according to impact, is the equidistant radius coefficient, c, while the smallest impact is from the trochoid radius coefficient, λ. Parameter, z, is a discrete value and is located in the set of previous values {4, 5, … , 13}, while for this particular problem it is in the subset of the set of values {4, 5, 6, 7}, as was noted in the beginning of this chapter. These kind of variables greatly facilitats further optimization, because the objective function can be viewed as independent of each value of the parameter z.

IDENTIFICATION OF THE MOST INFLUENTIAL TOOTH PARAMETER

Optimization according to its general definition pertains to the best and most acceptable solution to a defined problem. Mathematically speaking optimization implies finding a maximum or minimum of a function f(x), which depends on the vector parameters {X_1, X_2, … , X_n} while satisfying the constraint function g(x). Many methods have been developed for solving optimization problems. Depending on the type of problem a method for solving this problem is chosen or a new method is developed. For the task of optimizing the gerotor pump, operational displacement linear programming has been applied.

Optimization of pump gearing using linear programming method

Equation (1) could be subjected to optimization methods using quadratic programming, however in order to simplify the problem only part of the equation will be used (1), depending on which the objective function has a minimum or maximum. Therefore, the new objective function will have the following form:

$$f(x)_{min} = \lambda z - c \tag{4}$$

In this function, the parameter z will belong to a set of values z = {4, 5, 6, 7}. After this declaration, it can be seen that the linear programming optimization process has four iterations. In addition to the objective function for optimization process function limitations must also be defined [1]:

$$c > 2 \tag{5}$$

$$c \le z\lambda \sin\frac{\pi}{z} \tag{6}$$

$$c = z\lambda + 2 - S_{fa} \tag{7}$$

$$c \le z\sqrt{\left(\frac{3}{z+1}\right)^3\left(\lambda^2-1\right)(z-1)} \tag{8}$$

To perform linear programming functions suiting labels must be adapted to symbols which are used in linear programming. The way this is done is described in the following chapter.

Linear programing for z=6

Before the start of linear programming, all functions must be translated into a form that corresponds to the used method. Translating the objective function and the limitation to perform linear programming, for z = 6, is given by expressions:

$$f(x)_{min} = 6x_1 - x \tag{9}$$

$$g(x)_1 \Rightarrow 1 < x_1 < 2 \tag{10}$$

$$g(x)_2 \Rightarrow x_2 > 2 \tag{11}$$

$$g(x)_{1,26} \Rightarrow x_2 \le 6x_1 \sin\frac{\pi}{6} \tag{12}$$

$$g(x)_{1,26} \Rightarrow x_2 = 6x_1 - 5{,}5 \tag{13}$$

$$g(x)_{1,26} \Rightarrow x_2 \le 6\sqrt{\left(\frac{3}{6+1}\right)^3\left(x_1^2-1\right)(6-1)} \tag{14}$$

After transforming to the form which is suitable for the linear programming approach, linear programming diagrams are drawn. The diagram of linear programming for z=6, is shown in Figure 1.

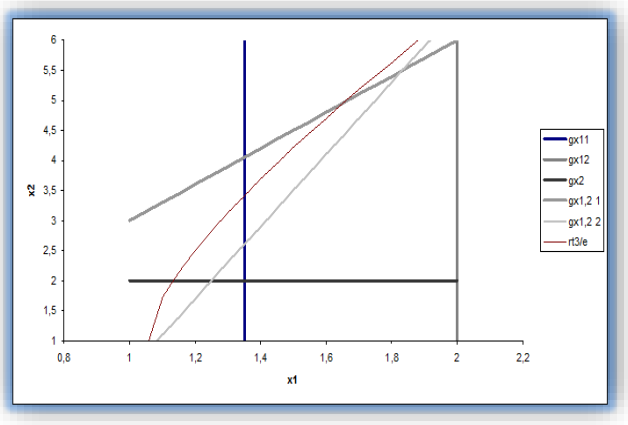

Figure 1. Diagram of linear programming for z=6

From figure 1 the middle of the line which is limited by the function (7) is found. Since the value, Sfa (Sfa=7,5), is also a constant for gear dimensions which are optimized, the function is as shown in (13). By calculating the line the midpoint, obtained optimal values are given in Table 3:

Table 3. Optimal parameters for z=6

z	λ	c
6	1.591	4.049

Optimal solution choice

The last step in the whole process, after four iterations of linear programming, is the choice of an optimal solution according to operational displacement criteria. Based on certain optimal values a table for comparison of working displacement has been formed according to the numbers of teeth (Table 4).

Table 4 shows that according to the criterion of maximum displacement the optimal solution is the combination of teeth number parameters for z = 6 teeth.

Table 4. Optimal solution choice

No. teeth	λ	c	q [mm³]
z=4	1,937	2,250	13290
z=5	1,749	3,247	14181
z=6	1,591	4,049	14772
z=7	No solution		

CONCLUSION

In this study, the two known are methods presented as new hybrid optimization method. The obtained results are compared with the results from paper [1]. By applying, the methods presented here a significant improvement, in terms of increasing displacement has been achieved. The methodology after determining the most influential parameter of the process the Taguchi method can be changed in various directions, that is, choosing other optimization methods for continuing the research.

Further research could include determining, using flow measuring methods, and the operational displacement of a gerotor pump with the newly attained gearing parameters. Experimental verification would confirm these methods.

NOMENCLATURE

Letter symbols:

- *b* Width of trochoidal gear, mm
- *c* equidistant radius ratio
- *e* pump eccentricity, mm
- *N* number of calculated objective functions
- *q* operational displacement of gerotor pump mm^3
- *r* invert of the outer radius of the circle gear, mm
- *s* distance from the center of the circular profile to the center of trochoidal gear, mm
- *S/N* signal to noise ratio
- *T* value of the objective function
- *z* number of external gear teeth

Greek symbols

- *λ* trochoid radius coefficient

Subscripts and superscripts

- *i* trial number
- *j* number of calculated objective function
- *o* outer

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MEASUREMENT OF TORQUE ON THE CARDAN SHAFT EMBEDDED IN THE FREIGHT VEHICLE

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Abstract: Before analysis, development or improvement of existing structure of drive unit or gearboxes, the load that appearing in exploitation must be known. This paper presents a method of load (torque) measurement, on the cardan shaft embedded in the freight vehicle, using strain gages. The aim of the study is to determine torque variation depending on the exploitation conditions (road surface, speed transmission, vehicle load, etc). The measurement was performed for different road characteristics (vehicle movement on flat terrain, up and down the slope). Results are presented using tables and diagrams, and percentage utilization of the power drive unit, embedded into freight vehicle, was calculated based on obtained values of torque. Obtained results have an important role for designers because they give a general insight in the load on the cardan shaft , which represent the basis for future development or redesign of power unit or gearboxes and basis for forming of specter of gear load and bearing embedded into gearbox.
Keywords: torque, cardan shaft, strain gages, freight vehicle

INTRODUCTION

Experimental and scientific researches that precede the development or reconstruction of gearboxes are very significant in terms of improving and complementing the existing results, in order to achieve robustness of the structure. The research may be carried out immediately before the process of development or reconstruction of the product, or it can be carried out later and optionally used for reconstruction. Such an experimental research, was performed in this paper and refers to the measurement of torque on the cardan shaft of the freight vehicle using strain gages.

Measurement of the torque by experimental methods in the vehicles may be performed on the basis of speed measurements of vehicle movement [1], and using sensors embedded in the motor without changing the structure during assembly [2]. In order to define a method of torque measurement that realizes synchronous motors, there are two different methods [3].

Besides the tests on engines, torque measurements on the manual gearboxes [4] and vehicle shafts can be performed [5, 6]. Strains gages are often applied for torque measurement on the shafts and they are very suitable for this use. They are glued to the appropriate places on the shaft so the corresponding stress can be measured. The measured value are transmitted to the sensor circuit where they are compared with calibration data, on which basis torque values are calculated. Strain gages are connected in Wheatstone bridge in order to obtain accurate results of the torques [6]. This paper is a extension of the research started in [7] and [8], through which the model of the gearbox was developed, and which is the basis for analysis of gearboxes.

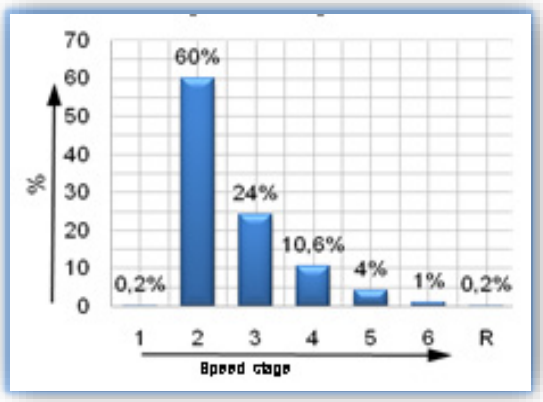
Freight vehicles are applied in almost all parts of the world. This form of transport is at the service of many companies for decades, especially those in mountainous and woods abounding areas. When driving a freight vehicle in different conditions, the driver has a very important role throughout the process. The manner in which he performs the vehicle operation depends on his ability, and therefore use of certain gearbox speeds. It should be noted that the vehicle driving in the same road conditions may not be the same.

ANALYSIS OF WORKING CONDITIONS AND TORQUE MEASUREMENT METHODS

Freight vehicles operate under different working conditions. During the exploitation, the road characteristics and loads are varying, and freight vehicle drivers are also very important. To determine how is changing the torque under different driving conditions and different gearbox speeds, the torque measurement on the Cardan shaft, which is embedded in the freight vehicle FAP 1620, was carried out.

As the freight vehicles used under various road characteristics, the test was made while driving the vehicle on plain terrain as a representative of lowland terrain, up and down the slope as a representative of mountainous terrain, using of appropriate gearbox speeds. For given test, using the method of interview the percentage share of gearbox speeds was obtained (Figure 1).

By analyzing the diagrams of percentage share of gearbox speeds for trucks, we can confirm the assumption that the driving over mountainous terrain mostly uses the lower gearbox speeds, while driving over flat terrain mostly uses the higher gearbox speed.



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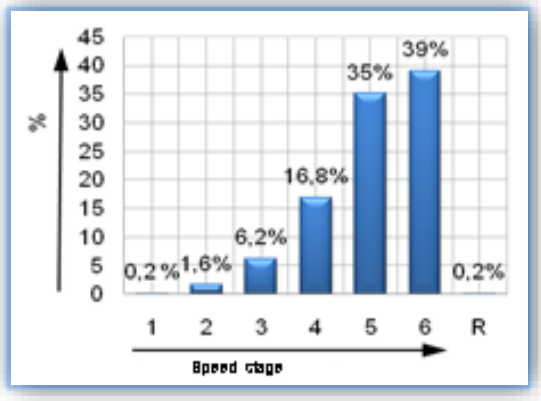

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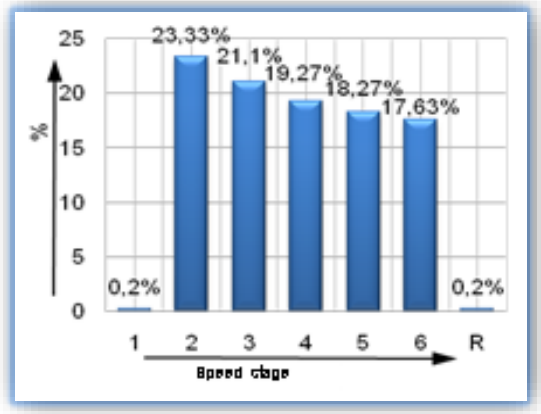


c)

Figure 1. Participation of gearbox speeds in truck drives under various operation conditions: a) mountain conditions, b) flat ground conditions, c) combination conditions

The vehicle (Figure 2) is equipped with six-speed gearbox 6MS-80 and FAMOS engine. The vehicle has been upgraded with vehicle-mounted grapple device for *wood transport.*

The basic parameters of the engine and gearbox are:

Engine

- *Type: FAMOS 2F 131 B*
- *Maximum power – Output: 147 kW/2200 min^{-1}*
- *Maximum torque: 668Nm/1400-1600 min^{-1}*

Gearbox

- *Type: FAMOS 6MS-80*
- *Construction: Synchronous Gearbox, six forward gears and one reverse*
- *Ratio 6,7; 3,86; 2,34; 1,44; 1,00; 0,73, reverse 6,31*

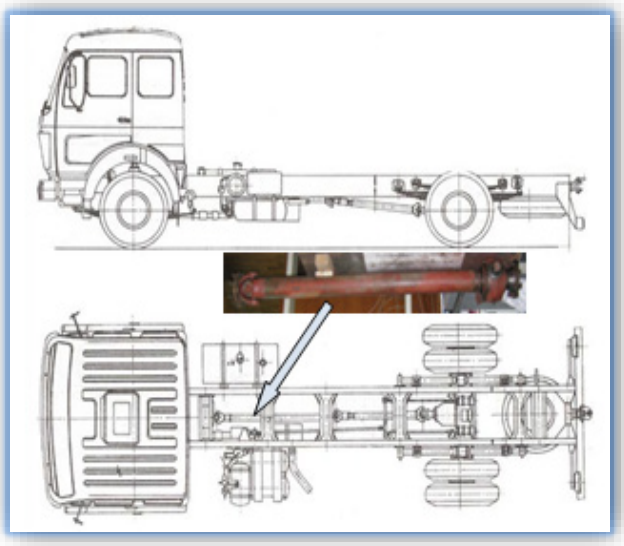
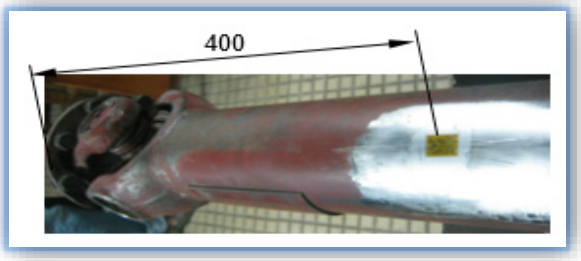


Figure 2. The vehicle for measuring torque brands FAP 1620

Based on a detailed analysis and observing of the possibility for realization torque measurement in all gears speeds for representative driving conditions, the most suitable place on the Cardan shaft was determined. The torque is transmitted via two cardan shafts from the gearbox to the drive shaft, one of which is directly connected to the gearbox output shaft, while on the other side relies on the bearing, whose length is fixed. The other shaft is telescopic and it is connected to the first Cardan shaft on the one side and to the differential transmission on the other side. For reasons of simpler and easier installation of measuring devices to the first shaft, the measurement is performed on it. The measurement was made with strain gages, which were glued on Cardan shaft at a distance of 400 mm from its beginning, i.e. on the side of gearbox (Figure 3a).



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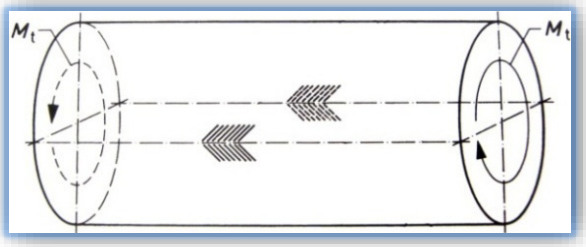

b)

Figure 3. Location of glued strain gage a) glued strain gage on the shaft; b) schematic view of strain gage

Tensiometers (strain gages) are most suitable for this purpose, so that the two strain gages were glued on cardan shaft in the form of herringbone at an angle of 180 degrees (Figure 3b). The strain gage technical data:

- *Tolerance of Temp Compensation α=11·10⁻⁶/°K,*
- *Gage Resistance 120,0 ±0,2%,*
- *K-factor 2,05 ± 1,0 %,*
- *Gage Factor Change with Temperature 95·10⁻⁶/°K.*

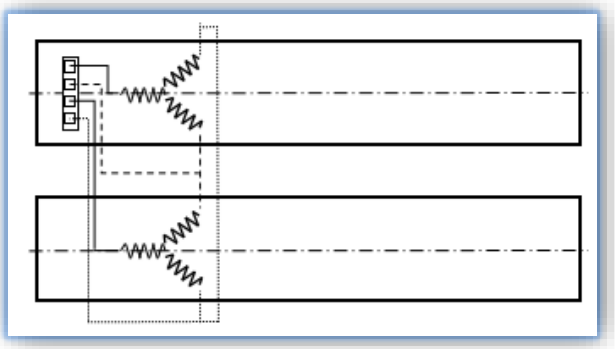

Figure 4. Method of connection strain gages with connectors

Glued strain gages are connected in Wheatstone bridge and the corresponding connectors on which are connected the device for contactless data transfer.

Figure 4 shows method of connection strain gages with connectors.

As a support to the torque measurement, communication module RN41 was used (bluetooth). The connection between the communication module RN41 and strain gages was made using a PIC 16 F 887 which transforms measured values from strain gages in a signal suitable for contactless data transfer to the receiver. Transmitted signals are recorded by a suitable device (Bluetooth for PC) on computer, and then in a suitable form shown. The computer was used for monitoring certain changes that take place on the shaft, and as a basis for visual display and recording of data served a software form Data Logger II v7.0 which is reprogrammed and adjusted for torque measurement. Before of each measurement the value of compensation was entered to avoid possible temperature changes.

The maximum theoretical output torque of the gearbox is less than 6000 Nm, and calibration was performed so that the maximum values that may occur at the output of the gearbox are set on determined value. In addition, the scale where the display range is set, is divided into two parts, so that one part of the bar shows a positive values for the forward movement of a truck, while the second part of the scale is set for showing and recording negative values for reverse movement of the vehicle.

TORQUE MEASUREMENT

Based on the obtained percentage participation of the gear pairs and set the measuring device to Cardan shaft, we have measured torque for unloaded and loaded vehicle for an representative working condition.

The movement of unloaded vehicles on the flat ground

When examining the truck on flat ground,, as a representative for plains driving conditions, were used all gears. From the idle state was launched vehicle first stage of transmission and measured the value of torque in the amount of 2820 Nm (Figure 5).

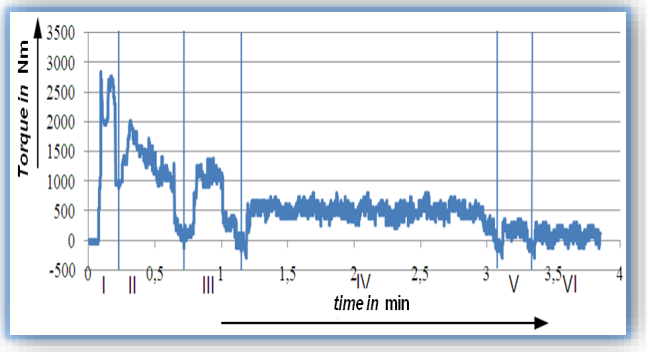

Figure 5. Diagram of the measured torque when driving unburdened freight vehicles using all gear pairs on flat terrain

On the diagram of the measured torque, sudden changes the intensity of the measured values show moments of switching from one gear pairs to another. The diagram also shows that the increase of gear reduces the value of the measured torque. The values of torque on the Cardan shaft were measured in terms of driving unloaded a truck at normal driving conditions (no overload). With the diagram (Figure 5) can be seen that during the long driving one stage of transmission can appearing several times the maximum torques, which shows stochastics driving conditions.

Based on the measured results can be seen that the maximum engine power is used in the driving fourth gear around 83%, while the lowest utilization of engine power when using sixth gear (Table 1). The values of maximum torque for all gears and percentage utilization of engine power when driving unburdened truck using all gears on flat terrain are given in Table 1.

Table 1. The values of maximum torque and the percentage of power utilization using all gears for driving unburdened a truck on flat terrain

Speed stage	*Maximum torque on Cardan shaft [Nm]*	*Engine power efficiency [%]*
First	*2820*	*62.93*
Second	*1940*	*75.15*
Third	*1250*	*82.95*
Fourth	*770*	*83.08*
Fifth	*351*	*54.83*
Sixth	*292*	*53.25*

When switching from one to another gear pairs can see a clear decrease in torque because at that point due to inertia of the vehicle does not appear torque by transmission than by the drive shaft.

The movement of unburdened vehicles up the slope

During freight vehicles driving up the slope it is important to notice that only three transmission stages are used and measured results are shown in Fig. 6.

During driving in second transmission stage, different values of torque were measured. Right side of diagram (Fig. 6) shows torque variation because of ride over rough terrain. Maximum of torque is 2800Nm and it is measured for the first transmission stage.

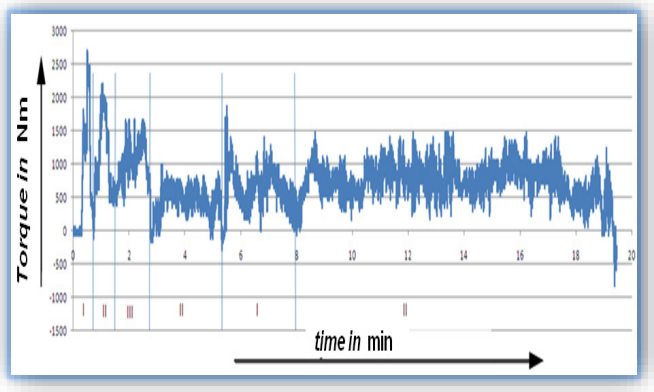

Figure 6. Diagram of measured torques during unloaded freight vehicles ride up the slope

Based on results in table 2, maximum engine power efficiency (cca. 87,33%) is during ride in third gear and minimum engine power efficiency is during ride in second gear.

Table 2. Maximum torques and engine power efficiency percentage values during unloaded truck ride up the slope

Speed stage	Maximum torque on Cardan shaft [Nm]	Engine power efficiency [%]
First	2800	63.56
Second	2200	85.22
Third	1609	87.33
Second	995	38.54
First	1870	42.45
Second	1450	56.17

The movement of unburdened vehicles down the slope

During riding down the slope truck accelerates because of inertial forces, so Caradan shaft is loaded in different way in order to truck riding up the slope. In this case, loads are same as loads using gear pair for reverse. Diagram of torque mesured results for two transmission stages and reverse is shown in Figure 7.

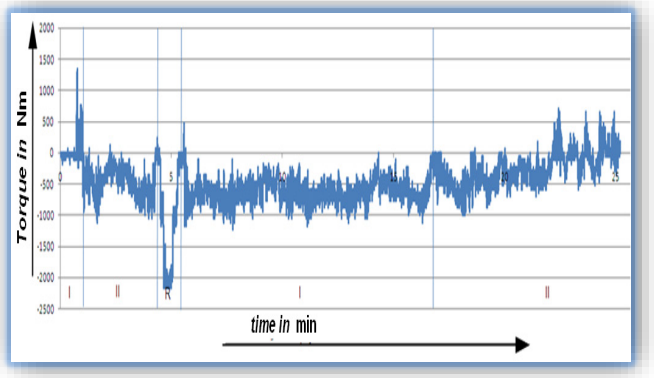

Figure 7. Diagram of measured torques during unloaded freight vehicles ride down the slope

On the same road both torque for riding in second gear and reverse was measured. Maximum torque of 2170 Nm on Cardan shaft was measured for reverse. Also, maximum engine power efficiency is for reverse (Table 3).

Table 3. Maximum torques and engine power efficiency percentage values during unloaded truck ride up the slope

Speed stage	Maximum torque on Cardan shaft [Nm]	Engine power efficiency [%]
First	1346	30,55
Second	-1053	41,50
Reverse	-2170	47,99
First	-1170	26,33
Second	-995	38,54

In the same manner and under the same road characteristics was measured the torque for laded truck whose weight was 15980 kg. During the loaded truck ride on the flat ground was obtained diagram of the measured maximum torque (Figure 8) with a percentage of engine power efficiency (Figure 9) for the respective transmission stage.

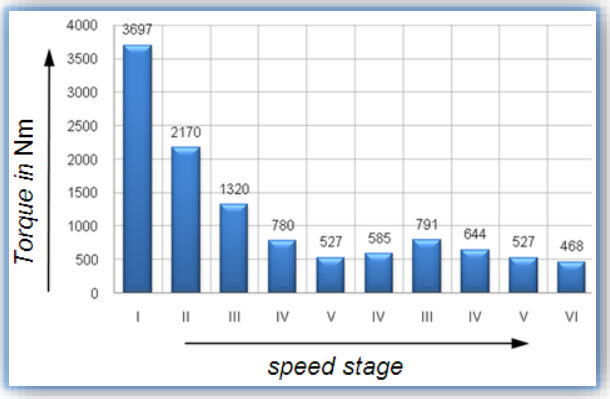

Figure 8. Diagram of maximum measured torques during loaded truck ride on the flat tertain

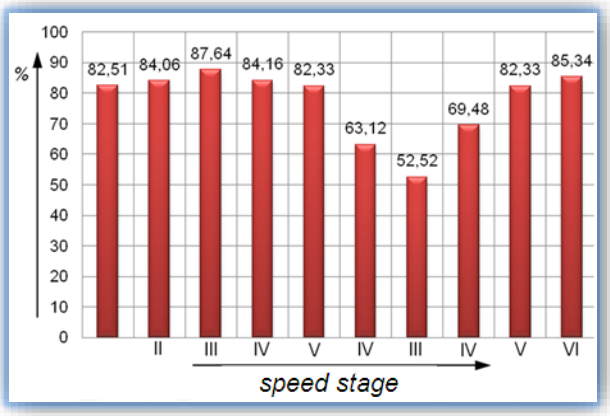

Figure 9. Percentage utilization of power engine when loaded truck driving on flat tertain

In addition, the measured values are not always the same and vary depending on driving conditions. During repeated measurements were obtained different values of torque when using some of transmissions stage. This suggests a stochastics change of the torque values. The measured values are only representative indicator of the state of working conditions. During the loaded truck ride on the flat ground in first gear was measured torque more than 870 Nm (23% more using engine power) truck unloaded ride for the same road

characteristics. During the unloaded truck ride in third gear was measured the highest engine power efficiency. During the truck loaded ride in the same transmission stage the engine power efficiency was 5% more then unloaded truck ride.

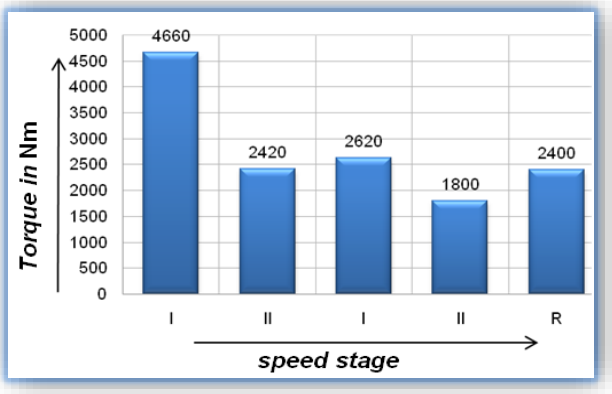

Figure 10. Diagram of maximum measured torques during loaded truck ride up the slope

Torque of 4660 Nm was measured during the loaded truck ride up the slope and this torque is higher for 1830 Nm than measured during the unloaded truck ride up the slope (Figure 10).

Engine power efficiency (over 92%) is during ride in first gear up the slope and this is 30% more than truck unloaded ride up the slope (Figure 11). Engine power efficiency is more than 9% in second gear.

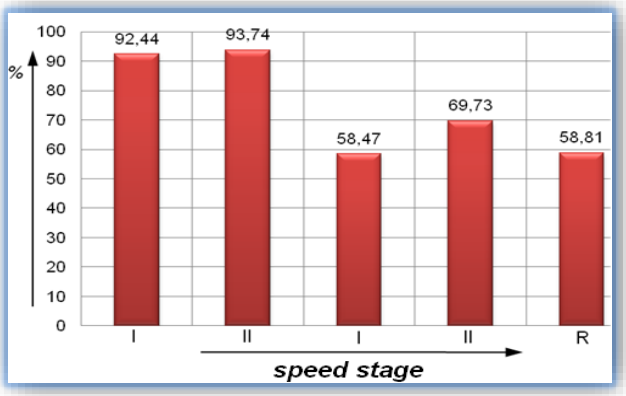

Figure 11. Percentage utilization of power engine when loaded truck ride up the slope

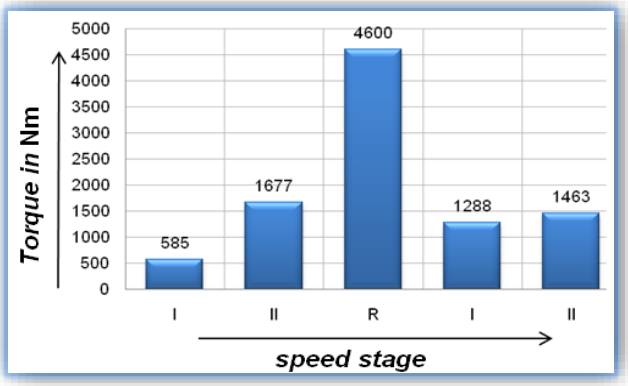

Figure 12. Diagram of maximum measured torques during loaded truck ride down the slope

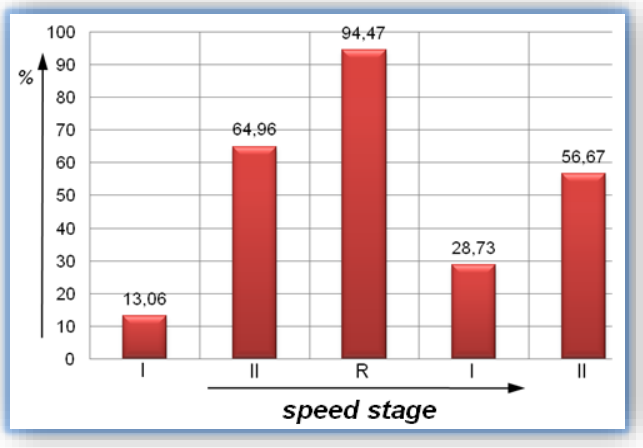

Figure 13. Percentage utilization of power engine when loaded truck ride down the slope

In the case, during the truck ride down the slope maximum torque of 4660 Nm on Cardan shaft was measured for loaded truck reverse (Figure 12). This torque is for 2430 more then unloaded truck reverse. Such an increase in torque resulting in increase efficiency of engine power unit for over 49%. Maximum engine power efficiency (over 94%) is during loaded truck reverse (Figure 13).

CONCLUSION

Before analysis, development or improvement of existing structure of drive unit or gearboxes, the load that appearing in exploitation must be known. This paper presents a method of measuring torque of Cardan shaft during exploitation. Through the paper shows a method of setting the strain gage on the shaft, as well as one of the possible contactless measurements methods. Torque was measured for different representative, different road characteristic and driving conditions. Small differences torque that occur in the experiment are due to changes in travel characteristics (substrate etc.).

The overall conclusion is that the torque will be higher for the loaded truck for the same road characteristics, was expected, but how will torque in which case increase and how will change engine power efficiency it was not possible to assume.

The paper also presents the percentage of engine power efficiency when loaded or unloaded truck ride in specific gear on same road characteristic. It is possible to expect similar behavior of Cardan shaft torque on other commercial truck similar purposes.

In accordance with the foregoing it can be said that the results of this study are important for mehanical constructors engineer and engineers who are engaged in developing, analyzing and reconstructing of powertrain, gear box, Cardan shaft for trucks. Also, the results are the basis for the formation of load spectrums of gears, bearings and gear boxes, as well as possibilities for simulation of real working conditions in Laboratory conditions for appropriate tests.

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FERROUS WASTES RECOVERY POSSIBILITIES IN THE AREA OF STEEL INDUSTRY – EXPERIMENTS IN THE LABORATORY PHASE ON THE BRIQUETTES PRODUCTION FROM FINE AND PULVEROUS WASTES

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Abstract: Life, in the form we all know, it exists because of air, water and earth, which are the main elements that underlie it. When one of these elements is disrupted by man and can no longer follow the natural cycles, the balance is destroyed, and we witness, without any right of reply, genuine environmental disasters. In the industrial sector, in most cases, in addition to the main product, there are one or more products which can be returned to the steel circuit after a quick processing. Reintroduction into the economic circulation of products/small and powdery ferrous wastes leads to reduction of water/air/soil pollution levels. Every tone of ferrous waste recovered and returned to steel production circuit leads to an economy of investments and operating costs. The paper approaches the problem of small and powdery wastes recovery from mining and steel industry in the western part of Romania. Research carried out shows that wastes can be used to produce pellets and briquettes.
Keywords: pollution, environment, steel industry, usage, wastes

INTRODUCTORY NOTES REGARDING THE WASTES RECOVERY

Nowadays, among the main materials consumed worldwide (wood, steel, cement, and plastic), steel is in the first place and will still be there in the future. Steel and iron used as materials in many industrial fields, have the property to be recovered from manufactured products after their usage, regardless of period of time corresponding to those products´life. During ferrous metallurgy processes by which iron ore is converted to steel (iron and steel) and continuing with the manufacturing processes of these products, there are different forms of iron and steel scrap that results, having the generic name ferrous scrap. The steel industry uses large quantities of materials both in primary and secondary development process. The raw material used for primary development process in steel industry is iron ore [3-5,18,19].

By the late ´60s it began to develop the idea of nature and environmental protection on the premises that industrial development, raising the level of civilization and ensuring consumer's needs, all these, increasingly higher, lead to many forms of pollution.

The term `pollution` (to make dirty, to make impure) defines any action that, by itself or by its consequences, brings alteration to biological balances, influences negatively natural or/and artificial ecosystems having adverse consequences for economic activity, health and comfort of human species [7].

In most industrialized countries pollution of air, water and landscape has a common cause: discharge of manufacturing wastes in the environment without a real concern of avoiding it. Measures needed to combat pollution require considerable investment and significant operating expenses, especially in the steel industry.

For human communities and natural ecosystems in the steel industry and mining sites, pollution and risk do not disappear with the cessation of mining and processing of minerals, furthermore, it continues, the sites remain sources of pollution and risk.

The alteration of global ecosystems, because of consumption and production, shows how important is the process of rethinking the use of natural resources by the economy and society. For industry, the problem of managing the recovery (recovery, recycling) is an environmental and economic priority [1,4,10,20].

Industrial wastes include substances, materials, products, waste generated by industrial activity whose elimination from the production cycle is ensured through proper management, namely: recovery (conditioning) and/or storage for recycling; disposal, stabilization/ solidification (to store the final waste) or incineration.

Wastes contain substances resulting from industrial activity where they are produced and disposal of these wastes from the production cycle is achieved by a proper recovery: recovery and / or disposal for recycling and stabilization/solidification for storage in landfills [18,19].

Recovery includes the collection, transport, storage, selection and processing of certain waste; this waste can be returned to a flow sheet by internal and/or external recycling.

Internal recycling (direct recycling) consists of reintroducing the recovered industrial wastes in the same flow sheet that generated them, and external recycling (reuse) is the industrial activity that

reintroduces the recovered waste in a flow sheet that is completely different from the one which generated it.

By combining economic imperative to maximize the recovery of scrap with the social aspect of action to combat environmental pollution in order to restore and maintain the ecological balance, a particular attention must be paid to waste recovery problem [7,9,12-22].

The flow of production in steel industry generates, on a continuous basis, wastes containing iron and carbon, in quantities directly proportional to the output. Within the manufacturing process, in addition to the main product there are sometimes secondary products, and there are always wastes: pulverous, small, large sizes, containing carbon, iron, alloying elements, and sometimes there are utile components for the formation and correction of the chemical composition of the slag, carbon powder.

Exploitation of iron ore deposits which are subjected to concentration operations, leads to obtaining fine grained iron concentrates which makes the process of agglomeration very difficult. Pulverous ferrous wastes can be processed by pelletizing and the fine and pulverous ones by agglomerating and briquetting.

MATERIALS / WASTES FROM THE STEEL INDUSTRY DESTINED TO THE BRIQUETTES PRODUCTION

From steel industry activities derive a wide range of wastes, that can be categorized as recyclable wastes (ferrous and nonferrous waste) and storable wastes, as well (slag, sludge, tar, oils). The flow of production in steel industry generates, on a continuous basis, wastes containing iron and carbon, in quantities directly proportional to the output [1,4].

On the platform of a steel mill virtually all sectors contribute to the pollution of at least one environmental factor.

Most frequent, ferrous scrap results from the steel industry while processing iron and steel, from industries where steel products are processed or used as such, and from the ferrous part recovery process.

Ferrous scrap in the steel industry may be pulverous, deriving from exhaust gas treatment plant, from steel processes, or may be pieces, deriving from steel and iron making processes. Ferrous scrap can and should be reused, in their entirety, within steel industry. Every tone of ferrous scrap recovered and returned to steel production circuit leads to an economy of investments and operating costs.

Within the manufacturing process, in addition to the main product there are sometimes secondary products, and there are always wastes: pulverous, small, large sizes, containing carbon, iron, alloying elements, and sometimes there are utile components for the formation and correction of the chemical composition of the slag, carbon powder.

Ferrous materials, pulverous or mud, are generated from the exhaust gas and wastewater treatment plants within steel technological processes. Their collection is performed for ecological purposes, to avoid air and water pollution, and for economical purposes also, to capitalize their intrinsic value, in the form of raw material substitute of that obtained in the country or imported.

Rolled steel industry sector constitutes the most significant source of industrial water pollution because of scale (iron oxide) and oil in suspension resulted in the different cooling and cleaning operations that occur in the process of rolling. Thus, the waste water from rolling contain iron oxide particles - scale - an amount that can vary between 1 g/l for hot strip mills and heavy plate and 5 g/l in the case of oil skimmer mills.

Ferrous material, as reusable powder, is about 20 thousand tons, containing about 70% iron at 1 million tons of steel. In addition, there are iron oxides that occur during flame cleaning process applied to ensure the quality of semi-finished rolled surface [8].

Ferrous material, as pieces, represents the most important quantity within mill sector. It starts with oil skimmer rolling mills, (bloom or slab) it continues with semi-finished rolling mills, and it ends with finishing mills of flat products, profiles, pipes, wire, etc. In all these rolling mill sectors obtaining quality products requires removal by cutting of ends or sides, areas where frequently occur rolling defects.

Among the sources for the production of ferrous recyclable materials, some pulverous wastes containing iron have to be mentioned, wastes resulted within technological processes in other industries and which can be used in steel industry after a prior processing. These are: pyrite ashes and red mud/sludge. Pyrite ashes result from roasting pyrite in the production of sulphuric acid. There are different methods to extract non – ferrous metals and the waste which can constitute a ferrous agglomerate can be used for furnace load.

Red mud is a waste product generated in the industrial production of aluminum oxide from bauxite. Containment of these industrial wastes can cause great difficulties in terms of water pollution. Oily scale comes from former coke plant, after the removal of liquid and oily ammonia fraction coming from coal volatile components.

Romanian steel industry is currently experiencing technological gaps regarding the collection, transport, storage and, especially, the use of all categories of waste.

EXPERIMENTS IN THE LABORATORY PHASE ON THE BRIQUETTES PRODUCTION FROM FINE AND PULVEROUS WASTES

Based on the documentation in literature, this paper will describe one of these three methods, namely briquetting.

Briquetting is the method by which pieces of spherical, oval or rectangular forms are obtained from fine/small and pulverous waste during compressing operations on specialized equipment, followed by a drying-roasting process in order to increase their mechanical characteristics [12-22].

Briquetting applies to pulverous wastes (powder resulting from dedusting plants) and also to fine products obtained by precipitation. For waste briquetting (at 50-60^{0}C) inorganic binders are used (limewash, Na_2SiO_3) and sometimes organic binders (sulphite liquor, heavy tars, etc.) Briquetting operation consists of:

- *preparation, mixing and homogenizing waste with binder to ensure optimum moisture and granulation;*
- *compression of the mixture;*
- *hardening;*
- *transport and storage of briquettes.*

Mixing and homogenization of the mixture is performed in mixture drums, screw mixers, paddle mixers. Compression is performed on presses with rotating cylinders and piston presses. Hardening is performed by cooling and sintering.

Experiments on the production of briquettes were conducted within the laboratory of the Doctoral School of the Faculty of Engineering Hunedoara, University Politechnica Timişoara. Determination of waste chemical composition was carried out in the laboratories of ArcelorMittal SA Hunedoara Company.

To obtain briquettes, the raw material is subjected to fine grinding, which usually is performed in ball mills. Wastes which are substandard in terms of grain size are ground with these mills. Recipes with pulverous wastes are prepared. Homogenization of waste is done manually or in mixing plant with the addition of binders, and to obtain briquettes, the press is equipped with a mold chosen in accordance with the type of desired briquette. The proportions of waste were determined in 4 recipes, compliance with these recipes is mandatory in order to obtain briquettes with appropriate quality standards [10,11,14,17,19].

Recipes composition and chemical composition of briquettes obtained were displayed in Table 1 and Table 2 [10,11]. Once the briquettes are obtained, they are subjected to hardening processes after a diagram heating/holding/cooling, and then dried and tested to determine the qualitative characteristics (compression tests to determine resistance to cracking, crushing and grinding interval).

For recovery of small and pulverous wastes as briquettes from steel industry, energy and mining, we considered the following wastes: dust from electric steel mill, dirt (sludge) from agglomeration–furnaces, scale (scale slurry) and as binder: limewash, bentonite, cement [10,11,17].

Table 1. Composition recipes (%)

Nr. crt.	Waste used	Composition recipes (%)			
		R1	R2	R3	R4
1.	Sintering furnace dust	25	35	40	50
2.	Steel mill dust	50	35	25	24
3.	Scale	14	19	25	15
4.	Bentonite	3	3	3	4
5.	Limewash	3	3	3	3
6.	Graphite powder	5	5	4	4

Table 2. Chemical composition of lighters (%)

Number recipe	Chemical composition (%)					
	SiO_2	FeO	Fe_2O_3	P_2O_5	S	C
R1	5.02	3.60	63.81	0.18	0.28	9.33
R2	5.70	4.44	57.27	0.14	0.39	11.10
R3	6.01	5.09	54.78	0.12	0.44	11.00
R4	7.51	5.06	48.79	0.13	0.56	11.79
	Al_2O_3	CaO	MgO	MnO	Other oxizes	
R1	2.33	5.36	0.67	2.60	6.84	
R2	3.00	6.13	0.85	2.03	8.95	
R3	3.33	6.51	0.94	1.66	10.13	
R4	4.16	7.39	1.15	1.64	11.83	

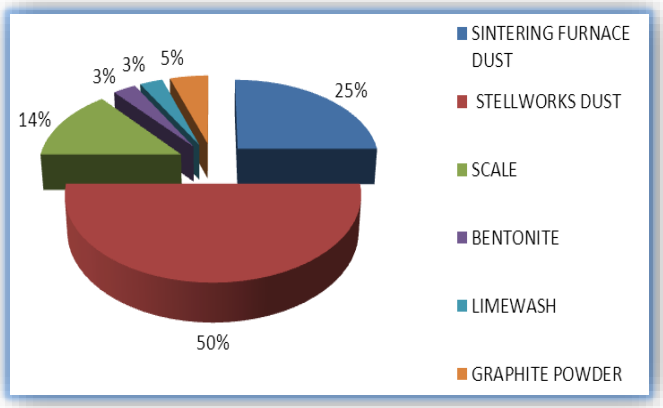

Figure 1. Composition of recipe R1

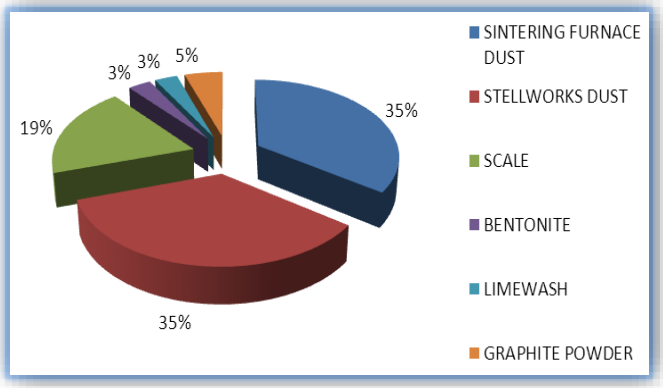

Figure 2. Composition of recipe R2

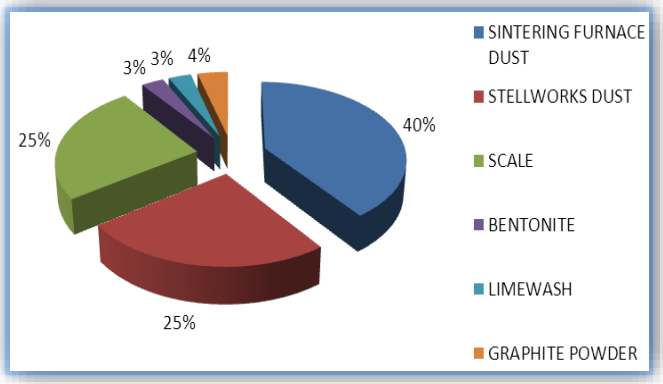

Figure 3. Composition of recipe R3

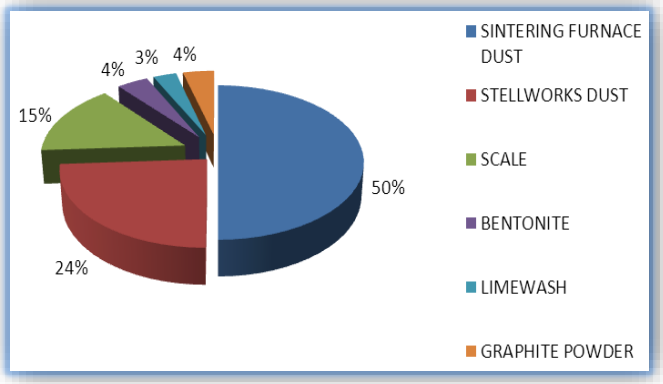

Figure 4. Composition of recipe R4

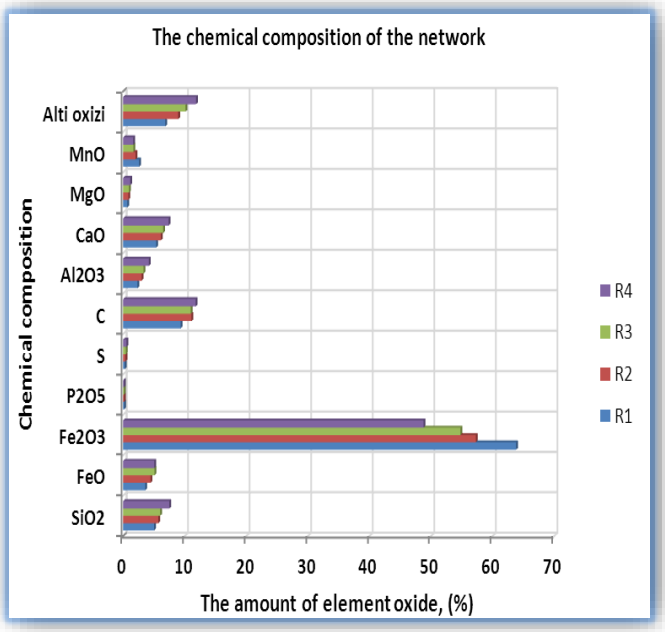

Figure 5. The chemical composition of recipes

For the determination of the quality characteristics were determined the resistance to cracking and crumbling, respectively, were also calculated between experimental crushing briquettes.

With the data obtained, we conducted several dependencies that demonstrates the influence of the composition of briquetting load on these indicators. A number of correlations are shown in the figures 6-26, so we plotted the variation in resistance to cracking, crushing and milling the respective range according to the proportion of the electric steelmaking dust, dirt (sludge) from the cluster, and that the scale furnaces. Analyzing these diagrams, it is found that the optimum proportion of the steel dust varies between 30-50%, powder-sintering furnaces 25-40% and 18-24% of scale.

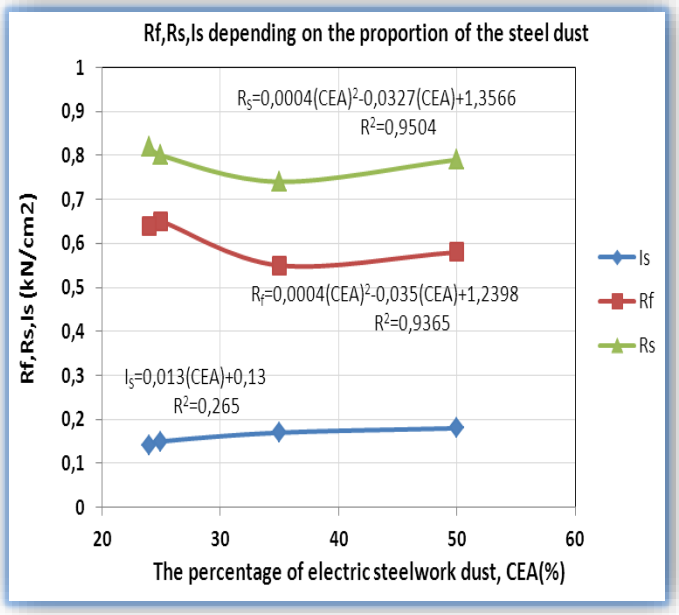

Figure 6. Resistance to cracking, crushing and milling range, depending on the proportion of electric steelwork dust, CEA

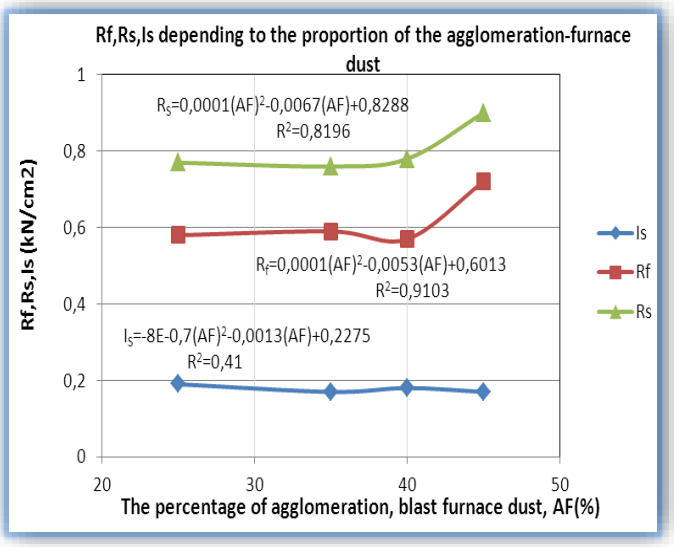

Figure 7. Resistance to cracking, crushing and milling range, depending on the proportion of agglomeration, blast furnace dust AF

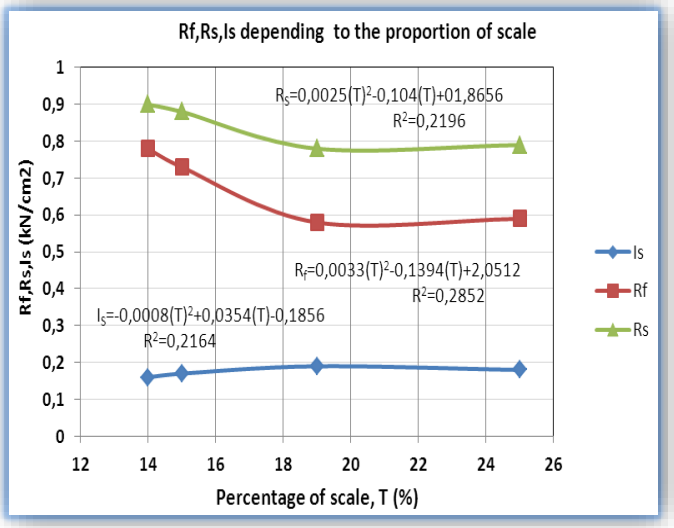

Figure 8. Resistance to cracking, crushing and milling range, depending on the proportion of the proportion of tunder

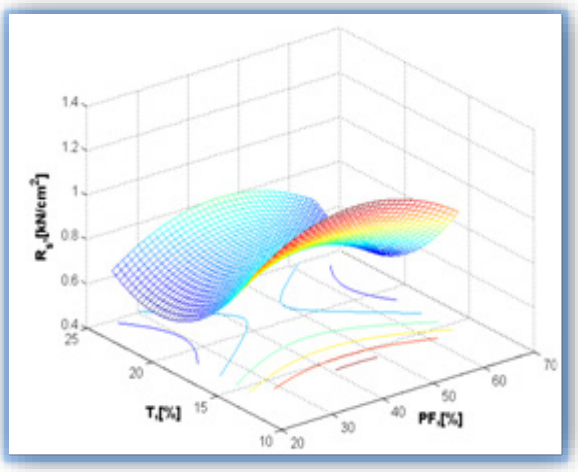

Figure 9. Resistance to cracking depending on the proportion of agglomeration, blast furnace dust AF of tunder (the regression surface)

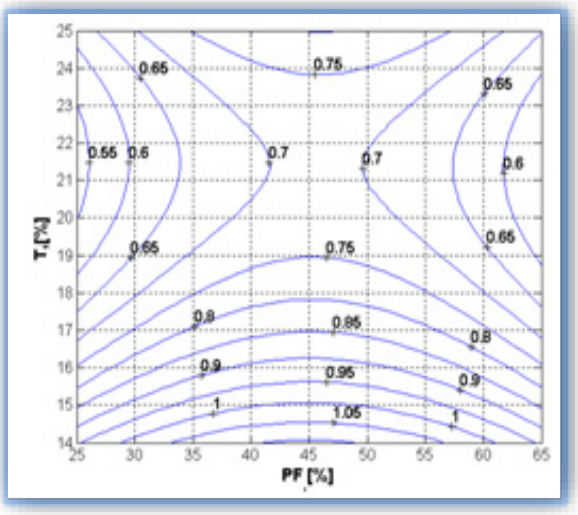

Figure 10. Resistance to cracking depending on the proportion of agglomeration, blast furnace dust AF of tunder (the correlation diagram)

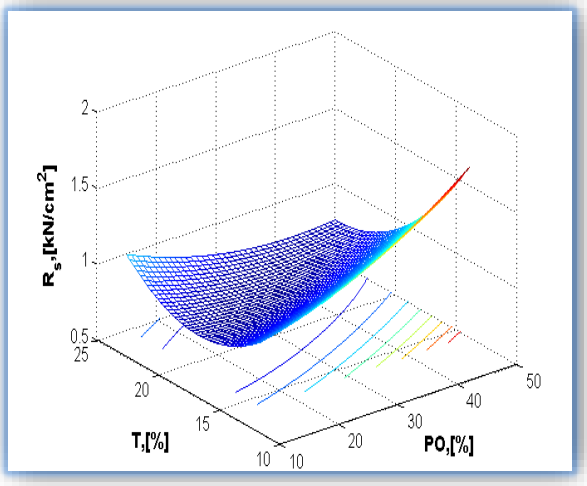

Figure 11. Resistance to cracking depending on the proportion of electric steelwork dust, CEA of tunder (the regression surface)

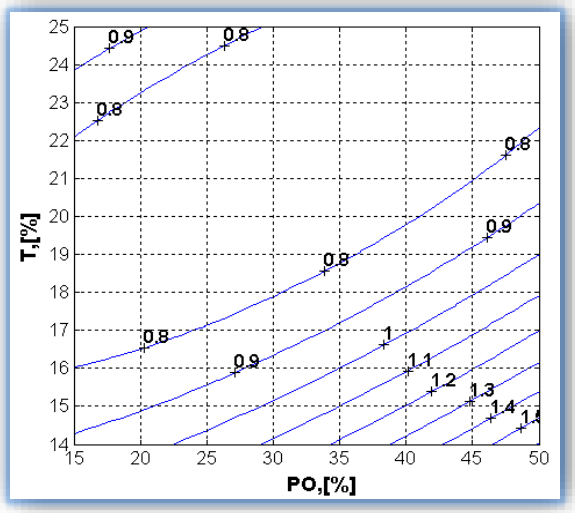

Figure 12. Resistance to cracking depending on the proportion of electric steelwork dust, CEA of tunder (the correlation diagram)

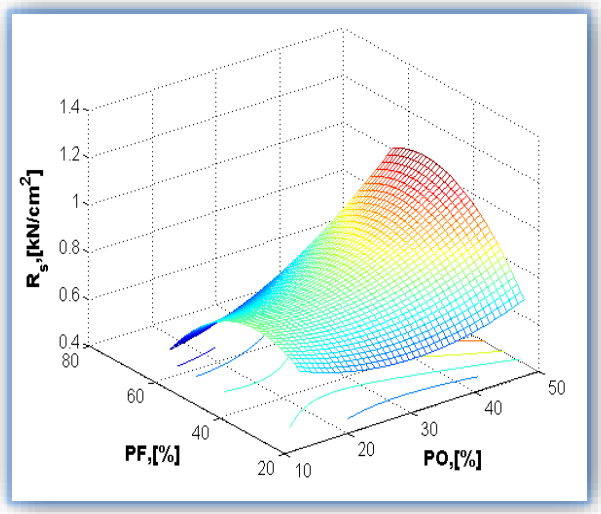

Figure 13. Resistance to cracking depending on the proportion of agglomeration, blast furnace dust AF of electric steelwork dust, CEA (the regression surface)

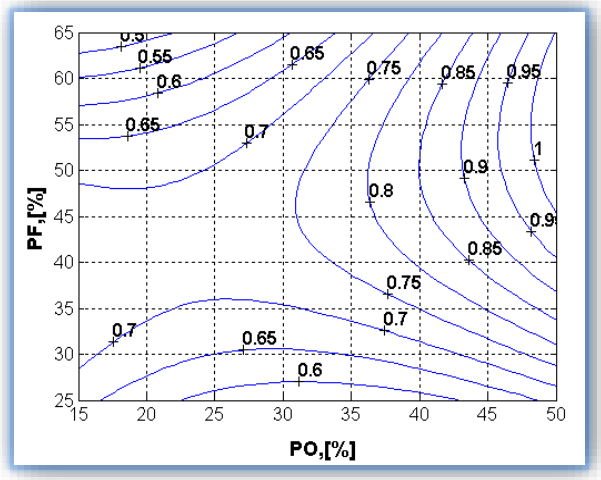

Figure 14. Resistance to cracking depending on the proportion of agglomeration, blast furnace dust AF of electric steelwork dust, CEA (the correlation diagram)

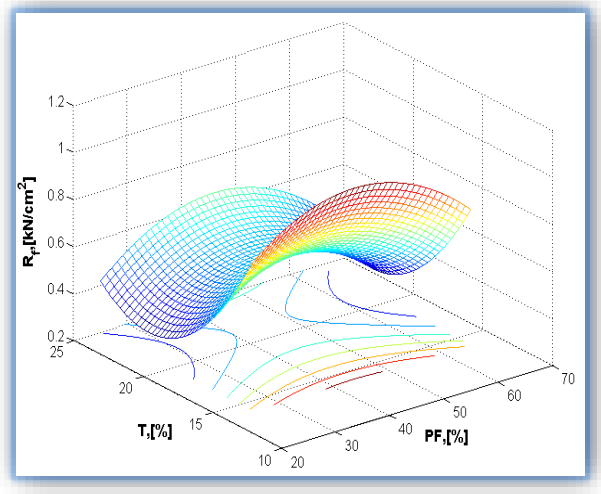

Figure 15. Resistance to crushing depending on the proportion of agglomeration, blast furnace dust AF of tunder (the regression surface)

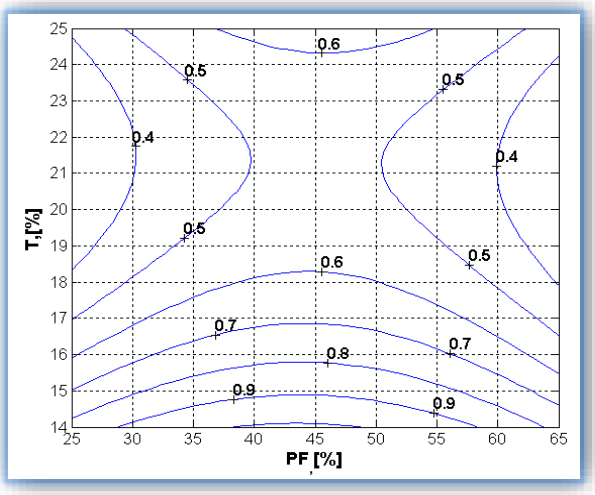

Figure 16. Resistance to crushing depending on the proportion of agglomeration, blast furnace dust AF of tunder (the correlation diagram)

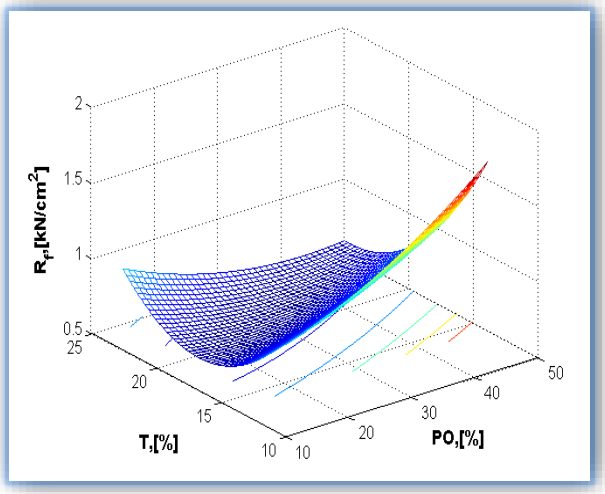

Figure 17. Resistance to crushing depending on the proportion of electric steelwork dust, CEA of tunder (the regression surface)

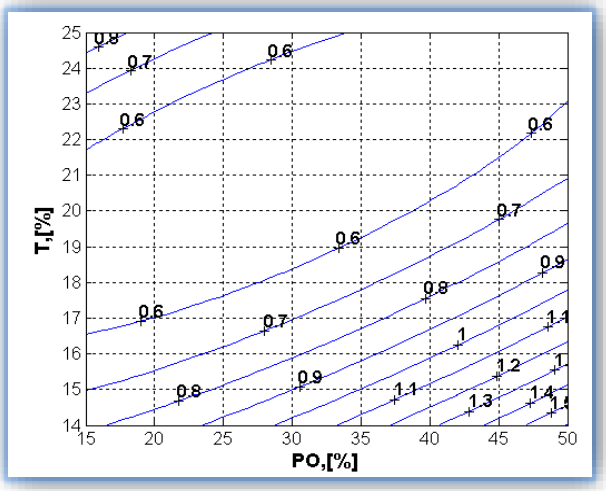

Figure 18. Resistance to crushing depending on the proportion of electric steelwork dust, CEA of tunder (the correlation diagram)

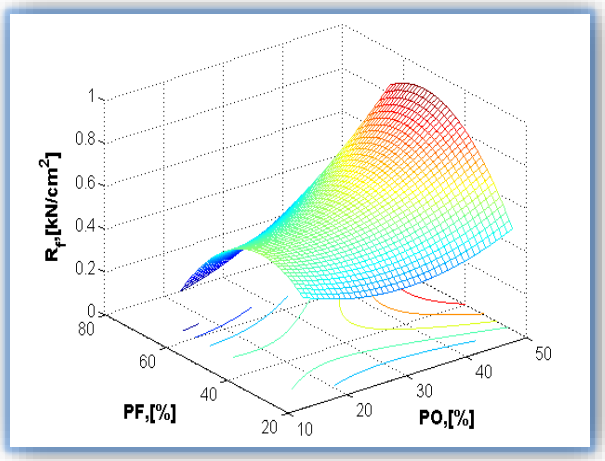

Figure 19. Resistance to crushing depending on the proportion of agglomeration, blast furnace dust AF of electric steelwork dust, CEA (the regression surface)

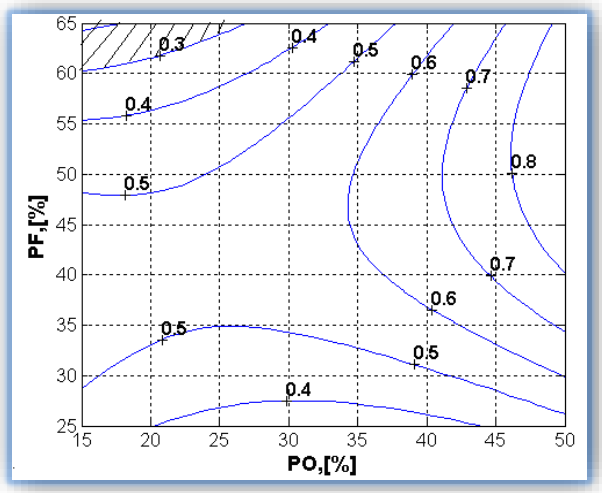

Figure 20. Resistance to crushing depending on the proportion of agglomeration, blast furnace dust AF of electric steelwork dust, CEA (the correlation diagram)

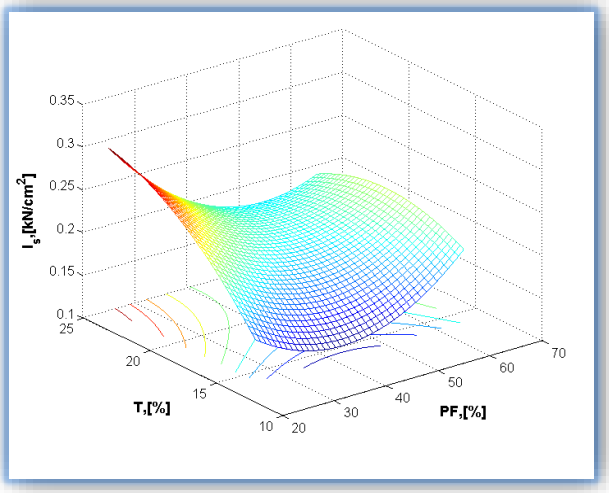

Figure 21. Resistance to milling range depending on the proportion of agglomeration, blast furnace dust AF of tunder (the regression surface)

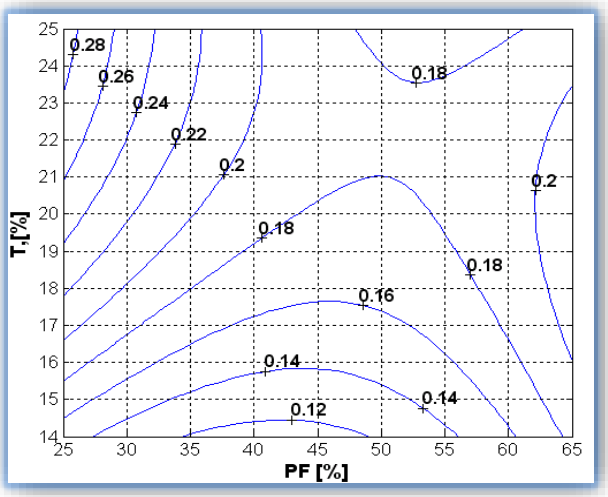

Figure 22. Resistance to milling range depending on the proportion of agglomeration, blast furnace dust AF of tunder (the correlation diagram)

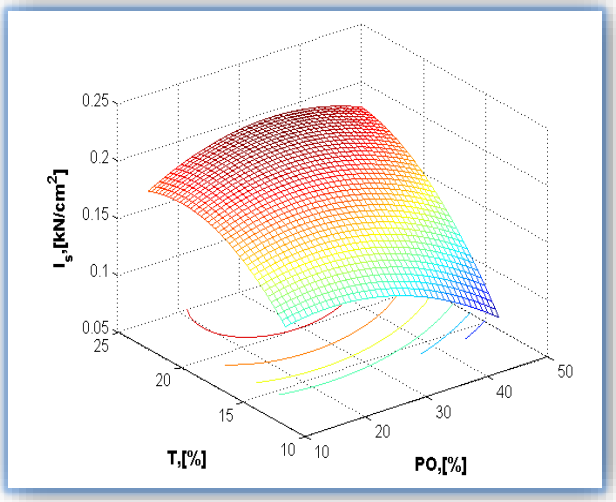

Figure 23. Resistance to milling range depending on the proportion of electric steelwork dust, CEA of tunder (the regression surface)

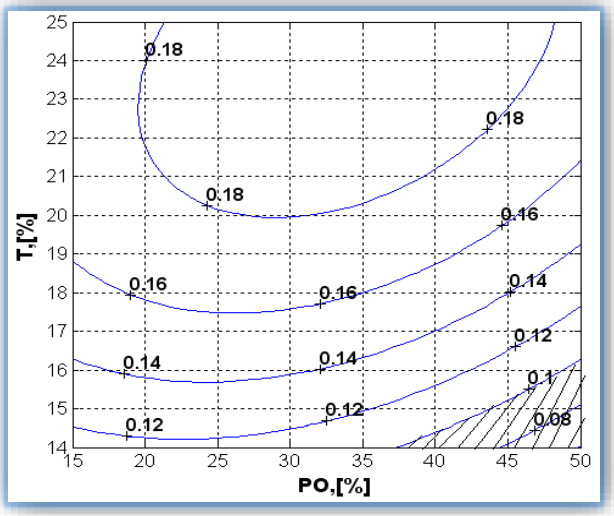

Figure 24. Resistance to milling range depending on the proportion of electric steelwork dust, CEA of tunder (the correlation diagram)

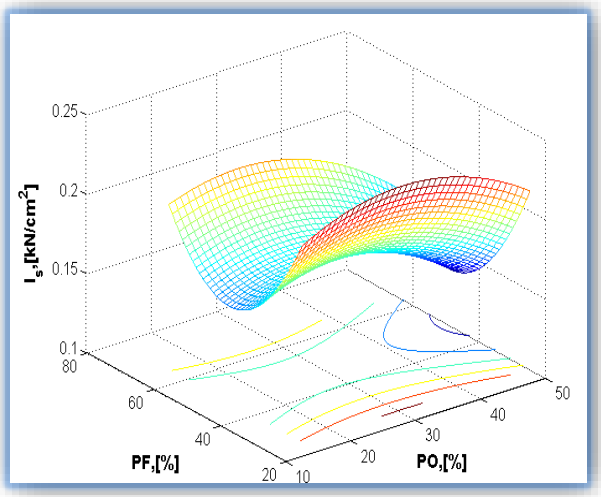

Figure 25. Resistance to milling range depending on the proportion of agglomeration, blast furnace dust AF of electric steelwork dust, CEA (the regression surface)

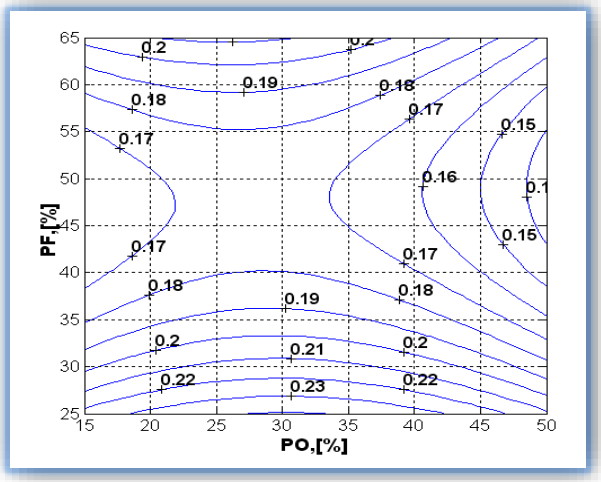

Figure 26. Resistance to milling range depending on the proportion of agglomeration, blast furnace dust AF of electric steelwork dust, CEA (the correlation diagram)

CONCLUSIONS

The paper presents results of research on the strength of briquettes from recycled materials, research conducted to acknowledge:

- *alteration of briquettes resistance in accordance with quantity of waste used for recipe preparation;*
- *influence upon resistances of some chemical compounds from materials recovered by briquetting.*

As a result of analyses performed on products obtained by processing small and pulverous wastes from industrial steel and mining areas and the experiments conducted in the laboratory stage, we consider the following:

- *wastes studied in the experiments can be processed by using the available technologies and can be reintroduced into the steel circuit with minimum investment costs;*
- *reintroduction of wastes into economic circuit has both economic and ecological effects, by releasing the occupied terrains (ponds,*

landfills, disused buildings) in case of deposited wastes, vacancy of areas for waste resulting routinely on technology flows.

≡ *the results of the experiments lead to the conclusion that the analyzed wastes can be processed by briquetting (to provide mechanical strength characteristics superior to those minimum values for this method), this method allows recovery of waste with high variation limits in terms of grain size (desirably under 2mm);*

Taking into consideration the existing local conditions, as a result of the strong economic restructuring, a large amount of pulverous and small ferrous wastes remained, it is necessary to intensify the wastes recovery process, both because it represents a source of iron, poor raw material, and because of technological and ecological considerations. We consider that can be processed both the wastes resulted in technological flows and those deposited in ponds or landfills.

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RATING OF THE SLOVAK BANKING SECTOR

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Abstract: *The article deals with the rating appreciation of the banking sector in Slovakia. It discusses the rating assignments beginnings for the Slovak banking. It is associated with the year 1994 when the first valuation was assigned by two major rating agencies, namely Standard & Poor's Rating and Investment Information. The article brings individual assessments based on positive and negative aspects that influenced them. The next section deals with the contribution of the further development of the rating to the present. It brings evaluations of the three top global agencies for each year that is generally reviewed in tabular and pictorial form with the appropriate commentary. The conclusion is devoted to the current situation in the banking segment in Slovakia with estimates of future development in this field.*
Keywords: *Rating, banking sector, rating agency, positive outlook, stable outlook*

INTRODUCTION

Rating means, as it is stated in [4], "an independent assessment of the entity's ability and willingness to meet its future obligations." Objective factors belong to the ability and subjective ones to the willingness. It is basically a standard product of capital and financial market bearing the information on the risk profile of the entity. It should be noted that rating also represents the risk to which potential partners enter through the performance of their all operations. The credit rating assessment thus objectifies and classifies risks. Risk related to the subject, emission, transaction or project is included in the allocated rating level via harmonized rating scale. Rating agencies therefore provide mutually comparable valuation.Minimal differences can arise only on the basis of "local rating." Harmonization is accordingly subject to the "requirements of the EU framework directives and national legislation"[2].

BEGINNINGS OF THE SLOVAK BANKING SECTOR RATING ASSESSMENT

Rating classification is used worldwide for almost a century. The origins of the Slovak banking segment rating are dated to 1994, one year after the establishment of the Slovak Republic, when as a sovereign state received ratings from the two leading rating agencies.

Agency Standard & Poor's S&P (1941 is the year of the company establishment, namely by the merger of Standard Statistics Company and Poor's Publishing Company with a focus on services in the finance domain - it is largely devoted to the rating evaluation, economic surveys, the S&P's indexes creation and it is a significant provider of independent investment information worldwide) assigned to the Slovakia rating BB-. It corresponds to a speculative investment with the difficult development forecast to the future. Its appreciation relied on some economic stability at the macro level, specifically:

- *low gross debt ratio,*
- *stable foreign exchange reserves increase of the National Bank of Slovakia and the overall banking sector,*
- *declining inflation,*
- *milder gross domestic product downturn in comparison with the expected trend in development.*

On the contrary, negatively were perceived in particular the following weaknesses:

- *short existence of the newly created State,*
- *unstable political environment,*
- *deterioration of the current account balance,*
- *poor investment inflows from abroad,*
- *insufficient statistics.*

Japanese agency Rating and Investment Information R&I (the agency was named Japan Bond Research Institute JBRI before the establishment of Rating and Investment Information) gave to Slovakia in mid 1994 initial rating at the investment grade BBB.This fact made Slovakia available to the capital market of Japan. Factors classified as positives of the mentioned evaluation were:

- *low rate of foreign debt,*
- *cheap labor,*
- *convenient location from geographical point of view according to the European Union area (significant both for export as well as foreign investments).*

For the negative were considered the following characteristicsby which the Slovak Republic was defined:

- *instability of the political system,*
- *low level of foreign reserves,*
- *dependence in the context of electricity production,*
- *situation of the heavy and just as the armaments industry.*

FURTHER DEVELOPMENT OF THE EVALUATION OF BANKING SECTOR IN SLOVAKIA BY GLOBAL CREDIT RATING AGENCIES

The positive direction of the economy development, compliance with the set targetsin the fiscal policy questions and the uniform euro currency adoption plan were by [7] rewarded in 2005 by the rise of the rating.It can be seen in "Table 1"which provides an overview of the ratingsassigned by three major rating agencies as them name [5].

Table 1. The rating levels assigned in the years 1995-2005 with the addition of each rating agency outlook

Year	Moody´s	S&P	Fitch Ratings
1995	Baa3	BB+stable	x
1996	Baa3	BBB-stable	BBB-
1997	Baa3	BBB-stable	BBB-
1998	Ba1	BBB-negative	BB+
1999	Ba1stable	BB+stable	BB+
2000	Ba1positive	BB+positive	BB+stable
2001	Baa3stable	BBB-positive	BB+positive
2002	A3stable	BBBpositive	BBB-positive
2003	A3stable	BBBpositive	BBBpositive
2004	A3positive	BBB+positive	BBB+positive
2005	A2stable	Astable	Astable

Source: own adaptationfrom [1]

Assessing the whole period of the previous year 2005[1] pursuant given ratings by individual agencies is obvious that this year was a breakthrough. Slovakia was videlicet ranked among the countries having positive and healthy economic background. The ratings scaled up on the degree of investment nature. For all three agencies belonging to the most important players on the market in a sector, it was a so-called stable outlook and a strong ability to fulfill the obligations.

The phase 2006-2008 can be considered, based on [8], as a total expansion in the economy. There was a slowdown in inflation rate, employment growth, increasing the investment volume and improvement of other macroeconomic indicators. Last but not least, the year 2009 should be mentioned. An important step was realized - not only in the banking field itself, but also the entire economy.It was transition to the euro.Ratings summary after the 2005 provides "Table 2".

Table 2. Ratings for the period 2006-2013 with a view of the agencies

Year	Moody´s	S&P	Fitch Ratings
2006	A1stable	Astable	Astable
2007	x	x	Apositive
2008	A1positive	Apositive	A+stable
2009	A1stable	A+stable	A+stable
2010	x	A+stable	A+stable
2011	A1stable	A+positive	A+stable
2012	A2negative	Astable	A+stable
2013	A2stable	Astable	A+stable

Source: own adaptation from [1]

[1] It means time interval since the Slovak Republic was established in 1993, respectively since first rating assignment was given in 1994, tillthe year 2005.

All above referred aspects ensuredto the Slovakia the retention of a rating assessment degree the so called safe investment with a positive or stable outlook. Although the change towardsrating increasing was not registered, on the other hand, there were no adverse trends either. To the factors suppressingthe impacts of the financial crisis on the banking sector may be ranked these points:

- entrance to the euro area,
- growth of the population savings deposition (primary related to the previous statement),
- active government policy in terms of adopting the package of resolute anti-crisis measures.

The year 2012 brought with it certain transformations in the functioning of the Slovak financial sector. A several changes in laws, in accordance with [3],came into force. Among the most fundamental ones may be included a decision to enlarge contributions into the state bank stabilization fund whatin a large extenthelped out to escalatebanking sector prosperity.

"Figure 1"presents a transparent summary of the ratingassigned by globally reputable agencies through graphical representation for each year from the reporting start to the present. As can be seen, the credit rating has an upward trend in assessing the entire observation period. The figure shows for better comparison both kinds of rating scales which are the most commonly used and standardized.Individual agencies evaluations are color coded for better clarity.

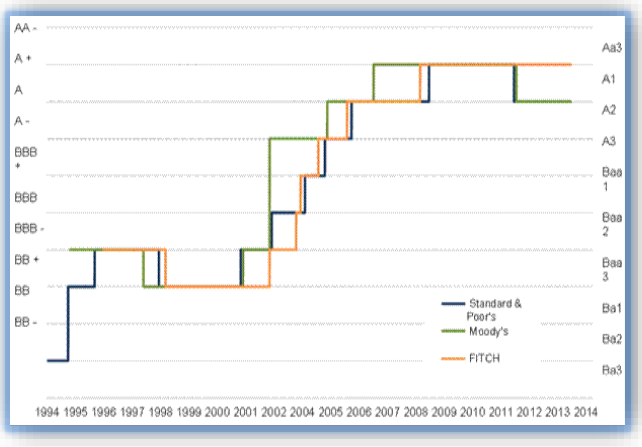

Figure 1. Rating classification progress of Slovakia. Source: [1]

THE CURRENT SITUATION IN THE BANKING SEGMENT IN SLOVAKIA

Recent Moody's statements [6] discuss theperspective change from negative to stable towards the Slovak banking system. This reflects the current macroeconomic environment improvement which limits the risk of a decline in asset quality and profitability. Actual Agency report explains the stable outlook by combining mentioned risk reducingin relation to adverse trend, along with "healthy" capital reserves in the system, stable funding and adequate liquidity.

Press release by Moody's renders a view that the operating environment of Slovak banks will strengthen after the economic

growth projection in the broader recovery in the euro area.A key driver of economic growth in Slovakia will be export. This argument is justified by more intensive demand from the Slovak strategic trading partners'side in Europe. Despite high unemployment agency expects growth in domestic demand under the influence of existing support public policy, including an accommodating stance of the European Central Bank.

Favorable situation in terms of macroeconomic stability and stronger operational background ease the pressure on the quality of bank assets, resulting mainly in the retail, entrepreneurship and industrial production.

Solid credit expansion plus lower borrowing costs put the banking sector in a position with good profitability retention. Return on assets is estimated at about 1%. On the other hand, Moody's admits that moving towards profitability will be limited. Finally the cause is a bank tax enacted by the government since January 2012.

The credit rating agency concludes that Slovak banks capitalization will continue as salubrious with respect to expected losses. Its assertion is based on the Slovak Central Bank's capital rules containing detailed prudential requirements. The agency adds that funding and liquidity profiles will remain stable. Moody's believes that despite the increase lending, the Slovak banks will be able to fully finance lending to subjects through their stable deposit base - bankswill keep a very low degree of dependence on wholesale funding sources.

CONCLUSION

Rating information beneficiaries are mostly the participants of financial and capital markets. These are therefore investors - companies carrying out investment activities, banks, retail investors, creditors, analysts etc. Basically it is everyone who has thetransaction relationship with rated entity. Assigned rating level is for them a decisive indicator and relevant source for decision making process. However, rating is also important from the reporting subject perspective. It offers an independent assessment of its own position within the partial trade market. This is related to simplifying comparison with the competition. The credit rating is valid one calendar year precisely. During the mentioned period is allowedreconsideration and subsequent modification. The foundation is represented by conclusions resulting from the systemic supervision of entities, emissions or projects.

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PREPARATION OF SUBMICRON SILICA GEL FROM RICE HUSK ASH USING WATER SHAKER BATH

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Abstract: Rice husk ash (RHA) is an agricultural waste and is rich in silica. Silica gel was extracted from RHA by burning, thoroughly washed and dried rice husk into ash in an enclosed drum, the ash was thereafter conditioned in a muffle furnace at a temperature of 650^{0}C; the conditioned ash was leached with various concentrations (0.5, 1.0, 1.5 and 2.0M) of sodium hydroxide (NaOH) in a water shaker bath at 100^{0}C for 1 hour, the solution was filtered with ashless filter paper number 41 and the filterate was precipitated with concentrated hydrochloric acid (HCl) to obtain solution until pH 7and incubated for 48 hours to promote silica gel formation. The silica gel produced was separated from soluble salt solution by vacuum filteration and washed with deionized water. The silica gel was dried in an air blast oven at 150^{0}C for 48 hours and ground into powder. The presence of silica in the gel was confirmed with Energy Dispersive X-ray Spectrometer (EDX). The chemical composition of the silica increases with increase in the concentration of NaOH. The EDX pattern of silica gel produced at 2.0 M NaOH treatment shows the composition of silica to be 96.28 wt.% . Horiba dynamic light scattering particle size analyser also revealed the particle size of the silica gel to be 427.1 nm.

Keywords: Rice Husk, Rice Husk Ash, Sodium hydroxide, Hydrochloric acid, silica gel

INTRODUCTION

At present, crude silicon known as metallurgical grade silicon, with 98-99% purity is obtained from quartz rocks by carbothermic reduction using electric arc furnace (Prasad and Pandey, 2012). This silicon is further refined into high purity silicon through expensive and complicated purification process such as chemical vapor deposition (CVD) process which is used for production of electronic grade silicon. Due to exponential growth of PV industry, the demand for solar grade silicon (SoG-Si) has increased tremendously over the past decade due to their extraordinary properties and their existing and potential applications in science and technology, silica gel has a wide range of applications such as dessicant, as a preservative tool to control humidity, as an adsorbent, as a catalyst and as a catalyst support (Prasad and Pandey, 2012).

At the beginning of PV-activities in 1980s, the high purity scrap silicon from the micro electronic industry was used by the PV-industry (Muller et al; 2006). However, increased demand that surpassed the limited supply of off-specification electronic grade silicon has created a thrust towards developing a dedicated technology for the production of solar grade silicon (Barry et al; 2008).

One of the approaches towards generation of SoG-Si is utilizing materials of very high purity to produce silicon. As an industrial waste, rice husk (RH) could be one of the potential raw materials for the production of solar grade silicon that can be used to develop siliceous particulate for use in solar panel assembly. Rice husk ash (RHA) is usually obtained by burning rice husk as fuel to generate energy from waste product).

Although various uses for rice husk and RHA has been suggested in the literature, their disposal or utilization remains a major concern. Soluble silicates produced from silica are widely used in glass, ceramics and cement as a major component and in pharmaceuticals, cosmetics and detergents industries as a bonding and adhesives agents (Anon, 1997; Laxamana, 1982). Silica also has been used as a major precursor for variety of inorganic and organometallic materials which have applications in synthetic chemistry as catalysts, and in thin films or coatings for electronic and optical materials (Lender and Ruiter 1990; Brinkerand and Scherer, 1990)

MATERIALS AND METHODS

The main materials that were used for this work are as follows: rice husk, distilled water, sodium hydroxide, hydrochloric acid and ashless filter paper.

Combustion of Rice Husk

The rice husk was collected from a local mill in Ajaokuta Steel City, Nigeria; It was thoroughly washed with water and dried in an oven at 80^{0}C for 24 hours to remove the water content. The dried rice husk was fed into an enclosed drum and burnt into ash, and thereafter conditioned at a temperature of 650 ^{0}C in a muffle furnace. The obtained rice husk ash (RHA) was used in the experimental work.

Extraction of Silica Gel from RHA

The Silica-gel was extracted from the rice husk ash by adding 10 grams of rice husk ash to various volumes and concentrations of sodium hydroxide solution (most solutions were 0.5 M= 660 ml, 1.0 M = 330 ml, 1.5 M = 247.5 ml and 2.0M = 165 ml sodium hydroxide (NaOH) solution. The mixture was then heated in a water shaker bath at 100^{0}C

in a beaker for one hour. The solutions were allowed to cool to room temperature, then, filtered through Whatman No 41 ashless filter paper and the carbon residue was washed with 100 ml of de-ionized water. Concentrated HCl was added to the obtained solution until pH 7.0 and incubated for 48 hours to promote silica gel formation. The silica gel produced was separated from soluble salt solution by vacuum filtration and washed with de-ionized water. Then silica gel was dried in an oven at 150^{0}C for 48 hours. The obtained white gel was pulverized into a powdery form.

Chemical Composition Analysis of Silica gels

The silicon content of the samples was estimated using energy dispersive X-ray (EDX) spectroscopy (Kevex Instruments, Valencia, CA).

Particle Size Analysis

The particle size of the powder was analyzed using Horiba dynamic light scattering particle size analyzer. The measurable particle size range of the instrument is 0.05-3000 µm and it is equipped with a small volume sample dispersion unit. A lens range of 300RF, a beam length of 2.4mm, and a presentation of 30AD with polydisperse analysis was used for this measurement. About 0.5 g of the silica powder was dispersed in de-ionized water in the sample dispersion unit of the instrument, vigorously mixed for about two minutes at speed of 2100 rpm, and sonicated for 45 seconds. The ultrasonic waves were used to break or minimize any particle agglomerates that may be present in the suspension. Measurements were taken and the diffraction data and graphs recorded by the instrument software program.

Examination of the surface morphology of Silica gels

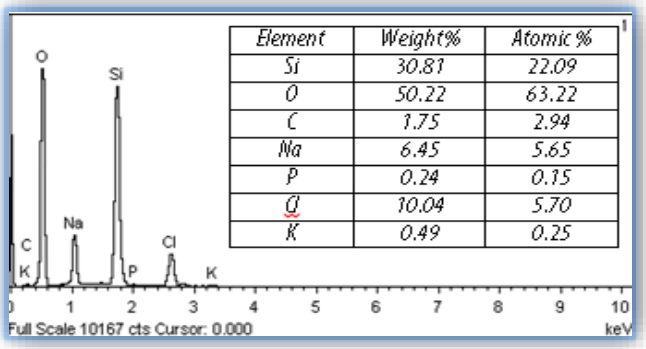
An AURIGA Scanning Electron Microscope (SEM) (Carl Zeiss Germany) with an accelerating voltage of 15KV was used to characterize the particle morphologies of the silica powder. Sample specimens were gold coated in a gold sputter coater for 90 seconds at 15 mA current output. The gold coating was necessary to ensure a conducting surface was obtained for electron bombardment and characterization. The Selected areas of interest were focused and micrographs were taken.

RESULTS AND DISCUSSIONS

Effect of Concentration of Sodium Hydroxide on Pure Silica Powder

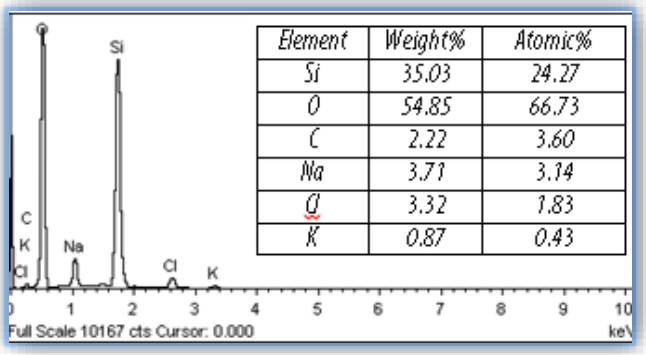
Energy Dispersive X-ray Spectrometric analysis was carried out on the silica powder at different concentrations of sodium hydroxide (0.5, 1, 1.5 and 2.0 M) in other to evaluate the effectiveness of the purification parameter and to confirm the presence of silica.

The results of the chemical composition of RHA and silica gels analyzed with Energy Dispersive X-ray Spectrometer (EDS) are shown in Figures 1- 5. The major elements present are silicon and oxygen along with traces of impurities such as sodium, chlorine, carbon, phosphorus and potassium. The elemental composition of silicon and oxygen increases with increase in the concentration of NaOH whereas the composition of the impurities such as sodium, chlorine and phosphorus decreases. Figure 4 shows the EDX spectra of silica powder leached with 2.0M NaOH which has the highest silicon and oxygen content .



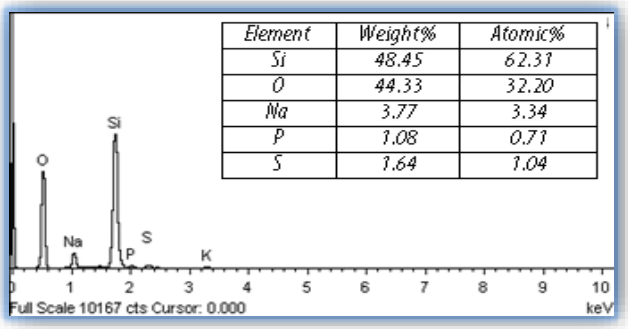
Element	Weight%	Atomic %
Si	30.81	22.09
O	50.22	63.22
C	1.75	2.94
Na	6.45	5.65
P	0.24	0.15
Cl	10.04	5.70
K	0.49	0.25

Figure 1: EDX spectrometric data of silica extracted from RHA with 0.5M NaOH



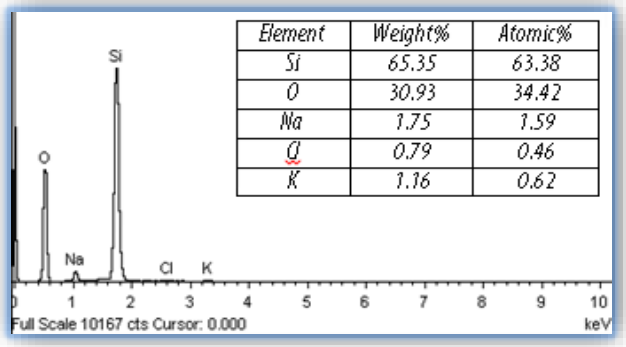
Element	Weight%	Atomic%
Si	35.03	24.27
O	54.85	66.73
C	2.22	3.60
Na	3.71	3.14
Cl	3.32	1.83
K	0.87	0.43

Figure 2: EDX spectrometric data of silica extracted from RHA with 1.0M NaOH



Element	Weight%	Atomic%
Si	48.45	62.31
O	44.33	32.20
Na	3.77	3.34
P	1.08	0.71
S	1.64	1.04

Figure 3: EDX spectrometric data of silica extracted from RHA with 1.5M NaOH



Element	Weight%	Atomic%
Si	65.35	63.38
O	30.93	34.42
Na	1.75	1.59
Cl	0.79	0.46
K	1.16	0.62

Figure 4: EDX spectrometric data of silica extracted from RHA with 2.0M NaOH

Particle Size Analysis

The chemical composition of silica powder extracted from RHA has been shown to be mainly silica (SiO_2). Since it is a known fact that particle size of filler materials has influence on the properties of composite, therefore, the cumulative particle size distribution of powder with the highest silica content was analyzed with Horiba dynamic light scattering particle size analyzer as show in Figue 3. The particle size distribution of the powder is approximately 427.1nm. The result of the average particle size of the silica gel is shown in Figure 5.

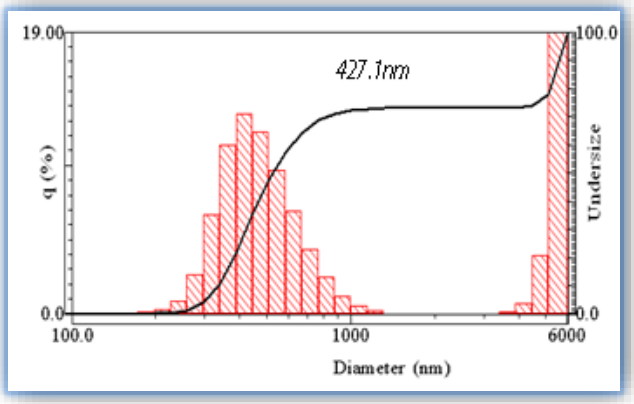
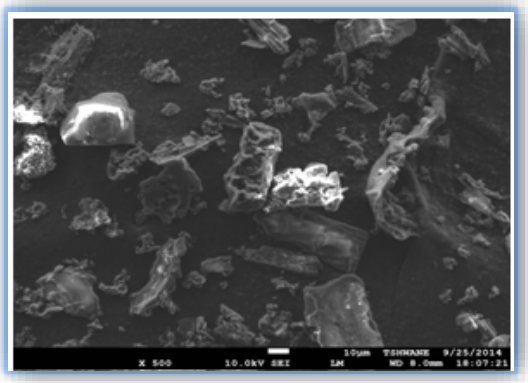


Figure 5: Particle size distribution by intensity produced by Horiba Dynamic Light Scattering Particle Size Analyzer. The average Particle size is 427.1nm

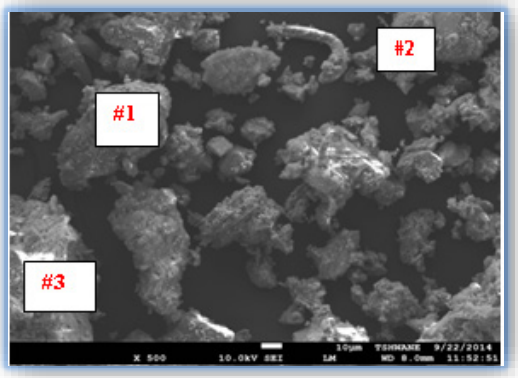
Scanning Electron Microscope (SEM) Images of RHA and Silica gel

The morphological features of the RHA and silica powder observed by scanning electron microscope (SEM) are shown in Plates (a-e). The SEM images were taken at a magnification of 500X, as from Plate (a), the as received RHA shows a porous and multifaceted particle shape and size. The honeycomb and porous morphology seen in Plate(a) can be attributed to burning out of organic component in the rice husk during combustion. The hydrated silica subsequently polymerizes to form a skeletal silica network which may explain the flaky and honeycomb-like structure in the SEM image of Plate (a).

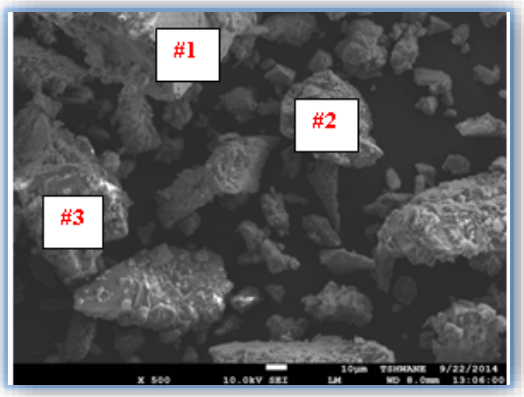
The EDX analysis at points #1, #2 and #3 in Plates (b-e) shows the crusty and fibrous surface to be silicon-rich and was mainly SiO_2 . The average elemental composition for each silica powder produced was calculated by adding the elemental composition of point #1, #2 and #3 and the average was calculated as shown in Figures 1-4.



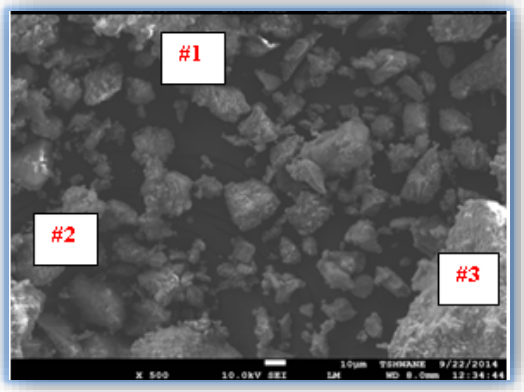
a)



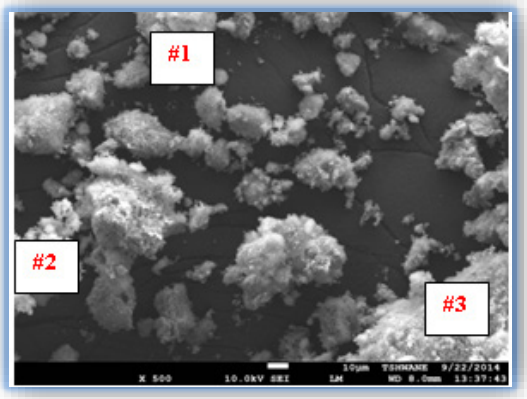
b)



c)



d)



e)

***Plates (a- e)**: SEM Images of RHA and silica gel extracted from RHA by Sol-gel process with NaOH (a) RHA (b) 0.5M NaOH (c) 1.0M NaOH (d) 1.5M NaOH (e) 2.0M NaOH*

CONCLUSION

This study revealed that silica gel and powder can be extracted from RHA, which is regarded as agricultural waste which can be used for several applications in industry. It has been confirmed that the concentration of NaOH when leached with RHA influences the purity of silica gel; The EDX pattern of submicron silica powder at various concentrations (0.5,1.0,1.5 and 2.0M) has shown that the elemental composition of silicon and oxygen increased, whereas impurities such as carbon, sodium, phosphorus,, chlorine and potassium decreased at 2.0M NaOH treatment. The silica extraction yield from RHA was 96.28 wt.% at 2.0M NaOH treatment. The average particle size of the silica powder as determined by particle size analyzer was 427.1nm which is regarded as submicron particle.

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THE APPLICABILITY OF THE METHOD AS-CFD INTO THE ANALYSIS OF DUCTILITY AND DISTRIBUTION OF STRESS OF AN ALUMINIUM ALLOY

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Abstract: *The aluminium alloys become increasingly higher into the metallic materials category for transport, aerospace, electrochemical, electronics and microelectronics, chemical, industrial and civil construction industries and so on, mainly due to high ratio between mechanic strength and density, high corrosion resistance, thermal conductivity and electrical which were perfectly raised. The research of aluminium alloys can be done through direct physical and chemical laboratory methods, but also through indirect methods that highlights the research through simulation and physical or mathematical modelling. Autodesk Simulator is a programme for simulation which can help us determine physical characteristics, mechanical properties of certain processes, materials or complex installations so that we can give an overview and insight into the future in terms of the property of the element studied but also the economic benefits. The paper presents the authors' personal research over the significant qualitative characteristics of certain aluminium alloys through simulation and modelling using Autodesk Simulator CFD. For the analysis it was used an alloy bar Al-5Ti-B and has been studied its behaviour to a certain magnitude and strength oriented linear on coordinate Ox. The results have a major importance to establish the stress resistance and ductility of the alloy.*

Keywords: *Al-Ti-B, AS-CFD, ductility, Stress Distribution*

INTRODUCTION

Worldwide, improving of aluminium alloys, especially the ones deformable are obtained through finishing grained, inoculating into the melt, before casing, an Al-Ti-B master alloy which contains TiB2 particles and TiAl3.

In this paper it has been chosen an Al-Ti-B alloy and has been studied, using AS-CFD, the stress distribution but also the influence it has on certain areas of material ductility.

AS-CFD programme is widely used in various simulations including in Metallurgy Industry (loading and distribution of raw materials into the furnace, oven, congestions, and the analysis of certain physical properties of ferrous and nonferrous elaboration). Into the Aluminium Industry we can highlight: the influence of chemical composition on the behavior of Al alloys in various processes, porosity analysis static stress etc. All these features can be combined and analysed also in Autodesk Simulation Mechanical (figure 1).

With the help of AS-CFD we can improve the ductility of alloys Al/Al-Ti-B using stress parameters (mechanical characteristics), in our case we have chosen only the unidirectional tests. A similar program has been used by others Japanese researchers [1-4].

Numerical modelling provides lots of information regarding the temperature conditions, stress, mechanical stress, electrostatic to optimize the development process of Al alloys, but also to approach a geometrical position corresponding to the mechanical request according to the product's destination.

MATHEMATICAL MODELLING AS-CFD/AS-M

The geometric model developed into Audesk Professional Inventor consists of a bar of Al-Ti-B of 70cm length (figure 2) and the chemical composition shown in Table 1.

Table 1. Chemical composition used in Al-Ti-B alloys bar

Alloy	Ti	B	Fe	Si	V	Al
Al-5Ti-1B	4.80	0.85	0.09	0.08	0.04	94.14

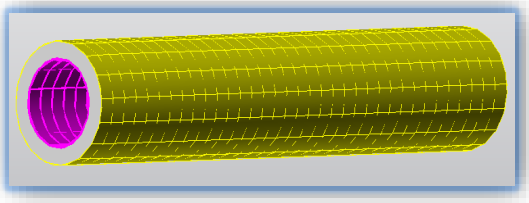

Figure1. AS-Mechanical-Aluminium Bar

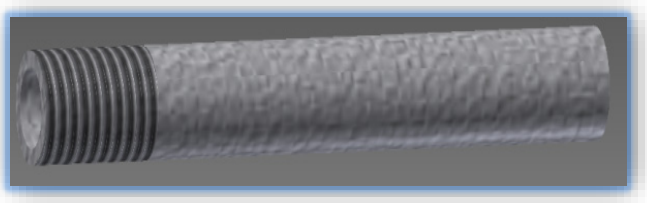

Figure 2. Model used into simulation

The inner diameter of the hollow Al-Ti-C bar is 5 cm, and 2 cm thick. Kinetics simulation requires the analysis of two models: a process of infiltration, clash, between 2 materials, but also the interaction between particles after the mechanical strain (Figure 3).

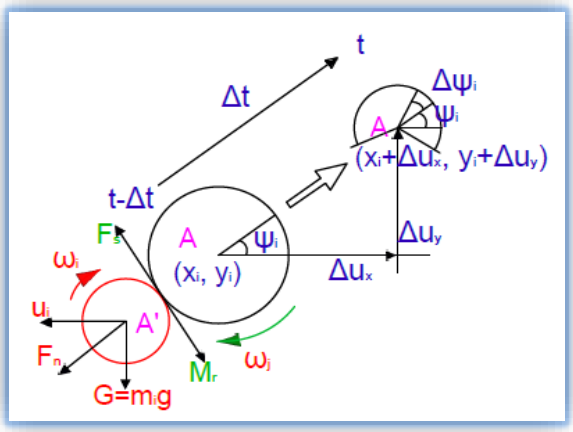

Figure 3. The forces who act between particles and schematic representation of Mathematic model used into simulation AS-CFD

where: M_r - Force moment, Nm, Δt - The time variation, s, F_n - normal force, N, ω -angular velocity, radian/s, G - Force of gravity, N, A, A' - A particle, B particle, ψ -acute angle between direction of mechanical stress and horizontal, rad, Δu- decomposition of particles on a flat surface coordinates O, X, Y.

RESULTS AND DISCUSSIONS

The simulation was performed with AS-M and AS-CFD for each area tracking the distribution variation of stress onto certain areas. The simulation was carried out into a period of time of 8 seconds for each surface of the work piece to the previous size.

The basic data used are given in Table 2, for materials in Table 3. According with the experiment of this piece it has been acted with a magnitude of 20sqm, and a parallel force with the magnitude of 100N.

Table 2. Mesh settings

Avg. Element Size (fraction of model diameter)	0.08
Min. Element Size (fraction of avg. size)	0.2
Grading Factor	1.5
Max. Turn Angle	60 deg
Create Curved Mesh Elements	No
Use part based measure for Assembly mesh	Yes

Figure 4 shows stress vectors analysed according to AS-CFD on the 3 axis X, Y, Z, as well as the plot vector of interference stress length. The minimum values are found in the imaginary center of the piece, following that the values to grow symmetrically on the sides of the piece. Following the simulation we have obtained minimum and maximum values, according to Figure 5 there are 2 maximum vales, one of them more pronounced due to the use of F force in the direction of action of magnitude of Ox axis.

Table 3. Material(s)

Name	Aluminum 6061	
General	Mass Density	2.71 g/cm^3
	Yield Strength	275 MPa
	Ultimate Tensile Strength	310 MPa
Stress	Young's Modulus	68.9 GPa
	Poisson's Ratio	0.33 ul
	Shear Modulus	25.9023 GPa
Part Name(s)	Piesa1	
	Piesa1	

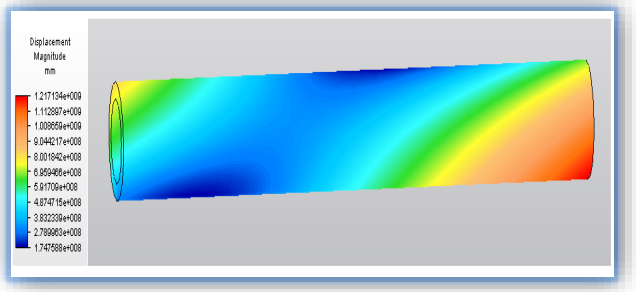

Figure 4. Stress distribution according to the analysed parameters.

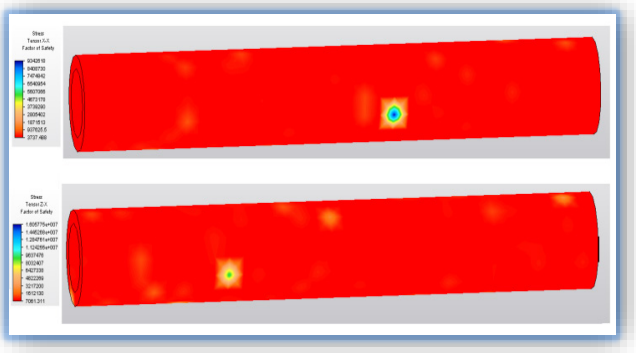

Figure 5. The tensor's stress variation on axis XX and ZX

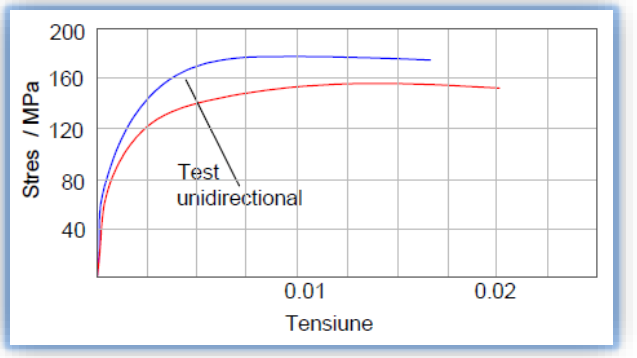

Figure 6. Curve of voltage-stress parameters of the experiment

From Figure 6 we can see that following the attempt to a magnitude of 20sqm, the unidirectional simulation test has raised to a closer value to alternative value given in the first place by the experiment (in our case highlighted with a red line). For a smaller diameter of the piece, the result was with 0.004 smaller than the results obtained to the alternative test (0.02). If it should be used only an Al material, the bar or wire would not

satisfy the conditions of ductility, but into this alloy Al-Ti-B the analysed material will satisfy both requirements: 160sqm magnitude and higher voltage than 0.015.

According to AS-CFD the coefficient of friction has been set up to a value of 0.1. The calculated values were Al alloy used A16061 with a density of 2.71g/ cm^3 and Ti with the density of 4. 51g/cm^3 (dates highlighted in conditions of the simulation in Materials Table 3). The magnitude was 310MPa and 344.5MPa max.

Von Mises stress represents an equivalent stress which combines the values of 6 stress values on different individual axis. We can compare the value von Mises with the normal stress value highlighted on the piece to predict the materials breaks with major implications on the ductility of the piece. Under normal frequency, the optional stress and result tension is calculated to return relatives values of distribution stress and tension on the analysed model. Combined with the analysis of plot vector, we can highlight already in Figure 7 the surface in which the percentage of occurrence of a fracture grows, but also the area in which we register small values of ductility on unidirectional tests towards the alternatives.

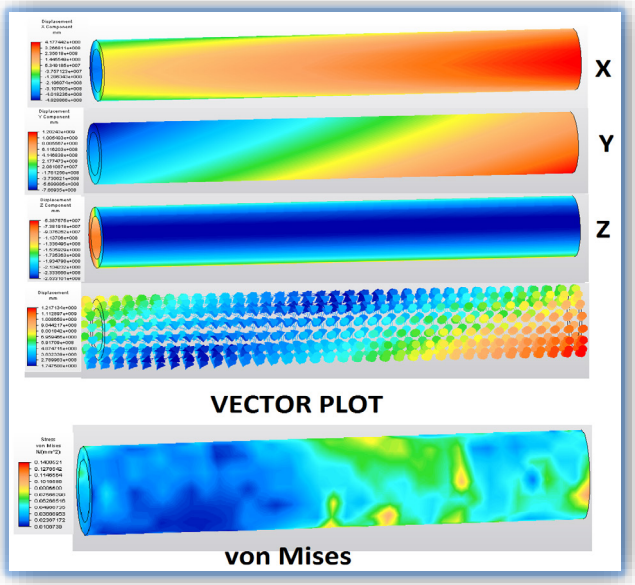

Figure 7. Magnitude distribution on the three axes X, Y, Z, and distribution vector / von Mises stress

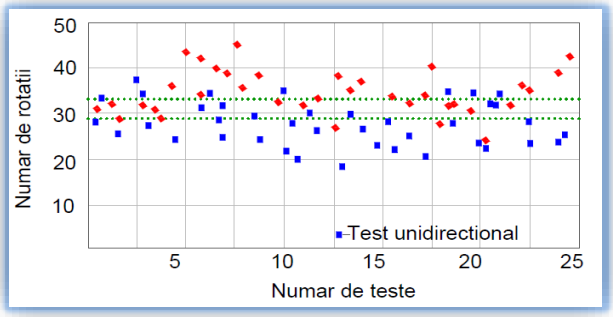

Figure 8. Variation characteristics for determining torsional ductility

Figure 8 shows the twisted values resulted after the simulation. By using the alloy Al-5Ti-B we can observe that the number of rotations per unidirectional test is very close to the same value of the alternative test result. For a given material or wire from Al, the value per rotations of the alternative test must of been almost double, establishing a value with 50% better ductility and stress resistance. Our bar used in the experiment performed talking values almost identical on both test models (29.5rot.-32rot.). These closed torsional values are shown also graphic in Figure 6 through the vector variation of surface von Mises. The figure shows a linearization of the tension distribution on bar/wire, an attempt to behave symmetrically towards both ends and to distribute evenly the tensions which appear, retaining the highest values towards the center of the material.

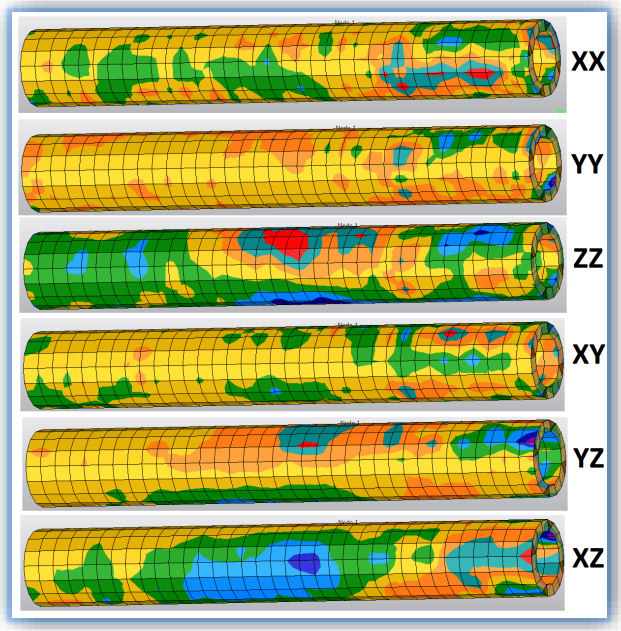

Figure 9. Stress linearization for each component part of barriers and test results.

Figure 9 and 10shows the phenomenon of linearization of stress distributions, the analysis was made with Autodesk Simulation Mechanical 2014 (AS-M) on all the axis of symmetry of the bar to be able to analyse the distribution of charged vector surfaces by a load of 20-160MPa and 100N. On 3 of the axis presented YY, ZY and YZ it can be best observed the phenomenon of linearization of vector distribution to resist to imposed request. Maximum points are shown on axis ZZ and partially on XX, and the minimum points are on XZ axis.

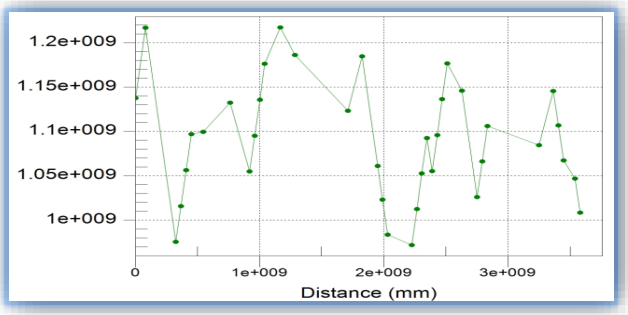

Figure 10. Symmetric variation of stress distribution over a certain distance

In the presented work was analysed according to AS-CFD stress distribution and the importance into the ductility analysis of Al-5Ti-B alloy emphasizing the following:

- *The alternative and unidirectional test values were very close; in our case the unidirectional test was smaller with 0.004 than the one alternative to a value of equalization decreasing value of the tension,*
- *The simulation on the Al alloy has passed the ductility test, resisting to a stress variation higher than 160MPa to a tension greater than 0.015. On this line, the torsional fatigue characteristics recorded improved values.*
- *The ductility values are close to both unidirectional and alternative tests, in the studied alloy produce a linearization on the piece length of stress distribution, which is highlighted by the vector values of surface into the Mises analysis.*

The test showed maximum variations of stress tensor in 2 points of maximum towards the bar center, the piece passing the ductility test: magnitude 160MPa and tension higher than 0.015.

In terms of vector orientation is observed a linearization of stress distribution to the whole surface of the piece, the alloy trying to resist to tension is higher than distributing them equable depending on the piece surface.

In conclusion, the test shows that using this alloy leads to obtaining a very close value for both tests: alternative and unidirectional, which is impossible in case of using only an Al material.

Acknowledgement:

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LOW COST DEVICE FOR GROUND REACTION FORCE MEASUREMENTS IN BIOMECHANICS

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Abstract: The term biomechanics or bio engineering has become synonymous with high cost measurement apparatus. This contribution focuses on force plate devices and challenges the current high cost trends of this technology by designing a low cost alternative capable of obtaining comparably accurate results. The design uses a simple and unique configuration of beam elements measured through strain gauges. The contribution explains the alternative devices evolution from concept to FEA calculations of active structural members, to the realization and testing of prototype. The data obtained from the prototype are compared to those from an established force plate manufacturer. The comparison of results shows that the prototype force plate obtains data that are comparable to the results acquired from high cost technologies, proving that the low cost alternative is capable of providing similar levels of accuracy at a fraction of current prices.
Keywords: force plate, ground reaction forces, strain gauge, finite element analysis, gait

INTRODUCTION

The evolution of biomechanics has accelerated rapidly in past decades as new technologies have become available. An important device in the analysis of human motion is force plate technology. This apparatus measured reaction forces when a patient stands, walks or even jumps on its measuring surface. It is a very useful tool in determining postural discrepancies and GRF (ground reaction forces) which can later be used to determine approximate JRF (joint reaction forces) through the application of inverse dynamics. An example of this can be seen in figure 1 where the approximate JRF at the knee can be determined by the following relations [1]:

$$R_x + F_x = m_t a_x$$
$$R_y + F_y - m_t g = m_t a_y \qquad (1)$$

where m_t is the mass of the shank and foot, a_x and a_y are the linear accelerations of the COM (centre of mass) and g is gravity.

These forces are a valuable indicator of a patients state of locomotion, especially when compared to results from a sample of statistically similar healthy individuals. On top of this the technology is capable of determining the direction of the reaction vector and COP (centre of pressure) during a certain activity.

The problem is that accurate systems capable of determining all of the above parameters continue to be costly especially considering that the measurement technology is already quite well established. At many teaching institutions, force plates are an exceptional tool for demonstrating how key biomechanical parameters effect a patients locomotion however they are often times financially unobtainable. This article challenges current high cost trends in biomechanical apparatus by designing and testing a simple apparatus that is capable of obtaining many of the same parameters at a fraction of current costs.

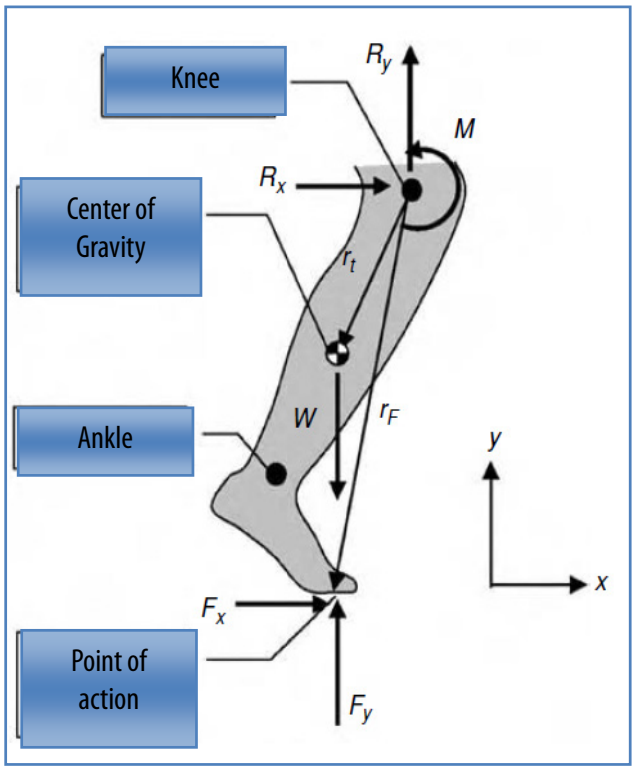

Figure 1: Free body diagram of reaction forces on the knee [1]

STRAIN GUAGE

Strain gauges are a reliable and well established technology that can accurately measure the deformation of structural members. They are constructed of an active grid configuration sandwiched between a flexible foil carrier. When glued to a structure that is loaded, the internal grid structure deforms and changes the output resistance. The sensitivity to change is known as the gage factor.

In practice, measurable strain is very small (often expressed in millistrain) thus it is important to be able to measure small changes in resistance which requires an excitation voltage V_{EX} across a bridge configuration like the one seen in figure 2.

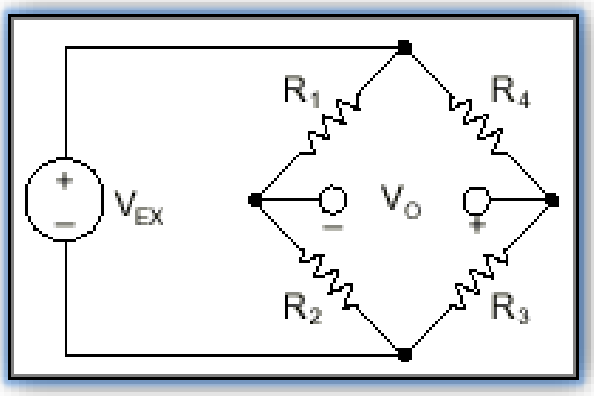

Figure 2: Wheatstone bridge configuration

The output voltage V_O across the bridge is then measured as:

$$V_O = \left[\frac{R_3}{R_3+R_4} - \frac{R_2}{R_1+R_2}\right] \cdot V_{EX} \qquad (2)$$

where one or more of the resistances R_1, R_2, R_3, R_4 in the bridge are substituted by the strain gage itself with a similar gage factor. With no change in resistance, the bridge is balanced and thus a zero voltage results. As soon as the gage is stressed a measurable nonzero voltage will result. In this way we can quantify the deflection of simple beam elements when subject to a known force.

DESIGN OF ACTIVE BEAM ELEMENT

Strain gages come in many configurations and specifications. In the intention of keeping costs low, a quarter bridge configuration is used for each measuring point. The active member is a simple beam element with circular cross section. The beam geometry is optimized to maximize sensitivity to deflection while remaining within the measurement range of the strain gage.

The proposed design utilizes strain gages from Vishay industries which have a particular measurement range up to 3% deflection along the measurement direction. Using this limitation as one of the design considerations and knowing that typical gait analysis encounter up to 2.5 to 3g of loading [2], a FEA (Finite Element Analysis) was constructed using a beam element with circular cross sectional area.

Loading the beam to the limiting case of a 100kg patient acting on the loading point of the member at3g allowed for optimization of geometry to obtain no more than 3% strain between corresponding elements along the measurement direction (Figure 3).

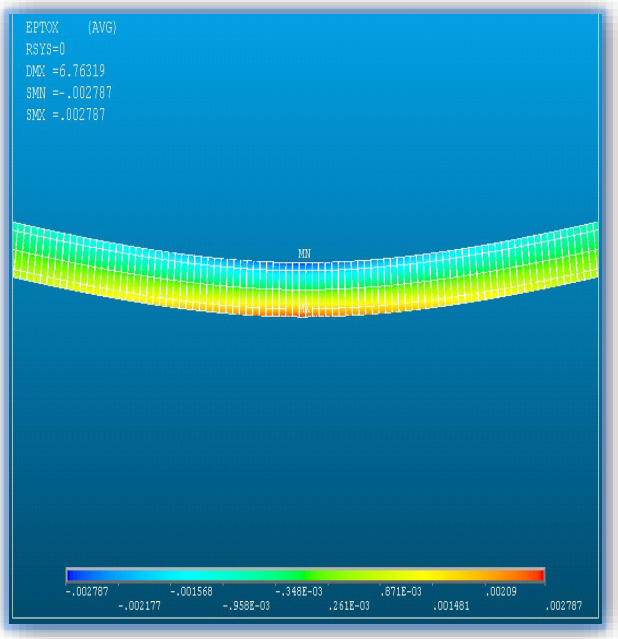

Figure 3: Analysis of total strain in the x direction (along axis of beam)

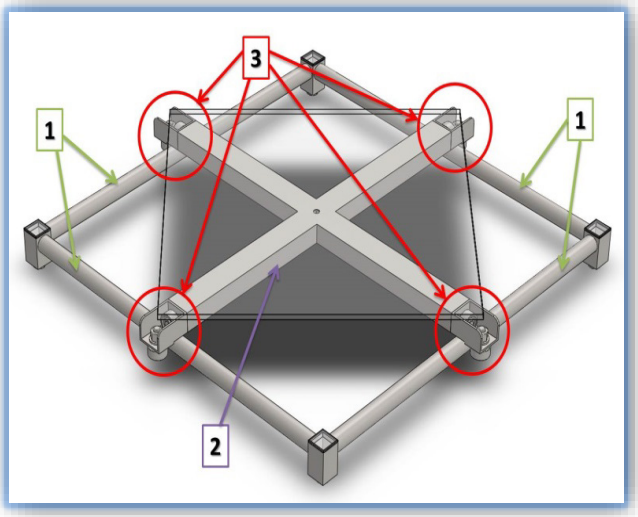

Figure 4: Model of 1 – active members, 2 – area of action, 3 – load points

Since there are four active members, this provides a large factor of safety since the patients weight is distributed over four beam elements. According to the FEA results, a model of the prototype was constructed with design considerations for loading points, ergonometric, and ease of data post processing (Figure 4).

DATA PROCESSING METHODOLOGY

The design configuration ensures that the active members are loaded in a controlled manner. The strain gages are mounted to measure tension on the beam underside in the area of maximum strain.

The quarter bridge for each gage were mounted on a standalone card with minimal lead length. The gages are excited by a stabilized 5V DC source. Voltage signals are fed through an ADC (analog to digital converter) to obtain data in a PC environment. Data acquisition was structured in labview software.

Firstly the unloaded signals were passed through an averaging block in order to detrend (zero) the signals in the unloaded state. Each loaded member is then calibrated using a 10, 20, and 30 kg mass respectively. the sensitivity is determined through the average difference in each loaded state from the reference detrended signal. After the calibration is completed, each signal is multiplied by its corresponding sensitivity and then summed to obtain the total vertical reaction force.

These values are then saved into .txt format after measurement completion for further data processing and interpretation. The constructed prototype can be seen in figure 5.

Figure 5: Prototype force plate design

RESULTS

The results of prototype measurements were compared to measurements obtained from a well-established force plate manufacturer used as a benchmark for comparison. Both force plates measured vertical GRF for the same test subject during gait. 10 measurements were performed for each force plate. An overlay of the results for the prototype force plate and benchmark force plate can be seen in figure 5.

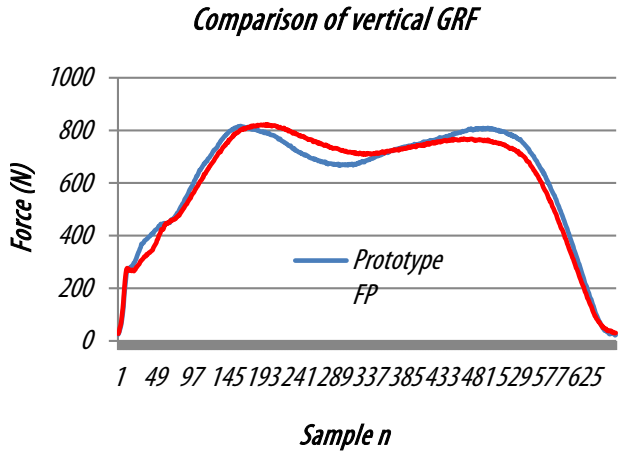

Figure 6: Comparison of averaged GRF measurements between prototype FP (force plate) and established FP apparatus

To quantify the strength of association between both sets of measurement, the linear correlation coefficient between the two results were calculated by the formula:

$$r = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{n(\sum x^2) - (\sum x)^2}\sqrt{n(\sum y^2) - (\sum y)^2}} \quad (3)$$

Where n is the sample size, x are values of one measurement, and y are the values for comparison. The coefficient returns values from -1 (negative correlation) to 1 (complete correlation). Comparison between the two measurements resulted in a correlation of 0.984. However a more accurate representation of how well the prototype measurements correspond to the measurements taken by the benchmark force plate was to calculate the RMSE (Root Mean Squared Error):

$$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_i - y_i)^2} \quad (4)$$

which returned an error of28.24 N compared to results from the benchmark force plate.

CONCLUSIONS

The preliminary results measured for this contribution show that the prototype design is more than capable of obtaining accurate results (provided some conditions are met), when compared to an industry standard device which measures the same physical quantities. It should be noted that the prototype is still in the alpha stages of development. The final design should be capable of determining the COP (Centre of Pressure) and with an additional four strain gages, should also provide reaction measurements in the horizontal direction. Together, the measurement data should be able to calculate the approximate direction of the resulting force vector.

However, there are some drawbacks to the proposed design. The active beam elements must be deflected in a precise area, else the tensile strain changes relative to the actual applied mass, thus the results are effected. Simultaneous contact must be ensured between the plate and beams or else the resulting vector be affected. The association between perpendicular beam elements may affect deflection. A floating beam would eliminate this problem. The diamond configuration results in a device which is larger than the area of action, requiring a runway to be built around it.

Finally, the beams are susceptible to plastic deformation if overloaded which can cause the strain gage to delaminate or change the characteristics of the measurements. Although it is true that most force plate designs utilize strain gages, they are less likely to be permanently damaged if overloaded.

Regardless the current prototype force plate performs well and costs much less to comparable systems. It is debatable which system is more accurate, but considering the results, low cost systems have the potential to perform just as well as the current high cost alternatives.

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RESULTS FROM THE ENERGY AUDIT OF THE HIGH SCHOOL DORM "MIRKA GINOVA"- BITOLA

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Abstract: *Measures for increasing of energy efficiency in buildings are closely related to Energy Audit. Faculty of technical sciences – Bitola (FTSB) is one out of five companies that were chosen as educating facilities for training of energy auditors. High School dorm "Mirka Ginova" in Bitola is the only state-owned dorm in the city. Preliminary energy audit for the nearby building of the dorm was performed as a part of the training for energy auditors. The calculations were performed by using of ENSI© EAB software.*
Keywords: *energy audit, dorm, energy class, ENSI software.*

INTRODUCTION

Following recent adoption of EU regulative in the area of energy auditing in the country, [1,2], the first step was to train energy auditors with a purpose of obtaining licenses for energy auditing. One of the institutions licensed for training of Energy Auditors is the Faculty of Technical Sciences in Bitola. In the course of this training, the building of the nearby High School dorm "Mirka Ginova", was used as an example for energy auditing with determination of its energy class using ENSI© EAB software.

The building of the dorm is located in the south-eastern part of the city of Bitola. The object does not have attached building to it, located in averagely urbanized part of the city, next to the city park, bus station and railway station. It was built in 1960 and significant reconstruction and extension took place in 1994. Main entrance of the building is on the south-western side (Fig. 1).

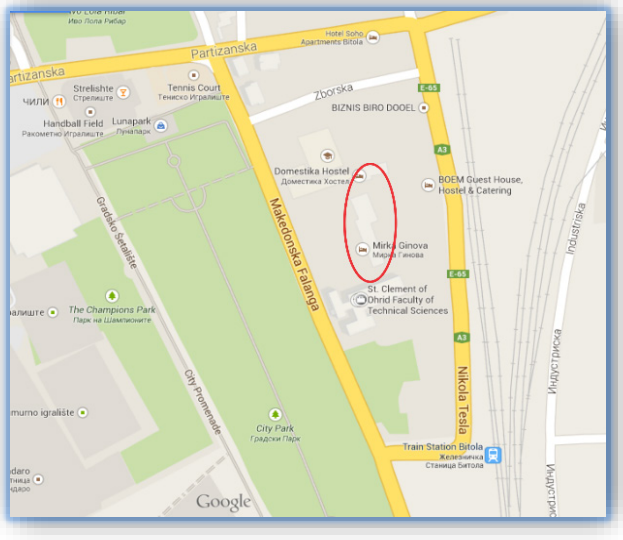

Figure 1. Location of the high school dorm "Mirka Ginova" in Bitola

DESCRIPTION OF THE BUILDING AND OTHER DATA REQUIRED FOR ENERGY AUDIT

Dormitory "Mirka Ginova" in Bitola is educational institution within the Ministry of Education and Science of the Republic of Macedonia, student standard department. The building is mainly divided in 2 parts: north and south part. South part consists mainly of bedrooms, while in the north part, the kitchen, dining room and administration offices are located. South part consists of basement, three floors with wooden roof construction covered with metal sheet roof, while the northern building has basement and two floors also covered with metal sheet roof. The capacity of the dorm is 270 high school students and 26 employees. In the summer months, the dorm is open to accommodate guests of different events in the city. In this period of the year, averages of 100-150 guests are staying at the dorm.

Total net area of the building is 3364 m^2, while total net volume is approx. 9420 m^3.

Last reconstruction of the building consisted of partial replacement of external windows and carpentry and took place in the year 2010.

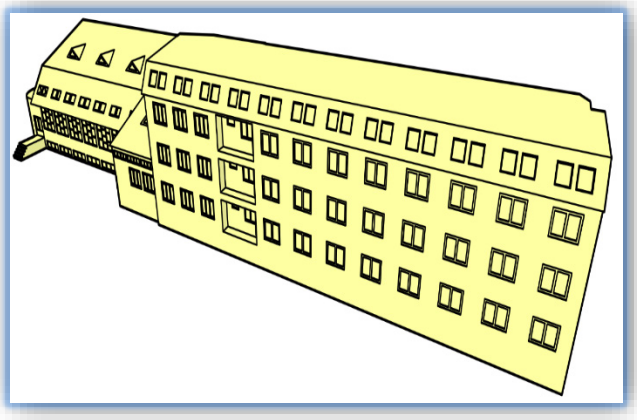

Figure 2. Appearance of the building from the south-west

Part of the other relevant data for the energy audit, required by the legislative, are given in the following table:

Table 1. Part of the data relevant for Energy Audit of dormitory's building

Characteristics of the building construction	Material (concrete, brick, hollow brick)	Total thickness [cm]	Thickness of the thermal insulation layer [cm]	Area of the construction [m^2]	Heat transfer coefficient U [W/m^2K]
External wall NORTH	Concrete	36	5	31,14	0,914
	Brick	43		297,61	1,16
External wall SOUTH	Brick	43		252,40	1,16
	Hollow brick	27		30,22	1,6

Table 2. Heat protection

	Execution of glazing for the windows, for example: triple insulated glass with inert gas and low emission coating	Carpentry – frame for the glazing, for example: wooden, aluminium, plastic etc.	Heat transfer coefficient through the window U [W/m^2K]
North façade [m^2]			
2,76	Double glazing	Wooden	2,9
21,66	Double thermopan glass with inert gas filling	Plastic (PVC)	1,3
15,00	Thermopan glass	Aluminum	3,25
2,54	Single glass	Steel	5,8
South façade [m^2]			
47,5	Double thermopan glass with inert gas filling	Plastic (PVC)	1,3
3,25	Thermopan glass	Aluminum	3,25
6,33	Single glass	Steel	5,8

Prior to entering of data in ENSI© EAB software, a detailed calculation of areas of all surfaces (external building envelope) as well as heat transfer coefficient for all materials was performed. In the following figures, example of calculated areas for building's south façade and cross-section of one type of external wall and roof are shown.

Figure 3. Dormitory's western façade – Total area without windows 517,1 m^2; red colored windows are with double glazing and wooden carpentry; yellow colored are with PVC carpentry and double thermopan glazing with inert gas filling, while blue colored windows are with aluminum carpentry and thermopan glazing.

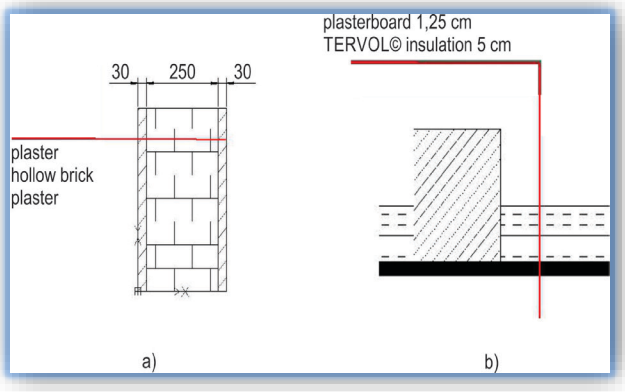

Figure 4. Cross section of construction – a) external wall with hollow brick; b) roof with plasterboard

At the end, we grouped external walls and windows in three groups according to building construction and heat transfer coefficients.

For the heating of building, hot water radiator heating system with forced circulation (with pump) is used. Heating installation is of a two-pipe system with lower horizontal branching. Two pumps are used for circulation of heating media (water). Boiler house consists of three hot water boiler connected in parallel, with a total of approx. 1100 kW installed heat power. Light oil is used as fuel. As part of the energy audit, a measurement of flue gases emission from one of the boilers was also taken.

Electrical equipment in use consists of more than 10 electric heaters (with total installed electric power of 54 kW) that are used prior to/after heating season (before 15.10 or after 15.04), electric appliances in the kitchen (total installed electric power of 116 kW), electric appliances in the laundry (around 53 kW), electric boilers with installed electric power of 102 kW, 15 personal computers copier machines, 11 air conditioning units (split system) etc. There are also around 180 fluorescent lightning tubes with electronic ballast installed for lamination and 52 light bulbs with total electric power of 5,2 kW.

For the purpose of energy audit preparation, detailed invoices – bills for electric energy and water consumption were collected from the accounting department.

INSERTING OF DATA IN ENSI© EAB SOFTWARE AND OBTAINING OF RESULTS

The ENSI© EAB Software, [3, 4], is tailored for quick energy calculations of the energy performance of existing and new buildings. The calculations can either be based on the standard climatic data, standard values and holiday tables that are included in the software, or by creating user defined standard values and holiday tables. In our case, we used the standard climatic values for the city of Bitola with user defined holiday tables, (Figure 5).

After naming the project in the software, the first step is to enter the actual condition of building envelope (areas and U-values). The software allows entering walls and windows in eight directions (N, NE, E, SE, S, SW, W, NW). "Walls" allow input of non-transparent constructions and "Windows" for transparent parts, (Fig. 6).

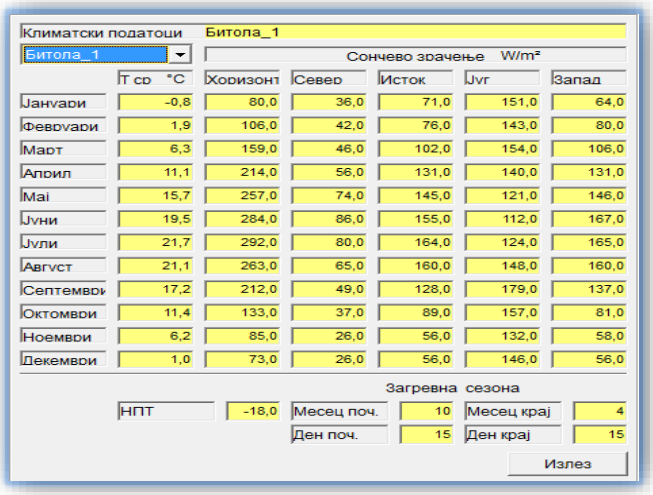

Figure 5. Climatic data for Bitola

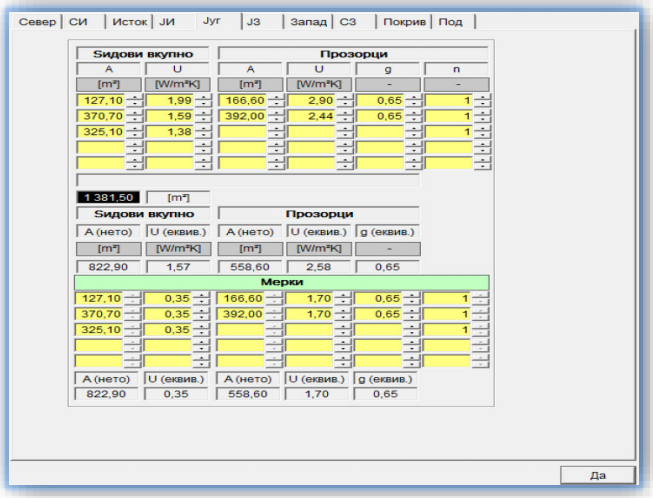

Figure 6. "Actual" and "After measures" condition of walls and windows on building's south façade

After entering of actual U-values, we also enter the U-values for the "Measures" – that is maximum permitted U-values for non-transparent surfaces according to the Rulebook for energy characteristics of buildings, [2]. When the entering of values for building envelope (walls, windows, floor and roof) is finished we proceed to enter the total conditioned (heated) area of the building and heat gains from occupants.

Next step is to enter/modify actual parameters for "Heating". This is done by changing of different efficiency coefficient referring to emission of heating objects, distribution efficiency, automatic control and production efficiency. It is also possible to enter parameters for "Measures" referring to condition after, for example, replacement of hot water boiler running on light oil fuel with corresponding boiler that uses wood pellets as fuel.

The next few steps include entering of values for "Ventilation" (in our case there is no mechanical ventilation of the building), followed by "Domestic Hot Water", "Fans, Pumps and Lighting", "Various exploitable and unexploitable" and "Cooling and Outdoor".

When all the data are filled in, the software gives the results of calculations on five screens. The "Energy Budget" includes the energy use for the standard building and calculated energy use for "Actual", "Baseline" and "After Measures". The "After Measures" values summarize all the savings from the "Measure" columns for each budget item.

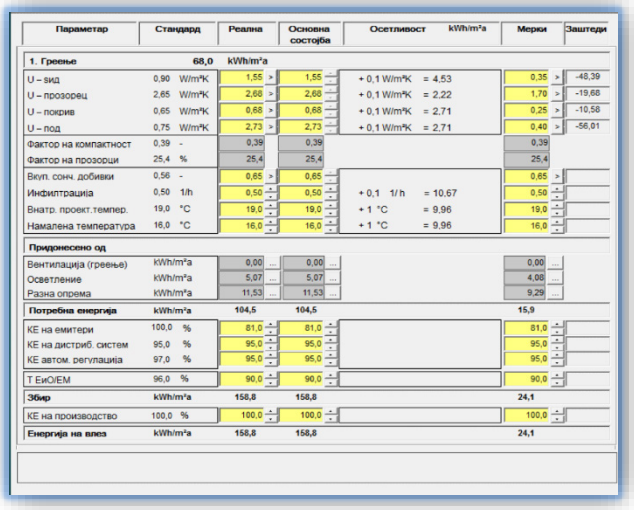

Figure 7. ENSI© EAB "Heating" screen

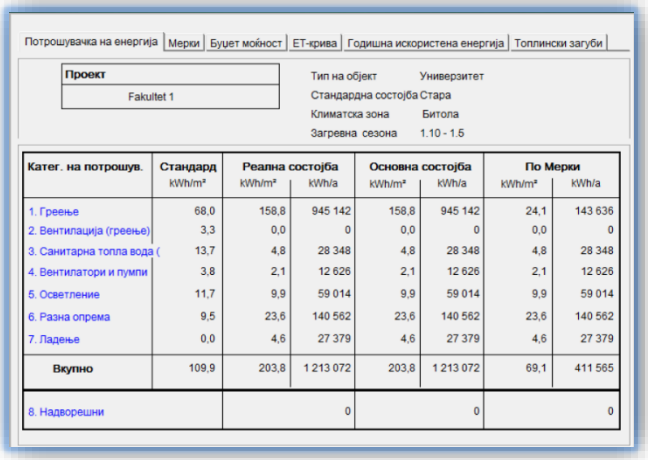

Figure 8. "Energy budget" results screen

By clicking "Power budget", the corresponding budget for maximum simultaneous power demand for each budget item will appear.

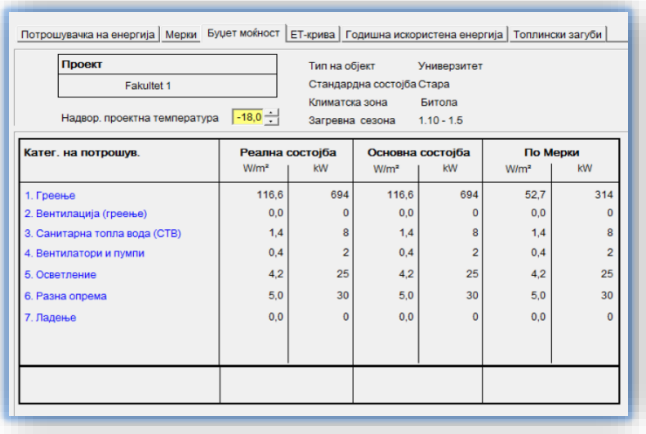

Figure 9. "Power budget" results screen

Both specific and total power demands are presented in the columns "Actual", "Baseline" and "After Measures". The kW's is the specific value multiplied by the conditioned area of the building, defined in the "Building envelope" window.

CONCLUSION

Following recent adoption of EU regulative in the field of Energy Auditing of buildings, the Faculty of Technical Sciences in Bitola is one of country's five licensed training centers for energy auditors, [5]. In the scope of training, practical part, the building of dormitory "Mirka Ginova" was taken as an example and general energy audit was performed on it. Calculations were performed using ENSI© EAB software for quick energy performance calculations.

The results from the calculations categorized the building of the High school dorm "Mirka Ginova" – Bitola as class "E" building. Calculated value of energy consumption is 158,4 kWh/(m²a).

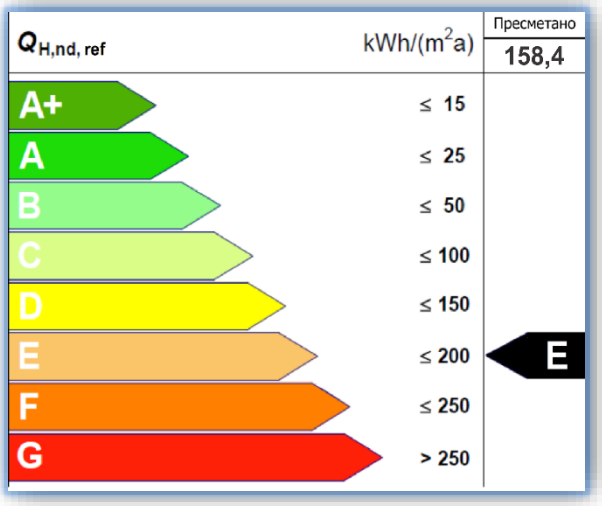

Figure 10. Energy class of the building

According to local legislative, [2], all buildings undergoing 'substantial reconstruction' must reach at least "D" energy class.

In the example of preliminary energy audit of the dormitory "Mirka Ginova" – Bitola building, the proposed measured would include:

- *Thermal insulation of all external walls in order to reach maximum allowed U-value of 0,35 W/m²K;*
- *Partial replacement of windows and carpentry in order to reach maximum allowed U-value of 1,7 W/m²K;*
- *Installation of additional thermal insulation for the roof in order to reach maximum allowed U-value of 0,25 W/m²K;*
- *Replacement of one of the hot water boiler running on light oil fuel with high efficiency hot water boiler running on wood pellets.*
- *Replacement of light bulbs and fluorescent lighting tubes with LED lights;*

Implementation of these measures would 'raise' building's energy class to "C".

Return on Investment (ROI) period for implementation of these measures was also calculated and it ranges from 2 years (lights replacement) up to 5,5 years (replacement of windows and corresponding carpentry).

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JUSTIFIABILITY OF EXECUTION OF SERBIAN TELESERVICE IN INDUSTRY

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Abstract: *In many areas of business services has a major impact on the decision for any manufacturer to decide, often even higher than the price or features. So, the classical servicers meet the above requirements only partially. To meet the above mentioned requirements is necessary to develop new concepts and methods, and one of them is the teleservice. This paper presents a teleservice as the process of removing electronic failures on machines from a distant place. Service is explained in details as new service, who gives a new concept of maintaining the production. Also included are all the positive and negative features of this service. The aim of the study was to analyze the reasonableness of performing Teleservice compared with the conventional way of service. The paper will be justification of service execution teleservice show an example of a machine for filling water.*
Keywords: *Teleservice, service, machine, the maintenance, failure*

INTRODUCTION

The teleservice means remote service that is process of technical services through telecommunications networks to remote location. This service includes remote access to the machine by an authorized company. Remote maintenance will provide servicer that he can from his work place directly on machines performs certain procedures. Each press of the keyboard and the mouse movement is directly transferred to a PC of person who ordered service. Servicer that can see the state of the PLC on that workstation. The main focus here is placed on proactive service, remote service and multimedia communication. The most important industries to support e-service are now in the process industry and medicine.

On the market today there are over 200 companies in e-services with different approaches and different technological parameters [1].

All bigger international competitions machine manufacturers forces the same to provide their customers with very good quality service network and not just big machinery manufacturers, but also even the little ones. Very important business activity of machine manufacturer after their sell are also after-sell services. This is primarily related to the repair and especially on maintenance. Customers today, from the manufacturer, not only expect a very high quality product, but a very high quality and efficient service.

In many areas of business services has a major impact on the decision for any manufacturer to decide, often even higher than the price or features. So, the classical servicers meet the above requirements only partially. To meet the above mentioned requirements is necessary to develop new concepts and methods, and one of them is the teleservice [2].

Competition has become very intense increase in the globalization of markets. Companies are forced to adopt new strategies in order to ensure their competitiveness. In the classical concept of service a large part of the supporting service was provided locally, in the sales, local cooperation or service personnel acting in the world. This concept requires huge financial, organizational and legal risk. Therefore, there must be developed alternative methods of service. The constant growth of is innovative machine manufacturers who are already using new information and communication technologies effectively in servicing the machines. These IT (information technology) services operate at a great distance and can be considered as teleservice [3].

The early 20th Century was the beginning of the development process teleservice on technical systems. The process is a technical point of view developed over time so that today are based on peer-to-peer connection via modem. Teleservice is characterized by a reactive service strategy. Remote services, which means the use of the service process across networks, especially the Internet has expanded the potential scope of services teleservice and strengthen it. Due to the increasing integration of production machines in the environment, teleservice centers are also increasingly necessity for the successful operation of any equipment. Teleservice significance and its potential variety in terms of global competition is undoubtedly an extremely large. Manufacturers as users can take advantage of a number of benefits that provide access to information and communication technology support. To fully exploit these advantages in practice, it is necessary to fulfill these demands acceptance by users, organizational integration, and technical aspects. If this meet teleservice provides adequate rational potential. In addition, the increasing development

of information and communication technologies will result in the realization, in today's conditions visionary concept and the constant increase in the spread of teleservice. Companies that intend to remain competitive today on international market will have to use a teleservice [4].

JUSTIFICATION OF TELESERVICE

Teleservice can still be defined as a method for data exchange based on remote access to the venue or technical equipment (machines, production lines, computers, etc.) to detect fault diagnosis, maintenance, data analysis and optimization. The connection between the user and the system can be established using the following communication media: analogue telephone network, ISDN, cellular networks and the Internet [5].

The complexity of modern machines and equipment that are used in industrial production requires new methods for easier troubleshooting. Troubleshooting and repairs in a classical way service machines require high costs and adds the following problems [6]:

- *Journey from servicer to user. During that time machine does not work causing great financial loss. Often technicians on-site find even trivial defect;*
- *Some errors can occasionally appear and disappear. In most cases, the customer just looked at this problem, and still operate. When the repairman arrives to the machine, all traces are gone. So it often happens that no one can find the cause of the failure;*
- *Servicers must bring with them a lot of funds for the work, equipment for measuring and tools. Often it can happen to forget the important special tool, then you have to wait until tool gets there;*
- *Service and transport costs a lot.*

As the basic requirements for the introduction of services Teleservice stand out [1, 7]:

- *limiting local manpower or reduce to a minimum,*
- *risk reduction in hazardous working environments, e.g. in explosive environments,*
- *entral expertise (locally solve small problems a remote, centralized complex problems by service personnel),*
- *efficiency and faster response from servicer and improving procedures for preventive maintenance due to constant monitoring of performance machines.*

In order to teleservice possibly work there need to be fulfilled the following conditions [1]:

- *Geographical distance: Service should be provided with spatial distance. This means that the service must provide a service technician who is far away from the user;*
- *The use of information technology - use of information and communication technologies is essential in performing services (i.e. Using ISDN or modem for the transfer of process or control data);*
- *Industrial service - Derivative services should be in the field of industrial services, for example, maintenance, diagnostics and repairs.*

Benefits of a teleservice bring the user the equipment and the equipment manufacturer are shown in Table 1.

Table 1. Advantages of the use Teleservice for users of equipment and equipment manufacturers

Equipment user	*Manufacturer of equipment*
Long-term reduction of labor costs *Reduction of cancellation* *Minimum cost service out of warranty* *Support during commissioning* *Increase competence within the company to resolve problems* *Increase employee satisfaction by expanding the knowledge base and expanding the scope of implementation of tasks* *Internal staff training*	*Reducing costs (labor and transport)* *Increased availability of experts within their own company* *Optimizing structure of service* *Improving the efficiency of service* *Intensified the obligations of user* *Economic presence in remote regions* *Increase performance service* *Reducing the response time*

MATERIALS AND METHODS

The paper will be the justification of service Teleservice in Serbia show on one machine for filling bottled water in water factory Water Villa Ltd Novi Sad. The above machine is used for filling Fruskogorska spring water in plastic bottles from 0.5 to 2.5 liters. To demonstrate the justification of performing services Teleservice it will be compared the conventional way of service on the example of a failure on the same machine. For the analysis of justification types of services will be analyzed following costs:

- *costs of a halt in the service,*
- *travel expenses and*
- *the cost of diagnosis and resolve a failure.*

RESULTS AND DISCUSSION

Machine to a standstill using the services Teleservice spent one hour, instead of the most minimal of six hours using the conventional way of service. Time turned into money needed for travel service in the classical way of service on the route to 150 km of that was 150 €. Total cost of the services Teleservice to fix the fault on the machine for filling water would amount to € 900, while the application of the conventional type of service the total cost of repair services amounted to € 2100, table 2.

Table 2. Comparison of the cost of services Teleservice with traditional service on the machine for filling water

Cost of services, which are compared	*Teleservice*	*The classical way of service*
Cost of service downtime in the process of servicing	*1h x 300=300 €*	*6h x 300=1.800 €*
Travel expenses (arrival and departure)	*-*	*1€ x 150 km =150 €*
Cost of diagnosis and the solving of a cancellation	*600 €*	*150 €*
Total costs =	*900 €*	*2.100 €*

Demonstrated on the example of two methods of maintenance is possible by applying a Teleservice reduce costs by up to 2.33 times. Online support, shown by the example of removing clients save time and money, reduces machine downtime period and reduces the number of personnel engaged.

The above shows online support on technical systems saves time and money, as do 90% of all electronic faults in machines and plants can be eliminated by using a Teleservice. Using a network connection and computer sharing, can monitor the status on your computer or on that workstation. Online support includes electronic services in the form of: system configuration, consulting services regarding support, support questions, upload and download data management it. Through online support can be a software update, if there is a need for it. Online teleservice training also saves valuable time when it comes to training courses. It is not rare that an online support can provide training for new software programs or special requests that they provide.

For example free access to the remote service can be based on the use of prepaid telecommunications services. With the consent of the Employer Services Teleservice, for example may be granted a loan of five hours. During the process of Teleservice, may at any time check how much credit or time remaining. So, the customer service always knows what his current loan and, if necessary, it can always supplement. When concluding the first contract for remote maintenance is usually more well-known companies give 5 to 10 credit hours for free.

CONCLUSION

Users of Teleservice need to realize the benefit of cost reduction-Reduction of failure, greater flexibility and productivity services. Teleservice Service providers on the other hand should look for their advantage to improve efficiency, customer loyalty and commitment to a better job. All of these justifies teleservice as a very current topic that is brought into context with the reliability of technical systems and defines it as an issue which is yet to speak, and an area that is yet to develop in the years to come.

Demonstrated on the example of service to the Teleservice filling machine bottled water maintainers funds for work in production could reduce their costs by up to 2,33 times compared to traditional ways of service.

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Edit Szilvia RUBOCZKI

NEW DIDACTIC METHODS IN CLOUD TEACHING

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Abstract: *This article deals with how gamification can open new ways in the education of cloud security. The new generation needs more exciting, more engaging tools at all stages of the flow of information – browsing webpages, reading news, using apps on mobile devices. This article focuses on those elements of gamification which can give a pleasant experience for the users, making them stay on the browsed pages and making them engaged for the downloaded applications. Cloud Computing is a widely used platform – and cloud security rules have to be kept by every user. But how can we make the users feel responsible for this security policy if they have no motivation to read at least the terms of use? A possible solution would be: gamification didactics tools.*

Keywords: *cloud; cloud computing; cloud security; cloud awareness; gamification; education*

INTRODUCTION

This article deals with new training solutions which make long-term education more enjoyable and less expensive. In a previous article [2] the characteristics of personal trainings were examined – these can be highly enjoyable, however they are the most expensive form of education. Of course not any subject is suitable for gamification – In the following, a novel approach is made to gamify a seemingly uninteresting topic: for example cloud security.

Two different user groups will be observed, describing the ways of teaching in these different platforms. Useful ideas will be discussed with the aim of reaching the audience and maintaining their attention. After having achieved the engagement of the audience for the gamified education app, a self-educating, satisfying IT teaching method can be established.

WHERE TO TEACH CLOUD SECURITY

Cloud Computing is a widely used platform in different environments. Several service providers make their services or applications accessible for all types of users from the cloud. It is essential to develop safer and more reliable apps which can be suitable for all users. Although safe using is the end user's responsibility, service providers create more and more simple and compact applications with built-in safety elements.

End users can be divided into two main groups, focusing on the course of the utilization. The first one: the so-called grouped using, when users are under a mobile device group management, under a company policy. These users' devices are under protection from outside threats but this gives them less freedom of use. The security policies are written by the company and all end users have to keep all rights by the enterprise. Cloud Security awareness is low but the developing could be organized and managed by the company. All education types could be suitable for the users because of the company's supervision. If the goal is engaging the participant, it is necessary to find and apply didactic elements that give success and self-motivation.

The second group includes consumers who can access the cloud using any device. The market offers the mainstream in usage but the device protection belongs to the end users. A wide range of apps address mobile users and most free apps are available with a simple free cloud account. In most cases, free of charge apps are the most expensive goods in the market – users pay with data, with usage information, user habits.

In this case there is no obligatory action to force end users to learn the security rules or comply with them. Here the only way that makes end users more compliant is creating an attractive platform which can be lovely, exciting and addictive enough to open it whenever the user has some free time.

HOW TO TEACH CLOUD SECURITY

First of all, teaching cloud security is the most important task we have to manage. Security questions are here, the cyberspace era poses frightening issues. Any IT device, software, hardware is reachable for everybody, and one cannot mention any kind of job not using an IT application via Internet. IT became an essential service, and all parts of business and private life use IT and cannot manage most actions without IT service.

Cloud computing brings new training and learning tools into education. Teachers or trainers reach their students in an easy way on different platforms, for example using web conference, social community sites, common sites, hosting sites or they can evolve a closed user group for a training team.

The advantages of cloud computing mean new possibilities for students as well. Students have access to the internet anywhere and anytime, they can even attend lectures of various universities simultaneously. Borders disappear, there is no physical barrier, and there is no distance between students in different universities, different countries. Students can use any device they have and connect easily to the university cloud. Studying can be supported by a range of

interactive or online elements, students can help each other solve a problem or they can work together on the same project using co-working apps.

Another advantage of using cloud at the university is the fact that students can get in-depth knowledge of the cloud which can be an asset for a job application. Students can take part in foreign scholarships or foreign projects without travelling abroad.

In Hungary, some universities have started to use advantages of the cloud. For example, the Óbuda University started a course in 2014, which is available for students at partner universities. The Informatics Faculty of ELTE was the first in Hungary that moved to the cloud, providing several features to its students. The University of Miskolc and the University of Debrecen have also moved to the cloud and provide their students mailbox, SharePoint sites, OneDrive cloud storage with 1 TB and professional web conference with presence and chat functions.

GAMIFICATION

Gamification is the straightest way to engage the customer. These days, one of the biggest problems in the online world is how to pay attention and maintain this attention for a while. Browsing a web page, downloading an application – it is engaging the attention just for a few minutes, or just for a few days. The best market-leading game software companies know the secret to keep the users in front of the application for hours. With gamification we can reach the end users regardless of age, geography or IT platform.

Nowadays website visitors need more visual information and less text, less uninteresting information. Text length is reduced, and the imagery is more expressive. But this is not enough to make the user an engaged user. Users want to be part of the story, part of the act, have influence on social networks, and have responsibility for the other users. Gamification can give all these features for all end users.

Chao Liu from Microsoft Research says that an average website visitor spends only 10 seconds on the site before deciding whether he/she wants to keep on reading or not. If the visitor spends 30 seconds more on the same website, there is a chance that he/she stays 2 whole minutes more. In mobile platform the results are more worrisome: according to Localytics research, 69% of the users use an average app at most 10 times. [5]

Gamification can be a motivation tool for every customer:

- *Desire*
- *Motivation*
- *Task*
- *Challenge*
- *Compliance*
- *Reward*
- *Feedback*
- *Excellence*

And what does engaging mean? If we can evolve an engaged user, we can get a variety of information on his/her habits:

- *Actuality – When was the last login?*
- *Frequency – How frequently are the users visiting the app/site in a time period?*
- *Period of time – When do the users log in and how long do they stay there?*
- *Spreading – How many users refer to the app or site?*
- *Assessment – How do they like and evaluate the app or site?*
- *Awareness – In test methods, how many users identify, recognize a specific brand or product?*

EFFECTIVENESS OF GAMIFICATION IN EDUCATION

Applying game theory online involves more than creating a contest. It applies the concepts of game design thinking into non-game applications. Gamification is a psychological process, utilizing public recognition and online competition to generate interest. [1]

Gamification could be a better way to get hold of crowd to increase the awareness of cloud security. Gamification techniques could be an enjoyable, long-term, impulsive and motivating education or marketing didactic tool. Some companies with different profiles tried it and could achieve higher or stronger profit. There are some significant results in cloud CRM usage of gamification, SalesForce could increase the sales process with 70%. [1]

Compared to other methods, gamificiation is a much more effective way to transmit information to large publics. Online trainings are less efficient, but they can reach more and more students in the world, in different languages at the same time. A subjective observation is that users do not take offline e-learning lessons seriously, not even the exam at the end. Online trainings are not free from restraints: tutor and students need real-time communication, so they have to be online at the same time. Tutors invest more energy to draw the attention – but in fact students give less heed.

Using gamification, tutors and developers make students into real participants – by involving them in a community or a motivating system. It is an interesting challenge to draw the cloud users' attention to the weak points or dangerous situations of usage of cloud computing. With gamification, users can learn how to use IT and cloud in a secure way – they can teach each other, debate issues, create workgroups and collect points for all these activities in the cyberspace.

With gamification it could be easier to teach the public and achieve educational goals than with any other web-based didactic tools. The author of this article has experience in editing e-learning materials, which can reach more students at the same time, in more languages, but she is not convinced of their effectiveness.

Using Gamification the users can be kept focused in a very addictive and motivating way, utilizing their social and game passions. It is a success if an enjoyable and interesting way can be found to inspire trainees to keep on learning.

Some elements of games that may be used to motivate learners and facilitate learning include:

- *Progress mechanics (points/badges/leaderboards)*
- *Narrative*
- *Player control*

- *Immediate feedback*
- *Opportunities for collaborative problem solving*
- *Opportunities for mastery, and leveling up*
- *Social connection*

Some of the potential benefits of successful gamification initiatives in the classroom include:

- *allowing students to work on their own*
- *opportunities for identity work through taking on alternate selves*
- *freedom to fail and try again without negative repercussions*
- *chances to increase fun and joy in the classroom*
- *opportunities for differentiated instruction*
- *making learning visible*
- *providing a manageable set of subtasks and tasks*
- *inspiring students to discover intrinsic motivations to learn*

Statistical research has been done [3] about the effectiveness of gamification in education. Comparing gamification with any other web-based education method, it is clearly seen that the involvement of gamification in the education of participants has significant advantages. There are clear differences in engagement levels between the groups (see Figure 1 for a summary of the results which showed a clear increase in engagement in the experimental gamified group). [3]

Specifically, it found that the gamified, experimental group:

- *had more members who gave responses(83% vs. 68% of members)*
- *was more likely to start discussions, as a greater proportion of posts were in response to other members' answers rather than directly to our structured questions (37% vs. 3% of posts were comments in response to other members' answers)*
- *had a higher average number of posts per participant (2.3 vs. 1.5)*

Unfortunately, due to the relatively small size of the group, it was not possible to take the results as clear-cut evidence for gamification's effectiveness, regardless of how compelling the results appeared. [3]

Kevin Spier and Dan Maier of Bunchball published another case study of gamification effectiveness. Bunchball integrates game elements into websites and non-traditional game media. They partnered with NBC Universal to revamp the fan site for their comedy series, Psych. Bunchball added several game elements to the site in order to achieve this goal, including allowing fans to accumulate points for completing tasks such as watching videos, solving puzzles and listening to songs. These points could be redeemed for prizes such as T-shirts, mugs and small autographed items. In addition, high-scoring fans competed with each other via an online scoreboard. [4]

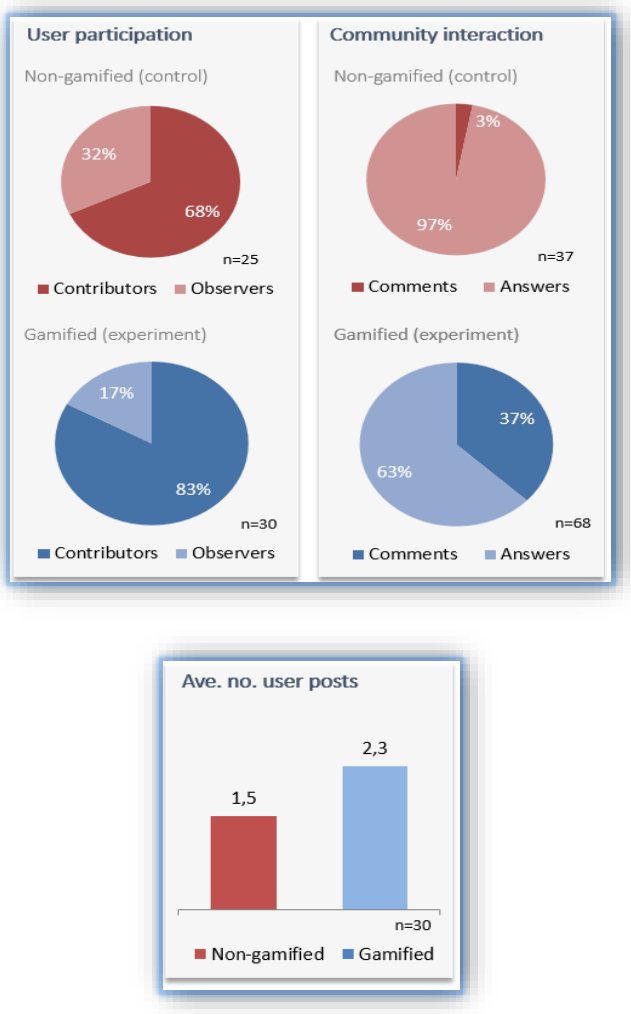

Figure 1: Proportion of non-gamified and gamified participants

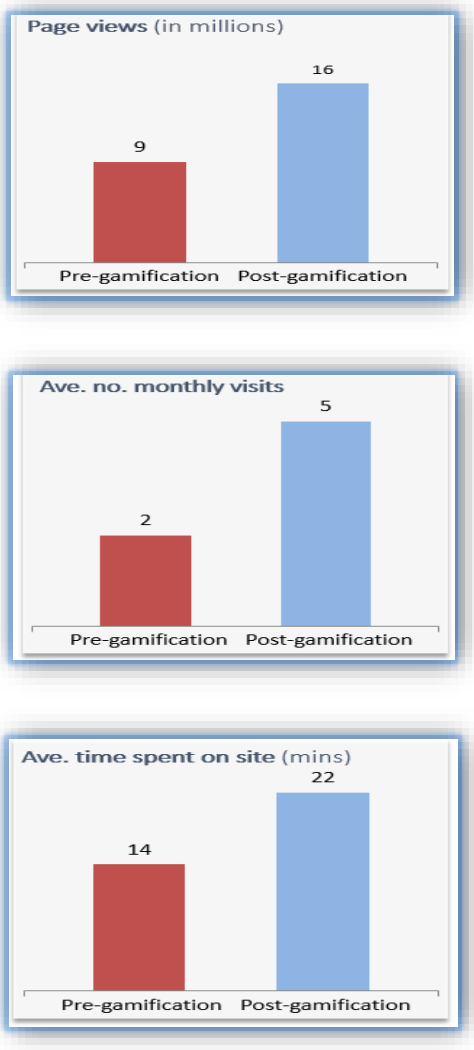

Figure 2: The effect of gamification in visiting, and spent time

The results seem to justify the value of creating a compelling online experience through game elements:

- *Overall site traffic increased by 30%,*
- *Page views increased from 9 million to 16 million within the last gamified season,*
- *The average visitor came four to five times a month instead of only twice a month,*
- *The average time spent on the site increased from 14 minutes to 22 minutes,*
- *Online merchandise sales increased by 47%.*

CONCLUSION AND FUTURE WORK

The author's future plan is to test gamification in a real enterprise environment. It will be a challenging task to select the most suitable platform, the suitable device, the methods, and the types of gamification to be applied. The author has already started collecting ideas for this test and its results are eagerly awaited.

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STUDIES ON THE MATHEMATICAL MODELING OF ARTIFICIAL SOIL COMPACTION

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Abstract: The compaction of agricultural soil is a phenomenon of degradation, occuring from natural or artificial causes and is defined by the increase in soil density and the decrease in soil porosity, with negative consequences for the environment and for agriculture. Artificial soil compaction is generated by the contact between soil and tires or tracks of tractors and agricultural machinery. This paper presents some general mechanical concepts regarding the behavior of soil under compressive stresses and a review of some mathematical models which can be applied to describe the behavior of soil at compaction, under the influence of various parameters.
Keywords: soil; artificial compaction; tire; contact area; stress; strain

INTRODUCTION

The phenomenon of soil compaction can be assimilated with the compressive strain and can be represented by a criterion of soil flow. A first compressive behavior of soil occurs when the compressive forces applied to the soil produce a certain degree of compaction, which, however, disappears after the removal of forces. In other terms, the volume decreases as stress increases, and viceversa. From an mathematical point of view, input and output variables are uniquely correlated to the entire field of values. Another behavior occurs when, after termination of the action of compressive forces, the soil does not return to its original state. In this case, input and output variables are uniquely correlated only to a certain set of values. The soil has both plastic (the most common situation) and elastic behavior. In order to develop and interpret equations that describe the behavior of soil to compaction, the circumstances in which the phenomenon occurs must be known [5].

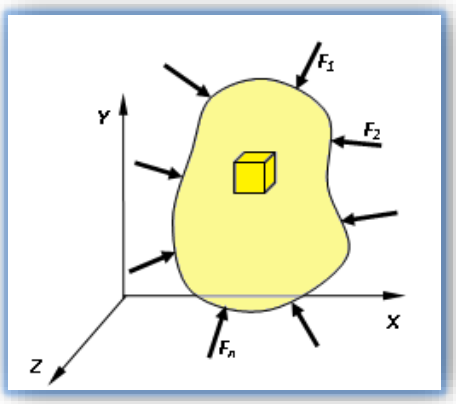

Figure 1. Action of a system of forces on an elastic body [3, 5]

A cubic element of volume, having the sides equal to the unit, is isolated from a linear-elastic, homogeneous and isotropic body upon which is applied a spatial system of forces (figure no 1). Stresses emerged on the sides of this element of volume can be decomposed after the directions of the three axes of the reference system (figure no 2).

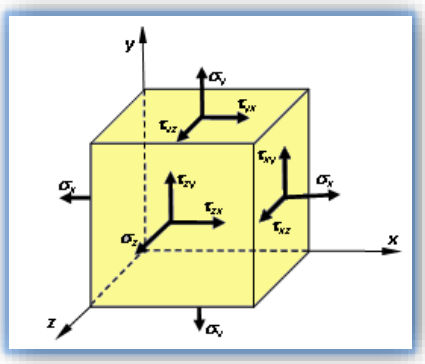

Figure 2. Stresses emerged on the sides of the element of volume [5]

MATERIAL AND METHOD

Stresses and strains in agricultural soil

Since the time of Archimedes, the distribution os stresses in the soil is a subject of scientific and engineering interest, culminating with the concept proposed by Cauchy (Truesdell, 1961; Davis şi Selvadurai, 1996), who assumed that the nature of reaction forces generated during the transmission of external loads appplied to the interior of a solid aren't different from the tractive forces applied to the boundary of a loaded solid [14].

The understanding of strain processes of arable soil is still limited. One reason for this fact could be that most research studies related to soil

compaction focused on the agronomic impact of compaction (and, more recently, on the environmental impact of compaction), at the expense of the strain process itself. External mechanical stresses applied to the soil (by the agricultural machinery) are related to the physical functions of soil or to crops reaction. To understand the impact of compaction on soil functions (reaction) is necessary to know the process of soil strain (cause). Strain is the response of soil to a mechanical or hydraulic stress applied on it. Soil stresses and strains are coupled phenomena: soil strain depends on soil stress and soil resistance, and the distribution of stresses in the soil depends on soil resistance and soil strain [14].

Stress tensor for the soil

Stress state of a cubic and infinitely small soil element can be descrbed by the normal stress σ_i - perpendicular to the side of the element of volume and by shear stresses τ_{ij} – tangential to the sides of the element [5, 12].

Stress state can be described by the matrix of stress tensor (Koolen & Kuipers, 1983) [12]. To describe the stress state in point A found in the interior of the element of volume on which is applied an external load, is chosen a system of axes x, y, z and is assumed an infinitesimal cube around point A, with the sides parallel to the axes of the coordinate system (figure no 3) [5].

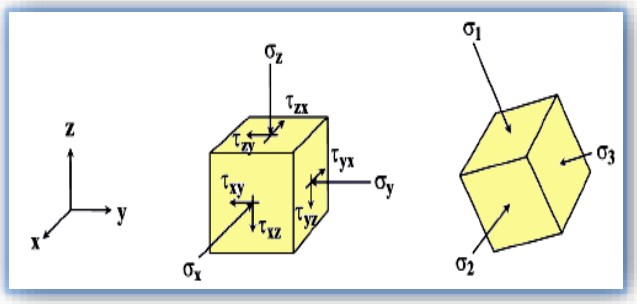

Figure 3. Components of stress [5, 6, 12, 16]

„Mohr's stress diagram" allows the plotting of stresses σ and τ for given σ_1 and σ_3 and for an variable θ angle. The steps required for this method are:

1. *drawing a rectangular system of axes with coordinates σ-τ;*
2. *positioning of stresses σ_1 and σ_3 on axis σ;*
3. *drawing a circle through the diametrically-opposite points σ_1 and σ_3 with the centre on axis σ;*
4. *drawing of A-B line from point σ_3 which makes an angle θ to the horizontal;*
5. *determining the coordinates of point B located on the circle, that represents the values of stresses σ and τ.*

This method is useful to find the values of stresses σ and τ for any θ angle, if the values of main stresses σ_1 and σ_3 are known (figure no 4).

Stresses theory for infinitesimal cubes can be extended to bodies (volumes of soil). This extension is verified experimentally using devices that measure the geometric changes of the volume of soil subjected to loadings, considering the soil samples as finite bodies rather than infinitesimal cubes. Next are analyzed the cases of a finite cube, a finite cylinder and a finite sphere.

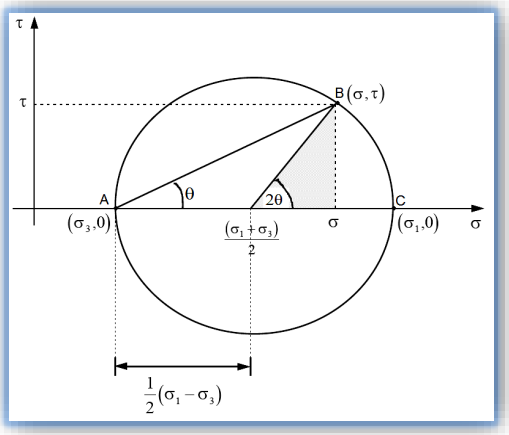

Figure 4. Mohr's stress diagram [5]

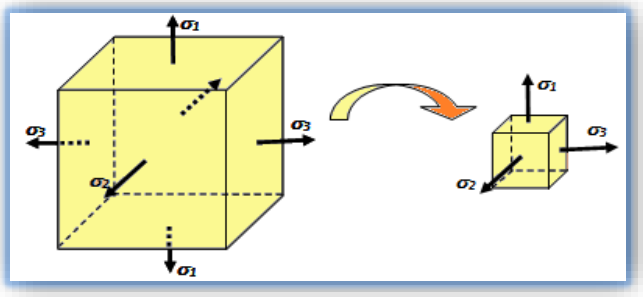

Figure 5. Finite cube [5]

Finite cube consists of small infinitesimal cubes, loaded with main stresses σ_1, σ_2 and σ_3. The large cube will have the following stresses: on the upper and on the lower side - normal stress σ_1, on the left and on the right side - normal stress σ_3, and on the front side and rear side – normal stress σ_2. So, if a cubic body is loaded by stresses σ_1, σ_2 and σ_3, then the stress state of each point will be given ny the matrix:

$$[\sigma]=\begin{bmatrix}\sigma_1 & 0 & 0\\ 0 & \sigma_2 & 0\\ 0 & 0 & \sigma_3\end{bmatrix} \quad (1)$$

having the axex parallel to the sides of the cube.

Finite cylinder is composed of small cubes, respectively small prisms in the walls area. For small cubes is assumed that $\sigma_2=\sigma_3$. For the upper and lower sides of the cylinder, the stress will be σ_1 and for stresses near the wall can be used equations 16 in section or Mohr's diagram, and it can be inferred that in figure no 6 the stress σ is equal to $\sigma_2=\sigma_3$ and τ=0. If a cylinder is loaded with σ_1 in the upper and lower sides, and with σ_m to the wall, then the stress in each point is given by the following matrix:

$$[\sigma_c]=\begin{bmatrix}\sigma_1 & 0 & 0\\ 0 & \sigma_2=\sigma_m & 0\\ 0 & 0 & \sigma_3=\sigma_m\end{bmatrix} \quad (2)$$

with σ_1 acting along the simetry axis of the cylinder.

For a finite sphere, loaded with σ_h after all directions, it can be shown similarly that stress state in any point is given by the matrix:

$$[\sigma_s]=\begin{bmatrix} \sigma_1=\sigma_h & 0 & 0 \\ 0 & \sigma_2=\sigma_h & 0 \\ 0 & 0 & \sigma_3=\sigma_h \end{bmatrix} \quad (3)$$

***Strain theory** [5]*

Theory of strain state in a point, with limitation in the area of small strains. At each point of the body (volume) of soil loaded there is a stress state and a strain state. Strains can be described comparably to that for the description of stress. Stress state has been described by normal and shear stress, and similarly the components of strain are: normal strain and shear strain.

Normal strain can be defined considering an infinitesimal line segment, with length L before the strain, respectively lenght $L+\Delta L$ after strain, thus:

$$\varepsilon=\frac{\Delta L}{L} \quad (4)$$

Shear strain is defined based on an angle which is straight before strain occurs for an infiniesimal volume of soil and for which, after strain, is rotated clockwise with an small α angle, while the horizontal side is rotated counterclockwise with an small β angle, then the shear strain of the initial right angle is given by the following equation:

$$\gamma=\frac{1}{2}\cdot(\alpha+\beta) \quad (5)$$

RESULTS

Probabilistic and deterministic mathematical models to express the behavior of soil at compression

Strategies and recommendations to prevent soil compaction are often based on simulation models (models of soil compaction), that allow the calculus of stress distribution and soil failure in the profile of soil for a certain mechanical loading (made by agricultural machinery) and for certain soil conditions (e.g., soil moisture and bulk density) and which can be of real benefit to farmers, in planning and deciding on the specific conditions of traffic on agricultural soils [13, 24].

Bekker (1956) and Söhne (1951, 1953) used the concepts of mechanics developed by Boussinesq (1885), Terzaghi (1925, 1943) and Fröhlich (1934) to obtain stress-strain soil models of soil under the traffic of agricultural vehicles [13, 14, 18].

Soil compaction models can be divided in three parts [8, 12, 13]:

1) *boundary conditions at soil surface, which refers to the contact area and the distribution of stress on soil surface;*
2) *distribution of equivalent stress in the soil;*
3) *soil behavior at stresses-strains.*

Among the three parts of soil compaction models there are various relationships, for example, the stress-strain behavior can influence the stresses on soil surface. First, must be defined the stresses at soil surface, then stress distribution is calculated, and soil strain is calculated by applying a stress-strain relationship to the calculated stress, or the state of compacted soil is estimated by comparing the calculated stress to the critical stress (for example, the precompression stress) [13]. It is neccessary to determine soil behavior in the field and then to correlate this behavior with in situ (in laboratory) behavior by mechanical tests, because [13]:

- *the duration of mechanical load in the field (for example, by agricultural tire) is much smaller compared to that of laboratory tests for the determination of soil mechanical properties;*
- *in the fied, loads are dynamic (so, the direction of main stresses is not constant in time), while in laboratory the loads are static;*
- *unlike filed loads, soil samples used in laboratory tests are often loaded under controlled conditions.*

Mechanical models simulate the processes taking place in a system, and empirical models define the relationship between input and output data, without defining the dynamic processes. The most common empirical model is the concept of soil resistance-soil stresses, in which soil resistance is considered similar to the preconsolidation pressure, and stress distribution in the soil can be estimated using a concentration factor [13].

Numerical models for soil compaction were proposed by Bailey et. al. (1986), Gupta and Larson (1982), Larson et. al. (1986), et. al. (1977a, 1977b), Smith (1985), Gupta and Allmaras (1987). Smith's model (1985) is based on the prediction of specific soil volume change due to changes in spherical stress produced by wheel load and contact area between tire and soil. Soil depth is divided into elements of layers, then is estimated the increase in spherical stress in the center of each layer under the wheel. The model can be used to compare the influence of different types and arrangements of wheels on the compaction. Gupta and Larson (1982) developed a model for soil compaction based on compression equations and on Boussinesq's equations modified by Söhne (1953), by introducing a concentration factor to describe different types and conditions of soil. Raghavan et (1977a; 1977b) developed an equation that describes the maximum change of loamy soil density after several passes of a tractor tire [10].

Mathematical models using bulk density to describe soil behavior at compression

The process of soil compaction can be described mathematically by relationships between soil bulk density (ρ) and the stress applied on the soil (σ).

✓ *Bailey's multiplicative model with three parameters (1986) [1]*

$$ln(\rho) = ln(\rho_0) - (a + b \cdot \sigma) \cdot (1 - e^{-c\cdot\sigma}) \quad (6)$$

where: ρ – soil density; ρ_0 – soil bulk density when the stress applied on the soil $\sigma = 0$; a, b, c – empirical parameters.

Logarithmic models predict that soil bulk density increases as the stress applied on the soil increases [1].

✓ *Assouline's model (1986) [1]*

Experimental observations based on Bailey's model indicate that the soil can be compacted to a maximum bulk density which depends on its initial state. In this regard, Assouline proposed the following logarithmic model:

$$ln(\sigma) = \rho_0 + (\rho_{max} - \rho_0) \cdot (1 - exp[-\xi \cdot \sigma]) \quad (7)$$

where: ρ_{max} and ξ – connection parameters.

Improvements to Bailey's model consist in the need of only two commection parameters, and the value of ρ_{max} can be determined in laboratory conditions using compression tests [1].

✓ Fritton's model (2001) [1].

Since the models proposed by Bailey and Assouline are not flexible enough to represent the variation of the shape of compression curves, from almost linear to S-shaped curves, expressed on logarithmic scale, Fritton proposed the following model:

$$\rho = \rho_m - (\rho_m - \rho_0) \cdot \{1 + [\alpha \cdot (\sigma + 1)]^n\}^{-m} \quad (8)$$

where: ρ_m – particle density; ρ_0 – initial bulk density; a, n, m – empirical parameters of connection.

By definition, for $\sigma = 0$ is required that $\rho = \rho_0$. Thus, Fritton's model becomes:

$$\rho = \rho_m - (\rho_m - \rho_0) \cdot [1 + \alpha^n]^{-m} \quad (9)$$

This model assumes that soil can be compacted until particle density, ρ_m, but this assumption is physically unrealistic and incompatible with the experimental observations of Amir et. al. (1976) and Faure (1981).

✓ Gupta and Larson's model (1982) [12]

Change of soil volume is described by a mathematical relationship between soil bulk density and the logarithm of maximum main stress:

$$\rho = [\rho_k + \Delta_T \cdot (S_l - S_k)] + C \cdot log\left(\frac{\sigma_a}{\sigma_k}\right) \quad (10)$$

where: ρ – final density corresponding to the applied stress σ_a; ρ_k – reference bulk density corresponding to reference stress σ_k on the virgin compression line (VCL); Δ_T – slope of variation curve of bulk density depending on water saturation degree at σ_k; S_l – desired saturation degree at σ_k; S_k – saturation degree at ρ_k and σ_k; C – compression index (slope of VCL).

✓ Bailey and Johnson's model (1989) [12]

This model describes the state of cylindrical stress in the soil:

$$ln\rho = ln\rho_0 - \left[(A + B \cdot \sigma_{oct}) \cdot (1 - e^{-C \cdot \sigma_{oct}}) + D \cdot \left(\frac{\tau_{oct}}{\sigma_{oct}}\right)\right] \quad (11)$$

where: ρ_0 – initial bulk density; σ_{oct} – octaedrical normal stress; τ_{oct} – octaedrical shear stress; A, B, C, D – compactity coefficients (for $D = 0$, this model is reduced to Bailey's model, 1986).

✓ Model to estimate soil density after tire passage, depending on the contact pressure [21]

Schwanghart studied the effects of agricultural vehicle tires on soil compaction, the pressure in these tires being generally lower than that of transport tires.

$$p = 45 + 0{,}32 \cdot p_i \quad (12)$$

where: p - contact pressure (kPa); p_i – tire inflation pressure (kPa).

Soil density after the passage of tire is given by the following relationship:

$$BD = \frac{3{,}275}{1{,}86 + \frac{0{,}36}{0{,}01 \cdot p + 0{,}277}} \cdot 1000 \quad (13)$$

where: p – contact pressure (kPa); BD – soil bulk density (kg/m³).

Based on these two models was obtained the variation presented in figure no 6, from which it can be noticed that the variation of tire inflation pressure has low effects on soil compaction.

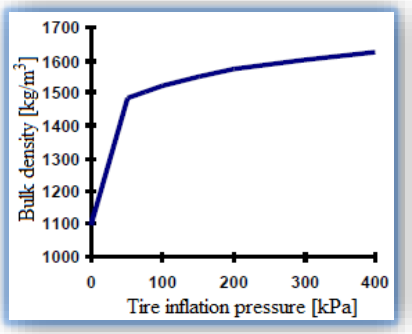

Figure 6. Influence of tire inflation pressure on soil bulk density [21]

✓ Model for the calculus of soil compactity [19]

Soil compactity is expressed as the ratio between the density of solid parts of soil ρ_s and total density of soil (voids and solid), ρ_b:

$$v = \frac{\rho_s}{\rho_b} \quad (14)$$

where: v – soil compactity; ρ_s – density of solid parts of soil; ρ_b – total density of soil.

Soil compactity is expressed as the maximum specific volume of soil at a certain given value of mean normal stress. The equation used for practical purposes is [12, 17, 19]:

$$v = N - \lambda_n \cdot lnp \quad (15)$$

where: λ_n – compression index; N – specific volume of soil if pressure p = 1 kPa.

✓ Model for soil sinkage after repeated passes of a tractor (Abebe, 1998) [20]:

$$z_n = z_1 \cdot n^{\frac{1}{a}} \quad (16)$$

where: z_n – soil sinkage after n passes (m); z_1 – soil sinkage after the first passage (m); n – number of passes; a – multipass coefficient.

Models for the calculus of the contact area

✓ COMPSOIL model for contact area [8]

O'Sullivan et. al. (1999) estimated soil bulk density on the longitudinal centerline of the wheel, starting with the tire's ruts on the soil. Contact area was calculated with the following relationship:

$$A = s_1 \cdot b \cdot d + s_2 \cdot L + s_3 \cdot \frac{L}{p_i} \quad (17)$$

where: A – contact area (m²); L – wheel load (kN); b – width of transversal tire section (m); d – overall tire diameter (m); p_i – tire inflation pressure (kPa); s_1, s_2, s_3 – empirical parameters depending on soil surface.

Table 1. Values of empirical parameters s_1, s_2, s_3 (O'Sullivan et.al.) [19]

Parameter	Rigid surface	Deformable surface
s_1	0,041	0,31
s_2	0	0,00263
s_3	0,613	0,239

✓ *Komandi's emprical model for contact area [7, 15, 22]*

$$A_{sol} = c \cdot F^{0.7} \cdot \sqrt{\frac{b}{D}} \cdot p_i^{-0.45} \quad (mm^2) \qquad (18)$$

where: c - constant (c = 0,3 - 0,32 for rather bearing soils; c = 0,36 - 0,38 for sandy soils; c = 0,42 - 0,44 for loose soil); F – wheel load (N); b – tire width (mm); D – tire diameter (mm); p_i – tire inflation pressure (MPa).

✓ *FRIDA model for footprint area [25]*

Is used to describe the footprint between soil and tire by an superellipse and the distribution of stress by an exponential function (perpendicular on the driving direction) or a power function (along the driving direction). The contour of footprint, in top view, can be modeled by a superellipse (Hallonborg, 1996; Febo ş.a., 2000; Keller, 2005) which, in orthogonal system with the center in the origin, has the following shape:

$$\left|\frac{x}{a}\right|^n + \left|\frac{y}{b}\right|^n = 1 \qquad (19)$$

where: a and b – half of small and large axes [m]; n – rectangularity. Boundary and interior of the superellipse are given by:

$$\Omega = \{(x,y) \,||x/a|^n + |y/b|^n \leq 1\} \qquad (20)$$

***Empirical models for footprint area** (Grecenko, 1995) [22]*

$$A = 1{,}57 \cdot (d - 2 \cdot r_l) \cdot \sqrt{d \cdot b} \qquad (21)$$

$$A = \pi \cdot \delta \cdot \sqrt{d \cdot b} \qquad (22)$$

$$A = c \cdot d \cdot b \qquad (23)$$

where: A – contact area (m^2); r_l – radius of unloaded tire (m); b – tire width (m); d – tire diameter (m); δ – soil deformation (m); c – constant (c = 0,175 for rigid tire on rigid soil; c = 0,245 for flexible tire with 20% deformation on soft soil; c = 0,270 for rigid tire on soft soil).

***Söhne's model for stress distribution at soil-tire interface** [9]*

Söhne proposed equations describing three types of vertical stress distribution (uniform, square, parabollic), for three types of soil (resistant, relatively resistant and soft), if the contact area has circular shape.

$$\sigma_v = \sigma_0 \qquad (24)$$

$$\sigma_v = 1{,}5 \cdot \sigma_0 \cdot \left(1 - \frac{\rho^2}{\rho_0^2}\right) \qquad (25)$$

$$\sigma_v = 2 \cdot \sigma_0 \cdot \left(1 - \frac{\rho^2}{\rho_0^2}\right) \qquad (26)$$

where: σ_0 – mean stress applied in the contact area; ρ – distance from the center of contact area to an considered point; ρ_0 – radius of circular contact area.

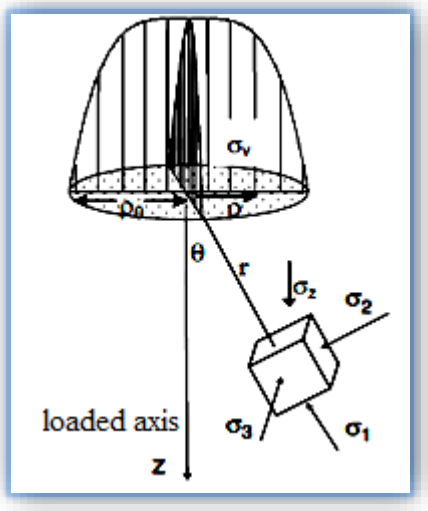

Figure 7. Stress on an elementary soil volume (Söhne) [9]

***Johnson and Burt's model for the estimation of stress in the footprint** (1990) [2, 11]*

Radial normal stress (maximum main stress) in any point of an elastic environment, due to a load applied in a point concentrated on a surface is given by Fröhlich's equation:

$$\sigma_r = \frac{v \cdot P \cdot \cos^{v-2}\phi}{2 \cdot \pi \cdot R^2} \qquad (27)$$

where: v – Fröhlich's concentration factor ($v \geq 3$); P – normal loaded point; R – radial distance between the concentrated load and the considered point; Ø – the angle between the normal load vector and the position vector from the concentrated load to the considered point (figure no 8).

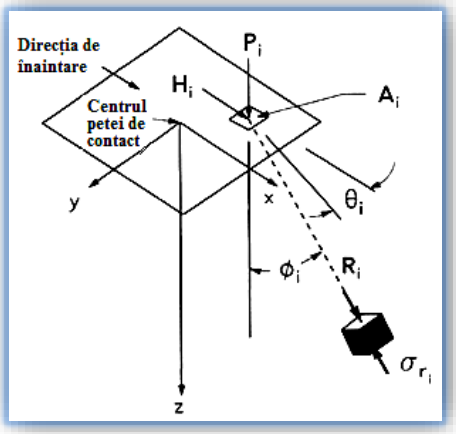

Figure 8. Geometrical relations for stress in a point of soil [11]

The concentration factor (v) can be: 3 – for very hard soil, the ideal case, 4 – for hard soil, 5 – for stable soil, 6 – for soft soil [19].

The equation proposed by Cerruti estimates the normal stress in a radial point of a semi-elastic medium, due to a single shear stress on the surface, taking into account the increase of the modulus of elasticity with increasing depth:

$$\sigma_r = \frac{v \cdot H \cdot \sin^{v-2}\phi \cdot \cos\theta}{2 \cdot \pi \cdot R^2} \qquad (28)$$

where: H_i – loaded shear point; θ – the angle between the vector of shear stress and the vertical plane in which is found the position vector from the shear stress to the considered point.

Johnson and Burt (1990) estimated the normal radial stress in an elastic half-space, due to a single concentrated shear load, using Fröhlich's equation. The stress for each concentrated stress applied on soil surface is given by the equation:

$$\sigma_{r_i} = \frac{v \cdot (P_i \cdot \cos^{v-2}\Phi_i + H_i \cdot \sin^{v-2}\Phi_i \cdot \cos\theta_i)}{2 \cdot \pi \cdot R_i^2} \quad (29)$$

***Keller's model for stress distribution in the soil** (2004) [12]*

The distribution of stress σ_1 under the action of a concentred vertical load P on a semi-infinite, homogeneous, isotropic and ideal elastic medium is given by:

$$\sigma_1 = \frac{3 \cdot P}{2 \cdot \pi \cdot r^2} \cdot \cos^3\theta \quad (30)$$

where: r – radial distance from the application point of load to a certain point; θ – angle between the normal direction of load vector and the direction of the position vector of the desired point towards the load application point (figure no 9).

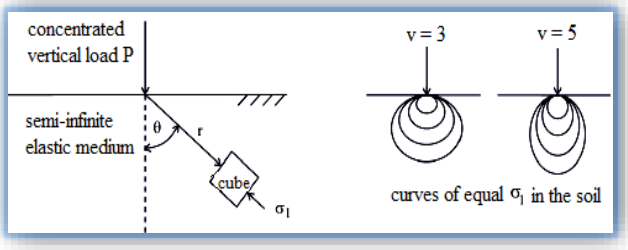

Figure 9. Soil stresses at the application of a vertical load (left) and soil behavior depending on agricultural conditions (right) [12, 16]

***Model for stress distribution under the agricultural tire** [12]*

It is considered that the shape of stress distribution in the forward direction and perpendicular to this direction is variable, the parameters used to generate the contact area and stress distribution being directly calculated based on the available parameters of the tire. For the law of stress variation in a direction perpendicular to the advance direction of the vehicle it can be used a Decay function, [12]:

$$\sigma(y) = C \cdot \left(\frac{w(x)}{2} - y\right) \cdot e^{-\delta\left(\frac{w(x)}{2} - y\right)} \quad (31)$$

$$0 \le y \le \frac{w(x)}{2}$$

where: C and δ – empirical parameters depending on the tire; w(x) – contact width.

The value of δ increases from 1,4 to 9 if tire width decreases from 1,15 m to 0,28 m. Depending on the value of δ, the maximum position of stress moves from the center of tire to its outline (from parabollic distribution to U-shapedd distribution) [9].

Stress distribution on the forwarding direction is given by:

$$\sigma(x) = \sigma_{x=0,y} \cdot \left[1 - \frac{\left(\frac{x}{l(y)}\right)^{\alpha}}{2}\right] \quad (32)$$

$$0 \le x \le \frac{l(y)}{2}$$

where: $\sigma_{x=0,y}$ – stress under the center of the wheel; l(y) – contact lenght; α – parameter.

Parameters in equations 31 and 32 are calculated knowing the values of wheel load, tire inflation pressure, the reccomended tire inflation pressure at a certain wheel load, tire width and the overall diameter of the unloaded tire. This model offers significantly useful input data for soil compaction models (figure no 10), increasing the accuracy of stress estimation and the precision of estimation of soil compaction due to the traffic of agricultural vehicles.

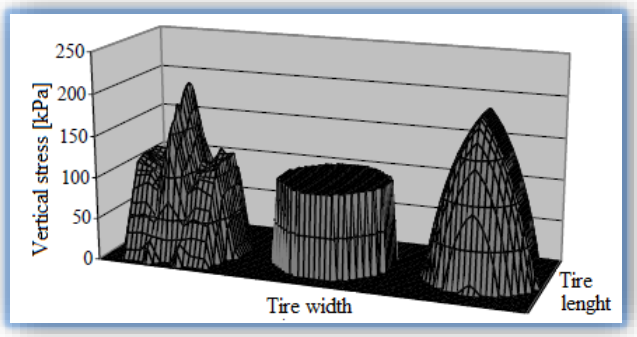

Figure 10. Measured stress (left), uniform stress distribution (center) and stress distribution obtained by modeling (right), under 1050/50 R32 tire, for tire inflation pressure of 100 kPa and wheel load of 86 kN on a wet clay soil [4, 12]

***Karafiath and Nowatsky's model for the calculus of contact pressure between tire and rigid surface** (1978) [22]:*

$$p = c_i \cdot p_i + p_c \quad (33)$$

where: p – tire contact pressure (kPa); c_i – constant of tire stifness (for high pressures $c_i = 0,6$ and for low pressures $c_i = 1$); p_i – tire inflation pressure (kPa); p_c – contact pressure of the non-inflated tire, when $p_i = 0$ kPa.

***Koolen's model for the calculus of pressure in the footprint** (1992) [22]:*

Koolen studied the stresses in the soil, produced by wheels of agricultural vehicles, and found that stress in the contact area (contact pressure) is twice larger than tire inflation pressure:

$$p = 2 \cdot p_i \quad (34)$$

***Helenelund's model for stress distribution in the soil** (1974) [23]:*

Stress distribution under a circular plate (figure no 11) is given by the following equation:

$$\sigma_z = p \cdot (1 - \cos^{\alpha}\beta) \quad (35)$$

where: σ_z – vertical stress in the soil at depth z (kPa); z – soil depth (m); α – concentration factor; β – angle depending on plate's radius at depth z.

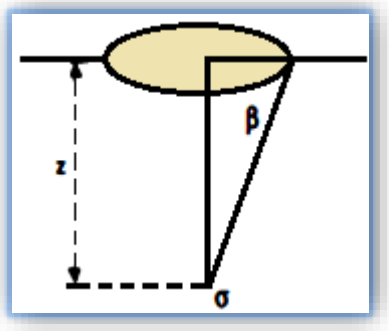

Figure 11. Vertical stress under a circular plate [23]

CONCLUSIONS

The soil doesn't have a heterogeneous structure, for which reason the modeling of artificial compaction is not easy to determine, in this regard being developed numerous models that considered various factors influencing this process:

- *soil bulk density and three empirical parameters (Bailey's model);*
- *soil bulk density, three empirical parameters and two connection parameters (Assouline's model);*
- *change of soil volume (Gupta and Larson's model);*
- *state of cylindrical stress in the soil (Bailey and Johnson's model);*
- *estimation of soil density after tire passage depending on contact pressure (Schwanghart's model);*
- *calculus of soil compaction state;*
- *estimation of soil sinkage after multiple passes of a tractor (Abebe's model);*
- *estimation of soil bulk density on the longitudinal central axis of the wheel, from the ruts formed on the soil (COMPSOIL and O'Sullivan models);*
- *determination of the contact area between agricultural tires and soil (Komandi's empirical model);*
- *estimation of footprint (FRIDA model);*
- *determination of footprint area (Grecenko's empirical models);*
- *estimation of stress distribution at soil-tire interface (Söhne's model);*
- *estimation of stresses in the footprint (Johnson and Burt's model);*
- *distribution of stress in the soil (Keller's model);*
- *estimation of stress distribution under the agricultural tire (Keller's model);*
- *calculus of contact pressure between tire and rigid surface (Karafiath and Nowatsky's model);*
- *calculus of pressure in the footprint (Koolen's model);*
- *estimation of stress distribution in the soil (Helenelund's model).*

Each of these models verify experimental data for the considered parameters, but each individual model cannot be extrapolated for any type of soil artificially compacted, because soil composition, the parameters influencing the compaction process and the atmospheric conditions vary from one plot to another.

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FORWARD MICRO EXTRUSION OF MICRO PARTS AND STUDY OF EFFECTS OF GRAIN SIZE

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Abstract: As demands on micro metal products increase significantly, micro forming becomes an attractive option in the manufacture of these products due to its advantages for mass production. Fundamental issues relating to materials, processes and analysis have been studied intensively in recent years and have been well documented in the literature. But still the application of metal forming to the manufacturing of micro parts is not widespread. One reason is that the knowhow of conventional forming cannot be simply transferred to the micro scale. Also the forming behavior mainly depends on the part's individual grain gathering leading to a rather unpredictable forming result and making a process design impossible. . It has become essential to develop a proper understanding which in turn could be used to develop dedicated processes for the manufacturing of metallic micro components. In this work, an attempt has been made to realize this special application of metal forming. A novel experimental setup consisting of forward extrusion assembly and a loading set-up has been developed to obtain the force-displacement response. The effects of grain size on micro components and the material behavior during forward extrusion are investigated. Key issues observed while designing forward extrusion assembly and performing microextrusion process are discussed. The results indicate that the size, orientation and distributions of grains play an important part in the extrusion process.
Keywords: Micro extrusion, Grain size, Extrusion die, Deformation, Flow stress

INTRODUCTION

Micro manufacturing is becoming more and more important due to the recent trend of product miniaturization. Micro manufacturing technologies can be classified into two categories. One is the micro electromechanical system based lithography technologies and the other is the mechanically based micro manufacturing processes. Although the former is well-established for semiconductor and microelectronics, the same cannot be said to the latter, which includes micromachining, microinjection molding and micro forming. Among these four mechanically based processes, the first two have been relatively well-investigated. For microforming, however, it has not yet been systematically explored and studied. There are still many issues which need to be addressed [1-2]. Micro forming is the branch of manufacturing technology that deals with the fabrication of metallic micro parts. A micro part is concerned with small parts with typical part dimensions in the range of sub millimeters up to a few millimeters, although part-features may be in the micro range. The typical positional precision is expected to be in the range of 0.1 to 10 µm [3].

This paper addresses some of the key issues encountered by researchers worldwide on micro forming, specifically micro extrusion. An experimental set up for realization of forward micro extrusion is developed and the micro extrusions of aluminium and copper billets with different grain sizes are conducted. All the findings in this work are critical to further facilitate the development of micro formed parts.

LITERATURE SURVEY

Among different microforming processes, micro extrusion is widely investigated in terms of the effects of specimen size, grain size, the formed part feature size, tooling workpiece interfacial friction and the forming temperature. Takatsuji et al. [4] investigated the friction behavior in the micro forward rod backward cup extrusion using aluminum alloy. Different coatings are applied on the tooling to study the friction effect. A similar study was conducted by Krishnan et al. [6] using brass. Their results, however, indicate that the coatings reduce the extrusion force and increase the length of the extruded pin. Different size scaled experiments on forward extrusion were conducted by Geiger and his colleagues [1, 6]. It is found that the punch pressure increases with the scaling down of the formed part size. A review on micro manufacturing and microforming can be found in Akhtar Razul Razali et al [7]. An intensive review on the latest development of microforming technologies is presented by M. W. Fu and W. L. Chan [8]. More recently micro gear extrusion of the high strength commercial aluminum alloy is performed by Xuehua Dong et al [9]. In their work, the effects of extrusion temperature, extrusion velocity and lubrication conditions on the formability, microstructure, and micro hardness of the aluminum alloy are studied. Based on the literature review, it can be noticed that different micro forming processes have been investigated independently and the focus is on a few factors in those studies. There is a lack of comprehensive research on different size effects in micro extrusion process. The objective of this work is to provide an in depth analysis on micro extrusion process in terms of the grain size.

EXPERIMENTAL ANALYSIS

In order to show the effects of minaturization and investigate the micro extrusion process, an experimental set-up is designed and micro

extrusion tests with aluminium and copper billets of different grain sizes have been conducted. In the following sections, the components of the experimental set up, the design process and the experimental results are presented.

Experimental Set-up

The experimental set up has four components: the micro-extrusion die, punch, the billet (work piece) and the press as shown in Figure 1. A computerized Universal Testing Machine (UTM) is found sufficient for micro extrusion process and the extrusion assembly is designed and dimensioned considering the same. This microprocessor based electromechanical machine designed with servo drive capable of testing mechanical behavior of metals and polymers. Table 1 gives the other important specifications of the machine. The extrusion dies used in the forward microextrusion experiments to determine the force-displacement response is shown in Figure 2.

Figure 1. Micro Extrusion Experimental Set Up

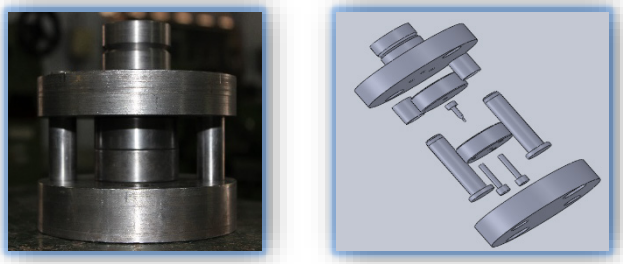

Figure 2. Micro Extrusion Die Assembly

Table 1. Micro Extrusion Machine: Specifications

No.	Parameter	Value
1	Load range	0-10 kN
2	Load measuring accuracy	± 2 % to 100% of load cell used
3	Maximum crosshead stroke	1000 mm (without grips and load cell)
4	Clearance between columns	450 mm
5	Crosshead displacement measurement	0.01 mm
6	Power supply	230 V AC, 50 Hz single phase

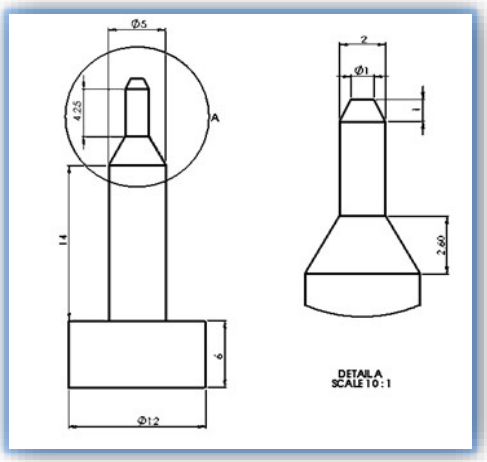

Figure 3. Micro Extrusion Punch Geometry

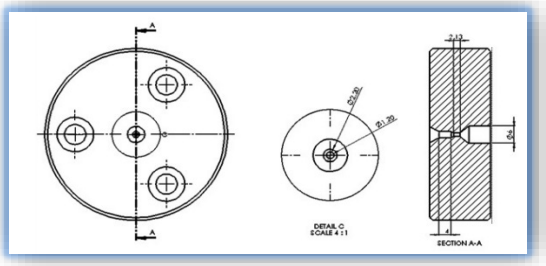

Figure 4. Die used for extrusion

The die assembly consists of an upper flange in which the punch holder and the punch are housed. This is guided into the die which is housed in the die holder which in turn is clamped on the lower flange. The lower flange is hosted by the UTM machine and the extrusion force is supplied by the upper flange. The punch and die geometry is given in Figure 3 and Figure 4 respectively.

Materials

Pure aluminium and copper billets are used in the experiments due to their wide applications in industry. The billets are cut from wires of 2 mm diameter. The average grain size of the selected copper is 38 µm. In terms of the experimental investigations it is important that the grain size of the material can be varied by heat treatment in a range of approximately 10 µm to 100 µm. The billets are exposed to heat treatment with different temperatures and working times to obtain different grain sizes. It is noticed that the grain size increases with the increase of working temperature and the grains are unevenly distributed in the billet. Specimens are also machined and finished by the highest possible accuracy. The final billets used in this work are given in Figure 5.

Figure 5. Aluminium and Copper billets (38 µm grain size)

RESULTS AND DISCUSSION

At first the experiments are conducted without lubrication at room temperature. In the second phase, machine oil is used as the lubricant and both the extrusion die and the billet are lubricated sufficiently. Experiments are conducted multiple times with both pure aluminium and copper billets. The micro parts produced are given in Figure 6. The following observations are made from the experiments:

(i) the bending of the micro parts occurs when the overall length exceeds 5 mm

(ii) to avoid 'bulging', the billet must be as straight as possible

(iii) for ease of removal of formed parts the die surface has to be highly flat and uniform.

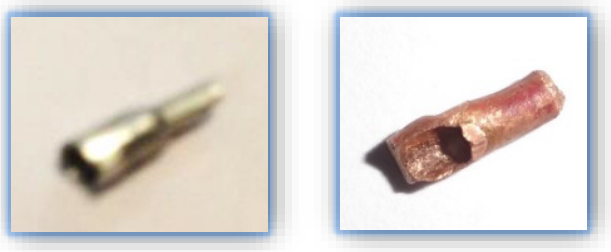

Figure 6. Micro Parts Made of Aluminium and Copper

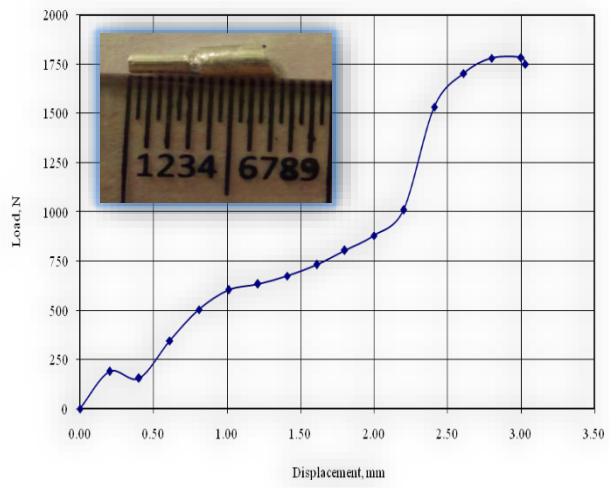

Figure 7. Load Vs Displacement Curve for Aluminium

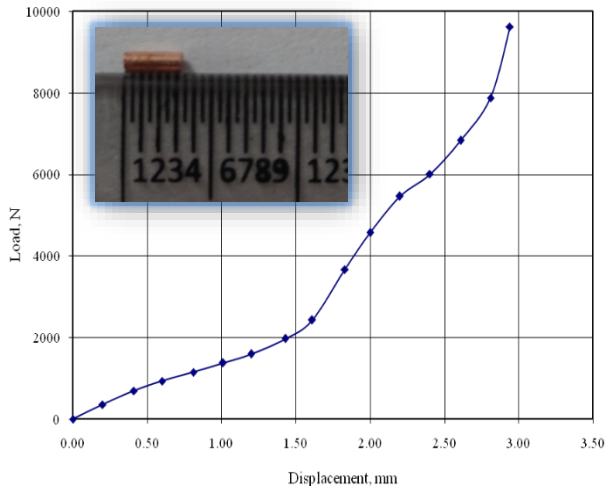

Figure 8. Load Vs Displacement Curve for pure Copper with out Heat Treatment

The load displacement curves for the experiments with pure aluminium billet are shown in Figure 7. It is found that aluminium can be extruded up to 3.6 mm with a peak load of 1750 N at 2.7 mm. The maximum flow stress of 567 N/mm^2 achieved at 3 mm. Pure cupper (grain size = 38 μm) without heat treatment is first subjected to micro forward extrusion and the load versus displacement plot shown in Figure 8 is observed. It is noticed that the load versus displacement plot with extremely fine grains has a steeper slope. This is attributed to the strengthening effect.

Due to the presence of a large number of grain boundaries more than grain interiors, the hardness of the sample is higher and requires higher deformation load and flow stress. A linear relationship is observed between the load and the displacement up to 1.49 mm which indicates the material flow into the cavity opening of the die. From 1.49 mm to 2.48 mm, stable forward extrusion takes place as the sample is extruded from larger diameter region to smaller one. The sudden increase in the load is attributed to the shearing of the sample. Based on the experiments it is found that the maximum load is 9612 N which is achieved at a stroke length of 2.94 mm.

During second part of the experiment with pure copper heat treatment is done for two hours (grain size = 110 μm). Then the heat treated copper is subjected to micro forward extrusion and load versus displacement plot as shown in Figure 9 is obtained. As the number of grains per unit volume is decreased with the increase of grain size, the volume fraction of the grain boundary increases. Therefore, the grain boundary strengthening effects diminish gradually and further lead to the decrease of deformation load. The same trend is observed by Krishnan et al [5] during their experimental work.

Figure 10 shows the flow stress curve obtained for the same specimen. The maximum flow stress is 1121 N/mm^2 which is at 2.62 mm. The presence of a large number of grain boundaries results in the increase of hardness and flow stress.

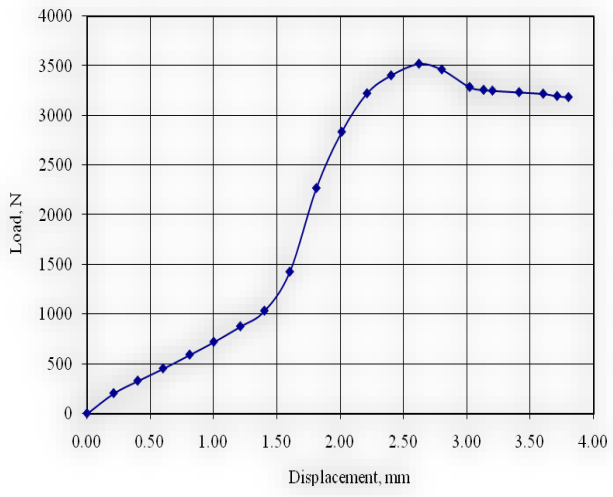

Figure 9. Load Vs Displacement curve for pure Copper with heat treatment

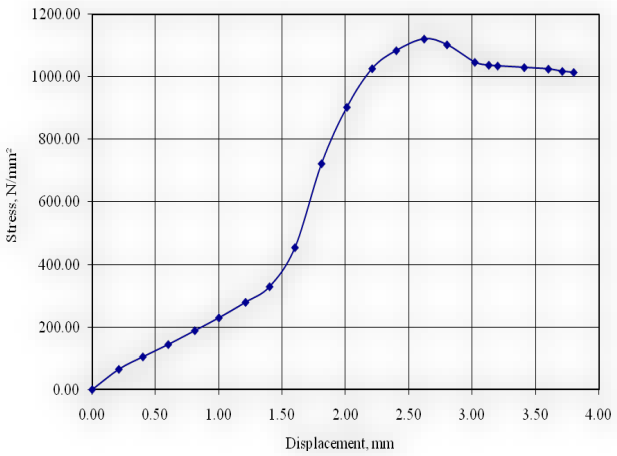

Figure 10. Stress Vs Displacement curve for pure Copper with heat treatment

CONCLUSIONS

Development of the advanced micro manufacturing technologies like micro extrusion for fabrication micro parts has become an important issue. In this work, a successful fabrication of micro extrusion assembly is done and extrudates up to 3.8 mm are obtained. The effect of grain size on deformation load an vvariation of strengthening effect are observed in different copper specimens. The grain size effect on material strengthening in deformation process is related to the characteristic of the grain boundary and the grain boundary is more strained and harder when compared to the grain interior. Further the experimental investigation results could be summarized as follows:

- *The load versus displacement plot for micro extrusion is similar in nature to that of conventional extrusion*
- *Beyond certain dimensions, factors that can be ignored with conventional machining suddenly play a big part in micro manufacturing*
- *An effective ejection system is essential to prevent material lost due to chipping while removal of the extrudates.*

It is also expected that further research activities, necessary to understand the micro and macro aspects of deformation

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BIOFUELS: FUTURE BENEFITS AND RISKS

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Abstract: Biomass continues to be investigated as an alternative resource to resolve the demanding consumption of petroleum-based gasoline and diesel fuel. In addition, biomass can be used to provide bio-oil, biogas, and hydrogen as well as electricity. The growing demand for alternative energy sources has contributed to increased biofuel production, but the effects on biodiversity of land-use change to biofuel crops remain unclear. As a result and in order to minimize impacts of biofuel crops on biodiversity, management practices that reduce chemical inputs, increase heterogeneity within fields, and delay harvests within wildlife areas are recommended. There is also the need to address the growing challenge of climate change by closer scrutiny of biofuels to assess whether they can be produced, traded and used sustainably. Criticism of biofuels has centered on the perceived negative impacts on the environment through deforestation, spread of monocultures, loss of biodiversity and possible higher GHG emissions under uncontrolled land-use change. The potential of biofuels to contribute to a shift into more sustainable energy systems has been contested, and scientists had to move away from emotional preferences and question the claimed environmental superiority of biofuels.
Keywords: Biomass, biofuel, hydrogen

INTRODUCTION

The term biofuel is referred to as liquid or gaseous fuels that can be used to supplement the demand for petroleum-based liquid fuels. Furthermore, biomass offers a sustainable source of liquid and gaseous fuels with the further promise of a reduction in the amount of greenhouse gas emissions as well as playing a role as a co-feedstock in the refinery of the future (Figure 1) (Reijnders, 2006; Speight, 2008, 2011a, 2011b, 2011c). Furthermore, the widespread availability opportunities of biomass resources may also allow the petroleum-importing counties to enjoy a measure of self-sufficiency in energy production (2011b).

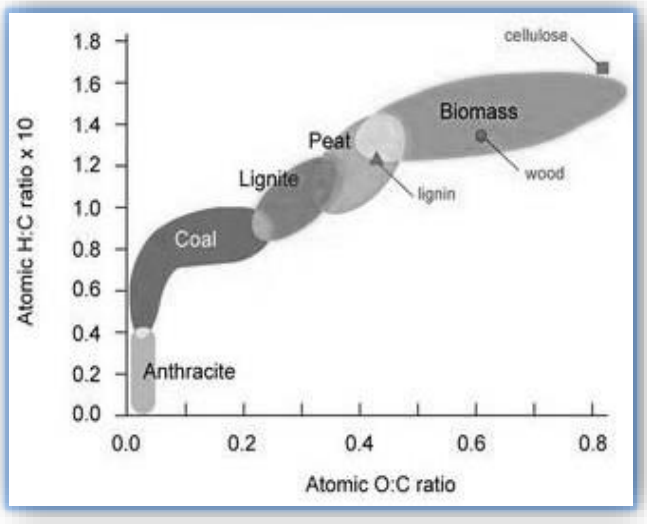

Figure 1: Van Krevelen Diagram showing the Relationship of Biomass and other Fuel Sources.

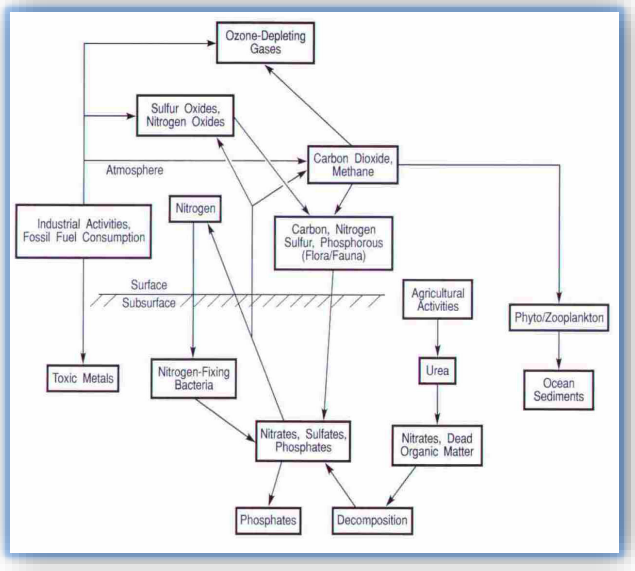

Figure 2: The Industrial Cycle Initiated by the Use of Fossil Fuels.

Biofuels, unlike fossil fuels which give rise to a compex industrial cycle (Figure 2) are a renewable energy source and the raw material (biomass) is are grown all over the world and include: (1) corn and soybeans, mainly in the United States, (2) palm oil in South East Asia, (3) rapeseed mainly in Europe, (4) sugar cane in Brazil, and (5) jatropha in India. In addition, food waste such as cooking oil can also be used as a feedstock to produce biofuels as can waste products such as straw, timber, cattle manure, and sewage (Gabrielle, et al., 2014). Furthermore, biofuels have (correctly or incorrectly) been recognized hailed as the answer to two major issues: (1) moving away from the heavy reliance on petroleum and (2) climate change. However,

biofuels may not be the panacea they have been made out to be and are worthy of a thorough analysis of the benefits and risks of using and producing such fuels.

BIOFUELS

There is no doubt that the supply of crude oil is finite and the flow of petroleum to refineries will eventually become unsustainable as supply/demand issues are erode by the depletion of the resource. However, the precipice will not appear suddenly and out-of-the-blue (as many observers seem to think). With adequate pre-planning and consideration of the resource availability in terms of real numbers, the peak-oil-production situation can be mitigated by the exploitation of more technically challenging fossil resources and the introduction of technologies for fuels and chemicals production from biomass. Consequently, in addition to the variety of potential energy-production technologies (Speight 2008), there is a renewed interest in the utilization of plant-based matter as a raw material feedstock for energy and chemicals production (Speight, 2008, 2011b). Plants accumulate carbon from the atmosphere via photosynthesis and the widespread utilization of these materials as basic inputs into the generation of power, fuels and chemicals is a viable route to reduce greenhouse gas emissions.

While the use of biomass may not be the ultimate source of energy, the production of fuels and chemicals from renewable plant-based feedstocks utilizing state-of-the-art conversion technologies presents an opportunity to fend off any potential energy crises which arise from the depletion of petroleum resources. However, bioprocessing routes have a number of compelling advantages over conventional petrochemicals production but in the last two decades rapid progress in biotechnology has facilitated the commercial development of plant-based processes with the emergence of the biorefinery concept (Figure 3), which is analogous to conventional petroleum refineries and petrochemical complexes that have evolved over many years to maximize process synergies, energy integration and feedstock utilization (Speight, 2008, 2011).

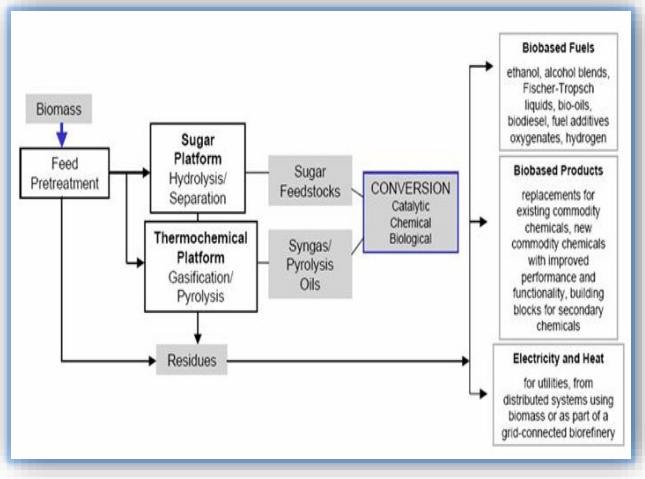

Figure 3: Fuels from Biomass using the Sugar (Biochemical) Platform and the Thermochemical Platform (Source: Office of the Biomass Program-Multiyear Plan 2004 and Beyond, Nov. 2003).

Plants offer a unique and diverse feedstock for energy and chemicals production. For example, biomass can be gasified to produce synthesis gas, which is a basic source of hydrocarbon fuels and chemical feedstock as well as a source of hydrogen for a future hydrogen economy (Table1, Figure 4) (Chadeesingh, 2011; Speight, 2013a, 2013b, 2014). In addition, the specific components of plants such as carbohydrates, vegetable oils, plant fiber and complex organic molecules known as primary and secondary metabolites can be utilized to produce a range of valuable monomers, chemical intermediates, pharmaceuticals and materials. Furthermore, a simple, cheap, and common method of obtaining energy from biomass is direct combustion. The heat of combustion can be used, through the use of a steam turbine, to produce electricity (Speight, 2013b).

Table 1: Fischer-Tropsch Reactions.

Reaction:	Reaction enthalpy: $\Delta H_{300\,K}$ [kJ/mol]
$CO + 2H_2 \rightarrow -CH_2- + H_2O$	- 165.0
$2\,CO + H_2 \rightarrow -CH_2- + CO_2$	-204.7
$CO + H_2O \rightarrow H_2 + CO_2$	-39.8
$3CO + H_2 \rightarrow -CH_2- + 2CO_2$	-244.5
$CO_2 + 3\,H_2 \rightarrow -CH_2- + 2H_2O$	-125.2

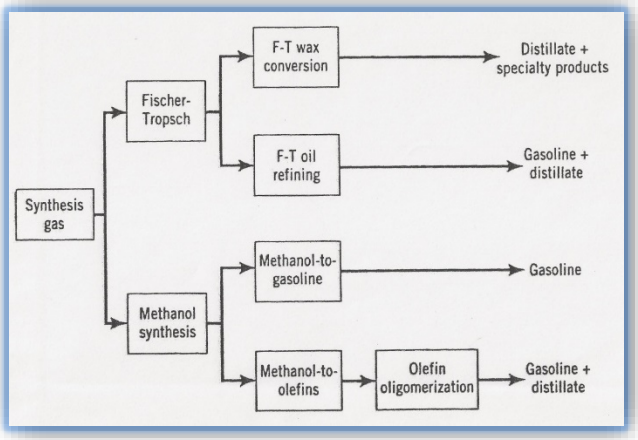

Figure 4: Routes for the Production of Fuels from Synthesis Gas.

Thus, almost all crops, whether grown for food, animal feed, fiber or any other purpose, result in some form of organic residues after their primary use has been fulfilled. These organic residues, as well as animal wastes (excrement) can be used for energy production through direct combustion or biochemical conversion. Current worldwide production of crop residues is very large; but an increased scale of use for fuel may have significant environmental impacts, the most serious being those of lost soil fertility and soil erosion.

BENEFITS

Biofuels have the potential to be a sustainable, low carbon fuel source and at a time when the depletion of petroleum reserves becomes obvious biofuels could be crucial factors in world energy production. Thus, with effective management and global compliance (Nasterlack et al., 2014), the biofuels industry could help to reduce the greenhouse gas emissions from transport, alongside increased fuel efficiency and

public transport improvements. However, whether or not biofuels can replace all of the crude oil that is currently used for energy and chemicals, it may not be possible to grow sufficient biomass without serious consequences for the environment and people. It has to be recognized that biofuels may only be part of the answer to provide energy after petroleum production has peaked and there will be limits to the amount of biofuel feedstocks that can be grown due to conflict with current land uses – growing food, forests, and human habitation. Food prices could increase significantly as crops once destined for food are sold for fuel instead.

Indeed, various national governments are insisting (even legislating) that petroleum refining companies start to use some biofuels in the fuel they sell. There is widespread support for an alternative to traditional fossil fuels. However, the possible negative impacts of a huge growth in biofuels are beginning to be realized.

In theory, biofuels are carbon neutral insofar as the carbon released (as carbon dioxide) when they are burned was taken from the atmosphere by the plants as they grew. However, the energy needed to transport and refine crops usually comes from fossil fuels and the chemical fertilizers and pesticides used in growing the crops require energy and cause nitrous oxide to be released. Potential climate benefits can be lost or limited this way. In addition, agricultural chemicals can make their way into water supplies, contaminating drinking water and killing aquatic life. The availability of water can also be affected if supplies are diverted to irrigate crops leading to the risk of drought in some areas.

As an example, one of the biofuels with the most contentious issues is palm oil – demand for palm oil from both the food and biofuel industries has led to massive expansion of oil palm tree plantations. This, in turn, requires clearing land for use as these plantations and the land cleared is often is often rainforest. Thus, natural habitats are lost and the biodiversity of the Earth, including many endangered flora and fauna will be threatened and eventually lost. The destruction of ecosystems such as rainforests has indirect impacts on people as well. The forests are responsible for regulating water flow and protecting soils; many people also depend on them for food and medicines. Destroying ecosystems can even lead to outbreaks of disease. These effects are felt most by the poor who are more dependent on the natural environment.

The implosion of new fuels, in this case biofuels, will have implications across many business sectors and in a time when interest in being green is high, the race to secure safe, sustainable stocks of biofuels is already in place. In fact, with a focus on the environment and worries about crude oil reserves becoming depleted, governments across the world are understandably getting involved to encourage the growth of the biofuels industry.

In 2007, EU leaders agreed on an integrated climate and energy policy which includes 'a 10% binding minimum target to be achieved by all Member States for the share of biofuels in overall EU transport petrol and diesel consumption by 2020. At first glance, many would see this as a step forward. However, if not implemented sustainably, it could actually set us back. In the UK, the government claims that the Renewable Transport Fuel Obligation (RTFO) will deliver substantial carbon savings but this assumes that biofuels will (pound for pound) emit less than half the carbon (dioxide) of fossil fuels and this is often not the case at the moment. Until there is a move to a system where only biofuels from sustainable sources are eligible for RTFO certificates, there will be no positive carbon balance. In the US, the strategy is to cut petroleum consumption by 20% by 2017, which is to be achieved (in part) by replacing approximately 15% of the gasoline used in vehicles with renewable fuels or biofuels. This will require the production of biofuels to increase five-fold to meet projected demand. However, biofuels do present the opportunity of a more environmentally friendly alternative to crude oil, but there is a risk of doing more harm than good if sustainability is not made a priority. If managed properly, biofuels could form part of the solution in the fight against climate change.

RISK ASSESSMENT

The quality and composition of a biofuel depends on the source of the biomass/feedstock as well as the types of processing and conversion techniques utilized in its manufacture (Ramroop Singh, 2011). The feedstock composition ultimately decides the yield from the chemical or biochemical conversion processes, which in turn, affects the production economics. There are many plant varieties which are used as biofuel sources - the geography, weather conditions, soil composition and legislation of a location normally dictates what types are grown specifically for biofuel production.

Furthermore, the risks that arise from the production of the raw starting materials for biofuels production can cause serious problems – for example the destruction of rainforests while in some places people may be forced from their land. Furthermore, greenhouse gas savings of some biofuels may even be just as bad as crude oil!

Agricultural feedstocks are critical for decreasing petroleum dependence through sustainable biofuels production. Continued rapid improvements in both biofuel resources and processes are needed if agricultural biofeedstock crops are to significantly address concerns about the depletion of fossil fuel reserves, energy security and greenhouse gas emissions as contributors to climate change (Antizar-Ladislao and Turrion-Gomez, 2008). The current first generation biofeedstock crops represent modification and the use of food-based grains for biofuel production. These will be largely supplanted by second generation crops representing specialized industrial oilseed crops and the utilization of lignocellulosic crops and crop residues (Gressel, 2008). Unless, and until, third generation technologies using algae and bacteria become a reality, plant-based agriculture – with the attendant tradeoffs regarding land use alternatives and the balance of needs for food, feed and fuel production – will remain the leading opportunity for biofuel production.

Briefly, risk in any area is the joint probability of exposure and the consequence of exposure, the conventional risk assessment process describes exposure and its consequence (an adverse effect or harm) in

four steps: hazard identification, dose-response, exposure characterization and risk characterization (EPA, 1998). Risk is assessed through a science-based process that integrates with risk management to facilitate informed decision-making.

The long-term success in developing sustainable bioenergy resources is frequently tied to perennial herbaceous and woody plants such as switchgrass (Panicum virgatum) and poplar (Populus) for ethanol production or jatropha (Jatropha curcas) for biodiesel production (Speight, 2011c). The targeted attributes for an ideal bioenergy crop vary, depending on whether the objective is a dedicated biofeedstock crop or a food and fuel crop. Nevertheless, in those cases where range and forest plants are targeted as dedicated biofeedstock crops there will be a need for domestication in order to improve agronomic performance, uniformity, quality and productivity. These crops will also need to undergo compositional modifications, for instance to better affect the conversion of lignin, cellulose and other cell wall polysaccharides to ethanol or to improve yield and quality of the bio-oils.

Food versus fuel is the dilemma regarding the risk of diverting farmland or crops for liquid biofuels production in detriment of the food supply on a global scale (Speight, 2008; 2011c). There is disagreement about (1) the cause, (2) the impact is, (3) the overall significance of such an issue, and (4) the resolution. Biofuel production has increased in recent years and some foodstock commodities such as corn, sugar cane, and vegetable oil can be used either as food, feed or to make biofuels. For example, vegetable oils have become more attractive recently because of its environmental benefits and the fact that it is made from renewable resources (Demirbaş, 2008). Vegetable oils are a renewable and potentially inexhaustible source of energy with energy content close to diesel fuel. On the other hand, extensive use of vegetable oils may cause other significant problems such as food shortages in many countries (Demirbaş, 2007).

The need to address the growing challenge of climate change has led to closer scrutiny of biofuels to assess whether they can be produced, traded and used sustainably. Criticism of biofuels centered on the perceived negative impacts on the environment through deforestation, spread of monocultures, loss of biodiversity and possible higher GHG emissions under uncontrolled land-use change. Moreover, the food crisis of 2007-08 and the ensuing surge of commodity prices heightened the debate over food versus fuel and the possible consequences of biofuel production on food security. The potential of biofuels to contribute to a shift into more sustainable energy systems became contested, and scientists had to move away from emotional preferences and question the environmental superiority of biofuels.

Biofuel certification schemes, despite their multiplicity, are dominated by a singular form of governance – namely voluntary, private industry-led initiatives targeting sustainability assurances with input from non-industry stakeholders. These schemes are driven as much by market access and trade considerations as by the need to provide sustainability assurances. This may explain why the first schemes and initiatives have focused on those feedstocks and biofuels most involved in south-to-north trade (soybeans, sugarcane and oil palm). This dual role of biofuel certification schemes also explains the tendency to target selected sustainability criteria and not others and hence the absence of a full integration of the three core dimensions (economic, environmental and social) into a coherent framework or strategy.

Rethinking sustainability also requires incorporating full environmental costs in economic cost-benefit assessments and fostering business models that can reconcile sustainability with economic growth and integrate inclusive-development with food security. Also required are policies, regulations and incentives that broaden the biofuel development options to include small-scale locally harnessed renewable energy technologies and systems.

Finally, biofuel sustainability will need to be integrated into major trends that focus on sustainability and climate-smart agriculture in line with the triple objectives of enhanced productivity, strengthened food security and climate change adaptation and mitigation.

CONCLUSIONS

The growing demand for alternative energy sources has contributed to increased biofuel production, but the effects on biodiversity of land-use change to biofuel crops remain unclear (Robertson and Doran, 2013; Dauber and Bolte, 2014). To minimize impacts of biofuel crops on biodiversity, management practices that reduce chemical inputs, increase heterogeneity within fields, and delay harvests until breeding seasons have ceased are recommended.

From the perspective of sustainability, biofuels offer not only advantages but also risks (Table 2) .

Table 2. Advantages and risks

Advantages	*Risks*
Contribute to increased energy security Help reduce GHG emissions Improve air quality in cities Spur growth in rural areas	*Negative impacts on biodiversity Replace of natural forest with biofuel crops Influence water availability Influence water quality Adversely influence GHG emissions due to indirect land-use change*

Indeed, balancing the economic benefits with environmental and social impacts is a delicate act. Even when biofuels meet environmental and social sustainability criteria, they need to first pass the economic sustainability (or viability) test. This means ensuring efficiency of production (through high yields and intensive management) and long run profitability, access to productive resources (e.g. land, labor, technology), and reliable output markets. The challenge is to achieve these goals while ensuring economic viability and minimizing potential negative social and/or environmental impacts.

Many of the initiatives on biofuel sustainability at the country or supranational levels come from industrialized economies where biofuel growth has been most dynamic and where there is large scope for bioenergy demand and huge energy substitution possibilities. Sustainability initiatives coming from Europe or North America largely

mirror the industrial economies' priorities for biofuels (e.g. energy security supply, protection of agriculture, and increasingly climate-change mitigation).

Finally, the need to address the growing challenge of climate change has led to closer scrutiny of biofuels to assess whether they can be produced, traded and used sustainably. Criticism of biofuels has centered on the perceived negative impacts on the environment through deforestation, spread of monocultures, loss of biodiversity and possible higher GHG emissions under uncontrolled land-use change. The potential of biofuels to contribute to a shift into more sustainable energy systems has been contested, and scientists had to move away from emotional preferences and question the environmental superiority of biofuels.

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MODERN METHODS OF RESEARCH THROUGH OPTICAL AND ELECTRONIC MICROSCOPY OF SPECIAL METALIC MATERIALS STRUCTURE

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Abstract: *In this paper we present the results of experimental research performed using a Philips XL 30 ESEM TMP scanning electronic microscope, owned by UPB-CEMS, on a number of 6 samples taken from an iron-nickel-chromium special material, used for making high voltage overhead power lines, which were disc-shaped, with a diameter of 7mm and a height of 0,5 – 1,2 mm, electrically eroded.[1],[2]. Inside a vacuum environment, using a 30 kV voltage for accelerating the electron beam, a spot dimension on the sample surface equal to 3 and a distance between the polar piece of the microscope and the surface of the sample of 10 mm, there have been obtained images of secondary electrons, which have helped morphologically characterize all the samples, at magnifications between 100x and 25.000x.*

Keywords: *electronic microscope, vacuum environment, secondary electrons, morphologically characterize*

INTRODUCTION

Results of the compositional analyzes have been obtained using a energy dispersion EDAX – Sapphire spectrometer, at acceleration voltages of 30 kV, dimension of electron beam spot equal to 5,5, distance between the polar piece and the surface of the sample of 10 mm, at an angle of 35° between the sample surface and the X-ray detector [3]. Compositional analyzes have been achieved at magnifications of 100x, on five fields, the results presented in this report being an average of the individual quantitative results. It must be taken into account during data interpretation that the microanalysis is a compositional characterization method of micro volumes, determining chemical composition of nonhomogeneous substance volumes requires performing atomic spectrometric or mass determinations.[4].

METHODOLOGY

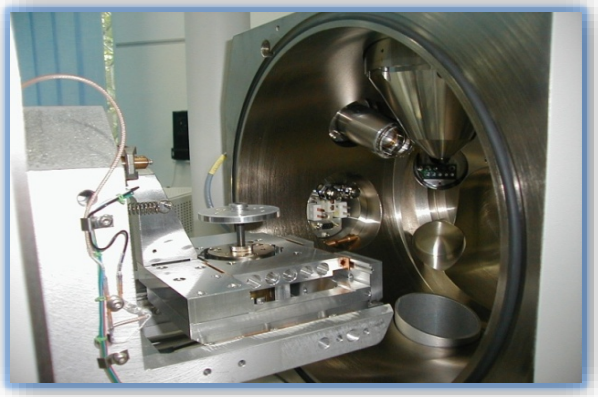
Within this study six samples (Sample 1 – Sample 6) have been examined through SEM / EDS method using a XL 30 ESEM (3,5 nm resolution) electronic scanning microscope, coupled with an energy dispersion EDAX Sapphire spectrometer (128eV resolution). (Figure 1a and 1b).

Table 1. Quantitative compositional results corresponding to sample 1.

Element	Wt %	At %
AlK	1.49	3.18
SiK	1.81	3.72
MoL	8.14	4.89
CaK	0.52	0.75
NdL	4.23	1.69
CrK	3.75	4.16
MnK	2.05	2.15
FeK	55.39	57.21
NiK	22.64	22.24
Total	100.000	100.000

Results are objectified by using morpho-compositional images (secondary and re-dispersed electrons) and EDS spectra with adjacent quantitative results.

a)



b)

Figure 1. EDAX Sapphire spectrometer

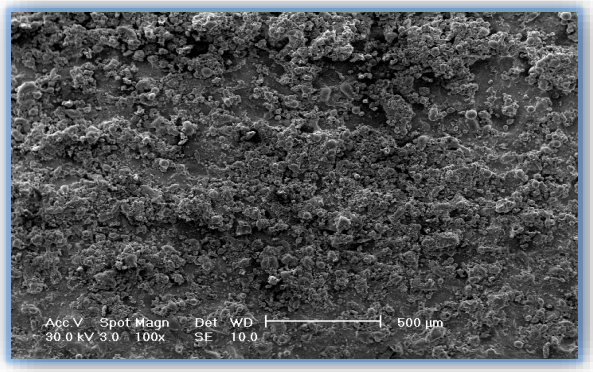


Figure 1.1 Secondary electrons image – surface morphology at 100x magnification.

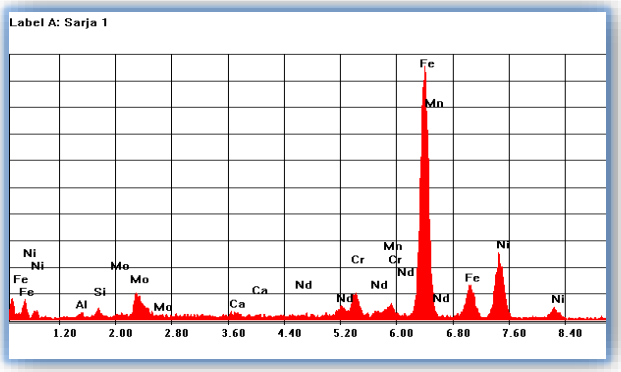


Figure 1.5. Characteristic X-ray emission specter, corresponding to sample 1 compositional analysis.

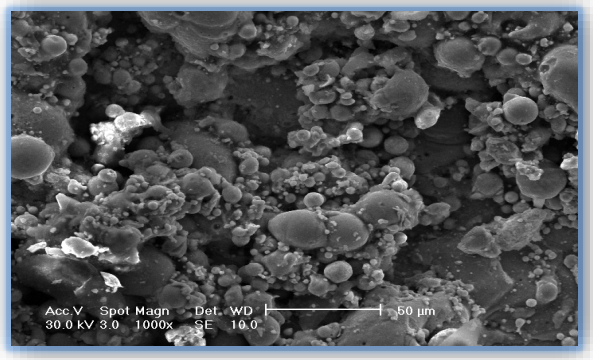


Figure 1.2. Secondary electrons image – surface morphology at 1.000x magnification.

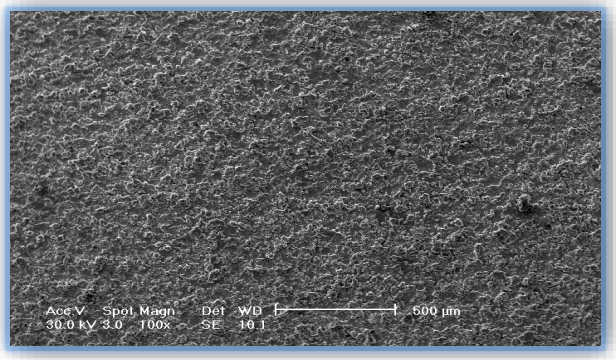


Figure 2.1. Secondary electrons image – surface morphology at 100x magnification.

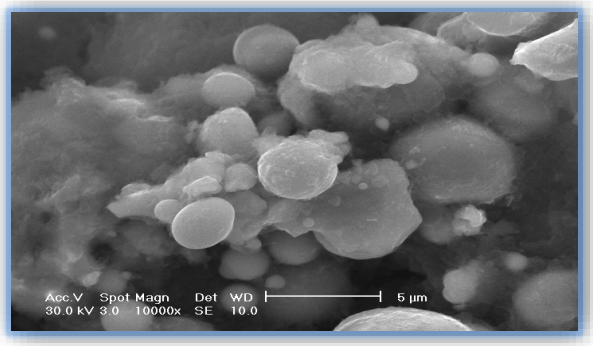


Figure 1.3. Secondary electrons image – surface morphology at 10.000x magnification.

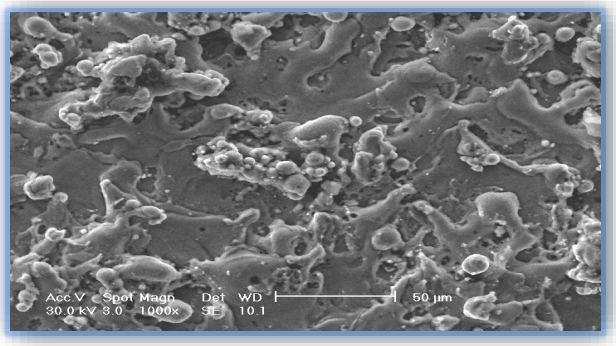


Figure 2.2. Secondary electrons image – surface morphology at 1.000x magnification.

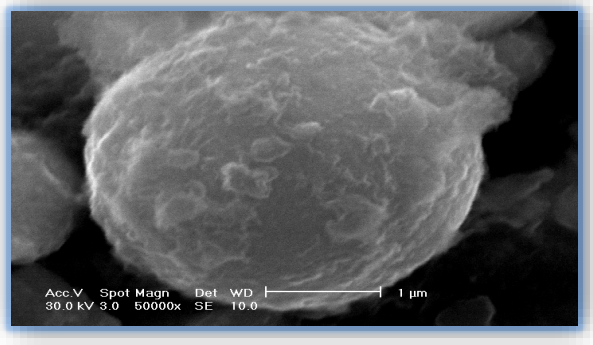


Figure 1.4. Secondary electrons image – surface morphology at 50.000x magnification.

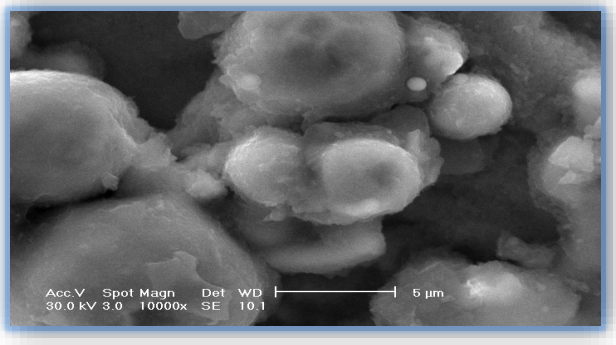


Figure 2.3. Secondary electrons image – surface morphology at 10.000x magnification.

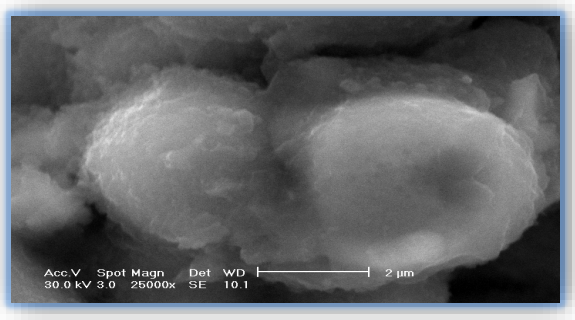


Figure 2.4. Secondary electrons image – surface morphology at 50.000x magnification.

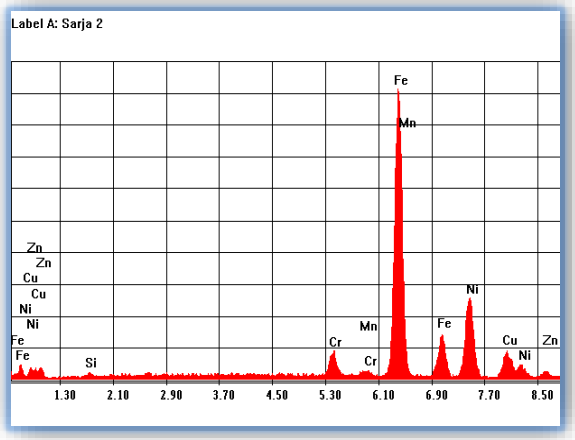


Figure 2.5. Characteristic X-ray emission specter, corresponding to sample 2 compositional analysis.

Table 2. Quantitative compositional results corresponding to sample 2.

Element	Wt %	At %
SiK	1.02	2.07
CrK	3.31	3.61
MnK	0.68	0.70
FeK	55.02	55.97
NiK	27.00	26.12
CuK	10.20	9.12
ZnK	2.77	2.40
Total	100.000	100.000

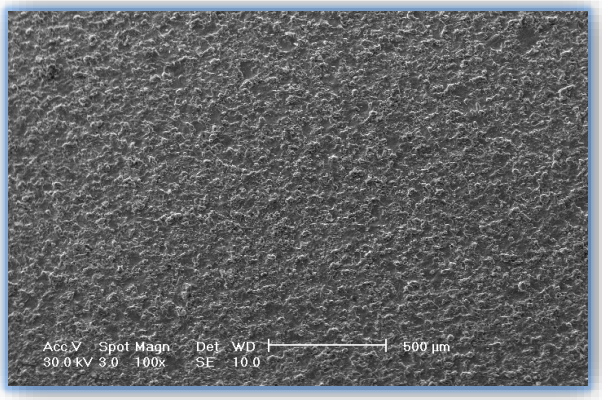


Figure 3.1. Secondary electrons image – surface morphology at 100x magnification.

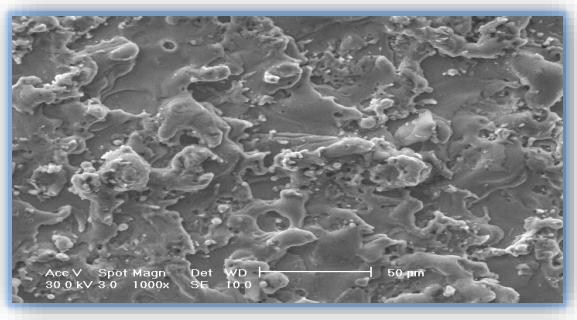


Figure 3.2. Secondary electrons image – surface morphology at 1.000x magnification.

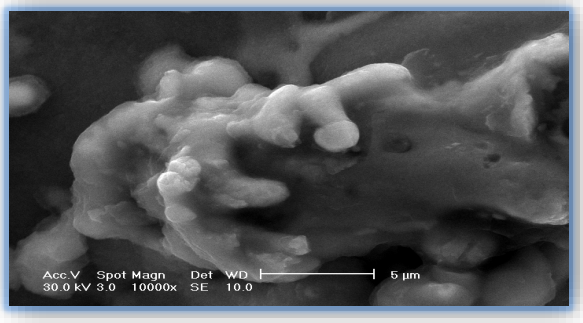


Figure 3.3. Secondary electrons image – surface morphology at 10.000x magnification.

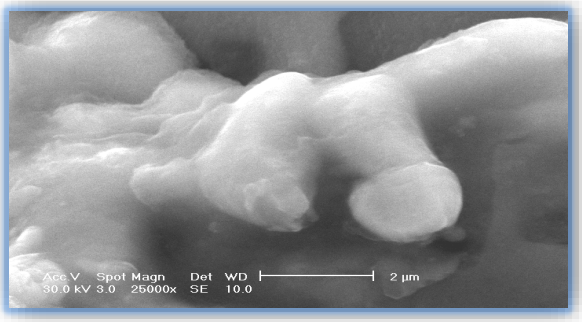


Figure 3.4. Secondary electrons image – surface morphology at 25.000x magnification.

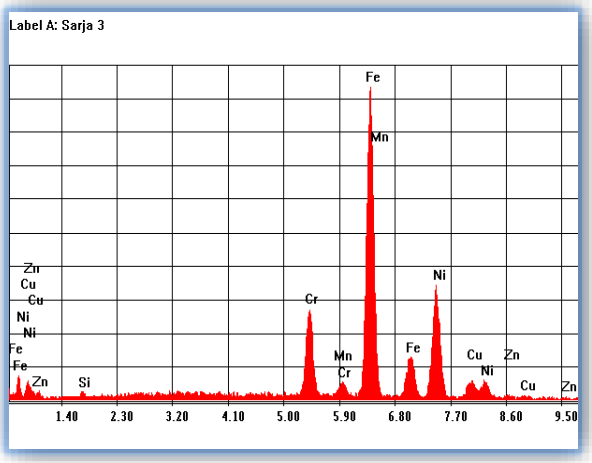


Figure 3.5. Characteristic X-ray emission specter, corresponding to sample 3 compositional analysis.

Table 3. Quantitative compositional results corresponding to sample 3.

Element	Wt %	At %
SiK	1.05	2.09
CrK	10.51	11.35
MnK	0.51	0.52
FeK	50.78	51.07
NiK	29.68	28.39
CuK	5.88	5.20
ZnK	1.59	1.37
Total	100.000	100.000

Table 4. Quantitative compositional results corresponding to sample 4.

Element	Wt %	At %
SiK	1.14	2.28
CrK	10.67	11.53
MnK	3.10	3.17
FeK	47.42	47.70
NiK	28.71	27.47
CuK	6.48	5.73
ZnK	2.47	2.12
Total	100.000	100.000

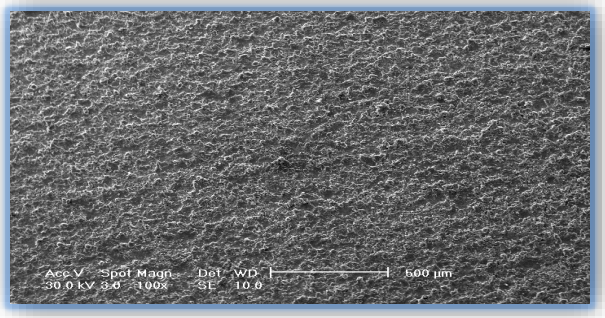


Figure 4.1. Secondary electrons image – surface morphology at 100x magnification.

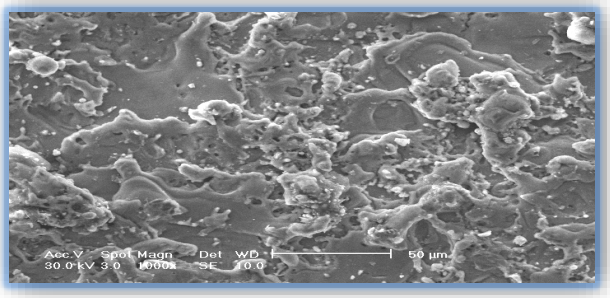


Figure 4.2. Secondary electrons image – surface morphology at 1.000x magnification.

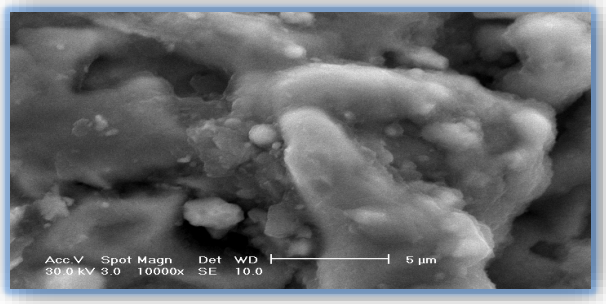


Figure 4.3. Secondary electrons image – surface morphology at 10.000x magnification.

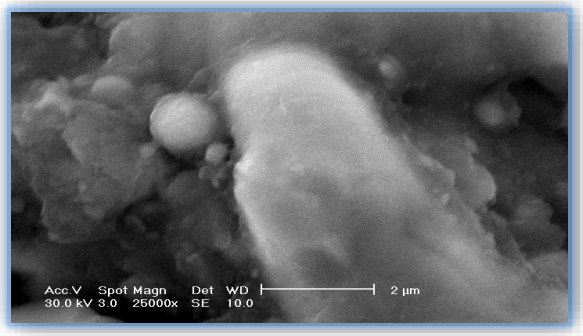


Figure 4.4. Secondary electrons image – surface morphology at 25.000x magnification.

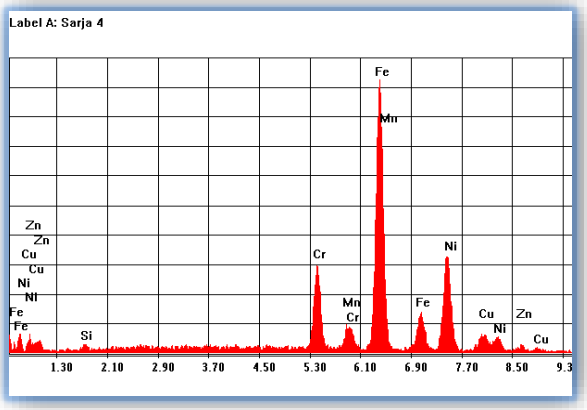


Figure 4.5. Characteristic X-ray emission specter, corresponding to sample 4 compositional analysis.

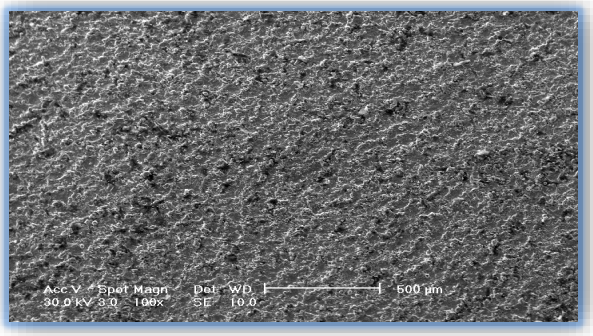


Figure 5.1. Secondary electrons image – surface morphology at 100x magnification.

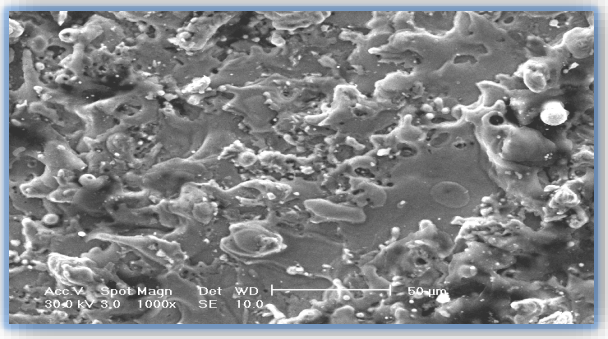


Figure 5.2. Secondary electrons image – surface morphology at 1.000x magnification.

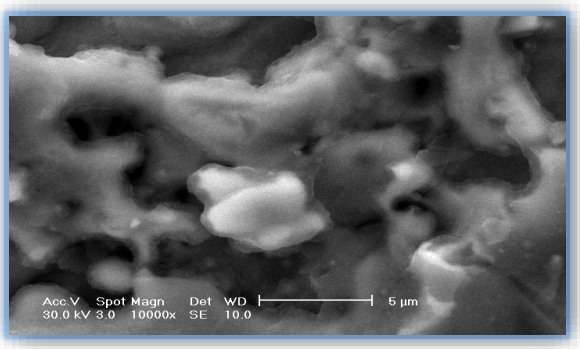


Figure 5.3. Secondary electrons image – surface morphology at 10.000x magnification.

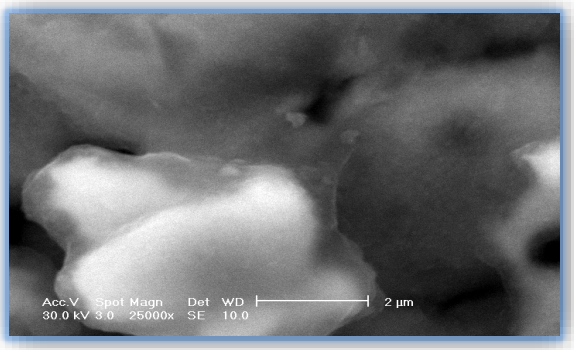


Figure 5.4. Secondary electrons image – surface morphology at 25.000x magnification.

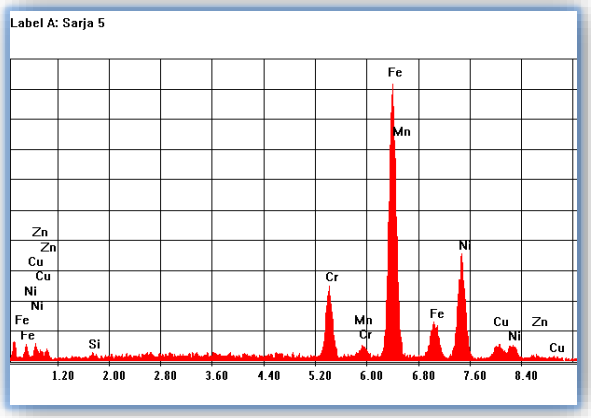


Figure 5.5. Characteristic X-ray emission specter, corresponding to sample 5 compositional analysis.

Table 5. Quantitative compositional results corresponding to sample 5.

Element	Wt %	At %
SiK	0.58	1.17
CrK	9.42	10.24
MnK	0.92	0.94
FeK	50.68	51.29
NiK	30.63	29.49
CuK	5.91	5.25
ZnK	1.86	1.61
Total	100.000	100.000

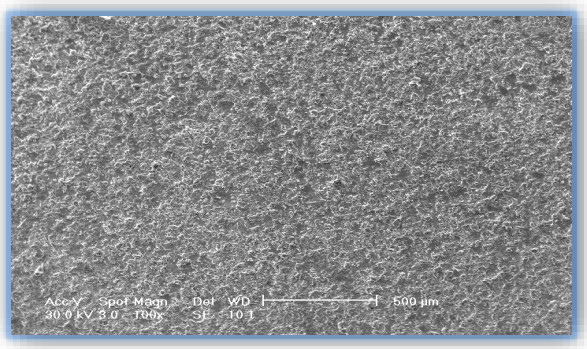


Figure 6.1. Secondary electrons image – surface morphology at 100x magnification.

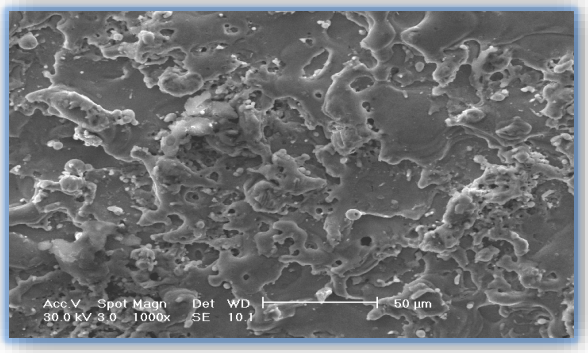


Figure 6.2. Secondary electrons image – surface morphology at 1.000x magnification.

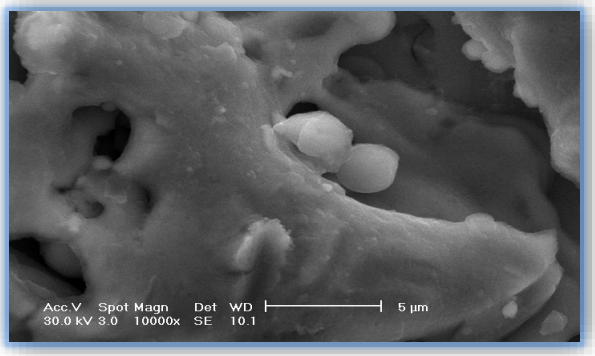


Figure 6.3. Secondary electrons image – surface morphology at 10.000x magnification.

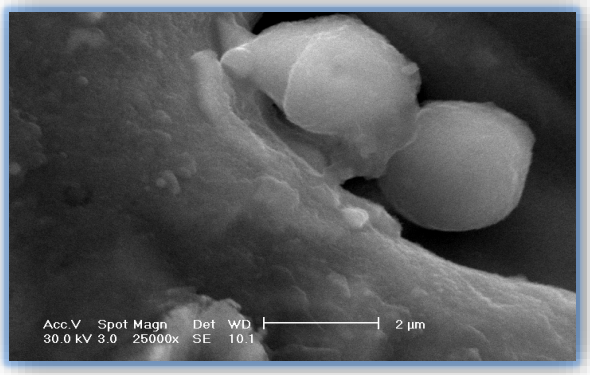


Figure 6.4. Secondary electrons image – surface morphology at 25.000x magnification.

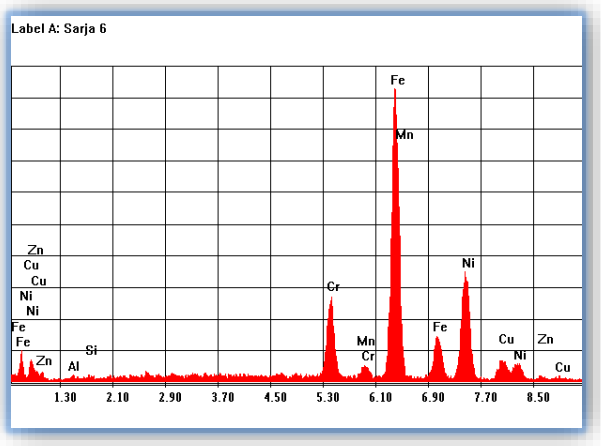


Figure 6.5. Characteristic X-ray emission specter, corresponding to sample 6 compositional analysis.

Table 6. Quantitative compositional results corresponding to sample 6.

Element	Wt %	At %
AlK	0.91	1.88
SiK	0.65	1.29
CrK	9.68	10.42
MnK	0.52	0.53
FeK	49.57	49.66
NiK	30.55	29.11
CuK	6.69	5.89
ZnK	1.43	1.22
Total	100.000	100.000

CONCLUSIONS

This report highlights the possibilities offered by this investigation method and allows drawing important conclusions over the structure of the investigated materials from analyzing the results.

Examining the samples using this method allows collecting information over:

- *The morphology of analyzed surfaces – characteristics of object surface or, also known as, details regarding their textures, the link between material characteristics and properties (ductility, resistance, reactivity, etc.);*
- *Chemical composition of the samples – data regarding elements and compounds they are made of, but also quantitative ratio*
- *Crystalline structure – atom distribution in the crystal; the direct correlation between atom arrangement in the crystal network and material properties (conductivity, electric properties, resistance, etc.).*

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OVERVIEW OF THE INFORMATION SECURITY STANDARDIZATION

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Abstract: There are different kinds of standards, treated by different organizations. In the article below they are presented to the standardisation bodies, which European and the Hungarian economy has big a impact. We do all this in order to find your way to the right so that the client can compare a multitude of information security.
Keywords: standardization; organizations of standardization; information security, information security standards

THE NEED FOR INFORMATION SECURITY STANDARDS

The information is an important value in the economic and social world. The information is the resource of the organizations. This is the basis for the efficient operation of the Organization's assets, and often also the status of your product.

The successful economic, social behaviour is now not only the high quality of carried out activity, a well-functioning organization, should be subject to competitive products and services, but also related to data and information management and protection, as well.

Basically, the reliability and safety of the information affects the body's functioning, as well as the operational, logistic, financial and other processes. And this is in addition to the productivity and legal compliance and profit-making capability, and the market image, and much more.

So, therefore it is essential that a sufficient level of protection of the information. The information security processes and activities of standardization could be applied by a single form. Compliance with the standards and certification audits, offer guarantees of the economic operators and public organizations as well. A number of government standards or recommendations developed along its own information security strategy, as the Government of Hungary did this, too.

THE STANDARDIZATION

A. The standard

A standard is a document that provides requirements, specifications, guidelines or characteristics that can be used consistently to ensure that materials, products, processes and services are fit for their purpose. [1]

B. Short history of the standardisation

The standardization is an activity that can be used again and gives solutions to general existing or anticipated problems, with a view to the effect that organizes the most favourable conditions possible. The standardization is nothing more than the pursuit of harmonisation. The history of standardization – if not in the today's form–, the instinctive standardization began when the languages and number systems, ensuring consistent communication within groups. The development of a system of units of measurement was a conscious tool of standardization, trade, manufacture, levy made this necessary.

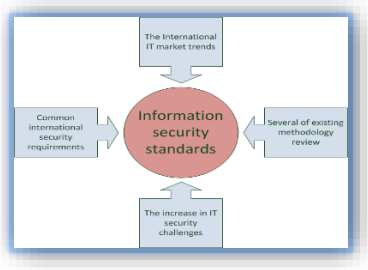

Figure 1. The main factors of the information security standards (by the authors)

The unification demands raised earlier but only in the 1790's made on a proposal French Bishop Talleyrand, the definition of the meter and prefixes. Organized by the national standardization bodies delegated to standardization began in the 20th century, when the Engineering Standards Committee was formed for the first time in London in 1901. In Hungary, two decades later, in 1921, has been converted into the corresponding Hungarian Institute for Industrial Standards. The standardization is the latest generation of the international standardisation, which was followed by the level of national standardization only a slight delay. The IEC[1] has been founded in 1906, and ISA[2] has been founded in 1928.

There are several levels of standardization, which are among the highest of international standardization, in this is participate the competent bodies of the countries. There are standards bodies on international level, as well as the ISO[3] since 1947, our country has been the member of it. And there is the IEC[4] and the ITU[5], which are the UN specialized agencies.

[1] The International Electrotechnical Commission
[2] National Standards Bodies International Association
[3] International Organization for Standardization
[4] International Electrotechnical Commission
[5] International Telecommunication Union

The regional standardization is such a standardization, which is the world's only in a specific geographical, political, or economic area countries can participate in the relevant bodies. There are regional standards bodies, such as the European Committee for Standardization (CEN[6]), and the European Committee for Electrotechnical Standardization (CENELEC[7]) and the European Telecommunications Standards Institute ETSI[8].

The national standardization is a specific country level current standardization. For example, our national standardization bodies are the Hungarian Standardization Institution (MSZT[9]), the BSI[10], the German Standards Institution (DIN[11]) and the ANSI[12].

We can talk about the enterprise standardization when the company is valid within its organisation, usually mandatory, mostly related to prepare and apply technical specifications, ensures enterprise-wide implementation of the national standard. The supplier is also demanding the corporate standards. [2]

ORGANIZATIONS OF INTERNATIONAL STANDARDIZATION

A. The International Organization for Standardization - ISO

The ISO story began in 1946 when delegates from 25 countries met at the Institute of Civil Engineers in London and decided to create a new international organization 'to facilitate the international coordination and unification of industrial standards'. In February 1947 the new organization, ISO, officially began operations.

Since then, they have published over 19 500 International Standards covering almost all aspects of technology and manufacturing.

Today they have members from 163 countries and 3 368 technical bodies to take care of standard development. More than 150 people work full time for ISO's Central Secretariat in Geneva, Switzerland.

Their name is ISO, because 'International Organization for Standardization' would have different acronyms in different languages (IOS in English, OIN in French for Organisation Internationale de Normalisation), their founders decided to give it the short form ISO. ISO is derived from the Greek isos, meaning equal. Whatever the country, whatever the language, they are always ISO.

ISO is an independent, non-governmental organization made up of members from the national standards bodies of 163 countries. Their members play a vital role in how they operate, meeting once a year for a General Assembly that decides on their strategic objectives.

They have a Central Secretariat in Geneva, Switzerland, that coordinates the system. Operations at the Central Secretariat are directed by the Secretary General. The ISO Council takes care of most governance issues. It meets twice a year and is made up of 20 member bodies, the ISO Officers and the Chairs of Policy Development Committees (CASCO, COPOLCO, DEVCO). Membership to the Council is open to all member bodies and rotates to make sure it is representative of the member community.

Under the Council there are a number of bodies that provide guidance and management on specific issues.

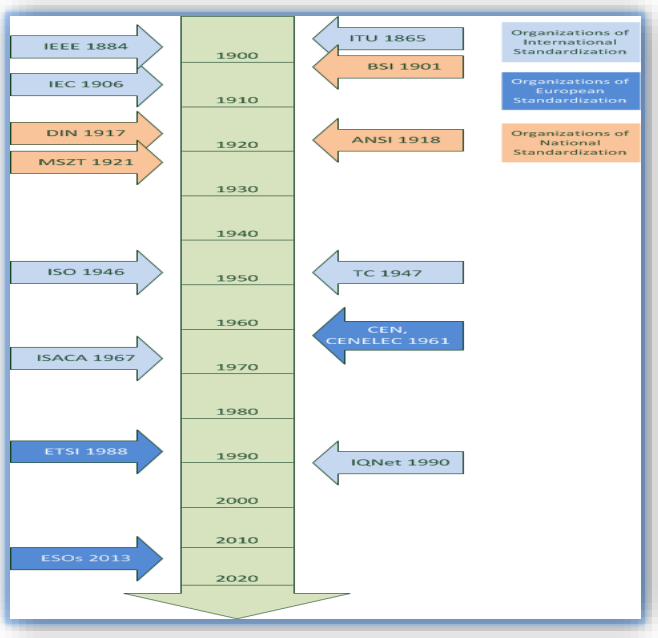

Figure 2. Formation of the organizations of standardization (by the authors)

The President's advise the Committee Council and oversee the implementation of the decisions taken by the Council and the General Assembly.

- *CASCO[13] - provides a guidance on conformity assessments*
- *COPOLCO[14] - provides a guidance on consumer issues*
- *DEVCO[15] - provides a guidance on matters related to developing countries*
- *Council Standing Committees - advise on financial and strategic matters*
- *Ad hoc Advisory Committees - can be established to advance the goals and strategic objectives of the organization*

The management of the technical work is taken care of by the Technical Management Board. This body is also responsible for the technical committees that lead standard development and any strategic advisory boards created on technical matters.

They work closely with two other international standards development organizations, the International Electrotechnical Commission (IEC) and International Telecommunication Union (ITU). In 2001, ISO, IEC and ITU formed the WSC[16] in order to strengthen the standards systems of the three organisations. The WSC also promotes the adoption and implementation of international consensus-based standards worldwide.

In addition, they also have a close relationship with the WTO[17] which particularly appreciates the contribution of International Standards to

[6] *Comité Européen de Normalisation*
[7] *Comité Européen de Normalisation Electrotechnique*
[8] *European Telecommunications Standards Institute*
[9] *Magyar Szabványügyi Testület*
[10] *British Standards Institution*
[11] *Deutsches Institut für Normung e.V.*
[12] *American National Standards Institute*
[13] *Committee on conformity assessment*
[14] *Committee on Consumer Policy*
[15] *Committee on developing country matters*
[16] *World Standards Cooperation*
[17] *World Trade Organization*

reducing technical barriers to trade. ISO also works with the United Nations partners. For example, they liaise with UN specialized agencies that do technical harmonization or technical assistance, including the ECOSOC[18]. In total, ISO collaborates with over 700 international, regional and national organisations. These organisations take part in the standard development process as well as sharing expertise and best practices. [3] They have been developed by the family of chief information security standard, ISO/IEC 27000, which we use today.

B. The Technical Committee - TC

The list of ISO technical committees provides basic information for each technical committee (TC). The TCs are listed in numerical order, following the order in which they were established. For example, TC 1 focusing on screw threads was created in 1947 and TC 269 on railway applications was created in 2012. JTC1[19] is the Joint ISO/IEC TC that was created in 1987.

Project Committees are established when there is a need for an International Standard on a specific topic that does not fall into the scope of an existing TC. Project Committees are disbanded once the standard has been published. [4]

C. The International Electrotechnical Commission - IEC

Millions of devices that contain electronics, and use or produce electricity, rely on IEC International Standards and Conformity Assessment Systems to perform, fit and work safely together. Founded in 1906, the IEC (International Electrotechnical Commission) is the world's leading organization for the preparation and publication of International Standards for all electrical, electronic and related technologies. These are known collectively as "electrotechnology".

IEC provides a platform to companies, industries and governments for meeting, discussing and developing the International Standards they require. All IEC International Standards are fully consensus-based and represent the needs of key stakeholders of every nation participating in IEC work. Each member country, no matter how large or small, has one vote and a say in what goes into an IEC International Standard. [5]

The International Electrotechnical Commission is the leading global organization that publishes consensus-based International Standards and manages conformity assessment systems for electric and electronic products, systems and services, collectively known as electrotechnology.

IEC publications serve as a basis for national standardization and as references when drafting international tenders and contracts.

The IEC Statutes and Rules of Procedure is the governing document of the IEC. It details the rights and obligations of the member National Committees, the IEC Officers and the different IEC management boards. The Directives outline the procedures of the IEC's technical work, including the rules for the structure and drafting of International Standards. [6]

D. The International Telecommunication Union - ITU

ITU (International Telecommunication Union) is the United Nations specialized agency for information and communication technologies – ICTs. For a century and a half since 1865, the International Telecommunication Union (ITU) has been at the center of advances in communications – from telegraphy through to the modern world of satellites, mobile phones and the Internet.

The story of ITU is one of international cooperation, among governments, private companies and other stakeholders. The continuing mission is to achieve the best practical solutions for integrating new technologies as they develop, and to spread their benefits to all. [7]

They allocate global radio spectrum and satellite orbits, develop the technical standards that ensure networks and technologies seamlessly interconnect, and strive to improve access to ICTs to underserved communities worldwide.

ITU is committed to connecting the entire world's people – wherever they live and whatever their means. Through their work, they protect and support everyone's fundamental right to communicate.

Today, ICTs underpin everything they do. They help manage and control emergency services, water supplies, power networks and food distribution chains. They support health care, education, government services, financial markets, transportation systems and environmental management. And they allow people to communicate with colleagues, friends and family anytime, and almost anywhere.

With the help of their membership, ITU brings the benefits of modern communication technologies to people everywhere in an efficient, safe, easy and affordable manner.

ITU membership reads like a Who's Who of the ICT sector. They are unique among UN agencies in having both public and private sector membership. So in addition to their 193 Member States, ITU membership includes ICT regulators, leading academic institutions and some 700 private companies.

In an increasingly interconnected world, ITU is the single global organization embracing all players in this dynamic and fast-growing sector. ITU is headquartered in Geneva, Switzerland, and has twelve regional and area offices around the world.

ITU membership represents a cross-section of the global ICT sector, from the world's largest manufacturers and carriers to small, innovative players working with new and emerging technologies, along with leading R&D[20] institutions and academia. [8]

E. The Institute of Electrical and Electronics Engineers - IEEE

IEEE[21], an association dedicated to advancing innovation and technological excellence for the benefit of humanity, is the world's largest technical professional society. It is designed to serve professionals involved in all aspects of the electrical, electronic, and computing fields and related areas of science and technology that underlie modern civilization.

IEEE's roots go back to 1884 when electricity began to become a major influence in society. There was one major established electrical industry, the telegraph, which since the 1840s had come to connect the world with a data communications system faster than the speed of transportation. The telephone and electric power and light industries had just gotten underway. IEEE, pronounced "Eye-triple-E," stands for the Institute of

[18] *UN Economic and Social Council*
[19] *Joint Technical Committee 1*
[20] *Research and development*
[21] *Institute of Electrical and Electronics Engineers*

Electrical and Electronics Engineers. The association is chartered under this name and it is the full legal name.

However, as the world's largest technical professional association, IEEE's membership has long been composed of engineers, scientists, and allied professionals. These include computer scientists, software developers, information technology professionals, physicists, medical doctors, and many others in addition to IEEE's electrical and electronics engineering core. For this reason the organization no longer goes by the full name, except on legal business documents, and is referred to simply as IEEE. [9]

IEEE is a leading developer of international standards that underpin many of today's telecommunications, information technology, and power generation products and services.

Often the central source for standardization in a broad range of emerging technologies, the IEEE Standards Association has a portfolio of more than 1,671 standards and projects under development. This includes the prominent IEEE 802® standards for wireless networking. [10]

The IEEE-SA[22] is a leading consensus building organization that nurtures, develops and advances global technologies, through IEEE external link. They bring together a broad range of individuals and organizations from a wide range of technical and geographic points of origin to facilitate standards development and standards related collaboration. With collaborative thought leaders in more than 160 countries, they promote innovation, enable the creation and expansion of international markets and help protect health and public safety. Collectively, their work drives the functionality, capabilities and interoperability of a wide range of products and services that transform the way people live, work and communicate.

The IEEE-SA is governed by the BOG[23] who are elected by IEEE-SA Members. The Board of Governors oversees number of committees that are dedicated to manage key operational aspects of the IEEE-SA. The IEEE-SA Standards Board reports directly to the BOG, and oversees the IEEE standards development process. Standards Board members are elected by IEEE-SA members as a privilege of membership, and all Board Members and Committee members must be IEEE-SA members in good standing.

The IEEE-SA standards development process is open to IEEE-SA Members and non-members, alike. However, IEEE-SA Membership enables standards development participants to engage in the standards development process at a deeper and more meaningful level, by providing additional balloting and participation opportunities. IEEE-SA members are the driving force behind the development of standards, providing technical expertise and innovation, driving global participation, and pursuing the ongoing advancement and promotion of new concepts. [11]

F. The Information Systems Audit & Control Association - ISACA

As an independent, non-profit, global association, ISACA[24] engages in the development, adoption and use of globally accepted, industry-leading knowledge and practices for information systems. Previously known as the Information Systems Audit and Control Association, ISACA now goes by its acronym only, to reflect the broad range of IT governance professionals it serves.

ISACA was incorporated by individuals who recognized a need for a centralized source of information and guidance in the growing field of auditing controls for computer systems. Today, ISACA has more than 115,000 constituents worldwide. [12]

ISACA got its start in 1967, when a small group of individuals with similar jobs—auditing controls in the computer systems that were becoming increasingly critical to the operations of their organizations—sat down to discuss the need for a centralized source of information and guidance in the field. In 1976 the association formed an education foundation to undertake large-scale research efforts to expand the knowledge and value of the IT governance and control field. Previously known as the Information Systems Audit and Control Association, ISACA now goes by its acronym only, to reflect the broad range of IT governance professionals it serves.

Today, ISACA's constituency is characterized by its diversity. Constituents live and work in more than 180 countries and cover a variety of professional IT-related positions—to name just a few, IS auditor, consultant, educator, IS security professional, regulator, chief information officer and internal auditor. Some are new to the field, others are at middle management levels and still others are in the most senior ranks. They work in nearly all industry categories, including financial and banking, public accounting, government and the public sector, utilities and manufacturing. This diversity enables members to learn from each other, and exchange widely divergent viewpoints on a variety of professional topics. It has long been considered one of ISACA's strengths.

Since its inception, ISACA has become a pace-setting global organization for information governance, control, security and audit professionals. Its IS auditing and IS control standards are followed by practitioners worldwide. Its research pinpoints professional issues challenging its constituents. Its CISA[25] certification is recognized globally and has been earned by more than 109,000 professionals since inception. The CISM[26] certification uniquely targets the information security management audience and has been earned by more than 25,000 professionals.

The CGEIT[27] designation promotes the advancement of professionals who wish to be recognized for their IT governance-related experience and knowledge and has been earned by more than 6,000 professionals. The CRISC[28] designation for those who identify and manage risks through the development, implementation and maintenance of information systems controls have been earned by more than 17,000 professionals. [13]

G. The International Certification Network – IQNet

IQNet - The International Certification Network has been active since 1990, and has almost 40 Partner certification bodies with more than 200 subsidiaries worldwide. Each of them IQNet Partners is a leader in their region; and collectively through IQNet, this represents the most extensive and reputable network of certification bodies worldwide. IQNet

[22] *IEEE Standards Association*
[23] *Board of Governors*
[24] *Information Systems Audit and Control Association*
[25] *Certified Information Systems Auditor*
[26] *Certified Information Security Manager*
[27] *Certified in the Governance of Enterprise IT*
[28] *Certified in Risk and Information Systems Control*

headquarters are based in Bern, Switzerland. IQNet supports the work of international organizations by its membership and involvement in for example IAF[29], and EA[30].

A common database of certified/registered companies has been established since 2005. Certificates/registrations contained in this database are issued by IQNet partners. Certificates are mainly third-party certification/registration of management systems in accordance with international standards such as ISO 9001, ISO 14001, sector specific standards, or national standards.

The objectives of this database are to promote valid certificates issued by IQNet partners, and to act as a point of verification for all conformity assessment stakeholders; including procurement bodies. IQNet partners are regularly updating and entering their data. With more than 250.000 entries, the IQNet database is one of the largest public listings on certified/registered companies worldwide. [14]

ORGANIZATIONS OF EUROPEAN STANDARDIZATION

A. The European Standardization Organizations – ESOs

The three European Standardization Organizations, CEN, CENELEC and ETSI are officially recognized as competent in the area of voluntary technical standardization. The European Union (EU) Regulation (1025/2012) which settles the legal framework for standardization, has been adopted by the European Parliament and by the Council of the EU[31], and entered into force on 1 January 2013.

Although they deal with different fields of activity, CEN, CENELEC, and ETSI cooperate in a number of areas of common interest, such as the machinery sector or information and communication technologies (ICTs). They also share common policies on issues where there is a mutual agreement.

An EN (European Standard) "carries with it the obligation to be implemented at national level by being given the status of a national standard and by withdrawal of any conflicting national standard". Therefore, a European Standard (EN) automatically becomes a national standard in each of the 33 CEN-CENELEC member countries.

Standards are voluntary which means that there is no automatic legal obligation to apply them. However, laws and regulations may refer to standards and even make compliance with them compulsory. [15]

B. The European Committee for Standardization – CEN

CEN, the European Committee for Standardization, is an association that brings together the National Standardization Bodies of 33 European countries. The core business of CEN is to develop and publish European Standards and technical specifications that meet the evolving needs of European businesses and other organizations. This important work brings concrete benefits, such as: improving safety, quality and reliability of products, services, processes; reinforcing the Single Market and supporting the economic growth and the spread of new technologies and innovation.

In order to prepare and produce state-of-the-art standards, CEN relies on the knowledge of some 50.000 experts, who participate in various technical activities through a network of 50 National Standards Bodies (33 Members plus 17 Affiliates) and continuous cooperation with organizations representing different stakeholders, including consumers, workers, environmental interests and SMEs[32].

The CEN/BT[33] is responsible for co-ordinating and managing the standards development work that is being carried out in more than 320 Technical Committees. In addition to overseeing these activities, as well as their related processes, the CEN Technical Board is also responsible for evaluating and addressing requests for standardization on new subjects.

The Vienna Agreement provides a framework for technical cooperation between CEN and the International Organization for Standardization (ISO). It provides provisions relating to the exchange of information between ISO and CEN, mutual representation at meetings, and parallel approval of standards.

CEN provides a European platform for the standardization of products, services, processes and systems across a wide range of sectors.

A growing number of sectors are being addressed by both CEN and the European Committee for Electrotechnical Standardization (CENELEC) in the framework of their joint activities. These include among others: Accessibility, Defence and Security, Energy Efficiency, Energy Labelling, Ecodesign and Energy Management, Health and Safety. [16]

C. The European Committee for Electrotechnical Standardization – CENELEC

CENELEC is the European Committee for Electrotechnical Standardization and is responsible for standardization in the electrotechnical engineering field. CENELEC prepares voluntary standards, which help facilitate trade between countries, create new markets, cut compliance costs and support the development of a Single European Market.

CENELEC creates market access at European level but also at international level, adopting international standards wherever possible, through its close collaboration with the International Electrotechnical Commission (IEC), under the Dresden Agreement.

In an ever more global economy, CENELEC fosters innovation and competitiveness, making technology available industry-wide through the production of voluntary standards.

Through the work of its members together with it's the experts, the industry federations and consumers, European Standards are created in order to encourage technological development, to ensure interoperability and to guarantee the safety and health of consumers and provide environmental protection. Designated as a European Standards Organization by the European Commission, CENELEC is a non-profit technical organization set up under Belgian law. It was created in 1973 as a result of the merger of two previous European organizations: CENELCOM and CENEL. [17]

D. The European Telecommunications Standards Institute - ETSI

ETSI[34] produces globally-applicable standards for ICT[35], including fixed, mobile, radio, converged, broadcast and internet technologies. They are officially recognized by the European Union as a European Standards

[29] *International Accreditation Forum*
[30] *European cooperation for Accreditation*
[31] *European Union*
[32] *Small and Medium-sized Enterprises*
[33] *CEN Technical Board*
[34] *European Telecommunications Standards Institute*
[35] *Information and Communications Technologies*

Organization. The high quality of their work and their open approach to standardization has helped us evolve into a European roots - global branches operation with a solid reputation for technical excellence.

ETSI is a not-for-profit organization with over 750 ETSI member organizations drawn from 64 countries across 5 continents world-wide. More information concerning ETSI member organizations is available in the membership section. [18]

'Openess' goes much further than simple access to a standard once it has been published. At ETSI, 'openess' is a question of culture.

They pride ourselves on being 'open', not only in creating their standards via consensus but via the direct input of their members. It is they who ultimately make and set ETSI standards.

'Openness', in ETSI terms, also means that almost any organization or person, from any part of the world, can become a member.

But having a truly 'open approach to business' does not stop there. They believe one of the best ways to encourage market growth and innovation is to allow 'open' access to standards, which is why anyone in the world can download ETSI standards free-of-charge, via their web site.

Standardization is high on the strategic agenda of any company with international ambitions. The 'openness' and knowledge accessibility within standardization is also a key driver in adding value to expensive research and development programmes.

Indeed, at the very core of standardization is the 'mutualisation' of technical development with the aim of enabling markets to grow, and industry to compete, with a minimum of interoperability and inter-working required.

For such a system to work most efficiently, it must be 'open' to all who wish to contribute and remain 'open' all along the standards production process, including delivery. [19]

ORGANISATIONS OF NATIONAL STANDARDIZATION

A. The American National Standards Institute - ANSI

The American National Standards Institute (ANSI) has served in its capacity as administrator and coordinator of the United States private sector voluntary standardization system for more than 90 years. Founded in 1918 by five engineering societies and three government agencies, the Institute remains a private, nonprofit membership organization supported by a diverse constituency of private and public sector organizations.

Throughout its history, ANSI has maintained as its primary goal the enhancement of global competitiveness of U.S. business and the American quality of life by promoting and facilitating voluntary consensus standards and conformity assessment systems and promoting their integrity. The Institute represents the interests of its nearly 1,000 companies, organization, government agency, institutional and international members through its office in New York City, and its headquarters in Washington, D.C.

ANSI facilitates the development of American National Standards (ANS) by accrediting the procedures of SDOs[36]. These groups work cooperatively to develop voluntary national consensus standards. Accreditation by ANSI signifies that the procedures used by the standards body in connection with the development of American National Standards meet the Institute's essential requirements for openness, balance, consensus and due process.

ANSI is often asked about the total number of standards (and standards setting bodies) in the United States. It is estimated that in the U.S. today there are hundreds of "traditional" standards developing organizations - with the 20 largest SDOs producing 90% of the standards - and hundreds more "non-traditional" standards development bodies, such as consortia. This means that the level of U.S. participation is quite expansive as the groups themselves are comprised of individual committees made up of experts addressing the technical requirements of standards within their specific area of expertise. [20]

B. The British Standards Institution - BSI

Sir John Wolfe Barry – the man who designed London's Tower Bridge - instigated the Council of the Institution of Civil Engineers to form a committee to consider standardizing iron and steel sections on 22 January 1901.

In World War 1, British Standards were used by the Admiralty, the War Office, the Boad of Trade, Lloyd's Register, the Home Office, the Road Board, the London County Council and a lot of colonial governments.

During the 1920s standardization spread to Canada, Australia, South Africa and New Zealand. Interest was also developing in the USA and Germany.

On 22 April 1929, the Engineering Standards Committee, (since 1918 the British Engineering Standards Association) was granted a Royal Charter. A supplemental Charter was granted in 1931 changing the name, finally, to The British Standards Institution.

Between 1939 and 1945 over 400 war emergency standards were produced. 1946 saw the first ever Commonwealth Standards Conference, held in London and organized by BSI, which led to the establishment of the International Organization for Standardization (ISO).

The UK's[37] first management systems quality standard, BS 5750, was published by BSI in 1979. In 1987, it was superseded by the ISO 9000 series of international standards which BS 5750 inspired.

Revised in 1994, 2000 and then in 2008, the international quality management systems standard has proved a global success with more than 1 million ISO 9001 certificates (2000 and 2008 combined) issued in 178 countries and economies by the end of 2009. [21]

They are the UK's National Standards Body (NSB) and were the first national standards body. They represent UK economic and social interests across all European and international standards organizations and in the development of business information solutions for British organizations of all sizes and sectors. [22]

BSI is recognized as the UK NSB[38] by the UK Government. This status is formally codified in the MoU[39] between the United Kingdom Government and the British Standards Institution in respect of its activities as the United Kingdom's National Standards Body.

[36] *Standards Developing Organizations*
[37] *United Kingdom*
[38] *National Standards Body*
[39] *Memorandum of Understanding*

The MoU recognizes BSI's status as the UK member of the international standards organizations, ISO and IEC; the European standards organizations, CEN and CENELEC; and as the NSO[40] participating on behalf of the UK in ETSI.

The MoU defines a number of key responsibilities for BSI as the NSB. Its membership of the international and European standards bodies also entails a number of specific responsibilities. In addition, there are certain aspects of BSI's work that are further defined through the World Trade Organization's TBT[41], to which the UK Government is a signatory.

Most of BSI's responsibilities are undertaken on a day-to-day basis by BSI Standards Ltd., a wholly owned subsidiary company of BSI Group. A Supply of Services Agreement sets the framework by which this can be systematically monitored.

The NSB has the responsibility of the Director of Standards and is administered within the External Policy team. It receives some funding from the UK Government in recognition of work undertaken in the public interest.

The exact scope of the activities regarded as belonging to the NSB is listed in the BSI Code of Conduct. [23]

C. The German Institute for Standardization - DIN

The remit of DIN German Institute for Standardization is to encourage, organize, steer and moderate standardization and specification activities in systematic and transparent procedures for the benefit of society as a whole, while safeguarding the public interest. The results of DIN's work serve to advance innovation, safety and communication among industry, research organizations, the public sector and society as a whole, and to support quality assurance, rationalization, occupational health and safety, and environmental and consumer protection. DIN publishes its work results and promotes the implementation of these results. Some 30,000 experts contribute their skills and experience to the standardization process which is managed and coordinated by the DIN staff of around 400. By agreement with the German Federal Government, DIN is the acknowledged national standards body that represents German interests in European and international standards organizations. Ninety percent of the standards work now carried out by DIN are international in nature. A registered non-profit association, DIN has been based in Berlin since 1917. [24]

D. The Hungarian Standards Institution - MSZT

The Hungarian Standards Institution was founded in 1921.

This legal status is non-profit body of public interest, according to Law XXVIII of 1995 on national standardization and its amendment by Law CXII of 2001; self-governed and registered in accordance with the provision of the Civil Code.

By virtue of the Law, the Hungarian Standards Institution (MSZT) is the national standards body of the Republic of Hungary.

Hungary is represented by MSZT, via its membership, in the following international and European standards organizations:

- *International Organization for Standardization (ISO) membership of MSZT: since the foundation of ISO - 1947*
- *International Electrotechnical Commission (IEC) membership of MSZT: since the foundation of IEC - 1906*
- *European Committee for Standardization (CEN) national membership of MSZT: from 1st of January 2003*
- *European Committee for Electrotechnical Standardization (CENELEC) national membership of MSZT: from 1st of June 2002*
- *European Telecommunication Standards Institute (ETSI) full membership of MSZT: from 1996*

The Officials of MSZT	*Activity*
President	▪ *simultaneously the Chairman of the Standards Council* ▪ *elected by the General Assembly* ▪ *responsible for his activities to the General Assembly* ▪ *performs activities as defined in the Statutes*
Vice-President	▪ *elected by the General Assembly* ▪ *also a member of the Standards Council*
Members of the Standards Council	▪ *elected by the General Assembly and delegated by central administrative bodies* ▪ *gives guidance for the activities of MSZT*
Members of the Financial Control Committee	▪ *elected by the General Assembly*
Chairmen of the national technical committees for standardization	▪ *elected by the relevant committee from its own members*
Managing Director	▪ *Manages the Executive Organization*

Officials of MSZT (by the authors)

The Bodies of MSZT	*Activity*
The General Assembly	▪ *chaired by the President* ▪ *approves the Statutes* ▪ *decides about the acceptance of the yearly report* ▪ *elects and discharges the President and vice-president of MSZT* ▪ *elects and discharges the eligible members of the Standards Council and the Financial Control Committee* ▪ *approves the accounts of the Standards Council and the Financial Control Committee* ▪ *approves the yearly budget* ▪ *responsible for any action referred to it by legislation or by the Statutes*
The Standards Council	▪ *chaired by the President* ▪ *determines the membership fees* ▪ *defines the basic policy for the functioning of MSZT* ▪ *approves the long-term and yearly programmes of national standardization*
The Financial Control Committee	▪ *inspects the conformity of the economic activities of MSZT to the rules*
The Technical Committees for National Standardization	▪ *carry out the professional work in each particular sector in an operative way*
The Executive Organization	▪ *provides continuous activities necessary for the functioning of MSZT*

Bodies of MSZT (by the authors)

[40] *National Standards Organization*

[41] *Technical Barriers to Trade Agreement*

1) *Members of MSZT*
- *Any legal entity as well as economic organization other than legal entity can become member of MSZT members of MSZT are registered;*
- *current number of MSZT members: 320 (this membership covers more than 85% of the Hungarian economy)*
- *MSZT members have delegated more than 3500 experts (representatives) to the 184 national technical committees for standardization;*

2) *Conditions of membership in MSZT:*
   - *acceptance of the Statutes;*
   - *applying for membership;*
   - *payment of membership fee.*

3) *The main responsibilities of MSZT, in accordance with the Law, are:*
- *development of national standards or provision for their development, their approval and publication, withdrawal and amendment as well as the preparation of the respective methodology and rules of procedure;*
- *participation in the work of the international and European standards organizations and the coordination of the participation by stakeholders;*
- *preparation of guidance and advice in national standardization issues;*
- *preparation and publication of studies related to standardization;*
- *determination of the use of the national standards mark as well as implementation and management of the rules for the application of international and European marks related to standardization;*
- *development and management of a certification system to assess conformity of products and services to national standards;*
- *participation in the development of rules for the certification of conformity with legal rules or other specifications;*
- *establishment of a system for the certification of quality assurance systems against standards;*
- *participation, on request, in the preparation of Hungarian legislation based on directives of the European Union;*
- *provisioning of information and dissemination of knowledge related to standardization and certification;*
- *management and development of trainings related to national standardization and certification of personnel;*
- *technical documentation and other services.*

4) *Sources for the functioning of MSZT:*
- *membership fees;*
- *sale of standards and publications;*
- *certification;*
- *training;*
- *information services;*
- *other services;*
- *mandates from Government;*
- *support from interested parties. [25]*

Acknowledgment

This article has been summarized in the structured organizations of standardization of information security, which International, European and national have been collected for the purposes of grouping. The organizations of standardization discussed in this article are all great impact in Europe and the Hungarian economy's life. [26, 27,28]

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THE DESIGN AND CONSTRUCTION OF AN AUTONOMOUS MOBILE MINI-SUMO ROBOT

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Abstract: The paper presents the design and construction of an autonomous mobile mini-sumo robot. The mobile robot is a combination of devices endowed with power drives and sensors, under the control of a hierarchical computing system operating in the real space, which has to plan the movements so as to perform a task depending on the initial state of the system as well as on the information received from the work environment. The robot was designed using Fritzing software and its programming has been done by means of Arduino programming language. In building the robot, the regulations of the sumo-type robot competitions were taken into account in order to allow it to take part in such competitions.
Keywords: robot, sensors, mini-sumo, programming language

INTRODUCTION

One of the most important aspects in human evolution is the use of tools, meant to ease physical work. Robots range within this category, their complexity offering them a privileged position, though [7]. The mobile robot is a complex system that can perform several activities in a variety of specific situations of the real world. It is a combination of devices endowed with power drives and sensors under the control of a hierarchical computing system operating in the real space, marked by a series of physical properties (for instance gravity, which influences the movement of all robots functioning on the Earth) and which has to plan the movements so as to achieve a task according to the initial state of the system and depending on the existing information, related to the work environment. The success in performing these tasks depends both on the knowledge the robot has about the initial configuration of the work space as well on the information acquired during its evolution [2] [8].

The specific problems arising with mobile robots are the following: avoiding the impact with stationary or moving objects, determining the position and orientation of the robot in the area and planning an optimal trajectory of movement.

In the case of an automatically distributed robotic system, the spatial positions are of utmost importance as they influence the achieving of the desired targets, as well as the functioning of the whole system. In other words, the robot must be able to plan its movements, to automatically decide upon the movements to be made in order to carry out a task, according to the momentary distribution of objects in the work space. Movement planning does not consist in a single, well-defined issue, but in a set of problems of which some are more or less variants of the others.

Avoiding collision with fixed or mobile obstacles (for instance other mobile robots) existing in the work space of the robot can be done by several methods: building a mechanical guard which, by deformation, stops the robot, using sensors to measure distance up to the obstacles in the direction of movement, the use of proximity sensors, the use of the information correlated from several types of sensors [3] [4].

Object spotting can also be done by physical contact, but this involves restrictions on the movement speed and the handled structure. The physical contact between the robot and the environmental objects triggers reaction forces that modify the state of the robot. The high work rates make the dynamic effects of a physical contact with obstacles or with the handled objects risky (they may damage the objects or the robot).

The sensor system is also called gauging system. It helps measure some physical magnitudes and possibly perceiving some significant alterations of these magnitudes.

Robot navigation is possible even in the absence of position determination and orientation with respect to a fixed coordinate system, but this information is useful for the movement control systems. Among the most commonly used navigation systems the following can be mentioned: measuring the number of rotations made by the driving wheels, the use of accelerators and gyroscopes, electromagnetic buoys located on the terrain, passive or semi-passive optical or magnetic signaling systems [5] [6].

THE ROBOT DESIGN AND BUILDING

In order for the robot to win a mini-sumo fight, its constructor and programmer has to take into account several factors. If the strategy is focused on a powerful and slow robot, then the motors should be chosen to have a high transfer rate. If, on the contrary, the choice is a fast and agile robot, then the motors should have a low transfer rate. The transfer rate refers to the gear that transfers the movement to the wheels (included in the motor case). A transfer rate of 50:1 means that for 50 rotations of the motor, the wheel turns once. The robot is agile,

but less powerful. A transfer rate of 298:1 means that for 298 rotations of the motor, the wheel turns once. The robot will be slow, but very powerful. Other factors that influence the complexity and efficiency of the robot are:

- *the type of distance and line sensors used (infrared, ultrasound);*
- *the response time of the sensors;*
- *adherence and the type of locomotion;*
- *the type of chassis;*
- *the duration of motor feeding (the robot should stay "alive" all along the fight, up to its end);*
- *the strategy of choice in programming the robot;*

Further on, a robot is presented, built to simulate a sumo fight, taking into consideration the above-mentioned elements.

Such robots can be used in various domains, as they are adaptable to the exploration of narrow or dangerous spaces, or even as a military application. Here is, next, the description of the robot and its main hardware elements. This is an autonomous mobile robot, which does not require its remote control by means of mobile phone applications.

The robot is fed by a set of 6 batteries located in a special case and connected to the GND (Ground) pin and to the 5V (Volt) pin [11].

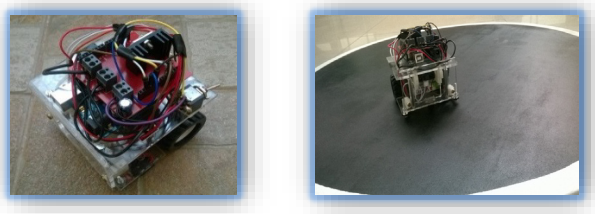


Figure 1. Robot overall view and the robot in the ring

The main hardware components used in building this robot are: the Arduino Uno board; 2 (line) reflection sensors; a distance sensor; the L298N shield; 2 c.c. motors

ARDUINO UNO

The moni sumo robot needs a brain. The best option in this sense is an Arduino UNO board. Arduino UNO is an open-source processing platform, based on a flexible and user-friendly hardware and software. It consists of a small platform (6.8 cm / 5.3 cm – in the most common version) built around a signal processor and capable of taking in data from the environment through several sensors and of performing actions upon it by means of lights, motors, power drives and other types of mechanical devices. The processor is able to run code written in a programming language that is very similar to C++[9] [10].

(LINE) REFLECTION SENSORS

These sensors consist of two components: an IR LED and an IR photosensitive transistor. When a voltage of 5V is applied to the VCC and GND pin, the IR LED will emit infrared light. A 100 Ohm resistor is connected in series to the IR LED, in order to limit the current. A 10 kOhm resistor sets the output pin to HIGH, but when the light emitted by the IR LED is reflected back towards the phototransistor, the output pin switches to LOW. The more light the phototransistor receives, the lower the voltage on the output pin [1].

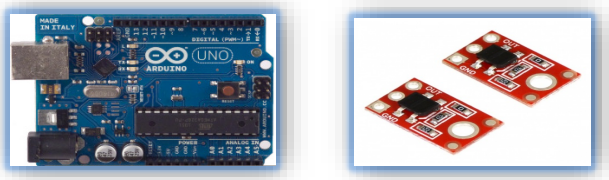


Figure 2. ARDUINO Microcontroller and Line sensors

DISTANCE SENSOR

In order for the robot to "see" its opponent, it needs at least one distance sensor. The Sharp distance sensor is a component that can be used with Arduino for measuring the distance to various objects in the surrounding area. They are the most suitable for this kind of robot, as they have a very fast response. The ultrasound sensors are not so efficient for sumo, as their response is relatively slow.

The principle underlying the functioning of the robot is the following: the sensor emits a pulse of infrared light of a certain wavelength and if the object is in the action area and on the trajectory of the IR beam, it will reflect the ray to the sensor. The sensor performs the readings with a certain frequency and reports the data as voltages. The Sharp distance sensors are available in three variants, according to their efficiency area. There are sensors that prove efficient within 3 cm to 40 cm, others between 10 cm and 80 cm, and also others between 15 cm and 150 cm. The sensor values cannot be used outside their efficiency area. The sensor of choice was in this case the one that is efficient between 10 cm and 80 cm[1][9].

C.C. MOTORS

The robot has two high power C.C. Pololu-type motors, with a transfer rate of 100:1. The transfer rate refers to the gear that transfers the movement from the motor to the wheels. A 100:1 transfer rate means that for 100 rotations of the motor, the wheel will turn once. If the strategy focuses on a powerful and slow robot, then motors with a high transfer rate are recommended. If, on the contrary, a swift and agile robot is needed, then the motors of choice will have a low transfer rate. In this case, the transfer rate chosen offers the robot a balance between speed and power.

Figure 3. C.C. motor and SHARP Distance Sensor

L298N MOTOR DRIVERS

Arduino is a very capable brain for this type of robots, but, as any brain, it can only perform precision operations. Arduino was not designed to offer high power for motors, but precise control signals. The motor driver is connected directly to the energy source (the battery) and it controls the motors according to the control signals received from Arduino.

Based on the L298N circuit, this motor driver can control 2 C.C. motors at a maximum current of 2 amperes. The driver is entirely assembled as an Arduino shield, which enables its simple usage. The connection to Arduino is done by plugging the shield board to Arduino and connecting the VIN and GND pins to the motor power source. The PWM pins controlling the L298 driver are 3, 5, 6 and 9 (also see the test program given further on). The two motors are connected to the screw pins marked "MOTOR1" and "MOTOR2". For this mini sumo robot the power needs to be high and continuously dissipated, so a radiator was used [11] [12]. The connection of the components that make up the mini-sumo mobile system is given herein after.

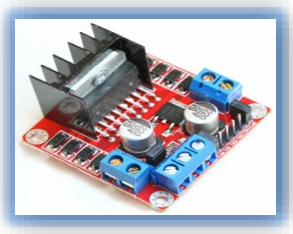


Figure 4. Motor driver

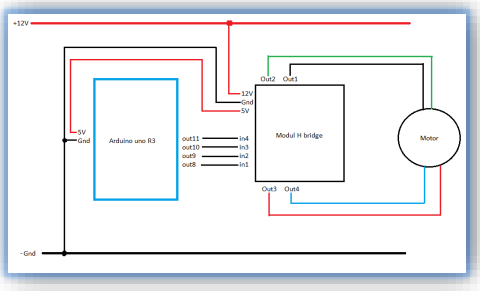


Figure 5. L298N Arduino connection diagram

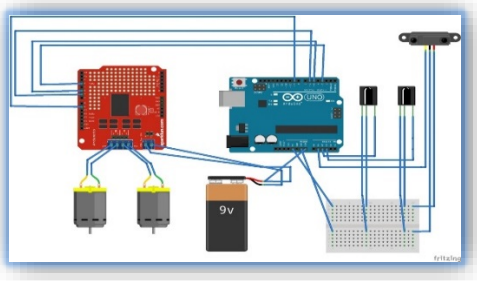


Figure 6. The connections of the robot components

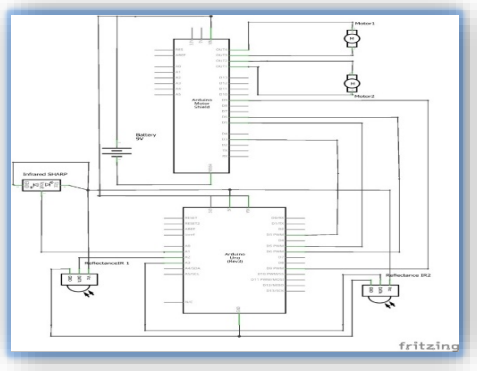


Figure 7. Connection diagram

SOFTWARE IMPLEMENTATION

The programming language used with the mini-sumo robot is similar to the C++ language and is called Arduino.

The window shown below is a programming editor used only for the Arduino development boards. To this purpose, it is needed to choose from the tools the board to be working with, as well as the port selected by the computer.

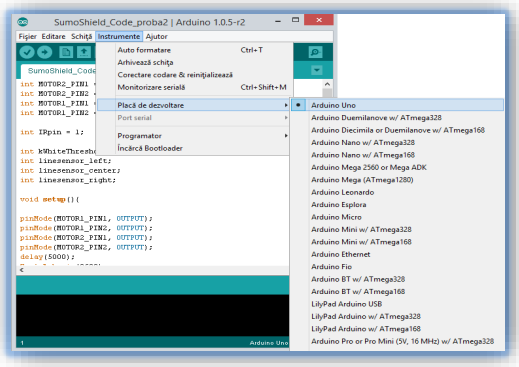


Figure 8. Choosing the Arduino board

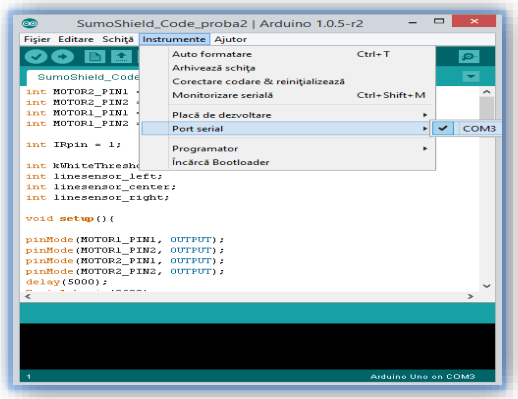


Figure 9. Port selection

Any code line has to be checked with the button  *that will check for errors in the program structure and, once the message "Done compiling" is displayed, the program can be run by pressing the upload button*  *that sends through port COM3 the instructions to the microcontroller, which processes it and sends it on to the output pins.*

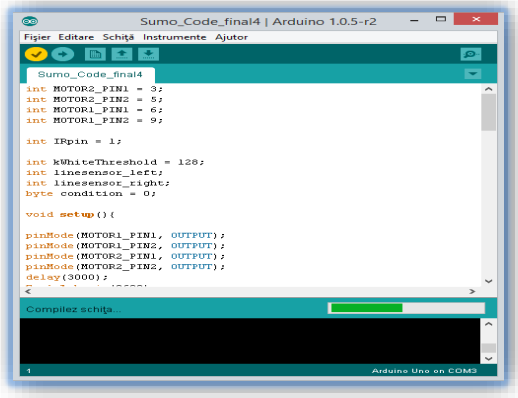


Figure 10. Program compiling

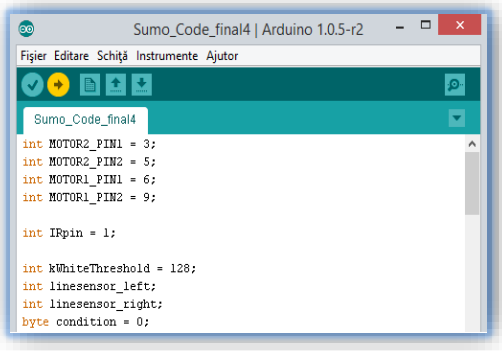
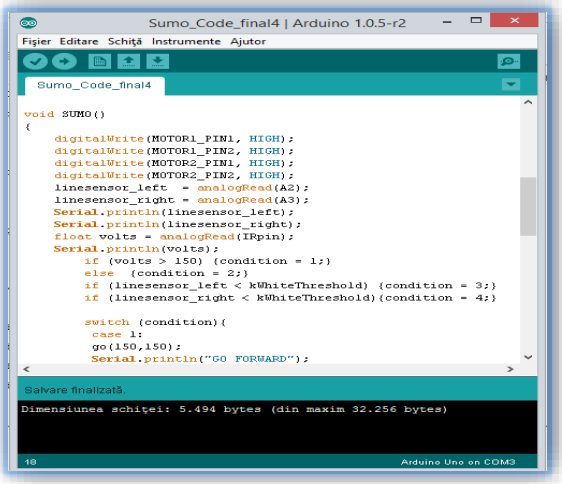


Figure 11 . Program uploading

Further on, some screen prints will show the code lines of the program.



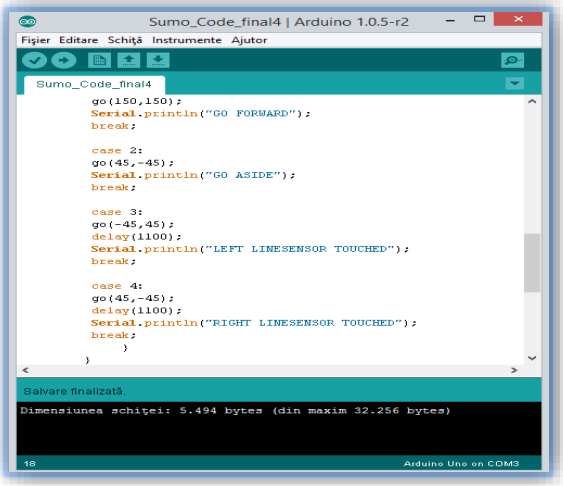


Figure 12. Program structure

CONCLUSIONS

The mobile robot is a complex system that can perform a series of activities in a diversity of real situations. It is a combination of devices equipped with power motors and sensors, under the control of a hierarchical system, operating in the real space and that has to plan the movements of the robot so that it can perform a task according to the initial state of the system and also in accordance with the existing information related to the work environment.

The paper presents the design and construction of an autonomous mobile robot used in mini-sumo competitions. The design has been done using the Fritzing software and the programming in the Arduino language.

This robot has several important advantages and it can be used as didactical equipment, a fighter in mini-sumo contests and, moreover, it can be adapted for the use in various domains, such as: the exploration of narrow or dangerous spaces, military applications, etc.

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BACKSTEPPING CONTROL FOR HEXA-ROTOR MICROCOPTER

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Abstract: Unmanned autonomous aerial vehicles have become a real center of interest. In the last few years, their utilization has significantly increased. During the last decade many research papers have been published on the topic of modeling and control strategies of autonomous multirotors. Today, they are used for multiple tasks such as navigation and transportation. This paper presents the development of a dynamic modeling and control algorithm - backstepping controller of an autonomous hexa-rotor microcopter. The autonomous hexa-rotor microcopter is an under-actuated and dynamically unstable nonlinear system. The model that represents the dynamic behavior of the hexa-rotor microcopter is complex. Unmanned autonomous aerial vehicles applications are commonly associated with exploration, inspection or surveillance tasks.
Keywords: dynamic model, dynamic behavior, unmanned autonomous aerial vehicles, autonomous hexa-rotor microcopter, under – actuated, dynamically unstable nonlinear system, complex, control strategies, backstepping controller

INTRODUCTION

Unmanned autonomous aerial vehicles have become a real center of interest [1-14]. In the last few years, their utilization has significantly increased. Today, they are used for civil and military applications, for multiple tasks such as navigation and transportation. Unmanned autonomous aerial vehicles applications are commonly associated with exploration, inspection or surveillance tasks.

During the last decade many research papers have been published on the topic of modeling and control strategies of autonomous multirotors [15-30]. One of the unmanned autonomous aerial vehicles with a strong potential is the hexa-rotor microcopter.

The autonomous hexa-rotor microcopter have numerous advantages over quadrotors, since they can offer more:

- power and
- speed, due to the properly position of the rotors.

Figure 1. Hexa-rotor microcopter used for the experiments

The autonomous hexa-rotor microcopter , Figure 1, consists of six rotors attached to a rigid body frame and these additional two rotors make it able to carry:

- more payload,
- the longest flight time and
- high maneuverability

compared to quadrotor. The autonomous hexa-rotor microcopters have additional redundancy over autonomous quad-rotor microcopters.

The control design carried out for an autonomous quad-rotor microcopter can be applied to the autonomous hexa-rotor microcopter since they are modeled as a rotating rigid body dynamic system wih six degres of freedom (6 DOF), Figure 2.

Figure 2. The Hexa-rotor microcopter in hovering conditions

The autonomous hexa-rotor microcopter is an:

- under-actuated and
- dynamically unstable nonlinear system.

The model that represents the dynamic behavior of the hexa-rotor microcopter is nonlinear and complex. This paper presents the development of a dynamic modeling and control algorithm of an autonomous hexa-rotor microcopter.

The paper is organized as follows: Section 1: Introduction. In Section 2, the dynamic modeling of a hexa-rotor microcopter is presented. In

Section 3 backstepping controller for hexa-rotor microcopter is presented. Conclusions are given in Section 4.

DYNAMIC MODELING OF HEXA-ROTOR MICROCOPTER

The model [31-46] of the hexa-rotor helicopter and the rotational directions of the propellers are presented in Figure 3. This cross structure is quite thin and light, however it shows robustness by linking mechanically the motors. Hexa-rotor microcopter body is rigid. The six rotors are symmetrically distributed around the center. All the propellers axes of rotation are fixed and parallel. Propellers are rigid. These considerations point out that the structure is quite rigid and the only things that can vary are the propeller speeds.

The hexa-rotor microcopter configuration has six rotors which generate the propeller forces F_i ($i = 1,2,3,4,5,6$) as it is shown in Figure 3. Control of quadrotor is achieved [2] by commanding different speeds to different propellers, which in turn produces differential aerodynamic forces and moments. In order to increase the altitude of the aircraft it is necessary to increase the rotor speeds altogether with the same quantity.

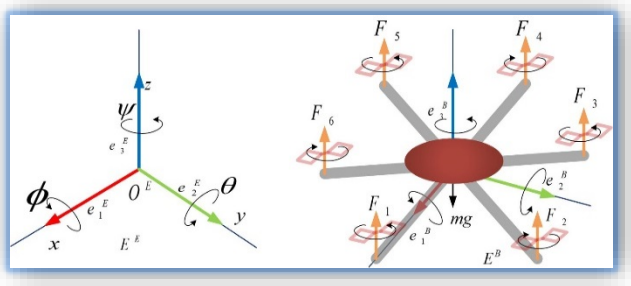

Figure 3. Hexa-rotor microcopter - a non-linear dynamic system

Each rotor consists of a:

- *brushless DC motor and a*
- *fixed-pitch propeller.*

This rotorcraft is constituted by:

- *three rotors which rotate clockwise (1,3,5), and*
- *three rotating counterclockwise (2,4,6).*

Forward motion is accomplished by increasing the speed of the rotors (3, 4, 5) while simultaneously reducing the same value for forward rotors (1, 2, 6). For leftward motion the speed of rotors (5 and 6) is increased while the speed of rotors (2 and 3) is reduced.

Backward and rightward motion can be accomplished similarly. Finally, yaw motion can be performed by speeding up or slowing down the clockwise rotors depending on the desired angle direction.

To describe the motion of a 6 DOF rigid body it is usual to define two reference frames (Figure 2):

- *the earth inertial frame (E-frame), and*
- *the body-fixed frame (B-frame).*

The equations of motion are formulated using the Newton-Euler laws with the following reasons:

- *the inertia matrix is time-invariant;*
- *advantage of body symmetry can be taken to simplify the equations;*
- *measurements taken on-board are easily converted to body-fixed frame;*
- *control forces are almost always given in body-fixed frame.*

The E-frame ($O^E xyz$) is chosen as the inertial right hand reference. This frame is used to define the linear position (in meters) and the angular position (in radians) of the quadrotor.

The B-frame is attached to the body. The origin of the B-frame is chosen to coincide with the center of the hexa-rotor microcopter cross structure. This reference is right-hand, too.

The linear position of the helicopter (X, Y, Z) is determi-ned by the coordinates of the vector between the origin of the B frame and the origin of the E-frame according to equation.

The angular position of the hexa-rotor microcopter (Φ, θ, ψ) is defined by the orientation of the E^B-frame with respect to the E^E-frame. This is given by three consecutive rotations about the main axes which take the E^E-frame into the E^B-frame. In this paper, the "roll-pitch-yaw" set of Euler angles (Φ, θ, ψ) were used.

The vector that describes quad-rotor position and orientation with respect to the E-frame can be written in the form:

$$s = [x, y, z, \Phi, \theta, \psi]^T \quad (1)$$

The rotation matrix between the E^E- and E^B-frames has the following from:

$$R = \begin{bmatrix} c\psi c\theta & c\psi s\theta s\Phi - s\psi c\Phi & c\psi s\theta c\Phi + s\psi s\Phi \\ s\psi c\theta & s\psi s\theta s\Phi + c\psi c\Phi & s\psi s\theta c\Phi - c\psi s\Phi \\ -s\theta & c\theta s\Phi & c\theta c\Phi \end{bmatrix} \quad (2)$$

Now, the model of hexa-rotor dynamics can be described by a system of equations:

$$\begin{aligned} \ddot{x} &= (\sin\psi\sin\psi + \cos\psi\cos\psi\sin\varphi)\frac{U_1}{m} + A_{10} \\ \ddot{y} &= (-\cos\psi\cos\psi + \sin\psi\sin\psi\sin\varphi)\frac{U_1}{m} + A_{12} \\ \ddot{z} &= -g + \cos\theta\cos\theta c\frac{U_1}{m} + A_8 \\ \ddot{\varphi} &= \frac{I_Y - I_Z}{I_X}\dot{\theta}\dot{\psi} - \frac{J_R}{I_X}\dot{\theta}\omega + \frac{U_2}{I_X}d + A_2 \\ \ddot{\theta} &= \frac{I_Z - I_X}{I_Y}\dot{\varphi}\dot{\psi} - \frac{J_R}{I_Y}\dot{\varphi}\omega + \frac{U_3}{I_Y}d + A_4 \\ \ddot{\psi} &= \frac{I_X - I_Y}{I_Z}\dot{\varphi}\dot{\theta} + \frac{U_4}{I_Z} + A_6 \end{aligned} \quad (3)$$

BACKSTEPPING CONTROLLER FOR HEXA-ROTOR MICROCOPTER

In this paper, controller design for the hexa-rotor microcopter is proposed by using backstepping technique. Backstepping is a recursive design methodology that makes use of Lyapunov stability theory to force the system to follow a desired trajectory. The hexa-rotor microcopter is controlled by angular speeds of six motors. Each motor produces a thrust and a torque, whose combination generates the main trust, the yaw torque, the pitch torque, and he roll torque acting on the hexa-rotor microcopter. First, the dynamical model is rewritten in state-space form:

$$\dot{X} = f(X, U) \quad (4)$$

by introducing :

$$X=[x_1..x_{12}]^T \in \Re^{12} \quad (5)$$

as space vector of the system:

$$\begin{aligned} x_1&=\phi & x_5&=\psi & x_9&=Y \\ x_2&=\dot{x}_1=\dot{\phi} & x_6&=\dot{x}_5=\dot{\psi} & x_{10}&=\dot{x}_9=\dot{Y} \\ x_3&=\theta & x_7&=X & x_{11}&=Z \\ x_4&=\dot{x}_3=\dot{\theta} & x_8&=\dot{x}_7=\dot{X} & x_{12}&=\dot{x}_{11}=\dot{Z} \end{aligned} \quad (6)$$

Next, the x- coordinates are transformed into the new z – coordinates:

$$\begin{aligned} z_1&=x_{1\_ref}-x_1 & z_7&=x_{7\_ref}-x_7 \\ z_2&=x_2-\dot{x}_{1\_ref}-\alpha_1 z_1 & z_8&=x_8-\dot{x}_{7\_ref}-\alpha_7 z_7 \\ z_3&=x_{3\_ref}-x_3 & z_9&=x_{9\_ref}-x_9 \\ z_4&=x_4-\dot{x}_{3\_ref}-\alpha_3 z_3 & z_{10}&=x_{10}-\dot{x}_{9\_ref}-\alpha_9 z_9 \\ z_5&=x_{5\_ref}-x_5 & z_{11}&=x_{11\_ref}-x_{11} \\ z_6&=x_6-\dot{x}_{5\_ref}-\alpha_5 z_5 & z_{12}&=x_{12}-\dot{x}_{11\_ref}-\alpha_{11} z_{11} \end{aligned} \quad (7)$$

By introducing the partial Lyapunov functions [2], to all x – coordinates results in the following backstepping controller:

$$\begin{aligned} U_X&=\frac{m}{U_1}(z_7-\alpha_7(z_8+\alpha_7 z_7)-\alpha_8 z_8) \\ U_Y&=\frac{m}{U_1}(z_9-\alpha_9(z_{10}+\alpha_9 z_9)-\alpha_{10} z_{10}) \\ U_1&=\frac{m}{\cos x_1 \cos x_3}(z_{11}+g-\alpha_{11}(z_{12}+\alpha_{11} z_{11})-\alpha_{12} z_{12}) \\ U_2&=I_{XX}(z_1-\frac{I_{YY}-I_{ZZ}}{I_{XX}}x_4 x_6+\frac{J_{TP}}{I_{XX}}x_4\Omega_r-\alpha_1(z_2+\alpha_1 z_1)-\alpha_2 z_2) \\ U_3&=I_{YY}(z_3-\frac{I_{ZZ}-I_{XX}}{I_{YY}}x_2 x_6-\frac{J_{TP}}{I_{XX}}x_2\Omega_r-\alpha_3(z_4+\alpha_3 z_3)-\alpha_4 z_4) \\ U_4&=I_{ZZ}(z_5-\frac{I_{XX}-I_{YY}}{I_{ZZ}}x_2 x_4-\alpha_5(z_6+\alpha_5 z_5)-\alpha_6 z_6) \end{aligned} \quad (8)$$

The position of the hexa-rotor microcopter in the earth reference frame is illustrated in Figure 4.

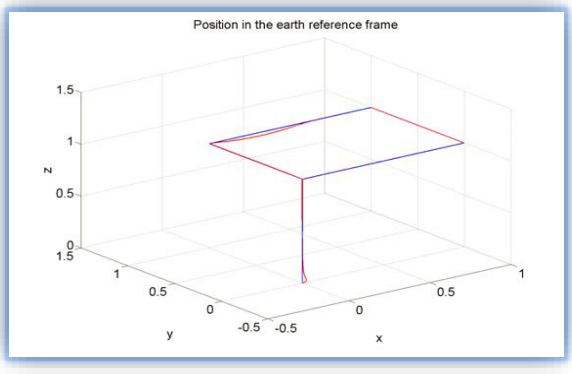

Figure 4. Position of the hexa-rotor microcopter in the earth reference frame.

CONCLUSIONS

This paper presents the development of a dynamic modeling and control algorithm of an autonomous hexa-rotor microcopter. During the last decade many research papers have been published on the topic of modeling and control strategies of autonomous multirotors.

The autonomous hexa-rotor microcopter is an under-actuated and dynamically unstable nonlinear system. The model that represents the dynamic behavior of the hexa-rotor microcopter is complex. Unmanned autonomous aerial vehicles have become a real center of interest. In the last few years, their utilization has significantly increased. The autonomous hexa-rotor microcopters have additional redundancy over autonomous quad-rotor microcopters.

The control design carried out for an autonomous quad-rotor microcopter - backstepping controller, can be applied to the autonomous hexa-rotor microcopter since they are modeled as a rotating rigid body dynamic system wih six degres of freedom.

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AXIAL VIBRATION OF A ROBOT SURGERY TENTACLE

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Abstract: *Fundamental working element of the most robot and manipulator arms is needle-sized tentacle which moves straight-line. One end of the tentacle is fixed and the other is free, and the corresponding physical model is a clamped-free beam. Operation of the tentacle is in straight-line direction and axial vibration appears. As the material of tentacle is usually with nonlinear properties, the model of the system is also nonlinear. Axial vibration is described with a nonlinear partial differential equation. In this paper an analytical method is developed for solving the equation. It is based on separation of the partial differential equations into two uncoupled strong nonlinear second order differential equations. Using boundary and initial conditions, parameters of vibration are obtained. The procedure suggested in this paper is applied for a beam with cubic nonlinearity. Frequencies of free axial vibration are determined. It is proved that they depend not only on the type of boundary conditions, but also on initial conditions. At the end of the paper the numerical solution of the axial vibration of the clamped-free beam with cubic nonlinearity is calculated.*

Keywords: *Robot surgery tentacle; Axial vibration; Fraction order nonlinearity; Clamped-free beam*

INTRODUCTION

One of the most responsible tasks for the robot arm is in surgery. Usually, the working element of the robot arm is a needle-sized tentacle. This type of tentacle is used in vascular surgery [1], in mandible reconstruction surgery [2], in orthognathic surgery [3],[4], trans nasal [5]. Robot arm may assist in renal and liver surgery [6]. Robot arm is used in laparoscopic surgery, too [7]. Unfortunately, recent investigation report about perioperative complications of robot-assisted laparoscopic surgery which use robot arms [8]. It is stated that the problem is with the accuracy of the mechanical system. To exceed the problem the control of the robot arm was improved. Results of investigation in robot control (see for example, [9]-[12]) are incorporated into the system, but did not give the expected results in motion accuracy. It gives us an idea to analyze the vibration properties of tentacle.

Tentacle is modeled as a beam which has axial vibrations. Very often the tentacle is not made of steel and the stress-strain property of tentacle material is not linear. Influence of nonlinearity on vibration of the system is already known (see for example [13]-[15]) and these results have to be included into consideration. Many papers are published which are dealing with the problem of axial vibrations of the beam with small nonlinearity [16]-[19]. In this paper the strong nonlinearity will be also investigated.

The aim of the paper is to obtain frequencies of free axial vibrations of the tentacle which is modeled as a clamped-free beam made of material with strong nonlinearity. The paper is divided into four sections. After Introduction, the model of the physical and mathematical model of the tentacle is given. In Section 3, a solving procedure is given. Method is based on variable separation which transforms the partial differential equation of vibration into two strong nonlinear second order differential equations. In Section 4, the model with cubic nonlinearity is considered. Numerical calculation is also done. Paper ends with Conclusions

MODEL OF THE SURGERY TENTACLE

In Fig.1, a surgery robot with three separate tentacles is shown. Each of tentacles is fixed at its one end to the robot arm and the other end is free. Motion of tentacles is in a straight line. Tentacle can be modeled as a clamped-free beam as one end is free, while the other is fixed (Fig.2). Cross-section properties of the beam are smaller than its length. During operation axial vibration of the beam appears.

Figure 1*. Robot surgery tentacle.*

Axial deflection y of the beam depends on time t and position x. Separating an elementary part of the beam, whose length is dx and mass ρAdx, where ρ is density of tentacle material, A is cross-section, the inertial force is product of elementary mass and acceleration: $\rho A dx(\partial^2 y/\partial t^2)$. Usually, material of the tentacle is with strong nonlinear properties as its stress-strain relation is

$$\sigma = E\varepsilon^{\alpha} = E(\partial y/\partial x)^{\alpha}, \qquad (1)$$

where E is the elasticity coefficient, ε is the deformation, and a is the order of nonlinearity obtained experimentally. Coefficient a is a positive real number which need not be whole but of any fractional type. Elastic force is

$$F = \sigma A = EA(\partial y/\partial x)^{\alpha}. \quad (2)$$

Equating the elementary elastic force dF and the elementary inertial force which act on the separated part of the bean (see Fig.2) the equation for longitudinal vibrations are obtained

$$\rho A \frac{\partial^2 y}{\partial t^2} = EA \frac{\partial}{\partial x}\left(\frac{\partial y}{\partial x}\right)^{\alpha}. \quad (3)$$

The boundary conditions are

$$y(0,t) = 0, \quad F(l,t) = EA\left(\frac{\partial y}{\partial x}\right)^{\alpha}(l,t) = 0, \quad (4)$$

and initial conditions are

$$y(x,0) = Y_0(x), \quad \frac{\partial y(x,0)}{\partial t} = 0, \quad (5)$$

where l is the length of the beam.

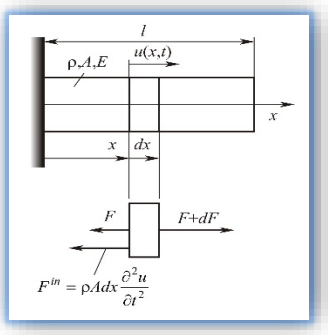

***Figure 2**. Model of the clamped-free beam.*

Mathematical model is a second order partial differential equation with strong nonlinearity. To give a valid analysis of the beam motion, it is necessary to solve equation (3) according to the boundary (4) and initial conditions (5).

SOLVING PROCEDURE

Let us introduce a solution in the form

$$y(x,t) = X(x)T(t), \quad (6)$$

where X(x) is a deflection function and T(t) is a time function. Substituting (6) into (3) - (5), we have

$$\frac{\rho}{E} X\ddot{T} = T^{\alpha}((X')^{\alpha})', \quad (7)$$

and

$$X(0) = 0, \quad X'(l) = 0, \quad (8)$$

$$X(x)T(0) = Y_0(x), \quad \dot{T}(0) = 0, \quad (9)$$

where $\ddot{T} = d^2T/dt^2$ and X'=dX/dx.

It is obvious that we can separate variables in (7) and we obtain

$$\frac{\rho}{E}\frac{\ddot{T}}{T^{\alpha}} = \frac{((X')^{\alpha})'}{X} = -k^2 = const. \quad (10)$$

i.e.,

$$\ddot{T} + c_1^2 T|T|^{\alpha-1} = 0, \alpha(X')^{\alpha-1}X'' + k^2 X = 0, \quad (11)$$

where k^2 is an unknown constant value and $c_1^2=(E/\rho)k^2$. Equations (11) are two ordinary strong nonlinear uncoupled differential equations.

Our major task is to determine frequencies of vibration based on the constants k and c_1.

Solving of the equaiton with displacement function

We rewrite the expression $(11)_2$ as

$$X''(X')^{\alpha-1} = -\frac{k^2}{\alpha}X. \quad (12)$$

For p(X)=dX/dx=X' and d^2X/dx^2 =p'p=p(dp/dX), equation (12) transforms into a first order equation

$$\alpha \frac{dp}{dX} p^{\alpha} = -k^2 X, \quad (13)$$

which solution is

$$X' = \left(\frac{\alpha+1}{\alpha}\right)^{1/(\alpha+1)} (K_1 - \frac{k^2}{2}X^2)^{1/(\alpha+1)}. \quad (14)$$

Finally,

$$\int \frac{dX}{(1-\frac{k^2}{2K_1}X^2)^{1/(\alpha+1)}} = \left(K_1 \frac{\alpha+1}{\alpha}\right)^{\frac{1}{\alpha+1}} (K_2 + x), \quad (15)$$

where K_1 and K_2 are arbitrary constants. For $k^2X^2/2K_1=z$, we have

$$\int \frac{dz}{\sqrt{z}(1-z)^{1/(\alpha+1)}} = k\sqrt{2}\left(\frac{\alpha+1}{\alpha}\right)^{\frac{1}{\alpha+1}} (K_1)^{\frac{1-\alpha}{2(\alpha+1)}}(K_2 + x). \quad (16)$$

If the integration is in the interval (see [19],[20]), we have

$$\int_0^1 z^{-\frac{1}{2}}(1-z)^{-\frac{1}{\alpha+1}}dz =$$

$$k\sqrt{2}(K_1)^{\frac{1-\alpha}{2(\alpha+1)}}\left(\frac{\alpha+1}{\alpha}\right)^{\frac{1}{\alpha+1}} \int_0^l dx. \quad (17)$$

Introducing into (17) the definition of the complete beta function

$$B(m,n) = \int_0^1 (1-z)^{n-1}z^{m-1}dz, \quad (18)$$

we have

$$B\left(\frac{\alpha}{\alpha+1}, \frac{1}{2}\right) = kl\sqrt{2}(K_1)^{\frac{1-\alpha}{2(\alpha+1)}}\left(\frac{\alpha+1}{\alpha}\right)^{\frac{1}{\alpha+1}}. \quad (19)$$

The relation (19) gives the relation for the constant

$$k = k(K_1, \alpha). \quad (20)$$

It depends on the order of nonlinearity and on the constant K_1,, too. This result is a new one and has to be proved.

For the linear oscillator, when a=1, relation (19) transforms into

$$B\left(\frac{1}{2}, \frac{1}{2}\right) = \pi = 2kl, \quad (21)$$

i.e.,

$$k = \frac{\pi}{2l}. \quad (22)$$

Due to periodicity of the function, it is k=(2n-1)π/2l. It is already well known solution for the linear oscillator, where the value of the constant k is independent on initial and boundary conditions.

Finally, using the relation (19) and the periodic property of the function X(x), the constant k is

$$k_n = B\left(\frac{\alpha}{\alpha+1}, \frac{1}{2}\right)\frac{(2n-1)}{\sqrt{2}l}(K_1)^{\frac{\alpha-1}{2(\alpha+1)}}\left(\frac{\alpha+1}{\alpha}\right)^{\frac{-1}{\alpha+1}}, \quad (23)$$

where n=1,2,3,…

Solving of the equation with time function

Equation $(11)_1$ has a first integral

$$\frac{\dot{T}^2}{2} + \frac{c_1^2}{\alpha+1}T^{\alpha+1} = K_3 = const., \quad (24)$$

where K_3 is an arbitrary constant. Rewriting (24) we have

$$\dot{T} = \sqrt{2K_3 - \frac{2c_1^2}{\alpha+1}T^{\alpha+1}}, \quad (25)$$

and after integration we have

$$\int \frac{dT}{\sqrt{2K_3 - \frac{2c_1^2}{\alpha+1}T^{\alpha+1}}} = t + K_4, \quad (26)$$

where K_4 is the unknown constant of integration. Unfortunately, in general, we cannot find the closed form solution of (26). It is convenient to assume the approximate solution as a trigonometric function. As (24) corresponds to a conservative oscillatory system it is known that the amplitude and the period of vibration are constant. Using (25) the exact value of the period of vibration of $(11)_1$ can be calculated.

Due to (25), it reads

$$\frac{dt}{dT} = 1/\sqrt{2K_3 - \frac{2c_1^2}{\alpha+1}T^{\alpha+1}}, \quad (27)$$

Using the periodic property of the oscillator and integrating (27), it follows

$$\int_0^P dt = 4\int_0^{K_3} \frac{dT}{\sqrt{2K_3 - \frac{2c_1^2}{\alpha+1}T^{\alpha+1}}}, \quad (28)$$

where P is the period of vibration. Introducing the new variable

$$z = \frac{2c_1^2}{\alpha+1}T^{\alpha+1}, \quad (29)$$

into (28), it is

$$P = \frac{4}{\sqrt{2}}\left(\frac{c_1^{-2}}{(\alpha+1)^{\alpha}}\right)^{1/(\alpha+1)} K_3^{(1-\alpha)/2(1+\alpha)} \int_0^1 z^{-\frac{\alpha}{\alpha+1}}(1-z)^{-\frac{1}{2}}dz. \quad (30)$$

Applying the definition (18), period of vibration is obtained

$$P = \frac{4}{\sqrt{2}}\left(\frac{\rho}{Ek^2(\alpha+1)^{\alpha}}\right)^{1/(\alpha+1)} K_3^{(1-\alpha)/2(1+\alpha)} B\left(\frac{1}{\alpha+1},\frac{1}{2}\right). \quad (31)$$

Based on (31) the frequency of vibration in axial direction is

$$\omega = \frac{2\pi}{P} = \frac{2\pi\sqrt{2}}{B\left(\frac{1}{\alpha+1},\frac{1}{2}\right)}\left(\frac{E}{\rho}\right)^{\frac{1}{\alpha+1}} k^{\frac{2}{\alpha+1}}(\alpha+1)^{\frac{\alpha}{\alpha+1}} K_3^{(\alpha-1)/2(1+\alpha)} \quad (32)$$

Substituting the constant (23) into (32) it is

$$\omega_n = \frac{2\pi}{P} = \frac{\pi\sqrt{2}}{2B\left(\frac{1}{\alpha+1},\frac{1}{2}\right)}\left(\frac{E}{\rho}\right)^{\frac{1}{\alpha+1}}(\alpha+1)^{\frac{\alpha}{\alpha+1}} K_3^{(\alpha-1)/2(1+\alpha)}$$

$$\left(B\left(\frac{\alpha}{\alpha+1},\frac{1}{2}\right)(K_1)^{\frac{\alpha-1}{2(\alpha+1)}}\frac{(2n-1)}{\sqrt{2}l}\left(\frac{\alpha}{\alpha+1}\right)^{\frac{1}{\alpha+1}}\right)^{\frac{2}{\alpha+1}}, \quad (33)$$

For $B(m,n) = \Gamma(m)\Gamma(n)/\Gamma(m+n)$, where Γ is the gamma function, and $\Gamma(1/2)=\sqrt{\pi}$, we have the frequencies of the free axial vibration of the beam

$$\omega_n = \frac{\pi\sqrt{2}\Gamma((3+\alpha)/2(\alpha+1))}{2\Gamma(1/(\alpha+1))\sqrt{\pi}}\left(\frac{E}{\rho}\right)^{\frac{1}{\alpha+1}}(\alpha+1)^{\frac{\alpha}{\alpha+1}} K_3^{(\alpha-1)/2(1+\alpha)}$$

$$\left(\frac{\Gamma(\alpha/(\alpha+1))}{\Gamma((3\alpha+1)/2(\alpha+1))}\sqrt{\pi}(K_1)^{\frac{\alpha-1}{2(\alpha+1)}}\frac{(2n-1)}{\sqrt{2}l}\left(\frac{\alpha}{\alpha+1}\right)^{\frac{1}{\alpha+1}}\right)^{\frac{2}{\alpha+1}}. \quad (34)$$

It is obvious that the frequency of vibration depends on the order of nonlinearity, but also on the constants which have to satisfy initial and boundary conditions.

For the linear oscillator, when α=1, the frequency relation (34) is

$$\omega_n = \frac{(2n-1)\pi}{2l}\sqrt{\frac{E}{\rho}} \equiv k_n\sqrt{\frac{E}{\rho}}. \quad (35)$$

This result for the linear oscillator is already known. For the linear oscillator the frequency does not depend on the initial conditions.

Eq. $(11)_1$ has an exact solution in the form of the Ateb function [20]. Nevertheless, in this paper the approximate solution in the form of a harmonic function is assumed as

$$T_n = K_3\cos(\omega_n t + K_4), \quad (36)$$

with amplitude K_3, phase angle K_4 and frequency ω_n.

Approximate solution

Using the solutions (15) and (36) with (23) and (35), we obtain the approximate solution of (1) as a sum

$$y(x,t) = \sum_{n=1}^{\infty}\frac{\sqrt{2T_0^2K_{1n}}}{k_n(K_{1n})}\sin(k_n(K_{1n})x)\cos(\omega_n((K_{1n},K_{3n})t) \quad (37)$$

and its first time derivative is

$$\frac{\partial y(x,t)}{\partial t} = -\sum_{n=1}^{\infty}\omega_n(K_{1n},K_{3n})\frac{\sqrt{2(K_{3n})^2K_{1n}}}{k_n(K_{1n})}\sin(k_n(K_{1n})x)\sin(\omega_n(K_{1n},K_{3n}))t). \quad (38)$$

Using the condition of orthogonallity, constants K_{1n} and K_{3n} are obtained.

BEAM WITH PURE QUADRATIC NONLINEARITY

Let us assume that the nonlinearity is pure quadratic and the mathematical model of the axial vibration of the beam is

$$\rho A\frac{\partial^2 y}{\partial t^2} = EA\frac{\partial}{\partial x}\left(\frac{\partial y}{\partial x}\right)^2. \quad (39)$$

According to the suggested procedure (39) is rewritten into two ordinary differential equations with separated variables. Specifying the nonlinearity, the equation (14) is

$$X' = 1.1447[(K_1 - \frac{k^2}{2}X^2)]^{\frac{1}{3}}. \quad (40)$$

Modifying (40) into the form

$$\int\frac{dX}{K_1^{1/3}\sqrt{1-\frac{k^2}{3K_1}X^2}} = 1.1447(K_2+x), \quad (41)$$

we have the approximate solution

$$X = \frac{\sqrt{3K_1}}{k}\sin[\sqrt{k}\left(1.1447K_1^{-\frac{1}{3}}(K_2+x)\right], \quad (42)$$

and its derivative

$$X' = \sqrt{\frac{3K_1}{k}}1.1447K_1^{-\frac{1}{3}}\cos[\sqrt{k}\left((1.1447K_1^{-\frac{1}{3}}(K_2+x)\right]. \quad (43)$$

Introducing the boundary conditions into (42) and (43), we obtain

$$K_2 = 0, \cos(1.1447K_1^{-\frac{1}{3}}l\sqrt{k}) = 0, \quad (44)$$

i.e., n solutions for k are obtained

$$k_n = 0.76316(\frac{(2n-1)\pi}{l})^2K_1^{\frac{2}{3}}. \quad (45)$$

where n=1,2,… According to (45), n frequencies of vibrations follow

$$\omega_n = 1.2247(\frac{(2n-1)\pi}{2l})^{2/3}K_1^{1/9}K_3^{1/6}\left(\frac{E}{\rho}\right)^{1/3} \quad (46)$$

Frequencies depend on constants K_1 and K_3, which can be calculated according to the initial and boundary conditions.

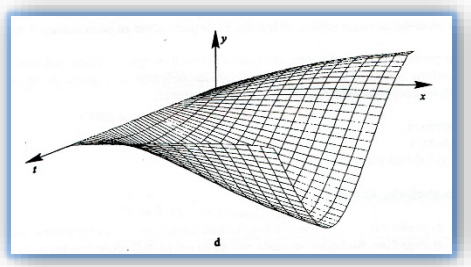

***Figure 3**. Axial vibration in y-x-t space.*

In Figure 3, axial vibration of the beam in y-x-t space is plotted. The surface represents the amplitude-position-time diagram obtained analytically. As the model is assumed to be conservative, only one period of vibration is plotted. Vibrations repeat in time, and have the same form.

CONCLUSIONS

Axial vibration of the tentacle settled on the robot arm which moves straight-line is considered. System is assumed to be nonlinear. Mathematical model of the motion is given with a strong nonlinear partial differential equation. In spite of the nonlinearity the solution of the equation is a product of two functions which depend on two independent variables: a displacement and a time function. Due to nonlinear properties of the system the constant of separation depends on the order of nonlinearity and on boundary conditions. Besides, the frequency of vibration is also dependent on the order of nonlinearity and coefficient of nonlinearity but also on the initial and boundary conditions. It is a quite new result in solving the nonlinear partial differential equation. The obtained result is proved numerically.

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A REVIEW OF THE STATE-OF-ART FOR THE COPPER INDUSTRY

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Abstract: Copper has outstanding electrical and thermal conductivity, brought about in both cases by electron transfer. The recycling of copper is, for example, in Europe, well-functioning with established business for collection, treatment and processing of highgrade scrap. Copper is a versatile metal with a variety of industrial and residential applications, such as in electronic products, construction, industrial machinery, transportation and as alloying element inbrass and bronze. This is shown in the rather large proportion of the copper produced originating from secondary sources. Various secondary sources and wastes containing copper-based alloys are generated in industries such as brass scrap, waste residue of electric arc furnace, automobile shredder scrap, rayon industry sludge, and the alkaline batteries. Materials form the fabric of our present society and are everywhere in our lives. Many gold producers are today processing gold ores containing significant amount of cyanide soluble copper. There are many studies about the separating and recovering or hydrometallurgical process.
Keywords: resources, scrap, copper, recycling

INTRODUCTION

It can be assumed that there will continue to be a demand for copper also for future generations, as it has properties that are difficult to compete with in certain applications. The recycling rates for copper are good, some challenges can be foreseen, such as a scarcity of pure and high-grade scrap and an increased amount of products containing a mixture of materials and with low copper concentrations, which means that the processing industry must deal with more impurities.[1]

In recent years, there is a gaining considerable interest to recover metals, such as zinc, copper, iron etc., from the secondary sources and wastes. Separating and recovery of these metals is important and necessary both from view of economic point and the increased requirement of environmental protection.[2] Copper has outstanding electrical and thermal conductivity, brought about in both cases by electron transfer; many of its alloys have a very useful level of corrosion resistance.

In the galvanic series, their corrosion resistance is below that of noble metals, graphite, titanium, silver, passive stainless steel, and certain nickel alloys, but above that of active nickel, stainless steels, tin, lead, cast irons, carbon steels, and aluminum, zinc, and magnesium systems.[3]

The challenge of sustainability is rooted in the way that we now process resources to make materials and products, which are often discarded at the end of life. This linear economy is now running into its limits given the large demand for materials and resources of an increasing (and increasingly affluent) global population. Industrial society has become extremely dependent on resources, as it produces more, builds an increasingly complex society and accumulates an incredible volume of resources. Mankind now dominates the global flows of many elements of the periodic table (Howard and Klee, 2004).

The materials are drawn from natural resources. However, the Earth's resources are not infinite, but until recently, they have seemed to be: the demands made on them by manufacturing throughout the industrialization of society appeared infinitesimal, the rate of new discoveries outpacing the rate of consumption. Increasingly we realize that our society may be approaching certain fundamental limits. This has made access to materials an issue of national security of many nations, especially also to ensure that emerging new "sustainable" technologies can be supplied with metals and materials. [4]

THE STUDY OF THE ISSUE

Many different approaches have been taken to quantify the rates at which metals are recycled. Inevitably, recycling rates have been defined in different ways, and this has made it difficult to determine how effectively recycling is occurring. [5]

Copper is an essential trace element found in all organs and cells. The redox chemistry of this element makes copper highly suitable as a catalytic co factor in oxidative enzymes. The absorption is dependent on the amount ingested, its chemical form, and the composition of other dietary components such as zinc. [6] Typically, cyanide destruction is used to prevent the discharge of copper cyanide into tailings storage facilities. This imposes a significant financial cost to producers from the additional cyanide used to solubilise the copper and the cost of cyanide destruction reagents. This includes enabling the treatment of gold ores with even higher soluble copper. Over the

years, a variety of processes have been developed or proposed to recover the copper and/or cyanide including acidification based technologies such as AVR and SART, direct electrowinning, activated carbon, ion exchange resins, solvent extraction, polychelating polymers, and membrane technologies.

In the paper, „A review of copper cyanide recovery technologies for the cyanidation of copper containing gold ores", these processes are critically reviewed and compared, with particular focus on the advantages and limitations, and the separation of copper from cyanide. Ultimately, there is no universal process solution and the choice is highly dependent on the nature of the stream to be treated and integration with the whole processing plant Due to the dwindling resources of simple cyanide extractable gold deposits, a large proportion of the gold processed in the 21st century will be recovered from complex gold ores, many of which will contain soluble copper mineralsVarious processes have been developed or proposed which all require a clarified feed solution.[7]

„A review of the genesis, geochronology, and geological significance ofhydrothermal copper and associated metals deposits in the great xing'an range", provides informations about the Great Xing'an Range, which is situated NE China, and hosts many hydrothermal Cu and other base and precious metal mineral deposits and mineralization. Is an important part of the giant Central Asian metallogenic belt, and has been the focus of many recent studies (Chen et al., 2011; Liu et al., 2004; Liu et al., 2012; Rui et al., 1994; Zeng et al., 2009, 2010, 2011; Zhao et al., 1997). Mineral exploration in this area resulted in the discovery of numerous large-,middle-, and small-sized Pb–Zn, Cu, andMo deposits, including the Errentaolegai and Jiawula Pb–Zn deposits, the Duobaoshan and Wunugetushan Cu–Mo deposits, the Lianhuashan and Naoniushan Cu–Ag deposits, and the Maodeng and Aonaodaba Cu–Sn deposits, and recent studies have increased our understanding of the processes that formed these deposits (Chen et al., 2011; Chu et al., 2012; Li et al., 2007; Liu et al., 2012). The hydrothermal copper and associated metals deposits in this area can be divided into three genetic types based on their geology and geochronology: porphyry Cu–Mo, high-sulfidation Cu–Ag and Cu–Sn epithermal, and Cu–Fe skarn.

All of these mineral deposits, barring the Cu–Sm epithermal deposits, are closely related to high-K calc-alkaline I-type graniticmagmatism. The geodynamic setting of the region during these mineralizing events is consistent with Early Paleozoic collision between the Xing'an Massif and the Songnen Terrane, Late Permian collision between the North China Craton (NCC) and the Heilongjiang Plate, Middle Jurassic collision between the Siberian Plate and the NCC epicontinental aggradational belt, and crustal extension and thinning during an Early Cretaceous collisional orogenic event. This indicates that the mineral deposits formed in an intracontinental transitional orogenic or post-orogenic extensional tectonic setting. [8] The work, "A critical review of the thermodynamics of hydrogen cyanide and copper-cyanide complexes in aqueous solution", brings the available thermodynamic data for the hydrogen/ cyanide and copper/cyanide systems in aqueous solution with special emphasis on measurements made at elevated ionic strengths and as a function of temperature.

The copper/cyanide system is of particular importance in gold hydrometallurgy as gold is often associated with copper sulfide minerals such as chalcopyrite, chalcocite, covellite and bornite, all of which except chalcopyrite are reasonably soluble in cyanide solutions due to the formation of copper/cyanide complexes. It has been found that,while reliable data are available at 25°C and very low ionic strengths, the data for higher ionic strengths and temperatures are limited. An attempt has been made to rationalize the available data, and to point out areas where further careful measurements are desirable. At low cyanide concentrations, Cu will be mostly present as the sparingly soluble white cuprous cyanide solid, CuCN(s). The solubility product for CuCN(s) at 25°C and infinite dilution was determined after an extensive study by Vladimirova and Kakovskii (1950).

In aqueous HCN solutions, the solubility of CuCN(s) varies with the square root of the HCN concentration. When copper minerals are present in gold cyanidation systems, especially those where remnant gold is recovered from copper sulfide flotation tailings, the cyanide-soluble copper is generally present in much higher concentrations than the gold, and can therefore compete with the gold for both available cyanide and for adsorption sites on activated carbon. This can cause significant processing problems both from excessive cyanide consumption and reduced gold adsorption into carbon, thereby increasing overall treatment costs and reducing recoveries. The equilibria between Cu and CN, in aqueous solutions are thus of critical importance in the study and modelling of real copper–gold–cyanide processes. The formation constants for Cu–CN– complexes, except for the difficult-to-detect CuCN0(aq), are well documented at 25 °C and at low ionic strengths. However, there is limited systematic knowledge on how these formation constants vary with ionic strength, solution composition and temperature. Further careful measurements of these effects are highly desirable because such constants are essential for modelling a variety of observed effects under actual hydrometallurgical conditions. A similar case can be made with regard to the corresponding enthalpies and entropies of reaction. [9]

ANALYSIS AND DISCUSSION

An important realization regarding metal recycling is that it is a sequence of steps. If any one step is done poorly, the efficiency of the entire sequence suffers. Attention needs to be paid to each of the steps, because one step may be the most inefficient for some types of products, other steps for others. The key questions, of course, are whether overall recycling efficiencies can be improved and, if so, by how much. That is, can materials cycles be transformed from open (without comprehensive recycling) to closed (completely reusable and reused), or at least to less open than they are at present.

These are issues that turn out to be quite complex, to involve everything from product designers to policies for pickup of discarded

electronics.[10] The use and degradation of refractory linings in copper furnaces are discussed, thereby describing the main steps taken at the research, developmentand industrial level to minimize refractory wear. Which combination of chemical, thermal and mechanical degradation mechanisms is dominantdepends on many factors such as the furnace type, the lining design, including the selection of the refractory type, and the process conditions.

Magnesia-chrome bricks are widely used to line copper furnaces, despite the potential risk for the formation of hexavalent Cr under specificconditions, typically in the presence of alkali or alkaline earth oxides. This review concludes with refractory selection and use on the industrial level, including the waste and recycling management of spent refractories.The pyrometallurgical processing of copper from ores or recycled scrap, may comprise either batch, semi-continuous, or fully continuous processes, thereby involving smelting, converting and/or refining furnaces. The reliable and profitable operation of these furnaces strongly depends on the integrity of the vessel, which is often subjected to turbu-lent and aggressive process conditions.

It is however not the only driving force for the refrac-tory companies to develop new bricks and procedures. Although the most appropriate material to line the furnaces of the copper industry so far is considered to be the magnesia-chrome type due to its high resistance against slags with different basic, the possible formation of Cr6+, above all when working with calcium ferrite slags in converting processes or sodium carbonate/hydroxide slags in refining processes, has increased the interest in magnesia and alumina bricks as alternatives. To the best of our knowledge, the use of the latter brick types is still mainly in the research and development phase, and their future evolution will depend amongst others on how the use of Cr containing bricks in the steel industry will evolve.

Finally, with respect to the recent evolutions in the copper production, two trends that will affect further brick development should be mentioned. Firstly, the input material of the primary copper production is changing as concentrates with low levels of impurity elements are becoming more scarce. These increased level of impurity elements can change the refractory degradation behavior, either directly or through a change in operation conditions. Secondly,secondary copper production is gaining importance, there by introducing new flow sheets, operating conditions and input material compared to the primary production processes. Prior to this work, multiple interesting review papers on refractory for use in the copper production can be found. Schlesinger provides an overview of the copper production units and their factors influencing the refractory behavior, the history of refractory material types, the use of magnesia-chrome refractories for copper production and the prospects for chrome-free refractories. For a summary of the main chemical, thermal and mechanical degradation mechanisms, the work by Barthel, Taschler and Rigby can be recommended. The paper by Barthel describes the factors influencing the refractory lining in copper smelting furnaces and how chrome-magnesia and magnesia-chrome bricks behave under these conditions. Besides the wear mechanisms, the review work by Taschler, for refractory use in the copper and lead industry, describes the main slag properties, the evolution in brick development and the quality requirements.

The paper by Köffel and Taschler, has similar content as the review paper by Taschler. The review paper by Rigby is in particular interesting for the refractory linings of converters and anode furnaces in the copper industry. The main wear mechanisms, the operational factors influencing there fractory life-span and the effect of lining installation practice and brick quality for these furnaces are summarized.[11] The pyrometallurgical recovery of copper-based alloys with zinc from secondary resources had been studied under different conditions. The equipment used in the pyrometallurgical process always includes blast furnace, reverberatory furnace, and converter et al. Zinc existed in scrap copper-based alloys is widely distributed in various parts of the process, which not only result in some trouble in recovery of zinc but also reduces the recovery rate of other metals. For example, when copper-based alloys with zinc are smelted in the blast furnace, 12% w 15% by weight of zinc exists in black copper, 45% w 55% volatilizes into smelter flue dusts in the form of ZnO, and 30% w 35% remains in slag, which causes the melting point of slag to rise and viscosity to magnify, thus, copper is prone to be mixed in slag, which reduces the recovery rate of copper.

In the hydrometallurgical process, different leaching agents, including sulfuric acid, hydrochloric acid, acetic acid, cyanide and ammonia, were used, which were studied or developed by many authors. However, the hydrometallurgical methods have draw backs such as complex process flows, high consumption of chemical reagents, high cost in operation and secondary environmental pollution. Therefore, it is necessary to research a progressive process for the recycling scrap copper-based alloy containing zinc for a complex system in the form of piece or block. Treatment of zinc based on conventional pyrometallurgical process Separation and recovery process of zinc from scrap copper-based alloy was carried out under vacuum condition in a sublimation reactor. [12]

In the study, „Effect of accumulative roll bonding process on the electrochemical behavior of pure copper" the effect of accumulative roll bonding (ARB) process on the electrochemical behavior of pure copper in 0.01 M borax solution has been investigated. The microhardness tests showed that by implementing the ARB process the values of microhardness improve with increasing the number of ARB cycles. Copper are extensively used in industrial applications, corrosion prevention, power generation, and heat exchanger tubes. So, there is an interest in studying the corrosion and electrochemical behavior of this metal in different conditions, particularly in alkaline environments.

The passivation behavior of copper in the alkaline solutions is very important because of the scientific importance of this phenomenon. Indeed, the passive film provides an efficient barrier against the metal dissolution. This behavior has been studied in correlation to the

protective nature and the electrochemical behavior of the copper passive film. [13] The authors Graham Llong ,Yongjun Peng, Dee Bradshaw, in their work, related that the arsenic is a toxic and volatile element that has little commercial use. This is causing some concern to copper smelters as they are obliged to dispose of arsenic materials produced as a by-product to the smelting process in accordance with ever tightening environmental guidelines. The onus is to move back to concentrate producers to remove toxic elements, such as arsenic, earlier in the concentrate supply chain.

The common copper–arsenic bearing minerals in copper ores, enargite (Cu3AsS4) and tennantite (Cu12As4S13), contain significant amounts of copper; 48.4% and 51.6% respectively. Removal of these minerals from the concentrate removes valuable metal, hence income. There is a dearth of literature concerning the selective removal of enargite and tennantite from sulphide ores, but there are reports on some success using either chemical oxidation or potential control. These methodologies have been applied to ores from mines as they deepen where arsenic levels in concentrate are becoming prohibitive. In copper ores, arsenic is often contained within tennantite (Cu12As4S13) or enargite (Cu3AsS4). These copper–arsenic minerals contain 51.6% and 48.4% copper respectively, so they tend to float similarly to other copper sulphide minerals, reporting to the concentrate.

With smelters having to dispose of arsenic products in accordance with environmental regulations, they are becoming more selective in the concentrates they buy, and imposing financial penalties for excessive arsenic levels on concentrates when appropriate.[14]

CONCLUSIONS

Materials will play a key role in the transition of our society toward sustainability. Today, China produces half of all the cement, steel and other commodities in the world. Recyclable wastes are often collected by cities and municipalities, selling them into a market of traders and secondary processors who reprocess the materials to eventually sell them to manufacturers. In the recycling market, prices fluctuate according to the balance of supply and demand, the prices of materials made from primary resources, as well as the behavior and organization of markets and its stakeholders (the role of increased market power concentration, and speculation of silver and copper). This couples the price of the recycled material to that of the primary or virgin material. The markets are also affected by economic or policy interventions.[15]

There are few studies of exposure levels in the work environment of copper-producing plants or plants using copper in their production in the scientific literature. Even fewer reported studies have used sampling techniques that take into account health-related aerosol fractions by sampling particles according to size. [16] Therefore, the recovery of copper as a valuable by-product and the recycle of cyanide to the leach circuit have the potential for significant economic and environmental benefits. It has been estimated that about 20% of all gold deposits have significant copper mineralization commonly associated with chalcopyrite, tetrahedrite, tennantite, as well as bornite and chalcocite in certain ores (Muir et al., 1989).

It has also been found that the majority of copper minerals including copper oxides, carbonates, sulfides (with the exception of chalcopyrite) and native copper are highly soluble in cyanide solutions (Marsden and House, 2006). [17] There is limited systematic knowledge on how these formation constants vary with ionic strength, solution composition and temperature.

Further careful measurements of these effects are highly desirable because such constants are essential for modelling a variety of observed effects under actual hydrometallurgical conditions. A similar case can be made with regard to the corresponding enthalpies and entropies of reaction.[18] The factors affecting the evaporation ratio of copper-based alloy and the separation efficiency of zinc, such as heating temperature, residual gas pressure, vacuum evaporation time and the amount of scrap copper-based alloy were separately investigated. The experimental results revealed that zinc was successfully separated from the scrap copper-based alloy, where the evaporation ratio of copper-based alloy reached 18.43%.

Namely, 96.09% by weight of zinc could be removed under the condition: residual gas pressure of 50 Pa, heating temperature of 1323 K and vacuum evaporation time of 90 min. If corresponding to the residual gas pressure 500 Pa, the evaporation ratio reached 18.17%, and 94.73% by weight of zinc could be removed under the following experimental conditions: temperature 1323 K, vacuum evaporation time 180 min. Meanwhile, the thermodynamics of vacuum sublimation and refining to recover zinc was analyzed and calculated.[19] Copper are extensively used in industrial applications, corrosion prevention, power generation, and heat exchanger tubes. So, there is an interest in studying the corrosion and electrochemical behavior of this metal in different conditions, particularly in alkaline environments.

The passivation behavior of copper in the alkaline solutions is very important because of the scientific importance of this phenomenon. Indeed, the passive film provides an efficient barrier against the metal dissolution. This behavior has been studied in correlation to the protective nature and the electrochemical behavior of the copper passive film.[20] The authors Graham Llong, Yongjun Peng, Dee Bradshaw, in their work, related that the development of an economical method of removing arsenic bearing minerals earlier in the beneficiation stream is becoming increasingly more important. Magnetic separation of copper and copper–arsenic sulphides present a low chance of separation, so little work to progress this treatment option appears to have been conducted. Roasting was also used to reduce the arsenic content of copper concentrates at the El Indio mine, Chile.

A high arsenic–copper flotation concentrate was produced that contained 10.5% arsenic, contained within enargite and tennantite. Kappes et al. (2007) investigated an unnamed gold–copper deposit that contained elevated levels of tennantite. Product specifications required a copper concentrate below 2000 ppm arsenic.[21]

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ACTA TECHNICA CORVINIENSIS – BULLETIN OF ENGINEERING. Fascicule 3 [JULY–SEPTEMBER]

ACTA TECHNICA CORVINIENSIS – BULLETIN OF ENGINEERING. Fascicule 4 [OCTOBER–DECEMBER]

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HARDENING OF SURFACE LAYERS

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Abstract: The present paper deals with the hardening of surface layers after machining. At the beginning residual stresses, which affect the status of a surface layer, are described. The Hertz contact pressure theory and the matter plastic deformation by the hardening of surface layers is explained. The methods and technical devices chosen for the mechanical hardening of surface layers are described along with the analysis of their technical features. A tool was created for the hardening of the surface layer and an experiment was carried out which verified its effect.
Keywords: surface layer, residual stresses, hardening of surfaces, stress, plastic deformation

INTRODUCTION

During the machining of plastic materials, the area of plastic deformation penetrates into the work-piece layers that are under the cutting edge. Plastic deformation of metal materials is always connected with a change in hardness and with the occurrence of residual stresses. The main mechanism of plastic deformation is the slip caused by the slipping motion of dislocations. The reasons for the experimentally observed complex form of the stress – deformation interdependence are to be found in the changed conditions of the motion of the dislocations. Plastic deformation is connected with significant hardening. The more the hardening, the lower yield point, and the hardness can be explained by different concepts including the impact of deformation conditions (mainly the temperature, size and speed of the deformation), as well as by the interrelations between the mechanical properties and the structure of the material in terms of the size of the grain, the dislocation density, etc. The hardness of the layer is significantly higher, its roughness is lower, etc. In some materials, the surface hardness of the machined material is 30% higher than the hardness of the basic material of the work-piece.

THEORETICAL CONSIDERATIONS

The most frequently used methods of strengthening are the following: shot peening, roll burnishing, very thin machining, pull broaching, push broaching and ballotining. Although these methods are methods of mechanical cold working of the thin surface layers of components after machining, they are included as machining processes because they are mainly performed at machining machines, are often connected with machining operations and are a part of their technological processes. Their common objective is to improve the quality of the surface layers of components. As a result of the incidence of a hard ball on a surface with the force of the ball's action equal to F, according to the magnitude of F, first an elastic deformation of the surface occurs and then a plastic one (the curve OAB at the Fig.1) [3]. Because plastic deformations occurred, the relieving process proceeds along the BC curve. The residual plastic deformation is manifested by the impression dimension d that corresponds to the dimension OC. Plastic deformation below the impression is evenly distributed, as if copying the ball's surface, not taking friction into account. The depth of the material compression h is proportional to the depth of impression h_1, i.e., $h = mh_1$. According to the conditions of the technological process, the coefficient $m = 2 \ldots 20$. The calculation of the stress in the surface layer is derived from the course and size of the deformation. Under a sufficiently large cover, the course of the stress below the surface is similar to that below the impression. The actual distribution of the pressure stresses is the result of plastic deformations in the surface layer and in deeper layers due to Hertz's pressures.

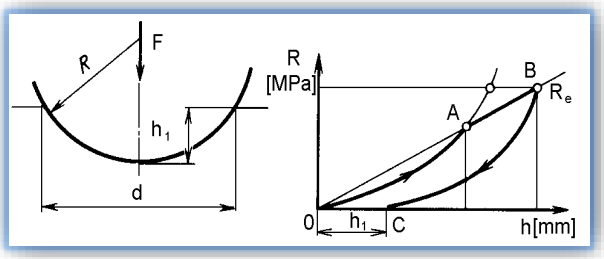

Figure 1. Surface changes due to the incidence of the ball on the surface and the course of the elastic and plastic deformations due to stress [2]

As early as the year 1881, Heinrich Hertz formulated the relation between the load value of the projected area of the surface pressures and contact of generally curved bodies. The solution derived by Heinrich Hertz only gives the orientation values of the contact pressures. The place of the highest stress is under the middle of the upper surface of the point of contact between the bodies, and the accumulation of stress is near the outer surface. The modulus of elasticity in the tension of both materials is constant; it does not vary with the load. Strains are very low in relation to the sizes of the bodies and their profile is in one plane (Hertz 1896). For the calculation these four laws defined by Heinrich Hertz the following must hold:

- isotropy and homogeneity of projected area material,
- over the course of deformation, Hooke´s law must be valid,
- shear stress is equal to zero. The influence of friction is not specified,
- projected areas are equal.

Two spherical bodies are contiguous at only one point. Owing to the load and deformation of the bodies, the point contact morphs into surface contact [2] (Figure 2). This surface is elliptic.

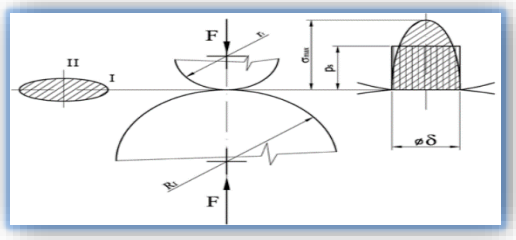

Figure 2. Diagram of the point of contact

DESCRIPTION OF EXPERIMENT

The physical and geometrical parameters as well as the turning parameters of the rotary work-piece remained constant during the experiment while variables such as the force F of the forming tool, the average dimension d of the forming tool, the feed f of the forming tool, and the material of the forming element were changed. The outcomes to be measured were the roughness of the surface Ra after each turning and forming operation, the Vickers hardness after machining operation, and the wear on the tools after hardening. The experiment consisted of the following activities:

- turning of the work-piece,
- hardening the surfaces of the rotary work-piece with the ball under various conditions,
- evaluation of the surface layers of the work-pieces after turning operations and the application of a static roller,
- comparison of the wear on the forming tools.

For the experiment, a hardening tool with damping was developed, consisting of the following parts [1]:

- a cage – material 7050 (aluminum),
- Linear housing Bosch Rexroth STAR ø20 (067-20),
- a round tool ø20 material steel Cf 53,
- forming element – balls for bearings, material: steel and Si_3N_4, with 2 diameters of 6 and 8 mm,
- dampening member – polyurethane material, hardness 85 + / -5 Shore A

For each type of shaping element two feeds were chosen, and for each feed the same three forces were selected, based on their calculated power during the process. Hardening of the samples was carried out under constant lubrication with Ekolube CPN 211 high quality cutting oil, which is a concentrate of high pressure additives (chlorinated paraffin, etc.) used in the machining of very tough materials. After the completion of the strengthening operations, the surface roughness, Ra $_2$, of each sample was measured using a profilometer. The roughness of each sample was measured 10 times in order to obtain the relevant average data on the roughness of the hardened samples.

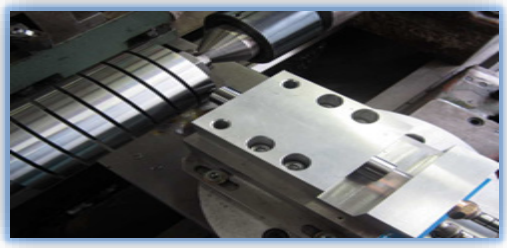

Figure 3. The tool for the strengthening of surfaces with a dynamometer to determine the contact force, and on the right, a detail of the ball

Figure 4. Measurement of roughness with a profilometer and the Vickers hardness measurements

CONCLUSIONS

The parameters of roughness after hardening with a bullet confirmed the assumption that the micro-roughness of the work-pieces would be smoothed (reduced values of the surface roughness were produced). Particularly low values of surface roughness were obtained when using the ceramic cutting tool (silicon nitride), which demonstrates the very good physical properties of this material.

Thanks to the properties of the ceramic tool (high hardness, durability, and resistance to high temperatures, wear and mechanical stress) reduced surface roughness was achieved with minimal compressive force. Reduced surface roughness was produced using a ceramic tool with minimal compressive force compared with the use of a steel ball. The roughness was already less using the minimum contact force compared to using a steel ball. The best surface roughness values were achieved with the bullet made of silicon nitride with d = 8 mm, f = 0.08 mm / rev. and shaping forces of 700 and 1000 N (value of Ra = 0.23 microns and 0.27 microns, respectively).

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CHARACTERIZATION OF SWIRLING FLOW AT INLET OF HYDRAULIC TURBINES DRAFT CONE BY PROPER ORTHOGONAL DECOMPOSITION

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Abstract: *In this paper we employ the method of proper orthogonal decomposition (POD) in conjunction with the radial basis functions interpolation (RBF) for characterization of the swirling flow at the inlet of the draft cone of hydraulic turbines by modal decomposition. The efficiency of the reduced order model is tested by employing different kernels for RBF interpolation and a rigorous error analysis for the obtained reduced order model is performed.*
Keywords: *proper orthogonal decomposition, hydraulic turbines, reduced order modeling*

INTRODUCTION

The increased quantity of information in parameter dependent problems necessitate simulation algorithms and complex data processing, whose efficiency depends on the degree of accuracy and time required to obtain useful information. The modeling of self-induced instabilities in turbomachinery depending on the discharge coefficient [1], investigations on dynamic stall control with passive elements [2] or magnetic interactions between the nanoparticles [3] are some pertinent examples.

The problem investigated in this paper originates from turbomachinery, where the direct application of model order reduction concepts for fluid control is not straightforward, mainly because of the nonlinearity of the Navier-Stokes equations. Our focus is to provide a solution to obtain a reduced model which accurately represents dominant features of the flow at the inlet of the draft cone.

In this paper we employ a data driven method of Proper Orthogonal Decomposition (POD), that use sample stored experimental data to generate the spatial modes. The POD method was introduced by several scientists independently, for different applications, in particular by Kosambi [4], Loeve [5], Karhunen [6] and Obukhov [7] and has been illustrated on a variety of examples ranging from fluid mechanics [8], turbulent flows [9] and oceanography [10].

The remainder of this article is organized as follows. The procedure of numerical data acquisition is presented in Section 2. The principles governing the Proper Orthogonal Decomposition are discussed in detail in Section 3 that includes also an algorithm for computing the proper orthogonal modes. We devote the Section 4 to reveal the numerical results estimated for the hydraulic turbine within the full operating range. The results are compared to an existing measurement for radial velocity profiles. Summary and conclusions are drawn in the final section.

NUMERICAL DATA ACQUISITION

Francis turbines cover the largest part of the installed hydropower capacity in the world, owing their name to the British-American engineer James B. Francis in the 1840s. A cross-section of the device is presented in Figure 1. The flow enters through a volute or scroll casing which is designated to evenly distribute the flow around the periphery of the inlet guide vanes. As the inlet guide vanes increase the angular momentum of the fluid, the turbine rotor turns the flow from the radial to the axial direction. The draft cone is the machine component where the flow exiting the runner is decelerated, where the excess of kinetic energy is converted into static pressure.

In order to derive the mathematical model of the swirling flow in the draft cone, we express the physical quantities in their dimensionless form using a reference radius R_{ref} *chosen as the runner outlet radius and a reference velocity* $V_{ref} = \Omega R_{ref}$, *where* Ω *represents the runner angular velocity. In consequence, by introducing the dimensionless velocity* $v = V / \left(\Omega R_{ref}\right)$ *we are concerned on the axial-tangential velocity profile* $\left(v_z, v_\theta\right)$ *downstream the runner, corresponding to the radial section* $S = \left\{ r \,\middle|\, r \in \left[0, r_w\right] \right\}$, *where* $r_w = R_w / R_{ref}$ *is the dimensionless radial distance to the cone wall and has the value* 1.063 *in our test bench (see Figure 1).*

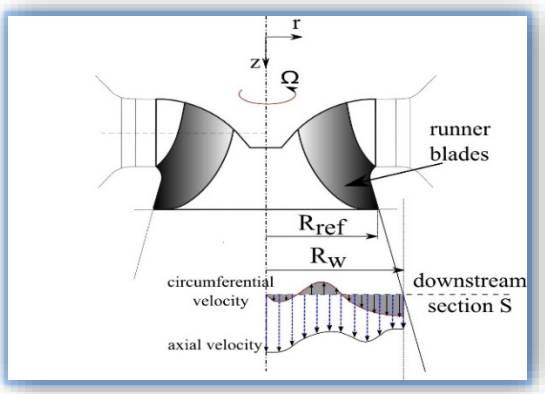


Figure 1. Meridional cross-section of the draft cone

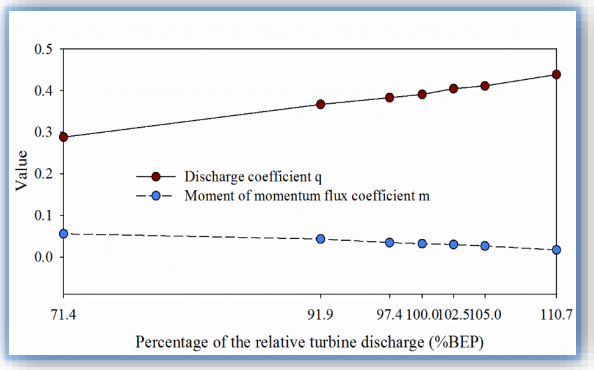


Figure 2. The two main integral parameters that characterize the swirling flow in the section S at each operating point

A turbine operating regime is defined by the pair (q,m) *where the turbine discharge* q *and the flux of moment of momentum* m *are evaluated in dimensionless form as*

$$q=\int_0^{r_w} v_z 2rdr,\quad m=\int_0^{r_w}(rv_\theta)v_z 2rdr. \tag{1}$$

The integrals in relations (1) are computed using the Simpson $1/3$ *rule and the corresponding values are given in Figure 2.*

First we consider the velocities expressed as a juxtaposition of a basic flow $(v_z{}^0, v_\theta{}^0)$ *and a perturbation part* $(\hat{v}_z,\hat{v}_\theta)$ *such that such that all the operating regimes exhibit a null discharge coefficient of the axial fluctuation and also a null flux of moment of momentum of the circumferential fluctuation. According to definitions (1), this is mathematically achieved by writing*

$$v_z=v_z{}^0+\hat{v}_z,\quad \int_0^{r_w}\hat{v}_z 2rdr=0, \tag{2}$$

$$v_\theta=v_\theta{}^0+\hat{v}_\theta,\quad \int_0^{r_w}(r\hat{v}_\theta)v_z 2rdr=0. \tag{3}$$

Next we compute the velocity components of the base flow such that the conditions (2) and (3) hold. It follows from (1) that

$$q=\int_0^{r_w} v_z{}^0 2rdr+\int_0^{r_w}\hat{v}_z 2rdr \tag{4}$$

and considering (2) yields that the axial velocity of the base flow is

$$v_z{}^0=\frac{q}{r_w{}^2}. \tag{5}$$

Considering that the fluctuation part of the circumferential velocity is expressed as product between the radial coordinate and the angular velocity $v_\theta{}^0=\omega^0 r$*, it follows from (1) that*

$$m=\int_0^{r_w}(\omega^0 r^2)v_z 2rdr+\int_0^{r_w}(r\hat{v}_\theta)v_z 2rdr \tag{6}$$

and considering (3) yields the expression of the circumferential velocity of the base flow as

$$v_\theta{}^0=\omega^0 r,\ \ \omega^0=m\left(2\int_0^{r_w} v_z r^3 dr\right)^{-1}. \tag{7}$$

In order to derive the mathematical model of the velocity components, we consider seven operating regimes covering both the overload, the best efficiency point (BEP) and the partial load behavior of Francis turbine. Both axial and circumferential velocity profiles are measured in the survey section S *downstream the runner, using Laser Dopler Velocimetry technique [11]. These measurements are used to develop the reduced order model that predicts the inlet velocity components for the operating regimes for which the experimental measurement are not available. We will further detail the results in the section dedicated to numerical experiments.*

POD-RBF ALGORITHM FOR REDUCED ORDER MODELING

We concentrate in this section to approximate the velocity components of the swirling flow fluctuation $\hat{v}=(\hat{v}_z,\hat{v}_\theta)$ *as a finite sum of form*

$$\hat{v}(r)\approx\sum_{j=1}^{p} a_j\phi_j(r). \tag{8}$$

In Proper Orthogonal Decomposition approach, we seek for an orthonormal basis functions, i.e.

$$\langle\phi_i(r),\phi_j(r)\rangle_{L^2(S)}=\delta_{ij}, \tag{9}$$

where δ_{ij} *is the Kronecker delta symbol and the coefficients* $a_j, j=1,\dots,p$ *are computed by projecting the velocity field onto the POD modes*

$$a_j=\langle\hat{v}(r),\phi_j(r)\rangle_{L^2(S)}. \tag{10}$$

This leads to the following POD algorithm for identification of the velocity field in the draft tube of hydraulic turbine, based on the singular value decomposition (SVD):

(i) Collect data $v(r_i;q_\ell)$, $i=1,\dots,m$, $\ell=1,\dots,N$ *at survey section* S *for* N *operating regimes.*

(ii) Arrange the set of data in an $m\times N$ *matrix called the snapshot data matrix,*

$$A=\begin{pmatrix} v(r_1;q_1) & v(r_1;q_2) & \dots & v(r_1;q_{N-1}) & v(r_1;q_N)\\ v(r_2;q_1) & v(r_2;q_2) & \dots & v(r_2;q_{N-1}) & v(r_2;q_N)\\ \vdots & \vdots & \vdots & \vdots & \vdots\\ v(r_m;q_1) & v(r_m;q_2) & \dots & v(r_m;q_{N-1}) & v(r_m;q_N)\end{pmatrix}.$$

(iii) Compute the base flow matrix B^0 *in the following form:*

$$B^0 \equiv B_z^0 = \left[q_1 / r_w^{\,2} \quad q_2 / r_w^{\,2} \quad \dots \quad q_N / r_w^{\,2} \right]$$

$$for\ v(r;q) \equiv v_z(r),$$

$$B^0 \equiv B_\theta^0 = \begin{pmatrix} r_1\omega_1^0 & r_1\omega_2^0 & \dots & r_1\omega_{N-1}^0 & r_1\omega_N^0 \\ r_2\omega_1^0 & r_2\omega_2^0 & \dots & r_2\omega_{N-1}^0 & r_2\omega_N^0 \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ r_m\omega_1^0 & r_m\omega_2^0 & \dots & r_m\omega_{N-1}^0 & r_m\omega_N^0 \end{pmatrix} \in \mathbb{R}^{m\times N}$$

$$for\ v(r;q) \equiv v_\theta(r).$$

(iv) Compute the base flow-subtracted snapshot matrix $A = A - B^0$.

(v) We employ an economy size singular value decomposition (SVD) of A *that guarantees the existence of real numbers* $\lambda_1 \ge \lambda_2 \ge \dots \ge \lambda_d > 0$ *and orthogonal matrices* $\Phi \in \mathbb{R}^{m\times m}$ *and* $\Psi \in \mathbb{R}^{N\times N}$ *such that* $A = \Phi D \Psi^T$, *where* $D = diag(\lambda_1,\dots,\lambda_d) \in \mathbb{R}^{d\times d}$.

(vi) The column space of A *can be represented in terms of the* d *linearly independent columns of* Φ . *Since* Φ *is orthogonal, we find that the columns of the snapshot matrix* A *are*

$$v_\ell = \sum_{i=1}^{d} A_{i\ell}\Phi_{:,i} = \sum_{i=1}^{d} \left(D(\Psi)^T \right)_{i\ell} \phi_i =$$

$$= \sum_{i=1}^{d} \left(\underbrace{(\Phi)^T \Phi}_{I_d} D(\Psi)^T \right)_{i\ell} \phi_i = \sum_{i=1}^{d} \left((\Phi)^T A \right)_{i\ell} \phi_i =$$

$$= \sum_{i=1}^{d} \left(\underbrace{\sum_{k=1}^{N} \Phi_{ki} A_{k\ell}}_{=\phi_i^T v_\ell} \right) \phi_i = \sum_{i=1}^{d} \langle \phi_i, v_\ell \rangle_{\mathbb{R}^m} \phi_i ,$$

where $I_d \in \mathbb{R}^{d\times d}$ *stands for the identity matrix and* $\langle \cdot,\cdot \rangle_{\mathbb{R}^m}$ *denotes the canonical inner product in* $\mathbb{R}^m$.

One measure of the effectiveness of POD is related to the rate of decay of the eigenvalues. We define the relative energy content (REC) of the singular value decomposition of A *by*

$$REC_{POD}(p) = \frac{\sum_{j=1}^{p} \lambda_j}{\sum_{j=1}^{d} \lambda_j} \qquad (11)$$

Table 1. Kernels for RBF interpolation

Name of the Kernel	Definition
Cubic	$k(z) = z^3$
Gaussian	$k(z) = \exp\left(-\frac{z^2}{2\sigma^2}\right)$
Thinplate	$k(z) = r^2 \ln(z+1)$
Multiquadric	$k(z) = \sqrt{1+\frac{z^2}{\sigma^2}}$

and we find the number of POD basis vectors $p < d$ *when the low-rank approximation is required to contain* $\delta\%$ *of the total information contained in the original snapshot matrix. The dimension of the subspace spanned by the first* p *singular modes* $\{\phi_j\}_{j=1}^{p}$ *is determined by*

$$p = \arg\min\{REC_{POD}(p); REC_{POD}(p) \ge \delta\}. \qquad (12)$$

Usually, we consider $99.00\% \le \delta \le 99.99\%$ *and by employing the radial basis function (RBF) interpolation, the coefficients* $a_j, j = 1,\dots,p$ *of the reduced order model can be determined for any operating regime* q .

Considering the precomputed POD coefficients as a set of distinct nodes $\{\mathbf{x}_i\}_{i=1}^{p\times N} \subset \mathbb{R}^2$ *and a set of function values* $\{f_i\}_{i=1}^{p\times N} \subset \mathbb{R}$, *the problem reduces to find an interpolant* $s : \mathbb{R}^2 \to \mathbb{R}$ *such that*

$$s(\mathbf{x}_i) = f_i \quad for\ i = 1,\dots,p\times N, \qquad (13)$$

where N *is the number of operating regimes for which experimentally measured data are available and* p *is the number of POD modes provided by the energy criterion (11). Note that we use the notation* $\mathbf{x} = (x,y) \in \{1,\dots,p\}\times[q_1,q_N]$ *for scattered points coordinates and* $f_i = a_j^\ell$, $j = 1,\dots,p$, $\ell = 1,\dots,N$ *for scattered points values. Following Duchon [13], the solution to the problem (12) is a function of the form*

$$s(\mathbf{x}) = \sum_{i=1}^{p\times N} w_i k\left(\|\mathbf{x}-\mathbf{x}_i\|_2\right) + \mathrm{P}(\mathbf{x}), \qquad (14)$$

where k *is a real valued function defined on the kernel* $k \in K : \mathbb{R}^{p\times N} \times \mathbb{R}^{p\times N} \to \mathbb{R}$, $\|\cdot\|_2$ *is the Euclidian distance between the points* $\mathbf{x}$ *and* $\mathbf{x}_i$, *the coefficients* $w_i \in \mathbb{R}$ *are constant real numbers, while* $\mathrm{P}(x)$ *is a global polynomial function of total degree at most* $n-1$ *with* n *considered small. The points* $\mathbf{x}_i$ *are referred as centers of the Radial Basis Functions* $k(z) = K(\mathbf{x},\mathbf{x}_i)$, *where the variable* z *stands for* $\|\mathbf{x}-\mathbf{x}_i\|_2$.

Table 1 lists the kernels for RBFs that we use in the following experiments, where parameter σ *is the shape parameter of the RBF. Changing the shape parameter of an RBF alters the interpolant surface, thus can have a significant impact on the accuracy of the approximation. Finding the shape parameter that will produce the most accurate approximation is a topic of current research. Investigations upon accuracy and stability of RBF based interpolation may be found in Fornberg and Wright [14].*

Considering that $\{p_1, p_2, \dots, p_n\}$ *represents a basis for the polynomial* $\mathrm{P}(\mathbf{x})$ *and* $\{c_1,\dots,c_n\}$ *are the coefficients that give the polynomial* $\mathrm{P}(\mathbf{x})$ *in terms of this basis, introducing Eq. (14) into (13) leads to a linear system to be solved for the coefficients that specify the RBF.*

The methodology presented herein leads to the following POD-RBF linear model for estimation of the perturbation part of the velocity field for the entire operating range.

$$\hat{v}(r;q) = \sum_{j=1}^{p} a_j^q \phi_j(r), \quad a_j^q = s(x,y),$$

$$x = j \in \{1,\ldots,p\},\ y = q \in [q_1, q_N], \qquad (15)$$

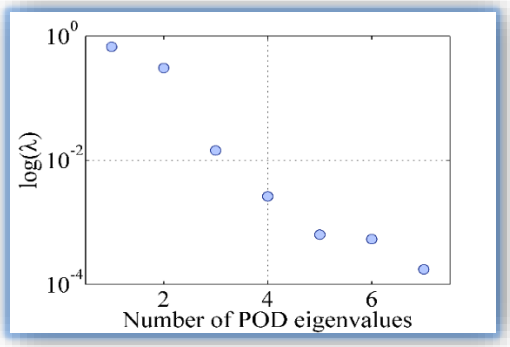
where a_j^q are the interpolated POD coefficients, $\phi_j(r)$ are the POD basis functions, p represents the number of the POD basis functions retained for the low order model and q denotes the value of the discharge coefficient.

VALIDATION OF POD-RBF MODEL AND NUMERICAL RESULTS

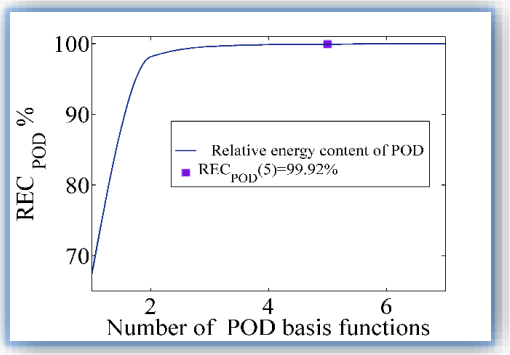
The aim of this section is twofold: first we verify the accuracy of the POD-RBF low order model developed herein and second, we illustrate the computational efficiency of the proposed model by employing different kernels for RBF interpolation.

Considering the set of $N = 7$ experimentally measured profiles representing the axial and circumferential velocities at the inlet of the draft tube (see Figure 1), experimentally measured for discharge coefficients settled in Figure 2, we employ the POD algorithm described in Section 3 to obtain a reduced order model of the velocity fields. The logarithmic plots of the singular values obtained from POD decomposition of the axial velocity perturbation and circumferential velocity perturbation are presented in Figure 3a and Figure 4a, respectively.

The relative energy content captured as the number of the POD modes is presented in Figure 3b and Figure 4b, respectively, for both velocity fields. Most of the energy defined by Equation (11) is contained in the first few modes.

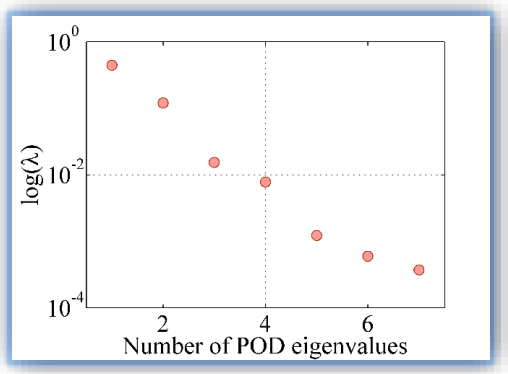


a.

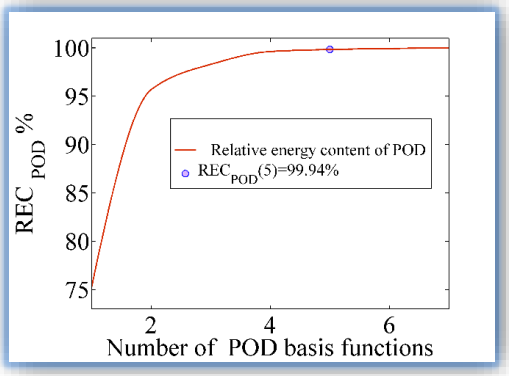


b.

Figure 3. a. POD eigenvalues of the axial velocity decomposition; b. Relative energy content captured by POD decomposition as the number of the POD modes



a.



b.

Figure 4. a. POD eigenvalues of the circumferential velocity decomposition; b. Relative energy content captured by POD decomposition as the number of the POD mode

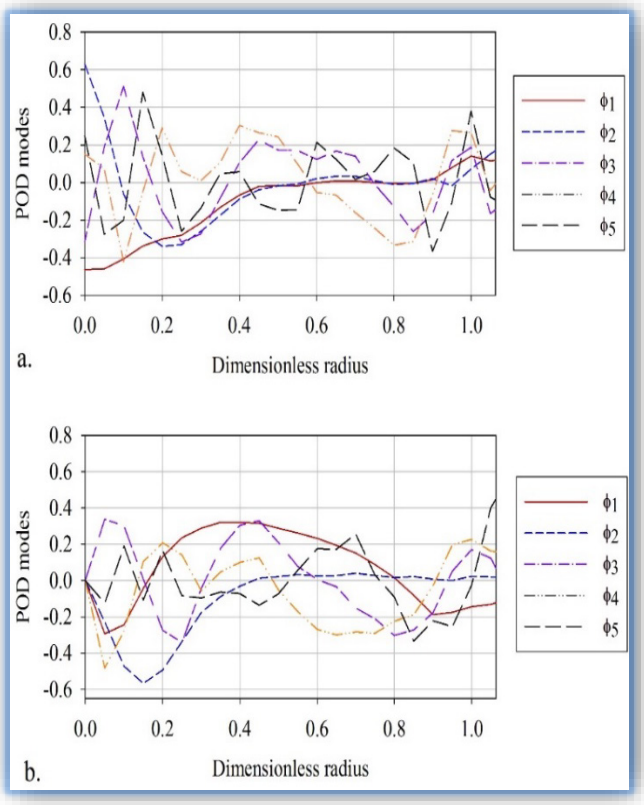
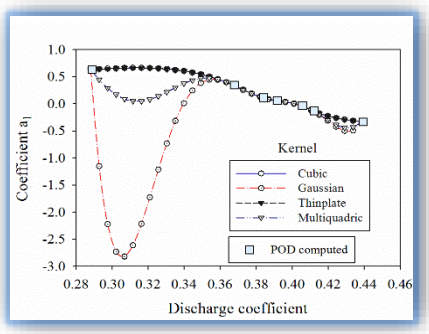
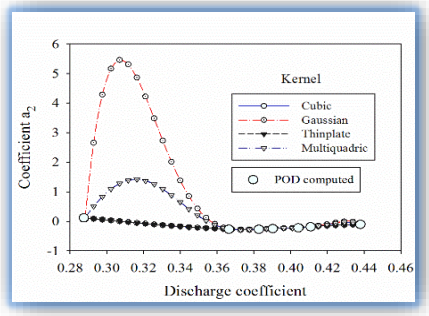
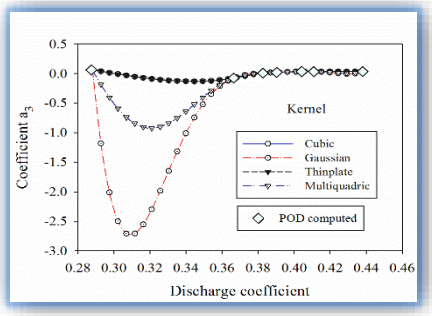
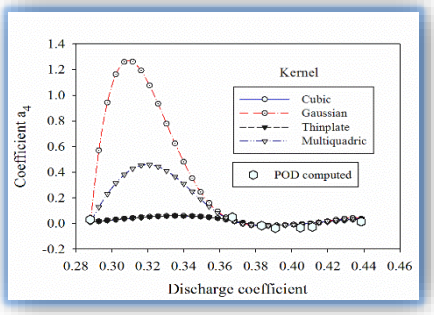


Figure 5. POD basis functions of the axial velocity decomposition (a) and circumferential velocity decomposition (b).









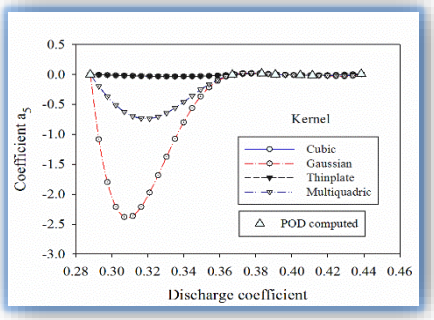
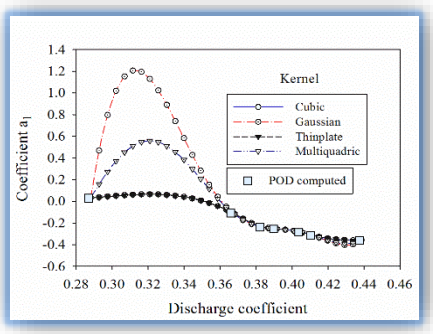
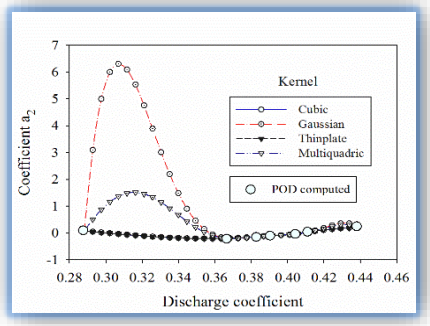
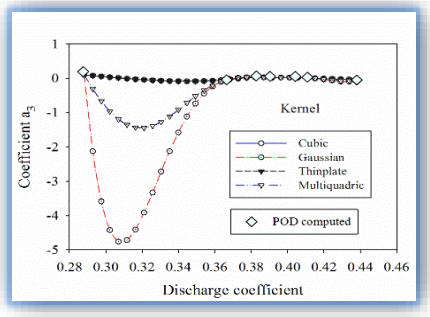
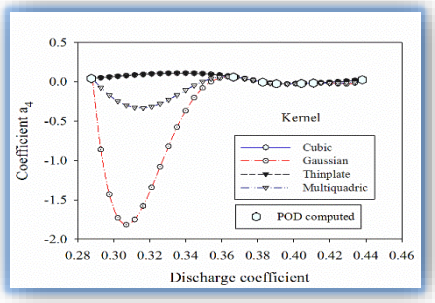


Figure 6. The RBF interpolated coefficients for axial perturbation vs. the POD computed coefficients









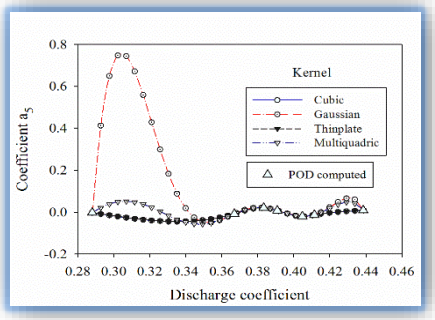


Figure 7. The RBF interpolated coefficients for circumferential perturbation vs. the POD computed coefficients

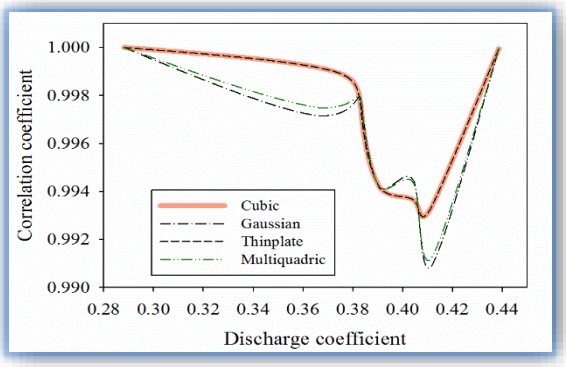
Specifically, the first five POD modes capture more than 99.92% of the total information contained in the original snapshot matrix, therefore we consider $p = 5$ the number of optimal POD basis functions retained for velocity fields estimation.

The orthonormal POD basis functions computed with the improved POD algorithm presented herein are depicted in Figure 5 for modal decomposition of the axial-circumferential velocity fields. The next figures illustrate the coefficients of the orthogonal decomposition interpolated using the method of RBF with the kernels listed in Table 1. Figure 6 presents the first five coefficients used for axial velocity decomposition and in Figure 7 the coefficients of the circumferential velocity are depicted, for the entire discharge window.

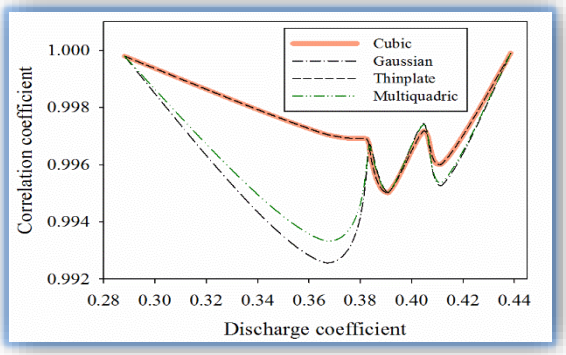
In addition to comparing coefficient profiles we compare the correlation coefficients of the reduced order model. The correlation coefficients defined below are used as additional metrics to evaluate the efficiency of the reduced order model

$$C^q = \frac{\left(\left\|v_{POD}(r;q)^H \cdot v(r;q)\right\|_2\right)^2}{\left\|v_{POD}(r;q)^H \cdot v_{POD}(r;q)\right\|_2 \left\|v(r;q)^H \cdot v(r;q)\right\|_2}, \quad (16)$$

where $v(r;q)$ represents the measured velocity profile at discharge q, $v_{POD}(r;q)$ is the estimated velocity profile obtained with the POD-RBF model, $\|\cdot\|_2$ stands for the Euclidean norm, $(\cdot)$ represents the Hermitian inner product and H denotes the conjugate transpose.

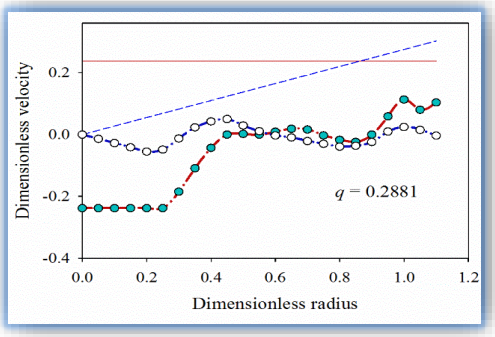


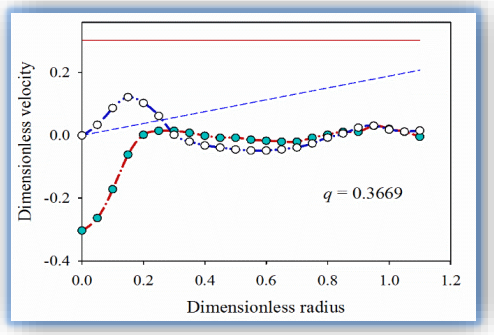
a.

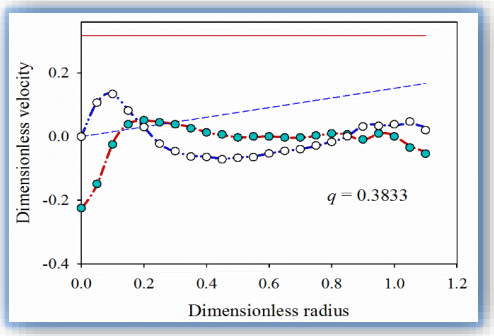


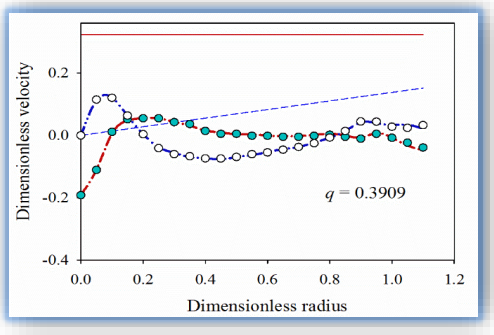
b.

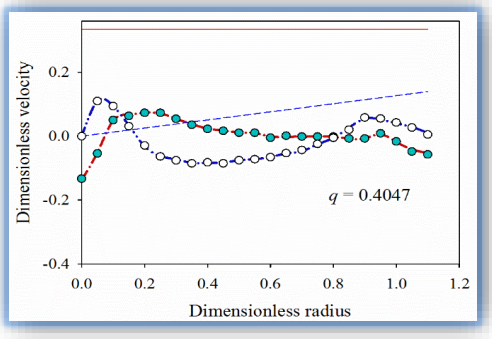
Figure 8. Correlation coefficients for estimation of axial (a) and circumferential (b) perturbations of the velocity profiles using the POD-RBF model (present research).











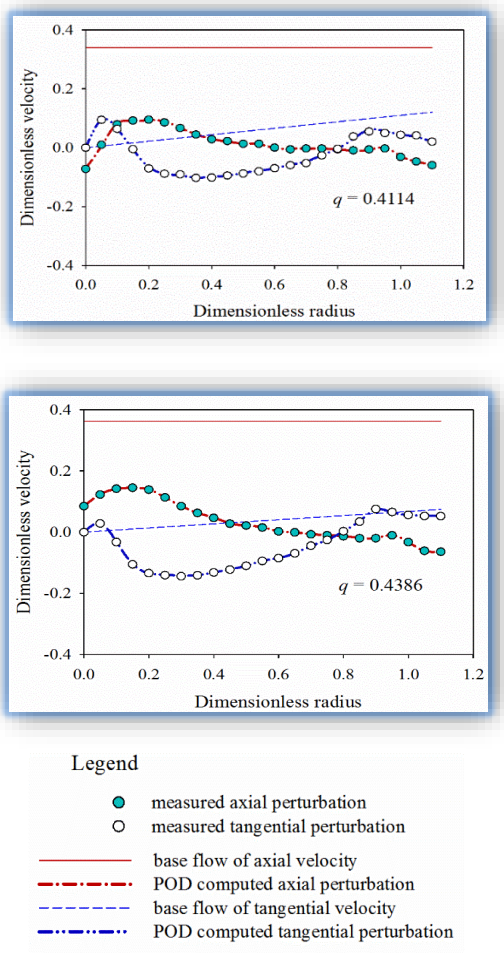


Figure 9. Velocity profiles estimated using the POD-RBF model (present research) in comparison with the experimentally measured profiles

A comparison of the correlation coefficients between the experimentally measured profiles and the reduced order models is provided in Figure 8. The values of the correlation coefficients are greater than 99% for axial and circumferential velocity profiles and confirm the validity of the reduced order model. Moreover, for the problem investigated in this paper, the most efficient kernels for RBF interpolation are both the cubic and the thinplate kernels.

In the following, we compare how the reduced order model assesses the velocity field in parallel with experimentally measured velocity profiles. The base flows of the axial and circumferential velocities have been computed respectively using the relations (5) and (7), whilst the velocity perturbations have been estimated employing the POD-RBF model developed in the paper, using the thinplate kernel. The numerical results are illustrated in Figure 9. Circles represent the measured velocity profiles for discharge coefficient q.

The perfectly match between the estimated velocity perturbations and the experimentally measured profiles confirms the efficiency of the reduced order model developed in this research.

SUMMARY AND CONCLUSIONS

In this paper we have proposed an algorithm for orthogonal decomposition of swirling flows in turbomachines. This framework is useful when a set of few experimentally measured velocity profiles are available and estimations of velocity profiles at intermediate discharge coefficients are needed.

We have implemented an algorithm based on Proper Orthogonal Decomposition in conjunction with Radial Basis Functions interpolation to obtain the reduced order model for estimation of the velocity perturbations. Key innovation for the model introduced in this paper resides in decomposition of the velocity field into a base flow part and a perturbation part, such that the resulting perturbation flow preserves a null discharge and a null moment of momentum flux, respectively. In consequence, the POD algorithm was applied to the perturbation flow quantity, for the axial and circumferential velocity filed, respectively. The proposed method allows the identification of the leading modes in the perturbed flow, modes that capture the most energy in the flow. The methodology presented herein offers an insight on the identification of the coherent structures in the perturbation flow. Once the leading coherent structures are identified, a hydrodynamic stability analysis of the perturbation flow can be performed. This is a topic that we will address carefully in our future work.

We have performed a rigorous error analysis of the reduced order model by computing the correlation coefficients when different kernels are employed for RBF interpolation. The values of the correlation coefficients greater than 99% for axial and circumferential velocity profiles, respectively, confirm the validity of the reduced order model.

By comparing the estimated reduced order solution with the experimentally measured profiles we emphasized an excellent behavior of the reduced order model.

Thus the methodology presented in this paper can be successfully applied not only to hydraulic turbines, but also for problems originating from different domains, where dynamics of the investigated phenomenon is strongly influenced by the system parameters.

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SELECTED EXAMPLE OF SUPPORT THE FLEXIBILITY IN PRODUCTION STRUCTURES BASED ON MODULAR DESIGN

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Abstract: *The objective of this paper is to present the modular workstations concept based on miniaturization and re-configurability trends. The article focuses on presentation of sample production system, referred as agile, with a modular construction structure made up of aluminium profile system by building-block principles. The modular architecture allows an individual and flexible adaptation of workstations to varying requirements of production tasks. In the first part of this article are discussed the specification of basic flexibility types in production system and the main impacts influencing design of manufacturing structures. The closing section of the article provides the specification of example solution of adjustable production platform with modular frame.*
Keywords: *modular workstations; reconfigurable structure; flexible production basis*

INTRODUCTION

Growing cost pressures, continuing miniaturization of products and ever-shorter product life cycles – these are the challenges facing manufacturing operations in a wide range of industries today. Manufacturing competitiveness is highly dependent on the companies' ability to rapidly reconfigure their manufacturing and assembly systems. The paradigm changes, the main trends influencing design process in many modernization projects of production basis are miniaturization, function integration, and densification: miniaturized products are required and manufactured, miniaturized production equipment are proposed and ultimately miniaturized factories are realized. The term "micro or desktop factory" appeared in various contributions and represents: small desktop-size production systems suitable for fabricating and manufacturing of small size parts and products, in the field of high-precision. The flexible and reliable way to the most economical production system offers building block concept of design. With this solutions can be achieve an objective: space saving, energy saving, materials saving and in general can be obtain environmental friendly, agile and point-of-need manufacturing syste.

BACKGROUND OF FLEXIBLE PRODUCTION SYSTEM

The production system must adapt continuously to meet the demands of increasing quantities, product modifications and the degree of automation. In general, there are 11 basic types of manufacturing systems flexibilities as given below [2, 7]:

- *Machine flexibility: the different operation types that a machine can perform - the number of operations performed without set-up of machine or control unit change.*
- *Process flexibility: the set of products that the system can produce - the set of part types that can be produced without major set-up changes.*
- *Transferring flexibility: the ability to move the products within a manufacturing facility - refers to flexibility in transferring various types and sizes of components.*
- *Routing flexibility: the different routes (through machines and workshops) that can be used to produce a product in the system - flexibility in part chosen and transfer a part from one workplace to another.*
- *Operation flexibility: the ability to produce a product in different ways - the different operation can do by interchanging machine or control unit on work piece.*
- *Product flexibility: the ability to add new products in the system - ease to ordering product place in an existing product mix.*
- *Actual flexibility: it's the ability to overcome concrete given changes - the number of products a system currently can produce.*
- *Potential flexibility: it refers to capability of coping with an undefined universe of change - the ability of the system to adapt to market demands.*
- *Volume flexibility: the ease to profitably increase or decrease the output of an existing system - the system should have economy of scope and not economy of scale.*
- *Expansion flexibility: the ability to build out the capacity of a system - the ease to capable, when needed, through physical change to operational system.*
- *Control program flexibility: the ability to run a system automatically - the capability to operate operation by intelligent machines tools and control software system.*

Manufacturers must accommodate changes in requirements to satisfy a variety of needs. The scope for actual designing of flexible production systems characterizes these main impacts [5]:

- *Environment sustainability: minimizing energy consumption, saving energy and resources for machinery building and operation such as power sources lighting, and air conditioning; reduced emission of heat, vibration, acoustical noise, waste.*
- *Enhanced cell manufacturing methodology: freedom of configuration and proportion in machine design will increase; improved equipment portability for installation, reconfiguration, replacement, disposal; process integration – conventionally separated processes for individual dedicated machinery or heterogeneous processes can be systematized.*
- *Customization: fast supply/manufacture/delivery of customized and personalized product of varying volumes (fast increase/decrease of quantities); products should have shorter product life cycle and there must be more variants of each product.*
- *Agility: easy and fast re-configurability of processes and production basis; dynamic scalability for changes in production volume; easier maintenance.*
- *Cost efficiency: cut initial/running costs; efficient use of space; product price must be lower – lower investment.*

Modular structure of production basis easily accommodates changes. A number of miniaturized stand-alone production machines and lines with universal modular platform have been put into commercial use. [6]

EXAMPLE OF MODULAR MANUFACTURING STRUCTURE: DESKTOP FACTORY

Example of presented modular production system in the form of lines provides solution from Bosch Rexroth, labelled Desktop factory. [4]

This is a concept for manufacturing and assembly lines that offers standardized factories in mini format. A future-oriented concept of production system is based on standardized structural frame designs, as well as process modules and plug-in modules with compact dimensions. Each plug-in module takes over one work step. Several plug-in modules can be placed next to each other in the frames in a flexible arrangement to correspond to the entire manufacturing process (see fig. 1). Standardized, modular construction and a reduction in complexity provide decisive advantages that are not achievable with more traditional manufacturing systems. [8]

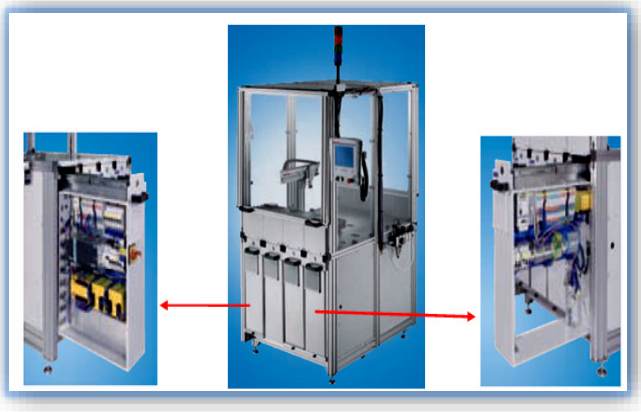

Figure 1. Basic frame of workstation with standardized plug-in modules. [8]

Desktop Factory (DTF) is a technically sophisticated, widely applicable production platform. It is a solid foundation that system builders and integrators can expand on when designing more sophisticated systems. The offering includes the basic structure consisting of a standardized basic cell with transfer, process and supply units, as well as electro-pneumatic equipment. The architecture is based on standardized modules, as shown in fig. 2. Various modules, e.g. for assembly, welding or press fitting, can be arranged in sequence in prefabricated plug-in units within one basic frame. Each module represents one operation. [1]

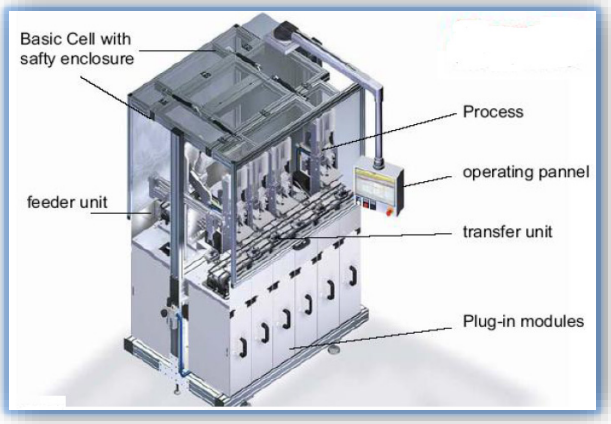

Figure 2. Example of DTF structure. [1]

The solution is available for many applications to manual and automatized production system and makes it possible to [1]:

- ✓ *Reduced costs*

Thanks to consistent standardization and a reduction in complexity, investment costs can be lowered by up to 15% compared to more traditional concepts. Savings in indirect costs are even more substantial. For example, power consumption can be cut by up to 20% and required space by up to 75% in contrast to conventional systems. Component reusability provides additional cost advantages and a high level of investment security.

- ✓ *Maximum reliability*

Independent process modules and the "plug & produce" system ensure fast, reliable start-ups. The DTF concept also permits easy transfer of processes proven effective during prototype build into further use in series production. A reduction to one process step per module results in high transparency and availability.

- ✓ *Enormous flexibility*

This modern, adaptive production system ensures fast and easy adaptation to quantity or product changes, also making step-by-step investment possible as the processes evolve. Even the degree of automation can be specified and adapted as needed, which makes it possible to implement manual workstations just as easily as partially and fully automated workstations.

The advantages of a DTF line can be seen in almost any industry – provided that certain product and process-specific requirements are met. The diagram below (see fig. 3) contains the most important criteria for orientation. DTF is an economical solution for the assembly of small products with weights up to 500 grams, for example such as switches or

thermostats, for the automotive, electronic, and electro-technical sectors as well as medical technology and household appliances. [4]

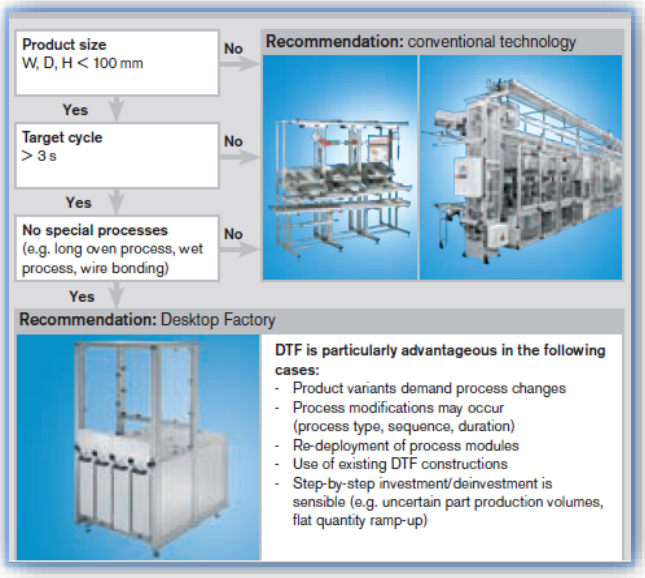

Figure 3. Decision criteria for a DTF assembly concept. [4]

The individual modules can be replaced and extended easily, making it fast and simple to adapt to new requirements such as higher production volumes. The degree of automation can also be chosen simply and varied according to demand – from manual workstations to fully automated manufacturing lines, as shown in fig. 4.

Figure 4. Process modules combined with a manual workstation. [3]

Existing high-performance design software of computer – aided tools allows to engineers solve the factory structures, layout and equipment in 3D visualisation. They declared significant reductions in the design effort by using pre-built components - modules. These programs help save time and allow them to develop simple and targeted planning variants. Computer aided tools to support design process of modular workstations systems can reduce engineering lead-time and cost by getting the ergonomic design right the first time through simulation (see fig. 5) and avoiding the need to go back and make changes later, when they will be more difficult and expensive. [8]

Figure 5. Examples of manual work cell design visualization. [8]

The workstation optimizes ergonomics in its design to maximize productivity within its work area. These units have been engineered to deliver improved productivity levels by means of improving aesthetic values, and providing better and safer working environments.

Each modular workstation system is easy and quick to customise and can be seamlessly combined with elements from modular conveyor systems and expansion ranges to create truly bespoke solutions that maximise productivity and profitability. Any workstation can be easily expanded, reconfigured, or relocated as work tasks change - start with a simple worktable for basic tasks and grow into a station in a progressive assembly system. Modularity also simplifies workstation design and assembly. Flexible expansion allows adaptation to changing manufacturing surroundings. [1]

The advantages of miniaturized manufacturing systems are considerable. Benefits of the analysed approach can be summarized. [3, 5, 6]

- ✓ *Economical and ecological opportunities and challenges:*
- ≡ *Remarkable savings in investment, space, energy, and resources (incl. assembly processes, cleaning, compressed air & air controlling units)*
- ≡ *Desktop size supports better lean production and automation assisted manual production*
- ≡ *Smaller production facilities or more production in the same space*
- ≡ *Lower investments in production systems*
- ≡ *Reduced material costs, less waste*
- ≡ *Reduced energy consumption and lower running costs.*
- ✓ *Increase agility:*
- ≡ *Easy to change the production (layout, reconfiguration, flexibility)*
- ≡ *Shorter ramp-up time*
- ≡ *Ubiquitous manufacturing (on-site, mobile…) - production and customization closer to the customer - distributed production and delivery, point-of-need manufacture*
- ≡ *Change the long-established image of factories*
- ≡ *Improved portability of the production equipment*
- ≡ *Better performance: less mass to move, shorter distances to transfer, smaller dimensions.*

The key benefit from using, in this article described, design principle is process flexibility: the standardized desktop factory modules can be quickly and easily adapted to production quantity, product, schedule, or sequence changes. The reusability of the individual desktop modules allowed the plant to develop a completely new platform in few months, including alteration of assembly sequences, development of new processes, and preparation for assembly application. [1]

CONCLUSION

The "microfactory" concept – miniaturize manufacturing machinery and systems – was introduced in a Japanese national project in the early 90s, when the advantages of miniaturization were thought mainly to be saving energy, space, and resources. Beside the trend to miniaturization there is the agility trend - from full automation or flexible automated cells to adaptive production systems - adaptive to the production volume, which is changing over the lifetime of the products to be assembled.

With miniaturization, consistent standardization and modularization, in this article described design of the DTF modular system helps reduce investment costs by up to 15 percent. Power consumption can be cut by up to 20 percent and surface requirements reduced by up to 75 percent compared to traditional manufacturing equipment. Components can be reused after production conversions, providing additional cost advantages and high investment security. This solution provides the user with a cost-efficient and trend-setting manufacturing concept.

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Holger HOTA

THE INCREASE OF RESISTANCE AT WEAR ON THE SELECTIVE TRANSFER

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Abstract: *Seeking for new ways to increase the wear resistance of the machine parts, the examples we found in nature turned out to be of great help. Searching the way of working of the strongly strained friction couples we found out that in nature there are two basic friction couples: open couples and closed couples . The selective transfer can be described as a special molecular interaction and is the result of chemical reactions and physical and chemical processes, as well as of the factors involved in these processes. The selective transfer is characterized by a special molecular interaction and it is the result of some chemical reactions and some physics and chemical processes. These reactions lead to a self – regulation formation in the balance/equilibrium processes, disturbed at the using appearance and also the reduction of the friction force. The formation of a servo wit film is typical of the selective transfer, where a special spreading mechanism is formed. This layer is formed at the beginning of the friction through the selective dissolvent of the anode components in the surface layers of the metal or alloy.*

Keywords: *selective transfer, friction, wears resistance, experimental approach*

INTRODUCTION

Seeking for new ways to increase the wear resistance of the machine parts, the examples we found in nature turned out to be of great help. Searching the way of working of the strongly strained friction couples we found out that in nature there are two basic friction couples:

- *open couples;*
- *closed couples.*

In open couples one hard material actuates upon another hard material; for instance, the animals' teeth and hooves. The animals couldn't ruminate a fodder of a hard consistency unless they had teeth of a hard material as well.

In closed friction couples, as for instance the animals' joints, they work on the same principles as with mechanical engineering. A hard bone is covered with soft cartilage in the friction zone. This cartilage is covered with a thin polymer layer, which is very mobile. The friction surface of the opposite body has the same structure, wherefrom we derive that one soft material actuates upon another soft material. These kinds of friction couples are common with animals' und humans'.

The way a friction couple works in case of selective transfer resembles in a certain manner the way joints work with living organisms. In order to achieve a selective transfer the hard steel surface will be covered with a thin layer, which in its turn will be covered by a thin polymer layer. The surface of the opposite body will suffer the same treatment. In this case, too, friction takes place between two identical materials. The aspects revealed allow developing different wear resistance friction couples.

The selective transfer can be described as a special molecular interaction and is the result of chemical reactions and physical and chemical processes, as well as of the factors involved in these processes, such as:

- *pressure;*
- *heating;*
- *sliding velocity, which causes collisions to the roughness of the friction surface;*
- *the occurrence of electric charges (the electric particles of different charges attract each other, making up a double electric layer);*
- *occurrence of different structural defects in metal;*
- *depolarization effects caused by friction when sliding one surface on the other, which leads to the reduction of autopassivation, to the destruction of the oxide layers und to the acceleration of the corrosion process;*
- *the effect of emitting exoelectrons, which occurs especially when the friction couple performs an oscillating motion.*

These reactions lead to a self-adjustment in the equilibrium processes, which are disturbed by the occurrence of wearing, as well as to the reduction of the friction force.

The selective process represents a complex made up of the following processes:

- *reduction of pressure in real contact areas;*
- *deformation compensation and reduction of the resistance to shearing strain in superficial areas;*
- *resetting of the particles (which were removed from the friction area) in the contact area;*
- *the occurrence of a special layer on the friction surface;*
- *protection of the metal against corrosion;*
- *the occurrence of a protecting polymer layer.*

When is using selective transfer the charge of the construction elements may increase, without causing an increase in weight and dimensions [4]. Typical to selective transfer is the occurrence of a serwit film, in which occurs a special mechanism of diffusion. This layer occurs in the starting phase of the friction strain through the selective dissolution of the anodic components in the superficial layers of the metal or alloy. The servowit layer has the propriety to assure in the deformation processes a sintering agglomeration, in the same way as in annealed metals. This propriety can protect the layer against destruction.

Figure 1 presents the variation of the friction coefficient "f" depending on the pressure for different sliding velocities (0.6 m/s; 1 m/s; 2 m/s) under the conditions of a selective transfer (interior curve) and a friction between the adherent layers (superior curves) [4;5].

Once the layer formed the friction will considerably be reduced on the contact surfaces. The friction force is tightly connected to:

- *formed structure, in the metallic friction surface areas, following the selective transfer;*
- *the proprieties of these metallic surface layers.*

The important parameters regarding the physical state of the superficial layers are:

- *micro voltages;*
- *its structure und modification on the friction surfaces;*
- *structure defects (dislocations, punctiform defects);*
- *the distribution mode of the supplements und the alloy elements.*

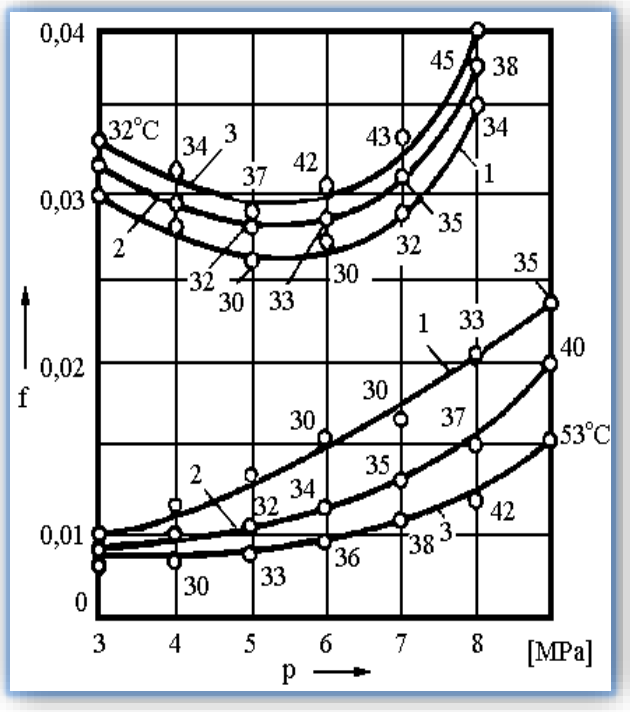

Figure 1. The variation of the friction coefficient "f" depending on the contact pressure "p" for the following sliding velocities: curve 1 at 0.6 m/s; curve 2 at 1 m/s; curve 3 at 2 m/s.

This phenomenon can prove very useful in improving the performance of the hip prothesis.

MEASURING AND TESTING METHODS

To check the transferred layer are used marking methods with informers using radioactive substances or irradiating by accelerated ion beam to cyclotron [7; 9].

During the occurrence of the layer the informers change their form, dimension or leave traces on the tested surfaces in the contact area. In order to make the measurements with informers useful these informers have to comply with certain conditions:

- *the thickness of the informer layer has to be greater than the highness of the roughness of the tested surface;*
- *the resistance of the informers has to be smaller than that of the roughness.*

In the case of the marking method by irradiation with accelerated ion beam to cyclotron it is allowed the marking of a thin layer (50 ÷ 700) μm by irradiation at the surface of the part. Depths of (50 μm ÷ 3 mm) can be obtained using protons and deuterons. When irradiating with ion beam a small surface can be marked (3 x 3 mm^2) and at the same time are produced radio isotopes within the same material, which allows to check simultaneously the wear and tear of (2 ÷ 3) surfaces.

As test tool could be used a test tribometer, break shoe on cylinder, preferably Amsler (friction couple third class) or a hip prothesis on a test stand.

The Amsler tribometer [1; 2; 3; 8] can be used to test all motion types: rolling, gliding and sliding. As a standard two collars [8 ÷ 10] of 42 mm in diameter are pressed one against the other. The lateral surfaces of the collar may theoretically be of any geometry. The moment of friction is continuously registered. The wear and tear can be determined by weighing or measuring after the experiment. By means of the eccentric that can be connected the rotation motion can be superposed a pulsating radial load (sudden uplift). A second eccentric allows an axial periodical to and fro pushing of the superior test body. When the superior shaft is standing still a semispherical bearing can be used instead of the cylindrical test body.

Table 1. Parameter of test stand

Number of rotations	*25 to 500 1/min*
Gliding	*0 – 100%*
Motor data	*1.5 kW, 5.7 A*
Load	*10 to 2,000 Newton*
Temperature	*RT*
Types of motion	*Gliding, rolling, slipping*
State of friction	*friction in fixed bodies, limit friction, mixed friction*
Type of the obtained friction	*Elastohydrodynamics*
Geometry of contact	*Contact – point or line*

Table 1 presents the summary of the test stand parameters. Figure 2 shows possible geometries of the tester.

The test stand allows to:

- *characterize the behavior of materials during friction and wearing;*

- *study the over rolling constancy in coatings that reduce friction and wear and tear;*
- *to study the material characteristics.*

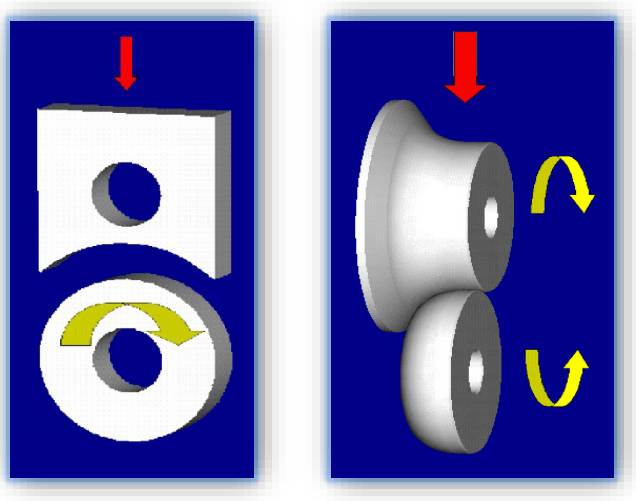

Figure 2. Possible geometries of the tester

CONCLUSION

The selective transfer phenomenon represents a very useful tool in order to obtaining an improved wear resistance of different kind of friction couples.

One of the possible efficient application fields can be the increasing of the hip prosthesis performances, respectively their reliability. One has to underline the well-known fact that by increasing their life-time only with 6 months, one can obtain not only a more competitive biomedical product, but also a significant reduction of the surgical interventions.

Especially for the elder patients, every surgical intervention can represents a great risk of their surviving. By prolongation of the prosthesis's lifetime, this risk will be reduced significantly and also the global intervention's costs will decrease.

Taking into the consideration only the biomedical applications of the selective transfer, one can put in evidence the following incontestable advantages:

- *the method allows conceiving and testing of new biocompatible materials (accepted by the surrounding tissues and of the organism as a whole);*
- *the selective transfer leads to increasing the durability of prosthesis;*
- *the implementation of the selective transfer allows a diminishing of the hip prosthesis' proice.*

In the next period, the author intends to look for some interested companies in improving the actual prosthesis' lifetime by implementation of the selective transfer's advantages.

One other further goal of the author consists of increasing the load-bearing capacity of several great importance bearings by means of the selective transfer.

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SPECIFICATION IN THE PRACTICE OF LAW ENFORCEMENT (APPLICATION OF BIOMETRY)

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Abstract: After the accession of Hungary to the Schengen region on 21 December 2007, the border control at internal borders was abolished. By the removal of this essential law enforcement measure some Member States experienced an internal security deficit that requires more intensive and efficient police and law enforcement activity and controls, well targeted and reliable identification methods. For the citizens of the European Union (hereinafter referred to as EU) the privilege of safe life has become a priority issue. In order to establish the area of "security, freedom and justice" it is indispensable to establish a person's identity conclusively and beyond any doubt. The application of biometric identification provides a quick, efficient and reliable method of identification for authorities excluding the possibility of errors arising from subjectivity. The only question is what methods and control mechanisms can guarantee the reliable execution of identification performed by police.

Keywords: security, biometry, identification, biometric identification for enforcement purposes

SECURITY AND FREEDOM (BASICS OF NATIONAL AND INTERNATIONAL APPLICATION OF BIOMETRY)

Abolition of borders, harmonisation of legislation, globalisation, integration, acceptance of individuals, surrender of cultural individuality on a certain level result in a number of legal and socio-political aspects. On the one hand, some adherence of national cultures to the grand European ideas, on the other hand shocking effects of cultural elements that must be handled on national level. Public security can be considered a variable of this kind. Open borders resulted not only in free movement of positive services and people respecting law between the member states of the European Union. Perpetrators to justice, criminal organisations and the crimes committed by them started to spread as well with the same intensity.[1][1] It is not entirely a coincidence that the objectives of the gradual abolition of checks at common borders of five countries were set out in Schengen Agreement signed on 14 June 1985 in Luxemburg.[2][2] After the

definition of these goals the other element influencing the national public safety and life of the EU citizens was the Treaty of Amsterdam on the creation of an "area of freedom, security and justice" [3] that was declared on 2 October 1997 and entered into force on 1 May 1999. As it was defined: "Freedom, security and justice are core values which constitute key components of the European model of society."[3][4]

Actual measures were defined by Tampere European Council on 15-16 October 1999 that reaffirmed its resolve to create an area of freedom, security and justice. Crime prevention, combating organised crime and the cooperation of police forces were emphasised.

The European Council of 5 November 2004 adopted the Hague Programme, where biometry was defined as the most objective form of identification and as possible means of the establishment of public safety.[5] The passports including biometric data – namely fingerprints - were introduced by the Member States in 2006. Following the harmonisation of legislation and the establishment of legal framework, the development of the second generation Schengen Information System (SIS) [4][6] and Eurodac System [5][7] was launched.

Joining this initiative Hungary – similar to other EU Member States – has been issuing e-passports with a photograph (first generation medium) since 29 August 2006. The passports issued since 28 June 2009 include the fingerprint of the owner as well (second generation).

Public safety is in direct cause-effect relationship with the efficiency of the police, which can be considered to be the crucial dimension of security. Quick, reliable and effective identification has a major importance in this structure.

An important issue is the way the identification of biometric data stored in data bases and documents is realised during enforcement controls.

1 Based on Unified Investigation Prosecution Court Statistics: regarding the number of committed crimes 1989. 185.000, 1998. 600.000, 2011. 432.000, 2012. 451.512 crimes were detected In: http://crimestat.b-m.hu/Default.aspx;

2Szabó J: Az Európai Ideától a Schengeni Egyezményen át, Magyarország teljes jogú schengeni csatlakozásáig vezető út - benne hazánk határrendészeti szerepvállalása, határrendészeti Tanulmányok V. Évfolyam 1. szám, 2008/1, Budapest, 2008. ISSN: 1786-2345, - p. 25.(Title in English: The Road from the Idea of Europe to Accession of Hungary to Schengen Zone – Role of Hungary, Border Protection Studies,)

3 Neither Maastricht Treaty nor the Treaty of Amsterdam defined the meaning of freedom, security and justice.

4 Rapcan, J-Rapcanova, M: The Context of Citizenship in the European Union and Freedom, Security and Justice, Pécsi Határőr Tudományos Közlemények XI, Pécs 2010, p. 1.

5 This program regards the application of biometry as a method to manage migration waves.

6 Regulation of the European Parliament and of the Council 1987/2006/EK (December 20, 2006.) on the establishment, operation and use of the second generation Schengen Information System (SISII) In: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:381:0004:0023:H U: PDF, downloaded 10.06.2012.

7 Regulation of the Council 2725/2000/EK (December 11, 2000) establishment of Eurodac for the comparison of fingerprints for the effective application of Dublin Convention, L316/L 22 Hague Programme: Strengthening Freedom, Security and Justice in the European Union (2005/C 53/01), Article 1.7.2.

What means are required to ensure the possibility of identification carried out at different control points (for instance public area, motorway parking area or roads) in a short time? During the completion of police controls the same question arises: is the person whose documents are examined identical with the person indicated in the documents shown by them? Exclusion of subjective factors from this process will lead to increased security. As it is believed, the application of identification for enforcement reasons based on biometric parameters will result in high objectivity, which will make it possible to eliminate the negative effects of subjective factors influencing the completion of identification carried out in a traditional way based on anatomic features.[8]

BIOMETRIC IDENTIFICATION

Biometric identification methods make it possible to identify the person itself who provides the sample, with the help of guarantee elements, such as live sample, it is possible to exclude even the possibility of deception. On the other hand, subjectivity of the person carrying out control that is considered to be another source of error can be practically eliminated.

Another major benefit is the decrease of control time, which can be measured in seconds in the case of biometric data even if high number of samples should be taken into account.

As for biometric identification systems, the technologies based on physiological features of the person are considered to be the most reliable option, for instance fingerprint recognition, iris scan, retinal scan, facial recognition[9]*, hand geometry, vein identification, voice recognition and DNA analysis.*

Biometric identification techniques using physiological characteristics are the following: fingerprint recognition, voice recognition, facial recognition in 2D, 3D, hand geometry, veins, iris recognition, retina scan and DNA. [6][10]

Similarly to other generally applied systems it is important to declare the aspects of operation security and reliability and establish a set of operation parameters. Basic elements are formulated in „Handbook of Biometrics" [7][11] *and publications of Applied Biometrics Institute – ABI [8]*[12]*, which enumerate eight biometric factors that can be used when assessing the suitability of the identification methods and tools. The eight principles of biometric identification are the following: 1. universality (generality), 2. uniqueness, 3. permanence, 4. availability, 5. productivity (performance), 6. acceptability, 7. circumvention, 8. measurability (collectability).*

1. *Universality of biometric data can be assured by two elements: on the one hand, every individual possesses a trait, and the percentage of probability that it passes into unauthorised hands is extremely low.*
2. *On the other hand this trait is unique and specific to the individual, and as such it can be related to an only person.*[13] *Reliability is well-established since this data cannot be lost, stolen or handed over.*
3. *It is indispensable that this data show permanence during different phases of an individual's life.*
4. *It is important that they are protected against attainment by a third party, they are safe so that they could be inalienable from the owner and it would be difficult to reproduce.*
5. *Two factors of the performance of the system is the speed and accuracy.*
6. *Acceptability means the positive attitude of the society towards the mass application of biometric identification.*
7. *Circumvention eliminates the successful manipulation of metric data by an unauthorised person.*
8. *Measurability declares that data taken and registered is accurate and exact and the measuring instruments are certified and verified.*

The issue of the reliability of the operation must be emphasised, and three indicators can characterise the systems from this point of view: [9][14]

1. *FAR (False Acceptance Rate): false acceptance rate shows the instance of a security system incorrectly identifying and verifying an unauthorised user.*
2. *FRR (False Rejection Rate): false rejection rate shows the instance of a security system rejecting an authorised user.*
3. *FTER (Failure To Enrol Rate): data entry error – the rate at which the attempts to sample input is unsuccessful. [10]*[15]

Based on the metrics described above FAR of some biometric system is the following: [11][16]

- ≡ *Voice recognition: 500 : 1*
- ≡ *Facial recognition: 2000 : 1*
- ≡ *Fingerprint recognition: 1 000 000 : 1*
- ≡ *Iris recognition: 10 000 000 : 1*
- ≡ *Retina scan: 10 000 000 : 1*

Besides classical elements other, practical elements are taken into consideration as well. For instance easy access to the sample: the unique pattern of the skin on a person's sole is suitable for individual identification, however, this biometric data will never serve as a basic element for an access system due to health and other application reasons.

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8 In the practice of the Hungarian Police biometric identification is not applied in every case, it can only supplement the traditional means of identification based on anatomical features. In case of doubt, identification based on biometric data can be performed if required.

9 This biometric identification system would serve as optimal and the most secure means during the entrance to the police object, movement between police units performing different service related tasks, information flow or sphere of activity of police forces with special covered tasks. However, due to the ontogenetic changes of users it weakens the principle of statics. The possible changes of facial proportions it includes the possibility of getting false results.

10 Kovács T: A biometrikus azonosítás alapjai:, Óbuda University Bánki Donát Faculty on Mechanical and Security Sciences Engineering Applied Biometrics Institute (ABI) Digital lecture notes 2014. (Title in English: Basics of Biometric Identification)

11 Jain-Flynn-Ross: Handbook of Biometrics Springer Science & Business Media, LLC. 2008.

12 Kovács T: A biometrikus azonosítás alapjai, Óbuda University Bánki Donát Faculty on Mechanical and Security Sciences Engineering Applied Biometrics Institute (ABI) Digital lecture notes 2014. (Title in English: Basics of Biometric Identification)

13 Disregard the least reliable behaviour based biometric identification, for instance analysis of signature sample or key presses, analysis of way of walking.

14 Nadort, A: The Hand Vein Pattern Used as a Biometric Feature. Vrije Universiteit , Amsterdam 2007.

15 Bunyita A: A ma és a holnap beléptető rendszereinek automatikus személyazonosító eljárásai biztonságtechnikai szempontból, Hadmérnök VI. / 1. pp. 24-25. In: http://hadmernok.hu/2011_1_bunyitai.pdf, Downloaded: 20.10.2014 (Title in English: Automatic Personal Identification Processes of Access Control System of Today and Tomorrow from Aspects of Security Technology),

16 Dr. Kovács T: A személyazonosítási módszerek általában , Digital Lecture Notes 2014., - p. 1-2., Óbuda University Bánki Donát Faculty on Mechanical and Security Sciences Engineering Applied Biometrics Institute (ABI) (Title in English: General Methods of Identification)

The primary element of applicability is the ability to produce quick reaction from the side of a population of any size. It means that it should perform the identification or negative recognition in a split second.

As for cost effectiveness, the launch of the operation requires higher costs compared to the traditional, token-based identification systems. On the other hand, when operating a token-based system, continuous replacement is required due to the movement of people, fluctuation, entrance cards and the depreciation of other equipment and as a result of this, the application of biometric identifiers will result in a more economical way of working after a while.

APPLICATION OF BIOMETRIC IDENTIFICATION IN THE FIELD OF LAW ENFORCEMENT

Special factors are to be taken in consideration in the course of the application of biometric identification in the field of law enforcement. There is a lack of fundamental literature in the topic, the area is developing its own methodology and application literature. Balla József police lieutenant colonel [12][17] has defined basic premises when introducing a unified system of requirements into the field of methods and means employed, which is considered to be a really thorough professional factor for the police.

A. *Method specific set of parameters - in the course of which it must be ensured that the identification is –*
   1. *Universal - applied for everybody*
   2. *Independent of the spot - it can be performed at different spots with the same efficiency, stable and mobile, it is reliable in road, air and railway circumstances.*
   3. *Independent of circumstances - it produces reliable results in different, extreme weather and temperature circumstances during different parts of the day*
   4. *Incorporated into regime measures - it can be fit into the control process*
   5. *It cannot be appropriated - performed via internal biometric identification*
   6. *Contact free - as for hygienic considerations, there is not a need for personal contact between the person and the instrument*
   7. *Time limit - it does not increase the basic control time significantly*
   8. *The result is categorical - possible only between two outputs: accept - refuse (GO-NO GO)*

B. *Equipment specific set of parameters - the equipment shall be able to perform the check on persons -*
   1. *Task-oriented structure - focus on the task to be solved, goal oriented, without applications*
   2. *Operational stability - operation should be reliable in extreme weather conditions and in the case of a large number of sample taking*
   3. *User-friendly - easy to use, it should not require specific knowledge from the user*

INTEGRATION OF THE BIOMETRY INTO BASIC POLICE TASKS

Public security is in immediate cause-effect relationship with the operational efficiency of the police, which is regarded a definitive factor of security. In order to provide this, quick, reliable and efficient identification has a crucial role.

Due to its geostrategic situation, Hungary has not only internal [13][18] but also external borders [14][19] functioning as a transit country for illegal migrants. There are certain views that consider illegal migration to be the major source of threat.[15][20] This approach emphasises the direct and significant responsibility of border control body in establishing the public security in member states as well, [16][21] making clear the relevance of the reliable identification.

It is acknowledged that managing migration is a real and significant law enforcement task and problem, however, the criminal threat arising from free movement of organised criminal structures must be considered to have the same significant importance. Open borders provide possibility not only for free flow of goods and services but also for criminal acts, crime and criminals. We must mention here terrorist threats, organised crime, escort networks, brothels, crime organisations specialised in making harm to the elderly, or simple "travelling crime" as well.

Work and border control activity of police bodies can be secure if it prevents and detects infringements and it prevents free movement of persons who may be a danger to the public security of the Union or Hungary. [17][22] Primary police measures in realising this is the control of documents that is quick and reliable identification of persons moving in the area. Apart from filtering out undesirable elements, free and undisturbed movement for the rest of EU citizens must be assured.

This is the reason why the identification methods of police play a crucial role in establishing the security of the area, Hungarian public security and internal security of Schengen region. The guarantee of security means the respect of free movement of individuals besides the reliable identification of persons by authorities.

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17 Balla J: Biometrikus adatok az azonosításban In: http://www.pecshor.hu/periodika/XIV/ballaj.pdf downloaded: 20.10. 2014. (Title in English: Applying Biometric Data for Personal Identification)

18 Member States of EU with common land borders (including lake or river borders as well), their airports for internal flights, sea, river or lake ports with regular ferry. Article of Regulation No 562/2006 EK of European Parliament and Council (15 March 2006.) establishing a Community Code on the rules governing the movement of persons across borders (Schengen Borders Code February 23, 2015)

19 Land borders of EU Member States including lake or river borders, sea borders, airports, river, lake or sea ports in case they are not internal borders. Procedures for refusing entry at the border: Regulation No 810/2009/EK [Official Journal L 243, 2009.9.15.]

20 Balla J: A biometrikus adatokat tartalmazó úti és személyazonosító okmányok biztonságnövelő hatása a határ- es közbiztonság alakulására Doktori (PhD) értekezés), National University of Public Service, Doctoral School on Military Sciences, 2013. (Title in English: Security Increasing Effects of Travel and Personal Identity Documents Containing Biometric Data on Border and Public Security; PhD Dissertation)

21 Dr. Ritecz Gy: A magyar Határőrség szerepe az európai biztonságban, Pécsi Határőr Tudományos Közlemények III., Pécs 2004. HU ISSN 1589-1674, - p. 1. (Title in English: The Role of Hungarian Immigration Office regarding European security)

22 "With the help of the control of border traffic on external Schengen borders and the performance of internal security strategy resulting from the cease of internal borders not only the security of Hungary but also the security of the whole Schengen area is provided" Balla J: A biometrikus adatokat tartalmazó úti- és személyazonosító okmányok biztonságnövelő hatása a határ- és közbiztonság alakulására Doktori (PhD) értekezés National University of Public Services Doctorial School on Military Sciences 2013. (Title in English: Security Increasing Effects of Travel and Personal Identity Documents Containing Biometric Data on Border and Public Security; PhD Dissertation)

SET OF CRITERIA FOR BIOMETRIC IDENTIFICATION FOR LAW ENFORCEMENT PURPOSES

As it has been made clear above, the application of biometric identification for law enforcement purposes has specific criteria. It must be universal, which means applicable for everybody, in different spots and control conditions, inserted into the control process of strict methodology of regime measures. Speed and reliability is a must, so it is essential to guarantee immediate results without loss of time. The identification needs to be performed via biometric identifier without contact. Only a part of biometric identifiers can meet the strict requirements from all respect. As for its application in public areas, the raison d'être of fingerprint recognition, facial recognition, vein identification or iris scan technique is unquestionable.

During the performance of tasks in public places, the policemen can control documents based on authorisation provided by national law [18][23] They can control the documents of a person whose identity shall be established in the interest of public security, crime prevention, or law enforcement purposes, in order to establish the lawfulness of their stay, during traffic police control procedures, and to protect the interests of natural, legal personalities or legal organisations. The law makes a difference between the citizens of Hungary and of other nationalities from the point of view of identity control. In the case of Hungarian citizens identity card, passport and driving licence of card format is acceptable as personal document for identification purposes [19][24]. The same Article stipulates that "fingerprinting or photographing of every person whose identity cannot be established with certainty on the basis of valid documents is allowed, their external corporal features can be recorded based on perception or measurement".[25]

Practical order of the identification of a person is realised primarily on the basis of anatomical properties. The given person is compared to his photograph included in his document used for identification, taking his age and other features into consideration. [20][26]. The efficiency of the method depends basically on the personal competencies of the police officer performing the action. Besides professional knowledge, external circumstances, weather, part of the day, the effects of environmental redundancy and time factor, the most crucial factor of the document control is the acting officer himself. The possible interference and distortion of subjectivity can influence efficiency, it is considered to be an element with the highest failure rate in the workflow. With the application of biometric identification process this subjectivity can be significantly decreased.

Public area activity is an emphasised part of police activity and due to special circumstances it demands extraordinary ability to react to the given situation in every case. Whether it is about patrolling or performing identification checks at control points (EÁ-p[27]), the factors influencing the activity must be taken into consideration every time.

It is believed that certain elements of the system need rethinking. Regarding the person performing identification, objective elements shall be completed with the degree of workload of the controller, which defines the quality, the length and accuracy of the control itself. It is also of utmost importance to examine the state of equipment used during the examination since it guarantees the quality and reliability. One of the primary objective elements regarding the person being controlled is the examination of clothing. The assessment of non-verbal signals must be continuous, and the extent of control and stress absorbing capacity must be taken into account since these factors can modify the control process in different ways. On the one hand it can be a warning sign so that the police officer shall deal with the person more thoroughly or on the contrary, the person controlled can suffer from neurodegenerative disease and he needs help to manage this control or stress situation.[28]

As the analysis of the results of previous police actions, regarding current social processes it is indispensable to carry out an analysis of the human composition of the areas involved, which has a significant influence on the result of police controls. [21][29]

The following table will summarise the factors influencing identification process supplemented with the elements listed above. It includes objective and subjective elements of police control performed in public area regarding the characteristics of the parties involved. As basic premises, the set of parameters collected by Balla József police lieutenant colonel was accepted and later supplemented with further important elements that influence identification. The workload of the officers performing controls is emphasized since it has a significant effect on their mental state and performance as well. As for the identified person, the evaluation of non-verbal signs, his tolerance to stress and to control, and physical state play an important role in the process. Regarding other factors, the human background of the place of control cannot be neglected as it has already been mentioned.

One of the basic elements of the formation relating to police service should be the support of practical activities. A number of initiatives and recommendation for supporting police forces performing on-the-spot identification checks have appeared so far including their provision with the necessary equipment. [22][30] On the basis of the current practice the

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23 Police Act No 1994. XXXIV. tv. 29. §.

24 This is a document issued by authority that authentically justifies the identity of citizen based on the Law No LXVI 1992 on the protection of individuals with regard to the record of personal data and address.

25 Police Act 1994. XXXIV. tv. 29.§.(4)

26 Lakatos G: Nyomozástan II. A kriminalisztika alapjai 1. Nemzeti Szakképzési és Felnőttképzési Intézet Budapest 2013. (Title in English: Methodology of Investigation II. Basics of Criminalistics)

27 Police activity of identification of persons at control points – grantor points.

28 Based on the experience gained during police controls in the area of Fejér County Police Department, when the police officer misidentified the person with mental disorder to be under the influence of alcohol – the person had limited ability to speak and walk due to a stroke – a Strokon Átesettek Érdekvédelmi Szervezete (Mutual Defence Organisation for people who had stroke) and Értelmi Sérültek Fejér Megyei Egyesülete (Fejér County Association for Mentally Disabled) worked out a leaflet including the most essential information about the disease and when there is a police control the patients can give it to the police officer in order to clarify the situation. Apart from this a training was held for police staff of Fejér County Police Department in 2013-14 in order to make them aware of the way the mentally handicapped people should be handled.

29 After the infamous case that is known as „Olaszliszka syndrome" many similar cases occurred. In: http://www.szon.hu/218jabb-soforveres-gyerekel252tes-utan-sajohidvegen/news-20080501-08022533 downloaded 03.03.2015.

30 Report on the research results carried out on modernization of IT system of police and border control activities in the framework of Check-net defined by the European Union. Based on a project accomplished in cooperation of ZMNE Faculty of Border Control and Council of Police Research Society, ZMNE 2006., Dr. László Zsigovits lieutenant colonel and Dr.Gábor Kovács lieutenant colonel

acting patrol performs primary control of checked person's data in the central data base via radio. Based on the information given by the patrol the data is checked in the electronic database by the contact person working in the centre. In the meantime personal and qualified data is transferred orally and openly, which raises concerns regarding data protection. This is the reason why it is justified to provide police units with mobile equipment that can eliminate these sources of failure. The application of mobile fingerprint and document reader has already been proposed. [23][31]

	OBJECTIVE ELEMENTS	SUBJECTIVE ELEMENTS
FACTORS ARISING FROM PERSONALITY OF CONTROLLER	Physical state (organs of sense)	experience-professional skill
	Place of service	Professional competencies
	Weather conditions	Ability to identify a person
	Parameters depending on the part of the day and season	Mental state
	Time spent on the control	Service time
	Workload	Experience in control activity
	State of instruments used for control	
FACTORS ARISING FROM THE PERSONALITY OF THE IDENTIFIED	Age related features	Behaviour
	Illnesses	Absorbing attention of controller
	Physical state	Degree of control tolerance Distracting techniques
	Non-verbal signs	(eg. Initiating conversation)
	Intention to cover face (eg. sunglasses, scarf)	
	Pretending sleeping	Degree of stress tolerance
	Clothing	Intensive discussion with others
FACTORS ARISING FROM OTHER CIRCUMSTANCES	Lighting of the control place	
	Brightness required for the control	
	Quality of the photo	
	Time elapsed since the photo was taken	
	Human background of the control place (composition of inhabitants)	
	Traffic conditions of the control place	
	Weather conditions at the time of control	

Figure 1. Factors influencing identification[32]

However, it has not been realized yet, the new measure to support objectivity was launched in October 2014. In order to support measures taken in public places the so called TIR-MOBIL system, a computer aided application was installed into patrol cars. This system makes it possible to realize screening of documents, cars or wanted persons. Although the system does not have fingerprint recognition or facial recognition functions, the opportunity of the introduction of this application is given. [24][33]

ACKNOWLEDGMENT

Biometric procedures can be inserted into the methodology of law enforcement control and they can assure identification conforming the level of the security risk. Evaluation of particular biometric identification methods based on law enforcement parameters is required to perform according to special internal measures adapting to special legislation and regime measures.

The scope of biometric identification methods that can be applied for enforcement purposes, namely for identification purposes, is much tighter than the full scope of available biometric means. The set of criteria for the application is defined not only by the group of general elements but also by law enforcement equipment and method specification described above. False Acceptance Rate (FAR) shall be highlighted among them since currently it is the main risk factor from the point of view of identification and security. In this case the system transfers unauthorised persons and such cases bring risk during police controls since wanted persons remain at large, runaway children cannot be found by authorities, cars or persons involved in criminal actions can slip through control points. Based on the above mentioned fact FAR value of particular control methods used in enforcement applications can be accepted only if they show low possibility of errors.

False Rejection Rate (FRR) cannot be tolerated either since an authorised person is rejected; in this case security risk does not appear, however, it means inconvenience for the controlled person. The clarification of the problem shall happen on the spot due to personality, legal and naturally financial and resources related issues.

The third element is data entry failure in the case of which exact and accurate measurements were carried out. According to the results it can be stated that the increased usage time of equipment results in a higher percentage of failure. As for fingerprints it can result in a FRR value of 60-80% based on 3500-piece measurement series. This percentage of failure cannot be tolerated in the field of police operations performed in public places. The total value of working hours for public places service of Fejér County Police Department reached 31 708 hours in 2013, with the number of 70.714 identified persons.[34] It means that in every case the identity of the persons was also checked. On country level about 1.500.000 people were affected.

The study of application of biometric identification methods and its compliance in law enforcement, more closely in police practice, is continuous. Based on four basic sets of criteria - reliability, evaluation time, permanence, circumvention – a comparative study [25][35] identifies three outstanding sets of identification measurement systems. At the same time, the most reliable biometric identification method, DNS identification shall be excluded from this set of measurements since it cannot meet the requirements of immediate feedback or evaluation. As a result of examinations and surveys performed it can be stated that if suitable conditions are provided, four different biometric identification methods seem to be applicable in the practice of police: facial recognition, fingerprint recognition, iris scan and vein identification.

31 Project DSVII-PA 2006 carried out by József Balla police lieutenant colonel: A biometrikus adatokat tartalmazó úti- és személyazonosító okmányok biztonságnövelő hatása a határ- és közbiztonság alakulására Doktori (PhD) értekezés. National University of Public Services Doctorial School on Military Sciences 2013. 69. (Title in English: Effects of Identification Documents Containing Biometric Data on the Status of Border and Public Security; PhD Dissertation)

32 Prepared by Krisztina Földesi

33 ORFK report of 2014/2 on Directive No 57/2013. (XII. 21.) on uniform way of operation for centers providing general police activities, duty of police and centers receiving distress calls.

34 FMRFK internal statistic data

35 Tajti B: A biometrikus ujjnyomat azonositás alkalmazásának új lehetőségei, Hadmérnök VII./ 1. , p 52. In: http://hadmernok.hu/2012_1_tajti.php , Downloaded: 29.06.2012. (Title in English: New Perspectives in Application of Biometric Fingerprint Identification)

Identification based on iris scan can be primarily applied, supported by a special software. The second method applicable in law enforcement is identification based on fingerprint recognition and vein identification. However, identification based on facial recognition is particularly suitable for executing special searches for missing persons or warrants. In these cases identification based on facial recognition is appropriate – in case of optimal arrangement of surveillance cameras – and it must be managed by human resources.

It is obvious that identification techniques via biometric data cannot be applied in every field of police work or in every control spot, and there are occasions when they cannot substitute the identification work based on traditional anatomic features. However, it is indispensable for the future generation of police officers who can make use of this reliable tool in the fulfilment of their tasks.

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URBANIZATION AND DISASTER RISK IN PAKISTAN

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Abstract: *This paper aims to represent the population trends, rapid un-planned urbanization and its related disaster risks. It is widely accepted that, the fatality of disasters has increased since the last decade. And it is an undeniable fact that Asia is more prone to disasters because of rapid urbanization and natural hazards. The greater the number of people settles in urban areas, the higher will be the probability of disaster occurrence. Thus, a single minor disaster event can result a human catastrophe to destroy decade of development gained. Similarly, Pakistan is one of the most vulnerable countries, where population and un-planned urbanization expanded rapidly. Most of the cities are growing, often in disorderly manner with low capacity and infrastructure, that becoming more vulnerable to disasters. Furthermore, lack of policies regarding land use planning and improper building codes enhanced scattered settlement that may further exposed the cities to disaster. Apart from that, the current population trends and unsafe settlement brings enormous challenges and high risk to disaster. However, cities that have sustainable development and disaster risk reduction measure and policies, are safe enough.*
Keywords: *Population growth, slump, urbanization, disaster*

INTRODUCTION

The world population increasing rapidly at the rate of 10,000/h, 250,000/day and annual increasing rate is more than 90,000,000. World population is unevenly distributed, 20% of the resources consumed in 80% developing countries, while developed 20% countries consuming 80% of the resources. World population is increasing at a rate that will reach to 7.2 billion in 2015. Furthermore, the world's half population will reside in cities at the end of 2015, where eight mega cities out of 15 will be in Asia. In 1900, 10% of the world population was residing in cities but now it has increased to 50 %. And cities are at higher risk than rural areas and more prone to the impacts of disaster (Juha 1998, Tingsanchali 2012).

The reasons for increasing urbanization are due to increase in growth rate as well as rural to urban migration. Asia is the largest continent with 4 billion populations that contains more than 60% of the world population. And it is quite likely that the increasing level of disaster risk associated with urbanization that international experts now perceived is an underestimate. Therefore, natural disasters caused deaths approximately 75% in this continent that showed its vulnerability to natural as well as manmade disasters (Xiaoyan and Xiaofei, 2012). The rapid increase in population results in un-settle urbanization that makes the people and communities more vulnerable to different hazards. Similarly, Pakistan is one of the countries of Asia that has a rapid growth in population, and having highest rate of urbanization. From 1950 to 2011 urbanization expanded seventh fold. According to 2011 estimation, the total population of Pakistan is around 183 million. Most of the urban settlement is unplanned with poor construction, lack of proper building codes and land use policies. In addition disaster risk reduction measures have not been implemented in the cities (Hamza and Roger, 1998). Consequently, weak urban settlement makes the cities prone and highly vulnerable to disasters. Furthermore, if proper measures are not acknowledged for overcoming this practice now disasters will occur at unprecedented scale.

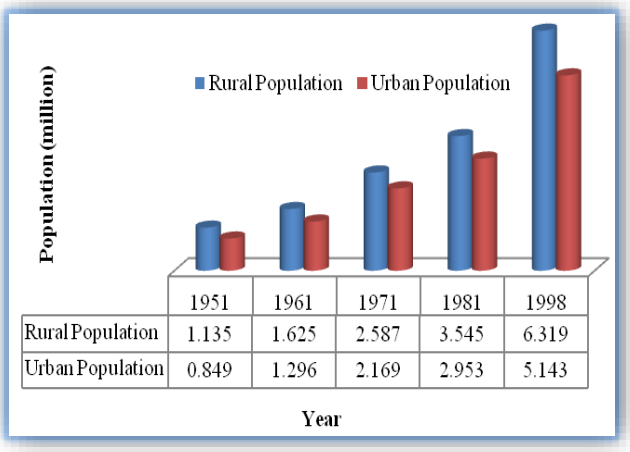
MAIN ISSUES RELATED TO URBANIZATION

- *Deforestation may leads to environmental and global effects on population, "forests are vanishing at a rate of 7.3 million hectares annually" (Jie et al. 2012).*
- *Inadequate provision of public infrastructure and basic services.*
- *The larger the number of people settled in an at-risk area, the higher the probability of human hazards as a result of hazardous and poor quality housing.*
- *People become more prone and vulnerable to floods, earthquake, land slide, etc (Chaolin et al. 2011).*
- *Expanded infrastructures make community more susceptible to disasters.*
- *Urban violence*
- *The people start living on marginal land*
- *Unplanned greater settlement and health challenges.*

RELEVANCE TO PAKISTAN

Urban violence: the rate of urban crimes and violence increase day by day. The ratio, of physical accidents and target killings, especially in (Sindh, Punjab and Baluchistan). On the other hand Terrorism is increases especially in KPK and some regions of Punjab due to overcrowding. Health challenge: Most of the cities populations are at high risk of developing communicable/ food and water born diseases and injuries. That unnecessarily high health burden on existing health facilities (Takeshi et al. 2009). Urban poverty: in most of the cities of Pakistan with Low and middle income groups, have built their houses on low cost at dangerous sites, for instance population along sea side at

Karachi, and population along Kabul river are at high risk to flood (Bharat 2012, Richard et al. 2014). Figure 1 illustrates the population growth of Pakistan from 1951 to 1998. And Figure 2 shows the percentage of fire incidents in various parts of the country.



	1951	1961	1971	1981	1998
Rural Population	1.135	1.625	2.587	3.545	6.319
Urban Population	0.849	1.296	2.169	2.953	5.143

Figure 1. Population data of Pakistan

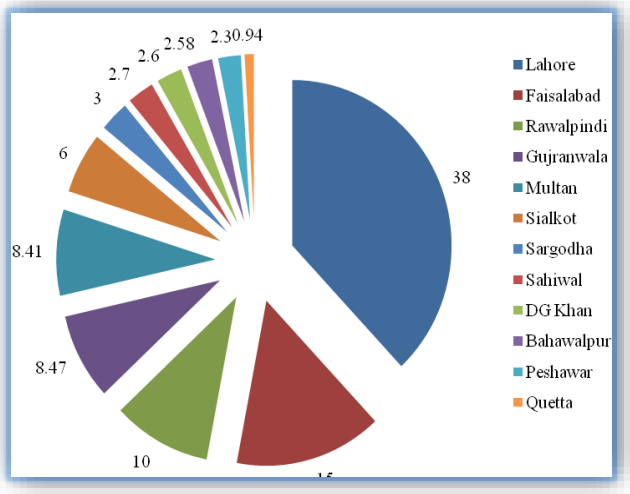


Figure 2. Percentile of fire incidents of Pakistan

URBANIZATION TRENDS IN MAJOR CITIES OF PAKISTAN

Karachi:

US magazine terms Karachi as the most dangerous megacity in the world. According to population census in 1941 Karachi population was reported as 0.34 million, the total area covered about 8.3 sq km in 1946. But now the city spread over 3530 sq km, with current estimated population over 18 million. By population Karachi is among the ten largest cities of the world (Takeshi et al. 2009).

Approximately half of the urban population of Karachi has five percent (5%) highest growth rate, while other cities have three percent (3%). Karachi population has increase more than 80% for the last 10 years. Migration from other regions of the country is also one of the factors for increasing in population of the city. Furthermore, Increase in population of the city boost in crime rate, environmental degradation, and shortage of resources. With increasing in population of the city, the rate of disaster incidents increase (Tracey et al. 2011). For instance, Fire in textile factory in the western part of Karachi, engulfed above hundred factory workers and some seriously injured. Similarly population expansion and rapid urbanization can increase in accidents and emergencies. The number of Pakistani industrial accidents grew up to 419 in 2008, compared to 354 in 2000.

Lahore:

Lahore is the old city and the second large city of Pakistan. According to 1998 census in Pakistan, the population of Lahore was 6,318,745, out of which 81.70% was urban. Today, the population of Lahore has reached to 10,000,000. Also according to 1951 census, urbanization in Lahore was 0.849 millions, now increased to 8.7 millions in 2006 (Leisnham, 2011).

The dense population of the city increase threats of multiple hazards. A survey was conducted for major fire incidents in some cities of Punjab by Rescue-1122 (Liang et al. 2012). The study focused on fire incidents in major cities of Punjab, they reported 37000 fire incidents with estimated with estimated loss of 18.133 billion.

Rawalpindi:

The population of Rawalpindi was, 3,363,911. Out of which 53.03% were urban, shows that Rawalpindi is the second most urban city of Punjab. Like other cities, Rawalpindi also facing high incidents rates of disaster. Ghakar Plaza fire incident occurred on December, 20th 2008. 18 persons were died and 59 were injured. The incident cost loss of 1.12 billion (Jun et al. 2011). Thus vulnerability of the city increasing to disaster, with lack of disaster reduction measures in the city.

Peshawar:

According to census of 1998, the population of Peshawar is roughly doubled to about 3.3 million people due to migration of different refugees and IDPs (Internally Displaced People). The estimated population for 2015 is 357100. Similarly Peshawar the capital of KPK is facing the same population trends, high crime rates and vulnerability to manmade as well as natural disaster (Lorena and Ian, 2005).

CONCLUSION

It is concluded that the population trend in Pakistan is very high, that may ultimately results in unplanned and rapid urbanization and at high risk to occurrence of disaster. Moreover, lack of policies, proper building codes, and scattered settlement may leads to weak planning capacity and high vulnerability to disaster in most cities of Pakistan. As we know that, it is almost impossible for organization departments to keep plan rapid urbanization trends, and building standards in large cities, however, it is important for them to take in account that the nature of vulnerability and risk is misinterpreting in urbanization. And finally it is concluded that, there is a link between urban and rural disaster impact. For instance, rural disasters bring disruptions to urban centers to which they supply materials like, fuel, food and other goods, while urban disasters disrupt the suppliers of all services. Therefore, the authorities should implement the following recommendations in order to minimize risk of disasters.

RECOMMENDATIONS

- *Provide proposal for proper land use, which contain social and demographic policies for urban disaster risk reduction*

- ≡ *The implementation of structural engineering techniques, development projects and maintenance of infrastructures may prevent or minimize disaster risks.*
- ≡ *Conduct risk and hazard assessment to identify the hazard prone areas and make safety of all infrastructures.*
- ≡ *Protect the natural environment and ecosystem.*
- ≡ *Promote emergency medical services and enhance early warning system to minimize loss during disasters.*

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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. Maximum length of title: 20 words.

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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.

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State the paper's purpose, methods or procedures presentation, new results, and conclusions are presented. 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.

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Place equations on separate lines, centered, and numbered in parentheses at the right margin. 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

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