ISSN: 2067-3809

ACTA TECHNICA CORVINIENSIS
BULLETIN OF ENGINEERING

fascicule 3
[July-September]

TOME V
[2012]

ACTA TECHNICA CORVINIENSIS
– BULLETIN of ENGINEERING

is covered by the following indexes:

INDEX COPERNICUS – JOURNAL MASTER LIST
http://journals.indexcopernicus.com/

GENAMICS JOURNALSEEK DATABASE
http://journalseek.net/

EVISA database
http://www.speciation.net/

GOOGLE SCHOLAR
http://scholar.google.co.in/

DOAJ - Directory of Open Access Journals
http://www.doaj.org/

SCIRUS - Elsevier
http://www.scirus.com/

ProQuest database
http://www.proquest.co.uk

EBSCO Publishing
http://www.ebscohost.com

Chemical Abstracts Service (CAS)
http://www.cas.org/

BASE - Bielefeld Academic Search Engine
http://base.ub.uni-bielefeld.de/

Open J-Gate Service
http://www.openj-gate.com/

getCITED: Academic research list
http://www.getcited.org/

Electronic Journals Library
http://ezb.uni-regensburg.de

"B+" category Journal according to CNCSIS –
THE NATIONAL UNIVERSITY RESEARCH COUNCIL'S CLASSIFICATION OF ROMANIAN JOURNALS (POZ. 940)

ACTA TECHNICA CORVINIENSIS
– BULLETIN of ENGINEERING
ISSN: 2067-3809 [CD-Rom, online]

Editorial & Advisory Board

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

Review process & Editorial Policy

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering is dedicated to publishing material of the highest engineering interest, and to this end we have assembled a distinguished Editorial Board and Scientific Committee of academics, professors and researchers.

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

The editorial policy of ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering is to serve its readership in two ways. Firstly, it provides a critical overview of the current issues in a well-defined area of immediate interest to materials scientists. Secondly, each review contains an extensive list of references thus providing an invaluable pointer to the primary research literature available on the topic. This policy is implemented by the Editorial Board which consists of outstanding scientists in their respective disciplines. The Board identifies the topics of interest and subsequently invites qualified authors. In order to ensure speedy publication, each material will be report to authors, separately, thought Report of the Scientific Committee. For an overview of recent dispatched issues, see the ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering issues.

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

The members of the Editorial Board may serve as reviewers. The reports of the referees and the Decision of the Editors regarding the publication will be sent to the corresponding authors.

The evaluated paper may be recommended for:

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

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

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering accept for publication unpublished manuscripts on the understanding that the same manuscript is not under simultaneous consideration of other journals. Publication of a part of the data as the abstract of conference proceedings is exempted.

All the authors and the corresponding author in particular take the responsibility to ensure that the text of the article does not contain portions copied from any other published material which amounts to plagiarism. We also request the authors to familiarize themselves with the good publication ethics principles before finalizing their manuscripts.

Manuscripts submitted (original articles, technical notes, brief communications and case studies) will be subject to peer review by the members of the Editorial Board or by qualified outside reviewers. Only papers of high scientific quality will be accepted for publication. Manuscripts are accepted for review only when they report unpublished work that is not being considered for publication elsewhere.

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

Aims & Scope

General Aims:

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

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

Topical reviews in materials science and engineering, each including:

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

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

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

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

Every year, in three issues, ACTA TECHNICA CORVINIENSIS – BULLETIN OF ENGINEERING publishes a series of reviews covering the most exciting and developing areas of engineering. Each issue contains papers reviewed by international researchers who are experts in their fields. The result is a journal that gives the scientists and engineers the opportunity to keep informed of all the current developments in their own, and related, areas of research, ensuring the new ideas across an increasingly the interdisciplinary field.

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

Audience:

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

About us:

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering is an international and interdisciplinary journal which reports on scientific and technical contributions and publishes invited review papers covering the full spectrum of engineering.

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

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering 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.

Coverage:

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

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

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

General Topics:

ENGINEERING
- MECHANICAL ENGINEERING
- METALLURGICAL ENGINEERING
- AGRICULTURAL ENGINEERING
- CONTROL ENGINEERING
- ELECTRICAL ENGINEERING
- CIVIL ENGINEERING
- BIOMEDICAL ENGINEERING
- TRANSPORT ENGINEERING

ECONOMICS
- AGRICULTURAL ECONOMICS
- DEVELOPMENT ECONOMICS
- ENVIRONMENTAL ECONOMICS
- INDUSTRIAL ORGANIZATION
- MATHEMATICAL ECONOMICS
- MONETARY ECONOMICS
- RESOURCE ECONOMICS
- TRANSPORT ECONOMICS
- GENERAL MANAGEMENT
- MANAGERIAL ECONOMICS
- LOGISTICS

COMPUTER AND INFORMATION SCIENCES
- COMPUTER SCIENCE
- INFORMATION SCIENCE

AGRICULTURE
- AGRICULTURAL & BIOLOGICAL ENGINEERING
- FOOD SCIENCE & ENGINEERING
- HORTICULTURE

CHEMISTRY
- ANALYTICAL CHEMISTRY
- INORGANIC CHEMISTRY
- MATERIALS SCIENCE & METALLOGRAPHY
- POLYMER CHEMISTRY
- SPECTROSCOPY
- THERMO-CHEMISTRY

EARTH SCIENCES
- GEODESY
- GEOLOGY
- HYDROLOGY
- SEISMOLOGY
- SOIL SCIENCE

ENVIRONMENTAL
- ENVIRONMENTAL CHEMISTRY
- ENVIRONMENTAL SCIENCE & ECOLOGY
- ENVIRONMENTAL SOIL SCIENCE
- ENVIRONMENTAL HEALTH

BIOMECHANICS & BIOTECHNOLOGY
- BIOMECHANICS
- BIOTECHNOLOGY
- BIOMATERIALS

MATHEMATICS
- APPLIED MATHEMATICS
- MODELING & OPTIMIZATION
- FOUNDATIONS & METHODS

Invitation:

We are looking forward to a fruitful collaboration and we welcome you to publish in our ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering. You are invited to contribute review or research papers as well as opinion in the fields of science and technology including engineering. We accept contributions (full papers) in the fields of applied sciences and technology including all branches of engineering and management.

Submission of a paper implies that the work described has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis) that it is not under consideration for publication elsewhere. It is not accepted to submit materials which in any way violate copyrights of third persons or law rights. An author is fully responsible ethically and legally for breaking given conditions or misleading the Editor or the Publisher.

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

Regional Associate Editors & Collaborators

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

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING
ISSN: 2067-3809 [CD-Rom, online]

Scientific Committee & Reviewers

The Scientific Committee members and Reviewers do not receive any remuneration. These positions are voluntary.
We are very pleased to inform that our journal ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING is going to complete its four years of publication successfully. In a very short period it has acquired global presence and scholars from all over the world have taken it with great enthusiasm. We are extremely grateful and heartily acknowledge the kind of support and encouragement from you.

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

Content of FASCICULE 3 [JULY–SEPTEMBER]

ABSTRACT: *Embedded systems are generally designed to perform the dedicated tasks with respect to device functions. Applications that are used in embedded systems are characterized by significant diversity with the different requirements for communication services. The interpretation of application data and control commands can be essentially different in interconnected embedded subsystems. The paper deals with CAN based application protocols that can be used for an interconnection of embedded devices via CAN fieldbus network. It is focused on selection of open application protocols that could be potentially used for device integration of different suppliers via CAN bus.*

ABSTRACT: *The energy efficiency improvement of the refrigeration system to improve the operation quality makes it unavoidable to strive for the refrigeration system operation. Nevertheless, the processes taking place in it should be as accurate as possible to describe the underlying physical and mathematical model development and refinement. The experimental investigation of any refrigeration system is usually very complicated, mainly due to the financial costs and the large number of variables involved. The use of numerical models can reduce the costs and also facilitate understanding the phenomena related to the problem. The article aims to present and analyze the behavior components of the vapor-compression refrigeration system in case of various refrigerants. Refrigerants included in the present analysis are R22/R134a/R407C/R410A. The simulation program is based upon steady state mathematical models of the refrigeration circuit including the compressor, heat exchangers and thermostatic expansion valve. The simulation results have been presented in a graphic.*

ABSTRACT: *Systems analysis and design work in chemistry is the result of a complex application called ChimUniv in the creation and operation of relational databases, the implementation of applications dedicated to Chemistry. The paper is addressed to students and all those who want to build applications using the skills and habits of Chemistry, Microsoft Access solution to offer. Fundamental theoretical notions database are missing from the scientific approach of this paper. In this paper we intend to highlight issues concerning the organization of elements in the periodic table, arranging them in groups and periods depending on their chemical properties.*

ABSTRACT: *In the various areas, quantities of the materials and goods used by mankind show rapid growth, whereas its form, rate of use is significantly varying. Today requirements and expectations concerning the various materials are wide ranging, so the properties of these materials are developed in accordance to the demands. Presently the carbon fiber is being used more and more frequently in those areas which require special demands. This is explainable by its outstanding properties, namely high tenacity, stiffness, low heat dilation, conductivity etc. From composites, lightweight structures may be produced to meet higher level applications. Carbon fiber reinforced composites – in the areas demanding high mechanical usage, will be of determining importance in the future.*

ABSTRACT: *Gear production is very important area of manufacturing industries because gears are the widest components in the machines and machine equipments. Mode of production and used tools are important elements of economical and quality part of production. Nowadays, there are developed the new constructional solutions of gear hobs which save time and money. For the hob which would produce precision involute gear there is possibility of finding profile which would provide this requirement. For the finding of the profile it is needed to have a good mathematical knowledge kinematic and geometrical properties investigated objects. The paper deals with mathematical description of basic hob surface with straight profile which is initial theorem for the determining of accurate profile of gear hob.*

ABSTRACT: *The first stage of any vision system is the image acquisition stage. If the image has not been acquired satisfactorily, then the intended tasks for image processing and image classification may not be properly achievable. In this study, a machine vision system was developed to evaluate the performance of CCD and CMOS cameras for real-time monitoring of cucumber growth in a greenhouse by extracting image textural features. The leaf samples of cucumber crops were brought to the laboratory from the greenhouses to measure the textural features. Laboratory was consisted of a digital camera for taking the images, a LDR array for providing a uniform lightening and a computer for measuring the textural parameters from the obtained images. The objective of the current study was to select which type of camera is ideal for real-time plant health and growth monitoring systems. The effect of distance between camera and leaves for three values (30, 40 and 50cm) and the type of camera (CMOS and CCD) on the uniformity of resulted data were considered in this article. Results showed that data for 40cm distance between camera and leaves with a CCD camera had an acceptable trend for extracting image textural features.*

ABSTRACT: *This paper shows how to plotting the profile of a plane rotating cam and a follower in the translational move, using Matlab program. Are shown how input the variables, kinematic analysis, speeds hodograph in graphical form, respectively plane cam profile designed, with a choice of several options for the best solutions.*

ABSTRACT: *The objective of the present study is to investigate thermal diffusion and radiation effects on unsteady MHD flow past a linearly accelerated vertical plate with variable temperature and mass diffusion under the influence of applied transverse magnetic field. The fluid considered here is a gray, absorbing/ emitting radiation but a non-scattering medium. At time t>0, the plate is linearly accelerated with a velocity u = u_o t in its own plane. And at the same time, plate temperature and concentration levels near the plate raised linearly with time t. The dimensionless governing equations involved in the present analysis are solved using the Laplace transform technique. The velocity, temperature, concentration, Skin-friction, the rate or heat transfer and the rate of mass transfer are studied through graphs and tables in terms of different physical parameters like magnetic field parameter (M), radiation parameter (R), Schmidt parameter (Sc), soret number (So), Prandtl number (Pr), thermal Grashof number (Gr), mass Grashof number (Gm) and time (t).*

ABSTRACT: *The continuous development of the energetic system and the necessity to increase the safety in operation and the quality of the supplied electric power imposes increasingly severe conditions to the protection and control systems. Among the most important components of SCADA systems used for the electric stations control and protection are the equipments for disturbances recording and analysis, such as the Compact Digital Recorder (CDR). The data stored in the internal CDR memory can be extracted on a PC by CDR Link for Windows program. This paper presents Focus for Windows program, designated for visualization, analysis, interpretation and printing the recordings performed in electric stations with CDR equipments.*

ABSTRACT: *This paper presents the impact study of GTO Controlled Series Capacitor (GCSC) parameters on MHO distance relays measured impedance for 220 kV protected electrical transmission line in the presence of phase to earth fault with fault resistance. The study deals with a 220 kV electrical transmission line of Eastern Algerian transmission networks at Group Sonelgaz (Algerian Company of Electrical and Gas), compensated by series Flexible AC Transmission System (FACTS) i.e. GCSC connected at midpoint of the line. The transmitted active and reactive powers are controlled by three GCSC's. The effects of maximum reactive power injected as well as injected maximum voltage by GCSC on measured impedance by distance relays is treated. The simulations results investigate the impact of GCSC injected parameters (reactance, voltage and reactive power) on measured resistance and reactance in the presence of earth fault with resistance fault for different cases study.*

ABSTRACT: *In general the application of die-casting technology in foundries that are focused on non ferrous metals allows producing cast parts with specific properties. Another advantage of pressure die-casting technology with hot chamber is the possibility of production of precision cast parts in low dimensional tolerances, often without further machining. Castings have got smooth surface, good mechanical properties, and they also may have complex construction workability. Required qualitative properties of castings produced with the pressure die-casting technology with hot chamber are dependent on several parameters, which include holding stable temperature of the die-casting nozzle. Therefore in this paper we proposed the mathematical model as one of the method how to control heating die-casting nozzle of the hot chamber pressure die-casting machine using a gas torch.*

ABSTRACT: *Inhomogeneous character of deformation in subsurface layers of metals in sliding resulted in generation of a nanocrystalline layer. Specificity of its deformation behavior is a hydrodynamic flow pattern developing due to shear instability under conditions of thermal softening. Macroscopic analysis of plastic deformation carried out on the assumption that deformation behavior of the nanocrystalline subsurface layer is similar to that of the parallel-plane viscous Newtonian flow. It was shown that velocity tangential discontinuity surfaces may exist inside the deforming subsurface layer. These surfaces are particular cases of Helmholtz instability and may serve as potential sites where turbulences may nucleate. The objective of this work is to estimate macroscopic conditions for generation of the eddy-like flow instability in sliding on the basis of hydrodynamic approach including previously obtained both experimental and numerical simulation results.*

ABSTRACT: *The fluid analysis module of the program is fluid solver for compressible and incompressible fluid provides a world-class finite element solutions and the ability to control the flow, fluid can contain free surface and fluid, as well as fluid flow and structure of the interface between. This paper presents a method of simulation and presentation of the load losses in a fluid flowing through a pipe. It also presents a study on the algorithm for calculating these losses depending on the flow regime & pipe type, and the determination of the longitudinal load loss coefficient. The theory and numerical methods used in the program for laminar and turbulent flow are summarized and then the solutions of various problems are presented.*

ABSTRACT: *We present comparative analysis of MANET (Mobile Ad-Hoc Network) and VANET (Vehicular Ad-Hoc Network) routing protocols, in this paper. The analysis is based on various design factors. The traditional routing protocols of AODV (Ad hoc On-Demand Distance Vector), DSR (Dynamic Source Routing), and DSDV (Destination-Sequenced Distance-Vector) of MANET are utilizing node centric routing which leads to frequent breaking of routes, causing instability in routing. Usage of these protocols in high mobility environment like VANET may eventually cause many packets to drop. Route repairs and failures notification overheads increase significantly leading to low throughput and long delays. Such phenomenon is not suitable for Vehicular Ad hoc Networks (VANET) due to high mobility of nodes where network can be dense or sparse. Researchers have proposed various routing algorithms or mechanism for MANET and VANET. This paper describes the relevant protocols, associated algorithm and the strength and weakness of these routing protocols.*

ABSTRACT: *The most practical and the most widely used technology of plastic profile extrusion technology is worm extruder. The contribution deals with the design and stress analysis of a single worm extruder. Extrusion technology is one of the leading production technology for processing thermoplastics, as well as elastomers (rubber). The introduction is given substance and principle of extrusion technology. In other parts of the paper is processed with design and stress analysis of a single worm.*

ABSTRACT: *Turbulent Ranque effect is a typical macro–quantum phenomenon, which cannot be described by classical theory. About a century of unsuccessful experience in defining this phenomenon on the basis of classical methods testifies to this. The basic idea of non–local thermodynamics is to use quantum entropy, with every quantum defined as equal to Boltzman constant. This hypothesis will allow applying thermodynamic energy. Further, correlations of quantum mechanics are used. In this article, the process of gasses' thermal division in turbulent tubes is described on the basis of thermodynamic theory according to Newtonian time.*

ABSTRACT: *In order to improve the strength and high-temperature properties of sintered iron, metal matrix iron- Alumina (Al_2O_3) composite material has been studied. In the present investigation, iron powder added by 0-8 Wgt % Al_2O_3 powder-where selected for the study. Powders where mixed, compacted and subsequently sintered at 1150°C in laboratory tube furnace, under an endo gas atmosphere. Composite material properties were evaluated. The outcome results is that 4 vol % Al_2O_3 is the optimal percentage of the Alumina to obtain superior properties of the metal matrix composite. The deep drawing die and punch have been designed by using metal matrix composite and experimentally tested.*

ABSTRACT: *The industrial robot acts on its operating space under different shapes, namely by manipulating parts, by executing processing technological operations, by measuring specific parameters of products or even of the operating space etc. Many applications and functions performed by a robot reveal an essential characteristic, namely their versatility. Studying the movement of a robot consists of a single well-defined problem but a collection of several problems that are more or less than one other option. Exemplification was performed using MSC NASTRAN program.*

ABSTRACT: *Acquisition of the most modern technical systems and their logistical support requires innovative approaches to be adopted in design, manufacturing and providing logistical services for their operation. The article aims to be a contribution to the acquisitional approach termed as CALS, i.e. to a modern, computer-based logistics. Integrated logistical support provided through electronization of design and operational documentation linked with standardization and continuous upgrade is yielding surprising benefits. Implementation of computer systems in logistics for modern trends in military and industrial branches is of vital importance, particularly for the purpose of obtaining higher quality from the aspect of system characteristics, both in view of the methods applied – concurrent engineering, limiting the variability of manufacturing and the like.*

ABSTRACT: *Data hiding is the art of embedding data into digital media in a way such that the existence of data remains concealed from everyone except the intended recipient. In this paper, we discuss the various Least Significant Bit (LSB) data hiding techniques. We first look at the classical LSB data hiding technique and the method to embed secret data into cover media by bit manipulation. We also take a look at the data hiding technique by bit plane decomposition based on Fibonacci numbers. This method generates more bit planes which allows users to embed more data into the cover image without causing significant distortion. We also discuss the data hiding technique based on bit plane decomposition by prime numbers and natural numbers. These methods are based on mapping the sequence of image bit size to the decomposed bit number to hide the intended information. Finally we present a comparative analysis of these data hiding techniques.*

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering, Fascicule 3 [July–September] includes original papers submitted to the Editorial Board, directly by authors or by the regional collaborators of the Journal. In this sense, ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering, Fascicule 3 [July–September] includes 25 scientific originals papers.

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

You are invited to contribute review or research papers as well as opinion in the fields of science and technology including engineering. We accept contributions (full papers) in the fields of applied sciences and technology including all branches of engineering and management.

Submission of a paper implies that the work described has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis) that it is not under consideration for publication elsewhere. It is not accepted to submit materials which in any way violate copyrights of third persons or law rights. An author is fully responsible ethically and legally for breaking given conditions or misleading the Editor or the Publisher.

The Editor reserves the right to return papers that do not conform to the instructions for paper preparation and template as well as papers that do not fit the scope of the journal, prior to refereeing. The Editor reserves the right not to accept the paper for print in the case of a negative review made by reviewers and also in the case of not paying the required fees if such will be fixed and in the case time of waiting for the publication of the paper would extend the period fixed by the Editor as a result of too big number of papers waiting for print. The decision of the Editor in that matter is irrevocable and their aim is care about the high content-related level of that journal.

The general mission of the ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering is to disseminate academic knowledge across the scientific realms and to provide applied research knowledge to the appropriate stakeholders. We are keen to receive original contributions from researchers representing any Science related field.

We strongly believe that the open access model will spur research across the world especially as researchers gain unrestricted access to high quality research articles. Being an Open Access Publisher, Academic Journals does not receive payment for subscription as the journals are freely accessible over the internet.

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome V (Year 2012). FASCICULE 3 [July–September]. ISSN 2067-3809

[1.] K. SONI PRIYA, [2.] T. DURGABHAVANI, [3.] K. MOUNIKA, [4.] M. NAGESWARI, [5.] P. POLURAJU

NON-LINEAR PUSHOVER ANALYSIS OF FLATSLAB BUILDING BY USING SAP2000 (STRUCTURAL ANALYSIS PROGRAM)

[1-5.] DEPARTMENT OF CIVIL ENGINEERING, KLCE, VADDESWARAM, GUNTUR DIST-522502, INDIA

ABSTRACT: *Recent earthquakes in which many concrete structures have been severely damaged or collapsed, have indicated the need for evaluating the seismic adequacy of existing buildings. About 60% of the land area of our country is susceptible to damaging levels of seismic hazard. We can't avoid future earthquakes, but preparedness and safe building construction practices can certainly reduce the extent of damage and loss. In order to strengthen and resist the buildings for future earthquakes, some procedures have to be adopted. One of the procedures is the static pushover analysis which is becoming a popular tool for seismic performance evaluation of existing and new structures. By conducting this push over analysis, we can know the weak zones in the structure and then we will decide whether the particular part is retrofitted or rehabilitated according to the requirement. In this paper we are performing the push over analysis on flat slabs by using most common software SAP2000.Many existing flat slab buildings may not have been designed for seismic forces. Hence it is important to study their response under seismic conditions and to evaluate seismic retrofit schemes. But when compared to beam-column connections, flat slabs are becoming popular and gaining importance as they are economical.*
KEYWORDS: *Pushover analysis, Retrofitting, Rehabilitation, Column jacketing, Response Spectrum, Demand curve, Capacity curve, Plastic hinge*

INTRODUCTION

The static pushover analysis is becoming a popular tool for seismic performance evaluation of existing and new structures. The pushover analysis of a structure is a static non-linear analysis under permanent vertical loads and gradually increasing lateral loads. The purpose of pushover analysis is to evaluate the expected performance of structural systems by estimating performance of a structural system by estimating its strength and deformation demands in design earthquakes by means of static inelastic analysis, and comparing these demands to available capacities at the performance levels of interest.

TYPES OF ANALYSIS

Different types of analysis are as follows:

1. *Linear Static Analysis.*
2. *Linear Dynamic Modal Response Spectrum Analysis.*
3. *Linear Dynamic Modal Response History Analysis.*
4. *Linear Dynamic Explicit Response History Analysis*

Among all the analyses, deformation can be predicted in nonlinear static and dynamic analysis. Two-dimensional nonlinear push-over analysis is carried out on a typical flat slab building.

Flat slab is an American development, originated by Turner in 1906. It is a concrete slab reinforced in two or more directions so as to bring its load to supporting columns, generally without the help of any beams or girders. Failure of RC flat slab farming systems during severe earthquakes have led to widespread rejection of flat slab as a viable system in regions of high seismicity. Many existing buildings do not have been designed for seismic forces. It is important to study their response under seismic conditions and to evaluate seismic retrofit schemes. A plot of the total base shear versus top displacement in a structure is obtained by this analysis that would indicate any premature failure or weakness. By conducting this push over analysis we can know the weak zones in the flat slab then the particular part is retrofitted. The retrofitting can be done by:

a) Column jacketing
b) Addition of beams at floor
c) Column jacketing and addition of beams

The retrofitting of ground storey by column jacketing is a good cost effective technique but is adequate only when seismic deficiency is small.

The beam retrofitting reduces the sagging hinging significantly. Increasing the number of storey of retrofitting by either column retrofitting alone or beam retrofitting alone does not improve the behavior significantly.

When column jacketing and addition of beam are adopted simultaneously on more number of stories, large increase in lateral strength and stiffness can be achieved.

PUSH OVER ANALYSIS

The pushover analysis of a structure is a static non-linear analysis under permanent vertical loads and gradually increasing lateral loads. The equivalent static lateral loads approximately represent earthquake induced forces. A plot of the total base shear versus top displacement in a structure is obtained by this analysis that would indicate any premature failure or weakness. The analysis is carried out up to failure, thus it enables determination of collapse load and ductility capacity. This type of analysis enables weakness in the structure to be identified. The decision to retrofit can be taken in such studies.

NECESSITY OF NON-LINEAR STATIC PUSHOVER ANALYSIS

The existing building can become seismically deficient since seismic design code requirements are constantly upgraded and advancement in engineering knowledge. Further, Indian buildings built over past

two decades are seismically deficient because of lack of awareness regarding seismic behavior of structures. The widespread damage especially to RC buildings during earthquakes exposed the construction practices being adopted around the world, and generated a great demand for seismic evaluation and retrofitting of existing building stocks.

PURPOSE OF NON-LINEAR STATIC PUSH-OVER ANALYSIS

The purpose of pushover analysis is to evaluate the expected performance of structural systems by estimating performance of a structural system by estimating its strength and deformation demands in design earthquakes by means of static inelastic analysis, and comparing these demands to available capacities at the performance levels of interest. The evaluation is based on an assessment of important performance parameters, including global drift, inter story drift, inelastic element deformations (either absolute or normalized with respect to a yield value), deformations between elements, and element connection forces (for elements and connections that cannot sustain inelastic deformations). The inelastic static pushover analysis can be viewed as a method for predicting seismic force and deformation demands, which accounts in an approximate manner for the redistribution of internal forces that no longer can be resisted within the elastic range of structural behavior.

PUSHOVER METHODOLOGY

A pushover analysis is performed by subjecting a structure to a monotonically increasing pattern of lateral loads, representing the inertial forces which would be experienced by the structure when subjected to ground shaking.

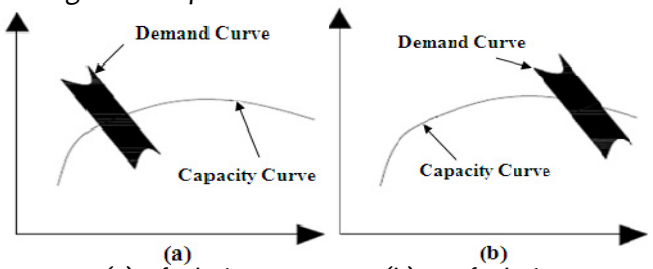
Under incrementally increasing loads various structural elements may yield sequentially.

Consequently, at each event, the structure experiences a loss in stiffness. Using a pushover analysis, a characteristic non linear force displacement relationship can be determined.

Main steps involved in pushover methodology

1. *Definition of plastic hinges: In SAP2000, nonlinear behavior is assumed to occur within a structure at concentrated plastic hinges. The default types include an uncoupled moment hinges, an uncoupled axial hinges, an uncoupled shear hinges and a coupled axial force and biaxial bending moment hinges.*
2. *Definition of the control node: control node is the node used to monitor displacements of the structure. Its displacement versus the base-shear forms the capacity (pushover) curve of the structure.*
3. *Developing the pushover curve which includes the evaluation of the force distributions. To have a displacement similar or close to the actual displacement due to earthquake, it is important to consider a force displacement equivalent to the expected distribution of the inertial forces. Different forces distributions can be used to represent the earthquake load intensity*
4. *Estimation of the displacement demand: This is a crucial step when using pushover analysis. The control is pushed to reach the demand displacement which represents the maximum expected displacement resulting from the earthquake intensity under consideration.*
5. *Evaluation of the performance level: Performance evaluation is the main objective of a performance based design. A component or action is considered satisfactory if it meets a prescribed performance.*

The main output of a pushover analysis is in terms of response demand versus capacity. If the demand curve intersects the capacity envelope near the elastic range, Fig.1a, then the structure has a good resistance. If the demand curve intersects the capacity curve with little reserve of strength and deformation capacity, Fig.1b, then it can be concluded that the structure will behave poorly during the imposed seismic excitation and need to be retrofitted to avoid future major damage or collapse.



(a)safe design *(b)unsafe design*

Fig.1 Typical seismic demand versus capacity

Depending on the weak zones that are obtained in the pushover analysis, we have to decide whether to do perform seismic retrofitting or rehabilitation.

SEISMIC RETROFITTING

Seismic retrofitting is the modification of existing structures to make them more resistant to seismic activity, ground motion, or soil failure due to earthquakes.

Various repair/retrofit options available today include crack injection, shortcreting, steel jacketing, steel plate bonding, CFRP/GFRP jacketing, RC jacketing, addition of new structural elements (braces, walls, etc.), incorporation of passive energy dissipation devices, and provision of base isolation.

Types of Retrofitting:

1. Local technique

a) Column jacketing

b) Addition of beams at floor

The retrofitting of ground storey by column jacketing is a good cost effective technique but is adequate only when seismic deficiency is small.

The beam retrofitting reduces the sagging hinging significantly. Increasing the number of storey of retrofitting by either column retrofitting alone or beam retrofitting alone does not improve the behavior significantly.

2. Global technique

This can be typically done by the addition of cross braces or new structural walls.

REHABILITATION

Rehabilitation or reconstruction or replacement includes work to restore the original capacity to meet

typical service loads by reconstructing the effected parts in a structure.

Rehabilitation Options:

1. Addition of new concrete shear walls
2. Use of Fiber Reinforced Polymer laminates to strengthen masonry, unreinforced clay tile, or concrete members.
3. Add steel bracing
4. Improve connection capacities
5. Reduce structure mass
6. Global stiffening

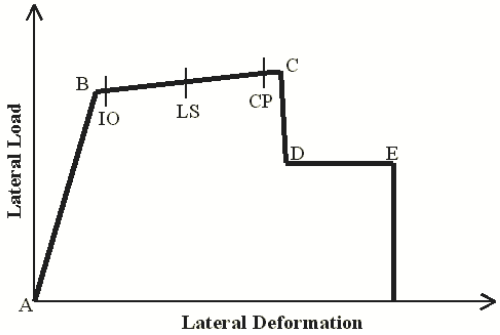


Figure 2. Lateral load Vs Deformation

A plot is drawn between base shear and roof displacement. Performance point and location of hinges in various stages can be obtained from pushover curve as shown in figure 2. The range AB is elastic range, B to IO is the range of immediate occupancy IO to LS is the range of life safety and LS to CP is the range of collapse prevention. If all the hinges are within the CP limit then the structure is said to be safe. However, depending upon the importance of structure the hinges after IO range may also need to be retrofitted.

DESIGN OF FLAT SLAB

A typical flat slab with two stories is considered in the present study.It has not been detailed for earthquake loads but have been designed for wind loads.The height of the each storey is 3m.

For the purpose of design, linear structural analysis of the building is carried out by the computer program SAP2000 (Structural Analysis Program, Version 12.00). The slab of the building is assumed to be acting like a rigid floor diaphragm. The building is designed as per IS: 456-1978 using limit state method of design. The load combinations used are as follows:

$$1.5\ DL+1.5\ LL$$

$$1.5\ DL+1.5\ LL+1.2\ WL$$

For the purpose of wind load calculations, the structure is assumed to be situated in Vijayawada.

The wind loads are calculated as per the IS: 875(Part 3)-1987:

$$V_z=V_b k_1 k_2 k_3$$

where V_z=design wind speed at any height z in m/s,V_b=basic wind speed in m/s(=50 m/s for building in Vijayawada).The design wind pressure(p_z) is calculated as follows:

$$P_z=0.6V_z^2$$

From the above equations, the total design wind speed on the building was obtained as 1.5 kN/m^2 acting along X-direction.The materials used are M 20 grade concrete and Fe 415 grade steel. The thickness of the slab is 200 mm and no shear reinforcement is provided in the slabs. The columns are 250 mm square in section.

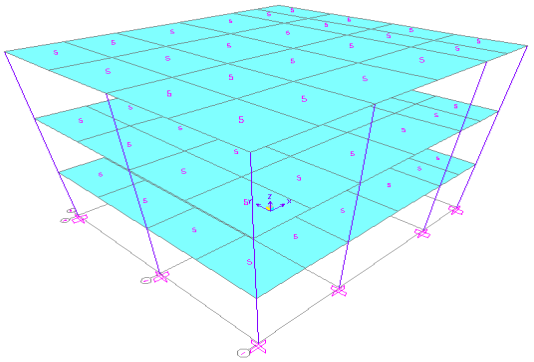


Figure 3. 3-D View

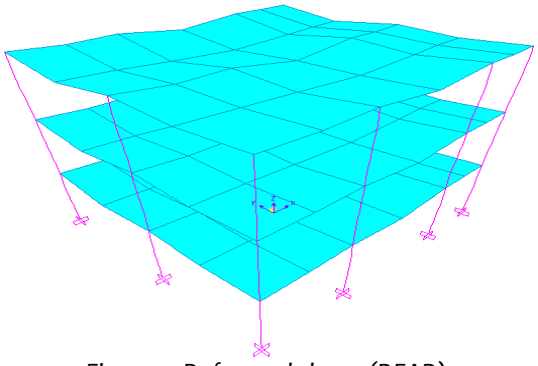


Figure 2. Deformed shape (DEAD)

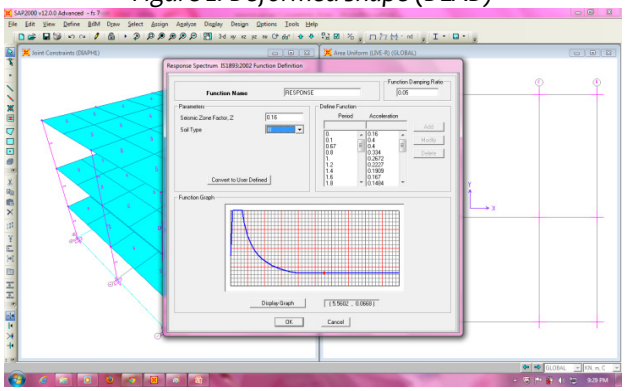


Figure 3. Response spectrum

Table1: Centre Of Masses At Different Levels

Height in m	Mass in kN-s^2/m
3	30.32
6	30.32
9	28.03

Table2: Pushover Loads(IS1893)

Height in m	Q_i (kN)
9	125.25
6	125.25
3	27.36

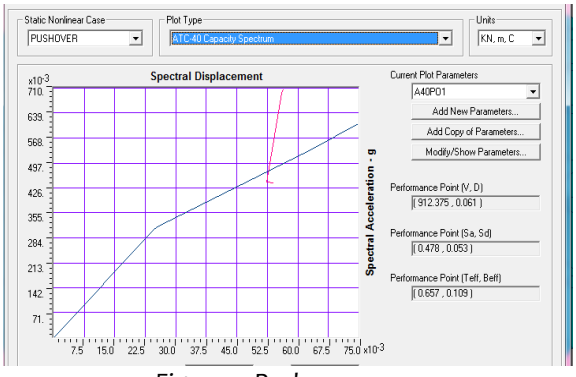


Figure 4. Pushover curve

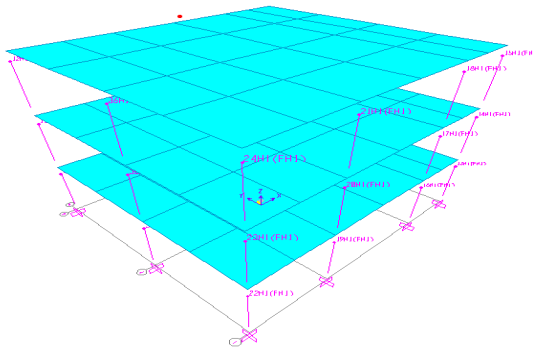


Figure 5. Framed hinges

RESULTS AND DISCUSSIONS

The resulting pushover curve for the G+2 building is shown in Figure 4. The curve is initially linear but start to deviate from linearity as the columns undergo inelastic actions. When the building is pushed well into the inelastic range, the curve become linear again but with a smaller slope. The curve could be approximated by a bilinear relationship.

Plastic hinges formation for the building mechanisms have been obtained at different displacement levels. The hinging patterns are plotted at different levels in figures 8 to16. Plastic hinges formation starts at base columns of lower stories, then propagates to upper stories and continue with yielding of interior intermediate columns in the upper stories.

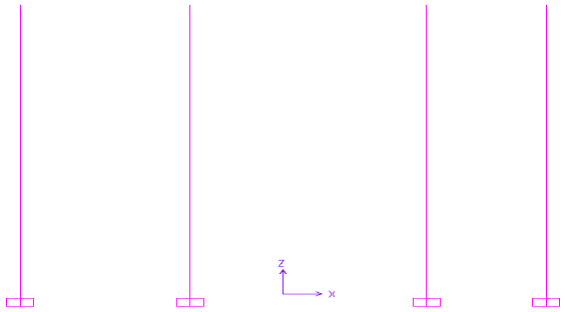


Figure 6. Deformed shape at step 0

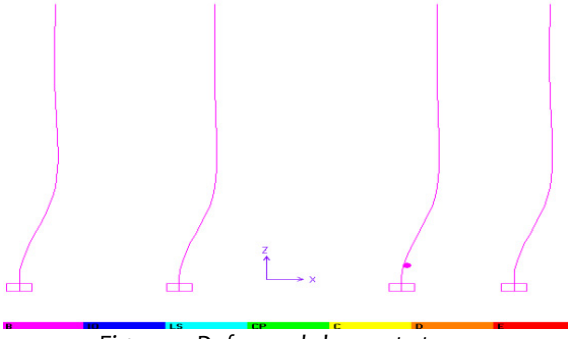


Figure 7. Deformed shape at step 1

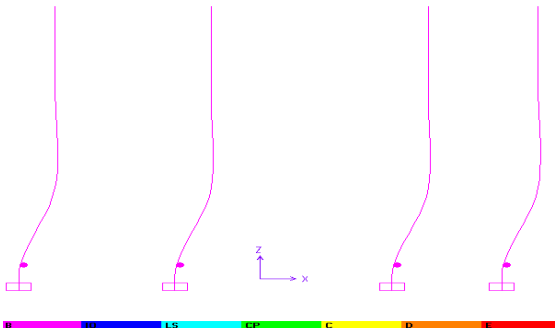


Figure 8. Deformed shape at step 2

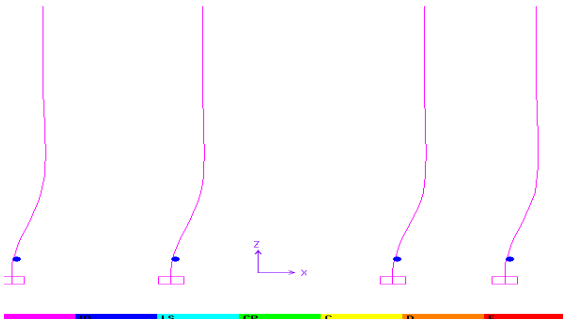


Figure 9. Deformed shape at step 3

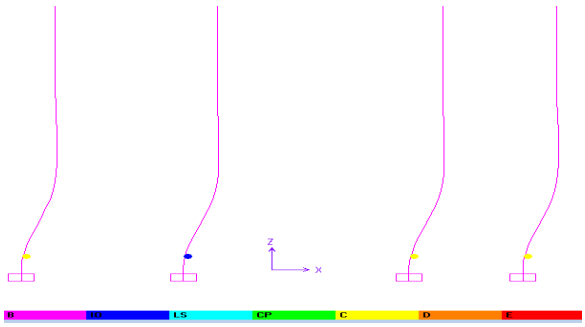


Figure 10. Deformed shape at step 4

CONCLUSIONS

Under the pressure of recent developments, seismic codes have begun to explicitly require the identification of sources of inelasticity in structural response, together with the quantification of their energy absorption capacity. Many existing buildings do not have been designed for seismic forces. It is important to study their response under seismic conditions and to evaluate seismic retrofit schemes. Hence push over analysis has been gaining importance for the strengthening and evaluation of the existing structures. By conducting the pushover analysis on flat slabs, pushover curve and demand curve can be obtained. Then, based on the results we need to decide whether to perform rehabilitation or retrofitting depending upon the seismic zone of the existing structures.

REFERENCES

[1] *Push over analysis on shear critical frames, Serhan Guner and Frank J. Vecchio*

[2] *Seismic retrofit of columns in buildings for flexure using concrete jacket.Gnanasekaran Kaliyaperumal and Amlan Kumar Sengupta*

[3] *Pushover analysis of reinforced concrete frame structures. A. kadid and A. boumrkik department of civil engineering, university of Batna, Algeria*

[4] *ISET Journal of Earthquake Technology, Paper No. 505, Vol. 46, No. 2, June 2009, pp. 77–107*

[5] *Asian Journal of civil engineering (Building and Housing)Vol. 9, No. 1 (2008) Pages 75-83*

[6] *CI Structural Journal/January-February 2010 by Serhan Guner and Frank J. Vecchio*

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome V (Year 2012). FASCICULE 3 [July–September]. ISSN 2067-3809

[1.] Jozef MAŠČENIK

THE EVACUATION OF PRESSURE MOULDS AS PROGRESSIVE DEVELOPMENTS OF DIE CASTING PROCESS

[1.] TECHNICAL UNIVERSITY OF KOŠICE, FACULTY OF MANUFACTURING TECHNOLOGIES, DEPT. OF TECHNICAL DEVICES DESIGN, PRESOV, SLOVAKIA

ABSTRACT: *In these days in foundry branch there is a rapid development of sectors of special casting technology with the aim to increase the quality and the efficiency of pressure casting production. In the production of castings cast under pressure there is an increased attention to the internal homogeneity of castings, where in accordance with the specifics of this technology are the most common casting errors internal cavities (bubbles, pores). Internal homogeneity of pressure casting, characterized by the extent of porosity can be affected by the setup of technological parameters of pressure casting and last but not least by vacuuming the molds, that means to exhaust air and gases from the mold cavity.*
KEYWORDS: *die casting, vacuum, porosity, quality of casting*

INTRODUCTION

Technology of casting metal in a vacuum was being put into the production process already in the middle of last century in the U.S., where three systems were developed (NELMAR, OHSE, Morton). From the point of then state of the techniques its practical use was at one point (closing of exhaust valve) insufficiently met. This technology was introduced to mass production in 80s in Japan. Today, the world leader in metal casting in a vacuum is vacuum systems developed by the Swiss FONDAREX.

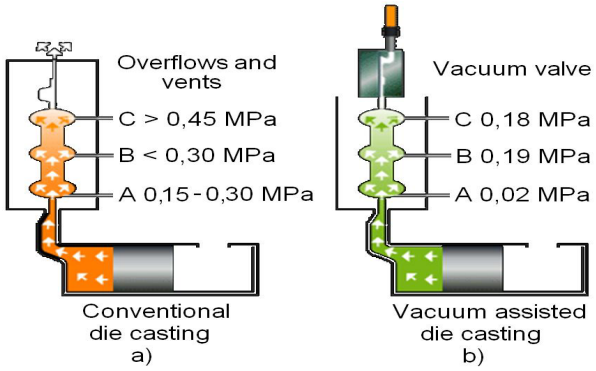


Figure 1. Comparison of conventional and vacuum pressure casting metal

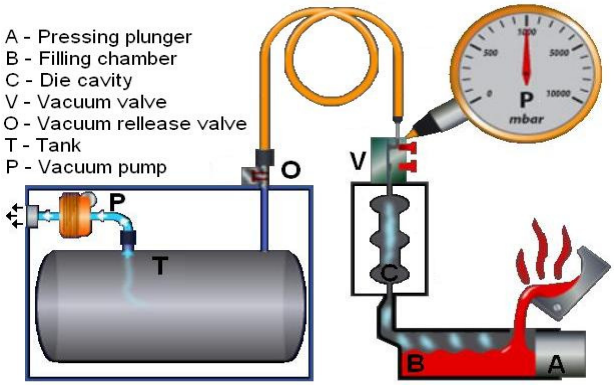


Figure 2. Scheme of vacuuming process [4]

By the conventional method of casting during the molding phase in the inlet system and the mold cavity, anti- pressure of gases and vapors is formed which during the short period of time sufficient compression are not fully taken by venting form system. Depending on the nature of the vent system and piston compression force in the filling chamber, the pressure in the mold cavity is increasing during the first stage of compression to the value of 0.3 MPa. In other phases of compression, these values may be doubled or even tripled.(fig. 1a) Venting the mold cavity by gas and air diversion gas using vacuum causes a reduction in back pressure in the mold cavity. In this way antipressure rarely exceeds 0.02 MPa [1,2].

The principle design of degassing pressure form is shown schematically in Fig. 2, where with the help of valve the valve suction device is formed, which has to within a few milliseconds, when the casting process takes place, drain away air and gases from the mold cavity. Exhaustion lasts throughout the molding cycle [3].

THE METHODOLOGY OF EXPERIMENTS AND EQUIPMENT

For the realization of experiments the compressed casting machine FRECH DAW125F was used, designed for casting non-ferrous metals with a vertically arranged filling chamber and degassing of the pressure casting mold was realized by a vacuum device FONDAREX. Analysis of the impact of degassing the pressure molds on casting porosity has been observed on the cast on Figure 3.

Figure 3. Analyzed Casting

The tested analyzed casting is made from an alloy ZnAl4Cu1, whose chemical composition responded to EN 1774 and is listed in the table 1.

Table 1. Chemical Composition of the Experimental Cast of the Applied Alloy

Chemical composition of the experimental cast of the applied alloy - % of elements content					
Al	Cu	Mg	Cr	Ti	Pb
3,9	0,8	0,05	-	-	0,001
according to EN 1774					
3,8 – 4,2	0,7 - 1,1	0,0035 - 0,6	-	-	max. 0,003

Chemical composition of the experimental cast of the applied alloy - % of elements content					
Cb	Sn	Fe	Ni	Si	Zn
0,002	0,001	0,001	0,001	0,01	95,225
according to EN 1774					
max. 0,003	max. 0,001	max. 0,02	max. 0,001	max. 0,02	the rest

Porosity analysis was performed by the indirect method of verification and the volume density of the samples. For this analysis was used Mettler Toledo scales PG203-S. The measured values were then calculated density cast by the relation:

$$\rho = \frac{m}{V} \qquad (1)$$

ρ – density [kg.m^{-3}], m – mass [kg], V – volume [m^3]. Subsequently, the calculated density values were determined by casting % porosity castings analyzed according to the relation:

$$porosity = \frac{density\,of\,the\,alloy - measured\,density\,of\,the\,alloy}{density\,of\,the\,alloy} * 100\% \qquad (2)$$

During the casting process in a vacuum and without vacuum there were constant technological parameters on the pressure casting machine FRECH DAW125F:

- time of increase pressure: 1,5 s,
- increase pressure: 16 MPa,
- temperature of alloy: 434 °C,
- velocity of I. phase: 0,12 m.s^{-1}
- velocity of II. phase: 1,2 m.s^{-1}

Analysis of the Achieved Results

The measured values of the analyzed samples porosity cast without degassing and with vacuuming of pressure molds are shown in Table 2. Graphical process of the porosity dependence of the samples cast in a vacuum and without vacuum is illustrated in Figure 4.

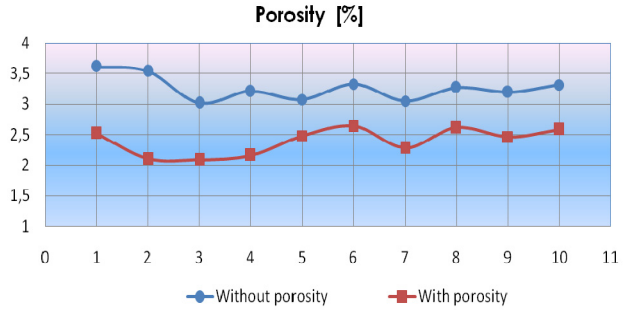


Figure 4. Graph of Porosity Values

Table 2. The measured mass and density and calculated porosity

No.	Without vacuum	With vacuum	Without vacuum	With vacuum	Without vacuum	With vacuum
	Mass [g]		Density [kg/dm^3]		Porosity [%]	
1	23,776	23,918	6,458	6,531	3,612	2,522
2	23,948	23,991	6,463	6,559	3,537	2,104
3	23,901	23,951	6,498	6,56	3,015	2,090
4	23,830	23,942	6,485	6,555	3,209	2,164
5	23,842	23,931	6,494	6,534	3,075	2,478
6	23,782	23,981	6,477	6,523	3,328	2,642
7	23,837	23,958	6,496	6,547	3,045	2,284
8	23,816	23,910	6,481	6,525	3,269	2,612
9	23,806	23,935	6,486	6,535	3,194	2,463
10	23,854	23,952	6,478	6,527	3,313	2,582
Min.	23,776	23,910	6,458	6,523	3,015	2,090
Max.	23,948	23,991	6,498	6,560	3,612	2,642
Average	23,839	23,946	6,481	6,539	3,259	2,394

Conclusions

The distribution of total volume of pores in the cross section of the casting depends on the conditions of implementation of the mold cavity. By the turbulence of the melt, air and gases are entrained from lubricants and mold forms system, they are not sufficiently vented and subsequently they are being closed to the wall casting. By the application of degassing pressure form are air and gases vented into the vacuum tank unit with a positive impact on minimizing the porosity of castings.

References

[1.] Gašpár, Š., Paško, J.: Technologické faktory tlakového liatia a ich vplyv na mechanické vlastnosti odliatkov zo silumínu. In: Stroiírenská technologie. Vol. 14 (2010), p. 53-56. ISSN 1211-4162
[2.] Gašpár, Š., Paško, J., Malik, J.: Elimination of porosity of die casting by increased pressure function. In: Výrobné inžinierstvo. Vol. 10, No. 2 (2011), p. 21-23. ISSN 1335-7972
[3.] Paško, J., Malik, J., Gašpár, Š., Novák-Marcinčin, J.: Influence of technological parameters of die castning on qualitative properties of castings. In: Manufacturing engineering and technology. No. 1 (2010), p. 3-6. ISSN 1312-0859
[4.] www. iron-foundry.com
[5.] www.subtech.com

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING
ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome V (Year 2012). FASCICULE 3 [July–September]. ISSN 2067-3809

[1.] Iosif POPA, [2.]Gabriel Nicolae POPA, [3.]Sorin DEACONU

THE DETERMINATION OF THE ELECTRIC MOTOR POWER THAT DRIVES THE BELT TRANSPORT CONVEYERS

[1-3.] DEPARTMENT OF ELECTROTECHNICAL ENGINEERING AND INDUSTRIAL INFORMATICS, FACULTY OF ENGINEERING HUNEDOARA, POLITECHNICA UNIVERSITY TIMIȘOARA, STR. REVOLUȚIEI, NO.5, HUNEDOARA, ROMANIA

ABSTRACT: *The paper introduces an analytical method to determine the electric motor power that drives horizontal and inclination belt transport conveyers, with and without deviation drums. To compute the electric motor power we used the permitted load, the proper weight of the belt, the advancing strength introduced by the support rolls and the supplementary inclination determinate by the winding on the return drum. The algorithm for electric motor power that drives the belt transport conveyors it was establish in the paper. The paper introduces on the base of studying spatiality literature may be present the method of calculation for motor power that drives the belt transport conveyers with slow and medium capacity.*
KEYWORDS: *electric motor power, belt transport conveyers, analytical method, algorithm*

INTRODUCTION

The paper introduces on the base of studying spatiality literature [1-4] may be present the method of calculation for motor power that drives the belt transport conveyers with slow and medium capacity. For this, it can do from mechanical tensions from the belt of transport conveyor, in the case of conveyers with and without deviation drums, after which it may determine the reduced resistant moments to shafts of drive motors, and then may be calculate the necessary power for motors. It may be considered that the belt transport conveyers are drive with triphasic cage induction motors [5-7].

THE DETERMINATION OF REDUCED RESISTANT MOMENTS AT MOTOR SHAFT

The tensions in the belt, for inclined transport conveyer with $\beta>0$, without deviation drum (fig.1), in points 1, …, 4 are:

$$S_1 = S_x \ [N] \tag{1}$$

$$S_2 = S_x + (q_b + q_{rg}) \cdot L \cdot w \cdot \cos\beta - q_b \cdot L \cdot \sin\beta \ \ [N] \tag{2}$$

$$S_3 = k_i \cdot S_2 \ \ [N] \tag{3}$$

$$S_4 = S_3 + (q_b + q_i + q_{rp}) \cdot L \cdot w \cdot \cos\beta + (q_b + q_i) \cdot L \cdot \sin\beta \ [N] \tag{4}$$

In these relations, the tension S_x in point of band detach from motor drum does not know, q_{rp} [N/m] and q_{rg} [N/m] are uniform distribute weights for mobile parts of the superior train rolls, respective for the inferior, w[-] it is the specific resistance to movement of the band (w=0,03… 0,05 for the pipe rolls) and k_i [-] it is a coefficient which put in the evidence the contribution of return and deviation drums, at modify the band tensions.

The uniform charge weights q_{rp} și q_{rg} may be calculate with:

$$q_{rp} = \frac{G_{rp}}{l_1} \tag{5}$$

$$q_{rg} = \frac{G_{rg}}{l_2} \tag{6}$$

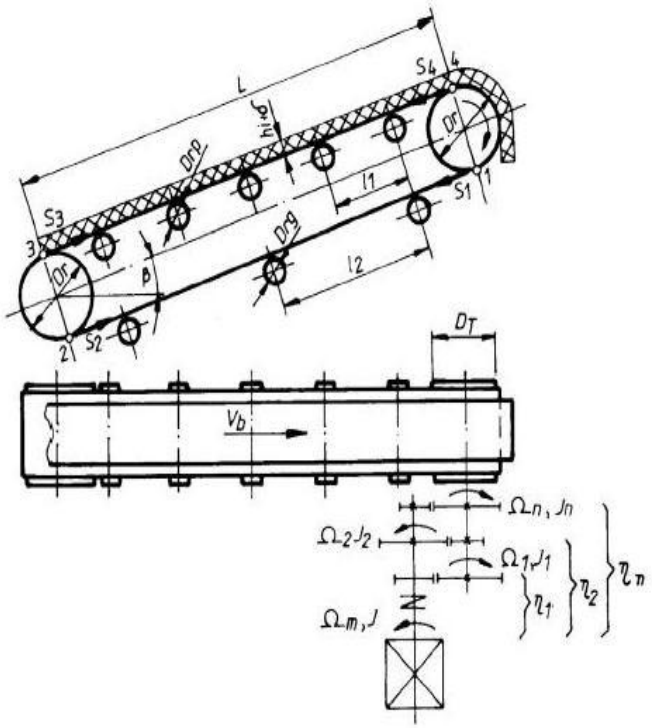


Fig.1. Belt inclinator transport conveyer without deviation drum

where G_{rp} [N] and G_{rg}[N] are the weight of movement parts of superior train rolls, respective of inferior train rolls.

The coeficient k_i takes values by 1,05… 1,07 for the wrap up angles by 180°, and 1,03… 1,05 for the wrap up angles by 90°, and 1,02… 1,03 the wrap up angles smaller than 90°.

The Euler ecuation about the condition of unslip of the band on motor drum is:

$$k_f \cdot S_4 = S_1 \cdot e^{\mu \cdot \alpha} \ [N] \qquad (7)$$

where k_f[-] is the safety coefficient for unslip on motor drum (k_f=1,2... 1,3), e is the base of naturals logarithms, μ [-] is the friction coefficient between the band and the driven drum (μ=0,25... 0,35) and α[rad] it is the angle of wrap up for the band on motor drum. With relations (1),..., (4) and (6) may be get:

$$S_1 = \frac{k_f \cdot L \cdot \begin{Bmatrix} w \cdot \cos\beta \cdot [q_b \cdot (1 + k_{\hat{i}}) + k_{\hat{i}} \cdot q_{rg} + q_{\hat{i}} + q_{rp}] \\ + \sin\beta \cdot [q_b \cdot (1 - k_{\hat{i}}) + q_{\hat{i}}] \end{Bmatrix}}{e^{\mu \cdot \alpha} - k_f \cdot k_i} \ [N] \quad (8)$$

$$S_4 = k_{\hat{i}} \cdot S_1 + \frac{S_c}{k_f} \ [N] \qquad (9)$$

The reduce resistant moments for motor shaft may be obtioned with:

$$M_{rr} = \frac{(S_4 - S_1)}{\eta_R \cdot i} \cdot \frac{D_T}{2} \ [Nm] \qquad (10)$$

where the tensions in band S_1 and S_2 are from expressions (8) and (9).

For horizontal transport conveyers, without deviation drums when β=0 and from expressions (8) and (9) result:

$$S_1 = \frac{k_f \cdot L \cdot w \cdot [q_b \cdot (1 + k_{\hat{i}}) + k_{\hat{i}} \cdot q_{rg} + q_{\hat{i}} + q_{rp}]}{e^{\mu \cdot \alpha} - k_f \cdot k_{\hat{i}}} \ [N] \quad (11)$$

$$S_4 = L \cdot \left\{ k_{\hat{i}} \cdot S_1 + w \cdot \begin{bmatrix} q_b \cdot (1 + k_{\hat{i}}) \\ + k_{\hat{i}} \cdot q_{rg} + q_{\hat{i}} + q_{rp} \end{bmatrix} \right\} [N] \qquad (12)$$

The reduce resistance moments at motor shaft, may be determinate with the formula (10) where S_1 and S_2 are given by expression (11) and (12).

The reduce resistance moments at shaft of driven motor, may be determinate for the belt transport conveyer with deviation drum is presented in fig.2.

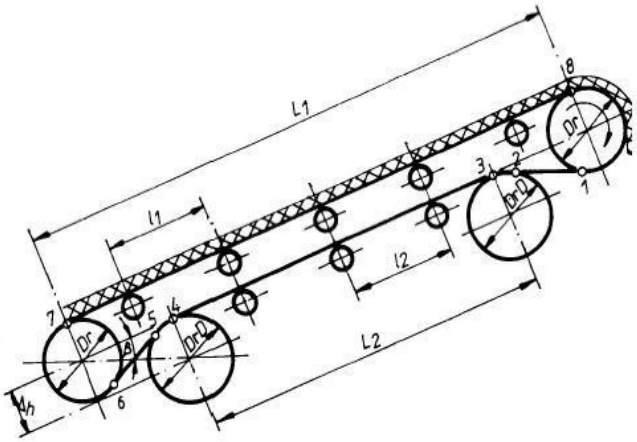


Fig.2. Belt inclinated transport conveyer with deviation drum

The tensions in band, in points 1,...,8, for β>0 are:

$$S_1 = S_x \quad [N] \qquad (13)$$

$$S_2 \approx S_1 \ [N] \qquad (14)$$

$$S_3 = k_{\hat{i}1} \cdot S_2 \ [N] \qquad (15)$$

$$S_4 = S_3 + \begin{matrix} (q_b + q_{rg}) \cdot L_2 \cdot w \cdot \cos\beta \\ - q_b \cdot L_2 \cdot \sin\beta \end{matrix} \ [N] \qquad (16)$$

$$S_5 = k_{\hat{i}1} \cdot S_4 \quad [N] \qquad (17)$$

$$S_6 \approx S_5 \quad [N] \qquad (18)$$

$$S_7 = k_{\hat{i}2} \cdot S_6 \ [N] \qquad (19)$$

$$S_8 = S_7 + \begin{matrix} (q_b + q_{\hat{i}} + q_{rp}) \cdot L_1 \cdot w \cdot \cos\beta \\ + (q_b + q_{\hat{i}}) \cdot L_1 \cdot \sin\beta \end{matrix} \ [N] \qquad (20)$$

where $k_{\hat{i}1}$ [-] it is the band loading coefficient because the band passing over deviation drums ($k_{\hat{i}1}$=1,02... 1,03) and $k_{\hat{i}2}$[-] it is the band loading coefficient over return drum ($k_{\hat{i}2}$=1,07... 1,09).

The band loading that passing over deviation drums have some coefficients values, because the angles of wrap up of band on these drums are equal.

The condition by unslip of band on motor drum is:

$$k_f \cdot S_8 = S_1 \cdot e^{\mu \cdot \alpha} \qquad (21)$$

With these expressions (13),...,(21) may be get the next ecuations:

$$S_1 = \frac{k_f \cdot S_A}{e^{\mu \cdot \alpha} - k_{\hat{i}1}^2 \cdot k_{\hat{i}2} \cdot k_f} \ [N] \qquad (22)$$

$$S_8 = S_1 \cdot k_{\hat{i}1}^2 \cdot k_{\hat{i}2} + S_A \ [N] \qquad (23)$$

where S_A has this formula:

$$S_A = w \cdot \cos\beta \cdot \begin{pmatrix} q_b \cdot (L_1 + k_{\hat{i}1} \cdot k_{\hat{i}2} \cdot L_2) \\ + q_{rg} \cdot k_{\hat{i}1} \cdot k_{\hat{i}2} \cdot L_2 + L_1 \cdot (q_{\hat{i}} + q_{rp}) \end{pmatrix} + \sin\beta \cdot (L_1 \cdot (q_b + q_{\hat{i}}) - k_{\hat{i}1} \cdot k_{\hat{i}2} \cdot q_b \cdot L_2) \qquad (24)$$

For horizontal transport conveyer (β=0) with band deviation drums, the tensions S_1 and S_8 from the band are:

$$S_1 = \frac{k_f \cdot S_B}{e^{\mu \cdot \alpha} - k_{\hat{i}1}^2 \cdot k_{\hat{i}2} \cdot k_f} \ [N] \qquad (25)$$

$$S_8 = S_1 \cdot k_{\hat{i}1}^2 \cdot k_{\hat{i}2} + S_B \ [N] \qquad (26)$$

where S_B may be calculate with:

$$S_B = w \cdot \begin{bmatrix} q_b \cdot (L_1 + k_{\hat{i}1} \cdot k_{\hat{i}2} \cdot L_2) \\ + q_{rg} \cdot k_{\hat{i}1} \cdot k_{\hat{i}2} \cdot L_2 \\ + L_1 \cdot (q_{\hat{i}} + q_{rp}) \end{bmatrix} \qquad (27)$$

For these two situations (β>0 and β=0) the reduced resistant moments at motor shaft may be compute with:

$$M_{rr} = \frac{(S_8 - S_1)}{\eta_R \cdot i} \cdot \frac{D_T}{2} \ [Nm] \qquad (28)$$

In the relations (10) and (28) i is the transmition ratio of reduction devices:

$$i = \frac{\Omega_m}{\Omega_T} \tag{29}$$

where $\Omega_m[s^{-1}]$ and $\Omega_T[s^{-1}]$ are the angular speeds of the motor and the driven drum.

THE NECESSARY POWER CALCULATION FOR DRIVING THE BELT TRANSPORT CONVEYERS

The necessary power for driving the belt transport conveyer may be calculate with:

$$\begin{aligned} P_T &= M_{rr} \cdot \Omega_m \cdot 10^{-3}; \\ P_T &= M_{rr} \cdot i \cdot \Omega_T \cdot 10^{-3}; \ [kW] \\ P_T &= M_{rr} \cdot i \cdot \frac{v_b}{R_T} \cdot 10^{-3} \end{aligned} \tag{30}$$

where v_b [m/s] is the band speed and R_T [m] is the ray of driven drum.

May be choise a motor which has the nominal speed n_n [rot/min]:

$$n_n \geq \frac{30 \cdot \Omega_m}{\pi} \tag{31}$$

and the power:

$$P_n \geq P_T \tag{32}$$

In continuation it is checking if the starting motor moment M_p [Nm] is bigger than the reduced resistant moment M_{rr} [Nm] at shaft of driven motor. For this, from the motor catalog, it is determining the variation of the motor moment in function with the slip s[-].

The motor moment is giving by simplification ecuation of Kloss:

$$M = \frac{2 \cdot M_k}{\frac{s}{s_k} + \frac{s_k}{s}} \tag{33}$$

where: M_k [Nm] is the critical motor moment, s_k [-] - the slip at the critical moment and s[-] is the motor slip. These size are calculating with:

$$\begin{aligned} M_k &= \lambda \cdot M_n; \\ M_k &= \lambda \cdot \frac{P_n}{\Omega_n}; \\ M_k &= \lambda \cdot \frac{30 \cdot P_n}{\pi \cdot n_n} \end{aligned} \tag{34}$$

$$\begin{aligned} s_k &= s_n \cdot \left(\lambda + \sqrt{\lambda^2 - 1}\right); \\ s_k &= \frac{n_o - n_n}{n_o} \cdot \left(\lambda + \sqrt{\lambda^2 - 1}\right); \\ s_k &= \frac{\Omega_o - \Omega_n}{\Omega_o} \cdot \left(\lambda + \sqrt{\lambda^2 - 1}\right) \end{aligned} \tag{35}$$

$$\begin{aligned} s &= \frac{n_o - n}{n_o}; \\ s &= \frac{\Omega_o - \Omega}{\Omega_o} \end{aligned} \tag{36}$$

$$\begin{aligned} s_n &= \frac{n_o - n_n}{n_o}; \\ s_n &= \frac{\Omega_o - \Omega_n}{\Omega_o} \end{aligned} \tag{37}$$

In this relations:

λ[-] is the motor overload coefficient gave it in the motor catalog,

P_n [W] is the motor nominal power,

n_o [rot/min] and Ω_o [s^{-1}] are the syncronic speed, respective the angular speed proper at this speed,

n_n [rot/min] and Ω_n [s^{-1}] are the nominal speed, respective the angular speed,

n [rot/min] and Ω [s^{-1}] are the momentan speed, respective the angular speed and

s_k[-], s_n[-] and s[-] are the slip proper for the critical moment M_k, nominal moment M_n and current moment M.

The motor starting moment M_p [Nm] are calculating with sympliphicate formula of Kloss for s=1:

$$M_p = \frac{2 \cdot M_k \cdot s_k}{1 + s_k^2} \tag{38}$$

The motor may win the dynamic moment M_d [Nm] if:

$$M_p > M_{rr} \tag{39}$$

If this condition is not carries out, may be choise a motor with bigger power.

CONCLUSIONS

This paper introduces on the base of investigation done it on spatiality literature [1-7], a quick calculation of necessary power for drive with triphasic cage induction motors the inclined or horizontal belt transport conveyer, with and without deviation drums.

For inclined or horizontal belt transport conveyer without deviation drums, the necessary power of driven motor are calculating with (30), (8), (9), (11), (12) and (10), and for inclined or horizontal transport conveyer with deviation drums, the necessary power of driven motor are calculating with (30), (28), (24), (22), (23) or (27), (26), (25) and (28) with carry out of inequality (39), for these two constructive types.

In this work may be establish the algorithm and the computing program of power driven motor for belt transport conveyer with small and medium capacity.

REFERENCES

[1.] N.V. Boțan - The Base of Computing Electrical Drives (in Romanian), Technical House, Bucharest, Romania, 1970 (Bazele calculului acționărilor electrice, Editura Tehnică, București, România, 1970).

[2.] Al. Fransua, C. Saal, and I. Țopa - Electrical Drives (in Romanian), Didactical and Pedagogical House, Bucharest, Romania, 1975 (Acționări electrice, Editura Didactică şi Pedagogică, București, România, 1975).

[3.] A.S. Ostrovski, A.O. Spivakovski, M.G. Potapov, and M.A. Kotov - Electrical Drive of Belt Transport Conveyers, Technical House, Bucharest, Romania, 1968 (in Romanian, translate from Russian), (Acționarea electrică a benzilor transportoare, Editura Tehnică, București, România, 1968).
[4.] I. Popa, and G.N. Popa - Electronic Device with Wiring and Programmable Structure, for Low-Voltage Three-Phase Induction Motors (in Romanian), Mirton House, Timişoara, Romania, 2000 (Dispozitive electronice cu structură cablată şi programată, de protecție a motoarelor asincrone trifazate de joasă tensiune, Editura Mirton, Timişoara, România, 2000).
[5.] J. Rodriguez, J. Pontt, N. Becker, and A. Weinstein - Regenerative drives in the megawatt range for high-performance downhill belt conveyors, IEEE Transaction on Industry Applications, vol.38, no.1, January/February 2002, pp. 203-210.
[6.] M.A. Abdel-halim, M.A. Badr, and A.I. Alolah - Smooth starting of slip ring induction motors, IEEE Transaction on Industry Applications, vol.12, no.4, December 1997, pp. 317-322.
[7.] L. Hewitson, M. Brown, and B. Ramesh - Practical Power Systems Protection, Linacre House, Jordan Hill, Oxford, U.K., 2004

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome V (Year 2012). FASCICULE 3 [July–September]. ISSN 2067-3809

[1.] Árpád FERENCZ, [2.] Márta NÓTÁRI

MANAGEMENT OF RURAL DEVELOPMENT IN COLLAGE OF KECSKEMÉT

[1-2.] COLLEGE OF KECSKEMÉT, HORTICULTURAL FACULTY, HUNGARY

ABSTRACT: *Taking all these challenges into consideration, training of farmers is a strategic task regarding the future of the country's future, to which College of Kecskemét is also willing to contribute actively. Beyond the basic training our goal is to provide further professional training for the farmers in order to make them acquire economic, management, regional and knowledge, and use it as a skill. The goal is to make them be able to accomplish management of production processes, organization, professional administration and consultancy tasks. With their advanced knowledge they need to be able to interpret the EU rural development policy, to plan and carry out programs.*
KEYWORDS: *rural development, basic training, goals, programs*

INTRODUCTION

As Hungary is a member of the EU, it is important to meet the EU requirements and legislation. During the accession negotiations, one of the most critical areas was the environmental protection and specialized agricultural administration which proved to be a significant gap to be overcome. To do so the existence of a significant number of well-trained professionals, who are capable to take appropriate actions, carry out a high level achievements according to the European Union directives and requirements, is outstandingly important and highly necessary.

The most significant challenges of the sand ridge to which the College of Kecskemét Horticultural Faculty has to find an educational strategy are drying and water scarcity. The most urgent tasks are summarized below:

- *the county's agricultural and rural development concept should be based on a strategy which has been elaborated to deal with drying-up*
- *on the ridge area further production extension, agro-environmental program expansion in a broader range, an appropriate adjustment of land utilisation to the conditions (stop the forestation, prefer the cultivated farms).*
- *utilize the dry-agriculture in its maximum potential, disperse drought-resistant species and varieties, and support related (applied) research and development functions,*
- *the priority development of animal husbandry,*
- *retention and development of large-scale cultivation,*
- *dissemination of the concept and means of precision agriculture*

from the side of wider economy, it is recommended to develop three sectors: environmental industry, food processing, rural tourism.

MATERIAL AND METHODS. Agricultural training in Horticulture Faculty

The College of Kecskemét Horticultural Faculty does extended research nationally and internationally, especially in applied research fields which are in close relationship with our educational profile.

The research of Faculty fields are ornamental plant-, vegetable-, fruit- and vine-growing, processing, machinery, economics, marketing, informatics and environmental protection. Three inventions and several innovations mark our research results. From among the inventions developed at the Faculty the frameless foil early growing method developed by the Vegetable Growing Institute is worth mentioning. It is used in more than 3000 hectare nationally.

The present projects of Faculty are on organic control products, developing environmentally friendly growing technologies, modelling sustainable development on the sand table-land between the Rivers Danube and Tisza, bio-ethanol-based utilisation of agricultural products. We intend to publish our results widely in national and international literature, at scientific conferences and discussions.

The Faculty organizes several professional conferences and exhibitions. The students of faculty also take part in the research projects of the institutions. Local and national student researchers' conferences provide a great opportunity for discussing and presenting their research results.

For post-graduates in college education we offer different specialist engineering further educational courses such as Specialised Engineer of Integrated Fruit Growing, Specialised Engineer of Agro-Environment, Vini- and Viticulture Specialised Engineer, Rural Development Manager, Specialised Engineer of Greenery Farming, Specialised Engineer of Vegetable Forcing and Mushroom Growing.

The Faculty has regular further education courses for people with basic, secondary and higher education qualifications in Flower arrangement, Park keeping, Pruning, Plant protection, soil protection, fruit and vegetable storing, vine-growing, wine-making and other fields. Silver spike farmer, Gold spike farmer, Agricultural entrepreneur training courses (which are on the national vocational training list) are also popular. Besides the training courses, our faculty is an

examination centre of the Hungarian vocational training.

INCLUDING RURAL DEVELOPMENT ACTIVITIES

The value of the region) is increasing, its unique (environmentally friendly, bio-) agriculture is getting a new chance, and it becomes possible to renew the farmsteads areas. Accordingly, the tasks are:

- to improve professional organization of the rural area development,
- there is a need for integrated rural development professionals with comprehensive knowledge, (education),
- It requires common, multi-disciplinary researches (applications)
- individual farm-specific modelling is needed

RESULTS AND DISCUSSION. The multifunctional agriculture and sustainable agriculture

The concept of multifunctional agriculture and sustainable agriculture must be applied in everyday practice. Primary concern is the environmental, economic and social sustainability. These correlations are summarized in Fig 1.

<table>
<tr><td colspan="6">Nature</td></tr>
<tr><td colspan="6">GLOBAL</td></tr>
<tr><td></td><td>Climate Changing</td><td>EU</td><td>Economy</td><td>Society</td><td></td></tr>
<tr><td></td><td>Drought, drying water scarcity Extreme Weather</td><td>System of agricultural subsidies</td><td>The decline of local farms</td><td>Urbanization, alienation, homogenization</td><td></td></tr>
<tr><td>ECO-NOMY</td><td></td><td colspan="2">The challenges and conflicts of agriculture in Bács-Kiskun County</td><td></td><td>SOCIETY (institutional system)</td></tr>
<tr><td>System Change Effects</td><td>The crisis of the agriculture</td><td>Migration, aging, poverty</td><td>Unstable land use, soil erosion,</td><td>Lack of economic planning, rural unemployment</td><td>Food safety, affordable food, lack of vision</td></tr>
<tr><td></td><td>NATIONAL</td><td></td><td></td><td>LOCAL</td><td></td></tr>
<tr><td>Politics</td><td>Economy</td><td>Society</td><td>Environment</td><td>Economy</td><td>Society</td></tr>
<tr><td colspan="6">SETTLEMENT (Infrastructure)</td></tr>
</table>

Figure 1: The impacts on rural development

FARMERS PROFESSIONAL DEVELOPMENT IN COLLAGE OF KECSKEMÉT

The Regional Advisory Centre providing continuous further education for farmers has been operating at the Horticultural College Faculty since 2007. With regular further training courses - like farmer entrepreneur, bio cultivator, park keeper, wine-grower, winemaker, vineyardist courses - we enhance farmers' theoretical and practical skills and competences in their profession. In addition, at the faculty we provide service with the accredited Plant Examination Laboratory of Soil for planters, which we will expand with environment, food and microbiological experiments and testing of raw materials.

The Regional Professional Advisory Centre assists the work of the accredited Plant Examination Laboratory of Soil to a significant extent, because the binding soil samples of contractual partners of 2008-2009 are analyzed here.

The Fig 2-3 give information about the farmers taking participation in the training.

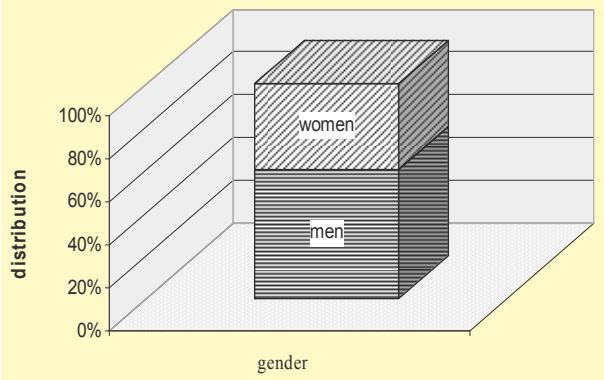


Figure 2. The gender proportion of trainees

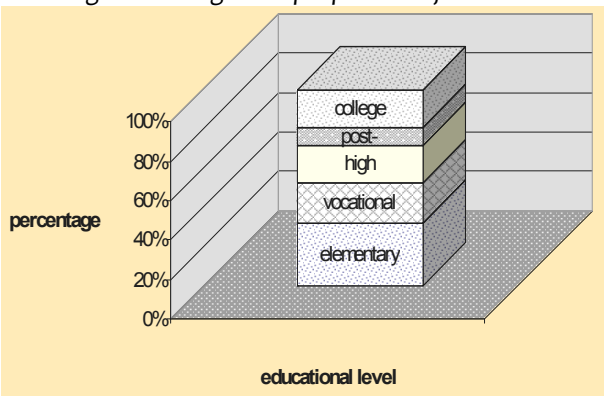


Figure 3. The educational level of trainees

Assessing the figures we can state that the 60% of participants are male, regarding the education level the primary/elementary school education is dominant among the participants, followed by the higher educational graduates. The reason why most people take part in the training is their obligations to meet and fulfil the expectations of grants they have won. Examining the scope of their activities we can conclude that nearly 90% of the participants work as active farmers. The aim of the Kecskemét College Faculty of Horticulture is that after the further training course farmers will be able to carry out:

- improvement measures regarding the standard of living of people living in rural areas,
- problem and development analysis of rural areas, prepare a business plan,
- continuous updating and improvement of the management structure,
- meeting the expectations of international standards of rural development management,
- how to write and coordinate rural development projects

CONCLUSIONS, SUGGESTIONS

The Faculty must strive for developing the infrastructural conditions in order to educate the discipline of theoretical and practical rural development in a most modern way. The training can be organized on three levels: basic full time courses (BSc) (bachelor degree program of economic and rural

development), vocational training in rural development, and MSc courses after the successful accreditation. Particular emphasis should be put on courses giving professional qualifications, most of which are subsidized by the state. As a result, we manage to develop close professional relationships with farmers, which partly serve as the practical criteria of the education as well.

In close cooperation with farmers we try to provide services beyond education and further training including both laboratory tests (soil and plant examination, food, raw materials testing, microbiological testing), and purchasing specialized books

REFERENCES

[1.] *Csatári, B. (2010): the common future of the countryside. Dialogue in the countryside, II. grade, 1 No. pp. 6-9*

[2.] *Glatz, F. (2009): The future of farms and the future of farm research. National Rural Forum. Dialogue in the countryside, Vol 1. No.1. pp. 16-17*

[3.] *3rd F. Glatz (2009): The Present and Future of Farms. II. National Rural Forum. Dialogue in the countryside, Vol 1. No. 3. pp. 3-5*

[4.] *Koponicsné Gy. D. -Varga, Gy. (2009): Learning and education opportunities in rural areas. The vision for agriculture and rural areas. West Hungarian University of Agriculture and Food Science, Mosonmagyaróvár, Conference Proceedings, Vol. 1. pp. 120-130*

[5.] *Kozar, J. – Toth, K. (2009): Regional aspects of the consultancy. The vision for agriculture and rural areas. West Hungarian University of Agriculture and Food Science, Mosonmagyaróvár, Conference Proceedings, Vol. 1. pp. 30-36*

[6.] *Stark A. (2009): Rural development funding in 2008-2010. II. National Rural Forum. Dialogue in the countryside, Vol.1. No. 3. pp. 12-15*

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

copyright © UNIVERSITY POLITEHNICA TIMISOARA,
FACULTY OF ENGINEERING HUNEDOARA,
5, REVOLUTIEI, 331128, HUNEDOARA, ROMANIA
http://acta.fih.upt.ro

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

copyright © UNIVERSITY POLITEHNICA TIMISOARA,
FACULTY OF ENGINEERING HUNEDOARA,
5, REVOLUTIEI, 331128, HUNEDOARA, ROMANIA
http://acta.fih.upt.ro

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome V (Year 2012). FASCICULE 3 [July–September]. ISSN 2067-3809

[1.] Harshavardhan KAYARKAR, [2.] Sugata SANYAL

A SURVEY ON VARIOUS DATA HIDING TECHNIQUES AND THEIR COMPARATIVE ANALYSIS

[1.] M.G.M's College of Engineering and Technology, Navi Mumbai, INDIA
[2.] School of Technology and Computer Science, Tata Institute of Fundamental Research, Mumbai, INDIA

Abstract: *With the explosive growth of internet and the fast communication techniques in recent years the security and the confidentiality of the sensitive data has become of prime and supreme importance and concern. To protect this data from unauthorized access and tampering various methods for data hiding like cryptography, hashing, authentication have been developed and are in practice today. In this paper we will be discussing one such data hiding technique called Steganography. Steganography is the process of concealing sensitive information in any media to transfer it securely over the underlying unreliable andunsecured communication network. Our paper presents a survey on various data hiding techniques in steganography that are in practice today along with the comparative analysis of these techniques.*
Keywords: *DataHiding, Cover Media, Steganography, Steganalysis*

Introduction

Internet came into existence in the late 1960s and 1970s out of the need to exchange research data among the researchers across different universities and also to enable communication in the battlefield to convey vital information which could prove advantageous in the war situations. Since the inception of the internet, the security and the confidentiality of the sensitive information have been of utmost importance and top priority.

The reason for this security and confidentiality is because the underlying communication network over which the transfer of sensitive information is carried out is unreliable and unsecured. Anybody with the proper knowledge and right applications can eavesdrop and learn of the communication and intercept the data transfer which could be very dangerous and even life threatening in some situations.

Ideally the internet and the communication network and the routing protocols should exhibit the following the properties:

- ***Security:*** *Security is an important property of the internet. The internet should provide and preserve the confidential and sensitive information that flows through it. The security should be such that only the intended recipient of the information should gain access to it.*
- ***Distributed Operation****: The internet should be distributed rather than only residing on some centralized server. In the event of the crash the internet should not lose its functionality and continue performing efficiently.*
- ***Reliability****: Reliable communication is one of the vital properties of the internet. The internet should guarantee the reliable delivery of the information to the intended recipient.*
- ***Fault-Tolerance****: Fault-tolerance means the ability of the system to operate normally even in the events of failure. Internet should exhibit fault-tolerance so that it keeps on functioning even when there is failure in some part of the internet.*
- ***Quality of Service Support****: Quality of Service (QoS) is one of the crucial properties in terms of communication. Inter should provide QoS support to various applications and sensitive data and should prioritize them depending on the nature of the data.*
- ***Robustness****: Internet should be robust in the sense that it should continue functioning normally even in the presence of errors and unexpected situations like invalid input.*

All the above mentioned properties are ideal and cannot be practically implemented in the structure and functioning of the internet as it comprises of many networks, different infrastructures: wired, wireless, ad hoc and various mobility models [1] [2] [3] [4] [5]. One such property that cannot be guaranteed in the internet is Security.

Due to the inability to guarantee security, various vulnerabilities exist in the network that can be exploited and gives rise to several security attacks. Some of the common security attacks are listed below.

- *Impersonation or Spoofing: The main goal of this attack is to assume the identity of the person and convince the sender that it is communicating with the intended recipient.*
- *Man in the Middle attack: In this attack, the attacker makes independent connections with the two parties across the network making them*

believe that they are communicating privately, when in fact the communication is controlled and intercepted by the attacker.

- Traffic Analysis: In this process the attacker listens to the chatter on the communication network between two parties without interacting between them and tries to learn the information that they are sharing.

To mitigate these security vulnerabilities and facilitate seamless and safe transfer of data over the communication channel, techniques like cryptography, hashing, authentication, authorization, steganography are developed.

Our paper illustrates various data hiding techniques in steganography to enable the safe transfer of critical data over the unsecure network.

Steganography is sometimes erroneously confused with cryptography, but there are some notable and distinctive differences between the two. In some situations steganography is often preferred to cryptography because in cryptography the cipher text is a scrambled output of the plaintext and the attacker can guess that encryption has been performed and hence can employ decryption techniques to acquire the hidden data. Also, cryptography techniques often require high computing power to perform encryption which may pose a serious hindrance for small devices that lack enough computing resources to implement encryption.

On the contrary, steganography is the process of masking the sensitive data in any cover media like still images, audio, video over the internet. This way the attacker does not realize that the data is being transmitted since it is hidden to the naked eye and impossible to distinguish from the original media.

Steganography involves 4 steps:

a. Selection of the cover media in which the data will be hidden.
b. The secret message or information that is needed to be masked in the cover image.
c. A function that will be used to hide the data in the cover media and its inverse to retrieve the hidden data.
d. An optional key or the password to authenticate or to hide and unhide the data.

In this paper we present a survey on various data hiding techniques in steganography along with their comparative analysis.

The rest of the paper is organized as follows: Section 2 presents the survey on various data hiding techniques and related work. Section 3 performs the Comparative Analysis of the techniques discussed in Section 2. Finally Section 4 draws the Conclusion of the paper.

VARIOUS DATA HIDING TECHNIQUES – Data Hiding Techniques in Still Images

In this section we will be presenting the survey on various data hiding techniques in steganography to facilitate secure data transmission over the underlying communication network.

Nosrati et al. [6] introduced a method that embeds the secret message in RGB 24 bit color image. This is achieved by applying the concept of the linked list data structures to link the secret messages in the images. First, the secret message that is to be transmitted is embedded in the LSB's of 24 bit RGB color space. Next, like the linked list where each node is placed randomly in the memory and every node points to every other node in list, the secret message bytes are embedded in the color image erratically and randomly and every message contains a link or a pointer to the address of the next message in the list. Also, a few bytes of the address of the first secret message are used as the stego-key to authenticate the message. Using this technique makes the retrieval and the detection of the secret message in the image difficult for the attacker.

Kuo et al. [7],[8],[9] and [10] presented a reversible technique that is based on the block division to conceal the data in the image. In this approach the cover image is divided into several equal blocks and then the histogram is generated for each of these blocks. Maximum and minimum points are computed for these histograms so that the embedding space can be generated to hide the data at the same time increasing the embedding capacity of the image. A one bit change is used to record the change of the minimum points.

Das et al. have listed different techniques to hide data [11] [12]. The authors have mainly focused on how steganography can be used and combined with cryptography to hide sensitive data. In this approach they have explained and listed various methods like Plaintext Steganography, Still Imagery Steganography, Audio/Video Steganography and IP Datagram Steganography which can be used to hide data. The authors have also elucidated the Steganalysis process which is used to detect if steganography is used for data hiding.

Naseem et al. [13] presented an Optimized Bit Plane Splicing algorithm to hide the data in the images. This method incorporates a different approach than the traditional bit plane splicing technique. In this approach instead of just hiding the data pixel by pixel and plane by plane, the procedure involves hiding the data based on the intensity of the pixels. The intensity of the pixels in categorized into different ranges and depending on the intensity of the pixel, the number of bits are chosen that will be used to hide data in that

particular plane. Also, the bits are hidden randomly in the plane instead of hiding them adjacent to each other and the planes are transmitted sporadically thus making it difficult to guess and intercept the transmitted data.

Fu et al. presented some novel methods for data hiding in halftone images [14], [15]. The proposed method enables to hide huge amounts of data even when the original multitone images are unavailable by forced pair-toggling. The resulting stego-images have high quality and virtually are indistinguishable from the original image.

Dey et al. [16] have proposed a novel approach to hide data in stego-images which is an improvement over the Fibonacci decomposition method. In this method the authors have exploited Prime Numbers to hide data in the images. The main agenda is to increase the number of bit planes of the image so that not only the LSB planes but even the higher bit planes can be used to hide to data. This is done by converting the original bit planes to some other binary number system using prime numbers as the weighted function so that the number of bits to represent each pixel increases which in turn can be used hide data in higher bit planes. The authors have also performed a comparison of the Fibonacci decomposition method with the traditional LSB data hiding technique showing that the former outperforms the latter method and comparing Fibonacci Decomposition method with the proposed method which outclasses the former method. Also, the proposed method generates the stego-image which is virtually indistinguishable from the original image.

Data Hiding Techniques in Audio Signals

Kekreetal proposed two novel methods to transfer secret data over the network by hiding them in the audio signals, thus generating a stego-audio signal [17] [18]. In the first method the authors hide the secret data in the LSB of audio by considering the parity of the sample, i.e. instead of directly replacing the digitized sample of the audio with the secret message, first the parity of the sample is checked and then the secret data is embedded into the LSB. This way it becomes even more difficult for the intruders to guess the bit or the data that is being transmitted. In the second approach, XORing of the LSB's is performed. The LSB's are XORed and depending on the outcome of this operation and the secret data that is to be implanted, the LSB of the sample data is changed or left unchanged. A different approach is followed by Kondo. Kondo [19] proposed a data hiding algorithm to embed data in stereo audio signals. The algorithm uses polarity of reverberations which is added to the high frequency signals. In this method the high frequency signals are replaced by one middle channel and then the data is embedded. The polarity of reverberations that is added to each channel is performed to adjust the coherence between these channels. The detection of the embedded data is done by employing the correlation between the sum and difference of the stereo signal. Also, original signal is not required to extract the hidden data by using this algorithm.

Data Hiding Techniques in IPv4 Header

To securely transmit the data over the network the Vasudevan et al. [20] used the analogy of the jigsaw puzzle. They insinuate to fragment the data into variable sizes instead of fixed size like the jigsaw puzzle and append each fragment of data with a pre-shared message authentication code (MAC) and a sequence number so that the receiver can authenticate and combine the received fragments into a single message. At the sender side every data fragment is prefixed and suffixed with a binary '1' and then XOR'ed with a Random number called the one-time pad and transmitted over the network. When the receiver receives the message it performs the exact opposite process of that to the sender and retrieves the intended message.

Ahsan and Kundurpresented two novel approaches that exploit the redundancy in the IPv4 header of the TCP/IP protocol suite to convey the secret message over the communication channel without detection [21], [22], [23], [24]. In the first method, the FLAGS field containing the fragmentation information is used to conceal the data and transmit over the network. In the second technique 16-bit identification field of the header through chaotic mixing and the generation of sequence numbers is used to hide the data and convey the information to the recipient.

Data Hiding Techniques in Video Sequences

Li et al. [25] and [26] suggested a data hiding technique based on the video sequences. This method implements an adaptive embedding algorithm to select the embed point where the sensitive data is to be concealed. The scheme functions by adopting 4x4 DCT residual blocks and determining a predefined threshold. The blocks are scanned in an inverse zigzag fashion until the first non-zero coefficient is encountered. The value of this coefficient is compared with predefined threshold and if it is greater than the threshold then that pixel is chosen to embed the data.

Data Hiding Techniques using DNA Sequences

Abbasy et al. [27] and [28] introduced a scheme to enable secure sharing of resource in cloud computing environments. The proposed method employs DNA sequences to hide data. The process consists of two steps. In the first step a DNA sequence is selected and the binary data is converted into this DNA sequence by applying the pairing rules. This step, apart from

converting the data also increases the complexity by applying the complementary rules and then indexing the garbled sequence. The second step involves the extraction of the hidden data from the DNA sequence where in exactly a reverse operation is performed to the first step.

COMPARATIVE ANALYSIS OF VARIOUS DATA HIDING TECHNIQUES

In this section a comparative analysis of different data hiding schemes in steganography is presented.

The authors in [6], [7], [13], [14] and [16] have all presented techniques to hide data in the still images and generated stego-images as the output. In [6] the authors embed the data in RGB 24 bit color image by using the linked data structures where in, the data hidden in the image is linked with other data.

The advantage of this method is that hiding the data randomly than sequential will make it difficult for the attacker to locate it and also without the authentication key the attacker will not be able to access the next piece of data in the image. Instead of using the whole image as the cover image, the authors in [7] have proposed a method that segments the image into blocks of equal sizes. Also, the process involved in this method is reversible hence there is no loss of hidden data. The approach followed in this scheme to conceal data is quite different. In this technique the histograms of the blocks of images is taken and they are shifted to minimum point of the histogram and then the data is hidden between these points. The improvement of this technique is that it provides higher capacity to hide data than the previous method.

In [13] optimized bit plane splicing method is implemented. In this method the intensity value of the pixel is divided into different planes and rather than using the traditional method of hiding the data into LSB of the pixel and plane by plane, the data in this approach is hidden based on the intensity of the pixels. The pixels are grouped based on the intensity and then number of pixels used to represent the data is chosen depending on the intensities. Also, rather than hiding the data sequentially in the planes, the data is hidden randomly and during the transmission of the data the planes are transferred randomly to make it difficult to intercept the data. The advantage of this technique is that by grouping the pixels according to the intensity more number of bits is available to represent the hidden data than just the LSB of the pixel. In [16] to increase and utilize the higher bit planes to hide the data a different approach from the one discussed earlier is employed. This is achieved by converting the original bit planes into some other binary number system using the prime numbers as the weighted function. This enables to use more number of bits to represent the hidden data.

The authors in [17] and [19] use audio signals as the cover media to hide the sensitive data. In [17] the authors present two techniques to hide data in the audio signals. In the first method before hiding the data in the LSB of the sample of the audio signal the parity of the sample checked. This method makes the attacker difficult to guess the transmitted data. In the second approach, the LSB's are XOR'ed and depending on the result of this operation and the hidden data the LSB of the sample data is decided to be changed or left unchanged. In [19] a separate approach is followed where in the stereo audio signals are used to embed the data. In the proposed algorithm the polarity of reverberations is applied to the high frequency signals which are then replaced by one middle channel to embed the critical data.

Jigsaw-based approach [20] is used to transfer data over the communication channel securely. In this scheme the data is fragmented in block of variable sizes and a message authentication code (MAC) is used to authenticate each and every piece of data. Also, every message is prefixed and suffixed with a binary 1 along with XOR-ing the data with the randomly generated one-time pad.By fragmenting the data the attacker is unable to make sense of the data at the same time he cannot access the data unless he possess the authentication code for the data. A diverse approach is followed by the authors in [21]. In this scheme the redundant fields in the IPv4 header is exploited to mask the data. The fragment bit of FLAGS and the 16-bit identification fields are utilized to pass the delicate data over the communication network.

TABLE I below provides a brief summary of the data hiding techniques in steganography with their advantages.

CONCLUSIONS

In this paper we discussed about steganography and presented some notable differences between steganography and cryptography. We also surveyed various data hiding techniques in steganography and provided a comparative analysis of these techniques.

In the Introduction section we discussed about various security flaws and vulnerabilities in internet.

We also discussed about various techniques to enable the secure transfer of data with the help of methods like cryptography, steganography, hashing, and authentication. In the next section we presented various techniques to conceal data in steganography. Comparative Analysis has been presented in Section 3, followed by the Conclusion.

Table Ia: A brief summary of various data hiding techniques in steganography - Data Hiding Techniques Proposed

Cover Media	Data Hiding Techniques Proposed
1. Still Image	1. In [6] the authors implemented a scheme that uses the concept linked list of randomly embedding the data in the image and linking them together.
	2. The method proposed in [7] divided the images into equal block sizes and then uses histogram to embed the data.
	3. Optimized Bit Plane splicing algorithm [13] is implemented where in the pixels are grouped based on their intensity and then the number of bits are to represent the hidden data are chosen.
	4. In [16] higher bit planes are generated by converting the pixels into different binary format using prime numbers as the weighted function.
2. Audio Signal	1. In [17] the authors proposed two methods to use the audio signals to hide the data. In the first method, the parity of the sample is checked before replacing the LSB of the sample. In the second approach XOR-ing is carried out.
	2. In [19] polarity of the reverberations is added to the high frequency channels and these high frequency channels are used hide the data.
3. IPv4 Header	1. In [21] the authors have exploited the redundant fields like fragmentation bit and the 16-bit identification field of the IPv4 header to covertly transfer the data over the communication network.

Table Ib: A brief summary of various data hiding techniques in steganography - Advantage(s)

Cover Media	Advantage(s)
1. Still Image	1. The attacker is unable to guess the next message as the data is not hidden sequentially. Also, without the password it is not possible to access the hidden data.
	2. Rather than sending a single image containing all the hidden data, blocks of images can be sent in out of order to confuse the attacker.
	3. Since data is hidden in the histogram it is difficult to locate the data along with the increase in capacity to conceal data.
	4. As the bits are grouped based on the intensity of the pixels, more number of darker intensity pixels can be used to represent the hidden data than just the LSB
	5. Higher bit planes can now be used to hide the data instead of just the lower bit planes.
2. Audio Signal	1. It is difficult to determine the data in the audio signals because the data is not hidden directly in the sample but the parity is checked before inserting the data.
	2. 1. As the polarity of the reverberations is used to hide the data in the high frequency signals, the stego-audio signals generated are more robust and resistant to errors during transmission.
3. IPv4 Header	1. As the inherent fields of IPv4 header are utilized to transfer the data, it is extremely difficult to detect these covert channels. Hence, the sensitive data can be communicated easily by using this technique.

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

REFERENCES

[1.] Bhavyesh Divecha, Ajith Abraham, Crina Grosan and Sugata Sanyal, "Analysis of Dynamic Source Routing and Destination-Sequenced Distance-Vector Protocols for Different Mobility models", First Asia International Conference on Modeling and Simulation, AMS2007, 27-30 March, 2007, Phuket, Thailand. Publisher: IEEE Press, pp. 224-229.

[2.] S. Gowrishankar, S. Sarkar, T. G. Basavaraju, "Simulation Based Performance Comparison of Community Model, GFMM, RPGM, Manhattan Model and RWP-SS Mobility Models in MANET," First International Conference onNetworks and Communications (NETCOM '09), 27-29 Dec. 2009, pp.408-413.

[3.] Jonghyun Kim, Vinay Sridhara, Stephan Bohacek, "Realistic mobility simulation of urban mesh networks", Journal of Ad Hoc Networks, Vol. 7, Issue 2, March 2009, Publisher: Elsevier,pp. 411-430.

[4.] Liu Tie-yuan, Chang Liang, Gu Tian-long, "Analyzing the Impact of Entity Mobility Models on the Performance of Routing Protocols in the MANET", 3rd International Conference onGenetic and Evolutionary Computing, 14-17 Oct. 2009, pp.56-59.

[5.] M.F. Sjaugi, M. Othman, M.F.A. Rasid, "Mobility models towards the performance of geographical-based route maintenance strategy in DSR", IEEE International Symposium on Information Technology, ITsim 2008 ,Vol. 3, 2008, pp. 1-5.

[6.] M. Nosrati, R. Karimi, H. Nosrati, and A. Nosrati, "Embedding stego-text in cover images using linked list concepts and LSB technique", Journal of American Science, Vol. 7, No. 6, 2011, pp. 97-100.

[7.] Wen-Chung Kuo, Dong-Jin Jiang, Yu-Chih Huang, "A Reversible Data Hiding Scheme Based on Block Division", Congress onImage and Signal Processing, Vol. 1, 27-30 May 2008, pp.365-369

[8.] Yih-Chuan Lin, Tzung-Shian Li, Yao-Tang Chang, Chuen-Ching Wang, Wen-TzuChen, "A Subsampling and Interpolation Technique for Reversible Histogram Shift Data Hiding", Image and Signal Processing,Lecture Notes in Computer Science, Vol. 6134, 2010, Publisher: Springer Berlin/Heidelberg, pp. 384-393.

[9.] Chyuan-Huei Thomas Yang, Chun-Hao Hsu, "A High Quality Reversible Data Hiding Method Using Interpolation Technique, "IEEE Fifth International Conference onInformation Assurance and Security,Vol. 2, 18-20 Aug. 2009, pp.603-606.

[10.] Che-Wei Lee and Wen-Hsiang Tsai, "A Lossless Data Hiding Method by Histogram Shifting Based on an Adaptive Block Division Scheme", Pattern Recognition and Machine Vision, River Publishers, Aalborg, Denmark, pp. 1–14.

[11.] Soumyendu Das, Subhendu Das, Bijoy Bandyopadhyay, Sugata Sanyal, "Steganography and Steganalysis: Different Approaches", International Journal of Computers, Information Technology and Engineering (IJCITAE), Vol. 2, No 1, June, 2008, Serial Publications, pp. 1-11.

[12.] Abbas Cheddad, Joan Condell, Kevin Curran, Paul Mc Kevitt, "Digital image steganography: Survey and analysis of current methods", Journal of Signal Processing, Elsevier, Volume 90, Issue 3, March 2010, pp.727-752.

[13.] M. Naseem, Ibrahim M. Hussain, M. Kamran Khan, Aisha Ajmal, "An Optimum Modified Bit Plane Splicing LSB Algorithm for Secret Data Hiding", International Journal of Computer Applications, Vol. 29, No. 12, 2011. Foundation of Computer Science, New York, USA, pp. 36-43.

[14.] Ming Sun Fu and O.C. Au, "Data hiding watermarking for halftone images", IEEE Transactions onImage Processing, Vol.11, No.4,Apr. 2002, pp.477-484.

[15.] Soo-Chang Pei and J.M. Guo, "Hybrid pixel-based data hiding and block-based watermarking for error-diffused halftone images", IEEE Transactions onCircuits and Systems for Video Technology,Vol.13, No.8, Aug. 2003, pp. 867- 884.

[16.] Sandipan Dey, Ajith Abraham, Sugata Sanyal, "An LSB Data Hiding Technique Using Prime Numbers", IEEEThird International Symposium on Information Assurance and Security,Manchester, United Kingdom, IEEE Computer Society press, USA,29-31 Aug. 2007, pp.101-106.

[17.] H.B. Kekre, Archana Athawale, Archana Athawale, Uttara Athawale, "Information Hiding in Audio Signals", International Journal of Computer Applications IJCA, Vol. 7, No. 9,Foundation of Computer Science, New York, USA, pp. 14-19.

[18.] B. Santhi, G. Radhika and S. Ruthra Reka, "Information Security using Audio Steganography-A Survey", Research Journal of Applied Sciences, Engineering and Technology, Vol. 4, No. 14, pp. 2255-2258.

[19.] K. Kondo, "A Data Hiding Method for Stereo Audio Signals Using the Polarity of the Inter-Channel Decorrelator",IEEEFifth International Conference onIntelligent Information Hiding and Multimedia Signal Processing,IIH-MSP'09.12-14 Sept. 2009,pp.86-89.

[20.] Rangarajan A. Vasudevan, Sugata Sanyal, Ajith Abraham, Dharma P. Agrawal, "Jigsaw-based secure data transfer over computer networks", Proceedings of International Conference onInformation Technology: Coding and Computing,Las Vegas, Nevada,Vol. 1, 5-7 April 2004, pp. 2- 6.

[21.] Kamran Ahsan, Deepa Kundur, "Practical data hiding in TCP/IP", Proceedings of ACM Workshop on Multimedia Security, Vol. 2002, pp. 7-19.

[22.] Steven J. Murdoch and Stephen Lewis, "Embedding covert channels into TCP/IP", Information Hiding, Lecture Notes in Computer Science, vol. 3727, Springer Berlin / Heidelberg, 2005, pp. 247-261.

[23.] Sebastian Zander, Grenville Armitage, and Philip Branch, "A survey of covert channels and countermeasures in computer network protocols", IEEE Communications Surveys & Tutorials, Vol. 9, No. 3, 2007, pp. 44-57.

[24.] Wojciech Mazurczyk and Krzysztof Szczypiorski, "Steganography of VoIP streams", On the Move to Meaningful Internet Systems,OTM 2008, Springer, Vol. 5332, pp. 1001-1018.

[25.] Yu Li, He-xin Chen, Yan Zhao, "A new method of data hiding based on H.264 encoded video sequences", IEEE 10th International Conference onSignal Processing(ICSP), 24-28 Oct. 2010, pp.1833-1836.

[26.] Xiaoyin Qi, Xiaoni Li, Mianshu Chen,Hexin Chen, "Research on CAVLC audio-video synchronization coding approach based on H.264",IEEEInternational Conference on Uncertainty Reasoning and Knowledge Engineering (URKE), Vol. 2, 4-7 Aug. 2011, pp.123-126.

[27.] Mohammad Reza Abbasy, Bharanidharan Shanmugam, "Enabling Data Hiding for Resource Sharing in Cloud Computing Environments Based on DNA Sequences", IEEE World Congress on Services (SERVICES), 4-9 July 2011, pp. 385-390.

[28.] H.J. Shiu, K.L. Ng, J.F. Fang, R.C.T. Lee, C.H. Huang, "Data hiding methods based upon DNA sequences", Information Sciences, Elsevier, Vol. 180, Issue 11, 1 June 2010, pp. 2196-2208.

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome V (Year 2012). FASCICULE 3 [July–September]. ISSN 2067-3809

[1.] Peter PENIAK

CAN BASED APPLICATION PROTOCOLS FOR EMBEDDED DEVICES

[1.] UNIVERSITY OF ŽILINA, FACULTY OF ELECTRICAL ENGINEERING, DEPARTMENT OF CONTROL AND INFORMATION SYSTEMS, ŽILINA, SLOVAKIA

ABSTRACT: *Embedded systems are generally designed to perform the dedicated tasks with respect to device functions. Applications that are used in embedded systems are characterized by significant diversity with the different requirements for communication services. The interpretation of application data and control commands can be essentially different in interconnected embedded subsystems. The paper deals with CAN based application protocols that can be used for an interconnection of embedded devices via CAN fieldbus network. It is focused on selection of open application protocols that could be potentially used for device integration of different suppliers via CAN bus.*
KEYWORDS: *CAN, CAL, CIP, ZAL, ZCL, APS, NWM, API, ODVA, CiA*

INTRODUCTION

Embedded systems are generally designed to perform the dedicated tasks with respect to device functions. The small, computerized parts within a larger device then could serve for more general purpose and provide variety of functions within overall subsystem. These devices can be implemented either as standalone devices without necessity to interconnect with the other systems, or have to cooperate in real-time performance constraints.

Applications that are used in embedded systems are characterized by significant diversity with the different requirements for communication services. The interpretation of application data and control commands can be essentially different in interconnected embedded subsystems. Therefore using of the common open application protocols, which are independent on proprietary solutions of the particular vendors, is a key factor for a success. The particular manufacturers tend to support various open communication protocols, such as CAN, DeviceNet, Ethernet/IP and ZigBee. Usually, there are no problems when using devices of the same manufacturers for there is a good chance to use the same applications and their proprietary application protocols.

An example of CAN as an internal interface for interconnection of the embedded devices within printer subsystem is shown in Figure 1. The different subsystems are connected via CAN bus and can cooperate with using selected application protocol. Although CAN itself has not been used by all providers and we can still find a high technological heterogeneity in available products, due to its popularity and widespread deployment in automotive industry, we will focus on the possible open application protocols for CAN based embedded systems.

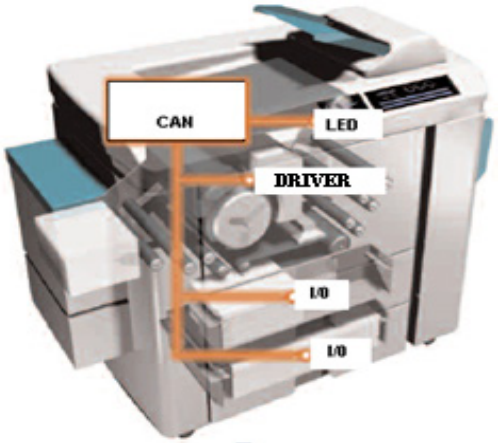


Figure 1. CAN internal interface for embedded printer subsystems

However, if there is a need to interconnect the devices of various manufacturers, the problems can occur despite using the same communication protocols. A vehicle control system can be used as a very good example as shown in Figure 2. CAN bus is very often implemented as integration layer for the devices of different vendors so that they can be interconnected with car's control system and on-board computer. Although a common application protocol has to be selected for their full integration.

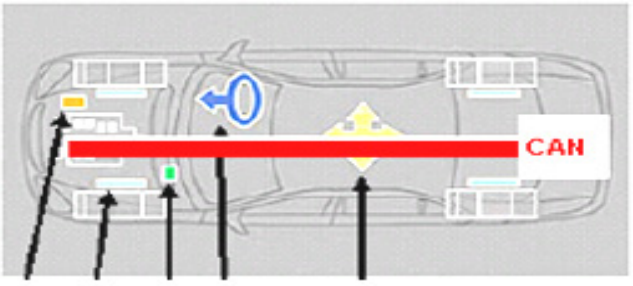


Figure 2. Vehicle control system with CAN

CAN APPLICATION PROTOCOLS

CAN application layer has to support implicit, explicit messages and provide mapping of CAN identifiers to the defined messages, or devices.

In addition, API (Application Programming Interface) is necessary for applications as well, providing the defined device profiles and necessary application objects. Device profiles and application objects represent virtual model of the defined devices and are used to identify capabilities of devices, map physical behavior to the variables and access application objects from applications.

Implicit and explicit application protocol messages with assigned CAN identifiers are encapsulated to the CAN frames and sent via CAN network. The network architecture and structure of the common application layer of CAN networks is shown in Table 1[1].

Table 1. CAN application layer

RM-OSI Layer	Network architecture (CAN based)	
API	Aplication objects Device profiles	
7	Implicit messages (I/O)	Explicit messages (I/O)
5, 6	(*Encapsulation*)	
4		
3		
2	CAN v.2	
1	ISO	

The application protocols used for embedded devices have not been unified yet. Individual vendors still try to use their proprietary architectures, however, there is an effort to create alliances of producers, such as ODVA, Fieldbus Foundation in order to promote a common standard for application layer [2,3]. The vendor independent standard CAL (CAN Application Layer) is supported by association CiA (CAN in Automation), while CIP (The Common Industrial Protocol) protocol for industrial automation applications is promoted by ODVA (Open DeviceNet Association).

As an alternative solution, ZigBee protocols ZAL (ZigBee Application Layer)/ ZCL (ZigBee Cluster Library) that are used in mobile applications and wireless networks, could be used as a potential solution for future as well. However, there have been no ZAL/ZCL implementations so far, except TCP/UDP encapsulation of ZAL/ZCL protocol messages [4]. Typical CAN/CAL application protocols that can be used with the CAN link layer services are shown in Table 2 [1]. ZigBee protocols are added as well, as a potential solution for integration with mobile devices.

Table 2. CAN based application protocols

RM-OSI Layer			
RM-OSI Layer	CAN/CAL protocols		
API	CAL	CIP	ZAL/ZCL
7			
5, 6	(*Encapsulation*)		
4			
3			
2	CAN v.2		
1	ISO		

CANOpen/CAL protocol

CAL provides a vendor independent application protocol for an object-oriented environment, which can be used for the integration of the various embedded devices. CAL protocol model is shown in Table 3.

Table 3. CAL application protocols

Layer	Protocol			
Device profiles	Profile A	Profile B	Profile C	……
7	CAL/CANopen (CiA)			
	NMT	DBT	LMT	CMS
-				
2	CAN 2.0			
1	CAN ISO 11898			

The protocol introduces a number of methods for transmitting and receiving messages through the so-called communication objects. CAL uses the following types of messages:

- *AM (Administration Messages)*
- *SDM/SDO(Service Data Messages/Objects)*
- *PDM / PDO (Process Data Messages / Objects)*
- *PM (Pre-defined Messages)*

PDO object is used for exchange of the implicit messages between applications. The objects are represented as variables, events (events), or data areas (domains), which are mapped to the corresponding PDO messages/objects in device directory. Always, the transmission is initiated by the client. SDO object is used for communication via explicit messages and supports communication in peer-to-peer mode. It can be used for non-fragmented messages with size 4B. Protocol is able to read and write data to object directory, transmit large volumes of data via fragmentation protocol.

Assignment of CAN identifiers is a key factor in the network architecture. CAN is able to control the priority of messages and provides a common list of identifiers (Poll), which are dynamically allocated to the end devices by object distributor (DMT). There is dedicated number of network identifiers (1260) available for objects (CMO) and only a small part is blocked for internal purpose.

CAL provides centralized management with network management server NMT, which basic task is the supervision of individual nodes in the network ("NMT Guarding"). NMT server maintains a list of active nodes and their status is periodically tested by message "Guard Request", as shown in Table 3. Device profiles are used for modeling of various network devices. CAL defines a common network directory for objects "Object Dictionary", in which every object is addressable by 16-bit index and 16-bit sub-index. The remaining CAL sub-protocols (DMT, CMS, LMT) will not be mentioned [1].

CIP PROTOCOL

CIP is object-oriented protocol for heterogeneous devices and networks (CAN, ControlNet, Ethernet/IP). The object model is applied for applications (API), but also in internal protocol architecture. It provides a wide range of communication services for embedded devices and supports the specific requirements of industrial and control applications [1].

CIP uses hierarchical model of communication and device addressing. Each device has assigned a unique identifier called MAC address (MAC ID #). The nodes are connected to the sub-networks interconnected to the CIP domain. CIP domain is seen as a logical area in which all nodes can be interconnected. To support specific communication requirements, the different domains can be established with assigned communication mode for each group independently (peer-to-peer, master-slave (cyclic), producer-consumer). There are two basic services:

- Explicit messages -for writing and reading of the object attributes, connection settings and file transfers
- Implicit Messaging – for exchange of /O process data in real time.

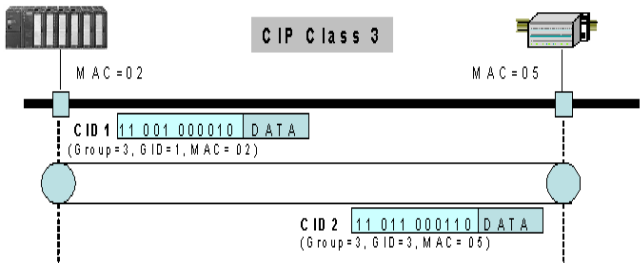


Figure 3. CIP addressing of CAL objects

The example of communication between two embedded devices via CAN and protocol CIP is illustrated by Figure 4. The format of CIP explicit messages is shown in Figure 10.

CIP Explicit Message

ID	DATA
11 b	8 B

0	GID		S –MAC ID	Group 1
1	0	MAC ID	GID	Group 2
1	1	GID	S-MAC ID	Group 3
1	1	1 1 1	GID	Group 4

GM	GID	MACID	F	XID	MAC ID	FT	FC	R/R	SC	A
2 b	3 b	6 b	1 b	3 b	6 b	2 b	6 b	1 b	n	

CIP header	
ID	*Identifier*
GM	*Group Message*
GID	*Group Message ID*
MAC ID	*MAC address*
S-MAC ID	*S MAC address*
F	*Fragment bit*
TID	*Transaction ID*
FT	*Fragment Type*
FC	*Fragment Count*
R/R	*Request/Response*
SC	*Service Code*
A	*Arguments*

Figure 4. Format of explicit CIP messages

ZigBee APPLICATION PROTOCOL (ZAL)

The ZAL protocol describes a set of structured communication primitives for an exchange of application data among mobile devices. ZAL protocol was designed for wireless communication of mobile devices via IEEE 802.15.4 link layer. The primary design goal of the ZAL was to support wireless communication of embedded systems, running on microcontrollers with limited amount of code, RAM and low network bandwidth. Therefore a compact low-traffic message format was developed with additional services, such as a device binding, service discovery and security protocol.

As a result, the ZigBee protocols became very popular and well-suited for a structured communication among networked embedded systems. There is a possibility that ZAL could be used as a common application protocol for CAN devices as well. Although the ZigBee Application Layer was originally designed to operate only over IEEE 802.15.4 wireless networks [6], an adaptation of the ZigBee Application Layer for CAN bus is generally possible. Figure 5 illustrates the possible use case. Mobile devices connected naturally use ZAL protocol for an internal communication via ZigBee. For a device integration, a dedicated gateway has to be used to link CAN devices with ZigBee ones. In addition, ZCL and APS (Application Support Sub-layer) application protocols are to be supported in CAN devices in order to enable full interoperability of the embedded devices.

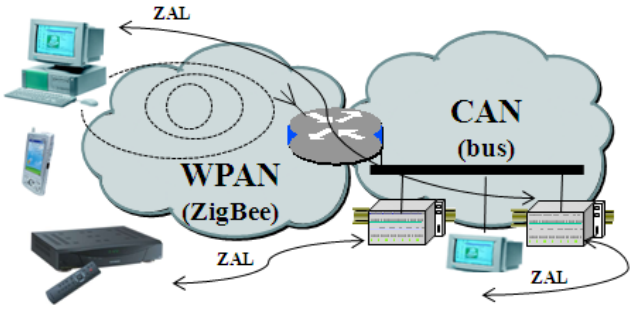


Figure 5. Integration of WPAN (ZigBee) and CAN devices

The integration approach has at least three major parts:

- ZigBee/CAN gateway for network integration
- Encapsulation of ZCL/APS messages via CAN bus protocol
- Mapping of addresses to CAN-ID identifiers

Figure 6 shows a model of ZigBee/CAN gateway. The gateway has physical interfaces for the both data link layers (CAN 2.0, IEEE 802.15.4).

In addition, the network layer protocol (NWM) is needed for ZigBee devices [5]. Finally, the main integration is to be covered by an additional application sub-layer (7+). Z-CAP protocol (ZigBee CAN Adaptation Protocol), responsible for address mapping and ZAL message encapsulation, is proposed to address the integration challenge.

The new protocol has to be implemented in ZigBee/CAN gateway and each CAN node (Fig. 6 b). However, ZigBee devices do not require any adaptation (Fig. 6 a).

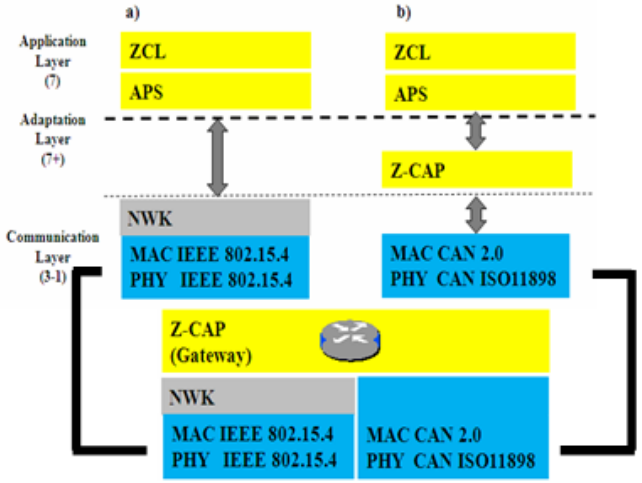


Figure 6. Protocol model of ZigBee/CAN integration with Z-CAP protocol

Z-CAP protocol offers two major services. Firstly, the mapping of ZigBee addresses to CAN-IDs is to be implemented. This process is based on Z-CAP binding table with assigned pairs of addresses (ZigBee, CAN). ZigBee devices would communicate with CAN devices as they would belong to ZigBee network. CAN applications would also use primarily ZigBee addresses. Z-CAP protocol just translates addresses to CAN-id and enables transfer of application messages among end nodes.

Secondly, an encapsulation of ZAL/ASP messages via CAN. Although an encapsulation is known technique, CAN propose very limited transport service with just 8B data left for a payload. It means, we cannot encapsulate the complete ZCL/APS messages (~70B) within one CAN frame (8B). Instead, ZAL message has to be divided to the several CAN frames and overall data integrity is to be managed by a fragmentation procedure. Z-CAP protocol therefore offers 1B of payload for fragmentation to identify all CAN frames belonging to 1 ZAL/ASP message (1B - FR=fragment id + FRC=fragment offset), as shown in Figure 7.

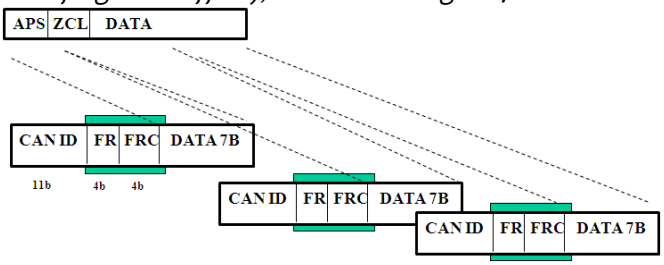


Figure 7. Encapsulation/Fragmentation of ZCL/APS messages via CAN

CONCLUSIONS

The paper dealt with CAN based application protocols that can be used for an interconnection of embedded devices via CAN fieldbus network. The main focus was on selection of open application protocols that could be used for integration of devices, with taking into consideration restriction to CAN link layer for transport of application protocol packets/messages. Besides the standard application protocols such as CAL and CIP, there is a new challenge with ZibBee application protocols that are much more popular and accepted by various vendors for mobile communication (WPAN). Therefore the recommendation is to focus on encapsulation of ZibBee protocols (ZAL, ZCS) via CAN messages in the same way as 6LoWPAN [RFC4944]. This would enable a simple integration with mobile embedded devices and could simplify overall network architecture of application layer for embedded devices.

REFERENCES

[1.] Franeková, M.- Kállay, F.- Peniak, P. Vestenický, P. (2007): Komunikačná bezpečnosť priemyselných sietí. ŽU Žilina, ISBN 978-80-8070-715-6 1.

[2.] Mahalik, N. P (2003).: Fieldbus technology, Industrial network standard for Real – Time Distributed Control, Springer, 2003

[3.] Kállay, F.- Peniak, P. (2003): Počítačové sítě LAN MAN WAN a jejich aplikace. Monografia, Grada Publishing 2003, ISBN 80-247-0545-1

[4.] Tolle G.(2008): A UDP/IP Adaptation of the ZigBee Application Protocol, October 2008, [WWW], http://tools.ietf.org/html/draft-tolle-cap-00

[5.] ZigBee specification, ZigBee alliance, January 17 2008, http://www.zigbee.org/Products/TechnicalDocuments Download/tabid/237/Default.aspx

[6.] IEEE 802 working group, Part 15.4: Wireless Medium Access Control (MAC) and Physical Layer (PHY), Specifications for Low-Rate Wireless Personal Area Networks (WPANs), IEEE Computer Society, Standard specification, http://standards.ieee.org/getieee802/download/802.15.4-2006.pdf

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome V (Year 2012). FASCICULE 3 [July–September]. ISSN 2067-3809

[1.] Róbert SÁNTA

INVESTIGATION OF THE REFRIGERANTS CHARACTERISTICS IN VAPOR COMPRESSION SYSTEMS

[1.] COLLEGE OF APPLIED SCIENCES – SUBOTICA TECH/ DEPARTMENT OF ENERGY AND ENVIRONMENT, MARKA ORESKOVICA 16, 24000 SUBOTICA, SERBIA

ABSTRACT: *The energy efficiency improvement of the refrigeration system to improve the operation quality makes it unavoidable to strive for the refrigeration system operation. Nevertheless, the processes taking place in it should be as accurate as possible to describe the underlying physical and mathematical model development and refinement. The experimental investigation of any refrigeration system is usually very complicated, mainly due to the financial costs and the large number of variables involved. The use of numerical models can reduce the costs and also facilitate understanding the phenomena related to the problem. The article aims to present and analyze the behavior components of the vapor-compression refrigeration system in case of various refrigerants. Refrigerants included in the present analysis are R22/R134a/R407C/R410A. The simulation program is based upon steady state mathematical models of the refrigeration circuit including the compressor, heat exchangers and thermostatic expansion valve. The simulation results have been presented in a graphic.*
KEYWORDS: *Refrigeration system, Refrigeration, Mathematical model, Simulation, COP*

INTRODUCTION

The European Commission accepts a proposal package [1] of future indicators at the beginning of 2008. The aim of this is to decrease the rapidly increasing greenhouse gas emissions based on the 2007 data. Furthermore to increase the renewable energy sources in the total energy consumption in the proportion of 20% by the year 2020.

The utilization of renewable energy sources is influenced by several factors. Besides the natural environment, the economic conditions are also major factors affecting the case of renewable energies. The fossil fuel prices and conditions of other energy costs are significantly determined by the demand for renewable as well as the amount of state aid and government fiscal policy application.

The energy efficiency improvement of the refrigeration system to improve the operation quality makes it unavoidable to strive for the refrigeration system operation. Nevertheless, the processes taking place in it should be as accurate as possible to describe the underlying physical and mathematical model development and refinement.

In addition to the structural design and dimensions of components of the refigeration system, the refrigerant is also a major influencing factor. The refrigerant disposes of a lot of thermodynamic characteristics which differ among themselves substantially. The thermodynamic characteristics are major contributors to the suitable choice of refrigerant, the choice of components of the refrigeration and cooling system, the refrigerant may be necessary when replacing.

The experimental investigation of any refrigeration system is usually very complicated, mainly due to the financial costs and the large number of variables involved. The use of numerical models can reduce the costs and also facilitate understanding the phenomena related to the problem.

Many researchers dealt with the description of the steady state behavior of a vapor compression refrigeration system such as Koury et al. [2] proposed a model for a refrigeration system with distributed parameter model for heat exchanger, Jong Won Choi et al.[3], Bellman et al.[4], Yang Zhao et al.[5] and S. A. Klein et al.[6].

DESCRIPTION OF PHYSICAL SYSTEM

The vapor-compression refrigeration cycles consists of the four main components: evaporator, compressor, condenser and expansion valves. The refrigerant is the working fluid of the refrigeration system.

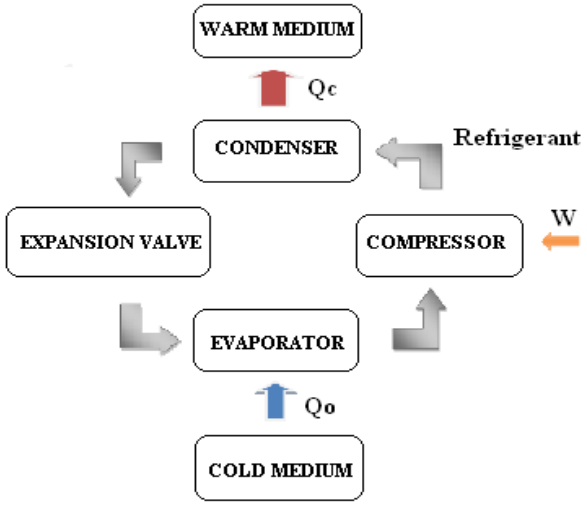


Figure 1. Energy flow diagram of the refrigeration system

In the evaporator, the refrigerant takes over the heat from the low-temperature primary fluid by vaporization. In the evaporator, the refrigerant is superheated and vapor is sucked in by compressor. With the invested mechanical work, it is brought higher level of energy. On the discharge side of the

compressor, the now hot and highly pressurized vapor is cooled in the condenser.
In the condenser, vapor provides the heat to the secondary fluid and then the refrigeration condenses. Condensation in horizontal tubes may involve partial or total condensation of the vapor. Depending on the application, the inlet vapor may be superheated, equal to 1.0 or below 1.0.
Superheated vapor enters the horizontal tube, which has a temperature below the saturation temperature of the vapor. The flow at this point in the tube is single-phase vapor flow. After the vapor cools and becomes saturated, condensation starts to occur on the inner wall of the tube.
Near the outlet of the horizontal tube, the vapor quality reduces to zero and the flow in the tube becomes single-phase liquid flow.
The condensed refrigerant then passes through a pressure-lowering expansion device.
The expansion device is to reduce the pressure and to regulate the refrigerant mass flow rate. The widely utilized expansion device is the thermostatic expansion valves. The thermostatic expansion is a valve for controlling the refrigerant flow by a sensor bulb placed in the evaporator discharge line and hence controls the mass rate by the degree of superheat.
The low pressure, refrigerant leaving the expansion device enters the evaporator, in which the refrigerant absorbs heat and boils. The refrigerant then returns to the compressor and the cycle is repeated.
The observed heat exchangers are counter-cross flow, shell and tube type. Tubes are made of copper and have a staggered layout. In the current case, the refrigerant flows through in finned tube bundle of heat exchangers, while primary and secondary fluid flow in the shell across the tube bundle.
In this case, the compression occurs on the principle of displacement reciprocating compressor. While the throttle is isenthalpic and occurs with variable cross-section of expansion valve.

MATHEMATICAL MODEL OF REFRIGERATION SYSTEM. Heat exchangers

The evaporation and the condenser are approached in a similar manner from the modeling point of view. Both are divided into regions associated to the phase of the refrigerant.
In the case of the condenser the superheated vapor, and the condensation are considered, whereas the evaporator is divided into the evaporating are superheated vapor regions.
For the each region, the overall heat transfer coefficients is evaluated by assuming that thermal resistance due to wall conduction, contact and fouling are negligibly small.
Heat exchanger energy balances:
Water side

$$Q = \dot{m} \cdot c_{pw} \cdot \Delta T_w \qquad (1)$$

Refrigerant side
Condensing region

$$Q = \dot{m}_{ref} \cdot \Delta i_{lv} \qquad (2)$$

Evaporating region

$$Q = \dot{m}_{ref} \cdot (i_v - i_i) \qquad (3)$$

Single phase regions

$$Q = \dot{m}_{ref} \cdot c_{pref} \cdot \Delta T_{ref} \qquad (4)$$

Overall Heat Exchangers

$$Q = A \cdot U \cdot LMTD \qquad (5)$$

Condenser

$$Q_C = Q_{desuperheated} + Q_{condensing} \qquad (6)$$

Evaporator

$$Q_o = Q_{evaporating} + Q_{desuperheating} \qquad (7)$$

LMTD is the logarithmic mean temperature difference defined by:

$$LMTD = \frac{\Delta T_2 - \Delta T_1}{ln \frac{\Delta T_2}{\Delta T_1}} \qquad (8)$$

The heat transfer correlation can be written as:

$$\frac{1}{U} = \frac{A_o}{A_i \cdot \alpha_w} + \frac{1}{\eta_o \cdot \alpha_r} \qquad (9)$$

Where is the finned heat transfer surface effiency given by the well known correlation:

$$\eta_o = 1 - \left(\frac{A_f}{A_o}\right) \cdot (1 - \eta_f) \qquad (10)$$

The heat transfer coefficient of single-phase refrigerant vapor was calculated by the Dittus-Boelter correlation [7]

$$\frac{\alpha_{vap} \cdot d_i}{\lambda} = 0.023 \cdot \left(\frac{G \cdot d_{in}}{\mu}\right)^{0.8} \cdot \left(\frac{\mu \cdot c_p}{\lambda}\right)^{0.33} \qquad (11)$$

Water-side heat transfer coefficient for staggered horizontal tubes is given by [7]

$$\frac{\alpha_w \cdot d_{out}}{\lambda} = C \cdot \left(\frac{G \cdot d_{out}}{\mu}\right)^{0.6} \cdot \left(\frac{\mu \cdot c_p}{\lambda}\right)^{0.33} \qquad (12)$$

Kandlikar correlation [8] was used for the prediction of the heat transfer coefficient in flow boiling. The final correlation consists of two sets of constants. One for the convective evaporation dominated regime and the other for the nucleate boiling dominated regime. The correlation is:

$$\alpha_{kf} = \alpha_f \cdot \left(C_1 \cdot (Co)^{C_2} \cdot \left(25 \cdot Fr_f\right)^{C_5} + C_3 \cdot (Bo)^{C_4} \cdot Fn\right) \qquad (13)$$

and the constants are given in the table below.

Table 1: Constants in Kandlikar (1990) correlation

constant	Convective evaporation	Nucleate boiling
C_1	1.1360	0.6683
C_2	-0.9	-0.2
C_3	667.2	1058
C_4	0.7	0.7
C_5	0.3	0.3

The correlation is calculated twice using each set of constants and the greater of the two values is used as the heat transfer coefficient.

$$\alpha_{tp} = max\left|\alpha_n, \alpha_c\right| \qquad (14)$$

For the two phase regions, in the condenser, Shah correlation [9] was selected to proposed heat transfer coefficient. The Shah correlation is a modified version

of Dittus-Boelter single-phase heat transfer correlation. The two-phase model the reduced pressure refrigerant takes into account.

$$\alpha_{kf} = \alpha_f \cdot \left[(1-x)^{0.8} + \frac{3.8 \cdot x^{0.76} \cdot (1-x)^{0.04}}{p^{*0.38}} \right] \quad (15)$$

Where the reduced pressure is: $p^* = \frac{p}{p_{crit}}$

In Eqs. (11) the single phase heat transfer coefficients are determined by the Dittus-Boelter correlation.

Compressor model

Refrigerant mass flow rate through the compressor is a function of compression ratio, refrigerant density and compressor speed, that is,

$$\dot{m} = f\left(\frac{p_c}{p_e}, \rho_{sz}, N\right) \quad (16)$$

The relationship between compressor exit and inlet temperatures is given by:

$$T_{ny} = T_{sz} \cdot \left[\left(\frac{p_{ny}}{p_{sz}} \right)^{\frac{k-1}{k}} - 1 \right] \quad (17)$$

Neglecting the thermal inertia effects, the indicated work is given by:

$$W = \frac{k}{k-1} \cdot p_{sz} \cdot v_{sz} \cdot \left[\left(\frac{p_{ny}}{p_{sz}} \right)^{\frac{k-1}{k}} - 1 \right] \quad (18)$$

Isentropic effiencies [10] is correlated as a function of the pressure ratio between condensation pressure and evaporation pressure.

$$\eta = A + \cdot B \cdot \tau + C \cdot \tau^2 \quad (19)$$

where A, B and C are the regression coefficients.

THERMOSTATIC EXPANSION VALVE MODEL AND REFRIGERANT

Thermostatic expansion valve is the valve that controls the refrigerants mass flow rate by sensing the degree of suction vapor superheat temperature. The enthalpy is assumed to be constant. The refrigerant mass flow is calculated by the following equation

$$\dot{m} = C \cdot \sqrt{2\rho \cdot (p_c - p_e)} \quad (20)$$

where C is the characteristic constant of the valve.

The refrigerants used in this study are the R22, R134a, R407C, R410A. Calculation of the refrigerants and transport properties is performed by correlations written as computer code function, using thermodynamic properties coming from SOLKANE database [11]. The effect of the circulation of oil is not taken into account in the model.

INITIAL CONDITION AND VALUES

The mathematical models are simulated by the use of the software tool Solkane.

The initial conditions and values for the simulation:

- Refrigerant: R22, R134a, R407C, R410A
- Refrigerating capacity: $Q = 2kW$
- Temperature of evaporator: $T_o = 0^\circ C$
- Pressure drop in evaporator: $\Delta p = 0.4bar$
- Superheating temperature: $\Delta T = 5K$
- Temperature of condenser: $T_c = 45^\circ C$
- Pressure drop in condenser: $\Delta p = 0.1bar$
- Isentropic efficiency of compressor: $\eta = 0.8$

SIMULATION RESULT AND DISCUSSION

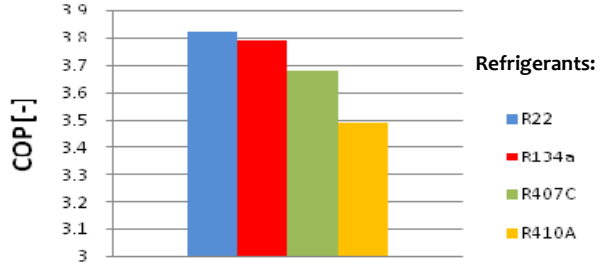


Figure 2. The coefficient of performance of the refrigerator

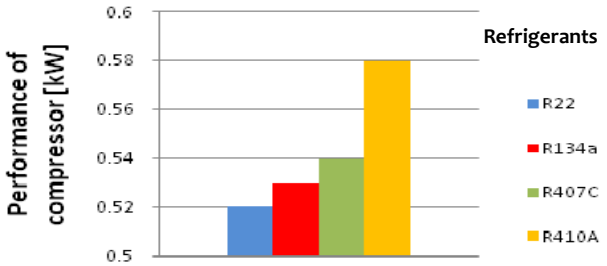


Figure 3. Performance of the compressor

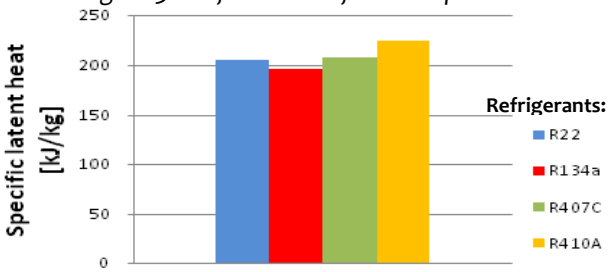


Figure 4. Specific latent heat of the refrigerants

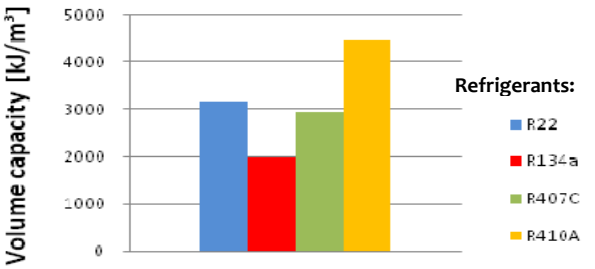


Figure 5. Volume capacity of the refrigerants

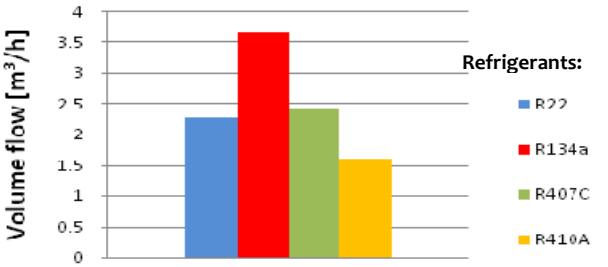


Figure 6.Volume flow of the refrigerants

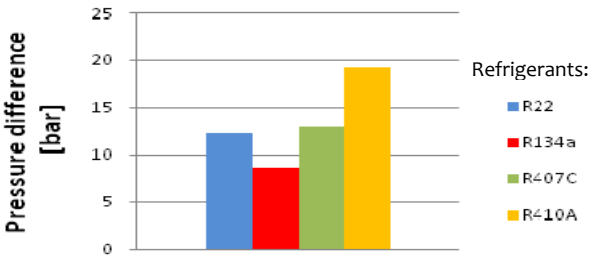


Figure 8. Pressure difference

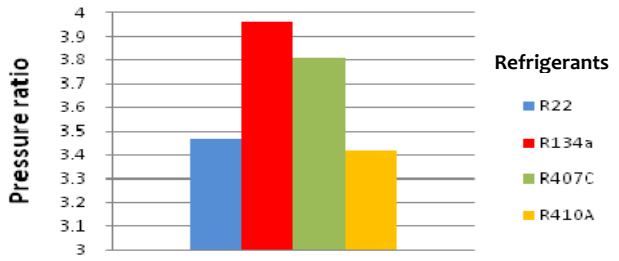


Figure 7. Pressure ratio of evaporator & condenser pressure

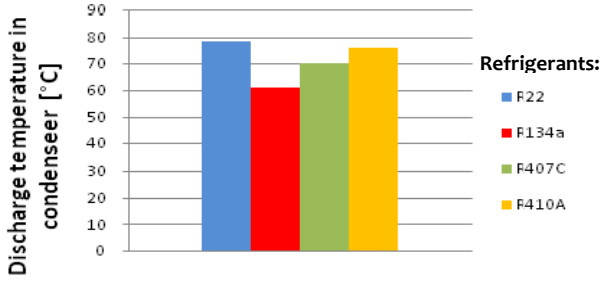


Figure 9. Discharge temperature

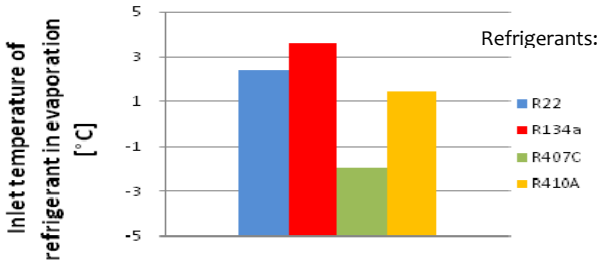


Figure 11. Inlet temperature of refrigerant in evaporator

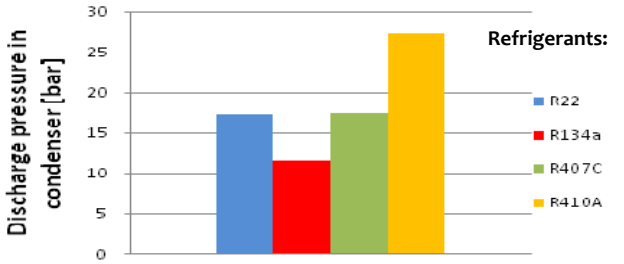


Figure 10. Discharge pressure

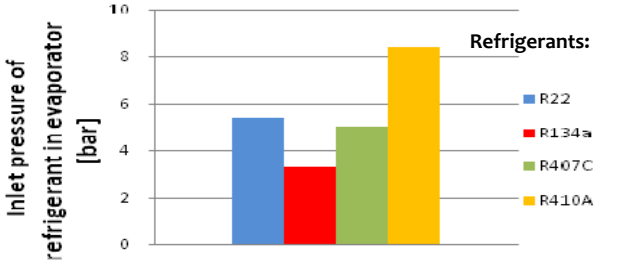


Figure 12. Inlet pressure of refrigerant in evaporator

CONCLUSIONS

- *The performance coefficient of the vapor refrigerant system of the refrigerant R22 is the highest of the investigated refrigerants since this one possesses the smallest refrigerant compressor power requirement and its latent heat is high. However, the applicability of the R22 refrigerant is of finite time, since it contains Cl its release is ceased until 2010, so it can be stated that R134a refrigerant dispose the best properties in terms of efficiency.*
- *Too high pressure is not favorable in the operation process of the equipment.The high partial pressure from the aspects of strength is unfavorable, it requires wall thickness contributing in costs increase.*
- *The pressure ratio in the condenser and the evaporator resulting positively of the piston compressors, while of the centrifugal compressors the small pressure difference between partial pressure is positive. The increase of pressure ratio in the piston compressor reduces volumetric efficiency of the compressor.*
- *When using reciprocating compressors it is advantageous if the volumetric capacity is high because that way the transportable volumetric flow and thus the machine sizes decrease. In the processes of turbo-compressors the high volumetric flow, low volumetric capacity is especially favorable.*
- *In the heat exchanger, the heat transfer is favorable, if the thermal conductivity coefficient is high,while the vapor,the liquid viscosity and surface tension of refrigerant is low.*
- *The refrigerant that meets all the requirements fully is non-existent. In each case the conditions and requirements must be examined in order to choose the most suitable and favorable refrigerant.*

REFERENCES

[1.] *Combating climate change The EU leads the way 2008 Edition, Catalogue number: NA-AB-08-128-EN-C.*

[2.] *R.N.N. Koury, L. Machado, K.A.R. Ismail: Numerical simulation of a variable speed refrigeration system, International Journal of Refrigeration 24 (2001) 192-200, PII: S0140-7007(00)00014-1.*

[3.] *Jong Won Choi, Gilbong Lee, Min Soo Kim: Numerical study on the steady state and transient performance of a multi-type heat pump system, International Journal of Refrigeration 34 (2011) 1157-1172, doi:10.1016/j.ijrefrig.2010.09.021.*

[4.] *Belman, J. M., Navarro-Esbrí, J., Ginestar, D. and Milian V., Steady-state model of a variable speed vapor compression system using R134a as working fluid. International Journal of Energy Research, 34: 933–945. (2010) doi: 10.1002/er.1606.*

[5.] *Yang Zhao, Zhao Haibo, Fang Zheng: Modeling and dynamic control simulation of unitary gas engine heat pump, Energy Conversion and Management 48 (2007) 3146-3153,*

[6.] *S. A. Klein, D. T. Reindl, and K. Brownell, Refrigeration System Performance using Liquid-Suction Heat Exchangers, International Journal of Refrigeration, Vol. 23, Part 8, pp. 588-596 (2000).*

[7.] *John R. Thome, Engineering Data Book III, Single-Phase Shell-Side Flows and Heat Transfer, Chapter 3, Swiss Federal Institute of Technology Lausanne CH-1015 Lausanne, 2004, Switzerland.*

[8.] *Satish G. Kandlikar, Heat transfer and fluid low in minichannels and microchannels, Mechanical Engineering Department, Rochester Institute of Technology, Elsevier Science (2005), ISBN: 0-0804-4527-6 , USA.*

[9.] *M.M. Shah. A general correlation for heat transfer during film condensation in tubes. International Journal of Heat and Mass Transfer, 22(4):547–556, 1979.*

[10.] *Verein Detscher Ingenieure VDI – Warmeatlas (VDI Heat Atlas), Chapter HBB, VDI – Gesellschaft Verfahrrenstechnik und Chemieingenieurwesen (GVC), Düsseldorf. 1993.*

[11.] *Solvay Chemicals Rue de Ransbeek 310 –1120 Bruxelles – Belgium*

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome V (Year 2012). FASCICULE 3 [July–September]. ISSN 2067-3809

[1.] Sorina ŞERBAN

ANALYSIS AND DESIGN OF INFORMATION SYSTEMS

[1.] UNIVERSITY POLITEHNICA TIMISOARA, FACULTY OF ENGINEERING HUNEDOARA, HUNEDOARA, ROMANIA

ABSTRACT: *Systems analysis and design work in chemistry is the result of a complex application called ChimUniv in the creation and operation of relational databases, the implementation of applications dedicated to Chemistry. The paper is addressed to students and all those who want to build applications using the skills and habits of Chemistry, Microsoft Access solution to offer. Fundamental theoretical notions database are missing from the scientific approach of this paper. In this paper we intend to highlight issues concerning the organization of elements in the periodic table, arranging them in groups and periods depending on their chemical properties.*
KEYWORDS: *applications, implementation, information system, computer system, database*

INTRODUCTION

In our everyday life, computers are commonplace and even essential in some cases. One could say rightly that we live in a computerized society. It should be noted that computer is actually a machine that processes a series of information that we give them.
Information is an essential element in this entire chain. In fact, in practice meet, among others, two related concepts, namely the information system and computer system.
The information system includes all elements involved in the collection, transmission, processing, etc.. information, so the role of information system is to transmit information.
The set of all elements involved in the process of processing and transmitting data electronically make up a computer system. In a computer system can get: computer, data transmission systems, other hardware, software, data processing, etc..
It can be said therefore that the information system is included in the computer system, the latter being an essential component of the first.
In the last fifty years, the production and use of computer - hardware and software - has grown beyond imagination. With the emergence of computers, programmers have the ability to design products faster and cheaper software for data maintenance and distribution.
The model used for data storage is a relational database. In database systems, data defining separate application programs, users saw only the external definition of an object, without knowing how it is defined and how it works.
In this way, the definition of the object can be changed without affecting its users if it does not change the external definition. For example, if you are new or changed data of Structural existing ones, where application programs are not affected, if not directly dependent on what is changing.
In databases there is a data query, meaning that more files are seen as a whole, eliminating redundant information as possible. It also allows simultaneous access to the same data, located in the same place or more spatially distributed users, each with personal work style. Software system that allows the construction of databases, input information into databases called management system database. [4]
A management system database enables a user to access data using a high-level language close to the usual way of expression, to obtain information, making abstraction of user selection algorithms apply the data involved and mode of storage them. DBMS is an interface between operating system users.
Access is a special type of database called Relational Database. A relational database shares information in distinct subsets. Each subset groups the information on a particular topic. In Access, these subsets of data residing in individual tables. Access allows us to create relationships between tables. These relationships are based on a common field in two tables.
When you create a database, we want to make sure that it is designed not only to meet our requirements related to data entry, but corresponds to viewing and reporting requirements of the data stored in various tables that form the database.

APPLICATION SUBMISSION

One of the features is an information explosion in recent years. Huge volume of information can not be used effectively through traditional methods. Automatic processing of information using electronic computing systems has become a necessity for all fields. Thus, the most advanced method of organizing information for a meeting of automatic processing databases.

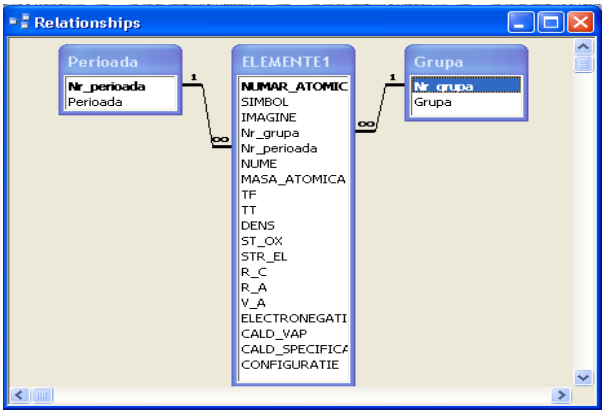


Figure 1. Relationships between tables

Physical data model (MFD) is obtained by the logical representation of data in a data description language closely related to a DBMS, in this case Access. [4]. Basically, he will use the physical data model in order to ensure a consistent processing cycle consists mainly of operations for creating, updating, mining, printing, reorganization, rescue, protection.

ChimUniv database application shows the following structure:

The objective is to create operating interface of the database. After creating database, tables and establishing relationships between tables, the database is:

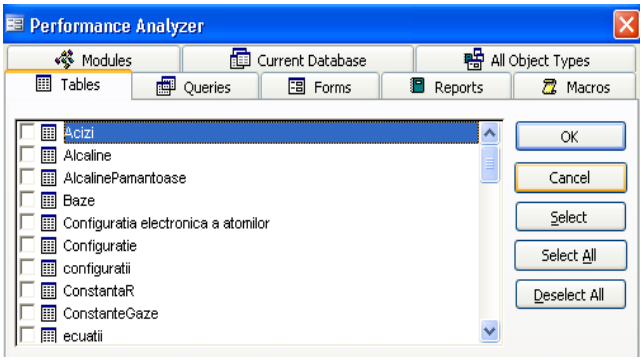


Figure 2. Performance Analyzer

The data elements contained in the table following form:

ELEMENTE : Table

Z	SIMBOL	IMAGINE	Nr_gr	Nr_pe	NUME	A	Tf	Tt	DENS	ST_OX	STR_EL	RAZA	R_A	V_A	ELECTR	CALD_V
1	H	Editor 3.0 Photo	1	1	Hidrogen	1,00797	-252,7	-259,2	0,071	1	1s1	0,32		14,1	2,1	0,108
2	He	Editor 3.0 Photo	8	1	Heliu	4,0026	-268,9	-269,7	0,126	0	1s2	0,93		31,8		0,02
3	Li	Editor 3.0 Photo	1	2	Litiu	6,939	1330	180,5	0,53	1	1s2 2s1	1,23	1,55	13,1	1	32,46
4	Be	Editor 3.0 Photo	2	2	Beriliu	9,0122	2770	1277	1,85	2	1s2 2s2	0,9	1,12	5	1,5	73,9
5	B	Editor 3.0 Photo	3	2	Bor	10,811		2030	2,34	3	1s2 2s2 2p1	0,82	0,98	4,6	2	126
6	C	Editor 3.0 Photo	4	2	Carbon	12,01115	4830	3727	2,26 ±4,2		1s2 2s2 2p2	0,77	0,714	5,3	2,5	171,7
7	N	Editor 3.0 Photo	5	2	Azot	14,0067	-195,8	-210	0,81	2,±3,4,5	1s2 2s2 2p3	0,75	0,92	17,3	3	0,888
8	O	Editor 3.0 Photo	6	2	Oxigen	15,9994	-183	-218,8	1,14	-2	1s2 2s2 2p4	0,73		14	3,5	0,815
9	F	Editor 3.0 Photo	7	2	Fluor	18,9984	-188,2	-219,6	1,505	-1	1s2 2s2 2p5	0,72		17	4	0,755
10	Ne	Editor 3.0 Photo	8	2	Neon	20,183	-246	-248,6	1,2	0	1s2 2s2 2p6	0,71		16,8		0,422
11	Na	Editor 3.0 Photo	1	3	Natriu	22,9898	892	97,8	0,97	1	[Ne] 3s1	1,54	1,9	23,7	0,9	24,12
12	Mg	Editor 3.0 Photo	2	3	Magneziu	24,312	1107	650	1,74	2	[Ne] 3s2	1,3	1,6	14	1,2	32,517
13	Al	Editor 3.0 Photo	3	3	Aluminiu	26,9815	2450	660	2,7	3	[Ne] 3s2 3p1	1,18	1,43	10	1,5	67,9
14	Si	Editor 3.0 Photo	4	3	Si	28,086	2680	1410	2,33	4	[Ne] 3s2 3p2	1,11	1,32	12,1	1,8	40,8
15	P	Editor 3.0 Photo	5	3	Fosfor	30,9738	280	44,2	1,82	±3,4,5	[Ne] 3s2 3p3	1,06	1,28	17	2,1	2,97
16	S	Editor 3.0 Photo	6	3	Sulf	32,064	444,6	119	2,07	±2,3,4,6	[Ne] 3s2 3p4	1,02	1,27	15,5	2,5	3,01
17	Cl	Editor 3.0 Photo	7	3	Clor	35,453	-34,7	-101	1,56	±1,4,5,6,7	[Ne] 3s2 3p5	0,99		18,7	3	2,44
18	Ar	Editor 3.0 Photo	8	3	Argon	39,948	-185,8	-189,4	1,4	0	[Ne] 3s2 3p6	0,98		24,2		1,58

Figure 3. Table ELEMENTS

It then creates forms. Forms are an effective way for displaying, entering and editing information in the database. You can create interactive forms of tables.

Home ELEMENT query query is used as shown below:

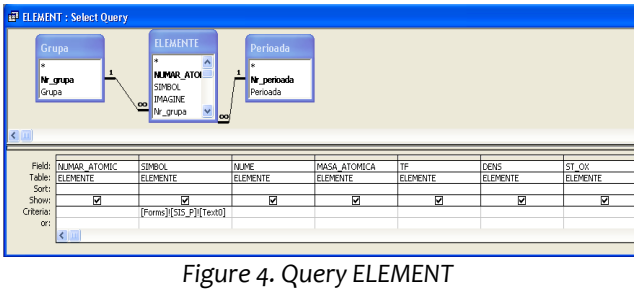


Figure 4. Query ELEMENT

This query is used to implement sufficiently detailed form that describes the main features of a chemical element. Parameter is the item for which we want to make the description. The use of this query do as described below.

Queries allow us to manipulate data in database tables. Queries are questions of fact. We use queries to get the answers we need, from information contained in the database.

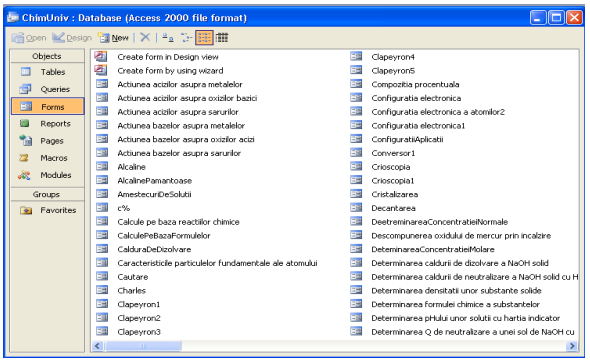


Figure 5. Base structure

THE STRUCTURE ANALYSE

Speaking at the click of a button, it will open forms. For most forms I used background images can add them using the forms properties window. Thus, the ownership Pictures give the file path will be the wallpaper, choose an embedded type (encapsulated), for it was not dependent on whether the image on that computer's hard disk, but to one embedded in our database And the forms are larger than the image stretch instead choose Clip property, because the image to expand across the entire form.

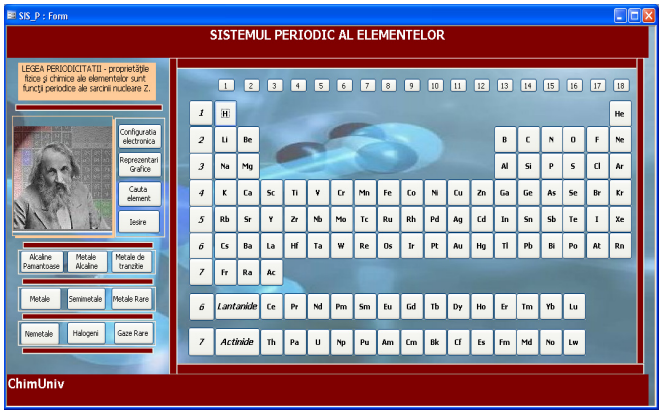


Figure 6. Periodic System Form

Periodic System form is made up of several buttons that we have the name and symbol of each element in the periodic table. The action on each of the buttons will open a form, the same for all buttons, open a form element, they will be displayed all the properties of elements. We notice the existence and Structure of the image, which is an OLE object in our database.

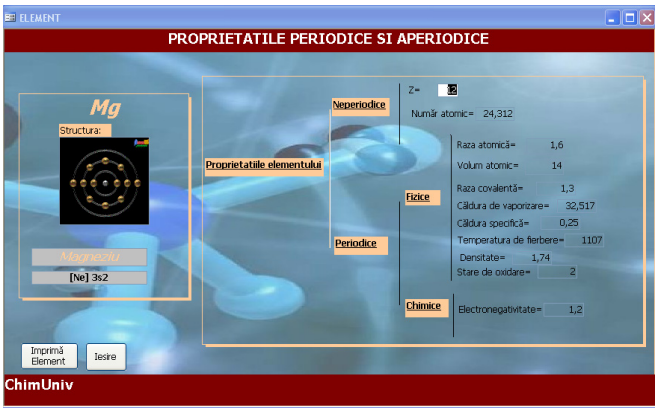


Figure 7. Form Elements

Electronic Configuration button opens a form where it shows the electronic shell structure for each element by simply selecting the desired item from the list.

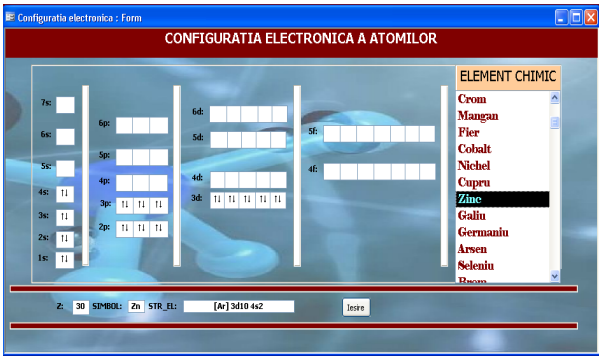


Figure 8. Electronic Configuration Form

The graphics button actuation, opens the graphics are presented and described the chemical properties in volute depending on atomic number of each chemical element. Observe the right of the form features of this property, which has corresponding text field in a table column of type memo Charts.

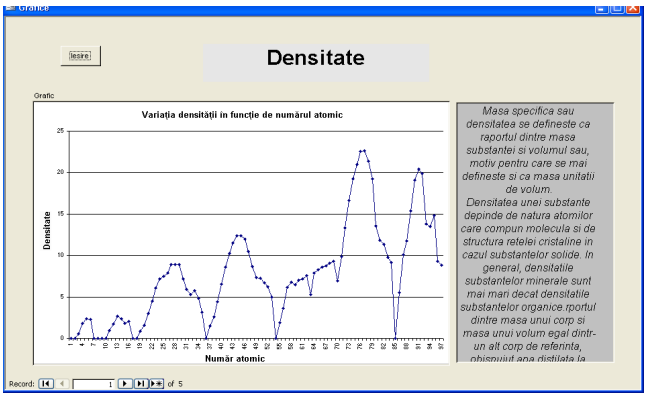


Figure 9. Shape variation depending on the atomic number density

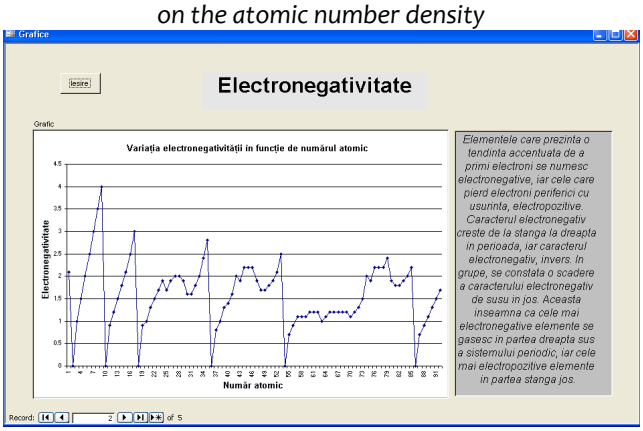


Figure10. Shape variation depending on the number of atomic electronegativity

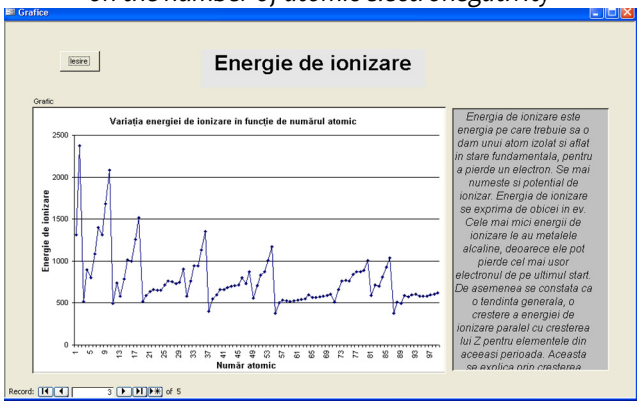


Figure 11. Shape variation of ionization energy according to atomic number

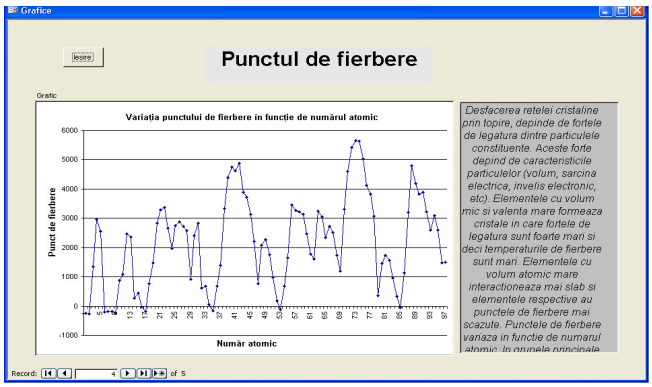


Figure 12. Shape variation of boiling point depending on the atomic number

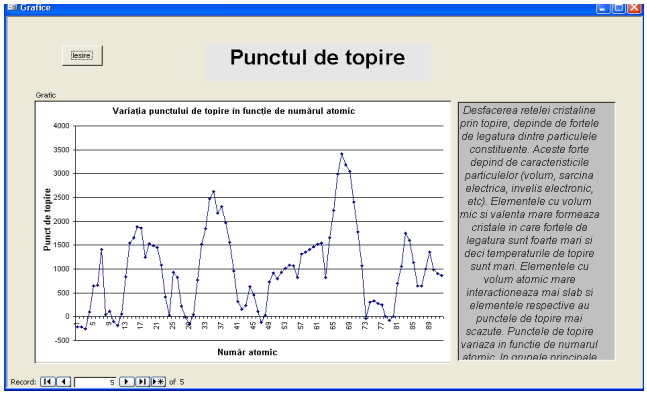


Figure 13. Shape variation of the melting temperature according to atomic number

As can be seen and buttons representing metals, alkaline earth metals, transition metals, rare gases, which are forms representing the OLE object type.

Figure 14. Forms for submission of metals and nonmetals

After achieving the necessary components of our database, integrate applications in a project using the Application Wizard. It can automatically generate an application project via File / New / Project / Wizard, executing the following steps:

1. *has created a new directory;*
2. *or copied files on the project ChimUniv;*
3. *wizard to launch the Application Wizard*
4. *or defined project attributes.*

The new project which now includes all forms generated, so that will be generated and tested the application executable. [1]

CONCLUSIONS

The study computer applications to achieve this, we can say that the use of databases in education can be a tool more attractive to users, this computer in teaching-learning process causing us to find solutions and modern interactive approach to class. Made using as an example I tried to demonstrate effective implementation of computers in teaching certain subjects. Using databases leads to increased competence and creativity, to growth and higher average educational attainment, the increased use of information technologies in different fields. [3]

REFERENCES

[1.] Ionel MUSCALAGIU, Teodora PETRAŞ, DATABASE Visual FoxPro DBMS software, Mirton Publishing House, Timisoara 2002

[2.] DRĂGĂNESCU, Mihai, Computers and Society, Technical Publishing House, Bucharest 1986

[3.] ADĂSCĂLIȚEI A., Computer Assisted Training, IAC. Multimedia Information Systems Design, Internet source http://www.ee.tuiasi.ro/~aadascal/

[4.] Eduard KOLLER, Monica ROŞCULEŢ, Programming in Access 97 , Theory, Bucharest 2002

[5.] S. ŞERBAN, Computer Training in Chemistry: Strengths and Weaknesses, ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering – Fascicule 2 – Tome III – 2010.

[6.] S. ŞERBAN, Educational soft for chemistry, ANNALS OF THE FACULTY OF ENGINEERING HUNEDOARA, 2006, Tome IV, Fascicule 3

[7.] Grupul BDSEIG, Baze de date. Fundamente teoretice şi practice, Editura InfoMega, 2001

[8.] Thomas CONNOLLY, Carolyn BEGG, Anne STRACHAN – Baze de date. Proiectare. Implementare. Gestionare, Editura TEORA, 2001

[9.] M.D. POPOVICI, Virtual Reality: Technology components, Politehnica University, Bucureşti, 2002

[10.] Sorina ŞERBAN, Vasile ALEXA, About the concept of educational software and the implementation in the University educational System, 1st Regional Conference - Mechatronics in Practice and Education MECH - CONF 2011, Subotica, SERBIA, 357-362

[11.] Vasile ALEXA, Imre KISS, Sorin Aurel RATIU, Vasile George CIOATĂ, E-Learning Practice in Performing the Laboratory Works Specific to the Pneumatic Drives, 1st Regional Conference - Mechatronics in Practice and Education MECH - CONF 2011, Subotica, SERBIA, 34-38

[12.] Sorin Aurel RATIU, Vasile ALEXA, Imre KISS, Ana JOSAN, Virtual Didactic Laboratory for the Interactive Study of an Internal Combustion Engine Management System, 1st Regional Conference - Mechatronics in Practice and Education MECH - CONF 2011, Subotica, SERBIA, 316-320

[13.] I. CERGHIT, Teaching methods, Polirom Publishing House, Iaşi, 2006

[14.] I. JINGA, E. ISTRATE, Training and computer-assisted assessment, ALL Publishing House, Bucuresti, 2006

[15.] F. MOLDOVEANU, Z. RACOVITA, S. PETRESCU, G. HERA, Computer graphics, Teora Publishing House, 1996

[16.] B. J. REISER, I. TABAK, W. A. SANDOVAL, B. SMITH, F. STEINMULLER, T. J. LEONE: BGuILE – Stategic and Conceptual Scaffolds for Scientific Inquiry in Biology Classrooms, Cognition and Instruction: Twenty five years of progress, Mahvah, NJ: Erlbaum, 2001

[17.] BAEK, Young K., LAYNE, Benjamin H., Color, graphics, and animation in a computer-assisted learning tutorial lesson, Journal of Computer-Based Instruction, Vol 15(4), 1988, 131-135

[18.] Roger P. GLADWIN, Don MARGERISON, Steve M. WALKER, Computer-assisted learning in chemistry, Computers & Education, 19, I1–2, 1992, 17-25

[19.] I.D. BENEST, Computer-Assisted Learning using dynamic electronic books, Computers & Education, 15, 1–3, 1990, 195-203

[20.] A. JONES, E. SCANLON, C. TOSUNOGLU, E. MORRIS, S. ROSS, P. BUTCHER, J. GREENBERG, Contexts for evaluating educational software, Interacting with Computers, 11, 5, 1999, 499-516

[21.] Dee BALDWIN, Joyce JOHNSON, Peggy HILL, Student satisfaction with classroom use of computer-assisted instruction, Nursing Outlook, 42, 4, 1994, 188-192

[22.] Hossein MAHDIZADEH, Harm BIEMANS, Martin MULDER, Determining factors of the use of e-learning environments by university teachers, Computers & Education, 51, 1, 2008, 142-154

[23.] ROŞCA, Ioan Gh., ZAMFIR, Gabriel, APOSTOL, Constantin-Gelu; BODEA, Constanța-Nicoleta, Informatica instruirii, Editura Economică, Bucureşti, 2002

[24.] ZAMFIR, Gabriel, Integrarea aplicațiilor în instruirea asistată, Editura Economică, Bucureşti, 2001

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome V (Year 2012). FASCICULE 3 [July–September]. ISSN 2067-3809

[1.] László SZABÓ, [2.] Rudolf SZABÓ

THE CARBON AGE – CHARACTERISTICS OF THE CARBON FIBERS

[1-2.] ENVIRONMENTAL PROTECTION ENGINEERING INSTITUTE, REJTŐ SÁNDOR FACULTY OF LIGHT INDUSTRY AND ENVIRONMENTAL PROTECTION ENGINEERING, ÓBUDA UNIVERSITY,1034 BUDAPEST, DOBERDÓ U. 6, HUNGARY

ABSTRACT: *In the various areas, quantities of the materials and goods used by mankind show rapid growth, whereas its form, rate of use is significantly varying. Today requirements and expectations concerning the various materials are wide ranging, so the properties of these materials are developed in accordance to the demands. Presently the carbon fiber is being used more and more frequently in those areas which require special demands. This is explainable by its outstanding properties, namely high tenacity, stiffness, low heat dilation, conductivity etc. From composites, lightweight structures may be produced to meet higher level applications. Carbon fiber reinforced composites – in the areas demanding high mechanical usage, will be of determining importance in the future.*
KEYWORDS: *carbon fiber fabrication, properties, application*

INTRODUCTION

Presently Carbon Fiber is being used more and more frequently in those areas which require special demands. This is explainable by its outstanding properties, namely, (high tenacity, stiffness, low heat dilation, conductivity etc.). Carbon Fiber is rigid, brittle and because of this, its processing requires particular care, special handling. With the development of the manufacturing, and processing technologies and the decrease of its price, carbon fibers expectedly and in the future will play a key role in the field of high demanding composites.

DISCUSSIONS

In the various areas, quantities of the materials and goods used by mankind show rapid growth, whereas its form, rate of use is significantly varying (Figure 1). In the second half of the 20th Century, concerning the high ratio of metal usage, a change and shift towards polymers, composites and ceramics can be observed, and their usage is increasing significantly. Today requirements and expectations concerning the various materials are wide ranging, so the properties of these materials are developed in accordance to the demands.

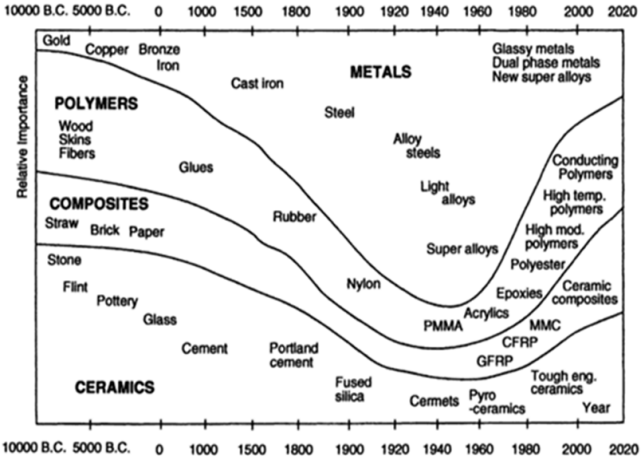


Figure 1. Relative importance of material development through history

In the development of new materials, a decisive role is played by Space Research and the Military Industry in which for developing special material properties, the sources for research are readily available. Demands are emerging in more and more areas for using the thusly developed materials and structures, and with the further development of processing technologies, along with mass production, their prices are decreasing making them available for use in a wide range.

In 1879, Edison made the first Carbon Fiber by carbonizing bamboo fiber to use it as incandescent filament in light bulbs. Carbon Fiber, because of its excellent properties and high price was first made in the 1960's from regenerated fibers, and then by carbonizing PAN fiber. It began to be applied in the Aerospace industry. This was followed by the expensive and valuable sport goods, and currently machinery parts (Figure 2).

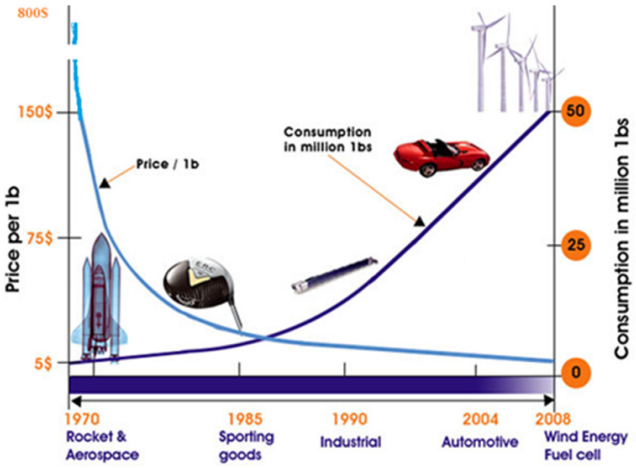


Figure 2. Trend and forecast in carbon fibres shipment

From composites, lightweight structures may be produced to meet higher level applications. The mechanical properties of fibers, textiles used for reinforcing composites, related to weight are characterized by high tenacity, low elongation and high elasticity modulus. Amongst the plastic-reinforcement fibrous materials, the properties of carbon fiber „Black Magic" are especially outstanding. Carbon fiber reinforced composites – in the areas demanding high mechanical usage, will be of determining importance in the future (Figure3).

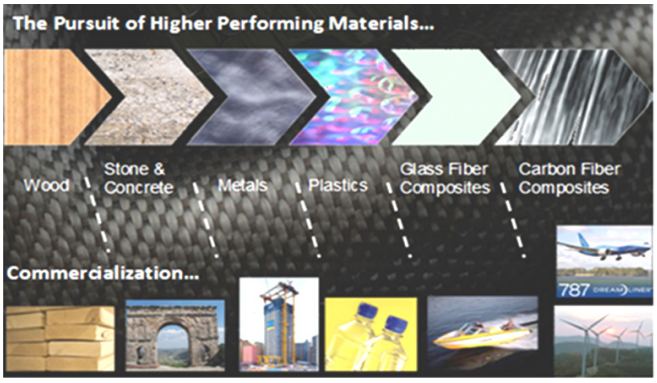


Figure 3. Materials evolution

The properties and price of carbon fibers also encompass a broad territory. With the price decreasing of the higher filament numbered (higher than 24K), carbon tows produced for commercial usage, the greater volume and the wider industrial usage came to prominence and this tendency, expectedly, will continue.

The Carbon Fiber is made mostly (approx; 95 %) from a synthetic fiber well known in the textile industry, namely PAN (Polyacrylonitrile), and it is so called precursor fiber (Figure 4), whereas the raw material of the remaining 5 % is either tar or regenerated fibers.

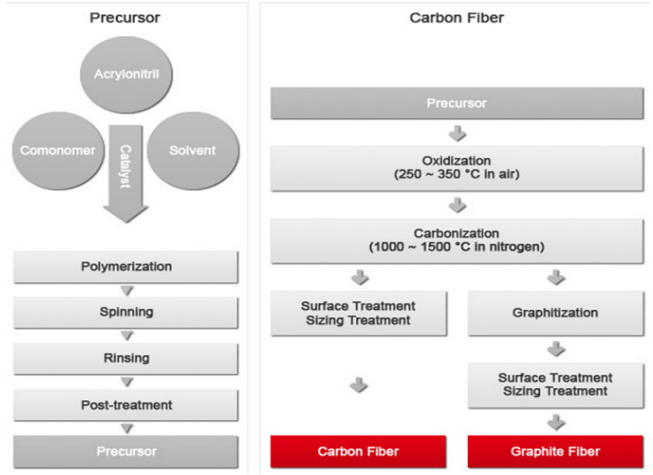


Figure 4. Manufacturing process of carbon fibers (PAN-based)

The PAN precursor based oxidized fiber (OPAN), carbon and graphite fiber production process is well depicted in Figure 5.

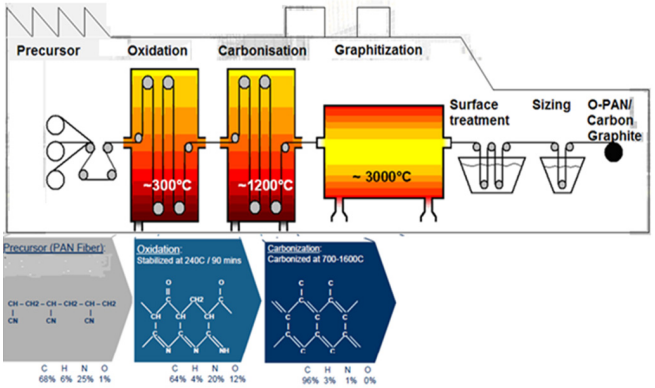


Figure 5. The oxidation, carbonization and graphitisation process

The OPAN fiber is produced by oxidizing the moderately stretched PAN fiber at 220-250 °C. In the process of the oxidation, taking several hours, most of the burnable gases and toxic materials are exhausted from the fiber, while its chemical structure changes. The OPAN fiber (approximate with 62% of carbon content) formed after oxidation, becomes a textile material having excellent heat, flame and fire resistant properties, which after various textile industry operations (Stretch - Breaking, Carding, Spinning, Weaving, Knitting, or in Tow / Staple fiber form using non-woven methods) may be further processed. Products' made from OPAN do not melt, have a high LOI value (40-60), its heat resistance is above (300 °C), and because of this, they are mainly used in areas where heat, fire resistance, heat insulation (welding blankets, protective clothing, etc.) is required. During the oxidation process, a crust forms on the surface of the OPAN fiber, and because of this, its loop tenacity is low (8-15% of the tensile strength), thusly the fiber is brittle. By increasing of the temperature and processing time, the density of OPAN fiber (ρ=1.35-1.42 g/cm^3) can also be increased, and with this, heat resistance of the material can be augmented, but the fiber will be more rigid. Although OPAN and carbon fibers are both black, their other properties are basically different (Figure 6.).

Properties	OPAN	Carbon fiber
C contain (%)	62	>95
Thermo resistant	Good thermo-Insulator	Good thermo-Conductor
Electric	Electric Protective	Electric Conductivity
Tensile strength (MPa)	260	4000
Modulus (GPa)	8,5	242
Elongation (%)	20-25	1,5

Figure 6. Properties of OPAN and carbon fibers

OPAN products processed by textile industry methods and then carbonized can be used in a variety of unique applications.

In the hydrogen driven electrical transformer, the carbon membrane allows the protons to pass through while by separating the electrons, electric current is generated.

In the case of sodium-sulphur electrical energy storing, the sulphur is stored in the carbonized OPAN membrane sponge.

In the C-C composite technology, the thick felt made from OPAN is carbonized at high temperature and the C is diffused into the material. From the thusly created, compact structured CandC composite material, high temperature 1000 °C bearing, aircraft and racing car brake discs and brake pads are made.

In the manufacturing of carbon fiber, by leading the pre-tensioned fibers exiting from the oxidation oven into high temperature (800-1500 °C) nitrogen gas blanketed ovens, the structure of the carbon fiber is formed (Figure 7).

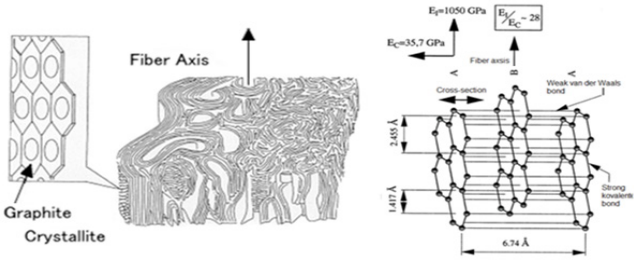


Figure 7. Structure of carbon fiber

To forward chemical bonding with the matrix material of the composite, after exiting from the ovens, the surface of the fibers is activated and sizing is also carried on to their surface.

In the course of graphite production the pre-tensioned fibers are further led through high temperature (2000-3000 ºC) nitrogen gas blanketed ovens. The raw material, production technology parameters (tensioning zones, stressing level, temperatures, surface treatment etc.) all have deciding effect on the properties of the fiber (by increasing the temperature, rigidity of the fiber also increases), thusly tenacity and stiffness properties of the carbon fibers encompass a wide range.

The carbon fiber, without twisting is wound onto 5-12 kg- spools. To avoid twisting, the tow is unwound tangentially from the rotating spool. The diameter of the carbon fiber is around 5-7 μm (approx. 0.4 – 0.7 dtex). The thickness of the carbon tow is defined by the number of single filaments it contains, where (K=1000) (1K, 2K, 6K, 12K, 24K, 50K, 60K, 300K, etc.).

The tows may also be used in the following forms:

- Milled powder (less than one mm long) form, or compacted into chips / pellet form.
- Chopped (3-10 mm),
- As tow, by direct extruding.
- Laid, spreaded tow, wound or,
- Using various textile technical methods, variously structured sheet forms (UD, BD, MD or 3D may be attained). Impregnated (pre-pregs) or using the dry infusion process, embedded in matrix material, they can be used as composite reinforcement (Figure 8).

Figure 8. Product forms of carbon fibers

From further processing point of the carbon fiber, it is important that the filaments in the tow be oriented and parallel. It is expedient to guide the carbon fiber – similarly to the Kevlar – on orange peel formed tow guiding elements.

At unwinding of the tows, tow forces should be identical, minimal and independent from changes in the diameter of the spool, in short, it must be constant. At the unwinding creel, when positioning the tow spools at the lateral guiding of the tows, one must strive to minimize any breaks and that tows arrive parallel to the positioning reed. During the guiding, contact between the tows must be reduced to the minimum, overlapping of the tows is not allowed.

In the 50K, 6-10 mm wide tow, there are 35-60 filament layers on top of each other. During sheet formation, it is important that the tow filaments be spread homogenously, without gaps in the plane of the fabric. Namely, uniform penetration of the matrix into the thick filament layers is not ensured and because of this, the tows, by spreading them, are widened and thinned out. An important aim, is the formation of homogenous, gap free, thin, low area density (80-120 g/m²) filaments, which make it possible to form light, selective and valuable composite structures (Figure 9).

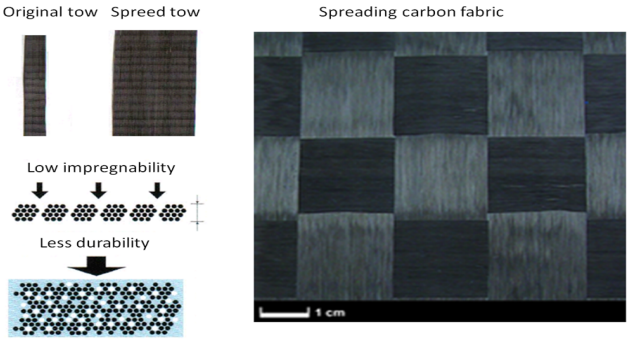


Figure 9. Spreading carbon tow and fabric

Table 1. The mechanical properties of metals

	C – HT High Tenacity	C – IM Intermediate Modulus	C – HM High Modulus	C – HMS High Modulus Strength	E - Glass	Aluminum	Steel
Dichte ρ g/cc	1.74	1.80	1.83	1.85	2.55	2.70	7.85
Elongation at break %	1.50	1.93	0.57	0.63	2.5		1.8
Tensile strength, σ MPa	3600	5600	2300	3600	2470	70-700	2880
Specific tensile strength σ* cN/tex (km)	206	301	125	194	95		36
Tensile modulus E GPa	240	290	400	550	70	70	200
Specific tensile modulus E* cN/tex (km)	13800	16100	21850	29730	2700		2500
Long time heat resistance ºC	500	500	500	500			
Coefficient of Liner Thermal Expansion, α 10^{-6}/ ºC	-0.91	-0.91	-0.91	-0.91	4-9	22.2	13
Fiber diameter, d, μm	7	5	6.5	5	7-13		
Melting / Sublimation ºC	3600	3600	3600	3600	840	660	1500

Spreading of the tow can be intensified by eliminating twists, reducing sizing, ensuring long free guiding, heating, vibrating and by blowing air on it.

Carbon fiber is a high tenacity, high modulus brittle material, and because of this, in its processing, special handling is required. Since the density of carbon fiber (ρ≈1.8 g/cm³) and fiber reinforced composites (ρ≈1.4 g/cm³) is small, their tenacity, in relation to the weight of the material (σ* = σ/ρg) and their elasticity modulus (E* = E/ρg) values considerably surpass the mechanical properties of metals (Table 1).

Tensile strength of the various materials, in general engineering practice is expressed to cross section

(GPa) and weight used in the textile industry (cN/tex, km) as shown in Figure 10.

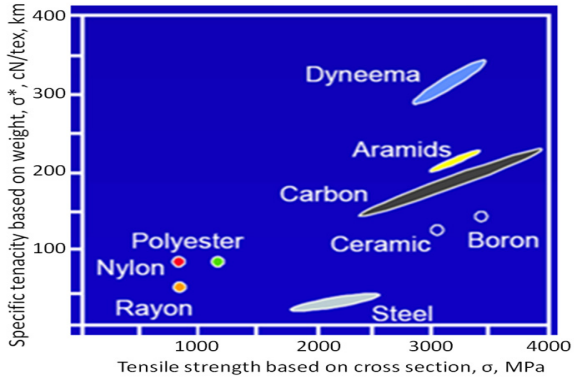


Figure 10. Tensile strength of the various materials, expressed to engineering (cross section) and weight use system

Characteristics of carbon fiber:

- *Excellent specific strength and excellent specific modulus*
- *Low density (ρ=1.7-1.8 gcc)*
- *High dimensional stability*
- *High toughness*
- *Fatigue resistance*
- *Good vibration damping*
- *Self lubrication*
- *Low coefficient of thermal expansion*
- *Conductivity and thermal stability*
- *Electrical conductivity*
- *X-ray permeability*
- *Electromagnetic protection*
- *Biological inertness*
- *Chemical inertness*
- *Imperviousness to corrosion (high resistance to alkalis, acid and organic solutions).*

The light (up to 24K) and heavy (above 24K) carbon fiber producers, and their development capacities are shown in Table 2.

TABLE 2

Manufacturer Nameplate Capacity, metric tonnes PAN-based Small-Tow (up to 24K) Carbon Fiber,	2008	2009	2010	2011	2012	2013	2014
Toray	17,600	17,900	18,900	18,900	18,900	18,900	18,900
Toho	10,500	12,200	12,900	12,900	12,900	12,900	12,900
Mitsubishi	7,900	10,850	10,850	10,850	10,850	10,850	10,850
Hexcel	3,550	4,850	4,850	7,300	7,300	7,300	7,300
Cytec	1,800	2,400	4,000	4,000	4,000	4,000	4,000
Formosa	2,850	2,850	3,000	3,850	4,000	5,000	6,000
Others	0	2,150	2,150	2,650	4,650	5,400	7,400
Total	44,200	53,200	56,650	60,450	62,600	64,350	65,350
PAN-based Large-Tow (more than 24K) Carbon Fiber,							
Zoltek	10,950	13,450	14,050	16,750	17,250	18,250	18,500
SGL	5,000	6,000	7,500	8,500	9,500	11,000	12,000
Toho	1,300	1,300	1,300	1,300	1,300	1,300	1,300
PR China	400	400	800	2,800	3,800	5,000	7,000
Toray	300	300	300	300	300	300	300
Others	100	100	100	1,600	3,100	4,100	4,100
Total	18,050	21,550	24,050	31,250	35,250	39,950	43,200

For the main areas of applications of the carbon fiber demands are shown in Table 3.

TABLE 3

Total Global Carbon Fiber Demand, metric tonnes	2009	2010	2011	2015	2019
Aerospace	5,800	6,410	7,010	13,090	18,100
Consumer	6,420	7,000	7,660	9,410	11,120
Energy and industrial	21,210	25,870	29,620	66,760	105,060
Total carbon fiber demand	33,430	39,280	44,290	89,260	134,280

It can be seen that the greatest increase of carbon fiber usage is expected to be in industrial applications. According to the latest forecasts, by 2020, the yearly carbon fiber demand is estimated to be 340 000 tons.

CONCLUSIONS

Light tows are used in the aircraft industry, for sporting goods and for fine machinery components, whereas the coarse, heavier (above 24K) tows are used for bracing large wind blades (blade length above 40 m), automobiles, high pressure tanks, pipelines, offshore drilling, mooring lines, ship hulls, buildings reinforcement (Figure 11).

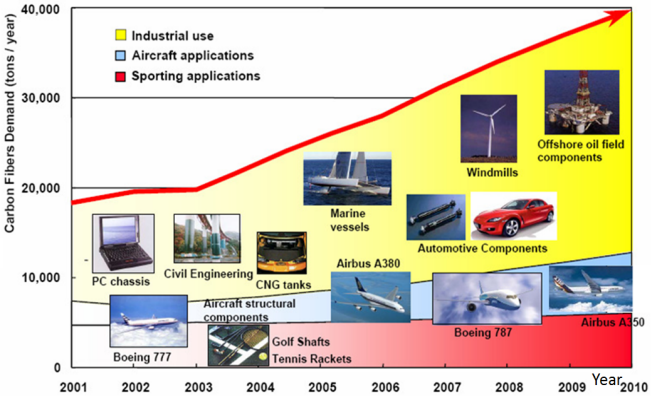


Figure 11. The main application areas of carbon fiber and trends

Carbon fiber – especially in cases where great mechanical requirements need to be met – is a composite reinforcer of key importance. The usage of the carbon fibers will expectedly have wider perspectives in the future.

REFERENCES

[1.] *Kolkmann A. –Gries T. Scheser M. – Dilthey U.: Innovative Yarn Structures and Coating for Textil – Reinforced Concrete Techtextil Symposion 2005 - Buildtech*

[2.] *Tálos G.: Kompozitok a textil szemszögéből TMTE TexPlat kiadvány 2009.*

[3.] *Szabó D. – Szabó L.: Textil erősítésű építőanyagok Magyar Textiltechnika 2008/6. p. 159-162.*

[4.] *Kollár L. –Kiss R.: Szálerősítésű műanyagok (kompozitok) az építőiparban Közúti és mélyépítési szemle 1998/9. p. 331-338.*

[5.] *Zsigmond B. – Szabó R: Oxidized and Carbon Fiber as Raw Material of Technical Textiles Budapest, Danubius Hotel Gellért 2010. on 23. September*

[6.] *Solan J.: Carbon fiber market: Cautious optimism High-Performance Composites March 2011.*

[7.] *Borbély B. – Szabó R.: Black Magic; The Present and the Future Application of Carbon Fibers 1-st Region Conferenc – Mechatronics in Practice and Education Szabadka 8-10. December 2011.*

[8.] *Szabó R.: Carbon Fibers and Weaving of Technical Textiles Seminar in Corlu Tr. 10. Juni 2011.*

[9.] *Szabó R.: Textil termékek szerepe a kompozit gyártásában 19. Műszaki Textil Fórum Tolna, 2011. 10. 27.*

[10.] *Szabó R.: Kompozitok Innovatív textil- és ruhaipari termékek a gazdaság minden területén Nemzetközi Konferencia BKIK Székház Budapest, 2011. okt. 6*

[11.] *Szabó R.: Műanyag erősítő textilanyagok és –szerkezetek, ERŐSÍTETT MŰANYAGOK 2010 Nemzetközi BALATON Konferencia 2010. május 18-20. Keszthely, Hotel Helikon*

[12.] *Spreading and spread-tow Weaving Machines Harmoni Industry Co.*

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome V (Year 2012). FASCICULE 3 [July–September]. ISSN 2067-3809

[1.] Juliana LITECKA, [2.] Slavko PAVLENKO

MATHEMATICAL MODELLING OF GEAR HOB SURFACE WITH BASIC PROFILE

[1,2] DEPARTMENT OF TECHNOLOGICAL DEVICES DESIGN, FACULTY OF MANUFACTURING TECHNOLOGIES OF TECHNICAL UNIVERSITY IN KOŠICE WITH A SEAT IN PREŠOV, ŠTÚROVA 31, PREŠOV, SLOVAKIA

ABSTRACT: *Gear production is very important area of manufacturing industries because gears are the widest components in the machines and machine equipments. Mode of production and used tools are important elements of economical and quality part of production. Nowadays, there are developed the new constructional solutions of gear hobs which save time and money. For the hob which would produce precision involute gear there is possibility of finding profile which would provide this requirement. For the finding of the profile it is needed to have a good mathematical knowledge kinematic and geometrical properties investigated objects. The paper deals with mathematical description of basic hob surface with straight profile which is initial theorem for the determining of accurate profile of gear hob.*
KEYWORDS: *gear hob, hob profile, hob surface, mathematical description, parametric equations*

INTRODUCTION

Gear hobbing is a continuous rolling method. The body enveloping is a cylindrical involute worm. Tool and workpiece rotate during the generating motion while the milling cutter executes the cutting motion as it circles around.

To manufacture spur gears, milling cutter and workpiece are shifted in relation to each other in the direction of the workpiece axis, and the generating motion is carried out at the same time. [1]

Gear hobs, shows on Figure 1. (a), are very productive cutting tools used for machining of gear wheel and other different components like spline shafts, chain wheels, ratchet gearing and parts with screw surface. Gear hobs are universal tools because with the same module we can machine gear wheels with different number of teeth, tooth inclination, corrected or uncorrected gear and worm wheels.

The characteristic element for the calculating and design of hob is basic surface of tool (Figure 1. (b)).

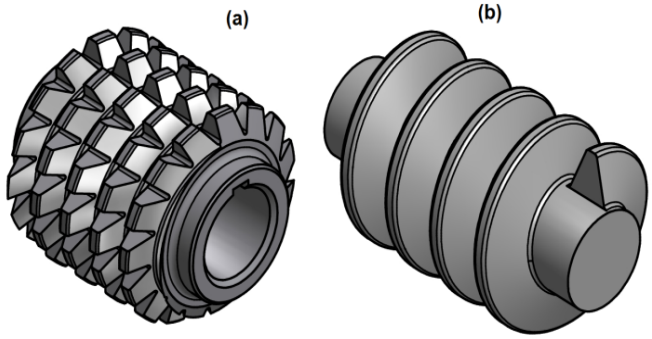


Figure1. (a) Constructional solution of solid gear hob (b) Basic surface of gear hob with straight profile

For the investigation of a basic tool surface we will use theory of three-dimensional curves and helix surfaces.

PRINCIPLES OF GEOMETRICAL THEORY

For investigate a case of hob we need to appear from three basic geometric definition: curve, surface, movement.

a. The curve

The curve is a geometrical concept, of which an exact and at the same time quite general definition presents considerable difficulties and is carried out differently in different branches of geometry.

In elementary geometry the concept of a curve is not clearly defined and is sometimes defined as "length without width" or as the "boundary of a surface" . In elementary geometry the study of a curve essentially reduces to consideration of examples (a straight line, an interval, a polygon, a circle, etc.).

Since it does not have general methods at its disposal, elementary geometry has gone quite deeply into the study of properties of specific curves (conic sections, certain algebraic curves of higher orders and transcendental curves), using special methods in each case. In analytic geometry a curve in a plane is defined as a set of points whose coordinates satisfy an equation $F(x,y)=0$.

Restrictions must be imposed on the function F so that, on the one hand, the equation should have an infinite set of solutions and, on the other hand, so that this set of solutions does not fill "a piece of the plane" .

An important class of curves comprises those for which the function $F(x,y)$ is a polynomial in the two variables; in this case the curve defined by the equation $F(x,y)=0$ is said to be algebraic. Algebraic curves specified by an equation of the first degree are straight lines. [2]

b. The surface

In geometry, a two-dimensional collection of points (flat surface), a three-dimensional collection of points whose cross section is a curve (curved surface), or the boundary of any three-dimensional solid.

In general, a surface is a continuous boundary dividing a three-dimensional space into two regions.

c. The movement

The movement is unlimited set of geometrical transformation the same type (e.g. set of rotations around axis, or set of translations along straight line) or unlimited set of geometrical affine transformations, which are analytical represented by transposed matrix:

$$T(u)=\begin{bmatrix} a_{11}(u) & a_{12}(u) & a_{13}(u) & a_{14}(u) \\ a_{21}(u) & a_{22}(u) & a_{23}(u) & a_{24}(u) \\ a_{31}(u) & a_{32}(u) & a_{33}(u) & a_{34}(u) \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (1)$$

where functions a_{ij} are function of one real variable, all defined, linear and least once differentiable on interval I.

For the describing of surface in the extensive Euclid space there will be equations:

$$F\{x,y,z,1\} = F\{x(t), y(t), z(t), 1\}.\ T(u) \quad \text{for } u \in I \quad (2)$$

where $F\{x(t),y(t),z(t),1\}$ is function of generating curve.

The equation (2) we may to write by parametric equations:

$$\begin{aligned} x &= x(t).a_{11}(u)+y(t).a_{12}(u)+z(t).a_{13}(u)+a_{14}(u) \\ y &= x(t).a_{21}(u)+y(t).a_{22}(u)+z(t).a_{23}(u)+a_{24}(u) \quad (3) \\ z &= x(t).a_{31}(u)+y(t).a_{32}(u)+z(t).a_{33}(u)+a_{34}(u) \end{aligned}$$

for each $u \in I$ and $t \in J$.

ANALYTICAL DESCRIPTION OF HOB SURFACE GEOMETRY

For the investigation of surface geometry of hob we will use the geometry of helix surface S which is created by helix movement of curve k. The curve k is a generating curve of a helix surface S. A set of all position of generating curve k for helix movement, which define helix surface S, is one system of curves which models the surface S. The helix surface S is one-parametric system of curves - all position k^u of generating curve k for helix movement which define surface S.

Each point P of helix surface S is situated on some position k^u of generating curve k (Figure 2.).

This fact we may formulate so that one-parametric variable of point P will be variable u. Position of this point P on curve k^u we describe by second parametric variable t (Figure 3.). The helix surface S is two-parametric system of points P(t,u) in the three dimensional space with coordinates (x,y,z).

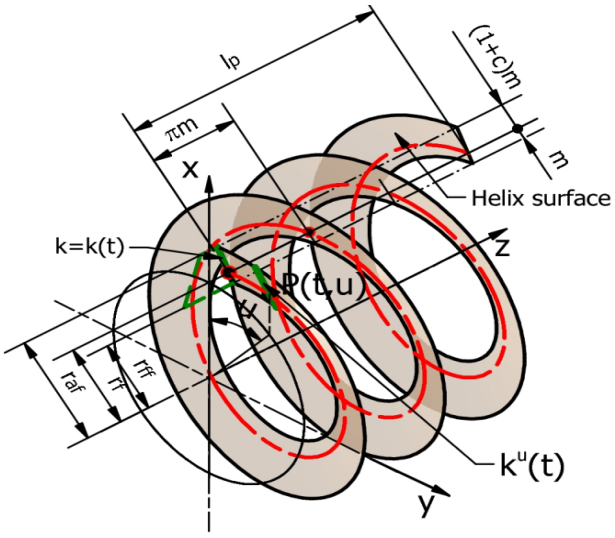


Figure 2. The generating of helix surface by curve k

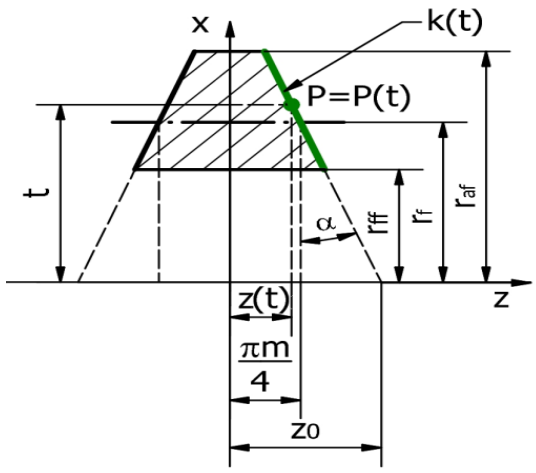


Figure 3. The generating of curve k by point P

Point P of generating curve k creates by helix movement the defining helix surface S - helicoid which is a curve on this helix surface.

Set of all helicoids which are created by each point of generating curve k is second system of curves which models helix surface S. All these helicoids have unit axis z, all they are clockwise or anticlockwise and they have the same size of convolution:

$$p = \pi.m \quad (4)$$

where m is module of hob.

On Figure 2 there is illustrated model of helix surface which is created by curve k by helix movement in the coordinate system (x,y,z) where axis z is axis of helixoid. Two systems of curves, it means system position curve k and system of helicoid created points of curve k, create model of helix surface.

For the mathematical description of helix surface we will use parametric equations of curve k, where $k:\{x=x(t),\ y=y(t),\ z=z(t),\ t \in \langle t_0, t_1 \rangle\}$, which is straight line of basic hob profile. Their parametric equations we may describe on based of Figure 3.:

$$\begin{aligned} x(t) &= t \\ y(t) &= o \qquad\qquad t \in \langle r_{ff}, r_{af} \rangle \\ z(t) &= z_o - t.tg(\alpha) \end{aligned} \tag{5}$$

where

$$z_o = \frac{\pi.m}{4} + r_f.tg(\alpha) \tag{6}$$

r_f *is a radius of hob pitch circle*
r_{af} *is a radius of hob addendum circle*
r_{ff} *is a radius of hob dedendum circle.*

In the case of hob we consider, helix surface which is created by curve k, clockwise and convolution is p. The transposed matrix of movement of curve k will be represented:

$$T(u) = \begin{bmatrix} \cos(u) & -\sin(u) & o & o \\ \sin(u) & \cos(u) & o & o \\ o & o & 1 & \frac{\pi.m.u}{360} \\ o & o & o & 1 \end{bmatrix} \tag{7}$$

After the writing the equations (5),(6),(7) to equation (2) we get final parametric equations of hob surface in the coordinates (x,y,z).

$$\begin{aligned} x &= t.\cos(u) \\ y &= t.\sin(u) \qquad\qquad t \in \langle r_{ff}, r_{af} \rangle \\ z &= \frac{\pi.m}{4} + r_f tg(\alpha) + \frac{\pi.m.u}{360} \qquad u \in \langle 2i\pi, 2(i+1)\pi \rangle \end{aligned} \tag{8}$$

where i is number of convolutions.

CONCLUSIONS

In the case of investigation of surface geometry of gear hob we was based on transformation of movement straight line curve which rotates around axis z and at the same time translates along the same axis z. The describing of the movement was realized by 4x4 transposed matrix and the results were represented by parametric equations of the surface. By these parametric equations we may investigate the hob movement in depends of gear movement for gear production in the next part of research of influence the hob profile to gear production. By analysis of results of the research we may to design new profile of gear hob which will be machine gear with higher accuracy.

REFERENCES

[1.] *Tschätsch, H.:Applied Machinig Technology, Springer Dordrecht Heildelberg London New York, pp. 398, 2009.*

[2.] *Hazewinkel, M.: Encyclopaedia of Mathematics, Supplement III, Springer, pp. 568, 2007.*

[3.] *Maščenik, J., Batešková, E.: Design and computing of gearing with Autodesk Inventor. In: MOSIS '09. - Ostrava, P. 227-230., 2009*

[4.] *Pavlenko, S., Haľko, J., Maščenik, J., Nováková, M.: Časti strojov II, 1. edition - Prešov: FVT TU, 2008.*

[5.] *Pavlenko, S.: K profilovaniu odvaľovacích fréz, FVT TU, Prešov, pp. 106, 2006, ISBN 80-8073-493-3*

[6.] *Pavlenko, S., Haľko, J., Paško, J.: Impact of spur-gear-hob diameter on tooth profile accuracy, In: Scientific Bulletin. Vol. 20, serie C (2006), p. 321-324, 2006,*

[7.] *Litvin, L. F., Fuentes A.: Gear geometry and applied theory, Cambridge University Press, 2004*

[8.] *Lawrence, D. J. : A catalog of special plane curves, Dover Publications. pp. 168,171–173., 1972, ISBN 0-486-60288-5.*

[9.] *Jüttler, B. , Piene, R., Dokken, T.: Geometric modeling and algebraic geometry, Springer, pp. 231, 2008, ISBN 978-3-540-72184-0*

[10.] *Radzevich, S. P. : Kinematic geometry of surface machining, CRC Press, pp. 508, 2007*

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

copyright © UNIVERSITY POLITEHNICA TIMISOARA,
FACULTY OF ENGINEERING HUNEDOARA,
5, REVOLUTIEI, 331128, HUNEDOARA, ROMANIA
http://acta.fih.upt.ro

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome V (Year 2012). FASCICULE 3 [July–September]. ISSN 2067-3809

[1.] Keyvan Asefpour VAKILIAN, [2.] Jafar MASSAH

PERFORMANCE EVALUATION OF CCD AND CMOS CAMERAS IN IMAGE TEXTURAL FEATURES EXTRACTION

[1-2.] DEPARTMENT OF AGROTECHNOLOGY, COLLEGE OF ABOURAIHAN, UNIVERSITY OF TEHRAN, TEHRAN, IRAN

ABSTRACT: *The first stage of any vision system is the image acquisition stage. If the image has not been acquired satisfactorily, then the intended tasks for image processing and image classification may not be properly achievable. In this study, a machine vision system was developed to evaluate the performance of CCD and CMOS cameras for real-time monitoring of cucumber growth in a greenhouse by extracting image textural features. The leaf samples of cucumber crops were brought to the laboratory from the greenhouses to measure the textural features. Laboratory was consisted of a digital camera for taking the images, a LDR array for providing a uniform lightening and a computer for measuring the textural parameters from the obtained images. The objective of the current study was to select which type of camera is ideal for real-time plant health and growth monitoring systems. The effect of distance between camera and leaves for three values (30, 40 and 50cm) and the type of camera (CMOS and CCD) on the uniformity of resulted data were considered in this article. Results showed that data for 40cm distance between camera and leaves with a CCD camera had an acceptable trend for extracting image textural features.*
KEYWORDS: *CCD Camera, CMOS Camera, Image Processing, Pattern Recognition, Textural Features*

INTRODUCTION

The first stage of any vision system is the image acquisition stage [1]. After the image has been obtained, various methods of processing can be applied to the image to perform the many different vision tasks required today. However, if the image has not been acquired satisfactorily then the intended tasks may not be achievable, even with the aid of some form of image enhancement [5].

Cameras are usually used for image acquisition stage. Charge Coupled Device (CCD) and Complementary Metal Oxide Semiconductor (CMOS) image sensors are two different technologies for capturing images digitally. Each type has certain strengths and weaknesses giving advantages in different applications. The current situation and outlook for both technologies is vibrant, but a new framework exists for considering the relative strengths and opportunities of CCD and CMOS imagers [4].

Both types of imagers convert light into electric charge and process it into electronic signals. In a CCD sensor, every pixel's charge is transferred through a very limited number of output nodes (often just one) to be converted to voltage, buffered, and sent off-chip as an analogue signal.

All of the pixel can be devoted to light capture, and the output's uniformity (a key factor in image quality) is high. In a CMOS sensor, each pixel has its own charge-to-voltage conversion, and the sensor often also includes amplifiers, noise-correction, and digitization circuits, so that the chip outputs digital bits. These other functions increase the design complexity and reduce the area available for light capture. With each pixel doing its own conversion, uniformity is lower. But the chip can be built to require less off-chip circuitry for basic operation [13].

Developing high quality cameras based on CCD and CMOS sensors and image processing techniques have created a large number of machine vision applications in precision agriculture. Computer programs have increased the ability of image processing for sorting and grading fruits and other agricultural products. Calculating image textural parameters such as entropy, energy, homogeneity and contrast is one of the principle methods for determining the situation of image objects.

Some of the machine vision applications needed for non-contact monitoring of agricultural products conditions have already been developed. In a research, images of plants' leaves were taken digitally by a CCD camera. Then, spectral and morphological characteristics of these leaves were used to detect nutrient deficiency. This research also suggested the possibility of using machine vision systems that could determine plant status and indicate deficiencies [8].

In a research, a CCD camera was used to take the images from greenhouse grown grass and broadleaf plants. CO-OCCURRENCE MATRICES WERE utilized on a gray-scale image to compute texture features such as inertia and angular second moment to classify greenhouse plants [9].

By using a CMOS camera, co-occurrence matrices was made for the hue saturation and intensity colour space to obtain an overall classification accuracy of 91% on images of seven common cultivars of nursery stock. Computation time was an important factor and suggested using a smaller set of texture features [11].

A machine vision-guided plant sensing and monitoring system was used to detect calcium deficiency in lettuce crops grown in greenhouse conditions. Images were taken by a CCD colour camera and then, the machine vision system extracted plant features to determine overall plant growth and health status. The methodology developed was capable of identifying calcium-deficient lettuce plants one day prior to visual stress detection by human vision [12].

In a study, researchers designed an automatic robot with real time image processing system to detect nitrogen deficiency in greenhouse cucumber crops. Images were taken digitally by a CMOS camera and image textural features were extracted for calculating three textural parameters: entropy, energy and homogeneity [2]. They also used a CCD camera to take the images and measured entropy and homogeneity values for greenhouse crop leaves' image with a computer image processing method in an experiment. The objective of their study was growth modeling with a machine vision system for tomato, cucumber and eggplant crops [3].

The objective of the current study was to select which type of camera is ideal for real-time plant health and growth monitoring systems. This could be achieved by a multi-sensing systems (including CCD and CMOS cameras) equipped with an artificial light source for extracting image textural features.

MATERIALS AND METHODS – Experimental setup for growing greenhouse crop

The plant-production system was constructed in a research center located at the Controlled Environment Agricultural Center at the College of Abouraihan (University of Tehran, Iran). A hydroponic greenhouse of cucumber crop was chosen to collect data. Two rows were selected near the center of greenhouse in a time of one month after two-leaf stage. 100 leaves were picked randomly from each row every three days in 12:00 am and were brought to the laboratory. The greenhouses were covered with a double polycarbonate glazing and equipped with a Pad and Fan evaporative cooling system.

Desired climate set points were maintained by an automatic climate control system. Environmental parameters were collected by a data logger (Pardazesh Tamkar, Iran). Connected to the data logger, for each of two rows, four temperature sensors (LM35, National Semiconductor, Japan), two relative humidity sensors (083E, Met One Instruments, USA) and one carbon dioxide sensor (TGS4161, FIGARO, Japan) were hung from the greenhouse roof, 2m above the ground level. The distances between temperature sensors and relative humidity sensors in the rows were approximately 2m and 4m, respectively. During the experiment, the greenhouse temperature was set to 25°C for the day (14 h) and 20°C for the night (10 h). Root-zone environments were maintained at a pH of 6.2, EC of 2.0 dSm^{-1}, and a temperature of 20°C. Nutrient solutions were changed every 7 days to maintain proper nutrient levels in the root zone.

Image acquisition system

After picking the leaves, they were brought to a dark room for taking pictures. A CCD color camera (Canon, Powershot, G12, Japan) and a CMOS color camera (Canon, Powershot, SX40 HS, Japan) were used to take pictures from the leaves. Distance between Camera and the Leaves (DBCL) was set as a variable with three values of 30, 40 and 50 cm. A 200-LEDs array with view angle of 70° was used above the camera to increase the light uniformity for the region of interest. Distance between LDR and the leaves was set as a 20 cm (Figure 1).

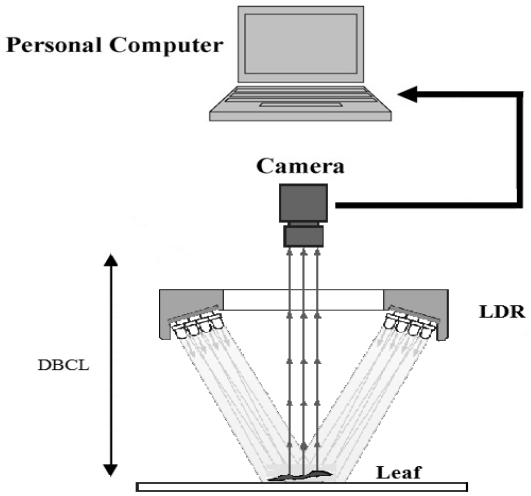


Figure1. Image acquisition system for plants' leaves

Two sequential images were taken by each camera from each plant leave with a certain DBCL. Images were transferred to the computer and then, image averaging was used for analysis to reduce the effect of random electronic noise and to reduce disturbances by factors that would cause the leaves to move. The captured images dimension was 1600 × 1200 pixels and was analyzed as a raw bitmap image. The program for the plant growth monitoring system was written with MathWorks MATLAB R2010b using Image Processing Toolbox.

Image processing and pattern recognition

From each retrieved image, the region of interest (the plant's leaf) was extracted through an image segmentation process [3,12]. This focused leaf image was used to calculate the colour features of the leaf. Gray-Level Co-occurrence Matrix (GLCM) was used to capture the spatial dependence of gray-level features of the image [6,7]. Each matrix was run through probability-density functions to calculate different textural parameters. After analyzing the colour features of the focused image, the textural features

were extracted. In one review, 21 textural parameters were identified [15]. However, another report indicated that only three textural parameters were useful in identifying plant health—entropy, energy, and homogeneity [12,14].

In this research, two textural parameters were used in identifying plant quality—entropy and homogeneity. After calculating textural parameters from each image, the values of parameters were averaged to obtain a dimensionless number to expose a parameter in an interval.

RESULTS AND DISCUSSION

The experiment ran for a total of 90 days. Figure 2 and Figure 3 illustrate the timeline of the extracted entropy at 12:00 am as averaged values obtained from cucumber crops.

It was assumed that changes in the plant texture and surface structure are external symptoms of the plant's internal physiological status [10].

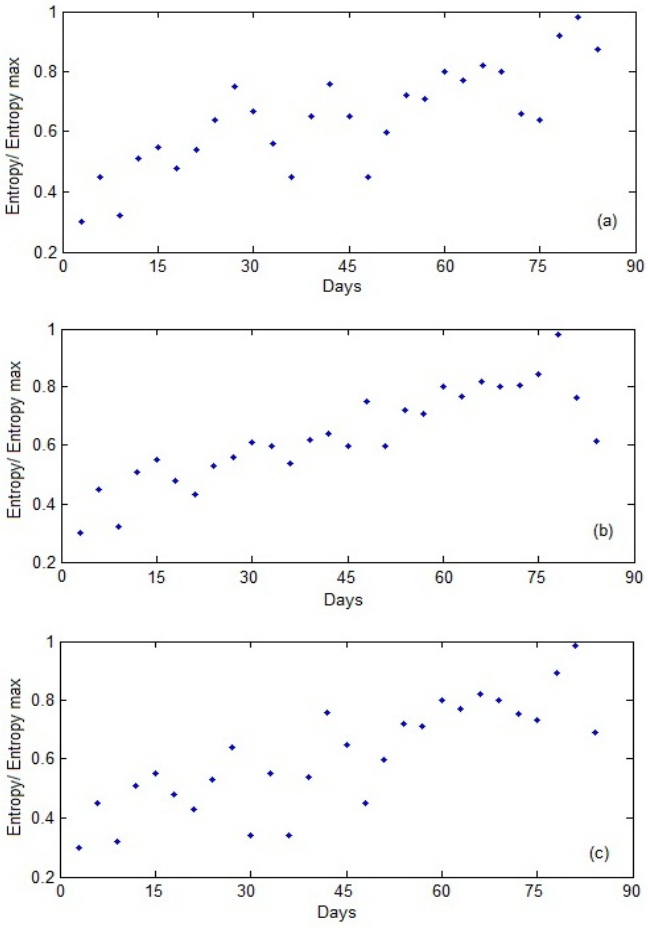


Figure 2. Timeline of the extracted entropy at 12:00 am as averaged values obtained from cucumber crops by CMOS camera when DBCL is: (a) 30cm, (b) 40cm, and (c) 50cm

In comparison with younger leaves, older plants' leaves are more colourful with different levels of green colour. This is usually detected by higher levels of entropy values from the images of older plants [3]. In this study, textural features were examined by probability-density functions on GLCM.

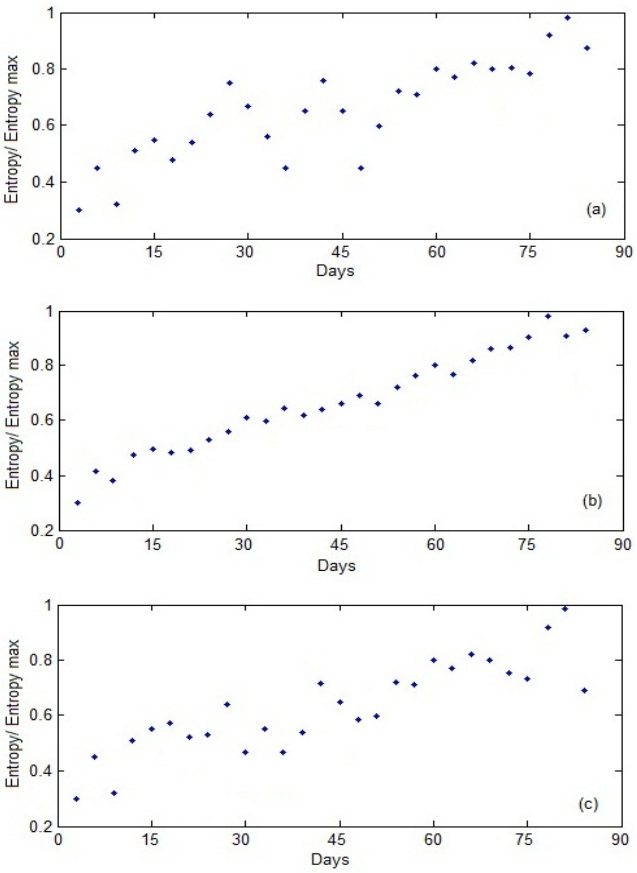


Figure 3. Timeline of the extracted entropy at 12:00 am as averaged values obtained from cucumber crops by CCD camera when DBCL is: (a) 30cm, (b) 40cm, and (c) 50cm

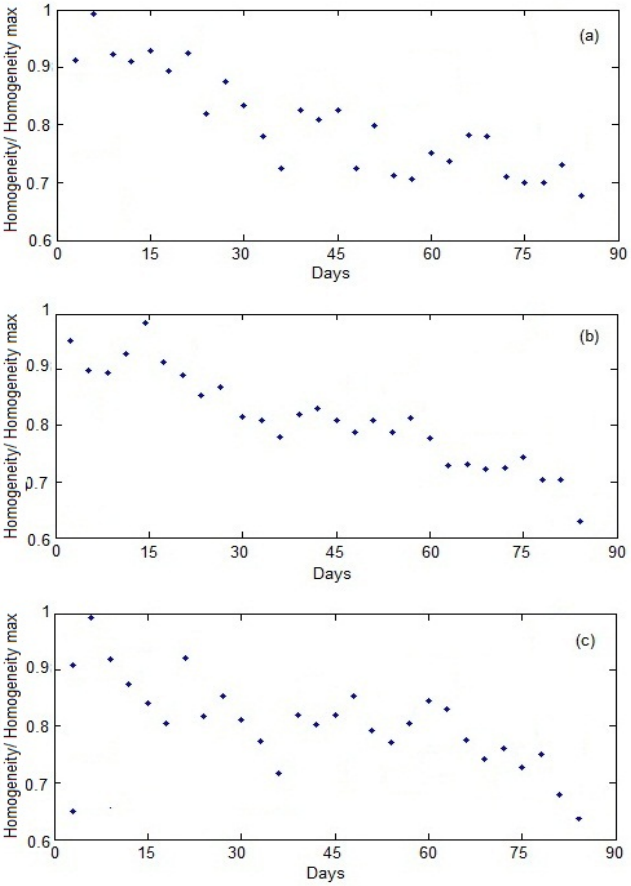


Figure 4. Timeline of the extracted homogeneity at 12:00 am as averaged values obtained from cucumber crops by CMOS camera when DBCL is: (a) 30cm, (b) 40cm, and (c) 50cm

During the experiment, non-uniform data with no certain trends was obtained by using CMOS camera in three values of DBCL to extract entropy.
Results of using CCD camera were also not reliable for DCBL 30cm and 50cm, but data for DCBL 40cm had an acceptable trend for extracting entropy feature.
Figure 4 and Figure 5 illustrate the timeline of the extracted homogeneity at 12:00 am as averaged values obtained from the cucumber crops.

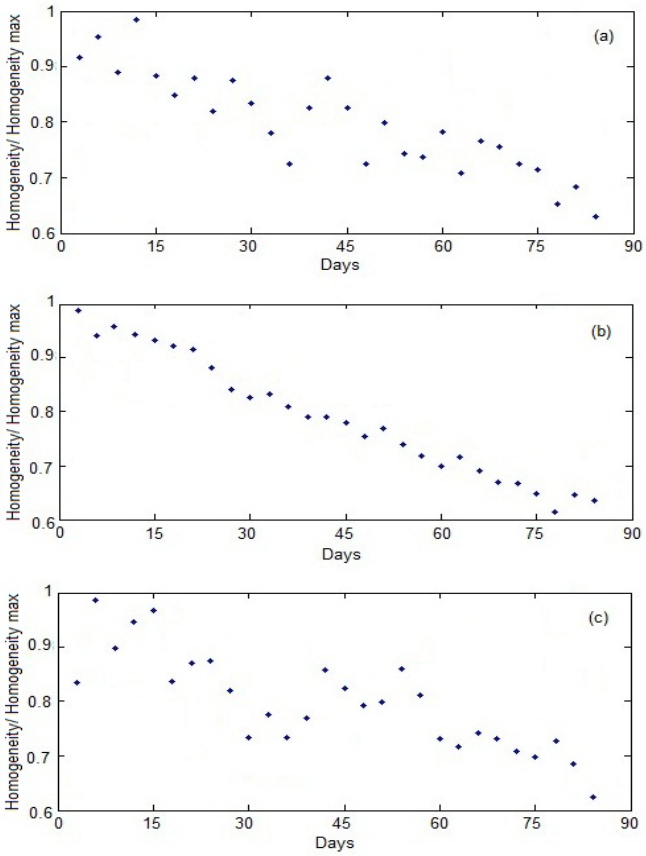


Figure 5. Timeline of the extracted homogeneity at 12:00 am as averaged values obtained from cucumber crops by CCD camera when DBCL is: (a) 30cm, (b) 40cm, and (c) 50cm

As older plants' leaves are more colourful with different shades of green, the related gray-level pixel distribution (homogeneity) decreases over time. Conversely, the younger plants, being more unified in colour, have higher homogeneity values [3]. During the experiment, non-uniform data with no certain trends was obtained by using CMOS camera in three values of DBCL to extract homogeneity. Results of using CCD camera were also not reliable for DCBL 30cm and 50cm, but data for DCBL 40cm had an acceptable trend for extracting homogeneity feature.

CONCLUSIONS

In this study, a machine vision system was developed to evaluate the performance of CCD and CMOS cameras for real-time monitoring of plant growth in a greenhouse. Entropy and homogeneity were measured as textural features for greenhouse plant leaves' image in an experiment for cucumber crops. The leaf samples were brought to the laboratory from the greenhouses to measure the textural features. The effect of Distance between Camera and Leaves (DBCL) for three values (30, 40 and 50cm) and the type of camera (CMOS and CCD) on the uniformity of resulted data were considered in this article.
Results showed that non-uniform data with no certain trends was obtained by using CMOS and CCD camera in two values of DBCL (30cm and 50cm) to extract entropy. Data for DCBL 40cm with a CCD camera had an acceptable trend for extracting both of entropy and homogeneity features.

ACKNOWLEDGEMENT

The authors would like to thank the University of Tehran for support of this research project.

REFERENCES

[1.] Asefpour Vakilian, A. and Asefpour Vakilian, K., A New Satellite Image Segmentation Enhancement Technique For Weak Image Boundaries, Annals of Faculty Engineering Hunedoara - International Journal of Engineering, X(2), 2012.
[2.] Asefpour Vakilian, K. and Massah, J., Design, Development and Performance Evaluation of a Robot to Early Detection of Nitrogen Deficiency in Greenhouse Cucumber (Cucumis sativus) with Machine Vision, International Journal of Agriculture: Research & Review, 2(4), 2012.
[3.] Asefpour Vakilian, K. and Massah, J., Non-linear Growth Modeling of Greenhouse Crops with Image Textural Features Analysis, International Research Journal of Applied and Basic Science, 3(1), 2012.
[4.] Boyle, W.S. and Smith, G.E., Charge Coupled Semiconductor Devices. Bell System and Technology Journal, 49(4), 1970.
[5.] Gonzalez, R. and Woods, R, Digital image processing. Addison-Wesley, New Jersey, 2002.
[6.] Haralick, R.M., Shanmugam, K., Dinstein, I., Textural features for Image Classification, IEEE Transactions on Systems, Man, and Cyberentics, 3(6), 1973.
[7.] Jain, R., Kasturi, R. and Schunck, B.G., Machine Vision. McGraw-Hill, 1995.
[8.] Ling, P.P, Giacomelli, G.A. and Russell, T.P., Monitoring of plant development in controlled environment with machine vision, Adv. in Space Research, 18(4-5), 1996.
[9.] Meyer, G.E., Troyer, W.W., Fitzgerald, J.B. and Paparozzi, E.T., Leaf nitrogen analysis of poinsettia (Euphorbia Pulcherrima Will D.) using spectral properties in natural and controlled lighting. Applied Engineering in Agriculture, 8(5), 1992.
[10.] Penuelas, J. and Filella, I., Visible and near-infrared reflectance techniques for diagnosing plant physiological status, Trends in Plant Science, 3, 1998.
[11.] Shearer, S.A. and Holmes, R.G., Plant identification using colour co-occurrence matrices, Transactions on ASAE, 33(6), 1990.
[12.] Story, D., Kacira, M., Kubota, C., Akoglu, A., An, L., Lettuce calcium deficiency detection with machine vision computed plant features in controlled environments, Computers and Electronics in Agriculture, 74, 2010.
[13.] Tompsett, M.F., Amelio, G.F., Bertram, W.J., Buckley, R.R., McNamara, W.J., Mikkelsen, J.C. and Sealer, D.A., Charge-coupled imaging devices: Experimental results, IEEE Transactions on Electronic Devices. 18(11) 1971.
[14.] Ushada, D., Murase, H. and Fukuda, H., Non-destructive sensing and its inverse model for canopy parameters using texture analysis and artificial neural network, Computers and Electronics in Agriculture, 57, 2007.
[15.] Zheng, C., Sun, D.W. and Zheng, L., Recent applications of image texture for evaluation of food qualities-a review Trends in Food Science and Technology, 17, 2006.

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome V (Year 2012). FASCICULE 3 [July–September]. ISSN 2067-3809

[1.] Imre Zsolt MIKLOS, [2.] Cristina Carmen MIKLOS, [3.] Carmen Inge ALIC

CAM PROFILE COMPUTER AIDED DESIGN PLOTTING

[1.] UNIVERSITY „POLITEHNICA" TIMIŞOARA, FACULTY OF ENGINEERING HUNEDOARA, ROMANIA

ABSTRACT: *This paper shows how to plotting the profile of a plane rotating cam and a follower in the translational move, using Matlab program. Are shown how input the variables, kinematic analysis, speeds hodograph in graphical form, respectively plane cam profile designed, with a choice of several options for the best solutions.*
KEYWORDS: *Cam, follower, cam profile*

INTRODUCTION

The transformation of one of the simple motions, such as rotation, into any other motions is often conveniently accomplished by means of a cam mechanism A cam mechanism usually consists of two moving elements, the cam and the follower, mounted on a fixed frame. Cam devices are versatile, and almost any arbitrarily-specified motion can be obtained. In some instances, they offer the simplest and most compact way to transform motions.

*A **cam** may be defined as a machine element having a curved outline or a curved groove, which, by its oscillation or rotation motion, gives a predetermined specified motion to another element called the follower. The cam has a very important function in the operation of many classes of machines, especially those of the automatic type, such as printing presses, shoe machinery, textile machinery, gear-cutting machines, and screw machines. In any class of machinery in which automatic control and accurate timing are paramount, the cam is an indispensable part of mechanism.*

Cam mechanisms design, respectively profile obtaining, may be realize by many methods. The first design methods for cam mechanisms war graphical. These methods require many graphical constructions with low precision. With the new entry calculation systems, have develop analytical methods to obtain cam profile by software writing (Basic, C++, Matlab, MathCAD, etc). These methods are faster, giving to the plant designer varieties data results and charts.

Plotting a plane cam profile requires knowledge of some initial elements of calculation. These are:

- *The motion phases based on the technological process data, defined by the angles of lifting, high stationary, going down and down stationary, respectively follower race (linear displacement respectively oscillating)*
- *Law of motion, which is chosed by the designer according to the angles values that define motion phases and by the value of the angular velocity of the cam. In most cases law of motion is chosen depending on the maximum acceleration of the follower (for the reasons of inertia forces equilibration), respectively on the acceleration jump from one phase to another.*
- *Maximum pressure angle (between the follower and cam)*
- *Motion (linear or oscillating) and follower form*
- *Follower roller radius (if necessary), according to the minimum radius of basic circle*
- *Expansion joints (if necessary)*

Plotting a plane cam profile can be made by graphical methods and analytical method. In both cases the design involves the following steps:

- *Kinematic analysis of a cam mechanism, respectively the graphical representation of displacement variation and follower low speed depending on the cam rotational angle*
- *Velocities hodograph building*
- *Determination of minimum radius of curvature of the cam*
- *Checking the contact pressure*
- *Entering in calculations the expansion joints (if necessary)*
- *Establishing minimum radius of the cam base circle, respectively the radius of the roller follower (if necessary)*
- *Cam profile construction*

PROGRAM AND RESULTS PRESENTATION

Plane rotating cam plotting profile, with follower in translation moving, was made with mathematical formulas provided by analytical methods [2], using a computer program designed and written in Matlab programming environment.

For the case study was considered a cam mechanism having the follower parabolic law of motion, respectively the following input data defined by the technological process requirements:

- *Follower lift: h = 50 mm*
- *Uplift angle: φ_1 = 150 grade*
- *Upper stationary angle: φ_2 = 30 grade*
- *Down angle: φ_3 = 150 grade*
- *Pressure angle allowed: δ = 30 grade*
- *Eccentricity: e = 10 mm*

When the computer program is launching appear a dialog box with the user, from which will be introduced the input data (dialog box defined with the input procedure). This is shown in Figure 1.

Based on input data (defined by the technological process) computer program make graphic representation of displacement and follower low speed depending on cam rotation angle (Fig. 2),

respectively velocities hodograph (velocity and displacement graphic dependence of the follower) (figure 3).

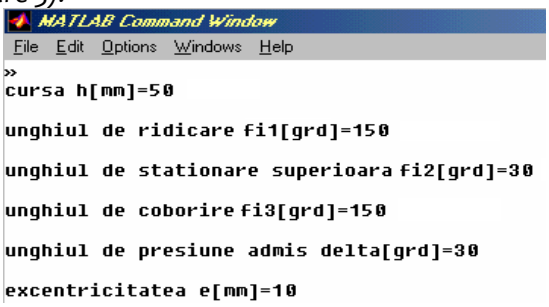
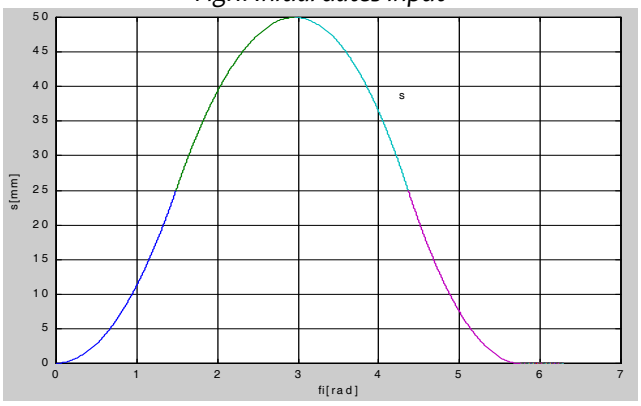


Fig.1. Initial dates input



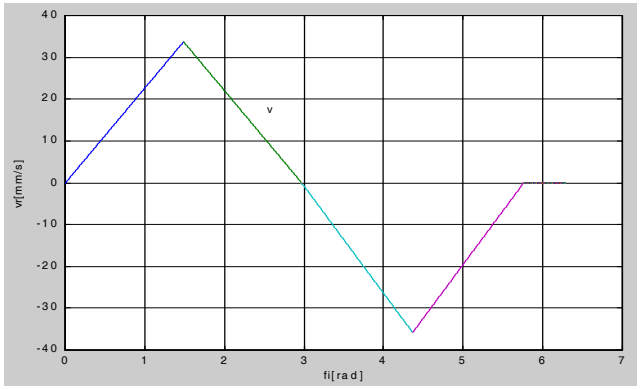


Fig.2. Cam mechanism kinematic analysis

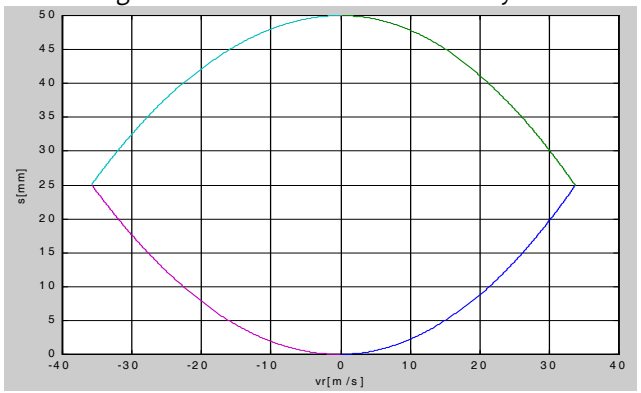


Fig.3. Velocity hodograph

It is known that on synthesis graphical method of cam mechanisms, the velocities hodograph is used to determine minimum radius on graphical method of basic circle. In case of analytical methods based on known relations [2], computer program determines the minimum value of basic circle, showing more options, the user entering through an input procedure, the chosen value, fig.4.

```
excentricitatea e[mm]=10

r =

   12.5901   12.5902    8.2049    8.2049   10.8307   10.8315

raza cercului de baza r=
```

Fig. 4. Choosing the minimum radius of basic circle

Further, the program performs roll follower radius calculation, follower and cam contact verification, respectively determines by graphic representation cam profile (based on user input data) Fig. 5.

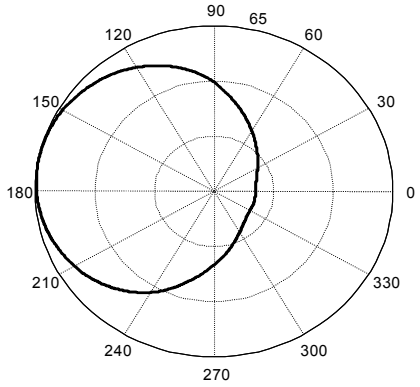


Fig. 5. Cam profile with parabolic motion law

CONCLUSIONS

The presented calculation program is very easy to use by the designer, through introduction of initial data, given by the technological process; in a very short time it can get the cam profile, respectively kinematics on cam mechanism graphic representations.

REFERENCES

[1.] *Artobolevski, I. Teoria mecanismelor şi a maşinilor, Editura Tehnică, Bucureşti, 1955*

[2.] *Chen, F. Y., Mechanics and Design of Cam Mechanisms, Pergamon Press, New York, 1982*

[3.] *Ghinea, M., Firețeanu, V., Matlab, calcul numeric, grafică, aplicații, Editura Teora, Bucureşti 1997*

[4.] *Kovacs, Fr., ş.a., Mecanisme, Litografia U.P. Timişoara, 1992.*

[5.] *Manolescu, N., ş.a., Teoria mecanismelor şi a maşinilor, Editura Didactică şi Pedagogică, Bucureşti, 1972.*

[6.] *Miklos, Zs., Mecanisme. Analiza mecanismelor, Editura Mirton, Timişoara. 2005*

[7.] *Miklos, I. Mecanisme şi organe de maşini, Universitatea Politehnica Timişoara, 1995.*

[8.] *Simionescu, I., Moise, V. ,Mecanisme, Editura Tehnică, Bucureşti, 1999.*

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome V (Year 2012). FASCICULE 3 [July–September]. ISSN 2067-3809

[1.] A.G. VIJAYA KUMAR, [2.] S.V.K. VARMA, [3.] Y. RAJASHEKARA GOUD, [4.] K. RAGHUNATH

THERMAL DIFFUSION AND RADIATION EFFECTS ON UNSTEADY MHD FLOW PAST A LINEARLY ACCELERATED VERTICAL PLATE WITH VARIABLE TEMPERATURE AND MASS DIFFUSION

[1.] DEPARTMENT OF MATHEMATICS, MVJ COLLEGE OF ENGINEERING, BANGLORE, KARNATAKA, INDIA
[2.] DEPARTMENT OF MATHEMATICS, S.V.UNIVERSITY, TIRUPATI, A.P, INDIA
[3.] DEPARTMENT OF HUMANITIES AND SCIENCES, G. PULLAREDDY ENGINEERING COLLEGE, KURNOOL, A.P, INDIA
[4.] DEPARTMENT OF MATHEMATICS, BHEEMA INSTITUTE OF TECHNOLOGY AND SCINECE, ADONI, KURNOOL, A.P. INDIA

ABSTRACT: *The objective of the present study is to investigate thermal diffusion and radiation effects on unsteady MHD flow past a linearly accelerated vertical plate with variable temperature and mass diffusion under the influence of applied transverse magnetic field. The fluid considered here is a gray, absorbing/ emitting radiation but a non-scattering medium. At time t>0, the plate is linearly accelerated with a velocity u = u_0 t in its own plane. And at the same time, plate temperature and concentration levels near the plate raised linearly with time t. The dimensionless governing equations involved in the present analysis are solved using the Laplace transform technique. The velocity, temperature, concentration, Skin-friction, the rate or heat transfer and the rate of mass transfer are studied through graphs and tables in terms of different physical parameters like magnetic field parameter (M), radiation parameter (R), Schmidt parameter (Sc), soret number (So), Prandtl number (Pr), thermal Grashof number (Gr), mass Grashof number (Gm) and time (t).*
KEYWORDS: *magnetic field, radiation, thermal diffusion, vertical plate, porous medium*

INTRODUCTION

The study of magneto hydro-dynamics with mass and heat transfer in the presence of radiation and diffusion has attracted the attention of a large number of scholars due to diverse applications. In astrophysics and geophysics, it is applied to study the stellar and solar structures, radio propagation through the ionosphere, etc. In engineering we find its applications like in MHD pumps, MHD bearings, etc. The phenomenon of mass transfer is also very common in theory of stellar structure and observable effects are detectable on the solar surface. In free convection flow the study of effects of magnetic field play a major rule in liquid metals, electrolytes and ionized gases. In power engineering, the thermal physics of hydro magnetic problems with mass transfer have enormous applications. Radiative flows are encountered in many industrial and environment processes, e.g. heating and cooling chambers, fossil fuel combustion energy processes, evaporation from large open water reservoirs, astrophysical flows, solar power technology and space vehicle re-entry.

MHD effects on impulsively started vertical infinite plate with variable temperature in the presence of transverse magnetic field were studied by Soundalgekar et al. [12]. The effects of transversely applied magnetic field, on the flow of an electrically conducting fluid past an impulsively started infinite isothermal vertical plate were also studied by Soundalgekar et al. [11]. The dimensionless governing equations were solved using Laplace transform technique. Kumari and nath [8] studied the development of the asymmetric flow of a viscous electrically conducting fluid in the forward stagnation point region of a two-dimensional body and over a stretching surface was set into impulsive motion from the rest. The governing equations were solved using finite difference scheme. The radiative free convection flow of an optically thin gray-gas past semi-infinite vertical plate studied by Soundalgekar and Takhar [13]. Hossain and Takhar have considered radiation effects on mixed convection along an isothermal vertical plate [5]. In all above studies the stationary vertical plate considered. Raptis and Perdikis [10] studied the effects of thermal-radiation and free convection flow past a moving vertical plate. The governing equations were solved analytically. Das et al [4] have considered radiation effects on flow past an impulsively started infinite isothermal vertical plate. The governing equations were solved by the Laplace transform technique. Muthucumaraswamy and Janakiraman [9] have studied MHD and radiation effects on moving isothermal vertical plate with variable mass diffusion.

Alam and Sattar [3] have analyzed the thermal-diffusion effect on MHD free convection and mass transfer flow. Jha and Singh [6] have studied the importance of the effects of thermal-diffusion (mass diffusion due to temperature gradient). Alam et al [1] studied the thermal-diffusion effect on unsteady MHD free convection and mass transfer flow past an impulsively started vertical porous plate. Recently, Alam et al [2] studied combined free convection and mass transfer flow past a vertical plate with heat

generation and thermal-diffusion through porous medium.

This paper deals with the effects of thermal-diffusion and radiation on unsteady MHD flow past an impulsively started linearly accelerated infinite vertical plate with variable temperature and mass diffusion in the presence of transverse applied magnetic field. The dimensionless governing equations involved in the present analysis are solved using Laplace transform technique. The solutions are expressed in terms of exponential and complementary error functions.

MATHEMATICAL ANALYSIS

Thermal-diffusion and radiation effects on unsteady MHD flow past of a viscous incompressible, electrically conducting, radiating fluid past an impulsively started linearly accelerated infinite vertical plate with variable temperature and mass diffusion in the presence of transverse applied magnetic field are studied. The plate is taken along $x'-$-axis in vertically upward direction and $y'-$axis is taken normal to the plate. Initially it is assumed that the plate and fluid are at the same temperature T'_∞ and concentration level C'_∞ in stationary condition for all the points. At time $t'>0$, the plate is linearly accelerated with a velocity $u=u_0t'$ in the vertical upward direction against to the gravitational field. And at the same time the plate temperature is raised linearly with time t and also the mass is diffused from the plate to the fluid is linearly with time. A transverse magnetic field of uniform strength B_0 is assumed to be applied normal to the plate. The viscous dissipation and induced magnetic field are assumed to be negligible. The fluid considered here is gray, absorbing/emitting radiation but a non-scattering medium. Then under by usual Boussinesq's approximation, the unsteady flow is governed by the following equations:

$$\frac{\partial u'}{\partial t'}=g\beta\left(T'-T'_\infty\right)+g\beta^*\left(C'-C'_\infty\right)+\nu\frac{\partial^2u'}{\partial y'^2}-\frac{\sigma\beta_0^2u'}{\rho} \quad (1)$$

$$\rho c_p\frac{\partial T'}{\partial t'}=\kappa\frac{\partial^2T'}{\partial y'^2}-\frac{\partial q_r}{\partial y'} \quad (2)$$

$$\frac{\partial C'}{\partial t'}=D\frac{\partial^2C'}{\partial y'^2}+D_1\left(\frac{\partial^2T'}{\partial y'^2}\right) \quad (3)$$

With the following initial and boundary conditions

$$t'\le o: u'=o,\ T'=T'_\infty,\ C'=C'_\infty,\ \text{for all } y'$$

$$t'>o:\ u'=u_0t',$$

$$T'=T'_\infty+\left(T'_w-T'_\infty\right)At',$$

$$C'=C'_\infty+\left(C'_w-C'_\infty\right)At' \ \text{ at } \ y'=o$$

and

$$u'=o,\quad T'\to T'_\infty,\quad C'\to C'_\infty \quad \text{as} \quad y'\to\infty \quad (4)$$

where $A=\dfrac{u_o^2}{\nu}$

The local radiant for the case of an optically thin gray gas is expressed by

$$\frac{\partial q_r}{\partial y'}=-4a^*\sigma\left(T'^4_\infty-T'^4\right) \quad (5)$$

It is assumed that the temperature differences within the flow are sufficiently small and that T'^4 may be expressed as a linear function of the temperature. This is obtained by expanding T'^4 in a Taylor series about T'_∞ and neglecting the higher order terms, thus we get

$$T'^4\cong 4T'^3_\infty T'-3T'^4_\infty \quad (6)$$

From equations (5) and (6), equation (2) reduces to

$$\rho C_p\frac{\partial T'}{\partial t'}=\kappa\frac{\partial^2T'}{\partial y'^2}+16a^*\sigma T'^3_\infty\left(T'_\infty-T'\right) \quad (7)$$

On introducing the following non-dimensional quantities

$$u=\frac{u'}{u_o},\ t=\frac{t'u_o^2}{\nu},\ y=\frac{y'u_o}{\nu},\ \theta=\frac{T'-T'_\infty}{T'_w-T'_\infty},$$

$$C=\frac{C'-C'_\infty}{C'_w-C'_\infty},\ a=\frac{a'\nu}{u_o^2},\quad \omega=\frac{\omega'\nu}{u_o^2}$$

$$G_r=\frac{g\beta\nu\left(T'_w-T'_\infty\right)}{u_o^3},\ G_m=\frac{g\beta^\bullet\nu\left(C'_w-C'_\infty\right)}{u_o^3},$$

$$P_r=\frac{\mu C_\rho}{\kappa},S_o=\frac{D_1(T'_w-T'_\infty)}{\nu(C'_w-C'_\infty)}$$

$$S_c=\frac{\nu}{D},\ M=\frac{\sigma B_o^2\nu}{\rho u_o^2},\ R=\frac{16a^\bullet\nu^2\sigma T'^3_\infty}{ku_o^2} \quad (8)$$

we get the following governing equations which are dimensionless.

$$\frac{\partial u}{\partial t}=G_r\theta+G_mC+\frac{\partial^2u}{\partial y^2}-Mu, \quad (9)$$

$$\frac{\partial\theta}{\partial t}=\frac{1}{Pr}\frac{\partial^2\theta}{\partial y^2}-\frac{R}{Pr}\theta, \quad (10)$$

$$\frac{\partial C}{\partial t}=\frac{1}{Sc}\frac{\partial^2C}{\partial y^2}+S_o\frac{\partial^2\theta}{\partial y^2} \quad (11)$$

The initial and boundary conditions in dimensionless form are as follows:

$$t'\le o: u=o,\quad \theta=o,\quad C=o \text{ for all } y,$$

$$t>o: u=t,\ \theta=t,\ C=t \quad \text{at} \quad y=o, \text{ and}$$

$$u\to o,\quad c\to o \quad \text{as} \quad y\to\infty. \quad (12)$$

The appeared physical parameters are defined in the nomenclature. The dimensionless governing equations from (9) to (11), with respect to the boundary conditions (12) are solved by usual Laplace transform technique and the solutions for hydro magnetic flow in the presence of radiation and thermal diffusion through are obtained as follows.

$$\theta(y,t)=\left(\frac{t}{2}+\frac{yPr}{4\sqrt{R}}\right)exp\left(y\sqrt{R}\right)erfc\left(\frac{y\sqrt{Pr}}{2\sqrt{t}}+\sqrt{\frac{Rt}{Pr}}\right)$$
$$+\left(\frac{t}{2}-\frac{yPr}{4\sqrt{R}}\right)exp\left(-y\sqrt{R}\right)erfc\left(\frac{y\sqrt{Pr}}{2\sqrt{t}}-\sqrt{\frac{Rt}{Pr}}\right) \quad (13)$$

$$C(y,t)=(1+b)\left[\left(t+\frac{y^2Sc}{2}\right)erfc\left(\frac{y\sqrt{Sc}}{2\sqrt{t}}\right)-y\sqrt{\frac{tSc}{\pi}}exp\left(-\frac{y^2Sc}{4t}\right)\right]$$
$$+\left(d-\frac{b}{c}\right)erfc\left(\frac{y\sqrt{Sc}}{2\sqrt{t}}\right)$$
$$-\frac{1}{2}\left(d-\frac{b}{c}\right)exp(-ct)\left[\begin{array}{l}exp\left(y\sqrt{-cSc}\right)erfc\left(\frac{y\sqrt{Sc}}{2\sqrt{t}}+\sqrt{-ct}\right)\\+exp\left(-y\sqrt{-cSc}\right)erfc\left(\frac{y\sqrt{Sc}}{2\sqrt{t}}-\sqrt{-ct}\right)\end{array}\right]$$
$$-\frac{1}{2}\left(d-\frac{b}{c}\right)\left[\begin{array}{l}exp\left(y\sqrt{R}\right)erfc\left(\frac{y\sqrt{Pr}}{2\sqrt{t}}+\sqrt{\frac{Rt}{Pr}}\right)\\+exp\left(-y\sqrt{R}\right)erfc\left(\frac{y\sqrt{Pr}}{2\sqrt{t}}-\sqrt{\frac{Rt}{Pr}}\right)\end{array}\right]$$
$$-b\left[\begin{array}{l}\left(\frac{t}{2}+\frac{yPr}{4\sqrt{R}}\right)exp\left(y\sqrt{R}\right)erfc\left(\frac{y\sqrt{Pr}}{2\sqrt{t}}+\sqrt{\frac{Rt}{Pr}}\right)\\+\left(\frac{t}{2}-\frac{yPr}{4\sqrt{R}}\right)exp\left(-y\sqrt{R}\right)erfc\left(\frac{y\sqrt{Pr}}{2\sqrt{t}}-\sqrt{\frac{Rt}{Pr}}\right)\end{array}\right]$$
$$+\frac{1}{2}\left(d-\frac{b}{c}\right)exp(-ct)\left[\begin{array}{l}exp\left(y\sqrt{R-cPr}\right)erfc\left(\frac{y\sqrt{Pr}}{2\sqrt{t}}+\sqrt{\left(\frac{R}{Pr}-c\right)t}\right)\\+exp\left(-y\sqrt{R-cPr}\right)erfc\left(\frac{y\sqrt{Pr}}{2\sqrt{t}}-\sqrt{\left(\frac{R}{Pr}-c\right)t}\right)\end{array}\right] \quad (14)$$

$$u(y,t)=A_1\left[\begin{array}{l}\left(\frac{t}{2}+\frac{yPr}{4\sqrt{R}}\right)exp\left(y\sqrt{R}\right)erfc\left(\frac{y\sqrt{Pr}}{2\sqrt{t}}+\sqrt{\frac{Rt}{Pr}}\right)\\+\left(\frac{t}{2}-\frac{yPr}{4\sqrt{R}}\right)exp\left(-y\sqrt{R}\right)erfc\left(\frac{y\sqrt{Pr}}{2\sqrt{t}}-\sqrt{\frac{Rt}{Pr}}\right)\end{array}\right]$$
$$+A_2\left[\left(t+\frac{y^2Sc}{2}\right)erfc\left(\frac{y\sqrt{Sc}}{2\sqrt{t}}\right)-y\sqrt{\frac{tSc}{\pi}}exp\left(-\frac{y^2Sc}{4t}\right)\right]$$
$$+(1-A_1-A_2)\left[\begin{array}{l}\left(\frac{t}{2}+\frac{y}{4\sqrt{M}}\right)exp(y\sqrt{M})erfc\left(\frac{y}{2\sqrt{t}}+\sqrt{Mt}\right)\\+\left(\frac{t}{2}-\frac{y}{4\sqrt{M}}\right)exp(-y\sqrt{M})erfc\left(\frac{y}{2\sqrt{t}}-\sqrt{Mt}\right)\end{array}\right]$$
$$+\frac{A_3}{2}exp(-ct)\left[\begin{array}{l}exp\left(y\sqrt{R-cPr}\right)erfc\left(\frac{y\sqrt{Pr}}{2\sqrt{t}}+\sqrt{\left(\frac{R}{Pr}-c\right)t}\right)\\+exp\left(-y\sqrt{R-cPr}\right)erfc\left(\frac{y\sqrt{Pr}}{2\sqrt{t}}-\sqrt{\left(\frac{R}{Pr}-c\right)t}\right)\end{array}\right]$$
$$+\frac{A_4}{2}exp(-ct)\left[\begin{array}{l}exp\left(y\sqrt{-cSc}\right)erfc\left(\frac{y\sqrt{Sc}}{2\sqrt{t}}+\sqrt{-ct}\right)\\+exp\left(-y\sqrt{-cSc}\right)erfc\left(\frac{y\sqrt{Sc}}{2\sqrt{t}}-\sqrt{-ct}\right)\end{array}\right]$$
$$+\frac{A_5}{2}exp(-lt)\left[\begin{array}{l}exp\left(y\sqrt{M-l}\right)erfc\left(\frac{y}{2\sqrt{t}}+\sqrt{(M-l)t}\right)\\+exp\left(-y\sqrt{M-l}\right)erfc\left(\frac{y}{2\sqrt{t}}-\sqrt{(M-l)t}\right)\end{array}\right]$$
$$-\frac{A_5}{2}exp(-lt)\left[\begin{array}{l}exp\left(y\sqrt{R-lPr}\right)erfc\left(\frac{y\sqrt{Pr}}{2\sqrt{t}}+\sqrt{\left(\frac{R}{Pr}-l\right)t}\right)\\+exp\left(-y\sqrt{R-lPr}\right)erfc\left(\frac{y\sqrt{Pr}}{2\sqrt{t}}-\sqrt{\left(\frac{R}{Pr}-l\right)t}\right)\end{array}\right]$$
$$+\frac{A_6}{2}exp(nt)\left[\begin{array}{l}exp\left(y\sqrt{M+n}\right)erfc\left(\frac{y}{2\sqrt{t}}+\sqrt{(M+n)t}\right)\\+exp\left(-y\sqrt{M+n}\right)erfc\left(\frac{y}{2\sqrt{t}}-\sqrt{(M+n)t}\right)\end{array}\right]$$
$$-\frac{A_6}{2}exp(nt)\left[\begin{array}{l}exp\left(y\sqrt{nSc}\right)erfc\left(\frac{y\sqrt{Sc}}{2\sqrt{t}}+\sqrt{nt}\right)\\+exp\left(-y\sqrt{nSc}\right)erfc\left(\frac{y\sqrt{Sc}}{2\sqrt{t}}-\sqrt{nt}\right)\end{array}\right]$$
$$+\frac{A_7}{2}\left[\begin{array}{l}exp\left(y\sqrt{R}\right)erfc\left(\frac{y\sqrt{Pr}}{2\sqrt{t}}+\sqrt{\frac{Rt}{Pr}}\right)+\\+exp\left(-y\sqrt{R}\right)erfc\left(\frac{y\sqrt{Pr}}{2\sqrt{t}}-\sqrt{\frac{Rt}{Pr}}\right)\end{array}\right]$$
$$+A_8erfc\left(\frac{y\sqrt{Sc}}{2\sqrt{t}}\right)$$
$$-\frac{1}{2}(A_7+A_8)\left[\begin{array}{l}exp(y\sqrt{M})erfc\left(\frac{y}{2\sqrt{t}}+\sqrt{Mt}\right)\\+exp(y\sqrt{M})erfc\left(\frac{y}{2\sqrt{t}}+\sqrt{Mt}\right)\end{array}\right] \quad (15)$$

where $b=S_0Sc,\ c=\frac{R}{Pr-Sc},$

$d=\frac{bPr}{R},\ l=\frac{R-M}{Sc-1},$

$n=\frac{M}{Sc-1},$

$A_1=\frac{bGm-Gr}{R-M},\ A_2=\frac{(1+b)Gm}{M},$

$$A_3 = \frac{bGm(R-cPr)}{cR(R-M+c-cPr)},$$

$$A_4 = \frac{bGm(R-cPr)}{cR(R-M+c-cPr)},$$

$$A_5 = \frac{(Pr-1)[RGr(R-M+c-cPr)+Gmbc(MPr-R)]}{R(R-M)^2(R-M+c-cPr)}$$

$$A_6 = \frac{Gm(Sc-1)[M(R+bcPr)+cR(1+b)(Sc-1)]}{M^2R(M-c+cSc)}$$

$$A_7 = \frac{cR(Pr-1)(Gr-bGm)+Gmb(R-M)(cPr-R)}{cR(R-M)^2}$$

$$A_8 = \frac{Gm[cR(Sc-1)+MPr\,bc-bR(M+c-cSc)]}{cM^2R}$$

THE RATE OF HEAT TRANSFER

From temperature field, now we study Nusselt number (rate of change of heat transfer)it is given in non-dimensional form as

$$Nu = -\left[\frac{\partial\theta}{\partial y}\right]_{y=o} \qquad (17)$$

From equations (13) and (17), we get Nusselt number as follows

$$Nu = \left[t\sqrt{R}erf\sqrt{\frac{Rt}{Pr}} + \sqrt{\frac{tPr}{\pi}}exp\left(-\frac{Rt}{Pr}\right) + \frac{Pr}{2\sqrt{R}}erf\sqrt{\frac{Rt}{Pr}}\right]$$

THE RATE OF MASS TRANSFER

From the concentration field, we now study Sherwood number (rate of change of mass transfer) it is given in non-dimensional form as follows

$$Sh = -\left[\frac{\partial C}{\partial y}\right]_{y=o} \qquad (18)$$

From equations (14) and (18), we get

$$Sh = 2(1+b)\sqrt{\frac{tSc}{\pi}} + \left(d-\frac{b}{c}\right)\sqrt{\frac{Sc}{\pi t}}$$

$$-\left(d-\frac{b}{c}\right)exp(-ct)\left[\sqrt{\frac{Sc}{\pi t}}exp(ct) + \sqrt{-cSc}erf\sqrt{-ct}\right]$$

$$-\left(d-\frac{b}{c}\right)\left[\sqrt{\frac{Pr}{\pi t}}exp\left(-\frac{Rt}{Pr}\right) + \sqrt{R}erf\sqrt{\frac{Rt}{Pr}}\right]$$

$$+\left(d-\frac{b}{c}\right)exp(-ct)\left[\sqrt{\frac{Pr}{\pi t}}exp\left(-\frac{Rt}{Pr}+ct\right) + \sqrt{R-cPr}\,erf\sqrt{\left(\frac{R}{Pr}-c\right)t}\right]$$

$$-b\left[t\sqrt{R}erf\sqrt{\frac{Rt}{Pr}} + \sqrt{\frac{tPr}{\pi}}exp\left(-\frac{Rt}{Pr}\right) + \frac{Pr}{2\sqrt{R}}erf\sqrt{\frac{Rt}{Pr}}\right]$$

GRAPHS

In order to get the physical insight into the problem, we have plotted velocity, temperature, concentration, the rate of heat transfer and the rate of mass transfer for different values of the physical parameters like Radiation parameter (R), Magnetic parameter(M), Soret number(So), Schmidt number (Sc), Thermal Grashof number (Gr), Mass Grashof number (Gm), time (t) and Prandtl number (Pr) in figures 1 to 14 for the cases of heating (Gr < 0, Gm < 0) and cooling (Gr > 0, Gm > 0) of the plate at time t = 0.4. The heating and cooling take place by setting up free-convection current due to temperature and concentration gradient.

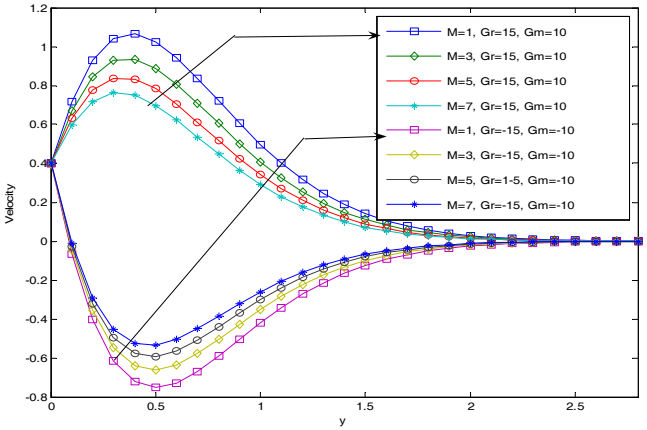


Figure 1: Velocity profiles when so=5, Sc=2.01, Pr=0.71, R=15 and t=0.4

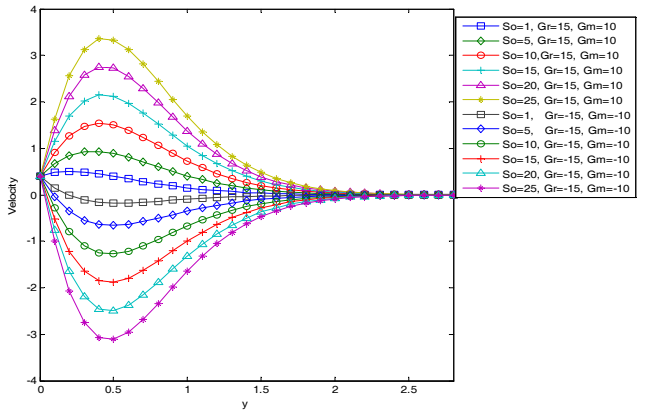


Figure 2: Velocity profiles when M=3, Sc=2.01, Pr=0.71, R=15 and t=0.4

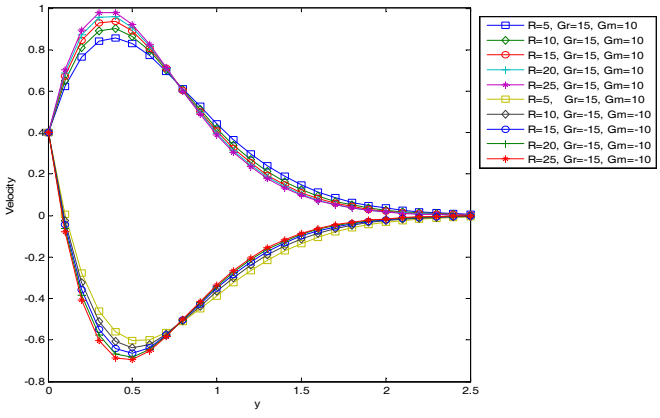


Figure 3: Velocity profiles when so=5, Sc=2.01, M=3, Pr=0.71 and t=0.4

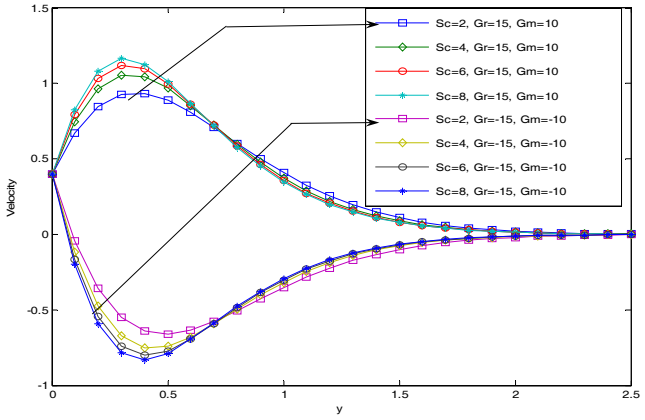


Figure 4: Velocity profiles when so=5, M=3, Pr=0.71, R=15 and t=0.4

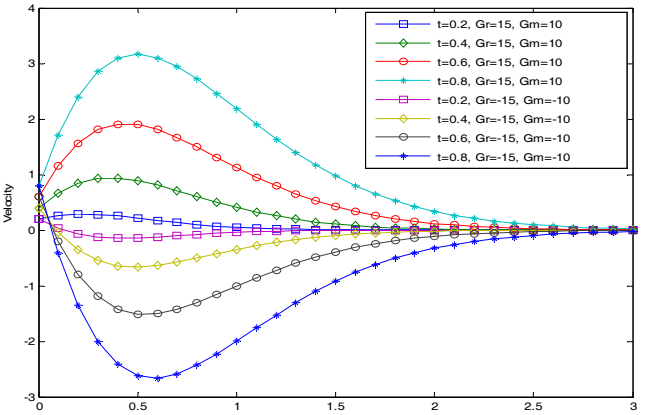


Figure 5: Velocity profiles when so=5, Sc=2.01, M=3, Pr=0.71, R=15

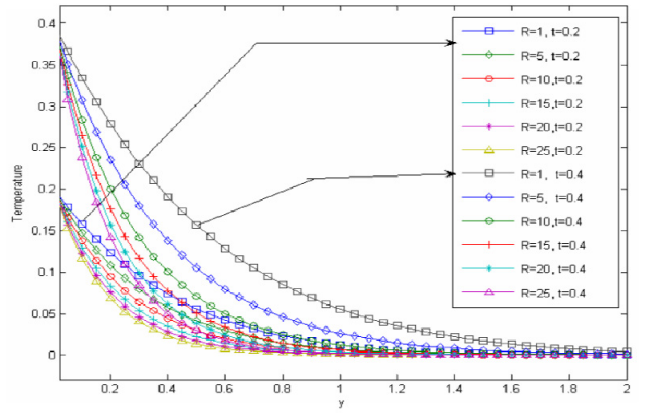


Figure 6: Temperature profiles when Pr=0.71

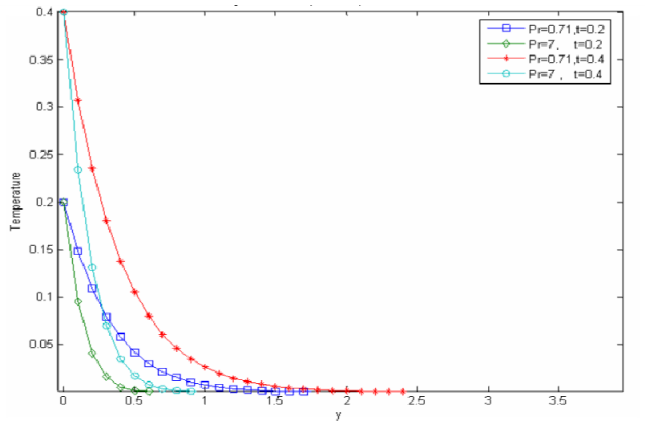


Figure 7: Temperature profiles when R=10

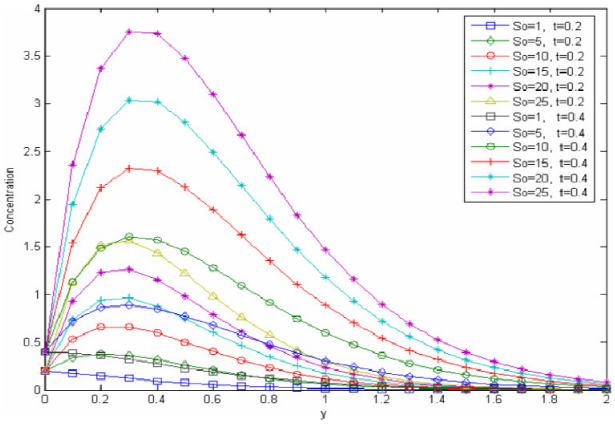


Figure 8: Concentration profiles when R=5, Sc=2.01 and Pr=0.71

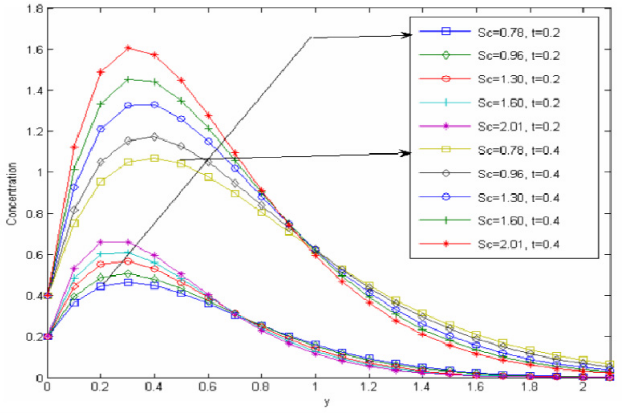


Figure 9: Concentration profiles when So=10, Pr=0.71 and R=5

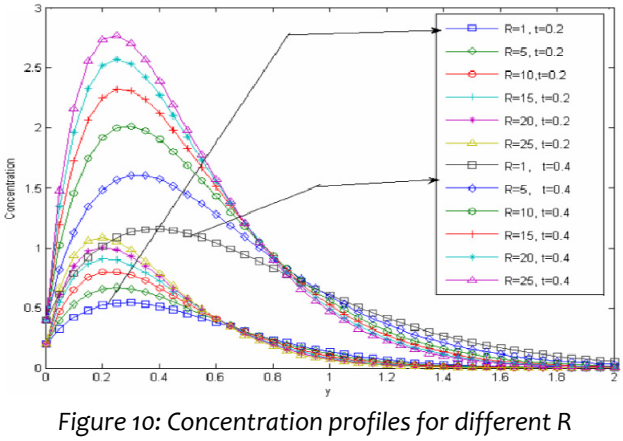


Figure 10: Concentration profiles for different R when So=5, Sc=2.01 and Pr=0.71

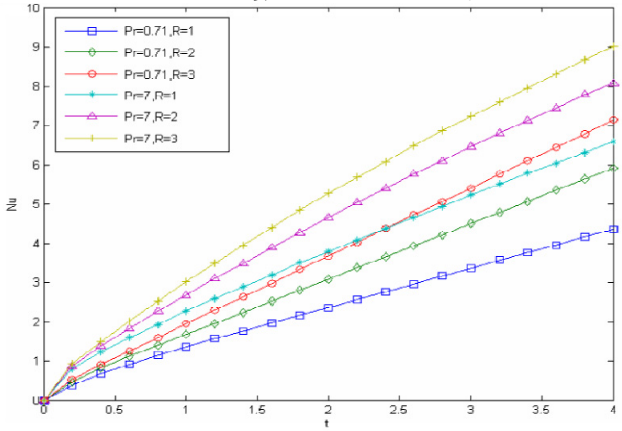


Figure 11: Nusselt number

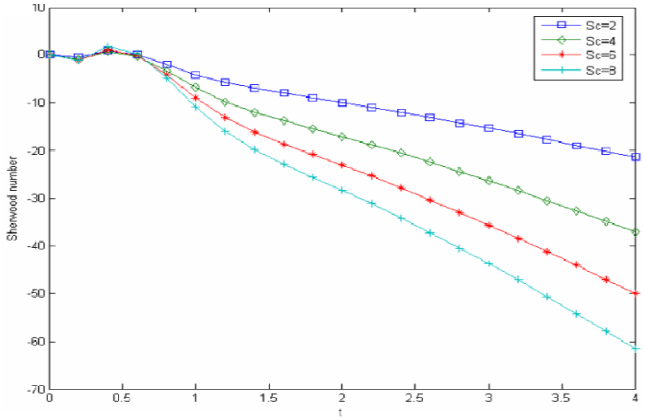


Figure 12: Sherwood Number for different Sc

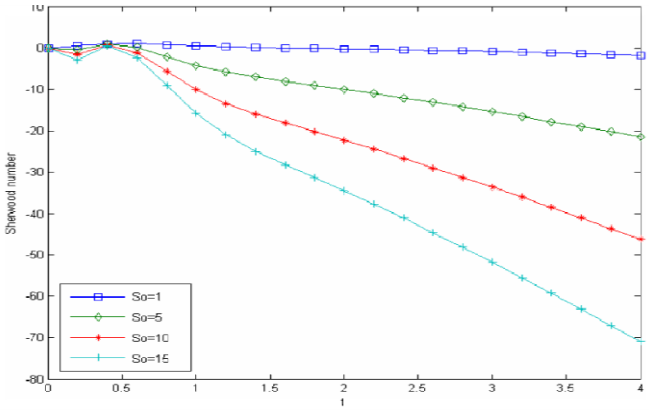


Figure 13: Sherwood Number for different So

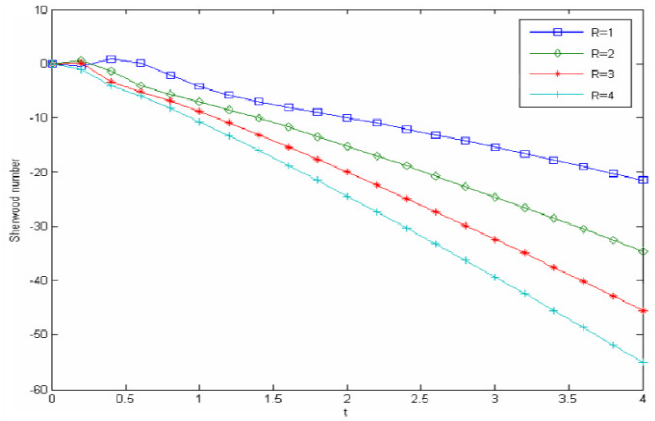


Figure 14: Sherwood Number for different R

DISCUSSION AND RESULTS

Figure (1) displays the influences of M (magnetic parameter) on the velocity field in cases of cooling and heating of the plate. It is found that the velocity decreases with increasing of magnetic parameter M in case of cooling, while it increases in the case of heating of the plate. It is seen that from Figure (2) the velocity increases with increase in So (Soret number) in the case cooling of the plate but a reverse effect is identified in the case of heating of the plate. From figure (3) and (4) it is observed that with the increase of radiation parameter R or Schmidt number Sc, the velocity increases up to certain y value (distance from the plate) and decreases later for the case of cooling of the plate. But a reverse effect is observed in the case of heating of the plate. The velocity profiles for different values of time t are shown in Figure (5), it is seen that as time t increases the velocity increases gradually in the case of cooling of the plate and the trend is just reversed in the case of heating of the plate.

The temperature of the flow field is mainly affected by the flow parameters, namely, Radiation parameter (R) and the prandtl number (Pr). The effects of these parameters on temperature of the flow field are shown in figures 6 & 7 respectively. Figure 6 depicts the temperature profiles against y (distance from the plate) for various values of radiation parameter (R) at time t=0.2 & 0.4 keeping Prandtl number (Pr) as constant. It is observed that as radiation parameter R increases the temperature of the flow field decreases at all the points.

Figure 7 shows the plot of temperature of the flow field against for different values of Prandtl number (Pr) at time t = 0.2 & t =0.4 taking radiation parameter (R) as constant. It is observed that the temperature of the flow field decreases in magnitude as Pr increases. It is also observed that the temperature for air (Pr=0.71) is greater than that of water (Pr=7.0). This is due to the fact that thermal conductivity of fluid decreases with increasing Pr, resulting decreases in thermal boundary layer.

The concentration distributions of the flow field are displayed through figures 8, 9 &10. It is affected by three flow parameters, namely Soret number (So), Schmidt number (Sc) and radiation parameter(R) respectively. From figure 8 it is clear that the concentration increases with an increase in So (soret number). Figure 8 & 10 reveal the effect of Sc and R on the concentration distribution of the flow field. The concentration distribution is found to increase faster up to certain y value (distance from the plate) and decreases later as the Schmidt parameter (Sc) or Radiation parameter (R) become heavier.

Nusselt number is presented in Figure 11 against time t. From this figure the Nusselt number is observed to increase with increase in R for both water (Pr=7.0) and air (Pr=0.71). It is also observed that Nusselt number for water is higher than that of air (Pr=0.71). The reason is that smaller values of Pr are equivalent to increasing the thermal conductivities and therefore heat is able to diffuse away from the plate more rapidly than higher values of Pr, hence the rate of heat transfer is reduced. Figure 12, 13 & 14 represent Sherwood number against time t. And it is observed that the Sherwood number decreases with increase in Sc (Schmidt number), So (soret number) and R (radiation parameter).

Nomenclature

*a** Absorption coefficient
a Accelerated parameter

Bo External magnetic field
C' Species concentration
C'_w Concentration of the plate
C'_∞ Concentration of the fluid far away from the plate
C Dimensionless concentration
Cp Specific heat at constant pressure
D Chemical molecular diffusivity
D_1 Coefficient of thermal diffusivity
g Acceleration due to gravity
Gr Thermal Grashof number
Gm Mass Grashof number
M Magnetic field parameter
Nu Nusselt number
Pr Prandtl number
q_r Radiative heat flux in the y- direction
R Radiative parameter
Sc Schmidt number
So Soret number
Sh Sherwood number
T Temperature of the fluid near the plate
T'_w Temperature of the plate
T'_∞ Temperature of the fluid far away from the plate
t Time
t Dimensionless time
u' Velocity of the fluid in the x' - direction
uo Velocity of the plate
u Dimensionless velocity
y' Co-ordinate axis normal to the plate
y Dimensionless co-ordinate axis normal to the plate

Greek symbols

κ Thermal conductivity of the fluid
$\propto$ Thermal diffusivity
β Volumetric coefficient of thermal expansion
β^* Volumetric coefficient of expansion with concentration
μ Coefficient of viscosity
ν Kinematic viscosity
ρ Density of the fluid
σ Electric conductivity
θ Dimensionless temperature
erf Error function
erfc Complementary error function

Subscripts

ω Conditions on the wall
∞ Free stream conditions

REFERENCES

[1.] M.S.Alam, M.M. Rahman and M.A. Maleque, Local similarity solutions for unsteady MHD free convection and mass transfer flow past an impulsively started vertical porous plate with Dufour and Soret effects, Thammasat int.j.sci.tech. 10(3) (2005),1-8.

[2.] M.S.Alam, M.M.Rahman and M.A. Samad, Numerical study of the combined free-forced convection and mass transfer flow past a vertical porous plate in a porous medium with heat generation and thermal diffusion , Nonlin. Anal.Model. Control 11(4) (2006), 331-343

[3.] M.M. Alam and M. A. Sattar, Transient MHD heat and mass transfer flow with thermal diffusion in a rotating system, J. Energy Heat Mass trans. 21 (1999)m 9-21.

[4.] U . N. Das, R.K. Deka and V.M. Soundalgekar , Radiation effects on flow past an impulsively started vertical infinite plate, J. heo. Mech. 1(1996), 111-115.

[5.] M. A. Hossain and H. S. Takhar, Radiation effect on mixed convection along a vertical plate with uniform surface temperature, Heat Mass Trans. 31(1996), 243-248.

[6.] B. K. Jha and A. K. Singh, Soret effects on free-convection and mass transfer flow in the Stokes problem for a infinite vertical plate, Astrophys.Space Sci. 173(2) (1990).

[7.] N. G. Kafoussias, MHD thermal –diffusion effects on free convective and mass transfer flow over an infinite vertical moving plate. Astrophys.Space Sci. 192(1) (1992), 11-19.

[8.] M. Kumari and G. Nath , Development of two-dimensional boundary layer with an applied magnetic field due to an impulsive motion, Indian J. pure Appl. Math. 30 (1999), 695-708.

[9.] R. Muthucumaraswamy and B. Janakiraman, MHD and radiation effects on moving isothermal vertical plate with variable mass diffusion, Theo. Appl. Mech. 33(1) (2006), 17-29.

[10.] A. Raptis and C. Perdikis, Radiation and free convection flow past a moving plate, Int. J.Appl Mech. Eng. 4(1999), 817-821.

[11.] V.M. Soundalgekar , S.K. Gupta and N.S. Birajdar, Effects of mass transfer and free convection currents on MHD Stokes problem for a vertical plate, Nuclear Eng. Des. 53(1979), 339-346.

[12.] V.M.Soundalgekar, M.R.Patil and M.D. Jahagirdar, MHD Stokes problem for a vertical plate with variable temperature, Nuclear Eng. Des. 64(1981), 39-42.

[13.] V.M. Soundalgekar and H.S. Takhar, Radiation effects on free convection flow past a semi-infinite vertical plate , Model. Measure.Comrol (1993), 31-40.

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

copyright © UNIVERSITY POLITEHNICA TIMISOARA,
FACULTY OF ENGINEERING HUNEDOARA,
5, REVOLUTIEI, 331128, HUNEDOARA, ROMANIA
http://acta.fih.upt.ro

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome V (Year 2012). FASCICULE 3 [July–September]. ISSN 2067-3809

[1.] Angela IAGĂR, [2.] Gabriel Nicolae POPA, [3.] Corina Maria DINIŞ

ANALYSIS OF EVENTS IN ELECTRIC STATIONS USING FOCUS FOR WINDOWS PROGRAM

[1-3.] DEPARTMENT OF ELECTROTECHNICAL ENGINEERING & INDUSTRIAL INFORMATICS, FACULTY OF ENGINEERING HUNEDOARA, UNIVERSITY POLITEHNICA TIMIŞOARA, STR. REVOLUŢIEI, NO.5, HUNEDOARA, ROMANIA

ABSTRACT: *The continuous development of the energetic system and the necessity to increase the safety in operation and the quality of the supplied electric power imposes increasingly severe conditions to the protection and control systems. Among the most important components of SCADA systems used for the electric stations control and protection are the equipments for disturbances recording and analysis, such as the Compact Digital Recorder (CDR). The data stored in the internal CDR memory can be extracted on a PC by CDR Link for Windows program. This paper presents Focus for Windows program, designated for visualization, analysis, interpretation and printing the recordings performed in electric stations with CDR equipments.*
KEYWORDS: *energetic system, safety in operation, Compact Digital Recorder (CDR), SCADA systems*

INTRODUCTION

In Romania, according to TRANSELECTRICA strategy (Romanian Transmission and System Operator), for managing the electric transport and distribution grid is used an EMS/SCADA system (Energy Management and Supervisory Control and Data Acquisition). This system has a hierarchical, decentralized, distributed and redundant architecture.

An EMS/SCADA system contains [1, 2]:

a. *measuring components (for electric grids are measured the voltages, currents, active and reactive powers, frequency, as well as the active and reactive energy);*
b. *drive and automation components (for electric grids: switches, circuit breakers, disconnectors etc.);*
c. *hardware components: computers, printers, plotters, monitors, synoptic displays, process management modules, PLC control modules, storing units (discs and/or magnetic tapes) etc;*
d. *software components: operation systems (in real time, or not), data collecting systems, database management systems, simulation programs, communication programs, archiving/data restoration programs;*
e. *communication components:*

- *LAN networks (Local Area Network: coaxial cables, UTP, fiber optic cables, network cards);*
- *telephone lines;*
- *terrestrial radio communication equipment (emission-reception stations, transmission relays);*
- *communication equipment.*

The measuring components could be simple transducers connected to an analogue-digital conversion unit, or can be instruments with digital output.

The digital value of measurement is taken by a RTU (Remote Terminal Unit), which evaluates the measurement result (is made a verification to frame within the pre-established measuring limits); for some usual cases RTU initiates the performance of some controls and communicates the measurement results to the processing central system.

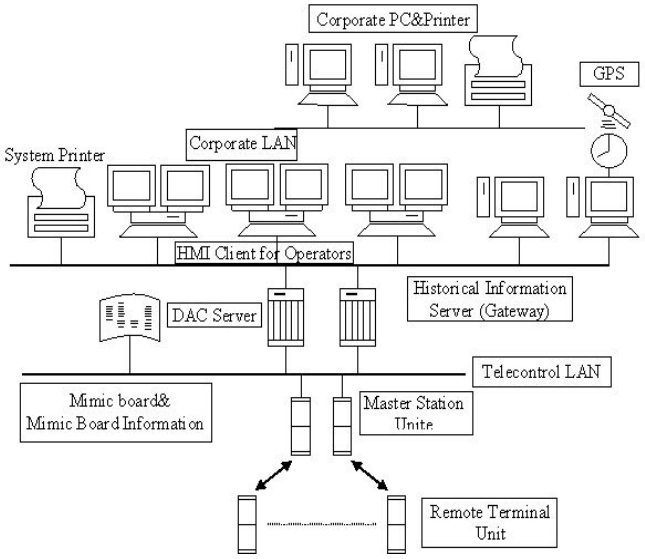


Figure 1. Principle diagram of an EMS/SCADA system

One of the most important components of EMS/SCADA systems is the database management system.

The drive and automation components are connected to the RTU tele-transmission terminal units or to PLCs, which, based on the evaluation results, or based on the controls arrived from the processing central system control the performance of some operations. RTUs are local decisional modules that can initiate some critical or routine operations.

The hardware components offer the processing, storing, enter, display and data printing support.
From safety considerations are used redundant elements to prevent the data loss or operations interruption.
The software components allow the data monitoring, visualizing and processing. Some of these components can initiate physical operations, such as controlling of some drive and automation elements.
The communication programs, beside the electronic communication support, ensure the connections between different system elements. Provided that the communications ensure the system's vital data flux, are used redundant means to prevent the system's partial or total drop.
EMS/SCADA functions within the energetic system are:

- *data acquisitions and exchange;*
- *chronological recording of events;*
- *data automatic processing;*
- *post fault analysis;*
- *real-time database updating; maintaining the database with historical information regarding the system operation;*
- *tele-control; warnings and alarms;*
- *user interface [3-7].*

When a disturbance occurs in electric stations, it takes place a variation of the analogue and binary parameters. This variation is recorded by the acquisition (scanning) equipments, from which category is also the Compact Disturbance Recorder produced by TELECOMM Bucharest [8].

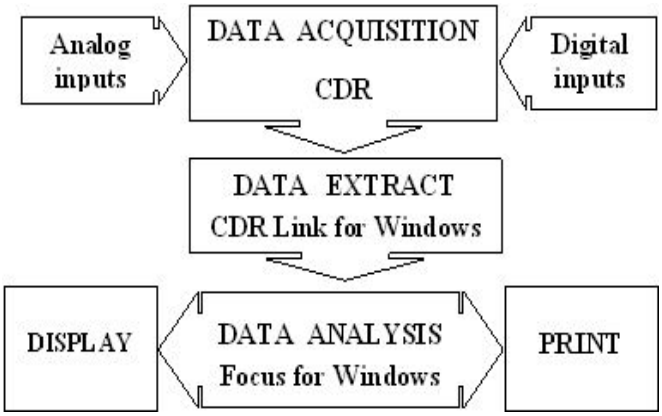


Figure 2. Logic operational diagram of the acquisition, extraction and analysis system of the events from an electric station

CDR records the disturbance data and events during the time period:

$$t_{recording} = t_{Pre} + t_{Fault} + t_{Post}, \quad (1)$$

where: t_{Pre} represents the pre-fault recording time, t_{Fault} is the fault recording time, and t_{Post} is the post-fault recording time.

Focus for Windows [9] is a program designated for visualization, analysis, interpretation and printing the recordings performed in electric stations with equipments of digital perturbograph type.
Each parameter is associated with a logic channel, a set of value segments (pre and post-fault) and auxiliary information. These are components of a focus document. Focus program provides a summary of the fault analysis through a disturbance report.
The quantities (analogue and numerical) acquired by CDR can be graphically visualized with Focus for Windows program.
The program provides, also, the phasor diagrams of voltages and currents, and their harmonic analysis.
There are two types of menus used within the program: static menus and contextual menus. The static menus provide general (global) options regarding the focus documents.
The contextual menu allows the obtaining of information about a channel (about a visible quantity) as well as performing of specific operations on the respective channel (amplification on abscise, on ordinate, color setting, graph line thickness setting etc.).

SUMMARY OF A FAULT REPORT GENERATED BY FOCUS PROGRAM

Further is presented a summary of the fault report generated by Focus program in case of a single-phase short-circuit with ground on the 400 kV overhead transmission line (OTL) Sibiu, in Mintia station.

A. Values of Pre-fault Quantities

The total time allocated to record the pre-fault quantities was 99.96 ms. Figure 3 show the phasor diagrams of voltages and currents at time moment t=-60 ms. The differences betweens the RMS values of phase voltages, respectively phase currents are very small: UL1=239.2 kV, UL2=240.6 kV, UL3=239.5 kV, IL1=365 A, IL2=374.6 A, IL3=369.5 A.

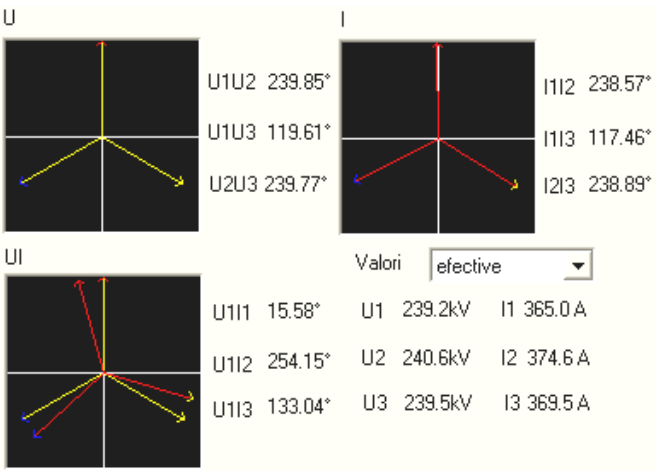


Figure 3. Marker 1: t=-60 ms (pre-fault). Phasor diagrams of voltages and currents

Phase difference between voltages is approximately 120 °. Also, the phase currents are shifted symmetrically by approximately 120 °. One can notice that the phasors U and I are slightly dephased. The homopolar voltage and the homopolar current have low RMS values: U0=5.159 kV, I0=42.23 A. All these indicate a normal operation of the electric line at the moment t=-60 ms.

In Figure 4, at t=-30 ms, the phase differences between the phase voltages are a little modified against the normal operation.

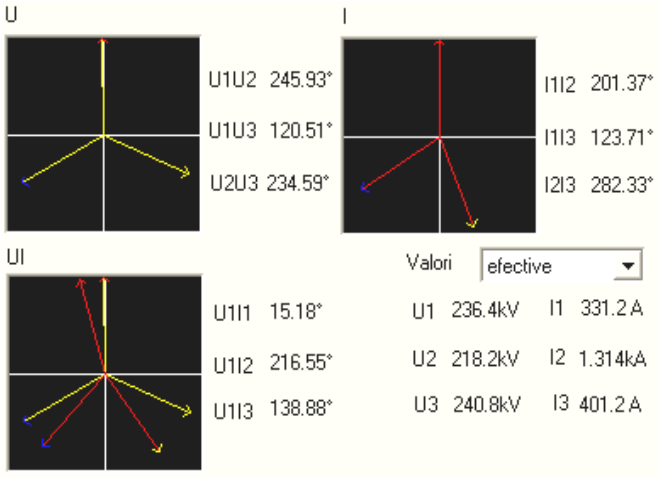


Figure 4. Marker 2: t=-30 ms (pre-fault). Phasor diagrams of voltages and currents

Is noticed a slight decrease of the voltage on phase 2 (UL2=218.2 kV) compared with the voltages on the other phases (UL1=236.4 kV, UL3=240.8 kV). The current on phase 2 (IL2=1.314 kA) has a higher value (IL1=331.2 A, IL3=401.2 A). The homopolar voltage and the homopolar current have high values (U0=111.8 kV, I0=1.344 kA).

Marker 2 (at t=-30 ms) catches the incipient stage of a phase-to-ground fault on phase 2 (L2).

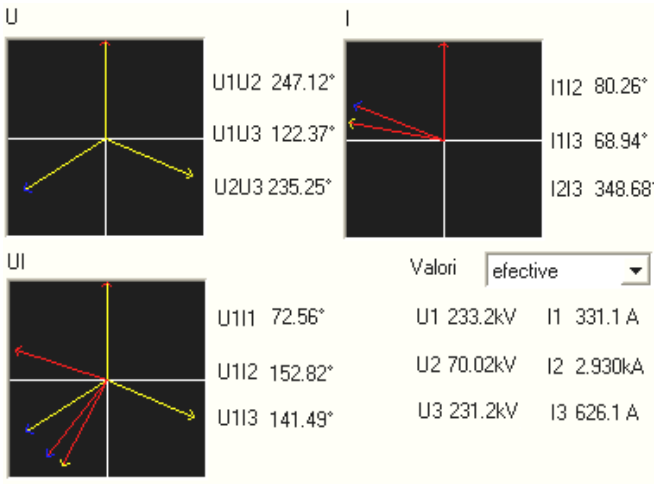


Figure 5. Marker 4: t=17 ms (fault). Phasor diagrams of voltages and currents

B. Values of Fault Quantities

The values measured at the moment t=17 ms (Figure 5) are framed within the fault period of the recording. At this moment is recorded a maximum value of the current on phase 2 (IL2=2.93 kA) and a voltage decrease on phase 2 (UL2=70.02 kV).

One can notice a significant increase of the homopolar quantities (I0=3.597 kA, U0=294 kV), up to the limit when the high-voltage breaker's protections of OTL Sibiu are triggered.

At t=34 ms (Figure 6) is noticed the disappearance of the phase fault current (IL2=44.49 A) and homopolar current (I0=312.6 A).

Analogue quantities in the time period t= -60 ...34 ms are presented in Figure 7. Numerical quantities in the time period t= -60 ...34 ms are presented in Figure 8.

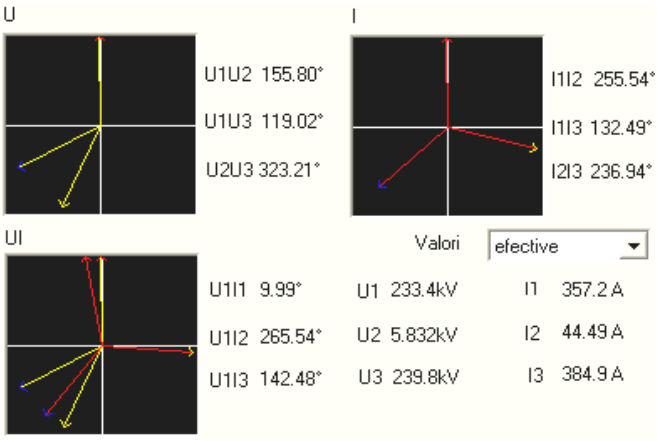


Figure 6. Marker 5: t=34 ms (fault). Phasor diagrams of voltages and currents

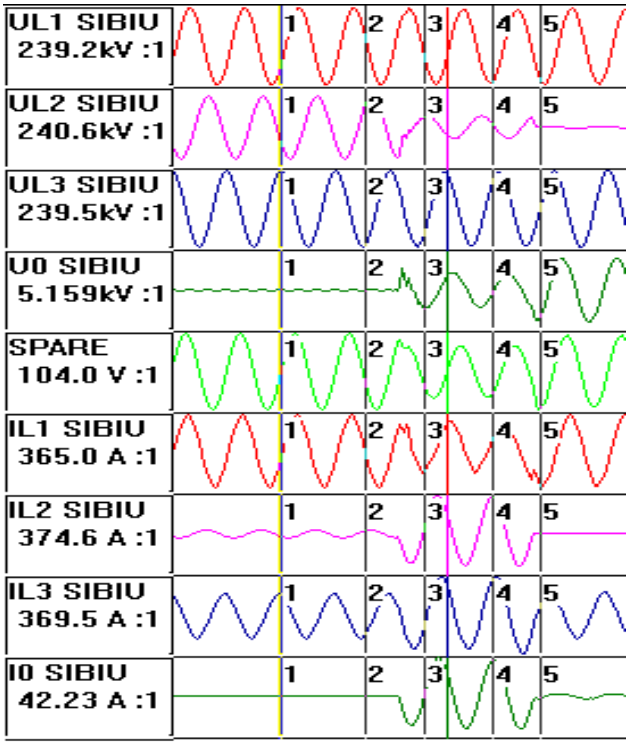


Figure 7. Analogue quantities in the time period t= -60 ...34 ms

Markers 1 (t=-60 ms) and 2 (t=-30 ms) show that the OTL protections are in stand-by (pre-fault period). Marker 3 (t=-8 ms) is close the trigger limit.

In Figure 8, marker 5 (t=34 ms) indicates: PLC REC CH 0:1 – trigger impulse issued by the distance protection REL 521 of the teleprotection channel that sends a trigger impulse to the high-voltage breaker of Sibiu station.

In Figure 8, marker 4 (t=17 ms) indicates the start of distance protections: START L2 RE 1:1 – start for group 1 of protections through the line distance protection terminal REL 521, phase L2; GEN. START 1:1 – general start of distance protection REL 521; GEN. TRIP R1:1 – trigger impulse sent by the distance protection REL 521 to the high-voltage breaker of OTL Sibiu, in Mintia station; DIST. TRIP 1:1 – trigger of distance protection REL 521; START L2 LZ 1:1 – start for group 2 of protections through the digital relay LZ96a, phase L2; GEN. START 1:1 – general start of digital relay LZ96a; DIST. TRIP 1:1 – trigger of digital relay LZ96a.

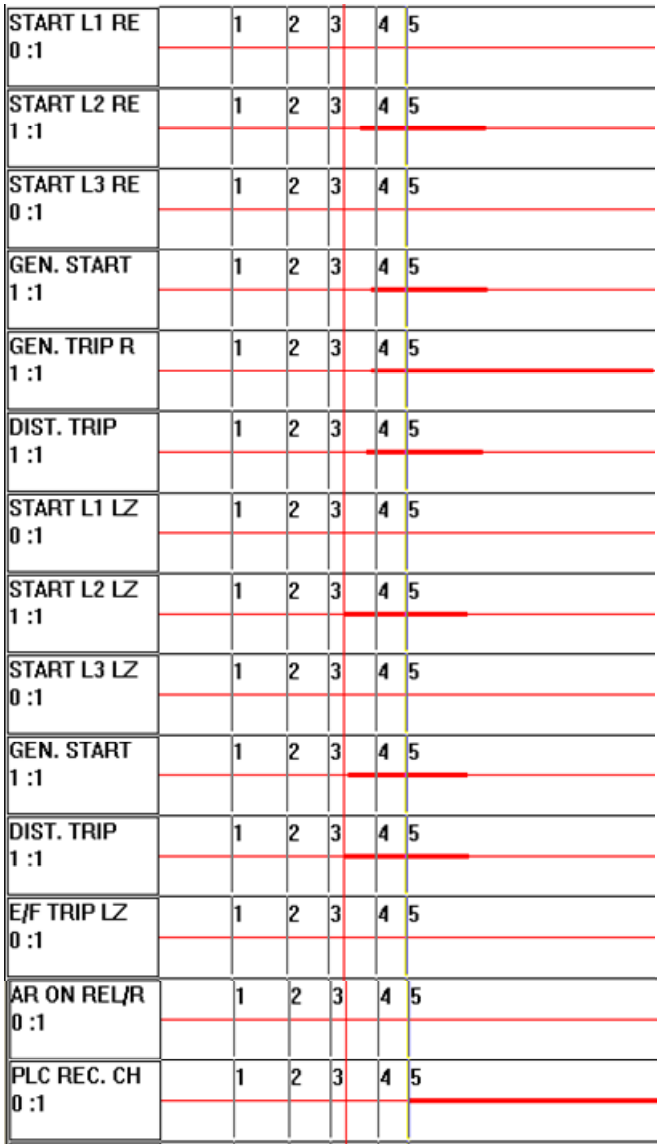


Figure 8. Numerical quantities in the time period t= -60 ...34 ms. Start of distance protections

In Sibiu station the distance protection frames the single-phase-to-ground fault in triggering step two, and the protection from the Sibiu station starts; the two breakers of high-voltage OTL, from Mintia, respectively Sibiu, trigger simultaneously.

In Figure 9, marker 6 (t=165 ms) presents the revert of the distance protection from initial state.

Fault locator of REL 521 terminal use for the distance to fault calculation a line modelling algorithm, that takes into account the sources at both ends of the line. Taking into account the RMS values of the phase currents and voltages, the distance is quantified from the place where the protection is mounted up to the fault place, and is equal by 24.2 km.

In Figure 10, marker 7 (t=1065 ms) indicates AR ON REL/R 1:1, with the following functions:

- *sending of a reclosing impulse to the Sibiu OTL's breaker in Mintia;*
- *sending of a reclosing impulse to the Mintia OTL's breaker in Sibiu, by emitting a high-frequency impulse through teleprotection (this being a common channel).*

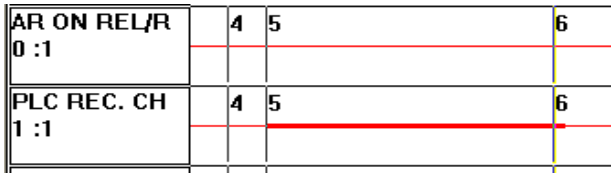


Figure 9. Marker 6 (t=165 ms): revert of distance protection from initial state

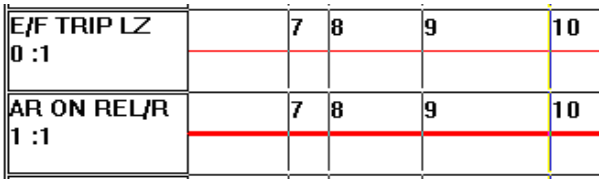


Figure 10. Marker 7 (t=1065 ms): reclosing impulses to the breakers

Marker 8 (in Figure 10) indicates the time moment t=1083 ms, when the Sibiu OTL' breaker is in closing progress.

Marker 9 (in Figure 10) indicates the moment t=1125 ms, when the Sibiu OTL breaker is closed.

C. Values of Post-fault Quantities

At the moment t=1184 ms (Figure 11) small differences between RMS values of the phase voltages (UL1=239.6 kV, UL2=242.5 kV, UL3=239.9 kV) and RMS values of the phase currents (IL1=375.8 A, IL2=394.3 A, IL3= 369.5 A) are noticed. The RMS value of the homopolar quantities are low (U0=37.58 kV, I0=42.23 A).

This figure presents the end of the successful reclosing (+).

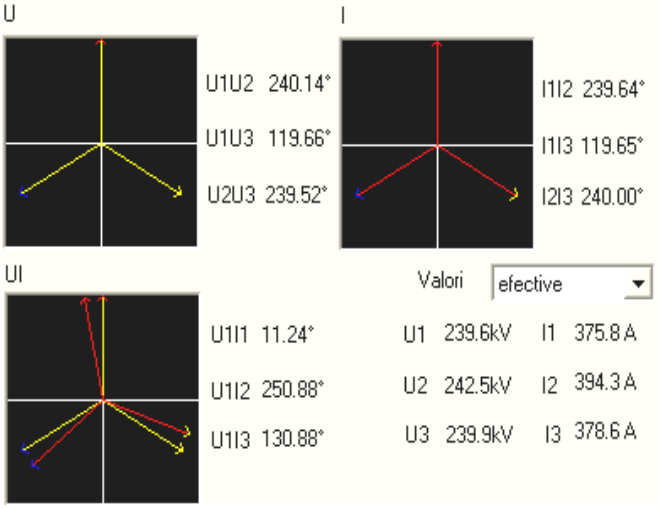


Figure 11. Marker 10: t=1184 ms (post-fault). Phasor diagrams of voltages and currents

CONCLUSIONS

The EMS/SCADA functions within the energetic system are: data acquisitions and exchange; chronologic recording of events; data automatic processing; post-fault analysis; real-time database update; maintenance with historic information regarding the system's operation; tele-control; warnings and alarms; user interface.

The Compact Digital Recorder (CDR) allows the recording of events that appear in electric stations operation.

Focus for Windows is a program designated for visualization, analysis, interpretation and printing the recordings performed in electric stations with equipments of digital perturbograph type. Each parameter is associated with a logic channel, a set of value segments (pre and post-fault) and auxiliary information. These are components of a focus document.

Focus program provides a summary of the fault analysis through a disturbance report. Are noticed especially the facilities offered by Focus program in analyzing the analogue and numerical quantities; the visualization of RMS values, phasor diagrams and harmonic analysis are in real time. Focus program allows the harmonic analysis of the voltages and currents up to 10-th order.

Further the analysis of the disturbance report issued by the Focus program, can be determined the causes, amplitude and consequences of the appeared disturbance.

REFERENCES

[1.] *Bailey, D and Wrigh, E: Practical SCADA for Industry, Elsevier, 2002.*

[2.] *Brand, K et al: Substation Automation Handbook, Utility Automation Consulting Lohmann, 2003.*

[3.] *Brand, K: The Standard IEC 61850 as Prerequisite for Intelligent Applications in Substations, IEEE/PES General Meeting, USA, 2004.*

[4.] *Matz, V; Radil, T; Ramos, P and Serra, A. C: Automated Power Quality Monitoring System for on-line Detection and Classification of Disturbances, IEEE IMTC 2007 – Instrumentation and Measurement Technology Conference, Warsaw, Poland, May 2007.*

[5.] *Mohamed, E.A; Talaat, H. A and Khamis, E.A: Fault Diagnosis System for Tapped Power Transmission Lines, Electric Power Systems Research, vol. 80, pp. 599–613, 2010.*

[6.] *Terzija, V and Radojevic, Z: Numerical Algorithm for Adaptive Autoreclosure and Protection of Medium-Voltage Overhead Lines, IEEE Trans. Power Deliv, vol. 12 (2), pp. 554-559, 2004.*

[7.] *Dobriceanu, M; Bitoleanu, A; Popescu, M and Vlăduț, G: Practical Aspects Concerning the Monitoring of the Electrical Stations, WSEAS Transactions on Information Science and Applications, issue 11, vol. 2, pp. 1897-1904, 2005.*

[8.] **** Compact Disturbance Recorder, TELECOMM, 2000.*

[9.] **** Focus for Windows v2.0, TELECOMM, 2000*

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

copyright © UNIVERSITY POLITEHNICA TIMISOARA,
FACULTY OF ENGINEERING HUNEDOARA,
5, REVOLUTIEI, 331128, HUNEDOARA, ROMANIA
http://acta.fih.upt.ro

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome V (Year 2012). FASCICULE 3 [July–September]. ISSN 2067-3809

[1.] Mohamed ZELLAGUI, [2.] Abdelaziz CHAGHI

MEASURED IMPEDANCE BY MHO DISTANCE PROTECTION FOR PHASE TO EARTH FAULT IN PRESENCE GCSC

[1-2] LSP-IE RESEARCH LABORATORY, FACULTY OF TECHNOLOGY, DEPARTMENT OF ELECTRICAL ENGINEERING, UNIVERSITY OF BATNA, ALGERIA

ABSTRACT: *This paper presents the impact study of GTO Controlled Series Capacitor (GCSC) parameters on MHO distance relays measured impedance for 220 kV protected electrical transmission line in the presence of phase to earth fault with fault resistance. The study deals with a 220 kV electrical transmission line of Eastern Algerian transmission networks at Group Sonelgaz (Algerian Company of Electrical and Gas), compensated by series Flexible AC Transmission System (FACTS) i.e. GCSC connected at midpoint of the line. The transmitted active and reactive powers are controlled by three GCSC's. The effects of maximum reactive power injected as well as injected maximum voltage by GCSC on measured impedance by distance relays is treated. The simulations results investigate the impact of GCSC injected parameters (reactance, voltage and reactive power) on measured resistance and reactance in the presence of earth fault with resistance fault for different cases study.*
KEYWORDS: *GCSC, electrical transmission line, earth fault, symmetrical components; MHO distance relay, measured impedance*

INTRODUCTION

Fault currents have an important influence on the design and operation of equipment and power systems. In Algerian Company of Electrical and Gas, more than 80% of the occurred faults on 220 and 400 kV overhead transmission networks are single phase to ground type. However, phase to phase faults are the most common fault type after single phase to ground faults.

Distance protection relays have been widely applied as the primary protection in high voltage transmission lines due to their simple operating principle and capability to work independently under most circumstances [1-2]. The basic operation principle of distance relay is based on the fact that the line impedance is fairly constant with respect to the line length. However, the implementation of FACTS Controllers in power system transmission for enhancing the power system controllability and stability have introduced new power system issues in the field of power system protection that must be considered and analyzed [3]. Some of the concerns include the rapid changes in line impedance and the transients introduced by the fault occurrence with the associated control action of the FACTS Controllers. The presence of the FACTS devices in the faulted loop introduces changes to the line parameters seen by the distance relay. The effect of FACTS device would affect both the steady state and transient trajectory of the apparent impedance seen by distance relays due to the fast response time of FACTS Controllers with respect to that of the protective devices. The impact of FACTS devices on distance protection varies depending on the type of FACTS device used, the application for which it is applied and the location of the FACTS device in the power system.

The effect of different types of series FACTS devices on distance protection of transmission lines has been reported: for Thyristor Controlled Series Capacitor (TCSC) in [4-7] and for Static Synchronous Series Compensator (SSSC) in [8-9], for shunt FACTS devices the type Static Synchronous Compensators (STATCOM) is study in [10-12] and for Static Var Compensators (SVC) in [13-14]. However, the authors have not come across any reported work on mitigation of the impact of midpoint series FACTS compensated transmission lines on distance protection.

In this paper we report the impact of variation of maximum reactive power injected by GCSC for three case study in the presence phase to earth faults (phase A) at the end of the transmission line with resistance fault (R_F). The GCSC is located on 220 kV midline of the Algerian transmission line between substations Ain M'lila and Khenchela which is protected by MHO distance relay installed at busbar A. The study concerns the impact of injected parameters (X_{GCSC}, V_{GCSC} and Q_{GCSC}) of the GCSC on the measured impedance by distance relay R_{seen} and X_{seen} for protected transmission line in presence of resistance fault which varies between 5 to 50 Ω.

REACTIVE POWER ON TRANSMISSION LINE IN PRESENCE GCSC

The compensator GCSC mounted on figure 1.a is the first that appears in the family of series compensators. It consists of a capacitance (C) connected in series with the electrical transmission line and controlled by a valve-type GTO thyristors mounted in anti-parallel and controlled by an extinction angle (γ) varied between 0° and 180° [15-17]. Controlled series

compensation, apply dynamic control of the degree of series compensation in a long line.

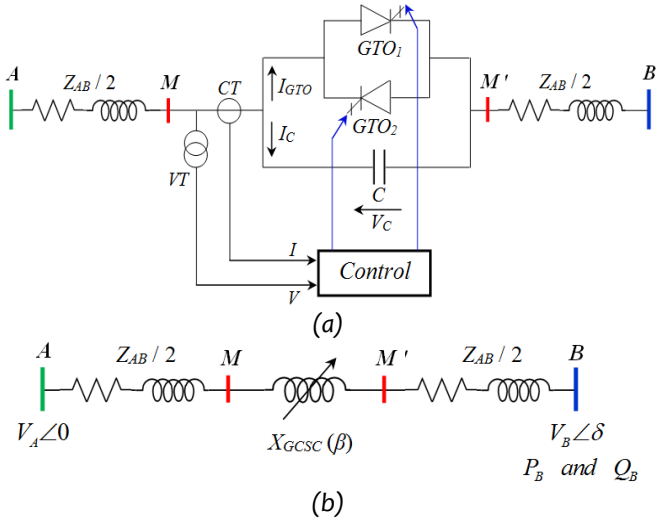


Figure 1. Transmission line in presence of GCSC system. a). Control principle, b). Apparent reactance.

Figure 2 shows typical current and voltage waveforms for the GCSC of Figure 1, for a given blocking angle γ. [16]. It is assumed that the transmission line current (I_L), is sinusoidal.

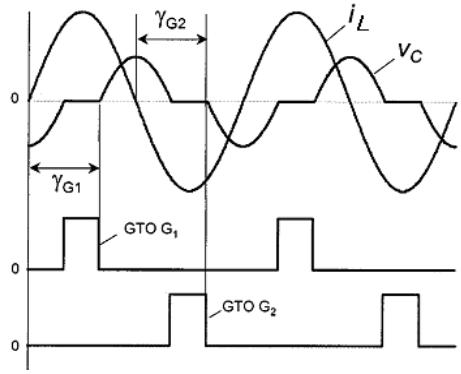


Figure 2. GCSC current, voltage waveforms and switch control

This compensator injected in the transmission line AB between busbar A (source) and B (load) a variable capacitive reactance (X_{GCSC}). From figure 1.b this capacitive reactance is defined by the following equation [18-19]:

$$X_{GCSC}(\gamma) = X_{C.Max}\left[1 - \frac{2}{\pi}\gamma - \frac{1}{\pi}\sin(2\pi)\right] \quad (1)$$

where, $$X_{C.Max} = 1/C_{GCSC}.\omega \quad (2)$$

The conduction angle (β) which varies between 0 to 90°, is defined by next relation:

$$\beta = \pi - 2\gamma = 2\left(\frac{\pi}{2} - \gamma\right) \quad (3)$$

From equation (3), the equation (2) becomes:

$$X_{GCSC}(\beta) = X_{C.Max}\left[1 - \left(\frac{\pi-\beta}{\pi}\right) - \frac{1}{\pi}\sin(\pi(\pi-\beta))\right] \quad (4)$$

where, the relation of injected voltage is:

$$V_{GCSC}(\beta) = V_{GCSC-Max}\left[1 - \left(\frac{\pi-\beta}{\pi}\right) - \frac{1}{\pi}\sin(\pi(\pi-\beta))\right] \quad (5)$$

The reactive injected power by GCSC is:

$$Q_{GCSC}(\beta) = \frac{V_{GCSC}(\beta)^2}{X_{GCSC}(\beta)} \quad (6)$$

The active and reactive power at busbar B with GCSC is defined by following equations:

$$P_B(\delta) = \frac{V_A.V_B}{R_{AB} - X_{GCSC}}\sin(\delta) \quad (7)$$

$$Q_B(\delta) = P_B(\delta) = \frac{V_B^2}{Z_{AB} - X_{GCSC}} - \frac{V_A.V_B}{Z_{AB} - X_{GCSC}}\cos(\delta) \quad (8)$$

where,

$$\begin{cases} V_B = V_{B.W} + V_{GCSC} \\ V_{B.W} = V_{A.W} - \Delta V \end{cases} \quad (9)$$

The $V_{A.W}$ and $V_{B.W}$ represent voltages at busbar A and B respectively without GCSC.

Impedance Measured By MHO Distance Relay

Distance protection has been widely used in the protection of EHV and HV transmission lines. The basic principle of MHO distance protection involves the division of the voltage at the relaying point by the measured current [1], [29]. The apparent impedance so calculated is compared with the reach point impedance. If the measured impedance (Z_{seen}) is less than the reach point impedance, it is assumed that a fault exists on the line between the relay and the reach point.

The basic principle of operation of distance protection is shown in figure 3. The input to the relay point is the phase voltages and line currents transformed with the help of voltage transformer (VT) and current transformers (CT).

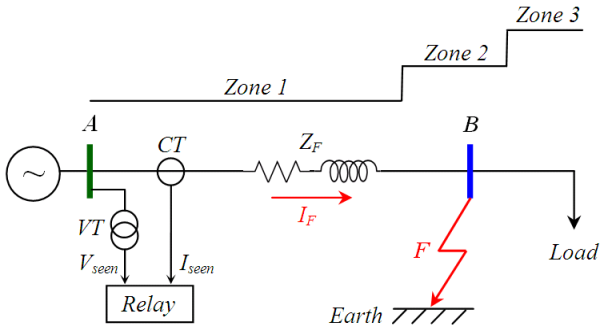


Figure 3. Principle of MHO distance protection in presence phase to earth fault.

The voltage would fall towards zero at the point of the fault. The impedance measured by MHO distance relay (Z_{seen}) in presence phase (A) to earth fault is calculate by flowing equation [20-21]:

$$Z_{seen} = \frac{V_{Relay}}{I_{Relay}} = \frac{V_A / I_A + K_o.I_o}{K_Z} = R_{seen} + j.X_{seen} \quad (10)$$

where, $K_o = \frac{Z_o - Z_1}{3.Z_1}$ and $K_Z = \frac{K_{CT}}{K_{VT}}$ (11)

PHASE TO EARTH FAULT CURRENT CALCULATION ON PRESENCE GCSC

Figure 4 is shows the equivalent circuit for transmission line en presence single phase (phase A) to ground fault with fault resistance (R_F) at busbar B with GCSC inserted on midline.

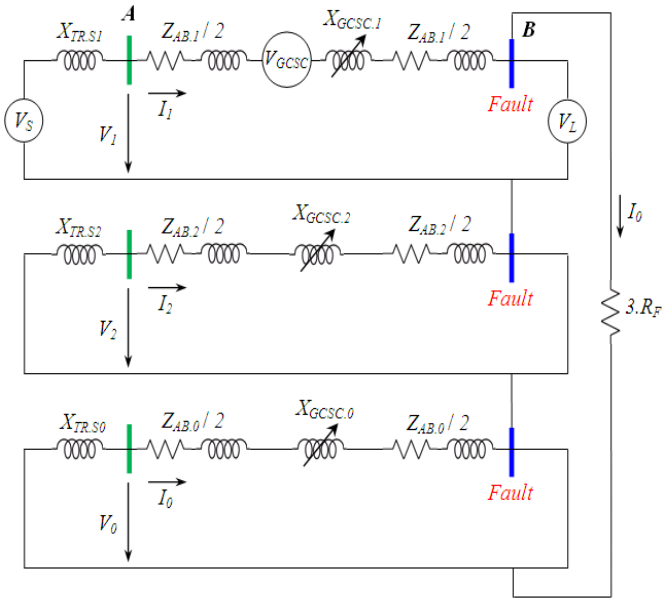


Figure 4. The equivalent circuit with GCSC

The total transmission line ($Z_{AB\text{-}GCSC}$) impedance with GCSC inserted on midline is given by:

$$Z_{AB-GCSC} = R_{AB} + j\left[X_{AB} - X_{GCSC}(\beta)\right] \quad (12)$$

Regarding reference [22], the basic equation for this fault is:

$$I_b = I_c = 0 \quad (13)$$

$$V_a = V_1 + V_2 + V_0 = R_F.I_a \neq 0 \quad (14)$$

The coefficients $Z_{AB\text{-}T}$ and $Z_{GCSC\text{-}T}$ are defined for simplicity is:

$$Z_{AB-T} = Z_{AB.1} + Z_{AB.2} + Z_{AB.0} \quad (15)$$

$$X_{GCSC-T} = X_{GCSC.1} + X_{GCSC.2} + X_{GCSC.0} \quad (16)$$

From figure 4, the symmetrical currents components are:

$$I_1 = I_2 = I_0 = \frac{V_S + V_{GCSC}}{\left(\frac{Z_{AB-T}}{2}\right) + X_{GCSC-T} + \left(\frac{Z_{AB-T}}{2}\right) + 3.R_F} \quad (17)$$

where, $I_1 + I_2 + I_0 = \frac{I_A}{3}$ (18)

From equations (17) and (18), the current in phase A is:

$$I_A = \frac{3.\left(V_S + V_{GCSC}\right)}{\left(\frac{Z_{AB-T}}{2}\right) + X_{GCSC-T} + \left(\frac{Z_{AB-T}}{2}\right) + 3.R_F} \quad (19)$$

The symmetrical components of voltages are:

$$\begin{bmatrix} V_0 \\ V_1 \\ V_2 \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 1 & 1 & 1 \\ 1 & a & a^2 \\ 1 & a^2 & a \end{bmatrix}\begin{bmatrix} V_A \\ V_B \\ V_C \end{bmatrix} \quad (20)$$

From equation (14) and matrix (20), the voltage at phase A is:

$$V_A = \frac{3.R_F.\left(V_S + V_{GCSC}\right)}{\left(\frac{Z_{AB-T}}{2}\right) + X_{GCSC-T} + \left(\frac{Z_{AB-T}}{2}\right) + 3.R_F} \quad (21)$$

From equations (10), (17), (19) and (21), the measured impedance Z_{seen} by distance relay is only related to:

- Parameters of transmission line : U_n , I_L , R_{AB}, and X_{AB},
- Current and voltage transformer ratios: K_{CT} and K_{VT},
- Parameters of GCSC installed: V_{GCSC} and X_{GCSC},

Fault conditions: location n_F and resistance R_F.

CASE STUDY AND SIMULATION RESULTS

The electrical network 220 kV, 50 Hz studied in this paper [23], is the eastern Algerian electrical transmission networks at Sonelgaz group (Algerian company of Electrical and Gas) is shows in figure 5. The MHO distance relay is located on the busbar at Ain M'lila in Oum El Bouaghi to protect the single transmission line between busbar A and busbar B at Khenchela substation HV/MV.

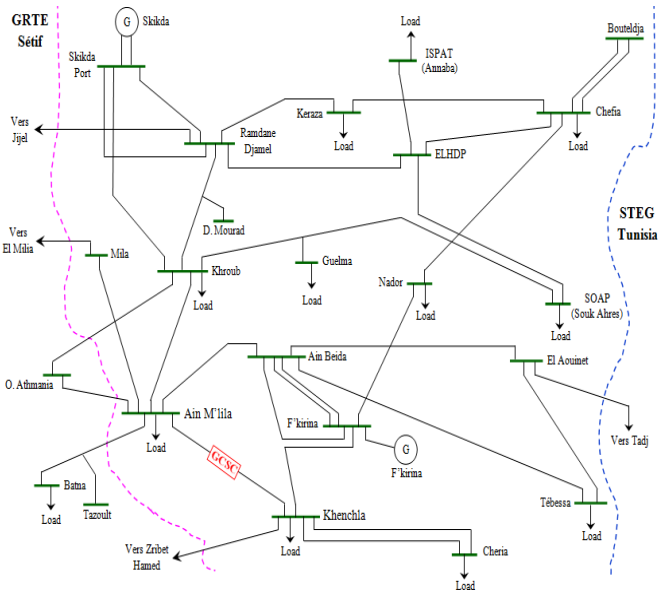
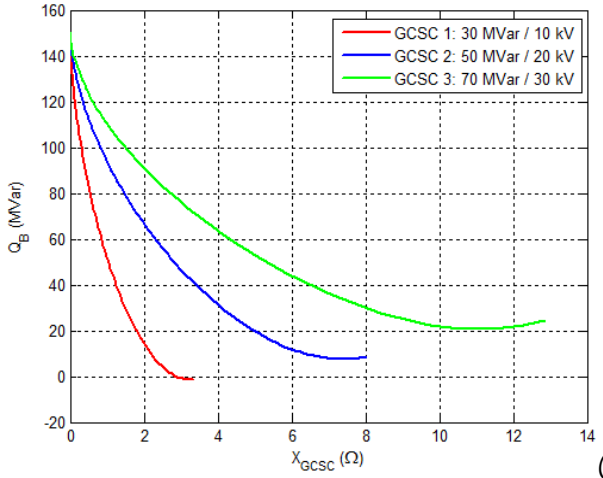


Figure. 5. Algerian electrical networks study

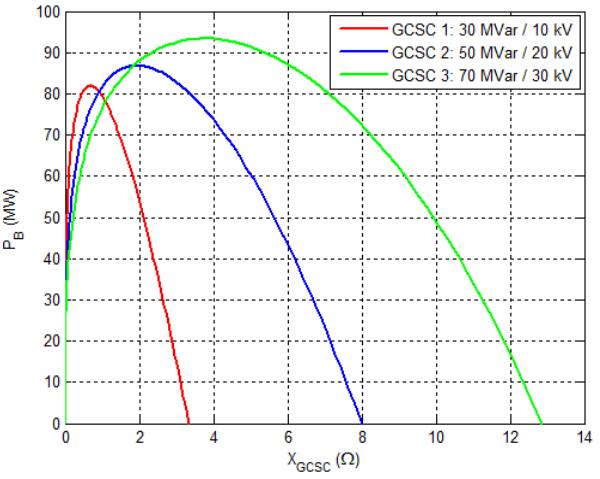
The GCSC system is installed in the midpoint of the protected line by a MHO distance relay. The investigation were carried out for three case studies respectively for 30, 50 and 70 MVar of injected reactive power as well as for 10, 20 and 30 kV injected voltage. The parameters of transmission line and the installed GCSC are summarized in the appendix.

A. Impact on transmission line protected

The figures 6.a and 6.b represent the variation of reactive power (Q_B) and active power (P_B) at the load busbar B respectively as a function of injected X_{GCSC} by different GCSC.



(a)

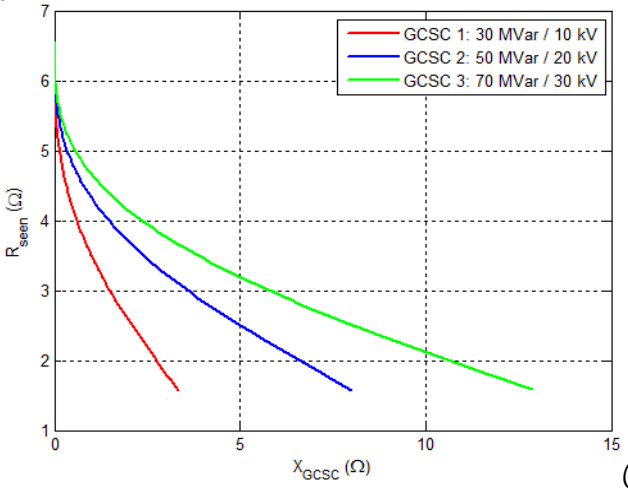


(b)

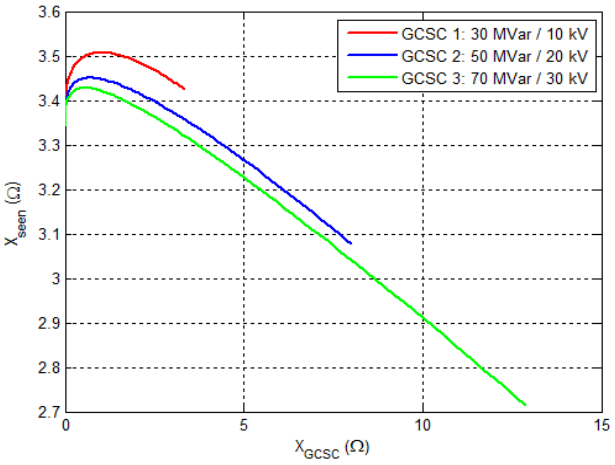
Figure 6. Powers Variation with respect to injected reactance. a). $Q_B = f(X_{GCSC})$, b). $P_B = f(X_{GCSC})$

B. Impact of X_{GCSC} on the impedance measured by relay

The figures 7.a and 7.b represent the variation of the resistance R_{seen} and reactance X_{seen} respectively as a function of injected X_{GCSC} by different GCSC in the presence R_F.



(a)

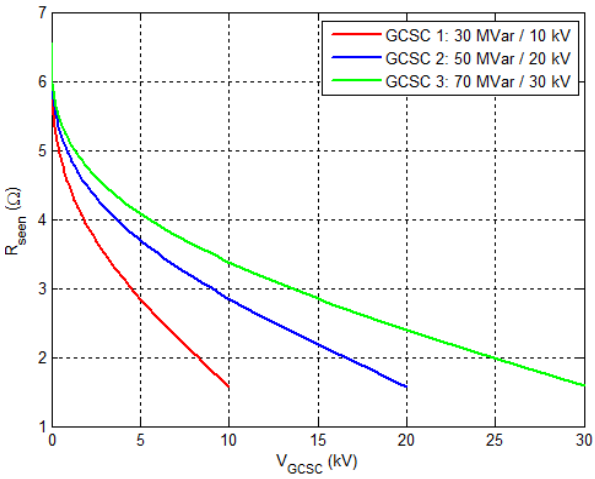


(b)

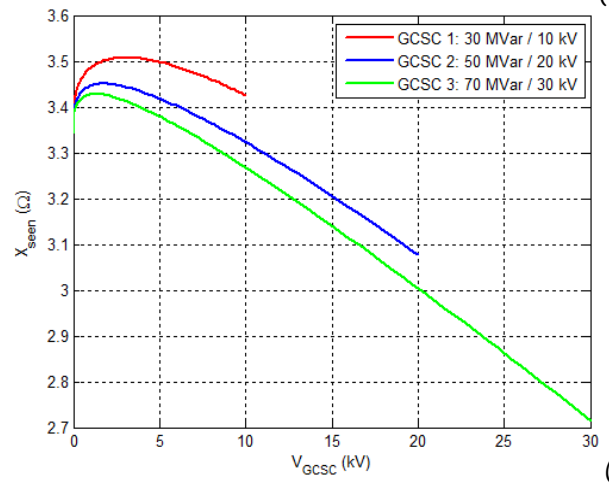
Figure 7. Distance relay measured impedance Variation Z_{seen}. a). $R_{seen} = f(X_{GCSC})$, b). $X_{seen} = f(X_{GCSC})$.

C. Impact of V_{GCSC} on impedance measured by relay

Figures 8.a and 8.b represent the variation of R_{seen} and X_{seen} respectively as a function R_F for different injected voltage V_{GCSC} by different GCSC study.



(a)



(b)

Figure 8. Distance relay measured impedance Variation Z_{seen}. a). $R_{seen} = f(V_{GCSC})$, b). $X_{seen} = f(V_{GCSC})$.

D. Impact of Q_{GCSC} on impedance measured by relay

Figures 9.a and 9.b represent the variation of R_{seen} and X_{seen} as a function R_F for different injected Q_{GCSC} injected by different GCSC study.

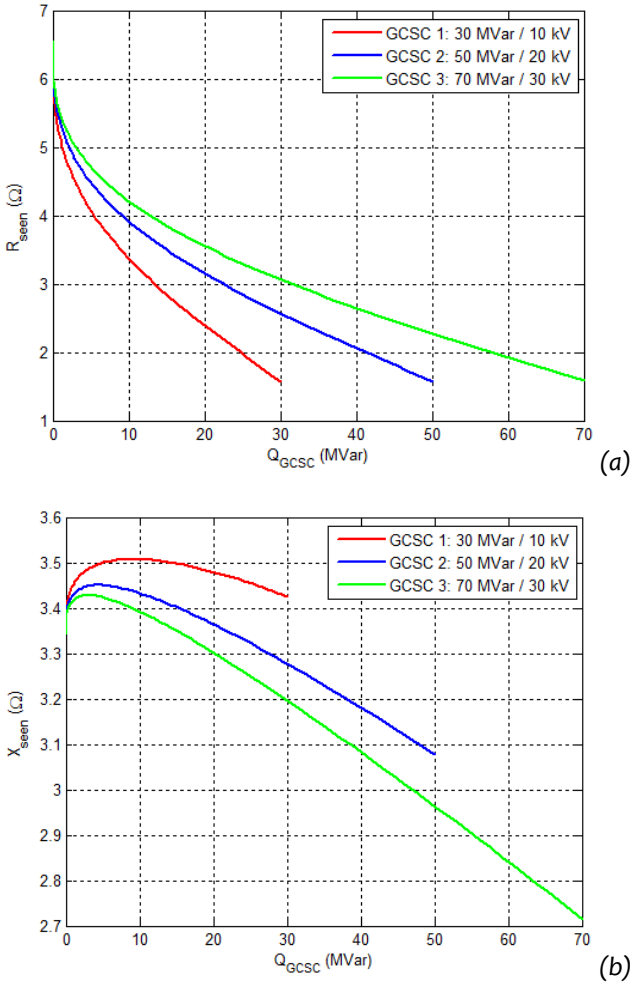


Figure 9. Variation of impedance Z_{seen} by distance relay. a). $R_{seen} = f(Q_{GCSC})$, b). $X_{seen} = f(Q_{GCSC})$.

CONCLUSIONS

The results are presented in relation to a typical 220 kV single electrical transmission system employing different GCSC (10 MVar/10 kV, 50 MVar/20 kV and 70 MVar/30 kV). The compensator is connected at the midpoint of a protected transmission line by distance relay. The simulation results show the direct impact on the total impedance of a protected line for different injected variable parameters X_{GCSC}, V_{GCSC} and Q_{GCSC} of the compensator. As can be seen the resistance R_{seen} and reactance X_{seen} respectively in the presence of GCSC and in case of earth fault with resistance fault R_F varied between 5 to 50 Ω at the end of the line are affected.

Therefore distance relay tripping characteristic depends on many factors including the power system structural and the pre-fault condition, the earth fault resistance, and parameters of reactance injected by GCSC based the maximum reactive power injected on electrical transmission line. So, it is necessary to modify the setting protection zones in order to prevent circuit breaker nuisance tripping and improve the performances of MHO distance relay protection.

Appendix

A. *Power source:*

$U_s = 11$ *kV,* $f_n = 50$ *Hz.*

B. *Power transformer:*

$U_{TR} = 11/220$ *kV,* $S_{TR} = 200$ *MVA,* $X_{TR1} = j\ 0{,}213\ \Omega$,

$X_{TR0} = j\ 0{,}710\ \Omega$,

C. *Electrical transmission line:*

$U_L = 220$ *kV, Length = 117 km,* $Z_1 = 0{,}1213 + j\ 0{,}4227\ \Omega/km$,

$Z_0 = 0{,}3639 + j\ 1{,}2681\ \Omega/k$.

D. *GCSC study:*

Case 1. $Q_{Max} = 30$ *MVar,* $V_{Max} = 10$ *kV,* $X_{C.Max} = 3{,}333\ \Omega$,

Case 2. $Q_{Max} = 50$ *MVar,* $V_{Max} = 20$ *kV,* $X_{C.Max} = 8{,}000\ \Omega$,

Case 3. $Q_{Max} = 70$ *MVar,* $V_{Max} = 30$ *kV,* $X_{C.Max} = 12{,}857\ \Omega$.

REFERENCES

[1.] *G. Zigler, Numerical Distance Protection : Principles and Applications, 3rd edition, Publics Corporate Publishing, Germany, June 2008.*

[2.] *AREVA, Network Protection & Automation Guide, 2nd Edition, Published by AREVA, Paris, France, January 2010.*

[3.] *K.K. Sen and M.L. Sen, "Introduction to FACTS Controllers: Theory, Modeling and Applications", John Wiley & Sons, Inc., and IEEE Press, New Jersey, USA, 2009.*

[4.] *A.N. Abdel-Latief, A.F. Abdel-Gawad and M.E. Mandour, "Mitigation the Effect of TCSC on the Transmission Lines Protection Devices", The 42nd International Universities Power Engineering Conference (UPEC), Brighton, UK, 4-6 September 2007.*

[5.] *M. Khederzadeh and T.S. Sidhu, "Impact of TCSC on the Protection of Transmission Lines", IEEE Transactions on Power Delivery, Vol. 21, No. 1, pp. 80-87, January 2006.*

[6.] *T.S. Sidhu, and M. Khederzadeh, "TCSC impact on Communication-aided Distance Protection Schemes and its Mitigation", IEE Proceedings on Generation, Transmission and Distribution, Vol. 152, Issue 5, pp. 714-728, September 2006.*

[7.] *M. Zellagui and A. Chaghi, "A Comparative Study of GCSC and TCSC Effects on MHO Distance Relay Setting in Algerian Transmission Line", International Journal of Engineering and Technology (IJET), Vol. 2, No. 2, pp. 220-228, February 2012.*

[8.] *S. Jamali and H. Shateri, "Locus of Apparent Impedance of Distance Protection in the Presence of SSSC", European Transaction on Electrical Power (ETEP), Vol. 21, No.1, pp. 398-412, January 2011.*

[9.] *Shojaei and S.M. Madani, "Analysis of Measured Impedance by Distance Relay in Presence of SSSC", 5th IET International Conference on Power Electronics, Machines and Drives (PEMD'10), Brighton, UK, 19-21 April 2010.*

[10.] *M.V. Sham, and K. Panduranga Vittal, "Simulation Studies on the Distance Relay Performance in the Presence of STATCOM", Journal of Electrical Engineering (JEE), Vol. 11, No. 3, March 2011.*

[11.] *Q. Liu, Z. Wang and Y. Zhang, "Study on a Novel Method of Distance Protection in Transmission Line with STATCOM", Power and Energy Engineering Conference (APPEEC'10), China, 28-31 March, 2010.*

[12.] W.H. Zhang, S.J. Lee, M.S. Choi and S. Oda, "Considerations on Distance Relay Setting for Transmission Line with STATCOM", 2010 IEEE, Power and Energy Society General Meeting, USA, 25-29 July 2010.
[13.] F.A. Albasri, T.S. Sidhu and R.K. Varma, "Performance Comparison of Distance Protection Schemes for Shunt-FACTS Compensated Transmission Lines", IEEE Transactions on Power Delivery, Vol. 22, No. 4, pp. 2116-2125, October 2007.
[14.] S. Jamali, A. Kazemi and H. Shateri, "Measured Impedance by Distance Relay for Inter Phase Faults in the Presence of SVC on Double-circuit Lines", IET 11th Conference on Developments in Power System Protection (DPSP'12), Birmingham, UK, 23 - 26 April 2012.
[15.] J. G. Agrawal and K.D. Joshi, "Experimental Study of Some Variable Impedance Type FACTS Devices", 4th International Conference on Emerging Trends in Engineering & Technology (ICETET'11), Nagpur, India, 18-20 November, 2011.
[16.] L. F. W. de S o w E. H. Watanabe and M. Aredes, "GTO Controlled Series Capacitors: Multi-module and Multi-pulse Arrangements", IEEE Transaction on Power Delivery, Vol. 15, No. 2. pp. 725-731, April 2000.
[17.] K.K. Sen and M.L. Sen, Introduction to FACTS Controllers: Theory, Modeling and Applications, John Wiley & Sons, Inc., and IEEE Press, New Jersey, USA, 2009.
[18.] M. Zellagui and A. Chaghi, "MHO Distance Relay of Transmission Line High Voltage using Series Compensation in Algerian Networks", Journal of ACTA Electrotehnica, Vol. 52, No. 3, pp. 126-133, October 2011.
[19.] L. Gérin-Lajoie, "A MHO Distance Relay Device in EMTP Works", Electric Power Systems Research (EPSR), Vol. 79, No. 3, pp. 484-49, March 2009.
[20.] D. Sweeting, "Applying IEC 60909, Short-circuit Current Calculations", 58th Annual IEEE, 2011 Record of Conference Papers Industry Applications Society, 19-21 September 2011.
[21.] Ha Heng Xu and Zhang BaoHui, "Study on Reactance Relays for Single Phase to Earth Fault on EHV Transmission Lines", International Conference on Power System Technology (PowerCon'04), 21-24 November 2004.
[22.] S. Jamali and H. Shateri, "Impedance Based Fault Location Method for Single Phase to Earth Faults in Transmission Systems", 10th IET International Conference on Developments in Power System Protection (DPSP'10), 29 March - 1 April, 2010.
[23.] Sonelgaz Group,"Electrical Networks High Voltage 220 kV", Company of Electrical Transmission, GRTE, Alger, Algeria, 30 December 2011.

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome V (Year 2012). FASCICULE 3 [July–September]. ISSN 2067-3809

[1.] Emil RAGAN, [2.] Marcel FEDÁK, [3.] Pavol SEMANČO

HEATING PROCESS MODELING FOR DIE-CASTING JETS ON THE MACHINES WITH HOT CHAMBER

[1.] FACULTY OF MANUFACTURING TECHNOLOGIES OF TECHNICAL UNIVERSITY OF KOŠICE WITH A SEAT IN PREŠOV, DEPARTAMENT OF TECHNOLOGICAL SYSTEMS OPERATION, PREŠOV, SLOVAKIA
[2-3.] FACULTY OF MANUFACTURING TECHNOLOGIES OF TECHNICAL UNIVERSITY OF KOŠICE WITH A SEAT IN PREŠOV, DEPARTMENT OF MANUFACTURING MANAGEMENT, PREŠOV, SLOVAKIA

ABSTRACT: *In general the application of die-casting technology in foundries that are focused on non ferrous metals allows producing cast parts with specific properties. Another advantage of pressure die-casting technology with hot chamber is the possibility of production of precision cast parts in low dimensional tolerances, often without further machining. Castings have got smooth surface, good mechanical properties, and they also may have complex construction workability. Required qualitative properties of castings produced with the pressure die-casting technology with hot chamber are dependent on several parameters, which include holding stable temperature of the die-casting nozzle. Therefore in this paper we proposed the mathematical model as one of the method how to control heating die-casting nozzle of the hot chamber pressure die-casting machine using a gas torch.*
KEYWORDS: *Pressure die-casting, die-casting nozzle, hot chamber pressure die-casting machine*

INTRODUCTION

High pressure die-casting technology in foundries processing non-ferrous molten metal metals allows producing casting of various shapes with specific properties. The advantages of applying the technology of high pressure die casting using hot chamber is the possibility of precision castings in low dimensional tolerance [1,2] .

These castings have a smooth surface often without any further machining, and they also have good mechanical properties [3]. This technology may produce castings with complex construction. The quality of the castings depends on several parameters. One of the important parameter is control and regulation of temperature stability of nozzle [4,5].

During the operation of pressure die-casting machines with hot chamber dynamic changes occur mainly in temperature time casting nozzle according to the casting machine cycle. It is needed to hold the temperature of casting nozzle at optimum value therefore it is necessary to eliminate dynamic changes. Given the operation consuming conditions during the die-casting process the nozzle is regulated by controlled gas torch. For regulation of nozzle temperature, there are several types of regulation [2,6].

In this paper we focus on the compilation of model with simple control loop with a mathematical description of the regulated system, and also on the creation of transitional characteristic with regulatory design. Simple control-loop that is formed by the torch that heats the nozzle of pressure die-casting machine uses the proposed proportional regulatory.

EQUATION MODEL DEFINITION OF REGULATORY SYSTEM

For appropriateness of the solutions it is firstly necessary to derive an equation describing the dependence of torch gas flow on temperature of casting nozzle as the equation of the regulatory system. In the regulatory system the gas flow of the gas torch is referred as input value q and the temperature difference of the nozzle expressed as T-T_o and surroundings temperature is an output variable [4].

For the casting nozzle we can determine equation for thermal balance:

$$nQ_1 = Q_2 + Q_3 \qquad (1)$$

where: Q_1 - amount of the heat per time unit generated by burning gas in torch, nQ_1 - amount of the heat per time unit generated by burning gas in torch that crossed into nozzle, Q_2 - amount of the heat per time unit generated by burning gas in torch that heats nozzle, Q_3 - heat loss per time unit.

Variable Q_1 can be expressed as:

$$Q_1 = ql \qquad (2)$$

where: q - gas flow of the torch, l - calorific value of the gas.

Variable Q_2 is expressed as:

$$Q_2 = cm\frac{dT}{dt} \qquad (3)$$

where: c - specific heat of the nozzle, m - weight of the nozzle, T - nozzle temperature, t - time.

$$Q = kS_p(T - T_o) \qquad (4)$$

where: k - heat transfer coefficient from the nozzle into the surroundings, S_p - surface area of the nozzle, T_o - surroundings temperature.

Substituting equations (2), (3), (4) into equation (1) with subsequent adjustment we determine equation of regulatory system:

$$q=\frac{mc}{nl}.\frac{d(T-T_o)}{dt}+\frac{kS_p(T-T_o)}{nl} \qquad (1.1)$$

The input quantity of the regulatory system is the gas flow q and output is the temperature difference of the nozzle $T\text{-}T_o$ together with the temperature of surroundings.

In operator's shape:

$$q=\left(\frac{mcp+kS_p}{nl}\right)(T-T_o) \qquad (1.2)$$

The transmission of the system S is represented by ratio of output to input quantity.

$$S=\frac{T-T_o}{q}=\frac{nl}{mcp+kS_p} \qquad (5)$$

TRANISTIONAL CHARACTERISTIC

Based on the establishment of the transmission of the system we described transitional characteristics for step unit change of input variable and also for particular value q.

Transitional characteristic of the system can be expressed as follows (see figure. 1a):

$$T-T_o=\frac{nl}{kS_p}\left(1-e^{-\frac{kS_p}{mc}t}\right) \qquad (6)$$

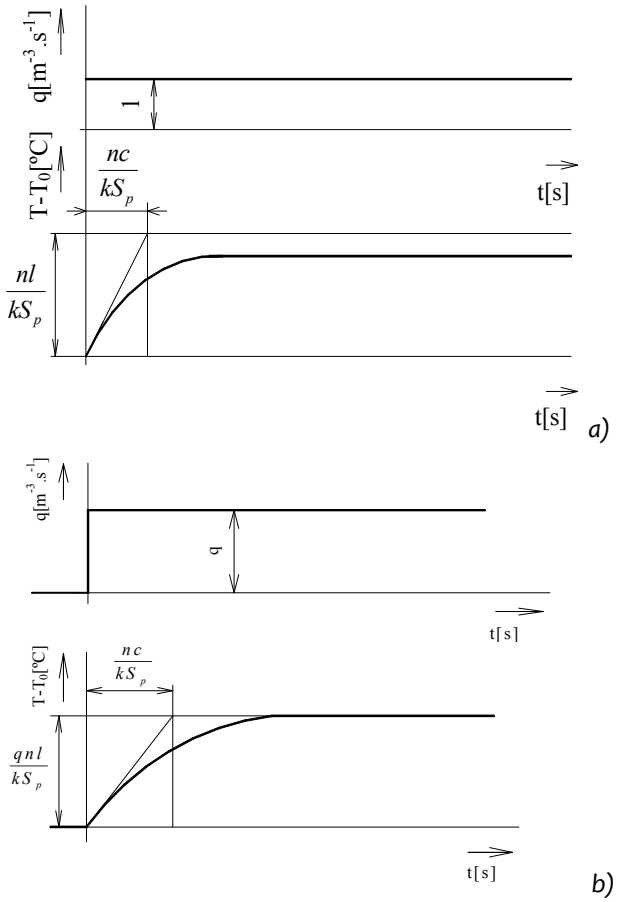


Figure 1. Transitional characteristic, a) with step b) with step q

If the step of the input variable is not unity, but enters particuler value q the course of the temperature difference of the nozzle and surroundings is described by the equation (figure. 1b):

$$T-T_o=\frac{nlq}{kS_p}\left(1-e^{-\frac{kS_p}{mc}t}\right) \qquad (6.1)$$

MODEL OF REGULATORY SYSTEM

The initiation of the temperature change of the nozzle towards surroundings can be realized by regulating of the gas flow q that enters the torch. To control the gas flow a proportional regulator can be selected.

Transfer of a proportional regulator is formulated as follows:

$$R=KP \qquad (7)$$

Regulatory circuit can be depicted by block diagram as in figure 2.

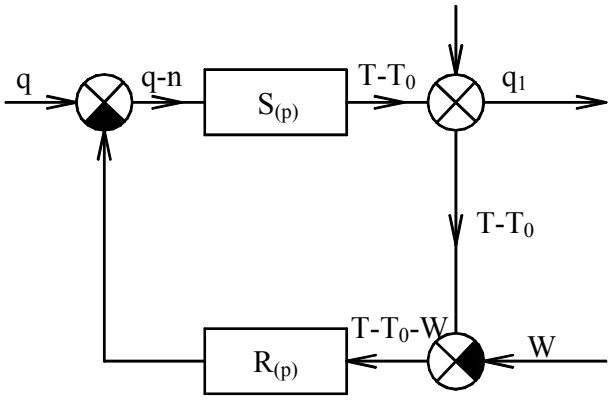


Figure 2. Block scheme of regulatory circuit

Transmission of the action variable is expressed by following equation:

$$F_a=\frac{S}{1+RS}=\frac{\frac{nl}{mcp+kS_p}}{1+\frac{KnlP}{mcp+kS_p}}=\frac{nl}{mcp+kS_p+KPnl} \qquad (8)$$

Figure 3 depicts amplitude and phase characteristics and figure 4 depicts transitional characteristic for K=1 and P=1. Circuit is characterized by stability and irregularity.

The transmission of the disturbance:

$$F_{Por}=\frac{1}{1+RS}=\frac{1}{1+\frac{KnlP}{mcp+kS_p}}=\frac{mcp+kS_p}{mcp+kS_p+KPnl} \qquad (9)$$

Amplitude and phase characteristic is depicted in figure 5 and figure 6 depicts transitional characteristic for K=1 and P=1.

The transmission of the control is:

$$F_r=\frac{RS}{1+RS}=\frac{\frac{knlP}{mcp+kS_p}}{1+\frac{KnlP}{mcp+kS_p}}=\frac{KnlP}{mcp+kS_p+KPnl} \qquad (10)$$

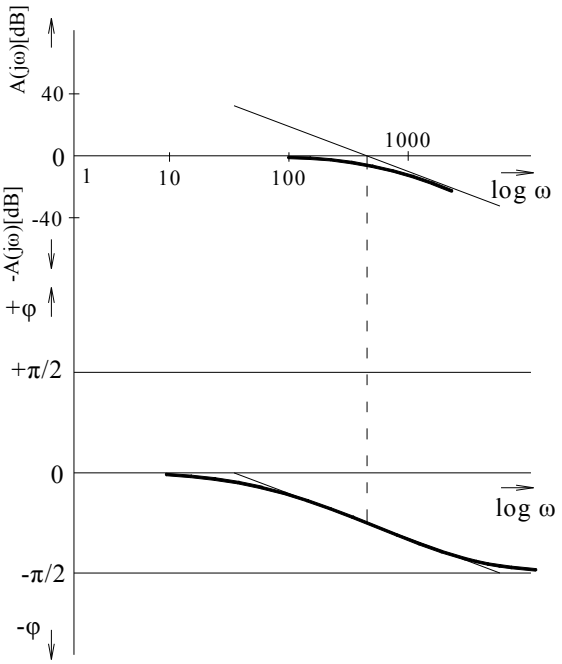


Figure 3. Amplitude and phase characteristics

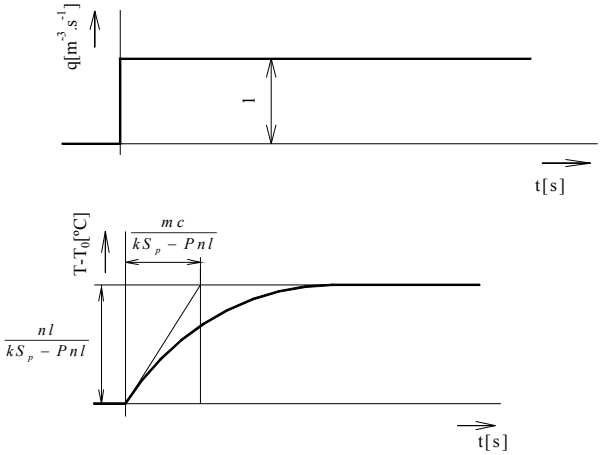


Figure 4. Transitional characteristic

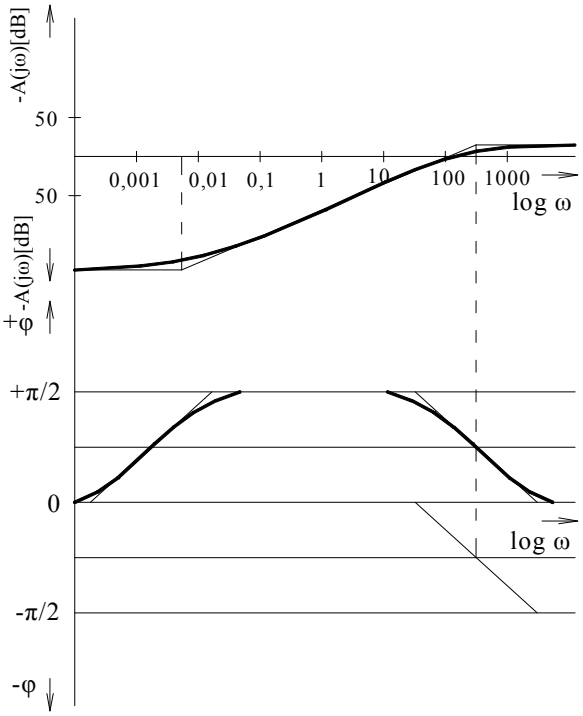


Figure 5. Amplitude and phase characteristics

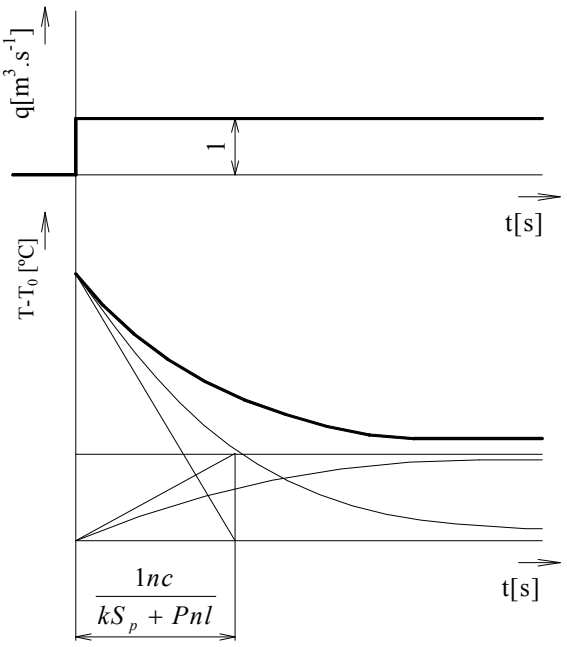


Figure 6. Transitional characteristic

CONCLUSIONS AND DISCUSION

For simple regulatory circuit formed by the torch that heats the nozzle the proportional regulator was used. On the basis of the proposed model of regulatory system the amplitude, phase and transitional characteristics of the action variable were determined (Figure 4 - 6). The control of the regulatory circuit was designed by equation of the transmission (10). From these characteristics, it is known that the regulatory circuit is stable and irregular. From transmission equation of disturbance (9) and based on the amplitude, phase and transitional characteristics for the failure of the circuit it is evident that the defect in the regulatory circuit is quickly diminishing. It can be concluded that heating the nozzle by gas torch in pressure die-casting machines with hot chamber together with proportional regulator is easy to control and it has relatively good regulatory characteristics.

REFERENCES

[1.] MALIK, J., GAŠPÁR, Š., PAŠKO, J.: Technologické faktory vplývajúce na kvalitu tlakovoliatych odliatkov zo zliatin hliníka, In: Výrobné inžinierstvo. Roč. 9, č. 1 (2010), s. 32-34, 38. - ISSN 1335-7972

[2.] RAGAN, E.: Liatie kovov pod tlakom, FVT TU Košice so sídlom v Prešove, Prešov, 2007, 381s ISBN 978-80-8073-979-9

[3.] MALÍK, J. a kol.: Vplyv podmienok tlakového liatia na mechanické vlastnosti tlakovo liatych odliatkov, Slévárenství 2007, č. 7, s. 311 – 315, ISSN 47 325

[4.] RAGAN, E.: Proces liatia pod tlakom, FVT TU Košice so sídlom v Prešove, Prešov, 1997

[5.] PAŠKO, J., MALIK, J., GAŠPÁR, Š., NOVÁK-MARCINČIN, J.: Influence of technological parameters of die castning on qualitative properties of castings, n: Manufacturing engineering and technology. No. 1(2010), p. 3-6. - ISSN 1312-0859

[6.] KRENICKÝ, T.: Monitoring prevádzky technických systémov s využitím virtuálnej inštrumentácie. Strojárstvo extra 5, 2010, p. 25/1-2, ISSN 1335-2938

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

copyright © UNIVERSITY POLITEHNICA TIMISOARA,
FACULTY OF ENGINEERING HUNEDOARA,
5, REVOLUTIEI, 331128, HUNEDOARA, ROMANIA
http://acta.fih.upt.ro

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome V (Year 2012). FASCICULE 3 [July–September]. ISSN 2067-3809

[1.] Sergei TARASOV, [2.] Valery RUBTSOV

FLOW WEAR BY SHEAR INSTABILITY IN SLIDING

[1-2.] INSTITUTE OF STRENGTH PHYSICS AND MATERIALS SCIENCES SB RAS, TOMSK, RUSSIA

ABSTRACT: *Inhomogeneous character of deformation in subsurface layers of metals in sliding resulted in generation of a nanocrystalline layer. Specificity of its deformation behavior is a hydrodynamic flow pattern developing due to shear instability under conditions of thermal softening. Macroscopic analysis of plastic deformation carried out on the assumption that deformation behavior of the nanocrystalline subsurface layer is similar to that of the parallel-plane viscous Newtonian flow. It was shown that velocity tangential discontinuity surfaces may exist inside the deforming subsurface layer. These surfaces are particular cases of Helmholtz instability and may serve as potential sites where turbulences may nucleate.*
KEYWORDS: *shear instability, nanocrystalline layer, sliding, wear*

INTRODUCTION

Now there is an interest in studying high-strain deformation behavior of nanocrystalline materials. The well-known fact is that inhomogeneous deformation in subsurface layers of metals in high-load sliding results in generation and flow of a nanocrystalline layer [1]. Specificity of its deformation behavior is a hydrodynamic flow pattern developing due to shear instability under conditions of thermal softening. The nature of shear instability here is a crossover from common shear deformation mode to the grain rotation governed either by grain boundary slipping mechanism (GBS) or rotational recrystallization mechanism [2] or disclination mechanism [3] under condition of submicron size grain structure formation and dynamic recrystallization. All these proposed deformation mechanisms might be discussed in studying deformation in nanocrystalline materials. However, GBS is the most studied and well-documented mechanism, which may serve a basis for analyzing the shear instability. Phenomenon of the shear instability in sliding is considered as a product of deep structure modification, which is a common finding in metals subjected to high strain rate impact test when adiabatic shear bands are generated [4].

Shear instability of a special type described as a Kelvin-Helmholtz instability is observed when metal (copper, beryllium or aluminum) plates collide each other in a glancing manner at 2 to 8 mm/μs velocity and small angle [5, 6]. Wave-like patterns or eddies are often found at the interface between the plates and are inherent in the said instability. Generation of this pattern may be suppressed by depositing either galvanic or electron beam coatings on the surface of samples. Such an effect of stabilization is explained by suppression of shear band generation due to refining source metal grains [6]. Judging by this explanation we may suggest that the developments of shear instability and shear bands are interrelated.

It is reported [7] that generation of eddy-like structures during high velocity impact might be by strain localization zones formed at the previous deformation stages. Once generated these zones become then involved in a vortex-like flow [7]. In our opinion these zones are the results of shear instability like those observed in impact welding, i.e. under high-velocity impact shear deformation.

Eddy-like structures of another nature may be found on the worn surfaces of soft Al–Sn and Cu–Pb alloys after testing at low sliding speeds [8]. It was suggested [8] that they might nucleate and grow under thermodynamic instability conditions with their axes being parallel to the sliding direction. However, the most feasible mechanism for formation of these structures may be mechanical mixing as follows from pioneering works of D.A. Rigney.

Dynamic high-speed sliding of aluminum/steel pair was reported [9]. It was shown that both eddy-like flow and intermixing occurred at the worn surfaces and resulted in formation of a mechanically mixed nanocrystalline layer (MML).

The objective of this work is to estimate macroscopic conditions for generation of the eddy-like flow instability in sliding on the basis of hydrodynamic approach including previously obtained both experimental and numerical simulation results.

EXPERIMENTAL CONDITIONS

Modern literature sources offer models for gradual formation of nanocrystalline layer in sliding test [9]. These models are based traditionally either on deformation rate or wear debris intermixing within the contact zone.

However, the nanocrystalline layer structure is very much alike the structure of adiabatic shear bands obtained in explosion loading [10]. It is possible with

the tribological experiment to simulate conditions close to both approaches depending on the sliding speed and the size of a real contact area. In connection with this, we carried out tribological experiments under conditions when friction coefficient changed sharply due to adhesive interaction between the samples' surfaces'.

Such an approach allowed obtaining fast changes in the contact geometry and thus provoked the occurrence of shear instability. Preliminary experiments allowed us to determine needed test regimes and sample dimensions.

Samples in the form of ∅5 mm and 20 mm length pins were cut off the ∅5 mm commercial copper rods using a lathe tool. End surfaces were ground manually and gently to remove lathe grooves and then used in wear test. After testing, the sample was fixed inside a steel nut using Wood's metal. The abrasive wheel rotating at1000 RPM with water cooling was used only for initial rough metal removal in the longitudinal cross-section so that it in no way could produce any artifact nanocrystalline layer at the end surface of the pin. All further polishing was carried out manually. A cross-section of a typical pin after preparation but before sliding looked like as having no plastic deformation traces.

Vertical pin-on-disk sliding tester 2169 UMT-1 (Tochpribor, Ivanovo) was used to test three samples simultaneously against a counterface of ∅320 mm 64 HRc tool steel disk. These samples were brought in an unlubricated sliding contact and then tested at 0.5 MPa, 0.6 m/s and 0.1 MPa, 1 m/s. It was shown by preliminary experiments that combination of low sliding speed and high contact stress is the most severe wear test mode for copper samples.

Microstructure of the worn samples was characterized using both an optical and a differential-interferential (DIC) contrast microscope Axiovert 200 MAT (Carl Zeiss). More details on the experiment and characterization are given in [15].

RESULTS

The result of experimenting was a realization of shear instability conditions (0.6 m/s, 0.5 MPa) and generation of a nanocrystalline layer having a clear boundary with the low-lying plastically deformed material (see Fig.1). This clear boundary may be evidence of shear mechanism of the nanocrystalline layer formation, which is similar to that of a shear band formation. Structurally, this layer may be divided into four zones as follows:

- *plastic deformation and texturized grain zone I;*
- *intense fragmentation zone II;*
- *"turbulent" flow zone III and finally,*
- *"laminar" flow zone IV.*

Zones I and II may be called also by usual deformation zones whereas both III and IV are the viscous flow zones [15]. One may see that both strain and fragmentation gradually grow starting from the deepest layers of zone I to the fragmentation zone II until an interface between zones II and IV (III) is formed as a result of shear instability.

Zone I is characterized by crystallographic rotation of the grains with respect to shear stress while zone II is a place of intense structural fragmentation.

More details on structure and mechanical characteristics of this layer are given elsewhere [15].

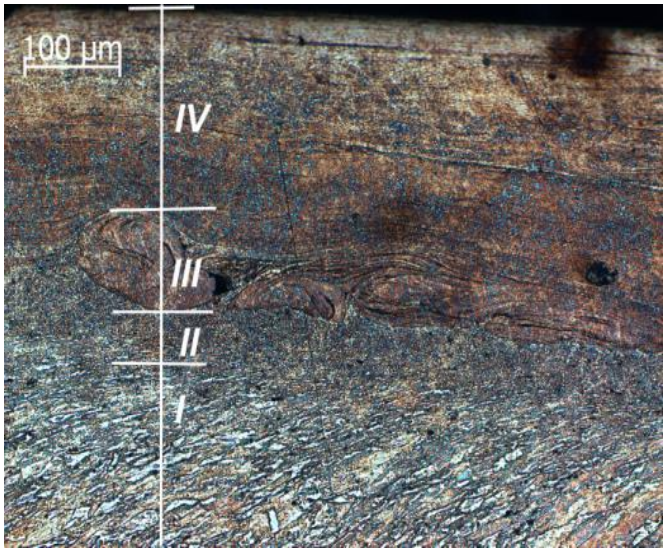


Figure 1. Microstructure of plastic deformation zones in a copper sample after sliding test at 0,6 m/s, 0,5 MPa). I – plastic deformation and texture zone ; II – fragmentation zone; III- flow instability zone; IV – stability low zone.

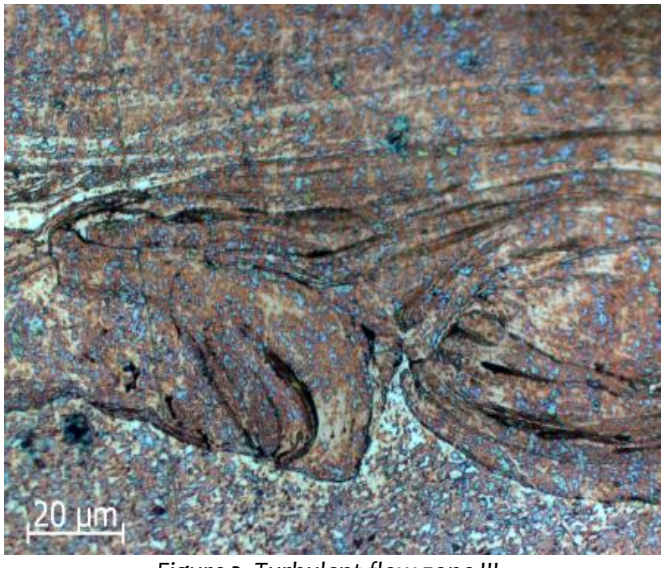


Figure 2. Turbulent flow zone III.

Morphological specificity of zones III and IV is that they are composed mainly of fine grains arranged in ~1 µm thickness sublayers which are elongated with the sliding direction.

Another important morphological feature is zone III within which one may see eddy-like flow of material which is very much alike the fluid turbulent flow patterns (see Fig.2). It is necessary to note here that those eddies are often found on the worn surfaces [8] as a result of mechanical intermixing. In our case, we found them generated at some depth below the worn surface, which may be related to the specificity of shear instability mechanism of nanocrystalline layer formation. Furthermore, the vortex flow may be found within zone IV which is composed of 1 μm thick sublayers [15].

DISCUSSION

It was shown in the first part of this work that plastic deformation patterns of nanocrystalline layer are similar to those of a flowing fluid. The zone IV sublayer interfaces denote shear direction in the materials and look similar to the flowing fluid laminar layers, whereas zone III rotation mode zones look like eddies initiated in turbulent mode flow. Let us assume that the basic deformation mechanism for nanocrystalline metals is by grain boundary slipping. Then, the nanocrystalline layer generated in sliding wear tests becomes even more alike a fluid since its structural elements are nanograins which are capable both of translational and rotational movements.

As noted [11], the polycrystalline material grains deforming in accordance with the diffusion accommodated grain boundary slipping mechanism reveal a behavior patterns very much alike if they possessed the Newtonian viscosity. Therefore, we can numerically evaluate a possibility of turbulent mode occurrence in a subsurface layer from a standpoint of hydrodynamics by drawing an analogy with a viscous fluid flowing in a space between two parallel plates, one of which is fixed while the other is moving relative to the first one (Couette flow) (see Fig.3).

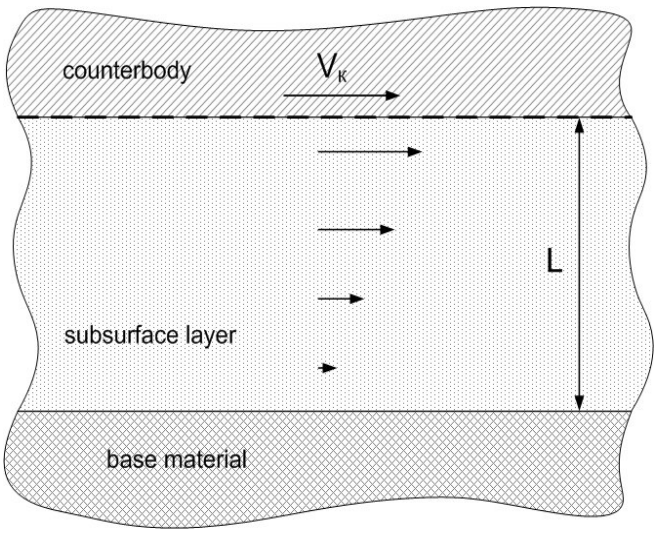


Figure 3. Plastic deformation of subsurface layer in the form of Couette flow.

The type of a flow regime is characterized by the Reynolds number:

$$Re = \frac{\rho L V_m}{\eta} \qquad (1)$$

where ρ is density, L is characteristic size, Vm is mean flow velocity , η - viscosity. In theory, the Couette flow is assumed to be absolutely stable against infinitesimal perturbances [12] whereas in practice a crossover from laminar to turbulent regime may be observed for Reynolds number in the order 10^3. To estimate the Reynolds number, we assume that the maximum mean flow velocity V_m is equal to the counterbody's velocity $V_c \approx 1$ m/s and the characteristic size coincides with the experimentally obtained nanocrystalline layer's thickness $\mathbf{L} \approx 500$ μm [15].

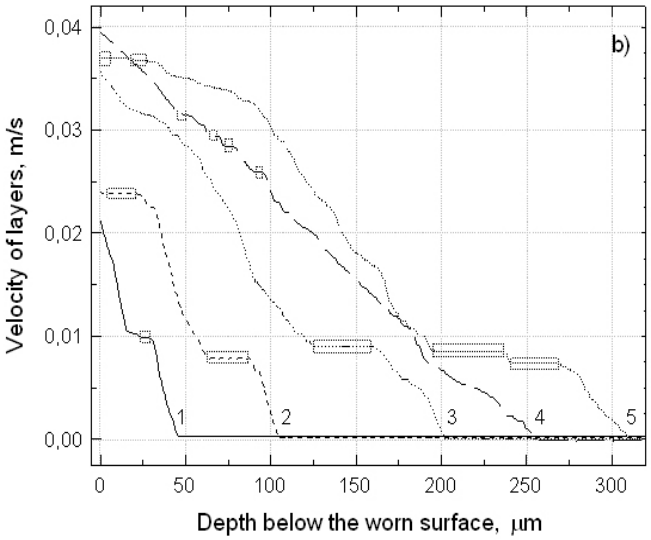


Figure 4. Subsurface layer velocity distribution vs. depth below the worn surface. Curves 1 to 5 correspond to different moments of time [15].

Both CBS deformation and, therefore, the viscosity of the nanocrystaline layer are controlled by the grain boundary diffusion. We are going to estimate the nanocrystalline layer's viscosity on the assumption that the nanocrystalline layer suffers a through-thickness flow. Assuming this, we can use the Coble's diffusion creep equation considered in details elsewhere [11] to determine the viscosity as follows:

$$\eta_B = \frac{1}{C_1}\frac{d^3 kT}{\delta D_B \Omega}, \qquad (2)$$

where d is a mean grain size, k is the Boltzmann constant, T is temperature, δ is a grain boundary width, Ω is atomic volume, D_B is a grain boundary diffusion coefficient, C_1 is a dimensionless coefficient which is $\approx 10^2$ for equiaxial grains [11].

The mean grain size is assumed to be $\approx$100 nm. The grain boundary width was 0.5 to 10 nm to estimate both maximum and minimum viscosity levels.

It is difficult to determine temperature in the vicinity of worn surface; therefore, we believe it is not below 200 ℃ since we found it experimentally to be at the level of ≈160 ℃ at the 1 mm depth below the worn surface [13]. Also, we believe the temperature was in the range of 300 to 400 ℃.

The grain boundary diffusion coefficient D_B determined by the Arrhenius equation both from diffusivity factor and activation energy [14] for nanocrystalline copper in the 200 to 400 ℃ temperature interval of interest is in the range 10^{-12} to 10^{-10} m²/s. Substituting corresponding temperature as well as diffusion coefficient in expression (2), we obtain the viscosity to be within $1 \cdot 10^6$ to $5 \cdot 10^4$ Pa·s range.

The result of dry sliding wear process simulation on a copper sample showed that plastic strain rate $\dot{\gamma}$ reached $10^3 s^{-1}$ for applied shear stress $\tau \approx 200$ MPa [15]. Using this result, we can determine the viscosity of a Newtonian fluid from a ratio between the shear stress and shear strain rate:

$$\eta = \frac{\tau}{\dot{\gamma}} \qquad (3)$$

Substituting the above found values of both τ and $\dot{\gamma}$ in (3) we obtain the viscosity $\approx 2 \cdot 10^5$ Pa·s, which falls within the above determined range $1 \cdot 10^6$ to $5 \cdot 10^4$ Pa·s. The Reynolds number determined using expression (1) from these viscosities will be in the order of 10^{-5}. From the standpoint of hydrodynamics, that low Reynolds numbers correspond only to nonperturbed laminar plastic flow of the nanocrystalline subsurface layer [12].

The Reynolds theory works correctly only for infinitesimal perturbances whereas the polycrystalline structure of materials implies the inhomogeneity of its characteristics in itself. Moreover, sliding test conditions serve to produce extra mechanical and thermal inhomogeneities in the material. It was shown by numerical simulations on a macroscopic one-dimension model that plastic shear in subsurface layer of copper sample is developed nonstationary in time and inhomogeneously through the depth below the worn surface [15]. This process generates a velocity field characterized by its non-linear profile contrastingly to that of the Couette flow (see Fig.4). It follows from Fig.4 those two types of velocity zones could exist in the deforming material. High velocity gradient zones (slope curve portions) correspond to shear instability zones developing under plastic deformation. Other zones of zero velocity gradients (horizontal curve portions shown in rectangles) are moving in parallel to the worn surface at the same velocity and carrying only elastic deformation.

Therefore, the surfaces with the velocity tangential discontinuities may exist inside the subsurface layer in different moments of time and different depths below the worn surface. From the hydrodynamics standpoint, the absolute instability is of occurrence on these surfaces. This instability may be interpreted as a simplest case of the Helmholtz instability which is a special type of an instability occurring at the interfaces between the flows of either the same or different fluids but under condition of having different flow rates [12].

Another example of a surface on which the Helmholtz instability may develop is a boundary between the subsurface layer and elastically deforming low-lying base metal.

Taking into account the results of numerical simulations, we may describe the process of deformation in the subsurface layer as follows. During any moment of time elastic deformation zones are generated together with one or even several shear instability zones where intense plastic shear occurs (see Fig.5), i.e. there is at least one interface on which the turbulence may develop.

To evaluate the feasibility of such a case, we invoke again the Reynolds number but now we apply it to some smaller structure scale of the subsurface layer, namely, to relative movement of 1 μm- thick sublayers which compose the subsurface layer [15].

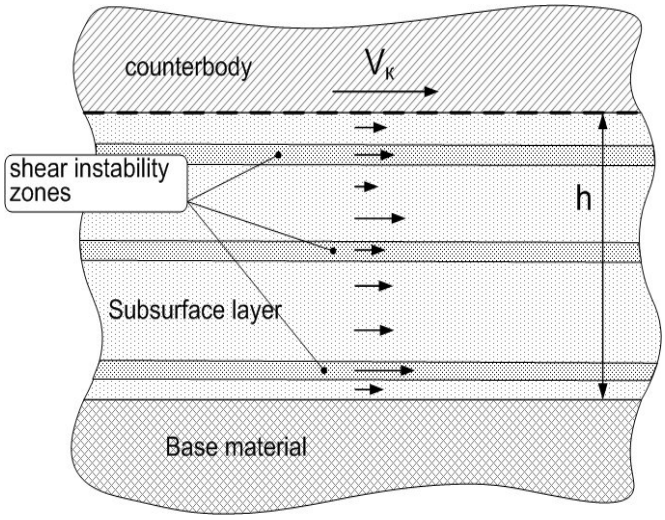


Figure 5. Schematic of the subsurface layer deformation in sliding

Reynolds himself defined his criterion as follows [16]:

$$Re = \frac{Vh}{c\lambda} \qquad (4)$$

where V is the flow velocity, h is the characteristic size of flow, c is the mean velocity of molecules, λ is the mean run of molecules. In our situation, V and h is the mean velocity of movement and the subsurface layer thickness, respectively.

Within the framework of our model [15], an elementary strain carrier is a 1 μm- thickness sublayer of material, therefore, parameters c and λ may be interpreted respectively as the velocity and displacement of this sublayer for a time during which it stays in the shear instability zone. Numerical modeling enabled the values of these parameters to be as follows: $V \approx 2 \cdot 10^{-2}$m/s, $h \approx 3 \cdot 10^{-4}$m, $c \approx 1 \cdot 10^{-2} - 4 \cdot 10^{-2}$m/s, $\lambda \approx 1 \cdot 10^{-8} - 8 \cdot 10^{-8}$m [15]. Substituting this numbers in expression (4), we obtain the Reynolds number to be in the range 1875 to 30000.

The system of parallel-plane flows as simulated in [15] and which describes deformation in a subsurface layer of metal in sliding becomes instable at that high Reynolds numbers and any infinitesimal perturbance may bring it to the turbulence regime.

CONCLUSIONS

Shear instability conditions were realized in the course of tribological experiment. A nanocrystalline 500 μm thickness subsurface layer was obtained as a result of shear instability (see Figs. 1, 2). Plastic deformation pattern of this layer gives evidence of a deformation mechanism much alike a viscous fluid flow. One of distinctive structural features of this layer is the occurrence of eddies both inside the layer and at the interface with the base low-lying material.

Macroscopic analysis of plastic deformation was carried out on assumption that the deformation behavior of the nanocrystalline subsurface layer is similar to that of the parallel-plane viscous Newtonian flow. Specificity of deformation mechanisms was not considered explicitly. From the standpoint of hydrodynamics, plastic flow of copper subsurface layer under existing experimental conditions should be absolutely stable, i.e laminar.

Situation becomes quite opposite when we take into consideration earlier revealed nonstationary and inhomogeneous shear deformation pattern. In this case, one or more velocity tangential discontinuity surfaces may exist inside the deforming subsurface layer at different moments of time and depths below the worn surface. These surfaces are particular cases of Helmholtz instability and may serve as potential sites where turbulences may nucleate. The feasibility of eddy-like structure in such zones was supported by estimating Reynolds number values.

ACKNOWLEDGEMENT

The reported here work was carried out under Project III.20.2.4. «Study of friction mechanisms and subsurface structure development in metals, alloys and composites under different conditions of friction contact and on a basis of multi-level approach» of Program III.20.2. «Scientific foundations for development of materials and coatings of non-equilibrium structural and phase states on a basis of multi-level approach» as well as with financial support from Russian Fund for Basic Research (grant No 10-08-00629-a).

REFERENCES

[1.] S.Yu. Tarassov and A.V. Kolubaev. Effect of friction on subsurface layer microstructure in austenitic and martensitic steels// Wear - 1999.-V.231. 228-234.

[2.] M.A. Meyers and H.R.Pak. Observation of an adiabatic shear band in titanium by high-voltage transmission electron microscopy. Acta Metall. **34**, 2493 (1986).

[3.] S.V. Bobylev, A.K.Mukherjee and I.A. Ovid'ko Transition from plastic shear into rotation deformation mode in nanocrystalline metals and ceramics Rev.Adv.Mater. Sci. 19 (2009) 103-113.

[4.] S. Yu. Tarasov, A.V. Kolubaev. Generation of shear bands in subsurface layers of metals in sliding. Physics of solid state, 2008. Vol.50.No 5. P.844-847.

[5.] O.B. Drennov. On development of shear instability in metals. Journal of technical physics **69**, (1999). 38-43

[6.] A.L Mikhailov Hydrodynamic instabilities in strength media – from object to tool. Physical mesomechanics V.**10**, No.5 (2007) 53-62.

[7.] V.G. Morozov, S.A. Saveliev, Yu.I. Mescheryakov, N.I. Zhigacheva, B.K. Barakhtin. Vortex model of elastic-plastic flow under impact loading. Physics and mechanics of materials **8,** 8 (2009).

[8.] R. Schouwenaars, V.H. Jacobo, A. Ortiz Microstructural aspects of wear in soft tribological alloys Wear 263 (2007) 727–735.

[9.] D. A. Rigney, Hong-Jin Kim, A. Emge, R. E. Winter, P. T. Keightley, Woo-kyun Kim; M. L. Falk. Nanostructures generated by explosively-driven friction-experiments and MD simulations. Acta Materialia, (2009) V. 57, No 17, Pages 5270-5282.

[10.] Y. Xu, H.J. Yang, M.A. Meyers. Dynamic recrystallization in the shear bands of Fe–Cr–Ni monocrystal: Electron backscatter diffraction characterization Scripta Mater. **58,** (2008) 691-694.

[11.] R.Raj and M.F.Ashby On Grain Boundary Sliding and Diffusional Creep / Metallurgical Transactions. – Vol.2. – April 1971. – P.1113 –1127.

[12.] Monin A.S., Yaglom A.M. Statistical hydromechanics. V.1., M.:Nauka, 1967. 640c.

[13.] S.Yu. Tarasov. Structural changes in metallic materials in adhesion sliding wear. Thes. Doct. of Sci. - Tomsk.- 2008.- 282 c.

[14.] Yu. R. Kolobov, R.Z. Valiev, G.P. Grabovetskaya et all. Grain boundary diffusion and properties of nanostructured materials. Novosibirsk: Nauka, 2001. - 232 p.

[15.] S. Tarasov, V. Rubtsov, A. Kolubaev Subsurface shear instability and nanostructuring of metals in sliding Wear 268 (2010) 59–66.

[16.] Problems of turbulence. Book of translated papers. Ed. by M.A.Velikanov and N.T. Shveikovsky. M.-L, ONTI, 1936, 332 c.

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

copyright © UNIVERSITY POLITEHNICA TIMISOARA,
FACULTY OF ENGINEERING HUNEDOARA,
5, REVOLUTIEI, 331128, HUNEDOARA, ROMANIA
http://acta.fih.upt.ro

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome V (Year 2012). FASCICULE 3 [July–September]. ISSN 2067-3809

[1.] Vasile ALEXA

SIMULATION OF HYDRAULIC LOAD LOSSES IN PIPES, USING THE WORKING MEDIUM "ADINA"

[1.] UNIVERSITY POLITEHNICA TIMISOARA, FACULTY OF ENGINEERING HUNEDOARA, HUNEDOARA, ROMANIA

ABSTRACT: *The fluid analysis module of the program is fluid solver for compressible and incompressible fluid provides a world-class finite element solutions and the ability to control the flow, fluid can contain free surface and fluid, as well as fluid flow and structure of the interface between. This paper presents a method of simulation and presentation of the load losses in a fluid flowing through a pipe. It also presents a study on the algorithm for calculating these losses depending on the flow regime & pipe type, and the determination of the longitudinal load loss coefficient. The theory and numerical methods used in the program for laminar and turbulent flow are summarized and then the solutions of various problems are presented.*
KEYWORDS: *hydraulic load losses, pipes, simulation, Adina program*

INTRODUCTION

ADINA has a wide range of simulation capabilities in mechanical field and has applications in such areas. ADINA program is the basic structure of the solver for solid, truss, beam, pipe, metal plate, shell and crannies provide diversification and general finite element analysis capabilities.

ADINA is based on the finite element and finite volume discrete map, with a very comprehensive and efficient solution to address all of arbitrary geometry flows. The fluid analysis module of the program is fluid solver for compressible and incompressible fluid provides a world-class finite element solutions and the ability to control the flow, fluid can contain free surface and fluid, as well as fluid flow and structure of the interface between.

Besides being used widely in industries, the ADINA System is also used effectively in teaching and research at universities all around the world. ADINA offers many attractive capabilities for use as a teaching and research tool.

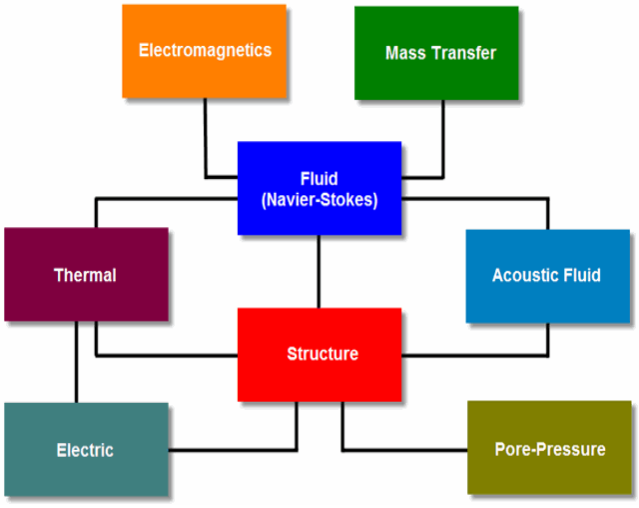


Figure 1. Fluid structure interaction [1]

Fluid-structure interaction (FSI) occurs when fluid flow causes deformation of the structure. This deformation, in turn, changes the boundary conditions of the fluid flow.

The above presented figure showed the fluid-structure interaction analysis of a membrane valve. Here, the fluid pressure deforms the membrane which changes the boundary conditions of the flow [1].

When the real fluids flow through pipes, two types of hydraulic losses occur:

- *Linear losses h_{pd}, (longitudinal or distributed), mathematically expressed by the Darcy's formula:*

$$h_{pd} = \lambda \frac{l}{d} \frac{v^2}{2g} \qquad (1)$$

- *Local losses h_{pl}, mathematically expressed by the Weisbach's formula:*

$$h_{pl} = \xi \frac{v^2}{2g} \qquad (2)$$

where:

- *l - lenght of pipe $[m]$;*
- *d - diameter pipe $[m]$;*
- *v - average speed section $\left[\frac{m}{s}\right]$;*
- *g - acceleration of gravity $\left[\frac{m}{s^2}\right]$;*
- *λ - linear coefficient of hydraulic losses;*
- *ξ - local hydraulic loss coefficients to different types of hydraulic resistance.*

The flow regime in pipes is characterised by the Reynolds similarity criterion value, Re, in relation to its critical value:

$$Re = \frac{vd}{\nu} \qquad (3)$$

where: "ν" represents the constitutive coefficient of the kinematics' viscosity.

The flow regime can be:

- laminar: $Re < Re_{crt} = 2320$;
- turbulent: $Re > Re_{crt} = 2320$.

The problem of determining the λ coefficient is the fundamental problem of pipe calculation. Nikuradse is the first who undertook a systematic study of this coefficient, establishing its relationship with the flow regime and the relative roughness, and drawing the diagram that bears his name [2].

An American engineer Lewis F Moody (1880-1953) prepared the diagram shown in figure 1 for use with ordinary commercial pipes. Today, the Moody diagram is still widely used and is the best means available for estimating the friction factor.

The fact that λ depends both on the Reynolds number and the wall roughness, makes it difficult to use unique formulas to calculate it, assuming that l, ν, d, v and k (equivalent roughness) are known [2].

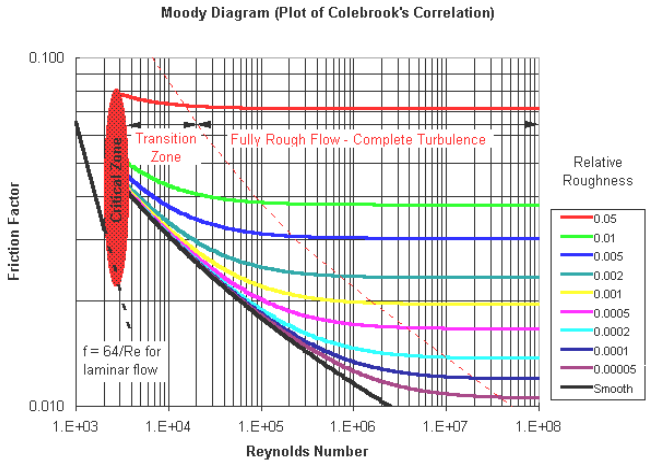


Figure 2. Moody diagram

a) If $Re < Re_{crt} = 2320$ (the flow regim laminar), for calculation of the Hagen-Poiseuille's relationship using:

$$\lambda = \frac{64}{Re} \tag{4}$$

b) If $Re > Re_{crt} = 2320$ (the flow regim turbulent), using Moody's criterion:

$$CRIT = Re\sqrt{\lambda_i}\frac{k}{d} \tag{5}$$

To assess this criterion, we approximate λ, admitting that its value is within the range:

$$\lambda_i = (0.02\text{-}0.04).$$

Depending on the value of this criterion, which describes the nature of the pipe, we shall apply one of the relations:

b.1. Hydraulically smooth pipe – CRIT < 9.4, the linear loss coefficient depends only on the flow regime $\lambda=\lambda(Re)$. Therefore, we shall apply one of the relations:

- Blasius - for $Re < 10^5$

$$\lambda = \frac{1}{\sqrt[4]{100Re}} \tag{6}$$

- Prandtl - for $10^5 < Re < 3\cdot10^6$

$$\frac{1}{\sqrt{\lambda}} = 2\lg\left(Re\sqrt{\lambda_i}\right) - 0{,}8 \tag{7}$$

- Konakov - for $3\cdot10^6 < Re < 10^7$

$$\frac{1}{\sqrt{\lambda}} = 1{,}8\lg Re - 1{,}5 \tag{8}$$

b.2. The pipe is under transition from hydraulically smooth to hydraulically rough 9.4 < CRIT < 200, the linear loss coefficient depends on the flow regime, but also on the equivalent roughness of the pipe $\lambda = \lambda(Re, \frac{k}{d})$, being applicable the relation of Colebrook-White:

$$\frac{1}{\sqrt{\lambda}} = -2\lg\left(\frac{2.51}{Re\sqrt{\lambda_i}} + \frac{k}{3.71d}\right) \tag{9}$$

b.3. Hydraulically rough pipe – CRIT > 200, the linear loss coefficient depends only on the equivalent roughness of the pipe $\lambda = \lambda\left(\frac{k}{d}\right)$, being applicable the relation of Karman-Nikuradse:

$$\frac{1}{\sqrt{\lambda}} = 2\lg\left(\frac{k}{d}\right) + 1.14 \tag{10}$$

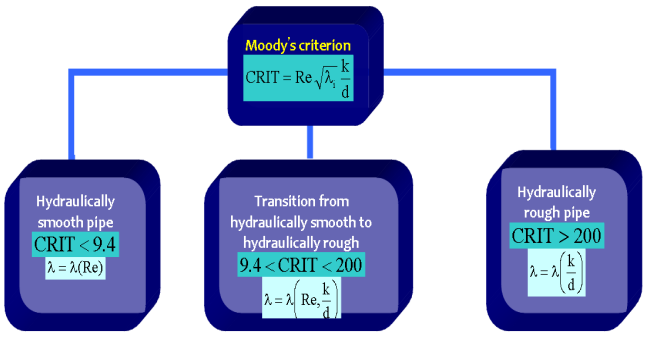


Figure 3. Algorithm to determinate the linear loss cofficient λ

Having the λ coefficient calculated with one of the above relations (case of the turbulent regime), we will check the value of Moody's criterion, which must correspond to the initially admitted domain. Otherwise, "λ" shall be recalculated applying the formula of the new value of the criterion, i.e. of the new hydraulic character of the pipe.

SIMULATION OF LINEAR LOAD LOSSES, USING THE WORKING MEDIUM "ADINA"

The ADINA CFD program provides state-of-the-art finite element and control volume capabilities for incompressible and compressible flows. The flows may contain free surfaces and moving interfaces between fluids, and between fluids and structures.

The procedure used in ADINA CFD is based on finite element and finite volume discretization schemes,

with a most general and efficient solution approach. General flow conditions in arbitrary geometries can be solved.

The steps taken to realise the simulations, using the CFD-3D model, were as follows:

a) Establishing the scope of analysis *– From the point of connection in the basement to the first consumer who lives on the ground floor, the length is 3.5 meters, and the other consumers are placed vertically, three meters apart from each other.*

The maximum circulated flow is $1.25 \cdot 10^{-3} \left[\frac{m^3}{s}\right]$ *(Figure 4).*

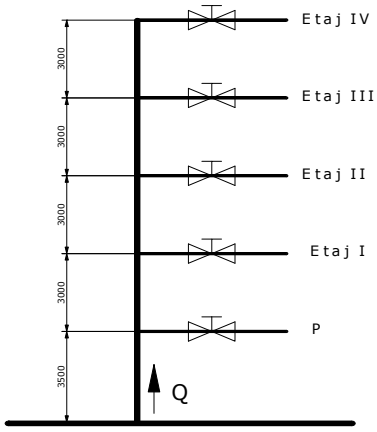


Figure 4. Case studied

b) Establishing the flow parameters *– To determine the linear loss coefficient, we will consider the vertical water column (pipe) of a block P+4 (ground floor + 4 floors), which has the diameter d = 0.03 [m] and the roughness k = 0.0014 m.*

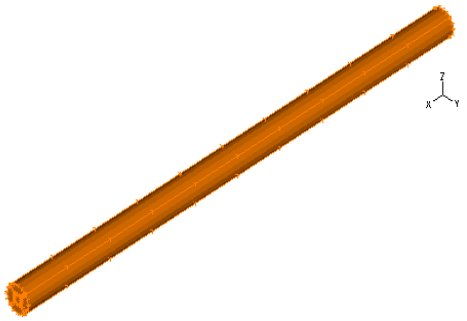


Figure 5. Establishing the flow parameters

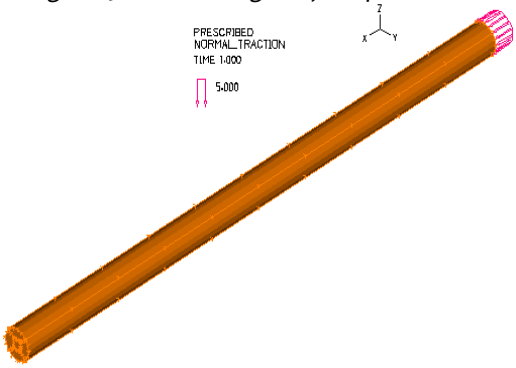


Figure 6. Establishing the loads (5 bar)

c) Establishing the properties of the material *– thermo-physical properties of the material and fluid, respectively;*

d) Establishing the loads *– as loads, we have the 5 bar pressure*

e) Finite element discretisation of the analysis domain. *After generating the discretisation network, we obtained 979 nodes and 4800 finite elements.*

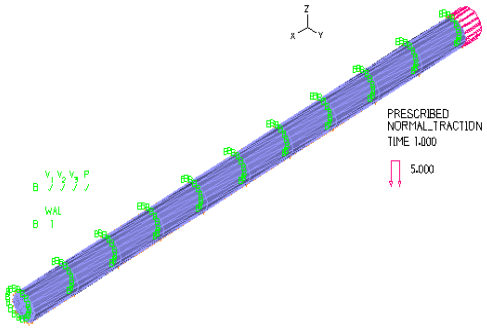


Figure 7. Finite element discretisation of the analysis domain

f) Establishing the conditions on the outline *– the pipe was assimilated as a wall with 1.4 μm roughness and 0.03 m diameter.*

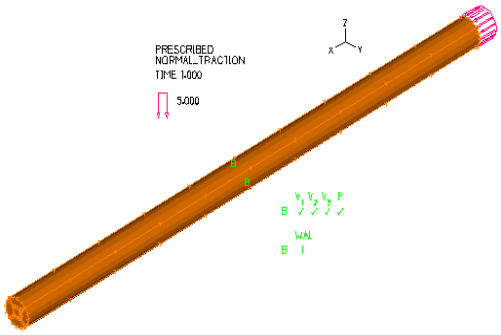


Figure 8. Establishing the conditions on the outline

CONCLUSION AND RESULTS OF NUMERICAL SIMULATIONS

The theory and numerical methods used in the program for laminar and turbulent flow are summarized and then the solutions of various problems are presented.

In this paper we presented the methodology for determining the linear pressure loss coefficient and pressure fluctuation in the pipe, using the working medium "ADINA".

The pressure variation in the pipe:

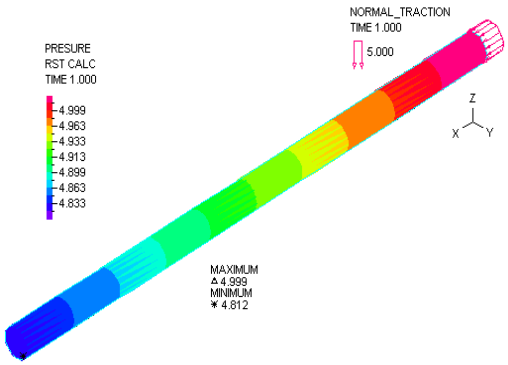


Figure 9. The pressure variation in the pipe

The velocity field in different planes:

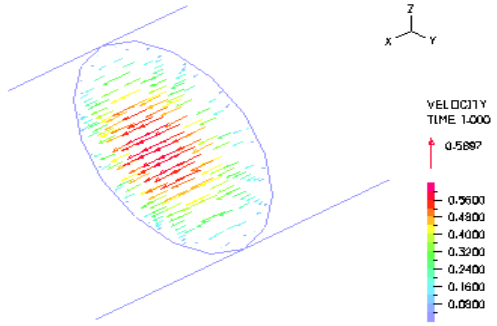


Figure 10. The velocity field in a plane perpendicular to the X-axis

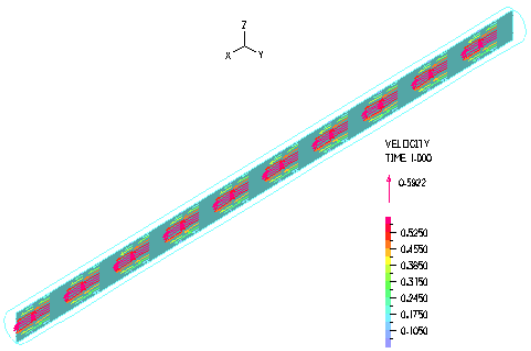


Figure 11. The velocity field in a plane perpendicular to the Y-axis

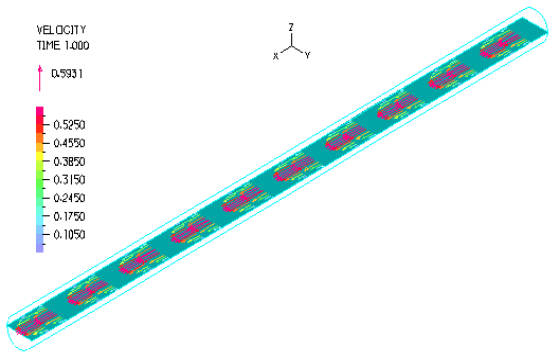


Figure 12. The velocity field in a plane perpendicular to the Z-axis

Fluid–structure interaction (FSI) can be simulated the velocity field in different planes and the pressure variation in the pipe.

REFERENCES

[1.] *Mark A. Robinson, Paul R. Sparrow, Chris Clegg, Kamal Birdi, Design engineering competencies: future requirements and predicted changes in the forthcoming decade, Design Studies, Volume 26, Issue 2, March 2005, Pages 123-153*

[2.] *V. Braibant, G. Sander, Optimization techniques: Synthesis of design and analysis, Finite Elements in Analysis and Design, Volume 3, Issue 1, April 1987, Pages 57-78*

[3.] *H.W. Wagener, K.J. Pahl. Energy flow, energy losses and efficiency of the hydraulic press system, Journal of Mechanical Working Technology, Volume 17, August 1988, Pages 93-102*

[4.] *P. Doron. D. Barnea, Flow pattern maps for solid-liquid flow in pipes, International Journal of Multiphase Flow, Volume 22, Issue 2, April 1996, Pages 273-283*

[5.] *T. Kava. R. Pérez, C. Gregori, A. Torres, Numerical simulation of transient operation of loop heat pipes, Applied Thermal Engineering, Volume 28, Issues 8–9, June 2008, Pages 967-974*

[6.] *K. Dasgupta, A. Chattapadhyay, S.K. Mondal, Selection of fire resistant hydraulic fluids through system modeling and simulation, Simulation Modelling Practice and Theory, Volume 13, Issue 1, January 2005, Pages 1-20*

[7.] *W. Borutzky, B. Barnard, J. Thoma, An orifice flow model for laminar and turbulent conditions, Simulation Modelling Practice and Theory, Volume 10, Issues 3–4, 15 November 2002, Pages 141-152*

[8.] *Dídia Covas, Iva N. Stoianov, Joao F. Mano, Helena Ramos, Nigel Graham, Cedo Maksimovic, The dynamic effect of pipe-wall viscoelasticity in hydraulic transients. Part II—model development, calibration and verification, Journal of Hydraulic Research, Volume 43, Issue 1, 2005, pages 56-70*

[9.] *Valentin Heller, Scale effects in physical hydraulic engineering models, Journal of Hydraulic Research, Volume 49, Issue 3, 2011, pages 293-306*

[10.] *Michael B. Abbott, Karsten Havn, Sten Lindberg, The fourth generation of numerical modelling in hydraulics, Journal of Hydraulic Research, Volume 29, Issue 5, 1991, pages 581-600*

[11.] *Hricová, B., Nakatová, H., Badida, M., Lumnitzer, E.. (2009) Aplication of ecodesign and life cycle assessment in evaluation of machine products, MMA 2009, Novi Sad, Serbia, p. 250-253*

[12.] *Hricová, B., Nakatová, H., Badida, M., Lumnitzer, E.. (2009) Utilisation of tools of environmental management in evaluation of environmental profile of products, MTeM 2009, Cluj-Napoca , Romania, p. 317-320*

[13.] *Košťál, P., Mudriková, A., Velíšek, K. (2008). Material flow in flexible manufacturing. 4th International Scientific Conference of the Military Technical College. The 13th International Conference on Applied Mechanics and Mechanical Engineering, Arab Republic of Egypt, Cairo*

[14.] *Lamár, K. (2004), Digital Control of Permanent Magnet Synchronous Motors, Proceedings of the Budapest Tech Jubilee Conference, Budapest, Hungary, pp. 213-228*

[15.] *Antal, G., Lamár, K. (2002), Modern Solutions to Integrated Building Automation Systems, Proceedings of the International Conference "Kandó 2002", Budapest, Hungary, p.5-10*

[16.] *Neszveda, J. (2009). Safety Lifecycle of Intermittently Operated Device, Academic and Applied Research in Military Science, Vol.8, Issue 2, pp. 203–211*

[17.] *Anagnostopoulos, J. (2003), Discretization of transport equations on 2D Cartesian unstructured grids using data from remote cells for the convection terms. International Journal for Numerical Methods in Fluids 42(3), 297 – 32*

[18.] *Choudhary, K., Mazumdar, Dipak, (1995). Mathematical modeling of fluid flow, heat transfer and solidification phenomena in continuous casting of steel, Steel Research, 66, No. 5*

[19.] *F. Stella, M. Giangi, F. Paglia, A. Casata, D. Simone, P. Gaudenzi, A numerical simulation of fluid–structure interaction in internal flows, Numerical Heat Transfer, Part B: Fundamentals: An International Journal of Computation and Methodology, Volume 47, Issue 5, 2005, pages 403-418*

[20.] *Peter Beater, Modeling and Digital Simulation of Hydraulic Systems in Design and Engineering Education using Modelica and HyLib, Modelica Workshop 2000, 2000, Lund, Sweden*

[21.] *W. Borutzky, B. Barnard, J. Thoma, An orifice flow model for laminar and turbulent conditions, Simulation Modelling Practice and Theory, Volume 10, Issues 3–4, 15 November 2002, Pages 141–152*

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome V (Year 2012). FASCICULE 3 [July–September]. ISSN 2067-3809

[1.] Preetida VINAYAKRAY-JANI, [2.] Sugata SANYAL

ROUTING PROTOCOLS FOR MOBILE AND VEHICULAR AD HOC NETWORKS: A COMPARATIVE ANALYSIS

[1.] DA_IICT, GANDHINAGAR, INDIA
[2.] TATA INSTITUTE OF FUNDAMENTAL RESEARCH, MUMBAI, INDIA

ABSTRACT: *We present comparative analysis of MANET (Mobile Ad-Hoc Network) and VANET (Vehicular Ad-Hoc Network) routing protocols, in this paper. The analysis is based on various design factors. The traditional routing protocols of AODV (Ad hoc On-Demand Distance Vector), DSR (Dynamic Source Routing), and DSDV (Destination-Sequenced Distance-Vector) of MANET are utilizing node centric routing which leads to frequent breaking of routes, causing instability in routing. Usage of these protocols in high mobility environment like VANET may eventually cause many packets to drop. Route repairs and failures notification overheads increase significantly leading to low throughput and long delays. Such phenomenon is not suitable for Vehicular Ad hoc Networks (VANET) due to high mobility of nodes where network can be dense or sparse. Researchers have proposed various routing algorithms or mechanism for MANET and VANET. This paper describes the relevant protocols, associated algorithm and the strength and weakness of these routing protocols.*
KEYWORDS: *Mobile Ad-Hoc Network, Vehicular Ad-Hoc Network, Routing Protocols, Geographic Source Routing (GSR), Spatially Aware packet Routing (SAR), Anchor-based Street and Traffic (A-STAR) aware routing, Connectivity Aware Routing*

INTRODUCTION

An emerging Mobile Ad hoc Networks (MANET) and Vehicular Mobile Networks (VANET) are expected to form network centric communications. Large number of mobile nodes communicates through single or multi-hop routing protocols. Although VANET is one of the classified scenarios of MANET, VANET nodes form highly dynamic network where node density could be either dense or sparse. Besides vehicle radios have very limited radio range and must communicate with one another by multi-hop routing protocols. Apparently, widely varying mobility characteristics of mobile or vehicular nodes are expected to have a significant impact on the performance of routing protocols. Therefore even though researchers have developed routing protocols like Ad hoc On-demand Vector (AODV), Dynamic Source Routing (DSR), Destination Sequence Distance Vector (DSDV) etc. for MANET [2], these protocols cannot be directly adopted in VANETs, efficiently, because of the rapid variation in link connectivity, high speed and extremely varied density of vehicular nodes in VANET. Researchers have developed special routing protocols for VANET [3], and these are aimed to adapt rapidly changing mobility pattern of the vehicular nodes.

Although such mobility characteristics exhibit spatial or temporal dependency of nodes, they are insufficient to capture some important mobility characteristics of scenarios in which MANETs may be deployed, i.e. the mobility characteristics generate protocol independent metrics [18]. But eventually this protocol independent metrics significantly influences the routing protocol performance. Attempt is made to categorize and summarize the routing protocols, as per the design factors, that influence the mobility performance.

This paper attempts to provide design factors that affect MANET and VANETs in section II. Subsections II also provide classification and qualitative comparison of MANET and VANET routing protocols. Finally section III discusses conclusion and open issues of developed or proposed routing protocols.

DESIGN FACTORS THAT AFFECTS THE ROUTING PROTOCOLS

In general, routing protocols designed for MANET and VANET are categorized from topology point, these are either flat, hierarchical or position based; Communication paradigm (uni-cast or multicast or broadcast), Delay tolerance, Quality of service, Cluster based routing

A. Topology

Flat topology: MANET routing protocols Optimized Link State Routing (OLSR), DSDV, Wireless Routing Protocol (WRP), Global State Routing (GSR), Fisheye State Routing (FSR), Source Tree Adaptive Routing (STAR) [7], Distance Routing Effect Algorithm for Mobility (DREAM) represents flat topology where route updates are periodically performed that constantly updates the network topology. This periodic updates are, regardless of network load, bandwidth or scalability. Such protocols are proactive and do not provide power saving as router updates are made periodically

Alternatively researchers have also developed there are reactive protocols in like AODV, Label-based Multipath Routing (LMR), Temporally-Ordered Routing Algorithm (TORA), Location Aided Routing (LAR), Zone Routing Protocol (ZRP), Flow Oriented Routing Protocol (FORP) where routing update is

made on demand. In this type of protocol design active routes between sender and receiver nodes is determined by making route discovery. Route discovery is made by flooding network with route request and receiving route response packets in network. Such phenomena, helps nodes to conserve power as there are no periodic signals to respond.

These MANET protocols are not suitable for VANET, as discovering routing path is time consuming as vehicular node's speed is high.

Hierarchical or Hybrid: In MANET routing protocol like ZRP [4], represent this category that uses the hybrid approach to improve scalability of routing protocol. By considering proactive and reactive mechanisms, ZRP divides network in intra and inter zones, where intra-zone protocols are proactive and inter-zone protocols are reactive. Although this protocol improves scalability, lack of implementation feasibility makes this routing aspect unsuitable for VANET.

Position-based: Position based routing protocols uses location aided approach for MANET.

In VANET vehicular nodes either communicate with another vehicle (V2V) or road side vehicle (V2R). In existing infrastructure and ad hoc nodes of IEEE 802.11 wireless standard the time required to authenticate and associate with Basic Service Set (BSS) is too long to be considered by VANET. Therefore 802.11p standard will provide wireless devices with ability to communicate through short-duration messages, necessary to communicate between a high speed vehicle and a stationary roadside unit (V2R) including high speed vehicle (V2V). This mode of operation is known as Wireless Access in Vehicular Environment (WAVE) [19].

Although this V2V communication decentralized, it is robust and supports the low data transport times for emergency [10] warning, Such thing is not feasible with roadside cellular base station as they are often overwhelmed by calls in emergency, due to lack of load balancing mechanism to avoid congestion in network [5].

In MANET the proposed routing protocol LAR, uses information about location through geographic coordinates or relative position of nodes to generate route information thus by reducing overhead of traditional flooding mechanism. Moreover location service may be built into nodes or distributed location services may be utilized [12, 5].

The position based routing approach was designed for MANET routing protocol called Greedy Perimeter Stateless Routing (GPSR) [25]. In this greedy forwarding strategy is used to forward messages toward known destination. However if at one or multi hop, there are no nodes in direction of destination then it uses the perimeter mode. Usage of such routing strategy in VANET is not efficient as in urban area radio obstruction restricts the effective route and usage of perimeter mode is often required. During obstruction this perimeter mode uses the created planner graph that causes the message to be delivered immediate node instead of farthest reachable node. Thus more nodes will carry messages, eventually increasing delays. Such inefficiency can also cause messages to be delivered in wrong direction when node moves from communication range of one node to another.

As a result VANET uses Geographic Source Routing (GSR) [11]. This particular routing mechanism uses Dijkstra's shortest path algorithm to find shortest path between source and destination. Using static street map in piror and location information about each node, source forwards the message to destination and computes route to destination using Dijkstra's shortest path algorithm. The source message computes the sequence of intersection that must be traversed in order to reach destination. Although this algorithm is VANET specific it does not consider vehicle density, however authors acknowledges this and can see a potential to improve this routing mechanism.

Another position based routing protocol called Spatially Aware packet Routing (SAR) [16], tries to prevent limitations of recovery strategy used by GPSR of MANET. It is similar to GSR, but relies upon the external service such as Geographical Information Service (GIS) to extract street map and construct 'spatial model' to calculate shortest path to route packet to a destination. When shortest path is decided, unlike GSR, it determines the geographical locations that need to be travelled in embedded in packet header. When node needs to forward packet it uses this immobile physical location information to route packet to next geographic location. Thus it avoids the greedy strategy like GSR toward destination. Author does provide recovery strategy if forwarding node cannot find next location specified in packet header. In one method it suggests the usage of suspension buffer to store information till node finds suitable location. In another method node greedily forwards packet to destination. Usage of suspension buffer provides the high packet delivery ratio with expense of delay compare to no recovery strategy in SAR.

Unlike GSR, Anchor-based Street and Traffic (A-STAR) [20] aware routing uses bus routes to find routes with high probability for packet delivery. It uses the geographic forwarding points to route packet to destination, including route information to determine traffic density. However this static approach is less

optimal compare to dynamic approach that utilizes latest traffic condition information.

In VANET, Connectivity Aware Routing (CAR) [15] maintains the cache of successful routes between various source and destination pairs. Nodes using CAR periodically sends HELLO beacons indicating the "velocity vector" information. On receiving this information receiving node will update its neighbour table and calculates its own velocity vector and velocity vectors of its neighbours. The entries in table expire after two HELLO intervals. However this HELLO beacon interval adapts as per traffic density, by increasing its frequency when traffic is sparse and by decreasing when traffic is dense. To maintain routing paths as the vehicle changes its position, guards are utilized to avoid the repetition of discovery phase of route. If the node at a route end point changes its direction then node activates guard with old and new velocity vectors. The node that is aware of a guard can use guard table information to ensure the delivery of messages to destination node that has moved. Once guard aware node receives a message addressed to the relocated node, it will add the guard coordinates as an anchor point to the message. Then it estimates the new position of the destination and forwards the message. Protocol also suggests two recovery strategies like "timeout algorithm with active cycle" and "walk around error recovery" to rectify the routing error incurred due to communication gaps between two anchor points or guards that are not maintained due to low traffic. Without making usage of map of location services, this protocol shows the ability to create the virtual infrastructure through 'guards'. Protocols also provide the street and traffic awareness during discovery phase and maintains the route and adapts to traffic densities.

B. Communication Paradigm

In general communication paradigm include unicast, multicast, geocast, anycast, geographical anycast communication. Unicast communication provides one-to-one communication where target node location is known precisely or it is in the communication range through single or multi hop distance. Multicast or broadcast communication provides one-to-many communication where many single node can communicate with group of target nodes identified by common destination address. Multicasting is interpreted for group oriented communication. This type of communication paradigm is more suitable for applications that will require dissemination of messages to many different nodes in the network. The specialized form of multicast group is also called geocast where nodes are within particular geographic location relative to source able to receive geocast messages. In addition to this there is also another specialized form of multicast called anycast where a node sends message to any destination node in a group of nodes. This anycast also provides data acquisition feature where a nodes sends messages to certain geographic area to request data from any node found in that geographic location, called geographical anycast.

Many multicasting protocols have been proposed for MANET as well as for VANET. Designed and developed MANET based routing protocols are either using tree structure or mesh structure. Within the MANET working group at IETF two proposed multicast routing for ad hoc networks are Multicast Ad-hoc On-demand Distance Vector (MAODV) [26] and On-demand Multicast Routing Protocol (ODMRP) [27].

MAODV uses the shared bi-directional multicast tree while ODMRP maintains the tree topology. In MOADV with hard state of connected links, any link breakage force actions to repair the tree. Group leader in multicast tree maintains the up to date information about multicast tree by periodically sending group hello message and receiver unicasts the reply back to source. But if intermediate node on route path move away, the reply is lost, eventually route is lost.

Unlike MAODV, ODMRP being mesh topology, alternative path is feasible where link failure need not trigger the re-computation of the mesh. Any broken link eventually time out and route information for source and receiver is periodically refreshed by the source. The broadcasted route refreshes from every source could result in scalability issue if intermediate nodes are not part of multicast group, resulting in extra processing overhead. This makes tree based MAODV topology more efficient as it avoids sending duplicate packets to receivers. However in high mobility environment where topology changes very fast, tree-based MAODV is not suitable as unicast reply back to source is unable to reach if intermediate node in route path moves away. However in mesh based ODMRP alternative routes updates are broadcasted from receiver to source, making more robust against link failure with expense of associated overhead. Therefore compared to tree based topology, mesh based topology outperforms in high mobility environment.

C. Delay Tolerance Network

Sparse MANETs are a class of ad hoc networks where node density is low and contacts between the nodes in network occurs infrequently. As a result, the network graph is rarely, if ever, connected where message delivery must be delay tolerant. However traditional MANET routing Protocols make the assumption that the network graph is fully connected and fail to route messages if there is no complete route from source to destination at the time of sending. For this reason

traditional MANET routing protocol cannot be used in sparse MANETs. A key challenge is to find a route that can provide good delivery performance and low end-to-end delay in a disconnected graph where nodes may move freely.

To overcome this issue, node mobility is exploited to physically carry messages between disconnected parts of network. The scheme that exploits the node mobility, referred to as mobility assisted routing that employs the store-carry-and-forward model is used. Mobility assisted routing consists of each node independently making forwarding decisions that take place when two nodes meet.

In VANET, when few vehicles are equipped with wireless transceivers, network will be sparse; delay tolerant routing algorithms are needed. The proposed Motion Vector Algorithm (MOVE) [8] for V2R VANET considers sparse network where prior prediction must be made for rare opportunistic routing. It is assumed that every node has knowledge of its own position and heading, where destination is a fixed globally known location. From this current vehicular node finds closest distance between vehicle and message destination along its trajectory. Current vehicular node periodically sends HELLO message. Neighbouring nodes sends RESPONSE message to make itself known to current vehicular node. Given the direction of where neighbouring node is heading; current node determines the shortest distance to destination along the trajectory of neighbouring node. The current node then makes decision to forward the message while determining the each vehicle's current distance from destination. This algorithm where data delivery rate is higher for sparse network, compared to greedy, position based routing and uses less system buffer space. With resulted performance evaluation, authors have noted that if routes are consistent and uniform, greedy position based routing performs better than MOVE.

In line with MOVE algorithm another algorithm called Scalable Knowledge based Vehicular Routing (SKVR) [1], also makes the usage of the predictable routes and vehicle schedules. It divides the network in inter-domain and intra-domain. In inter-domain routing source and destination belong to different routes whereas in intra-domain source and destination belong to same route. In inter-domain algorithm, message is forwarded to a vehicle travelling in destination domain and once destination domain is reached intra-domain message delivery procedure will be followed. In intra-domain messages are sent in forward or reverse directions, depending on the entires of contact list. If the sending vehicle contact list does not contain any vehicle in the destination's domain, then messages are delivered to the other vehicles in contact list. When vehicles along the same route encounter one another, a node carrying a message must decide whether to continue buffering the message, or to forward it, based on the direction information of the vehicle.

Using strategy called 'carry-and-forward' Vehicle Assisted Data Delivery (VADD) [17] algorithm allows packets to be carried by vehicles in sparse network and eventually relaying it to appropriate node when it enters in broadcasting range. Each node in VADD knows its own position and also requires external street map that includes traffic statistics. Selection of the candidate node, to which message need to be forwarded, is encountered through different selection criteria. However such criteria are either not scalable or consumes more bandwidth through duplication of packets. Authors have observed while using VADD, network becomes unstable as vehicle density decreased, because optimal paths were not available and because algorithm relies upon probabilistic traffic density information.

Unlike VADD, Static Node Assisted Adaptive Vehicular routing (SADV) [6] where static node has capability to store a message until it can forward the message to a node travelling on the optimal path. Algorithm also dynamically adapts to varying traffic densities in network, so that every node can measure the amount of time required to deliver message. However like any 'store-and-forward' this algorithm requires the efficient buffer management. By using 'Least Delay Increase' strategy, where static node checks which paths are currently available and eliminates packets which will not significantly increase their delivery delay.

Routing called Geographical Opportunistic (GeOpps) [9] routing in delay tolerant network is using opportunistic routing with carry-and-forward approach to route messages. Algorithm assumes that vehicle is using GPS and Navigation system that helps to route and locate static road site unit.

D. Quality of Service (QoS)

QoS routing strategy is not followed by any traditional MANET routing protocols. However there are research attempt to integrate such strategies within MANET routing protocols.

Multi-hop Routing Protocols for Urban VANET (MURU) [13], estimates quality factors of a route based on vehicle position, speed and trajectories. Based on this quality factors MURU introduces new metric called 'Expected Disconnection Degree' (EDD). Hence MURU nodes need to know its own position and have external street map including presence of efficient location service. This new metric value considered to be low as EDD, is an estimation of probability that determines the breakability of route during given time

period. Based on destination location and street map, source node calculates the shortest trajectory to the destination to find route to destination. This shortest trajectory detail is stored in the packet and is used as a directional guideline for Route Request (RREQ) message. Node receiving RREQ message calculates EDD of the link between two subsequent nodes. MURU uses pruning method to improve the scalability of RREQ message, where node receiving RREQ message will wait for backoff delay that is directly proportional to the EDD between the previous forwarder of RREQ and current one. During this backoff interval the node determines whether to drop the RREQ message or rebroadcast it. Nevertheless, by using pruning method broadcasting area iteratively becomes smaller to receive RREQ broadcast. Eventually when destination receives the RREQ message from different routes, it selects the route with smallest EDD. This smaller broadcasting area is problematic if the next hop node is located outside of broadcasting range. However with low overhead and delay, MURU provide quality route with high percentage of throughput.

Another algorithm called Prediction Based Routing (PBR) [14], focussed on providing Internet connectivity to vehicles. This algorithm assumes that each vehicle has knowledge of its own position. The algorithm takes advantage of the less erratic vehicle movement patterns on road to predict the duration and expiry of a route from a client vehicle to a mobile gateway vehicle. Just before route failure is predicted, PBR pre-emptively seeks new route to avoid loss of service. However, it is unclear that how gateway will share bandwidth demand with number of vehicles.

E. Clustering based routing

Clustering is a process that divides the network into interconnected substructures, called structures. A group of nodes identifies themselves to be a part of cluster and a node designated as cluster head (CH) will broadcast the packet to cluster. The stability of node is the key to create the stable cluster infrastructure. There have been attempts to study cluster-based routing protocols in MANET. VANETs behave in a different way than the model that predominate in MANET's research, are due to driver behaviour, constraints on mobility and high speeds.

In MANET, Weighted Clustering Algorithm (WCA) [21] based on the use of weight metric that include several system parameters like the node-degree, distance with all its neighbours, node speed and time spent as a CH. Each node obtains the weight value of other nodes and CHs through re-broadcasting. As a result it induces overhead. If node moves into region which is not covered by CH, then once again cluster set-up process gets invoked. Such procedure is time consuming as it introduces more overhead to process. The performance of WCA is enhanced by algorithm called Distributed Weighted clustering Algorithm (DWCA) [22], which localizes the configuration and reconfiguration of cluster and restricts the power requirement on CHs.

In VANET, a reactive Location Routing Algorithm with Cluster Based Flooding (LORA-CBF) [23], where each node can be CH, gateway or cluster member. For each cluster there is CH, a node that connects two clusters called gateway. The packets are forwarded by protocol similar to greedy routing. If location of destination is not available then source will sent location request. This is similar to route request in AODV, but only CH and gateways can disseminates the location request and location reply. Performance results show the network mobility and size of the network affects the performance of AODV and DSR [2], more significantly than LORA-CBF.

Another VANET routing algorithm called Clustering for Open IVC Networks (COIN) [24], where CH is based on vehicular dynamics and driver intensions. Performance shows that COIN represents more stable clustering structure of VANET, at the cost of little overhead.

CONCLUSIONS AND OPEN ISSUES

In this paper attempt is made to provide comparative and qualitative analysis of MANET and VANET routing protocols by categorizing them within five different design factors.

Although foundation of MANET and VANET routing protocols is well established; it is essential to make comprehensive performance evaluation of various algorithms, by implementing them in real-time scenario.

The performance of routing protocols MANET and VANET depends significantly on the mobility models and the density of nodes. Therefore it is essential to design routing protocols specific to given mobility models.

REFERENCES

[1.] S. Ahmed, S.S. Kanere, "SKVR: Scalable Knowledge-based Routing Architecture for Public Transport Networks", Proceedings of the 3rd International Workshop on Vehicular Ad hoc Networks (VANET'06), ACM, New York, NY, USA, 2006, pp. 92-93.

[2.] R. Bai, M. Singhal, "DOA: DSR over AODV routing for mobile ad hoc networks", IEEE Transactions on Mobile Computing, vol.5, no.10, Oct. 2006, pp.1403-1416.

[3.] E. Fonseca, A. Festag, "A survey of existing approaches for secure ad hoc routing and their applicability to VANETS", NEC network laboratories, 28 pages, Version 1.1, March- 2006, pp. 1-28.

[4.] Z. J. Haas, M. R. Pearlman, P. Samar, "The Zone Routing Protocol (ZRP) for Ad hoc Networks", IETF Internet Draft, July 2002. http://tools.ietf.org/id/draft-ietf-manet-zone-zrp-04.txt

[5.] J. Bernsen, D. Manivannan, "Unicast Routing Protocols for vehicular Ad Hoc Networks: A critical comparison

and classification," In Journal of Pervasive and Mobile Computing 5, 2009, Elsevier, pp. 1-18.
[6.] Y. Ding, C. Wang, L. Xiao, "A static-node assisted adaptive routing protocol in vehicular networks" Proceedings of the fourth ACM international workshop on Vehicular ad hoc networks, VANET'07, ACM, New York, NY, USA, 2007, pp. 59-68.
[7.] F. Giudici, E. Pagani, "Spatial and Traffic-Aware Routing (STAR) for Vehicular System." Proceedings of First International Conference on High Performance Computing and Communications, Lecture Notes in Computer Science. Publisher: Springer Berlin Heidelberg, Vol. 3726, 2005, pp. 77-86
[8.] J. LeBrun, C.N. Chuah, D. Ghosal, M. Zhang, "Knowledge-based opportunistic forwarding in vehicular wireless ad hoc networks", Proceedings of the 61st IEEE Vehicular Technology Conference (VTC), vol. 4, 30 May-1 June 2005, pp. 2289- 2293.
[9.] I. Leontiadis, C. Mascolo, "GeOpps: Geographical Opportunistic Routing for Vehicular Networks", IEEE International Symposium on World of Wireless, Mobile and Multimedia Networks, 18-21 June 2007, Espoo, Finland, pp. 1-6.
[10.] C. Lochert, H. Hartenstein, J. Tian, H. Fussler, D. Hermann, M. Mauve, "A routing strategy for vehicular ad hoc networks in city environments", Proceedings of the IEEE Intelligent Vehicles Symposium, 9-11 June, 2003, pp. 156-161.
[11.] C. Lochert, M. Mauve, H. Fussler, H. Hartenstein, "Geographic routing in city scenarios", ACM SIGMOBILE Mobile Computing and Communications Review, vol. 9, No. 1, January, 2005, pp. 69-72.
[12.] M. Mauve, J. Widmer, H. Hartenstein, "A survey on position-based routing in mobile ad hoc networks", Journal of IEEE Network, vol.15, no.6, Nov/Dec 2001, pp.30-39.
[13.] Z. Mo, H. Zhu, K. Makki, N. Pissinou, "MURU: A Multi-hop routing protocol for urban vehicular ad hoc networks", Proceedings of the Third IEEE Annual International Conference on Mobile and Ubiquitous Systems Workshops, 17-21 July 2006, pp.1-8.
[14.] V. Namboodiri, L. Gao, "Prediction-based routing for vehicular ad hoc networks", IEEE Transactions on Vehicular Technology, Vol. 56, No. 4, July 2007, pp. 2332-2345 .
[15.] V. Naumov, T. R. Gross, "Connectivity-aware routing (CAR) in vehicular ad-hoc networks", Proceedings of the 26th IEEE International Conference on Computer Communications, 6-12 May 2007, pp.1919-1927.
[16.] J. Tian, L. Han, K. Rothermel, "Spatially aware packet routing for mobile ad hoc inter-vehicle radio networks", Proceeding of the IEEE Intelligent Transportation Systems, Vol. 2, 12-15 October, 2003, pp. 1546- 1551.
[17.] J. Zhao, G. Cao, "VADD: Vehicle-Assisted Data Delivery in vehicular ad hoc networks", Proceedings of the 25th IEEE International Conference on Computer Communications (INFOCOM), 2006, pp. 1-12.
[18.] Bhavyesh Divecha, Ajith Abraham, Crina Grosan and Sugata Sanyal "Analysis of Dynamic Source Routing and Destination-Sequenced Distance-Vector Protocols for Different Mobility models", First Asia International Conference on Modelling and Simulation, 27-30 March, 2007, Phuket, Thailand, pp. 224-229.
[19.] Status of Project IEEE 802.11 task group p, "Wireless Access in Vehicular Environment" (WAVE)", http://www.ieee802.org/11/Reports/tgp_update.htm
[20.] R.C. Seet, G. Liu, B.S. Lee, C.H Foh, K.J. Wong and K.K. Lee, "A-STAR: A mobile ad hoc routing strategy for metropolis vehicular Communication", Performance of Computer and Communication Networks, Lecture notes in Computer Science, Vol. 3042, Publisher: Springer Berlin Heidelberg, 2004, pp. 989-999.
[21.] M Chatterjee, S. Das and D. Turgut, "WCA: A Weighted Clustering Algorithm for Mobile Ad hoc Networks", Journal of Cluster Computing (Special Issue on Mobile Ad Hoc Networks), Vol. 5, No. 2, Springer, pp. 193-202, 2002
[22.] W. Choi and M. Woo, "A Distributed Weighted Clustering Algorithm for Mobile Ad Hoc Networks", In Proceedings of IEEE Advanced International Conference on Telecommunications and International Conference on Internet and Web Applications and Services, 2006, pp. 73.
[23.] R. A. Santos, A. Edwards, R.M. Edwards and N.L.Seed, "Performance evaluation of routing Protocols in Vehicular Ad Hoc Networks," The International Journal of Ad Hoc and Ubiquitous Computing, Vol. 1, No. 1, pp. 80-91, Inderscience, 2005
[24.] J. Blum, A. Eskandarian and L. Hoffman, "Mobility Management in IVC Networks," In Proceedings of IEEE Intelligent Vehicles Symposium, 2003, pp. 150-155.
[25.] B. Karp, H.T. Kung, "GPSR: Greedy Perimeter Stateless Routing for Wireless Networks," In Proceedings of the 6th International Conference on Mobile Computing and Networking, MobiCom'00, ACM, New York, NY, USA, 2000, pp. 243-254.
[26.] E. M Royer, C. E. Perkins, "Multicast Ad hoc On-demand Distance Vector (MAODV) Routing," Internet Draft, http://tools.ietf.org/html/draft-ietf-manet-maodv-00
[27.] Y. Yi, Sung-Ju Lee, W. Su, M. Gerla, "On-demand Multicast Routing Protocol (ODMRP) for Ad hoc Networks", Internet Draft, http://tools.ietf.org/html/draft-ietf-manet-odmrp-04

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome V (Year 2012). FASCICULE 3 [July–September]. ISSN 2067-3809

[1.] Vladimir KULIK, [2.] Ján PAŠKO

THE STRUCTURAL DESIGN AND STRENGTH CALCULATION WORM EXTRUSION MACHINES FOR PRODUCING PLASTIC PROFILES

[1-2.] TECHNICAL UNIVERSITY OF KOŠICE, FACULTY OF MANUFACTURING TECHNOLOGIES, DEPARTMENT TECHNICAL DEVICES DESIGN, PRESOV, SLOVAKIA

ABSTRACT: *The most practical and the most widely used technology of plastic profile extrusion technology is worm extruder. The contribution deals with the design and stress analysis of a single worm extruder. Extrusion technology is one of the leading production technology for processing thermoplastics, as well as elastomers (rubber). The introduction is given substance and principle of extrusion technology. In other parts of the paper is processed with design and stress analysis of a single worm.*
KEYWORDS: *extruders, extrusion, worm*

INTRODUCTION

Extrusion technology is one of the leading production technology for processing thermoplastics, as well as elastomers (rubber). The essence of this technology lies in the heated feed material (plastic) in the melting chamber at a temperature of about 200°C (at which the plastic in the plastic state), which is also stirred by the worm and then extruded through the exit portion of a worm into the mold or mold through the hole.

After printing, material should be cool for the stabilization of product shapes and sizes. Profile resulting from the extrusion head is continuously pulls and further adjusts depending on the technology. In the production of extruded profiles after the mold processing there are cooling process continued, which is in the most cases cooling medium is water. For extrusion through a hole shaped, this profile which is created have to be stabilized by water or air-cooling.

To avoid over cooling the melt extruded profile, change dimensions, there are placed it in the profiled bore gauges, where the profile is cooled to a temperature such as, that the resulting profile was dimensionally stable. In the case of extrusion rubber mixtures can be extruded profile led directly to vulcanization [4] [7].

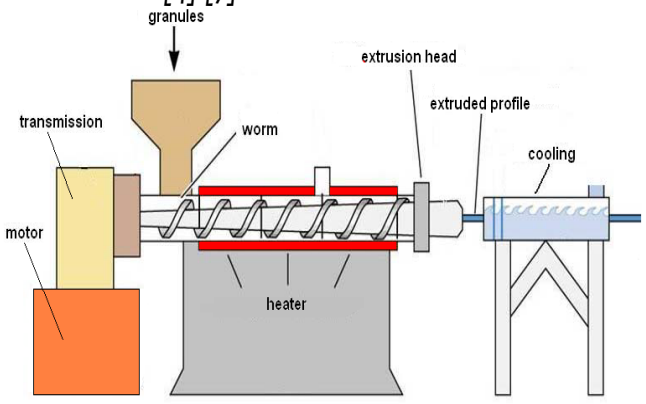


Figure 1. The principle of a worm extruder

THE STRUCTURAL DESIGN WORM EXTRUDERS

Worms are among the main functional parts of the worm extrusion machines, whose construction depends on the type of processed material. An important variable is the compression ratio, which expresses the ratio of the volume profile for a worm pitch of the worm in two places. A change of a compression ratio is usually achieved by varying the thickness profile of the worm. The size depends on the size of a worm extruder. Worm is determined by diameter D and length L, which usually refers to the average L / D. For extruding thermoplastic extruder worms are used most frequently with a length of 23 to 30 D and a compression ratio of 1:1.5 to 1:4,5 and polymers with narrow melting temperature range is typically processed to worm with a higher compression ratio. When geometry of a worm is selecting, should be taken care of the material characteristic to be processed. Compression ratio for the machine filled with a preheated mixture ranges from 4 to 6, for machines to meet a cold mixture of 10 to 18. [4]

Save the worm machine is bearings. Worm is connected to the drive shaft coupling or pen. In processing there are must respect certain technological parameters, mainly because power must be designed so that the performance was sufficient and the worm speed should normally be continuous or stepped and changeable in a wide range. [7]

Worms from the design point of view can be divided into:

a.) variable angle of climb,
b.) long transition zone,
c.) double-acting worm,
d.) short transition zone,
e.) completed a smooth torpedo,
f.) with the driving element degassing and stirring part.

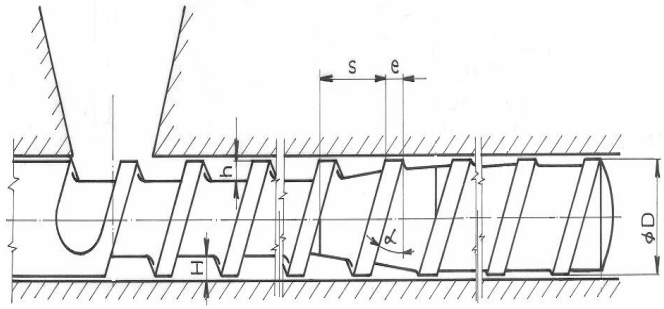


Figure 2. Diagram of a simple worm [7]

Figure 1 shows a diagram of a simple worm, where they are displayed basic geometric parameters too. Total volume of material transported by worm can be calculated from the basic relationship [4]:

$$Q = \alpha.n - \frac{\beta}{\eta}\cdot\frac{\Delta P}{L}$$

where:
Q – total volume of the worm material per unit time [$mm^3.s^{-1}$],
n – rotational speed [s^{-1}],
ΔP – pressure gradient in the direction of the worm axis [MPa],
η – viscosity of the polymer [$kg.m^{-1}.s^{-1}$],
D – worm diameter [mm]

STRENGTH CALCULATION OF SIMPLE WORM EXTRUDERS

Worms are much stressed functional parts of the worm extruders. They are stored in the bearings, which allow rotational movement of the worm and capture the axial and radial forces. [3] [7]

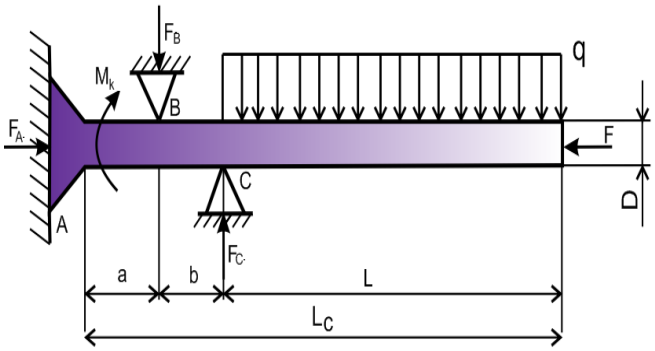


Figure 3. Load a single worm

The sizes of forces acting on the bearings are calculated from the following relations:

$$F_A = \frac{\pi D^2}{4}\cdot p;$$

$$F_B = \frac{qL^2}{2b};$$

$$F_C = \frac{qL}{2b}(1+2b)$$

where:
D – worm diameter [mm],
p – pressure at the end of the worm [MPa],
q – continuous load [$N.mm^{-1}$]

Worms are loaded with axial force on the pressure or buckling. It depends on the ratio of worm length and its diameter. It is therefore necessary to calculate the slenderness ratio (λ).

$$\lambda = \frac{L_o}{i}$$

where:
λ – slenderness ratio [-],
L_o – reduced length [mm],
i – radius of inertia [mm]
Worms whose slenderness ratio exceeds 50 (λ> 50) are strained to the bar and worm whose slenderness ratio is less than 50 (λ> 50) are stressed by the pressure. When stress is calculated on the pressure reduced stress (σ_r), which must be less than the allowed voltage (σ_D). [6] [7]

$$\sigma_r = \sqrt{\sigma_{max}^2 + 4\tau_{max}^2} \le \sigma_D$$

$$\sigma_{max} = \sigma + \sigma_O = \frac{F}{S} + \frac{M_O}{W_O};$$

$$\tau_{max} = \frac{M_{Kmax}}{W_K}$$

where:
σ_r – reduced stress [MPa],
σ_{max} – maximum normal stress [MPa],
τ_{max} – maximum tangential stress [MPa],
σ_D – maximum possible stress [MPa],
F – axial force applied to the worm [N],
S – Cross-section worm [mm^2],
M_O – bending moment [N.mm],
W_O – selectional module for bend [mm^3],
M_{Kmax} – maximum torque [N.mm],
W_K – sectional module for torsion [mm^3]
The maximum deflection at the end of the worm is calculated from the relationship:

$$y_{max} = \frac{qL^4}{8EJ};$$

$$J = \frac{\pi D^4}{64}\left[1 - \left(\frac{d}{4}\right)^4\right]$$

where:
y_{max} – maximum deflection [mm],
q – continuous load [$N.mm^{-1}$],
L – worm length [mm],
E – Modulus of elasticity [MPa],
J – moment of inertia of the cross section of the worm [mm^4],
D – maximum diameter of the worm [mm],
d – minimum diameter of the worm [mm]
For reliable operation of these machines is also important to twist the worm. Twisting the worm should not exceed 1.5 to 3° degrees [7]. For the true size of the torsion:

$$\varphi^{\circ}_{max} = \frac{M_K L}{GJ} \cdot \frac{180}{\pi} \leq \varphi_D$$

where:

φ°_{max} *– maximum tortion [°],*

M_K *– torque [N.mm^{-1}],*

L – worm length [mm],

G – modulus of elasticity [MPa],

φ_D *– the maximum possible tortion[°]*

CONCLUSIONS

Design and calculation of components of the machinery is a creative activity using theoretical and practical experience. This activity must be geared mainly to meet the requirements. At present, virtually all areas of design activities supported by computer technology that can be effectively used in the design of machinery components particularly in the construction of technical documentation and field strength calculations.

REFERENCES

[1.] *Gašpár, Š.: Implementácia programu Autodesk Inventor 2009 pri riešení rovinne zaťažených, staticky určitých priamych konštrukcií. ERIN 2009: 3. ročník medzinárodní konference, Ostrava, VŠB-TU, 2009, ISBN 978-80-248-1982-2*

[2.] *Batešková, E. – Maščenik, J. – Haľko, J. – Gašpár, Š: Device for measurement of clamped joints friction torque. In: Technological Developments in Networking, Education and Automation. - Dordrecht: Springer, 2010, p. 417 – 419, ISBN 978-90-481-9150-5*

[3.] *Horvát, T. – Pavlenko, S. – Palko, A.: Použitie programu Autodesk Inventor pri vytváraní a dimenzovaní hriadeľov, 2010. In: Vzdelávanie učiteľov stredných odborných škôl v nových európskych normách : zborník referátov informačno-tématického seminára : 21. október 2010, Prešov FVT TU, s. 110-114., ISBN 978-80-553-0549-3*

[4.] *Liptáková, T. – Alexy, P. – Gondár, E. – Khunová, V.: Polymérne technické materiály, ŽU Žilina, 2009, 182 s.*

[5.] *Maščenik, J. – Haľko, J.: Proposal and calculation of worm gear with PC upport /Návrh a výpočet závitovky s podporou PC /, In: ERIN 2009. - Ostrava : VŠB-TU, - ISBN 9788024819822*

[6.] *Pavlenko, S. – Haľko, J. – Maščenik, J. – Nováková, M.:Navrhovanie súčastí strojov s podporou PC, 1. vyd. – Prešov : FVT TU, 2008, 347 s.,ISBN 978-80-553-0166-2*

[7.] *Ragan, E. a kol.: Vstrekovanie plastických hmôt, FVT TU Prešov, 2008, 548 s., ISBN 978-80-553-0102-0*

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

copyright © UNIVERSITY POLITEHNICA TIMISOARA,
FACULTY OF ENGINEERING HUNEDOARA,
5, REVOLUTIEI, 331128, HUNEDOARA, ROMANIA
http://acta.fih.upt.ro

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome V (Year 2012). FASCICULE 3 [July–September]. ISSN 2067-3809

[1.] Koros NEKOUFAR

NEW MODELING OF THERMAL DIVISION IN TURBULENT TUBES

[1.] ISLAMIC AZAD UNIVERSITY, CHALOOS BRANCH, IRAN

ABSTRACT: *Turbulent Ranque effect is a typical macro–quantum phenomenon, which cannot be described by classical theory. About a century of unsuccessful experience in defining this phenomenon on the basis of classical methods testifies to this. The basic idea of non–local thermodynamics is to use quantum entropy, with every quantum defined as equal to Boltzman constant. This hypothesis will allow to apply thermodynamic energy. Further, correlations of quantum mechanics are used. In this article, the process of gasses' thermal division in turbulent tubes is described on the basis of thermodynamic theory according to Newtonian time.*
KEYWORDS: *Non-local thermodynamic, Ranque effect, vortical tube*

INTRODUCTION

Turbulent Ranque effect is a typical macro–quantum phenomenon, which cannot be described by classical theory. About a century of unsuccessful experience in defining this phenomenon on the basis of classical methods testifies to this.

Another new approach to solve this problem is using non-local version of thermodynamics, developed in the Moscow State University of Engineering Ecology [1].

The basic idea of non–local thermodynamics is to use quantum entropy, with every quantum defined as equal to Boltzman constant– k. This hypothesis will allow to apply thermodynamic energy – kT. Further, correlations of quantum mechanics are used. For brevity purposes, only the relation of energy–time is used here:

$$\Delta E \Delta t = \hbar / 2 \qquad (1)$$

Using $\Delta E=kT$ in the relation (1) allows establishing the minimum interval macroscopic processes that depend only on temperature:

$$\Delta t = \frac{\hbar}{2kT} \qquad (2)$$

In addition, radius r and volume V in the environment for time Δt is:

$$r = c\Delta t = \frac{c\hbar}{2kT} \qquad (3)$$

$$V = (4/3)\pi r^3 = (\pi/6)(c\hbar/kT)^3 \qquad (4)$$

For example, at T=293K, by using relations (2), (3), (4) we will receive following results:

$$\Delta t = 1.3 * 10^{-14}\ s,$$
$$r = 3.9 * 10^{-6}\ m,$$
$$V = 2.5 * 10^{-16}\ m^3$$

Volume V, calculated using the minimum sizes of ΔE, Δt, k on physical sense is the minimum macroscopic volume. The enclosed area by this volume is named macro cell in non–local version of thermodynamics. The macro cell can be considered as shortly living and special physical cluster, over the molecular level in hierarchy of macroscopic system.

Characteristic of a macro cell as a physical self–reliant object is that, on the one hand, it is the maximum microscopic volume and quantum mechanics laws apply to it, and on the other hand, is the minimum macroscopic volume, to which apply minimum classical definitions. Hereafter there is a possibility of simultaneous existence of Boltzman and Planck constants at macro level.

For example, in the new approach it has been shown that the ensemble of particles in a macro cell act as a unit and their collective speed at time Δt is $\upsilon = (kT/m)^{1/2}$. In other words, in non-local version of thermodynamics, balance is considered as dynamic resilient position and for its maintenance, function of certain forces is required which depend on temperature:

$$F_m = \pm \frac{m}{\Delta t}\sqrt{\frac{kT}{m}} \qquad (5)$$

It was on this basis that Ranque effect was described thermodynamically [2].

CALCULATION

For this purpose, we will start with some macroscopic elements in hydrodynamics. In the way that the macroscopic elementary stream will have the maximum section of a macro cell, the connected surface stream will have a thickness of 2r, where r is macro cell radius. Obviously, macroscopic the elementary stream will have a radius of R with the maximum section of a macro cell.

Let the ensemble of such elementary streams have a macroscopic and connected surface stream of width b and volume V=2brR, but the attached surface stream with N package will have such volume of V_p=2brRN.

The mass of surface package of stream is calculated from the following relation:

$$M=2brRN\rho \qquad (6)$$

where ρ indicates density, and N indicates the number of elementary surface vortex.

In a vortex tube, the centrifugal force arising in a macroscopic vortex (6) operates with angular speed ω:

$$F=M\omega^2R \qquad (7)$$

Force F as an external force acts on macro cell of non-local version of thermodynamics in which operates resilient force (5).

As a result, according to the non–local version of thermodynamics, the macro cell moves from one equilibrium to another dynamic equilibrium position, observing the equality of centrifugal force and resilient inertial forces in a macro cell.

At resilient equilibrium state of this position, the other macro cell will have a new temperature according to the relation (5).

Equating (5), (7) it results in:

$$M\omega^2R=\frac{m}{\Delta t}\sqrt{\frac{kT}{m}}\,.$$

Considering m=Vρ and (6) we will have:

$$2br\omega^2R^2N\rho^{1/2}=\frac{V}{\Delta t}\sqrt{\frac{kT}{V}}\,.$$

As $V=(4/3)\pi r^3$, $\Delta t=\hbar/2kT$, $r=c\hbar/2kT$, it is possible to have the following ratio:

$$b\omega^2R^2N\rho^{1/2}=aT \qquad (8)$$

here $a=\pi ck(2/3\pi c\hbar)^{1/2}=0.0337\ (m.J)^{3/2}/s.K$ (a collection of constants)

Thus, the right side of expression (8) only depends on temperature and some basic constants. Parameters in the left part depend on current vortex's radius R_i, and so we can write the following expression:

$$(\omega^2\, bR^2\, N\sqrt{\rho})_i=aT_i \qquad (9)$$

Later expressions (8), (9) are the main equations for describing the regime and structural effect of parameters of Ranque vortex tube, which are obtained exclusively based on macro quantum parameters.

One can easily analyze hydrodynamic vortex attached to the tube's internal wall. For this purpose we may use linear speed in tube's entrance of vortex tube's connector, which has been calculated on the basis of entrance section of connector tube's nozzle and specific efficiency $\upsilon=2\pi R\omega$.

Whence $\omega=\upsilon/2\pi R$ and finally, from relation (7) we will get:

$$\upsilon^2bN\rho^{1/2}=a'T \qquad (10)$$

here, $a'=4\pi^2a=1.3304\ (m.J)^{3/2}/s.K.$, i.e. in the condition of applying optional linear speed, entrance stream of Ranque effect is determined by dependent package bN and density ρ.

Amount of selection of cold (hot) stream should be considered separately. Selection affects hydrodynamic stream. So we will consider the linear speed at tube's wall equal to $\upsilon_R=2\pi R\omega_R$ and $\upsilon_i=2\pi R_i\omega_i$. Dividing υ_R on υ_i we'll have:

$$\upsilon_i=\upsilon_R(R_i/R)(\omega_i/\omega_R) \qquad (11)$$

The ratio of first relation decreases as the radius of vortex decreases, but the second ratio may increase which results in the decrease or increase of external stream's temperature. This naturally influences selection of hot stream.

Therefore, selection influence can lead to a minimum of external stream's temperature and a maximum of division efficiency. If we arrive at the conclusion that thermodynamic nature of all division processes is identical, optimum thermodynamic selection will have always an identical probability without any special restrictions, i.e. the ratio of selections of cold and hot streams should be equal. These facts have been proved by examinations.

Results and Discussions

The analysis of industrial cyclone devices "NIIOGaz" type 15–D×1YP by calculating various entrance parameters according to the obtained mathematical model (10) showed that for a regime, which its temperature has not exceeded its boiling point, just 3–12 macroscopic elementary vortexes of "solid-state" character are needed.

This analysis shows that in order to maintain required effect without exceeding boiling point, we just need to have kept a thin wall layer in dependent vortex of solid object. Such a state regarding solid object in the region of vortex tube in the Gutsol experimental work [3] has been considered based on high–speed filming.

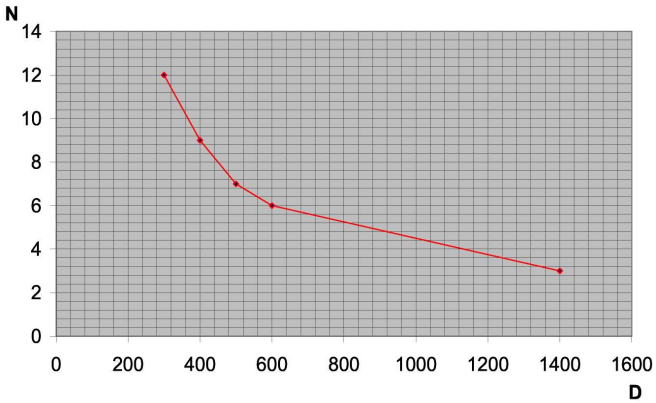


Figure 1. Changes of the number of macroscopic vortexes as compared to diameter of vortex tube for the (calculation) devices.

To analyze the mentioned method, experimental data of PhD thesis of doctorate student of Moscow State University of Engineering, M.A. Terekhov, which was done under supervision of Professor O.A. Troshkin [4], were used.

Researches were done on a Ranque tube with separable box's diameter of D=18mm; and length of L=125mm. The experimental stand was equipped by the modern measurement and control set of equipments and automation equipments and advanced integral software programs.

Of experimental data, all regime parameters, which are used in the formula (10), except the number of macroscopic elementary dependent vortex, are clear in the package N. Their number was calculated 16 with general thickness of 2rN=0.11mm.

For comparison it should be noted that in this experiment there are h/2r=513 dependent elementary macroscopic layer in the opening of entrance tube.

CONCLUSIONS

During processing of experimental data with various ratios of products it has been noticed that multiplication of υbN in the formula (10) changes unnoticeably by change of selection of product in the selection region of m=0.5.

According to this feature, thermodynamic method of the analysis of the vortex equipments was formulated, and following results were obtained accordingly:

1– On the basis of regime and structural parameters of vortex tube, the number of elementary macroscopic vortex for the regime of vortex tube N without exceeding of temperature from boiling point was calculated:

$$N=4\pi^2\, aT\rho^{3/4}\, bh^2/G^2$$

2– The analysis of the received result was carried out. There should be enough macroscopic vortexes so that the increase of vortex's width (b) when the stream enters the vortex tube, does not lead to decrease of wave to N<1. On the opposite, macroscopic vortex will transform to a microscopic state, which is the state of non-formation of stream's cooling effect. To avoid this state, we may increase N against what we did at first and change the regime and structural parameters of device.

3– Recommended radius of selection of hot stream with theoretical justification in m=0.5:

$$R_k=R-(1/2)\,h$$

4– We can estimate ideal of stream for macroscopic state by using information entropy of Shannon for two streams at the state of m=0.5:

$$\frac{T_{in}-T_C}{T_{in}}=\frac{\Delta T_C}{T_{in}}=H=$$
$$=-m\ln m-(1-m)\ln(1-m)=$$
$$=\ln 2=0.693.$$

5– Real efficiency of cooling could be estimated. For an analyzed vortex tube this size equals to $(\frac{\Delta T_c}{T_{in}})$ =0.0741. Hence, the coefficient of thermodynamic positive function will read: 0.0741/0.693= 0.107.

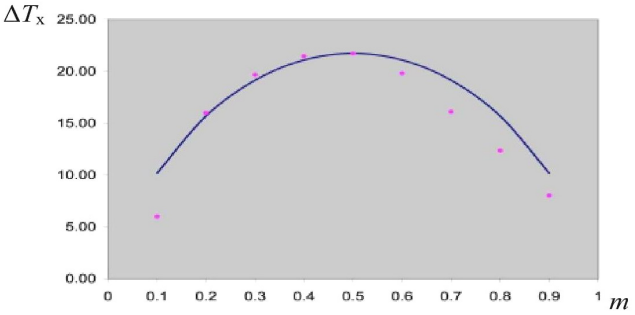


Fig.2. Comparison of the computational data with experimental data
Calculation —, Experiment • • • •
(T=293K, G=0,0032kg/s, P=168KPa)

As you see, the approach of thermodynamic calculation can be applied for other separator (dividing) systems [5].

Symbols. Subscripts

c – Velocity of light in vacuum, c =2.998108m/s
F_m - Inertial force in a macro cell, N
ħ – Planck's constant, ħ = $1.055*10^{-34}$ J.s
k – Boltzma's n constant, k = $1.381*10^{-23}$ J/K
m – Weight of a macro cell, kg
M – Molecular weight, kg/kmol
P – Pressure, N/m^2
R_i – Radius of a current whirlwind, m
r – Macro cell radius, m
T – Absolute temperature, K
Δt - The minimum macroscopical time scale, s
ρ – Density, kg/m^3
ω – Frequency (angular speed), 1/s
D (R) – Diameter (radius) of a vortex tube, m
L – Length, m
m – Relative (dimensionless) share of cold stream
Q – The volume expense, m^3/s
υ – Linear speed, m/s
V – Whirlwind volume, $м^3$
c – Cooled stream

REFERENCES

[1.] MAYKOV V.P., The expanded version of classical thermodynamics – physics of discrete space-time [in Russian], Moscow, 1997–160p.

[2.] KOROS NEKOFAR, Modeling of process of temperature division of gas (Ranque effect) on the basis of the expanded version of thermodynamics [in Russian]. PhD thesis, Moscow State University of Engineering Ecology, 2005.

[3.] GUTSOL A.F., The Ranque effect [in Russian]. Phys-Uspekhi 1997; 40(6):639-58.

[4.] TEREKHOV M. A., Efficiency of thermal processes and clearing of air of a dust in a vortex tube of a low pressure [in Russian]. PhD thesis, Moscow State University of Engineering Ecology, 2004.

[5.] BALUNOV A.I., MAYKOV V.P., Entropy and the information in the rectification theory [in Russian].// Chemistry and chemical technology. 2003, T.46, No.9, p.54-67.

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

copyright © UNIVERSITY POLITEHNICA TIMISOARA,
FACULTY OF ENGINEERING HUNEDOARA,
5, REVOLUTIEI, 331128, HUNEDOARA, ROMANIA
http://acta.fih.upt.ro

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome V (Year 2012). FASCICULE 3 [July–September]. ISSN 2067-3809

[1.] Igor LAZAREV, [2.] Karl KUZMAN, [3.] Jovan MICKOVSKI,
[4.] Jovan LAZAREV, [5.] Jasmina CALOSKA, [6.] Atanas KOCHOV

METAL MATRIX COMPOSITES AS TOOLS MATERIAL FOR THE DEEP DRAWING

[1.] ORBICO MAZIVA, PRVOMAJSKA STR. BB, SKOPJE, R .of MACEDONIA
[2.] FACULTY OF MECHANICAL ENGINEERING, UNIVERSITY OF LJUBLJANA, LJUBLJANA, SLOVENIA
[3.] FACULTY FOR TECHNOLOGY AND METALLURGY, UNIVERSITY "ST CYRIL AND METHODIUS", SKOPJE, R. of MACEDONIA
[4-6.] FACULTY OF MECHANICAL ENGINEERING, UNIVERSITY "ST. CYRIL AND METHODIUS", SKOPJE , R. of MACEDONIA

ABSTRACT: *In order to improve the strength and high-temperature properties of sintered iron, metal matrix iron- Alumina (Al_2O_3) composite material has been studied. In the present investigation, iron powder added by 0-8 Wgt % Al_2O_3 powder where selected for the study. Powders where mixed, compacted and subsequently sintered at 1150°C in laboratory tube furnace, under an endo gas atmosphere. Composite material properties were evaluated. The outcome results is that 4 vol % Al_2O_3 is the optimal percentage of the Alumina to obtain superior properties of the metal matrix composite. The deep drawing die and punch have been designed by using metal matrix composite and experimentally tested.*
KEYWORDS: *sintering, compressing, strength, hardness, tools*

INTRODUCTION

Sintered iron components are used for various commercial applications. However, inferior strength is a limitation of sintered straight iron powder metallurgy products in many applications. Therefore, it is very important to increase the strength of straight iron powder metallurgy products. There are references [1÷4] for sintered iron and iron-carbon premixes. However, sintering often is carried out in the relatively higher temperature. The purpose of the present investigation was to increase the strength of the sintered iron by incorporating ceramic particles and to obtain sintered materials at relatively lower temperature, than generally used in industry.

The Faculty of Mechanical Engineering in Skopje and Ljubljana have conducted project which is oriented to the usage of composite materials as materials for tool and die design and this material meets the requirements for mechanical properties to insure the strength of the tools for sheet metal forming.

The series of numerical and experimental analysis for defining the material characteristics have been performed to optimize the mechanical properties.

EXPERIMENTAL PROCEDURE

In order to define a composite material that will be most suitable for preparation of the working elements of the tools for deep drawing, which will have sufficient strength to withstand the pressure transmit the stresses of work, but will also have good properties of friction and lubrication, composites iron - alumina were examined (Fe-Al_2O_3).

Iron powder is product by Swedish company Hoganas. To determine the optimal composition of used materials for sintering technique and to obtain the maximal deformation strengthening behaviours of sintered iron-alumina composites was prepared different mixture.

Alumina and iron powder have been mixed by using a rotary mill regards of small portions of mixture (100 gr mixture). Then, in the mixed powders is added a certain quantity of polyvinyl chloride as a means of lubrication using laboratory mortar, to improve the plasticity of mixture for consolidation of shapes by pressing. Mixed material has been compacted into cylindrical shape (test pieces) with a diameter 12 mm and height about 15 mm by onsite uniaxial compressing in pressings tool (Fig.1). Compacting was curry out in a hydraulic press fabricated by Erichsen. For all five mixture are prepared test pieces by using four different compaction pressures of 200, 400, 600 and 800 MPa, with aim to determine the influence of pressure to green and sintered density and to optimising out coming sinter properties of pieces regards to straight and microstructure (optimal densification) of composite.

When the compressing and receiving process have been finished, compacts were placed in the furnace, for a very slow warm up to 100°C, hold 5 hours by this temperature and warm up to 200°C with 20 hours hold time, in order to dry and evaporate the polyvinyl chloride used as lubricator and bonding mean of the matrix and reinforcement. After drying and evaporation, weight measurement of test pieces was made, on the scales with an accuracy of 1 / 1000 grams and dimensional measurement with an accuracy of 1 / 100 mm.

The sintering of the green cylindrical compacts was carried out in a laboratory tube furnace (Fig.2),

equipped with tube made from stainless steel, with input and output of neutral and reduction gas furnace atmosphere. The sinter atmosphere coexist from 90% Nitrogen and 10% hydrogen.

Fig.1 - Tool for compacting of test pieces

The whole process is carried out during 5 hours and 40 minutes. The sintering was realized by heating 1 hour and 40 minutes to the required temperature 1150°C and hold time of 1 hour and ± 40 minutes at this temperature. Cooling was carried out gradually in the protective atmosphere of gases. When the temperature dropped to a temperature of 400°C, test pieces were left to cool to room temperature in the furnace, without the circulation of gases. If cooling is performed in air to temperatures up to 480°C, then the iron can oxidize.

Fig.2 - Sintering furnace

After sintering, dimensional and weight measurement was made. Then the hardness is measured by Rockwell method, use ball 1/16" and force of 100 daN

Composite hardness

The most important characteristic that should have composite, since the goal and purpose that he should have this investigation, applying for the processing tools, is the hardness and wear. The aim of this investigation is to determine the most appropriate composition of the composite in terms of representation of Al_2O_3, the pressure at which it should be compressed by forming and consolidation of tools for deep drawing. The influence of sintering temperature shout is investigated in future.

On the figure 3 can be seen that the composite containing 4% Al_2O_3 has the largest hardness and this is achieved at pressures 600 and 800 MPa. This is another proof that the iron composite containing 4% Al_2O_3 has the best characteristics compared to other composites.

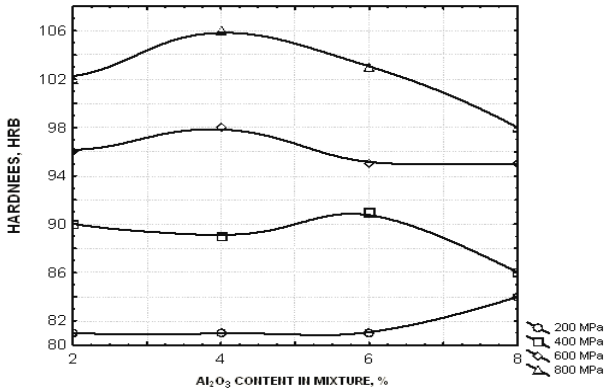


Fig.3 - Hardness diagram at iron composites depending by participation of Al_2O_3 and the compressing pressure

Microstructure

Metallographic images were made starting from 100% up to 92%Fe in mixture and for all pressures of the manufactured compact from 200 to 800 MPa, and analyze the structure of the compact. Figures 4 and 5 are showing metallographic some images of composite material with 100% Fe, compressed with pressure 200 and 600 MPa, and figures 6 and 7 show metallographic images of composite material of 96%Fe and 4 % Al_2O_3, during same pressures for compressing, as show of microstructure of pressing compacted and sintered specimens. All specimens are sintered on temperature of 1150°C in time of 45 minutes, as were pointed in advance.

Microstructure of sintered specimen's of pure Fe, show that is build bond between ferritic grains, with a amount of rest porosity, results from relative high forming porosity. The presence porosity show that the sintering temperature end time was not sufficient to obtain pore's free shape.

The build microstructure to specimen doped with Al_2O_3 show higher porosity as pure sintered Fe. The porosity increase with amount of added Al_2O_3. Fe grains are sintered in claster and between they are present Al_2O_3. Between Fe- and Al_2O_3 – grains are not enough close phase interface, which should be contribute to better mechanical properties of material, especialy to increasing of toughness. The added Al_2O_3 is isolated between Fe-grains or is depozited in pores. The present Al_2O_3 grains in the microstructure should be obstacle for free deforming of Fe grains, resulting to reinforcement of base Fe material coresponding to their hardness and deformation resistance. In the present microstructure, Al_2O_3 isolate grains could be contribute to satisfied mechanical properties of base Fe material for the goal of employment – as tools material for deep drawing. The presents of relative high porosity contributed to keep lubricant to surface of tools and drawing goods.

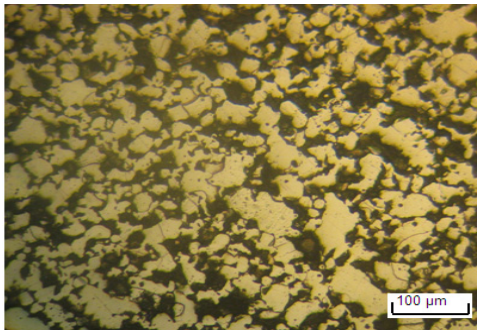


Fig.4 - Metallographic images of composite 100%Fe compressed by pressure of 200Mpa

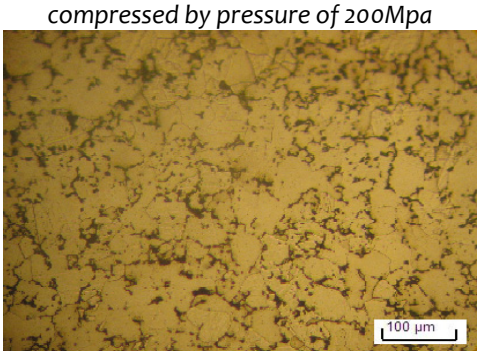


Fig.5 - Metallographic image of composite 100%Fe compressed by pressure of 600 MPa

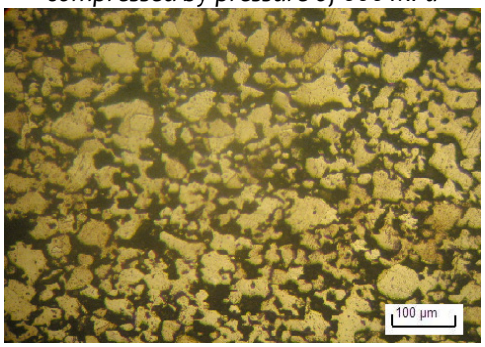


Fig.6 - 96%Fe-4% Al_2O_3, - 200 Mpa

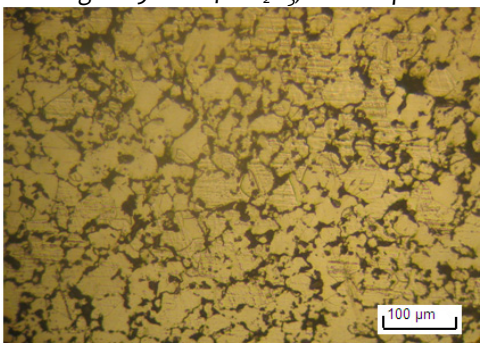


Fig.7 - 94% Fe- 4% Al_2O_3 – 600 Mpa

Deep Drawing Die Design

The goal of carry outer investigation, which same of results is presented in this paper, is to find the most suitable composite Fe-Al_2O_3, according to researches made and previously explained the optimal composite is presented below (Table 1).

Table 1. The most suitable composite Fe-Al_2O_3

Fe	Al_2O_3	Compressing pressure	Sintering temperature	Sintering time
96 %	4 %	600 MPa	1150°C	40 min.

This composite has the characteristics presented in Table 2.

Table 2. Characteristics of composite Fe-Al_2O_3

Green density	Sintered density	Strength during 10% strain	Hardness
6,03 g/cm^3	6,188 g/cm^3	200 N/mm^2	115-130 HRB

From this composite, two elements for deep drawing tool were made: die and blank holder for second draw (Fig. 9) for cylindrical deep drawn parts with a diameter of 50 mm in cylindrical part with diameter 35 mm.

For compressing of these parts from composite material, special tools are designed and manufactured. Images are shown on figure 8.

Fig. 8 - Compressing tool for die

a)

b)

Fig.9 - Blank holder (a) and die (b) manufactured by composite material 96%Fe and 4% Al_2O_3 compressed by pressure of 600MPa and sintered on temperature of 1150°C

The tool (the die and the blank holder) made of iron composite Fe-Al_2O_3 is used to deep drawn 105 pieces of low carbonic sheet metal. Figure 10 shows the drawn pieces including the die and the blank holder. The results are shown in form of a diagram in Figure 11.

The deep drawing was made of low carbonic sheet steel thick 1 mm. If we analyze the diagram in Figure 11 we can conclude that there is a difference in the strength of deep drawing. It is a result from the non-homogeneous structure of the cold rolled sheet metal. The strength at depth of deep drawing h_1=38 mm, which is the subject of the analysis is between the minimum 43 kN and the maximum 47 kN. If we consider the tendency of this strength we can state that it decreases by increasing the number of drawn pieces (Fig. 11). It is a result of self-polishing the surface due to the wear of the radius of the die.

Fig. 10 - The die, the blank holder and deep drawn pieces

Fig.11 - The tendency of decrease of the deep drawing strength in the second operaiton of deep drawing wiht tool Fe-Al_2O_3

The tool has successfully endured all the deep drawings without any damages. In addition to the batch of 105 pieces around 10 pieces of galvanized low carbonic sheet metal have been deep drawn as well.

CONCLUSIONS

In this paper is made a substitution of classical tool steels (OCR12, Mat. No. 1.2080, DIN X210Cr12) with composite material for the deep drawing tool, presenting innovation and contribution to the development of tools production.

Moreover the composite material was made of working elements of the deep drawing tool, blank holder and die for drawing of cylindrical parts for the second operation. Manufacturing the tool elements for the second operation of deep drawing process were chosen with the reason that they are with smaller size compared with the tools for fist draw. The powder material, iron and alumina were supplied from the Swedish company Hoganes.

First of all researches were made in order to determine which composition from the powder materials will create composite materials with the best mechanical characteristics (pressure strength and hardness). Mixed material is compressed in samples with a diameter 12 mm and height about 15 mm by compressing in specially developed tool. The compressing is performed on Erichsen hydraulic machine owned by the laboratory of Faculty for Mechanical Engineering in Skopje. For all 5 groups of mixtures, 4 compressing were made with different pressure of 200,400,600 and 800 MPa. The manufactured samples were drying and sintering in the dryer and sintering furnace in the laboratory of Faculty for Technology and Metallurgy in Skopje. Sintering furnace has a tube chamber with diameter of 80 mm. Sintering is performing in protective atmosphere with nitrogen and hydrogen. Sintering time after reaching temperature of 1150°C for samples is 40 minutes and for parts of tool is 1 hour and 20 minutes. Thus the sintering of the samples is achieving hardness of 96 HRB, and working elements of the tool to 120 HRB.

Investigation showed that the best mechanical characteristics were achieved with the composition of 4% Al2O3 and 96% iron power. In a view of pressure, the best results are achieving under pressure of 800 MPa, but because it is very high pressure, it is adopt working pressure of 600 MPa.

The company MK Mold DOO manufactured two tools for compressing die and blank holder. With this tools are manufactured two pieces of die and two pieces of the blank holder for drawing of cylindrical parts.

Given the porosity of composite material have better hold on characteristics for the lubricant thereby it reduces the forces and the friction stresses. Besides that it does not damage the surface of the deep drawn parts.

The strength of the deep drawing, shows a slight tendency of decrease depending on the number of deep drawn parts. It is a result from the fact that the die and the blank holder have been used directly following the compacting and sintering, with no additional mechanical processing. During the work due to gliding and attrition, there is self-polishing the surface of die.

ACKNOWLEDGEMENT

The project has been financed by:

- *Ministry of Education & Science of Rep. of Macedonia;*
- *Ministry of Height Education & Science of Rep. of Slovenia.*

REFERENCES

[1.] *J. Caloska, I. Lazarev, J. Lazarev, J. Mickoski: Metalni matricni kompoziti za izrabotka na alati otporni na abenje. Razvojno istrazuvacki proekt sofinansiran od Ministerstvoto za obrazovanie i nauka. Skopje, 2009 godina*

[2.] *Lazarev, K.Kuzman J. Mickovski, J.Lazarev, J.Caloska: Sintered Iron-Alumina Composites as tools material for the deep drawing. 3rd International Conference "Advanced Composite Materials Engineering "COMAT 2010. 27- 29 October 2010, Brasov, Romania*

[3.] *J.K. Mickovski, I.J. Lazarev, J. Lazarev, D. Stoevska-Gogovska: Microstructure case study of LENStm processed cilinder from AISI H13 steel. Journal for Technology of Plasticity, No 1-2, 2010, Novi Sad*

[4.] *S. K. Mukherjee, B. Cotterell and Y. W. Mai: Sintered iron-ceramic composites. Journal of Materials Science, Springer Netherlands, Volume 28, Number 3/ February, 1993*

[5.] *J. H. Schneibel, C. A. Carmichael, E. D. Specht and R. Subramanian: Liquid-phase sintered iron aluminide-ceramic composites. Metals and Ceramics Division, Oak Ridge National Laboratory, PO Box 2008, Oak Ridge, Tennessee 37831-6115, USA, 1996*

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome V (Year 2012). FASCICULE 3 [July–September]. ISSN 2067-3809

[1.]Georgeta Emilia MOCUȚA, [2.]Mihaela POPESCU, [3.]Ioan Dănuț DAN

THE BEST WAY OF WORKING SPACE ROBOT WHICH EQUIPS A FLEXIBLE MANUFACTURING CELL COMPONENT OF WELDED IN RAIL FIELD

[1-2.]POLITEHNICA UNIVERSITY OF TIMISOARA, ROMANIA
[3.] SOCIETATEA NAȚIONALĂ TRANSPORT FEROVIAR MARFĂ, "CFR MARFA"-SA SUCURSALA TIMISOARA, ROMANIA

ABSTRACT: *The industrial robot acts on its operating space under different shapes, namely by manipulating parts, by executing processing technological operations, by measuring specific parameters of products or even of the operating space etc. Many applications and functions performed by a robot reveal an essential characteristic, namely their versatility. Studying the movement of a robot consists of a single well-defined problem but a collection of several problems that are more or less than one other option. Exemplification was performed using MSC NASTRAN program.*
KEYWORDS: *industrial robot, operating space, movement of a robot, exemplification*

INTRODUCTION

The industrial robot acts on its operating space under different shapes, namely by manipulating parts, by executing processing technological operations, by measuring specific parameters of products or even of the operating space etc.

Many applications and functions performed by a robot reveal an essential characteristic, namely their versatility.

Versatility defined as the robot's physical ability to perform various functions and to take various actions in a given technological application is closely related to the structure and mechanical ability of the robot, which in turn determines the configuration of the robot workspace.

Since the workspace of a robot has geometry depending on components and structure of its mechanisms, in this space the characteristic point of the robot must execute motions on trajectories imposed by obstacles to avoid collision. In a first analysis of a robot working space should not be dealt with "obstacles" and can be utilized. "Obstacles" are operating in the area of warehouses or other exhaust retrofit devices of flexible robotic cell in which all components must interact.

Trajectory through "obstacles" can be chosen so that we can avoid collisions with maximum probability.

THE STUDY

Studying the movement of a robot consists of a single well-defined problem but a collection of several problems that are more or less than one other option.

The robot is becoming a more autonomous mechanical system that increases the need for automatic trajectory planning in its development.

The simplest planning problem assumes that the robot is only moving object in space which does not possess dynamic properties thus avoiding temporal problems.

It also considers that the robot does not come into contact with surrounding objects, thus avoiding problems of mechanical interaction.

These considerations turn the physical planning problem into a purely geometric problem.

Furthermore it is considered that the robot is only moving rigid solid which is limited only by the obstacles.

With these simplifications the basic problem of planning robot trajectories can be formulated as follows:

- *let's consider A a single solid or rigid (robot) that moves in a Euclidean space W, called workspace, represented by Rn, n = 2 or 3; it's movement is not limited by any restriction on kinematics.*
- *let's consider B1,...,Bq fixed rigid objects (obstacles) distributed in well defined positions in working space W;*
- *knowing the position and orientation, at baseline, the robot, and final finishing position and orientation of this workspace W, generate a path specifying a continuous sequence of positions and orientations of A starting from the initial configuration (position and orientation), avoiding the contact with obstacles Bj and finishing in the final configuration (position and orientation) final;*
- *if such a path does not exist, "error" must be reported.*

It is obvious that although the basic planning problem is super simplified it is still a difficult problem with many solutions and direct extensions to more complicated issues.

Objectively mobile object (the robot the characteristic point) in such a matter is referred to in the literature as "flying objects".

The basic problem involves the robot path planning through exactly the trajectory generated by the planner. It is also assumed that both the geometry and robotics as well as obstacles positions are known with precision. In reality no planning problem meets these assumptions. Moreover, they control their robots and geometric patterns are not precise. Since the robot has no a priori information about the

desktop, it must be based on runtime its sensory system for recording information necessary to achieve the task. It must work in exploring space and solve the problem of planning in the presence of uncertainties.
The problem is to calculate the trajectory generation based on data received from the motion planner sizes order to ensure passage of the robot through the established points.
Generation of movement can be made directly in the space coordinates kinematics couplings, or operational area.
Navigation strategy refers to determining how (methods) to move the robot according to the type of task performed.
Modelling space implies establishing navigation maps in the considered space.
Modelling methods known in literature are [1-5]:
- *uniform grid method;*
- *tree method;*
- *heterogeneous grid method;*
- *convex polygon method;*
- *method of crossing points.*

Evolution of the robot in the workspace imposes the statement that the space of configurations SC is intrinsically independent of the choice of reference systems SA and SW.
Trajectory planning problem in the presence of obstacles can be expressed as: given a workspace populated with obstacles known through their borders, and by moving objects, must determine a path without collisions with obstacles in bringing mobile objects in the final initial configuration.
The problem can be approached in two ways global or local, hence the two types of planning methods: global and local.
Application of global methods require complete knowledge of the working space "in advance", modelling proper clearance, research and selection of all possible paths of a certain trajectories corresponding to a minimum cost criterion. Such a method guarantees the existence or absence of a solution. Also global planning methods can be easily adapted to the off-line programming.
Applying a local method requires partial knowledge of the workspace.
Such a method does not guarantee reaching the final configuration, but the advantage of good real-time adjustments.
In both cases, solving the planning problem involves solving geometric problems (pure geometry) or combine geometry with kinematics and/or dynamics.
In such situations often are used the results of algorithmic geometry.
In general the application of planning methods must meet certain restrictions such as: the safest way, the shortest path, etc.

ANALYSES, DISCUSSIONS, APPROACHES AND INTERPRETATIONS

Analyzing the best methods in place of the theoretical and the application can highlight the road map method, exact cell decomposition method and the potential field method. Of these potential field method treats the robot represented as a point in configuration space, that as a particle under the influence of an artificial potential field U whose local variations reflects "structure" of the free space.
Potential function is defined as the amount of free space on an attractive potential, which attracts the robot toward the final configuration, and a repulsive potential, which removes the robot from obstacles.
The method was originally developed as an "on line" method to avoid collisions to be applied when there is no model of obstacles, in advance, but they may refer to during the execution of movement. In particular, the procedure can lock in a local minimum of potential function.
This deficiency can be corrected by calculating the finite element method applied to study a potential field.
Starting from the potential field finite element method we propose, as an effective tool for the analysis of optimum road space of the robot.
Thus we suggest that the workspace of a robot to be modelled as a homogenous body which is dependent on structure geometry of components and obstacles.
In this space to work tasks the robot must go through the obstacles imposed trajectories which it has to avoid.
The road through the obstacles can be chosen so that to avoid the maximum probability collisions. If we accept that two neighbouring obstacles behave as two sources of the same physical stationary field and consider that the moving of the characteristic point is carried on the same potential trajectory as that of the resulting field we can select a family of trajectories corresponding to a certain field potential in a given interval.
In the application illustrated in Figure 1 the working space was modelled as a homogeneous body with known thermal characteristics.

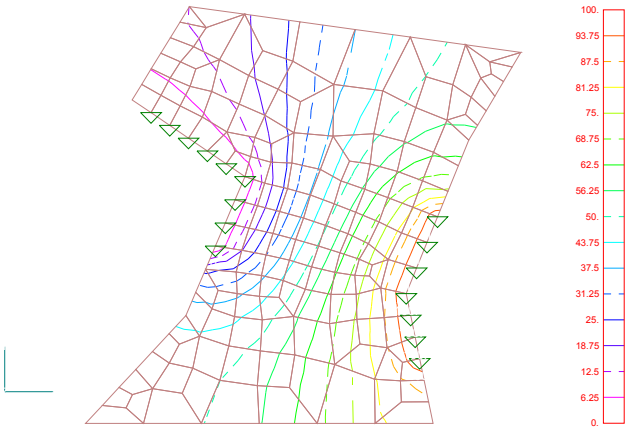


Figure 1 Thermal analysis of a working space modelled as homogeneous body found in a field where the heat source hot / cold data are boundaries of obstacles.

Obstacles are considered as being ,,hot" or "cold" areas/sources on the boundary of the considered working space as being a homogenous body on which a thermal field is applied from the hot/cold sources (modelled obstacles).
Applying the finite element method analysis facility on the thermal model workspace the outcome is isothermal surfaces. From these areas we can define

curves obtained by modelling which can be trajectories of the characteristic point.
Using the family of isothermal surfaces in the average temperature (resulting from thermal finite element analysis) on this can reside optimum trajectories to be passed.
So configurations libraries can be built-up for the working space and trajectories to pass, respectively located on the average temperature isothermal surface.
Illustrated in Figure 1 is a workspace of a robot modelled as homogeneous body found in a field where heat sources hot / cold data are borders of the obstacles that need to avoid in his motion.
Thermal finite element analysis on the isothermal model gives us the results. The treaty was exemplified in the plan but can be generalized in three-dimensional space. Most times one of the 3D motion parameters can be imposed by the kinematics couplings which controls programming. Applications can be treated and depending on who is involved in the process robot. The most complex situation is found in welding rail vehicle structures.

CONCLUSIONS

A key issue in the field of industrial robots operation (i.e. programming the optimal path of motion) enjoys the benefits of programs devoted to finite element analysis to allow for applying the "potential field method" as an analysis of a stationary thermal field.
Exemplification was performed using MSC NASTRAN program.

REFERENCES

[1.] Garbea D., Analiză cu elemente finite Editura Tehnică Bucuresti 1990
[2.] Hubner H. K., "Metoda Elementului Finit Pentru Ingineri" Departamentul de inginerie mecanică, Laboratorul de cercetari Genenral Motors, Wiley-Interscience, John Wiley&Sons, New York, London, Sydney, Toronto, 1990
[3.] Pires, J. N, Loureiro, A., Bölmsjo, G., Welding Robots - Technology, System Issues and Application, 1st Edition., 2006, XVIII, 180 p. 88 illus., Hardcover, ISBN: 978-1-85233-953-1
[4.] Staicu, S., Liu, X-J., Wang, J., Inverse dynamics of the HALF parallel manipulator with revolute actuators, Nonlinear Dynamics, Springer, 50, 1-2, pp. 1-12, 2007
[5.] Staicu,S., Zhang, D., A novel dynamic modelling approach for parallel mechanisms analysis, Robotics and Computer-Integrated Manufacturing, Elsevier, 24, 1, pp. 167-172, 2008

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

copyright © UNIVERSITY POLITEHNICA TIMISOARA,
FACULTY OF ENGINEERING HUNEDOARA,
5, REVOLUTIEI, 331128, HUNEDOARA, ROMANIA
http://acta.fih.upt.ro

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

copyright © UNIVERSITY POLITEHNICA TIMISOARA,
FACULTY OF ENGINEERING HUNEDOARA,
5, REVOLUTIEI, 331128, HUNEDOARA, ROMANIA
http://acta.fih.upt.ro

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome V (Year 2012). FASCICULE 3 [July–September]. ISSN 2067-3809

[1.] Martin PETRUF, [2.] Ján KOLESÁR

LOGISTIC AND ACQUISITION

[1-2.] TECHNICAL UNIVERSITY, FACULTY OF AERONAUTICS, DEPARTMENT OF AVIATION ENGINEERING, RAMPOVÁ 7, 041 21 KOŠICE, SLOVAKIA

ABSTRACT: *Acquisition of the most modern technical systems and their logistical support requires innovative approaches to be adopted in design, manufacturing and providing logistical services for their operation. The article aims to be a contribution to the acquisitional approach termed as CALS, i.e. to a modern, computer-based logistics. Integrated logistical support provided through electronization of design and operational documentation linked with standardization and continuous upgrade is yielding surprising benefits.*
KEYWORDS: *Logistics Support, Production's Logistics, Continued Acquisition, Life-Cycle, Logistical management, Simulted engineering*

INTRODUCTION

Long term aspect of life-cycle at complex and costly systems in aviation and defence industry is necessitating continuous and rapid solutions to economically demanding upgrades, modernization and innovation. All that requires knowledge of steady and more frequent and revolutionary facts from sciences and technology bound to growing need for computer technology, new information and testing technologies, etc.

Implementation of computer systems in logistics for modern trends in military and industrial branches is of vital importance, particularly for the purpose of obtaining higher quality (complex quality) from the aspect of system characteristics (readiness, performance, reliability, safety, viability for manufacturing, maintainability, availability, supportability, partial or overall modernization, recycling, etc....), both in view of the methods applied (concurrent engineering, limiting the variability of manufacturing and the like).

The CALS Initiative (Computer Aided Acquisition and Logistic Support)- was incepted in 1985 and starting with 1994 it has been meant as continuous acquisition and life cycle support as a means of integrated logistical support for complex technical systems [1].

THE CALS APPROACH AND PRODUCT ACQUISITION

Technologies based on CALS have been originally designed only for information support of logistics. Gradual development, mostly the increasing performance of information technologies caused CALS to transform into the means of informational support for research-manufacturing–operation and modern logistical support of complex technical systems (CTS) in all phases of the product life-cycle, starting with market research and ending with its liquidation. Interconnection of design of complex technical systems and their manufacturing through information technologies, i.e. Computer Aided Design (CAD), Computer Aided Manufacturing (CAM) is affected by rapid changes in modernization, facts that require comprehensive revision of the manufacturing processes and activities related to both acquisition and support of logistics.

The fundamental thing in managing CTS is management of logistics in terms of acquisition disciplines, directed in all the phases of the acquisition life-cycle. The complex effort is covered by the notion of integrated logistical support (ILS) and is continuously defining, projecting, upgrading and ensuring a comprehensive readiness support of the CTS throughout its entire life-cycle [2].

Fig. 1. Acquisition approach of the CALS

CALS is aimed to bring revolutionary changes in the fields of collecting, archiving and transfer of digital data as well as unification of information and testing technologies. Computer aided design and manufacturing enables replacement of drawing and copies by data modelling the new product to be manufactured taking the form of an integrated

database, which makes it possible to design and plan both manufacturing and logistical support in real time, involving production teams, further contractors and sub-contractors. There is thus an integrated Product Team - the IPT. Such approach is termed as Concurrent Engineering - CE, see illustration in Fig.1.

In practice, CALS involves organization of a joint information area supported by automated systems designed to ensure efficient solution of engineering problems and planning of company resources, as well as planning of manufacturing, remote approach to information and on-line solutions of supplier-and-customer relations, prognoses development and tasks of prediction. The joint integrated database features uniform and standard rules of generating, downloading, upgrading, searching and transferring information.

Administration of the joint data base is ensured by a system called PLM (Product Lifecycle Management), either serving as a comprehensive file of computerized systems such as CAE/CAD/CAM/PMD and ERP/CRM/SCM for development, design and integrated logistic support of CTS, or as an information system for a company facilitating interaction with other manufacturers.

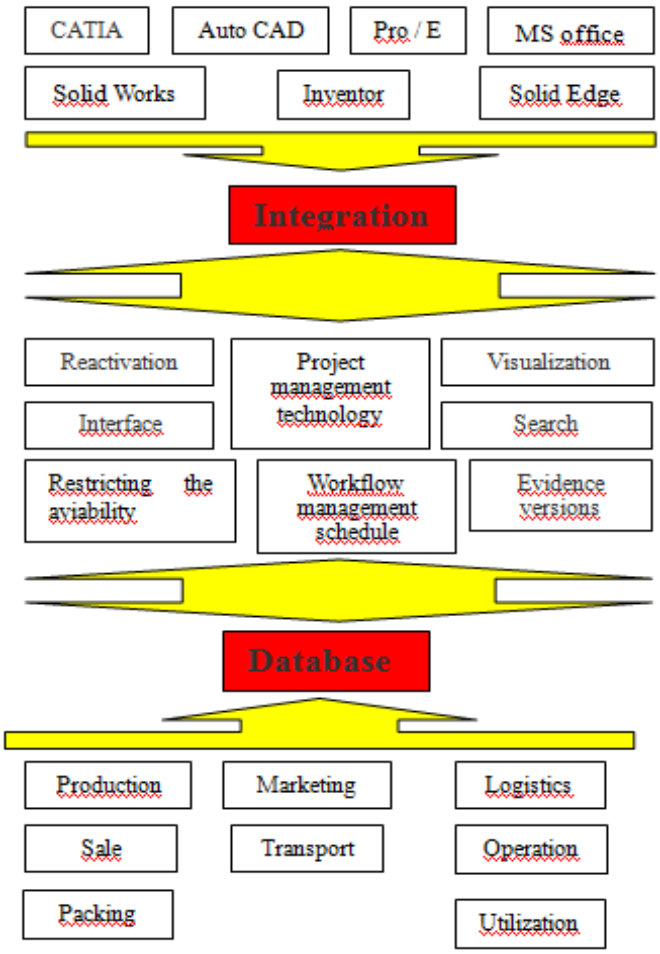


Fig. 2. System Smart Team

Currently from the PDM systems is the most famous ENOVIA and Smart Team (Dessault System), Teamcenter (Unigraphics Solutions), Winchill (PTC), my SAP PLM (SAP), Baan PDM (PDM), and Russian system Pilot: PLM (ASCON), PMD Step Suite (MO "Applied logistics), Party Plus (Pilot Software).

Dessault Systems Company a program based on ENOVIA PDM (Product Manager) integration modules CAD/CAM/CAE designed to simulate a product data management, processes and resources at different stages of life cycle – from conceptual design to disposal. The Smart Team is based on Interbase or Oracle with different visualizer – Fig. 2

PLM as a system – illustrated in Fig.3 forms fundaments of integrating the information area of industrial products and on the basis CALS, it enables interaction of a wide spectrum of manufacturers utilizing computerized systems.

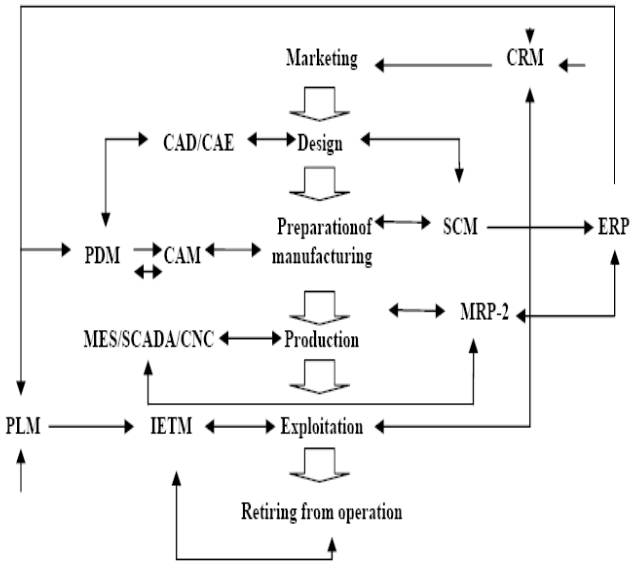


Fig. 3. Life cycle of industrial manufacturing and the computerized systems applied

Legend:

PLM – life-cycle management, PDM – management of system data, CAD –design, CAE – engineering, CAM – technology and manufacturing, CRM – customer data management , SCADA – dispatching management, MES – managing performances, SCM – managing the supply chain, ERP – company planning and management, CNC – computer based control of the machinery, MRP-2 – planning of production resources, ITEM – interactive electronic manuals.

The market success of the CTS without the CALS technology would be in these days a mission impossible. Standardized data formats of network servers enable rapid propagation of modern designs avoiding „reinventing the wheel". Such a modern approach to design and manufacturing of high-tech products consists of:

- applying computer and modern information technology in all phases of the product life-cycle,
- applying a unified methodology to process controlling,
- cooperating with the participants (manufacturers, contractors, operators ...) in compliance with the requirements set out by international standards regulating such interactions (electronic data exchange).

Implementation of the CALS should be integrated into the Contracts on delivery of CTS concluded between the manufacturer, contractor and the customer. Higher level of information integration is known as the „Joint CALS Program and the „ Joint Engineering Data Management of Information Control Systems – JED-MICS". Both are considered as revolutionary programs identifying a range of functional requirements for the logistical processes of the CTS, such as:

- Logistical support analysis / LSA /,
- Logistical support analysis recording / LSAR /, etc....,

or supporting the spare parts supply for the equipment repair processes.

LOGISTICAL SUPPORT TO MANUFACTURING AND OPERATION

The introduction of CALS for manufacturing and logistics was of key importance owing to its single and integrated databases equally suitable for the supplier, designer, technical manuals, trainers and logistic specialists as well. Existence of different databases designed and maintained on the part of the supplier and customer raises the need for standardization and cooperation. Then both parts of the logistics, acquisition and maintenance are fused into a single, integrated logistics, which starts before research and ends at retiring the item from operation. Most of the life-cycle phases, starting with choosing the suppliers of raw materials and components ending with selling the product require logistical support, i.e. controlling the supplier chain to increase the value added to the product, to decrease material demand and cut short the time of waiting for the product made ready. The more frequently used approach „ Make or Bay ", particularly at limited manufacturing capacities, or advantages in completion of standard parts. Most of the firms are developing specialized software and hardware for example - commerce and, either they are providing or using a joint information area, to provide services, ensure operation for building, manufacturing or delivery the products on order [4]. Design and manufacturing of CTS directly on order with re-defined parameters and specifications, when using CALS technology, enables minimizing time on cost per order. Coordination of the activities of all the partner companies making use of the internet and e-commerce, /electronic data Exchange/ known as the system of data administration /CPC/ integrated information area enables repeated use of identical project documentation in joint projects, an approach that substantially reduces the time of developing a new product, reduces the costs of the entire design and the cycle of manufacturing as well as simplifying functioning of the systems (Fig. 4).

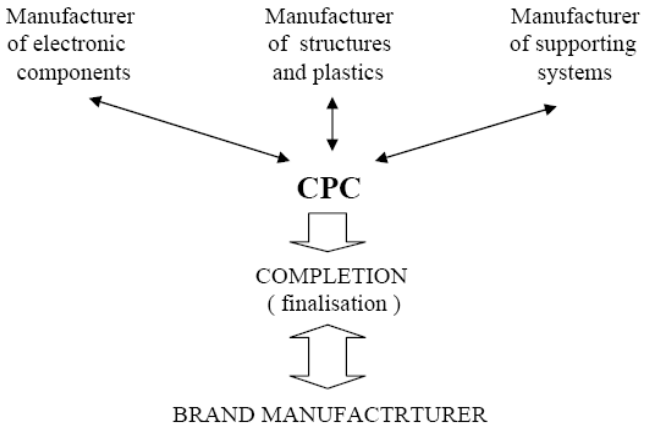


Fig. 4. Virtual company and interaction with subcontractors

MODERN LOGISTIC SYSTEM based on the CALS vision will be a system continuously upgraded and standardized. The standards must be applied in all the participating companies involved in the research, development and manufacturing of the CTS, on the basis of internationally accepted documents for the integrated logistical support. The synergic effect of implementing the CALS is remarkable and some of the sources declare:

- 30 - 40% acceleration in implementation of re-search and development,
- Up to 30% cuts in cost of purchasing new CTS,
- Up to 20% cuts in the time of purchasing and delivering spare parts,
- As much as the 9th multiple of reducing time needed for adaptation of projects [1],[5].

In view of the manufacturing, substantial in-crease in the quality of products, as much as 50% reduction of the time for development and preparation of manufacturing, increase in productivity by 75%, savings in inventory management by 60%, increasing return of investments by 70% and as high as 50% reduction in the services and stocks.

On introducing CALS, the savings presented can be even higher thanks to its function of maintenance and sub-function of testing, measurement and diagnostics (TDM – Test Measurement Diagnostic), which enable transition from the time-bound maintenance to maintenance by status quo. Furthermore, CALS is providing accelerated research and development of ZTS reducing the periods of 6 up 10 years down to 4 and rapid implementation of top-level technology into manufacturing processes. Researches centres of CALS

technology – „Applied logistics„ are in economically developed countries (USA, France, Germany, Russia, UK .....) are intensively dealing with research and implementation of software solutions for high-tech products and their in-formation support. Provision of logistical services for the implementation of solutions is conditioned by the joint approach of the participating companies at creating integrated information products and modern technology-based approaches.

INTEGRATED LOGISTICAL SUPPORT (ILP) is ensured by a set of Technologies focused on improving operational and technical features of products as well as on cutting life-cycle costs. For example, „Tupolev" by developing its operational documentation Tu – 204/214 to the international standard known as the ASD S 1000 D is managing its post-sale service and increasing its product competitiveness. Key component of this technology for monitoring technical status is in creating and maintaining electronic form for aircraft, automated data processing, using RFID components, etc. ..., what in their long run provides excellent reliability of aircraft manufactured and passenger safety. The first Russian aircraft designed by means of the CALS technology, including the digital analysis of logistical support (ALP) is the one known as the SSJ – 100, an aircraft entirely designed in digital environment, making extensive use of the CAD and PDM technologies.

CONCLUSIONS

Systems-based approach in developing integrated information systems in support of high-tech products and CTS throughout their entire life-cycle makes it necessary to adopt continuous improvements of concepts, in-depth study and development of CALS technologies. Knowledge of top-level products and procedures of the CALS enables high-speed configuration of the CTS, integrated logistical support and its analysis in all phases of the product life-cycle, re–engineering of company processes in research, manufacturing and operation of high-tech products. The system of PDM data administration plays a decisive role in an integrated in-formation environment and provides retrieves rationally structured data for product design, technology, manufacturing and operation as well as operation of realization of modern logistical support for complex technical systems. A new standard ASD S 3000 L is being prepared today with participation of world leaders in research of technologies. Certain modules for logistics and safety mostly in aviation technology are object of development conducted by the AVIS, a well established Slovak company.

REFERENCES

[1] PETRUF, M.: Logistika OS z pohľadu poznatkov v strojárske praxi špeciálnej techniky, výzbroje a materiálu. Trenčín: Transfér, 2004. 5strán.

[2] JAHELKA, K.: Kontinuálna akvizícia a podpora životného cyklu zbraňových systémov. Brno: Zborník VA Brno, 1996.

[3] MADARASZ,L.,BUČKO,M.,ANDOGA,R.: Integračné aspekty tvorby a prevádzky systémov CIM, TUKE FEI Košice, Elfa s.r.o., 2006

[4] MADARASZ,L.: Inteligentné technológie a ich aplikácia v zložitých systémoch, TUKE FEI Košice, University Press Elfa, 2004

[5] MALINDŽAK,D.: Výrobná logistika I.,TUKE F BERG Košice, Vydavateľstvo ŠTROFEK Košice, 1996

[6] KYSEĽOVÁ, K., CEHLÁR, M.: Economic characterization of raw material extration technological processes by computer. Košice : Acta Mettallurgica Slovaca, Roč. 9, č.1 (2003), s.55-62, ISSN 1335-1532

[7] www.cals.ru/collaboration/

[8] ru.wikipedia.org/wiki/CALS-technologie

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome V (Year 2012). FASCICULE 3 [July–September]. ISSN 2067-3809

[1.] Rajdeep BORGOHAIN

DATA HIDING TECHNIQUES USING NUMBER DECOMPOSITIONS

[1.] DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING, DIBRUGARH UNIVERSITY INSTITUTE OF ENGINEERING AND TECHNOLOGY, DIBRUGARH, INDIA

ABSTRACT: *Data hiding is the art of embedding data into digital media in a way such that the existence of data remains concealed from everyone except the intended recipient. In this paper, we discuss the various Least Significant Bit (LSB) data hiding techniques. We first look at the classical LSB data hiding technique and the method to embed secret data into cover media by bit manipulation. We also take a look at the data hiding technique by bit plane decomposition based on Fibonacci numbers. This method generates more bit planes which allows users to embed more data into the cover image without causing significant distortion. We also discuss the data hiding technique based on bit plane decomposition by prime numbers and natural numbers. These methods are based on mapping the sequence of image bit size to the decomposed bit number to hide the intended information. Finally we present a comparative analysis of these data hiding techniques.*
KEYWORDS: *Data Hiding, Least Significant Bit, Steganography, Steganalysis*

INTRODUCTION

Sharing of digital media is one of the main reasons for the boom of the internet. Users can share between them various information in digital format. But with the increasing threat of security [14] in the cyber world, it has become very important that any important information shared through these digital media be concealed in such a way that only the intended recipient will be able to retrieve the information. In this context data hiding in the form of steganography plays a very important role. The word steganography is derived from Greek which means "Concealed Writing" [15]. The intended data is embedded in an image in such a way that no one but the recipient can extract the hidden message.

For data hiding, the requirements [5] are:

- *A medium to hold the hidden information which is known as cover media.*
- *The secret message which the sender intends to embed within the cover media.*
- *A steganography function and its inverse.*
- *An optional key (stego-key) that is used to hide or unhide the data.*

For hiding the data, the cover media can be any one of the following digital media [6]:

- *Plain Text*
- *Digital Image*
- *Audio*
- *Video*
- *IP Datagram*

The process of hiding data, we first take the cover media which can be of any format as mentioned above.

After that we take the secret information which we want to hide in the cover media. The secret message can be in any form, plain text or cipher text or even other image file.

The cover media and secret message is then passed through a steganography function and the message is embedded in the cover media. We can also optionally use a key to hide the message and later decode it using the same key [13].

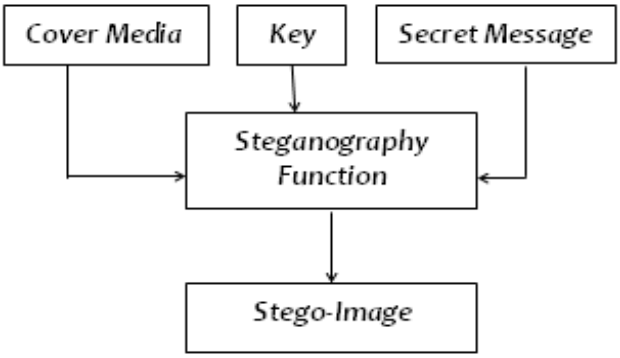


Figure 1. Steganography Process

For embedding data in digital media, two domains are generally considered, spatial domain [16, 21] and the transform domain [17, 22]. In the transform domain, the domains considered are Discrete Cosine Transform (DCT) [7], Discrete Fourier Transform (DFT) [23] and Discrete Wavelet Transform (DWT) [8].

Both the spatial and transform embedding scheme has to fulfill three requirements of visibility, robustness and capacity. Visibility is concerned with the fact that human observers should not be able to detect distortions due to the hidden message in the digital media. On the other hand, it is very important that once a secret message is inserted, it becomes impossible to delete or manipulate that message. This is the requirement for robustness. Moreover, the capacity of the digital media should be kept in consideration while inserting the message. These three factors are dependent on each other and a balance must be maintained between them as

increase in one of the factors leads to the decrease in other [9].

Though, there are many data hiding techniques [2, 3, 4], in this paper, we consider the spatial domain of data hiding. We discuss the various data hiding techniques using bit manipulation of the lowest significant bit (LSB). We take a look at how the bit planes can be increased by various number decomposition methods without compromising on the three requirements of visibility, robustness and capacity.

The rest of the paper is organized as follows. In Section 2 we take a look at the classical LSB data hiding technique. Here we discuss how secret text can be embedded in cover image using LSB manipulation. Section 3 of the paper contains the Fibonacci LSB data hiding technique. Section 4 of the paper contains the LSB data hiding technique using decomposition of prime numbers. The approach for decomposition using prime numbers is discussed here. Section 5 contains LSB data hiding by natural numbers. Here the decomposition of bit planes by natural numbers is discussed. In Section 6 we present a comparative analysis between the various LSB data hiding methods. Finally, in Section 7, we present the conclusion for the paper.

CLASSICAL LSB DATA HIDING TECHNIQUE

One of the simplest implementation of data hiding technique is the classical least significant bit data hiding technique [18]. The technique is based on manipulation of the least significant bits of the carrier image to accommodate the hidden message.

The insertion of LSB varies according to the number of bits in an image. For an 8 bit image, the value of 8^{th} bit, which is the least significant bit of each pixel, would be modified and the secret message would be embedded [19].

*Suppose if we wanted to insert the letter **'A'** into an image. The binary equivalent of **'A'** is 10000001. Now if our sample image of 8 bit has the following pixel values:*

10101010 10001010 11111111 010110101
10101010 10101010 10001011 10101111

*So, embedding the binary equivalent of **'A'** i.e. 10000001would change the pixel values of our sample image to:*

*1010101**0** 10001010 1111111**0** 0101101**0***
*10101010 10101010 1000101**0** 0101111*

In our sample image the least significant bit value of pixel 1, 3, 4 and 7 have been changed.

Similarly, for an image of 24 bit, we need to change the RGB (Red Blue Green) color values. Suppose our sample image has the following pixel values,

[10010101 10101010 11110101]
[10001001 10001110 10000010]
[11110101 01001010 10001011]

*So to accommodate our desired character, **'A'**, we have to make the following modifications:*

*[10010101 10101010 1111010**0**]*
*[1000100**0** 10001110 10000010]*
*[1111010**0** 01001010 10001011]*

So, basically we have changed the values of 3 bit to accommodate our desired character.

Though, classical data hiding is simple to implement, it is vulnerable to image manipulation [15].

LSB DATA HIDING USING FIBONACCI NUMBERS

Battisti et al. [1] proposed a method of embedding data into digital media by decomposition of Fibonacci number sequence which allowed different bit plane decomposition when compared to the classical LSB scheme.

The Fibonacci sequence, named after Leonardo of Pisa, also known as Fibonacci, is a sequence of numbers in the following integer sequence:

0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89 …

The Fibonacci numbers are defined by a recurrence relation:

$$F_p(0) = F_p(1) = 1$$

$$F_p(n) = F_p(n-1) + F_p(n-p-1), \ \forall n \geq 2, n \in N$$

The bit planes are now decomposed based on the Fibonacci sequence. The main drawback of this approach is that of redundancy and to counter that and obtain a unique representation, Zeckendorf theorem [20] is used.

To embed the intended message in the cover image, it is decomposed into bit planes by using Fibonacci p-decomposition. The Zeckendorf condition is checked for each bit to be modified. If the condition is fulfilled, the bit is inserted otherwise the bit following it is considered.

LSB DATA HIDING USING PRIME NUMBERS

LSB data hiding using prime numbers is a data hiding technique proposed by Dey et.al [10] as an improvement over the Fibonacci numbers data hiding technique proposed by Battisti et. al. The main idea of the work was to use the prime number decomposition and generate new set of bit planes and embed information in these newly generated bit planes with minimal distortion.

*In this approach, the researchers took an image of **m** bits and increased the number of bit planes to **n,** where the value of **n** was equal or greater than or equal to the number of bit planes of the image. This was achieved by converting the bit planes of the image to another number system using prime numbers as the weighted function. This resulted in the increase of number of bits and consequently it could be used for hiding data in higher bit planes with minimal distortion.*

For decomposition, the weight function was defined as:

$$P(o) = 1,\ P(i) = p_i\ \forall i \in Z^+,\ p_i = i^{th}\ Prime$$

In case of any ambiguity, the lexicographically higher number is given preference.

For embedding the data in the image, a number n is chosen in such a way that all possible pixel values in the range of $[0, 2^k - 1]$ could be represented using first **n** prime number, so that **n** virtual are achieved after the decomposition.

The value of **n** can be found out by the formula,

$$\sum_{i+o}^{n-1} p_i \geq 2^k - 1$$

After finding the prime numbers, a k-bit to n-bit sequence is mapped, marking all the valid prime number in the system. Now, for each pixel of the image, a virtual bit plane is chosen and secret data is embedded is by modifying the corresponding virtual bit plane by the desired information bit by bit. If the resulting sequence of data after embedding the data matches the k-bit to n-bit mapping, the bits are kept otherwise it is discarded. After insertion of the hidden data, the resultant prime number system is converted back to the original binary system and the stego-image is achieved.

For extraction, each pixel with the hidden information is converted into prime decomposition and from those bit planes, the secret message is extracted. All the bits are combined together to get the final message.

LSB DATA HIDING USING NATURAL NUMBERS

The approach of LSB data hiding by natural numbers was proposed by Dey et.al [11]. In this approach, the researchers proposed data hiding by decomposition of a pixel value in sum of natural numbers. This resulted in generation of more bit planes than the Classical LSB data hiding, Fibonacci LSB data hiding and the Prime number data hiding [10].

For decomposition, the weight function is defined as:

$$W(i) = N(i) = i + 1,\ \forall I \in Z^+ \cup \{0\}$$

The researchers used the same concept in case of ambiguity which gave higher precedence to lexicographically higher number.

For embedding the data into the k-bit image, a number **n** is chosen in a way such that all pixel values in the range of $[0, 2^k - 1]$ could be represented using first n numbers, which resulted in generation of **n** virtual bit planes .

The value of **n** can be found out by the formula,

$$n \geq \frac{-1 \pm \sqrt{2^{k+3} + 9}}{2}$$

After finding the value of n, a k-bit to n-bit map is created and all valid representations in natural numbers system are marked. Now, for each pixel a virtual bit plane is chosen and the secret data is embedded. If the virtual bit plane matches the mapping system, the hidden data is kept otherwise it is discarded. After insertion of the secret message, the natural number system is converted back to its original binary form and the stego-image is achieved.

To extract the message from the stego-image, all the pixels with embedded data bit are converted to the natural number decomposition, and the secret message bits are extracted. Finally, all bits are combined together to get the embedded hidden message.

COMPARISON OF LSB DATA HIDING TECHNIQUES

In the previous section, we have looked at the various techniques for data hiding using number decomposition. Here, we present a comparative analysis between the various data hiding techniques using number decomposition.

Table 1. Technique used in LSB data hiding

Classical LSB	Classical LSB data hiding uses the simplest approach. In classical LSB data hiding, the least significant bit of a pixel is manipulated in order to embed the desired image.
Fibonacci Technique	In Fibonacci approach, the bit planes are decomposed so as to generate more bit planes and then the secret message is embedded on following the Zeckendorf theorem.
LSB data hiding by prime numbers	In LSB data hiding using prime numbers, the bit planes are decomposed by using sum of prime numbers. After that the secret message is embedded lexicographically.
LSB data hiding by natural numbers	In LSB data hiding using natural numbers, the bit planes are decomposed by using sum of natural numbers. Here also the secret message is embedded lexicographically.

Table 2. Embedding Techniques used in LSB data hiding

Classical LSB	Data are inserted in the least significant bit of the cover image.
Fibonacci Technique	Technique uses Fibonacci P-sequence for generation of bit planes and data is inserted if it passes the Zeckendorf condition.
LSB data hiding by prime numbers	A k-bit to n-bit map is created where the value of n is, $\sum_{i+o}^{n-1} p_i \geq 2^k - 1$ Data is inserted bit by bit matching the k-bit to n-bit mapping sequence.
LSB data hiding by natural numbers	A k-bit to n-bit map is created where the value of n is, $n \geq \frac{-1 \pm \sqrt{2^{k+3} + 9}}{2}$ Data is inserted bit by bit matching the k-bit to n-bit mapping sequence.

Table 3. Weight functions

Classical LSB	The least significant bit of the image pixel is manipulated. In case of 8 bit image it is the 8^{th} bit of each byte. For 24 bit image the RGB color code are changed [12].
Fibonacci Technique	$F_p(0) = F_p(1) = 1$ $F_p(n) = F_p(n-1) + F_p(n-p-1)$, $\forall n \geq 2, n \in N$
LSB data hiding by prime numbers	$P(0) = 1$, $P(i) = p_i \ \forall i \in Z^+$, $p_i = i^{th}$ Prime
LSB data hiding by natural numbers	$W(i) = N(i) = i + 1, \ \forall I \in Z^+ \cup \{0\}$

Table 4. Number of bit planes generated

Classical LSB	8 bit planes using gray scale 8bit Lena image.
Fibonacci Technique	12 bit planes using gray scale 8bit Lena image.
LSB data hiding by prime numbers	15 bit planes using gray scale 8bit Lena image.
LSB data hiding by natural numbers	23 bit planes using gray scale 8bit Lena image.

CONCLUSIONS

In this paper, we looked at the different approaches of the spatial data hiding techniques using Least Significant Bit manipulation.

We discussed about the classical LSB data hiding technique which is based on manipulation of the least significant bit. We took a further look at the different number decomposition techniques by which more bit planes could be generated to conceal more data without causing significant distortion.

By comparative analysis, we could see that among the data hiding techniques, decomposition using natural numbers yielded the highest number of bit planes which was 23. This was followed by 15, 12 and 8 bit of Prime number technique [11], Fibonacci Technique and Classical LSB technique respectively.

Finally we can say that in this era of internet where there is increasing use of digital format to send valuable information and data, steganography will play a very important role in the days to come.

REFERENCES

[1.] F. Battisti, M. Carli, A. Neri, K. Egiaziarian, "A Generalized Fibonacci LSB Data Hiding Technique, 3rd International Conference on Computers and Devices for Communication (CODEC-06), Institute of Radio Physics and Electronics, University of Calcutta, December 18-20, 2006.

[2.] Aruna Ambalavanan and Rajarathnam Chandramouli "A Bayesian Image Steganalysis approach to estimate the embedded secret message," International Multimedia Conference, Proceedings of the 7th Workshop on Multimedia and Security, ACM Press, New York, USA, 2005, pp. 33 –38.

[3.] Liu Shaohui, Yao Hongxun, Gao Wen, "Neural network based steganalysis in still images," Proceedings of the 2003 International Conference on Multimedia and Expo (ICME 2003), vol.2, July 2003, pp. II – 509–512.

[4.] Patricia Lafferty, Farid Ahmed "Texture-based steganalysis: results for color images," Proceedings of the SPIE Mathematics of Data/Image Coding, Compression, and Encryption VII, with Applications, vol. 5561, 2004, pp. 145 – 151.

[5.] Steganographic Techniques and their use in an Open-Systems Environment-Bret Dunbar, The Information Security Reading Room, SANS Institute 2002, http://www.sans.org/readingroom/whitepapers/covert/677.php

[6.] Steganography Primer - Ruid, Computer Academic underground,2004,http://www.dustintrammell.com/presentations/Steganography-Primer.pdf

[7.] J. R. Hernandez, J. M. Rodr´ıguez, and F. P´erez-Gonz´alez, "Improving the performance of spatial watermarking of images using channel coding," Signal Process. 80(7), pp. 1261–1279, 2000.

[8.] F. Battisti, K. Egiazarian, M. Carli, and A.Neri, "Data hiding based on Fibonacci-Haar transform," in Mobile Multimedia/Image Processing for Military and Security Applications, SPIE Defense and Security, Vol. 6579, May 2007.

[9.] E. Mammia, F. Battisti, M. Carlia, A. Neria, and K. Egiazarianb, "A novel spatial data hiding scheme based on generalized Fibonacci sequences", Mobile Multimedia/Image Processing, Security, and Applications 2008, Proceedings. of SPIE ,Vol. 6982 69820C, (2008)

[10.] Sandipan Dey, Ajith Abraham and Sugata Sanyal "An LSB Data Hiding Technique Using Prime Numbers", Third International Symposium on Information Assurance and Security, August 29-31, 2007, Manchester, United Kingdom, IEEE Computer Society press, USA, ISBN 0-7695-2876-7, pp. 101-106, 2007.

[11.] Sandipan Dey, Ajith Abraham and Sugata Sanyal "An LSB Data Hiding Technique Using Natural Numbers", IEEE Third International Conference on Intelligent Information Hiding and Multimedia Signal Processing, IIHMSP 2007, Nov 26-28, 2007, Kaohsiung City, Taiwan, IEEE Computer Society press, USA, ISBN 0-7695-2994-1, pp. 473-476, 2007.

[12.] Nani Koduri, "Information Security through Image Steganography using Least Significant Bit Algorithm", Master's Thesis, Information Security and Computer Forensics, University of East London.
[13.] Soumyendu Das, Subhendu Das, Bijoy Bandyopadhyay and Sugata Sanyal, "Steganography and Steganalysis: Different Approaches", International Journal of Computers, Information Technology and Engineering (IJCITAE), Vol. 2, No 1, June, 2008, Serial Publications.
[14.] Dhaval Gada, Rajat Gogri, Punit Rathod, Zalak Dedhia, Nirali Mody, Sugata Sanyal and Ajith Abraham, "A Distributed Security Scheme for Ad Hoc Networks", ACM Crossroads, Special Issue on Computer Security. Volume 11, No. 1, September, 2004, pp. 1-17.
[15.] Neil F. Johnson and Sushil Jajodia, "Exploring steganography: seeing the unseen," IEEE Computer 31(2), pp. 26-34, 1998.
[16.] Jessica Fridrich and Miroslav Goljan, "On estimation of secret message length in LSB steganography in spatial domain," in Security, Steganography, and Watermarking of Multimedia Contents VI, Proceedings of SPIE 5306, pp. 23-34, 2004.
[17.] Guorong Xuan, Yun Q. Shi, Zhicheng Ni, "Reversible data hiding using integer wavelet transform and companding technique," IWDW04, Korea, October 2004.
[18.] Chi-Kwong Chan and L. M. Cheng, "Hiding data in images by simple LSB substitution," Pattern Recognition, pp. 469–474, Mar. 2004.
[19.] Walter Bender, Daniel Gruhl, Norishighe Morimoto, and A. Lu, "Techniques for data hiding." I.B.M. Systems Journal, vol. 35, no. 3 & 4, pp. 313{336, 1996.
[20.] Verner E. Jr. Hoggatt, "Fibonacci and Lucas Numbers," The Fibonacci Association, Santa Clara, California, USA, 1972.
[21.] Raymond B. Wolfgang and Edward J. Delp, "A watermarking technique for digital imagery: further studies." In International Conference on Imaging, Systems, and Technology, pp. 279{287, IEEE, Las Vegas, Nevada, U.S.A., 30 Jun, 1997
[22.] Mauro Barni, Franco Bartolini, Vito Cappellini,Alessandro Piva(1998), "A DCT-domain system for robust image watermarking", Signal Processing, Vol. 66 (1998), pp.357–372.
[23.] Nabin Ghoshal , Jyostna Kumar Mandal, "A Novel Technique for Image Authentication in Frequency Domain using Discrete Fourier Transformation Technique", Malaysian Journal of Computer Science, ISSN 0127-9094, Vol. 21, No. 1, pp. 24-32, 2008.

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

copyright © UNIVERSITY POLITEHNICA TIMISOARA,
FACULTY OF ENGINEERING HUNEDOARA,
5, REVOLUTIEI, 331128, HUNEDOARA, ROMANIA
http://acta.fih.upt.ro

Scientific Events in 2012

1. THE 20th ANNUAL INTERNATIONAL CONFERENCE ON COMPOSITES, NANO OR METALS ENGINEERING – ICCE-20
22–28 July 2012, Beijing, CHINA

The ICCE conference is unique in that while it is an engineering conference, it has attracted numerous chemists, physicists and scientists from diverse fields in our efforts to promote interdisciplinary research on composites. Of particular concern is the challenge for materials engineers to understand the wide diversity of length scales ranging from nano to micro to macro and full scale and to question the validity of the theories or models which are known to be valid only in certain length scales. The ICCE is among the first composite materials conferences which take a leading vital role to bridge the gap between nano-chemistry and nano-engineering and attracted hundreds of papers in this existing relatively new field of nano-composites engineering.
The ICCE conference will provide a forum for the exchange of information and ideas in virtually all areas composite materials research. The goals of the ICCE conference are:
- *To BRIDGE THE GAP between Materials Science, Mechanics and manufacturing of Composite Materials;*
- *To ENCOURAGE INTERDISCIPLINARY research bridging the gap between aerospace technology, bio-materials, chemistry, electronics, fluid mechanics, infrastructures, magnetic materials, nanotechnology, physics, powder metallurgy, sensors/actuators, among others and*
- *To ENCOURAGE LEVERAGING of composite materials research resources through joint research between participants and writing joint research proposals.*

Detailed informations here: www.icce-nano.org

2. THE 6th INTERNATIONAL CONFERENCE ON INDUSTRIAL ENGINEERING AND MANAGEMENT – IEM2012
10–12 August, 2012, Zhengzhou, CHINA

You are invited to submit papers in all areas of Industrial Engineering and Management. All papers accepted will be indexed by Ei Compendex and ISTP.
Manufacturers and developers of equipment, components, software and services complementing the topics of the conference are invited to display their state-of-the-art products. The exhibition will be placed in the conference area. For further information, potential exhibitors can contact with email: iciem2012@163.com.
Detailed informations here: http://www.ieee-iciem.org

3. THE 9th INTERNATIONAL CONGRESS "MACHINES, TECHNOLOGIES, MATERIALS - INNOVATIONS FOR THE INDUSTRY" – MTM'12
19–21 September, 2012, Varna, BULGARIA

We invite you to take part in the 9th International Congress "Machines, Technologies, Materials - Innovations for the Industry", which will be held from 19th till 21st September 2012 again in hotel "Aqua Azur" in the sea resort "St. Konstantin and Elena", region Varna, as a comprehensive scientific-technical manifestation, which includes three main topics. The Congress program includes also five special congress sub-sections which previously were held separately.
We believe that and this time the Congress will be a successful international forum in the field of engineering science. We hope that in this way the Congress MTM'12 will become a bigger innovation mediator between scientific research and industry and we offer you to take advantage of this opportunity. We believe that you will take this opportunity and contribute to the success of the Congress with your researches and experience.
We would be very grateful to you if you recommend MTM'12 to colleagues of yours, from your country and abroad, who might have scientific and practical interests in the thematic area of the Congress.
Short information about the Congress you may find in the attached file and detailed information is available on http://mech-ing.com/mtm/

4. THE 4th INTERNATIONAL CONFERENCE ON MATERIALS SCIENCE AND TECHNOLOGIES – ROMAT 2012
17–19 October, 2012, Bucuresti, ROMANIA

On behalf of the Organizing Committee, we are honored to invite you to participate and submit a paper at the 4-th INTERNATIONAL CONFERENCE ON MATERIALS SCIENCE AND TECHNOLOGIES – ROMAT 2012 organized by POLITEHNICA University of Bucharest - Materials Science and Engineering Faculty in association with Bucharest Chamber of Commerce and Industry.
We are convinced that your presence will particularly contribute to a high level of the conference and it is an occasion to achieve an efficient idea and information exchanges for further development of this field.
Detailed informations here: http://www.romat2012.eu/

5. FEDERATED CONFERENCE ON COMPUTER SCIENCE AND INFORMATION SYSTEMS – FedCSIS 2012
9–12 September, 2012, Wrocław, POLAND

The 2012 Federated Conference on Computer Science and Information Systems cordially invites you to consider contributing an Event (conference, symposium, workshop, consortium meeting, and special session).
Each Event may run over any span of time within the conference dates (from half-day to three days). The FedCSIS Events provide a platform for bringing together researchers, practitioners, and academia to present and discuss ideas, challenges and potential solutions on established or emerging topics related to research and practice in computer science and information systems.
The FedCSIS Events provide a platform for bringing together researchers, practitioners, and academia to present and discuss ideas, challenges, and potential solutions on established or emerging topics related to research and practice in computer science and information systems.
The Events will be selected based on the scientific/technical interest and/or their relevance to practitioners in their topics, the clarity of the proposal in addressing the requested information, the innovativeness of the Event topics, and the capacity in the FedCSIS multi-conference program.
Detailed informations here: http://www.fedcsis.org/

6. THE 5th INTERNATIONAL CONFERENCE ON MASS CUSTOMIZATION AND PERSONALIZATION IN CENTRAL EUROPE (MCP – CE 2012) – CUSTOMER CO-CREATION IN CENTRAL EUROPE
19 – 21 September, 2012, Novi Sad, SERBIA

On behalf of the Organizational Board and Scientific Committee of the 5th International Conference on Mass Customization and Personalization in Central Europe (MCP – CE 2012), we cordially invite you to participate and to share your research ideas, efforts and results with other scientists, entrepreneurs and corporate managers, dedicated to the idea of Mass Customization and Personalization.
Organized for the fifth time, the biannual MCP-CE conference would like to emphasize the role and importance of Customer Co-Creation that offers customers a chance to express their differences, and also an opportunity for innovations and new business models such as MC and Open Innovation platforms, for sharing designs and developments and benefits from the experiences of others.
Detailed informations here: http://www.mcp-ce.org/

7. THE 18th EUNICE CONFERENCE ON INFORMATION AND COMMUNICATIONS TECHNOLOGIES
29–31 August, 2012, Budapest, HUNGARY

The aim of the annual EUNICE conference is to provide a forum that brings together young researchers and scientist from Europe and neighboring regions to meet and exchange ideas and recent works on all aspect of information and communication technologies.
For any additional information please consult the conference website: http://tmit.bme.hu/eunice2012

8. MACHINE-BUILDING AND TECHNOSPHERE OF THE XXI CENTURY
17 – 22 September, 2012, Sevastopol, UKRAINE

International Union of Machine-Builders, Donetsk National Technical University and a number of leading companies of Ukraine, Russia, Belarus, Romania, Poland and other countries will host the XIX international science and engineering conference MACHINE-BUILDING AND TECHNOSPHERE OF THE XXI CENTURY taking place in the city of Sevastopol on September 17-22nd 2012.
The aim of the conference is to exchange the science and engineering information, define new engineering and technologies development and creation forward-looking ways develop joint research programmes, establish business contacts and commercial links in this area.
Detailed informations here: http://donntu.edu.ua/ukr/7/konf/sevastopol/about.htm

9. INTERNATIONAL CONFERENCE on MATHEMATICAL MODELING IN PHYSICAL SCIENCES – IC-MSQUARE 2012
3 – 7 September, 2012, Budapest, HUNGARY

The conference aims to promote the knowledge and the development of high-quality research in mathematical fields that have to do with the applications of other scientific fields and the modern technological trends that appear in them, these fields being those of Physics, Chemistry, Biology, Medicine, Economics, Sociology, Environmental sciences etc. Some of the main topics are:

- *mathematical modeling in Fundamental Physics: e.g. high-energy physics, particle physics, nuclear, atomic, and molecular physics, gravitation, cosmology, astrophysics, plasma physics, electrodynamics, fluid dynamics, condensed-matter physics, chemical physics, chaos, statistical mechanics etc.*
- *evolutionary computation (Genetic algorithms, Evolutionary programming, Eagle strategy, Swarm intelligence, Ant colony optimization, Particle swarm optimization, Differential evolution etc.)*
- *mathematical methods and tools for modeling complex physical and technical systems*
- *software and computer complexes for experimental data processing*
- *methods, algorithms, and software of computer algebra*
- *computational chemistry, biology, and biophysics*
- *new generation computing tools, distributed scientific computing*
- *efficient solvers and nonlinear problems, computational modeling in engineering and science*
- *multiscale modeling, multiphysics modeling*
- *progress in discretization methods*

Conference organizers are supporting educational actions during the Conference meeting.
You may find details of the Conference visiting the Conference website at http://www.icmsquare.net

10. 11th INTERNATIONAL SCIENTIFIC CONFERENCE – MMA 2012 – ADVANCED PRODUCTION TECHNOLOGIES
20 – 21 September, 2012, Novi Sad, SERBIA

Chair for Metrology, Quality, Fixtures, Tools and Environmental Aspects, Chair for machine tools, technological processes, flexible technological systems and design processes and Chair for Metal Cutting Technologies, within the Department for Production Engineering, at Faculty of Technical Sciences in Novi Sad, organize 11th International Scientific Conference MMA 2012 under the motto ADVANCED PRODUCTION TECHNOLOGIES.
By continuing 33-years tradition of the Conference, it is expected that presented results from the scientific institutions, as well as from the industrial research departments will contribute to the further development of production processes in the metal industry. We hereby extend this call to all researchers, scientific workers and industry professionals to contribute to the International Scientific Conference MMA 2012 by submitting scientific papers, and to the affirmation of production engineering in the region by active participation in its work.
The Conference shall be held from September 20-21, 2012 in Novi Sad, at the Faculty of Technical Sciences, Trg Dositeja Obradovica 6, Serbia. Information about the programme committee, the organization committee, and other information related to the MMA 2012 conference, can be found on http://www.ftn.uns.ac.rs/mma2012

11. 4th INTERNATIONAL SCIENTIFIC AND EXPERT CONFERENCE – TEAM 2012 (Technique, Education, Agriculture & Management)
17 – 19 October, 2012, Slavonski Brod, CROATIA

The International TEAM Society in cooperation with Mechanical Engineering Faculty in Slavonski Brod – Josip Juraj Strossmayer University of Osijek, is honored to invite you to the 4th International Scientific and Expert Conference TEAM 2012. The conference will provide an open forum for scholar students, academicians, researchers or scientists and insure the exchange of experiences and research results on various aspects and application areas. Conference also gives an excellent opportunity to establish useful professional and research contacts with foreign colleagues and begin a common cooperation between universities and research centers.
Aim and Scope of the conference: Transfer of Knowledge and Dissemination of Achievements Mobility of Teachers and International Cooperation Interdisciplinary Approach on Development
You may find details of the Conference visiting the Conference website at http://team2012.sfsb.hr

12. 1st INTERNATIONAL SCIENTIFIC CONFERENCE – COMETa 2012 – CONFERENCE on MECHANICAL ENGINEERING TECHNOLOGIES AND APPLICATIONS
28 – 30 November, 2012, Jahorina, BOSNIA&HERZEGOVINA

Faculty of Mechanical Engineering University of East Sarajevo initiates first international conference COMETa 2012, with aims to contribute to the implementation of new technologies into production processes as well as achieving better cooperation between scientific research institutions and enterprises.
Basic concept of the Conference: Plenary session (invited papers about global issues), Symposium (oral presentation on the conference topics) and poster presentation, Workshops. The main goal of this conference is to bring together renowned national and international experts in the field of research and application of new technologies and development of mechanical systems, for sharing experiences and knowledge. Moreover, public presentations of actual researches and new construction solutions improve the competitiveness of the economy in region.
We have great pleasure to invite all interested scientific research institutions and businesses to actively participate and with their papers contribute to successfully organizing of this scientific conference. Detailed informations here:
http://www.ues.rs.ba/en/university/international-cooperation/scientific-conferences-and-meetings/cometa-2012

13. 4th INTERNATIONAL CONFERENCE ON MATERIALS SCIENCE AND TECHNOLOGIES - ROMAT 2012
17 – 19 October, 2012, Bucharest, ROMANIA

On behalf of the Organizing Committee, we are honoured to invite you to participate and submit a paper at the 4-th INTERNATIONAL CONFERENCE ON MATERIALS SCIENCE AND TECHNOLOGIES - ROMAT 2012 organized by POLITEHNICA University of Bucharest - Materials Science and Engineering Faculty in association with Bucharest Chamber of Commerce and Industry. The Conference topics will cover the following fields:

- *Advanced materials and technologies: Ferrous and Non-ferrous Metallurgy; Materials Engineering; Materials Processing; Nanomaterials; Casting-solidification; Biomaterials and Medical Devices;*
- *Materials Characterization: Characterization of Microstructure and Material Properties; Functional Materials Modeling; Nucleation, Microstructure Evolution and Phase Transition; Interface Dominated Mechanical Properties; Nanostructured Coatings, Surfaces & Films;*
- *Environmental protection in materials industry: Advanced Techniques for Industrial Effluent Treatment; Environment Management; Instruments under Sustainable Development Requirements; Solutions for Re-use of By-products and Wastes; Health and Environment;*
- *Economics and management in materials industry: Globalization and Prospects on Regional Metallurgy; The Complementarity – Definition Criterion for Industrial Strategies; The Competitiveness – Fundamental Component of Industrial Policies.*

Detailed informations here: http://www.romat2012.eu/

14. 2nd INTERNATIONAL CONFERENCE ON CIVIL ENGINEERING AND BUILDING MATERIAL – CEBM 2012
17 – 18 November, 2012, Hong Kong

The 2nd International Conference on Civil Engineering and Building Material (CEBM 2012) will be held in Hong Kong from November 17-18, 2012. It is a premium international conference covers all areas related to the Theory, Development, Applications, Experiences and Evaluation of Civil Engineering and Building Materials and gathers fellow students, researchers and practitioners in these fields from all around the world.
The conference will continue the excellent tradition of gathering world-class researchers, engineers and educators engaged in the fields of Civil Engineering and Building Materials to meet and present their latest activities. You are cordially invited to attend this interesting event. This conference is co-sponsored by Asia Civil Engineering Association, the International Association for Scientific and High Technology and International Science and Engineering Research Center.
Detailed informations here: http://www.iasht.org/cebm/

15. 7th INTERNATIONAL ICQME CONFERENCE (Quality, Management, Environment, Education, Engineering)
19 – 21 September, 2012, Tivat, MONTENEGRO

University of Montenegro, Faculty of mechanical engineering (Podgorica), Centre for quality and Ministry for Economy are organising 7th International Conference ICQME (Quality, Management, Environment, Education, Engineering) to be held in Tivat, September 19-21, 2012.
The idea of Conference has first come to life when a need was felt to have the eleventh traditional National Conference on Quality Management System (SQM) with the international participation evolve into an international conference, with an extension of thematic areas to be covered.
National Conference on Quality Management System (SQM) with the international participation has been gathering prominent experts from the field of quality over the last twelve years. In addition to the local, Montenegro experts, the participation lists included a number of well-known scientists and experts from France, Spain, Canada, England, Italy, Denmark, Slovenia, Serbia, Bosnia-Herzegovina, Croatia, and 7th International ICQME Conference some of the vital issues of quality, management, engineering, education, and environmental protection will be discussed, and the participants will be from both the university and the commercial fields, which will contribute to a more productive exchange of ideas and experiences.
The conference intends to shed further light on the complex and potentially conflicting choices firms take in order to acquire, exchange, and create knowledge in order to improve its performance. This theme relates to quite a wide variety of aspects relating to the increasing complexity (e.g. economic, management, engineering, sociology) of systems for knowledge creation and innovation. This complexity implies a more intensive and more frequent need to embrace as well as to connect both internal and external source of knowledge in the search for new technological achievements.
Detailed informations here: http://wbc-inco.net/object/event

16. INTERNATIONAL CONFERENCE ON NEW ENERGY, BIOLOGICAL ENGINEERING AND FOOD SECURITY - NEBEFS 2012
4 – 5 September, 2012, Hong Kong

2012 International Conference on New Energy, Biological Engineering and Food Security (NEBEFS 2012) will be held on September 4-5, 2012, Hong Kong.
The goal of this conference is to bring together the researchers from academia and industry as well as practitioners to share ideas, problems and solutions relating to the multifaceted aspects of New Energy, Biological Engineering and Food Security.
Detailed informations here: http://www.nebefs-conf.org

17. INTERNATIONAL CONFERENCE ON MANUFACTURING – MANUFACTURING 2012
14 – 15 November, Macau, CHINA

Manufacturing 2012 will be the most comprehensive conference focused on the various aspects of advances in Manufacturing and Materials Science. This Conference provides a chance for academic and industry professionals to discuss recent progress in the area of Manufacturing and Materials Science. Furthermore, we expect that the conference and its publications will be a trigger for further related research and technology improvements in this important subject.
The goal of this conference is to bring together the researchers from academia and industry as well as practitioners to share ideas, problems and solutions relating to the multifaceted aspects of Manufacturing and Materials Science.
Detailed informations here: http://manufacturing2012.org/index.htm

18. 2nd INTERNATIONAL CONFERENCE ON INTEGRATED INFORMATION – IC-ININFO 2012
30 August – 3 September, 2012, Budapest, HUNGARY

The Conference website at http://www.icininfo.net is given to you as a reference for the aims and scopes of the IC-ININFO 2012.
- ☐ 5th Symposium on Dynamic Simulation Models supporting Management Strategies
- ☐ 2nd Symposium on Evidence-Based Information in Clinical Practice
- ☐ Information and Knowledge Management
- ☐ Entrepreneurship and the Role of Information
- ☐ 2nd Symposium on Advances Information for Strategic Management
- ☐ 2nd symposium on Contemporary issues in Management: Organizational Behavior, Information Technology, Education & Hospital leadership
- ☐ 2nd Symposium on Integrated Information: Theory, Policies, Tools
- ☐ 2nd Symposium on Open Access Repositories: Self-archiving, Metadata, Content Policies, Usage

You are welcomed to propose a session or a symposium for IC-ININFO 2012.
Session organizers will be benefited by a 15% refund of their session.
For more information, contact the conference secretariat at secretariat@icininfo.net

19. INTERNATIONAL CONFERENCE ON MANUFACTURING ENGINEERING AND TECHNOLOGY FOR MANUFACTURING GROWTH – METMG 2012
1 – 2 November,2012, San Degio, USA

METMG 2012 will be the most comprehensive Conference focused on the various aspects of advances in Manufacturing Engineering and Technology for Manufacturing Growth. Our Conference provides a chance for academic and industry professionals to discuss recent progress in the area of Manufacturing Engineering and Technology for Manufacturing Growth. Topic:
- ☐ Computer Aided Design and Manufacturing and related topics
- ☐ Material Forming Processes and related topics
- ☐ Machining Technology and related topics
- ☐ Welding Technology and related topics
- ☐ Metallurgical Manufacturing Processes and related topics
- ☐ Automation in Manufacturing and related topics
- ☐ Micro and Nano Fabrications and related topics

Detailed informations here: http://metmg-conf.org/

20. INTERNATIONAL CONFERENCE ON APPLIED PHYSICS AND MATERIALS SCIENCE (APMS 2012)
5 – 6 October, 2012, Dalian, CHINA

APMS 2012 will be the most comprehensive conference focused on the various aspects of advances in Applied Physics and Materials Science. Our Conference provides a chance for academic and industry professionals to discuss recent progress in the area of Information Technology, Applied Physics and Materials Science.
The goal of this conference is to bring together the researchers from academia and industry as well as practitioners to share ideas, problems and solutions relating to the multifaceted aspects of Information Technology, Applied Physics and Materials Science.
Detailed informations here: http://www.apms-conf.org/index.htm

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

ISSN: 2067-3809 [CD-Rom, online]

Indexes

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering

is accredited and ranked in the B+ category by

CNCSIS

CNCSIS – The National University Research Council's Classification of Romanian Journals,
http://www.cncsis.ro/

member of

SCIPIO
SCIENTIFIC PUBLISHING & INFORMATION ONLINE

The Romanian Editorial Platform SCIPIO
http://www.scipio.ro

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering

is indexed in the following databases and directories:

INDEX COPERNICUS
INTERNATIONAL

INDEX COPERNICUS – JOURNAL MASTER LIST
http://journals.indexcopernicus.com/

Journal Seek

GENAMICS JOURNALSEEK DATABASE
http://journalseek.net/

evisa.

EVISA database
http://www.speciation.net/

Google Scholar

GOOGLE SCHOLAR
http://scholar.google.co.in/

DOAJ DIRECTORY OF OPEN ACCESS JOURNALS

DOAJ - Directory of Open Access Journals
http://www.doaj.org/

SCIRUS - Elsevier
http://www.scirus.com/

ProQuest database
http://www.proquest.co.uk

EBSCO Publishing
http://www.ebscohost.com

Chemical Abstracts Service (CAS)
http://www.cas.org/

Open J-Gate
http://www.openj-gate.com/

Bielefeld Academic Search Engine
http://digital.ub.uni-bielefeld.de

Electronic Journals Library
http://ezb.uni-regensburg.de

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
Tome V (Year 2012). FASCICULE 3 [July–September]. ISSN 2067-3809

MANUSCRIPT PREPARATION – General Guidelines

These instructions are written in a form that satisfies all of the formatting requirements for the author manuscript. Please use them as a template in preparing your manuscript. Authors must take special care to follow these instructions concerning margins. The basic instructions are simple:

- *Manuscript shall be formatted for an A4 size page.*
- *The top and left margins shall be 25 mm.*
- *The bottom and right margins shall be 25 mm.*
- *The text shall have both the left and right margins justified.*

The original of the technical paper will be sent through e-mail as attached document (.doc, Windows 95 or higher). Manuscripts should be submitted to e-mail: redactie@fih.upt.ro, with mention "for ACTA TECHNICA CORVINIENSIS – Bull. of Eng.".*

STRUCTURE

The manuscript should be organized in the following order: Title of the paper, Authors' names and affiliation, Abstract, Key Words, Introduction, Body of the paper (in sequential headings), Conclusion, Acknowledgements (where applicable), References, and Appendices (where applicable).

THE TITLE

The title is centred on the page and is CAPITALIZED AND SET IN BOLDFACE (font size 14 pt). It should adequately describe the content of the paper. An abbreviated title of less than 60 characters (including spaces) should also be suggested.

AUTHOR'S NAME AND AFFILIATION

The author's name(s) follows the title and is also centred on the page (font size 11 pt). A blank line is required between the title and the author's name(s). Last names should be spelled out in full and succeeded by author's initials. The author's affiliation (in font size 11 pt) is provided below. Phone and fax numbers do not appear.

ABSTRACT

A nonmathematical abstract, not exceeding 200 words, is required for all papers. It should be an abbreviated, accurate presentation of the contents of the paper. It should contain sufficient information to enable readers to decide whether they should obtain and read the entire paper. Do not cite references in the abstract.

KEY WORDS

The author should provide a list of three to five key words that clearly describe the subject matter of the paper.

TEXT LAYOUT

The manuscript must be typed single spacing. Use extra line spacing between equations, illustrations, figures and tables. The body of the text should be prepared using Georgia or Times New Roman. The font size used for preparation of the manuscript must be 11 points. The first paragraph following a heading should not be indented. The following paragraphs must be indented 10 mm. Note that there is no line spacing between paragraphs unless a subheading is used. Symbols for physical quantities in the text should be written in italics.

FIGURES AND TABLES

Figures (diagrams and photographs) should be numbered consecutively using Arabic numbers. They should be placed in the text soon after the point where they are referenced. Figures should be centred in a column and should have a figure caption placed underneath. Captions should be centred in the column, in the format "Figure 1" and are in upper and lower case letters.

When referring to a figure in the body of the text, the abbreviation "Figure" is used Illustrations must be submitted in digital format, with a good resolution. Table captions appear centred above the table in upper and lower case letters.

When referring to a table in the text, "Table" with the proper number is used. Captions should be centred in the column, in the format "Table 1" and are in upper and lower case letters. Tables are numbered consecutively and independently of any figures. All figures and tables must be incorporated into the text.

EQUATIONS AND MATHEMATICAL EXPRESSIONS

Equation numbers should appear in parentheses and be numbered consecutively. All equation numbers must appear on the right-hand side of the equation and should be referred to within the text.

CONCLUSION

A conclusion section must be included and should indicate clearly the advantages, limitations and possible applications of the paper. Discuss about future work.

ACKNOWLEDGEMENTS

An acknowledgement section may be presented after the conclusion, if desired. Individuals or units other than authors who were of direct help in the work could be acknowledged by a brief statement following the text.

REFERENCES

References should be listed together at the end of the paper in alphabetical order by author's surname. List of references indent 10 mm from the second line of each references. Personal communications and unpublished data are not acceptable references.

Journal Papers: *Surname 1, Initials; Surname 2, Initials and Surname3, Initials: Title, Journal Name, volume (number), pages, year.*

Books: *Surname 1, Initials and Surname 2, Initials: Title, Edition (if existent), Place of publication, Publisher, year.*

Proceedings Papers: *Surname 1, Initials; Surname 2, Initials and Surname 3, Initials: Paper title, Proceedings title, pages, year.*

ACTA TECHNICA CORVINIENSIS – BULLETIN OF ENGINEERING. FASCICULE 1 [JANUARY-MARCH]
ACTA TECHNICA CORVINIENSIS – BULLETIN OF ENGINEERING. FASCICULE 2 [APRIL-JUNE]
ACTA TECHNICA CORVINIENSIS – BULLETIN OF ENGINEERING. FASCICULE 3 [JULY-SEPTEMBER]
ACTA TECHNICA CORVINIENSIS – BULLETIN OF ENGINEERING. FASCICULE 4 [OCTOBER-DECEMBER]

ISSN: 2067-3809 [CD-Rom, online]

ACTA TECHNICA CORVINIENSIS
– BULLETIN of ENGINEERING

ACTA TECHNICA CORVINIENSIS
– BULLETIN of ENGINEERING
ISSN: 2067-3809 [CD-Rom, online]

http://acta.fih.upt.ro

ACTA TECHNICA CORVINIENSIS
BULLETIN OF ENGINEERING

ISSN: 2067-3809

fascicule 3
[July-September]

TOME V
[2012]