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the Faculty of Technical Systems
and Energy Efficient Technologies

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D S M : I E
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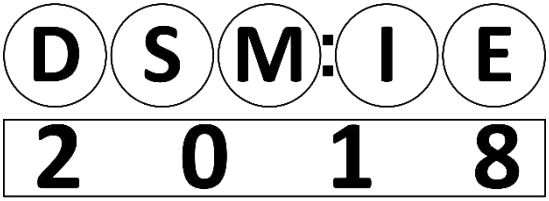
International Conference on Design, Simulation, Manufacturing: The Innovation Exchange

June 12-15, 2018 | Sumy, Ukraine

Book of Abstracts

Ministry of Education and Science of Ukraine
Sumy State University



International Conference on Design, Simulation, Manufacturing: The Innovation Exchange (DSMIE-2018)

June 12–15, 2018

Book of Abstracts

Sumy
University Book
2018

Design, Simulation, Manufacturing: The Innovation Exchange: Book of Abstracts of the International Conference, Sumy, Ukraine, June 12-15, 2018 / Vitalii Ivanov, Oleksandr Liaposhchenko, Ivan Pavlenko, Oleksandr Gusak (Eds.). – Sumy, PF «Publishing House "University Book"», 2018. 128 p.

Recommended by Academic Council of Sumy State University
(Minutes of the Meeting No. 7, April 12, 2018)

This book reports on topics at the interface between manufacturing, mechanical and chemical engineering. It gives a special emphasis to CAD/CAE systems, information management systems, advanced numerical simulation methods and computational modeling techniques, and their use in product design, industrial process optimization and in the study of the properties of solids, structures and fluids. Control theory, ICT for engineering education as well as ecological design and food technologies are also among the topics discussed in the book. Based on the International Conference on Design, Simulation, Manufacturing: The Innovation Exchange (DSMIE-2018), held on June 12-15, 2018, in Sumy, Ukraine, the book provides academics and professionals with a timely overview and extensive information on trends and technologies behind current and future developments of Industry 4.0, innovative design and renewable energy generation.

ISBN 978-966-680-860-1

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Welcome Message

International Conference on Design, Simulation, Manufacturing: The Innovation Exchange (DSMIE-2018), held in Sumy, Ukraine in June 12-15, 2018. The conference was organized by the Faculty of Technical Systems and Energy Efficient Technologies, Sumy State University, in partnership with Technical University of Kosice (Slovak Republic), Kielce University of Technology (Poland), University of West Bohemia (Czech Republic), Association for Promoting Innovative Technologies – Innovative FET (Croatia).

DSMIE-2018 received 91 contributions from 14 countries around the world. After a thorough peer-review process, the DSMIE-2018 Editorial Board accepted 55 papers, written by authors from 11 countries. Thank you very much to all authors for their contribution. These abstracts are published in present book, achieving and acceptance rate of about 60%.

I would like to take this opportunity to thank members of Program Committee and invited external reviewers for their efforts and expertise in contribution to reviewing, without which it would be impossible to maintain the high standards of peer-reviewed papers. 53 Program Committee members and 14 invited external reviewers devoted their time and energy for peer reviewing manuscripts. Our reviewers come from all over the world and represent 17 countries and affiliated with 41 institutions.

Thank you very much to all keynote speakers, who came from Poland, Slovak Republic, Czech Republic and Ukraine, and share their knowledge and experience.

I appreciate the partnership with Springer, Unicheck and EasyChair and our Sponsors for their essential support during the preparation of DSMIE-2018.

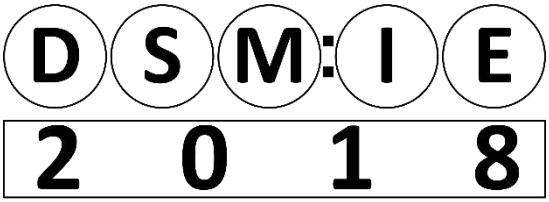
Thank you very much to DSMIE-2018 Team. Their involvement and hard work were crucial to the success of the DSMIE-2018 conference.

DSMIE-2018's motto is **"Together we can do more for science, technology, engineering and education"**.

Vitalii Ivanov,
Conference Chair of DSMIE-2018

About DSMIE-2018

International Conference on Design, Simulation, Manufacturing: The Innovation Exchange **(DSMIE-2018)** is the international forum for fundamental and applied research and industrial applications in manufacturing.



DSMIE-2018 focuses on a broad range of research challenges in the fields of Manufacturing, Mechanical and Chemical Engineering, addressing current and future trends in design approaches, simulation techniques, computer-aided systems, software development, ICT tools and Industry 4.0 strategy implementation for engineering tasks solving. DSMIE-2018 brings together researchers from academic institutions, leading industrial companies, and government laboratories located around the world for promoting and popularization of the scientific fundamentals of manufacturing. The conference schedule will include keynote sessions and technical sessions, expert panels, an exhibition of industry partners and more.

The working language of the conference (including conference proceedings, presentations, and discussions) is English.

The Conference is organized under the patronage of **Prof. Anatoliy Vasylyev**, Rector of Sumy State University and **Dr. Oleksandr Gusak**, Dean of Faculty of Technical Systems and Energy Efficient Technologies.

Conference Committees

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Oleksandr Liaposhchenko, Sumy State University (Ukraine)
Ivan Pavlenko, Sumy State University (Ukraine)

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Viliam Zaloga, Sumy State University (Ukraine)
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Przemyslaw Zawadzki, Poznan University of Technology (Poland)

DSMIE-2018 Team

Vitalii Ivanov
Oleksandr Gusak
Oleksandr Liaposhchenko
Ivan Pavlenko
Kristina Berladir
Maryna Demianenko
Olha Lytvynenko
Ivan Dehtiarov

Conference Topics

Manufacturing Engineering

- CAD/CAE Systems for Design of Products, Metalworking Equipment, Fixtures, Cutting Tools
- CAPP/CAM/CAQ Systems for Advanced Manufacturing and Assembling Technologies
- CAx Technologies for Manufacturing Engineering
- Information Management Systems for Manufacturing Enterprises
- Intelligent Manufacturing Systems
- Flexible Manufacturing Systems, Automation and Robotics
- Methods and Technologies for Additive Manufacturing
- Numerical Simulation in Materials Science
- Smart Manufacturing and Industry 4.0 Strategy
- ICT for Engineering Education

Mechanical Engineering

- Engineering Design and Optimization Using CAD/CAE Software
- Using CAE Software in Mechanics of Solids, Structures and Fluids
- Computer Modeling of Fracture, Failure and Fatigue
- Computational Techniques in Machine Mechanics and Dynamics
- Numerical Methods for Dynamics, Acoustics and Vibration
- Computational Methods for Control Theory
- Numerical Simulation of Nonlinear Dynamic Systems
- Simulation Software for Modeling Fluid-Structure Interaction
- Multiphysics Analysis of Coupled Systems

Chemical Engineering

- Theoretical Fundamentals and Mathematical Modeling of Chemical Process Technology
- Computational Fluid Dynamics, Thermodynamics, Heat and Mass Transfer
- Numerical Simulation and Optimization of Industrial Chemical Processes
- CAD/CAM/CAE Systems for Chemical Engineering and Plant Design
- SCADA Process Control Systems for the Chemical Industry
- Resource-Saving and Energy Efficient Technologies, Conversion and Utilization
- Alternative and Renewable Energy, Generation and Recovery
- Biotechnologies and Bioengineering, Bio-based Fuels, Food Technologies
- Industrial Ecology, Sustainable Engineering and Ecological Design

Publishing Opportunities

Full papers of selected contributions of DSMIE-2018 published in Springer Lecture Notes in Mechanical Engineering (ISSN 2195-4356). The books of this series are indexed by Scopus and submitted ISI Proceedings (Web of Science).

Title: Advances in Design, Simulation and Manufacturing.

Subtitle: Proceedings of the International Conference on Design, Simulation, Manufacturing: The Innovation Exchange, DSMIE-2018, June 12-15, 2018, Sumy, Ukraine

Editors:

- Vitalii Ivanov, Sumy State University, Ukraine
- Yiming Rong, Southern University of Science and Technology, China
- Justyna Trojanowska, Poznan University of Technology
- Joachim Venus, Leibniz Institute for Agricultural Engineering and Bioeconomy, Germany
- Oleksandr Liaposhchenko, Sumy State University, Ukraine
- Jozef Zajac, Technical University of Kosice, Slovak Republic
- Ivan Pavlenko, Sumy State University, Ukraine
- Milan Edl, University of West Bohemia, Czech Republic
- Dragan Perakovic, University of Zagreb

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To read papers, please visit official webpage on Springer's website via QR-code.

Extended versions of best papers, presented at DSMIE-2018, will be considered for special issues of selected journals, subject to further review:

Management and Production Engineering Review, Poland
(ISSN 2080-8208,
e-ISSN 2082-1344)
http://mper.org

Archives of Mechanical Technology and Materials, Poland
(ISSN 2450-9469)
https://www.degruyter.com/view/j/amtm

Journal of Engineering Sciences, Ukraine
(ISSN 2312-2498,
e-ISSN 2414-9381)
http://jes.sumdu.edu.ua

Organizer

Sumy State University

Sumy State University is located in Sumy city in the North-East of Ukraine. Its history began in 1948. Today, SSU is a leading university of a classical type with the III-IV accreditation level in the region. The University currently serves about 16,000 students who are pursuing pre-bachelor, bachelor, specialist and master degrees in 46 majors and 22 fields of knowledge. About 1300 foreign students represent almost 50 countries worldwide. Sumy State University is included in Global Research University Profiles (GRUP) by Shanghai Ranking taking position 500+. SSU is also included in the directory of world's best universities by the Times Higher Education World University Rankings. Sumy State University enters the TOP-group (3%) of leading universities of the world and is classified as a university with high research intensity according to the international ranking of higher education institutions QS World University Rankings. Sumy State University is the first Ukrainian higher education institution, which passed in 2014 an independent external audit of the QS Company and was given the highest points (5 stars) in such categories as Teaching, Engagement, Access and E-learning.

Faculty of Technical Systems and Energy Efficient Technologies

The Faculty of Technical Systems and Energy Efficient Technologies is one of the most successful faculties of the Sumy State University. The faculty carries out significant number of works aimed at improving the educational process, increasing the quality of specialists training, using new forms and methods of education, training the academic staff and conducting the advanced scientific researches.

✉ 2 Rymskogo-Korsakova St., Sumy, 40007, Ukraine
💻 http://teset.sumdu.edu.ua

Partners

Technical University of Kosice,
Faculty of Manufacturing
Technologies with a seat in Presov
(Presov, Slovak Republic)

Kielce University of Technology,
Faculty of Management and
Computer Modeling
(Kielce, Poland)

University of West Bohemia,
Faculty of Mechanical Engineering
(Pilsen, Czech Republic)

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JSC "NASOSENERGOMASH Sumy"

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Facts and figures:

- Production floor spaces cover more than 81,250 m2.
- Production range of serial products totals more than 200 item names (makes).
- During the entire period of its existence, the Company has made over 550.000 pumps.
- More than 1200 various pumps have been supplied for NPP's.
- Pumping equipment is made in accordance with Russian and international branch standards.
- Pumps for nuclear power generation are entered in Uniform Specialized Nomenclature Catalog for Equipment and Materials Used During NPP Design, Construction and Operation (EOHKOM);
- Pumping equipment for petroleum industry is are included in Transneft's Register of Goods and Equipment (Major Products)
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PJSC “Ukrhimproekt” is one of the leading design institutes of Ukraine, the geography of implemented projects which goes far beyond our country. Today the PJSC “Ukrhimproekt” performs complex design of chemical industry, oil and gas and petrochemical complexes, as well as civil and industrial construction. In addition, it performs engineering surveys and certification of buildings, structures and individual building structures. Among their reliable partners are dozens of major industrial enterprises and design institutes of Ukraine, Kazakhstan, Uzbekistan, Turkmenistan, Azerbaijan and other foreign countries. Hundreds of successfully implemented projects and positive feedback from customers not only testify to our high professionalism, but also inspire strong confidence in their own abilities.

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💻 http://ukrhimproekt.com.ua

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Center of Technological Initiatives

The company was founded in 2011 by the team of associates who have and maintain a high level of innovative and intellectual potential. Developments are performed by professionals of high qualification, including doctors of philosophy and doctors of sciences in the field of machining operations, machines and tools, manufacturing engineering and industrial electronics. Broad practical experience of our professionals allows solving complex manufacturing problems that require nonstandard solutions and deep fundamental knowledges. We are proud that our specialists seek to improve their qualifications by attending conferences, exhibitions, training seminars and special courses at every opportunity not only in Ukraine, but also abroad.

We strive to be the initiators of introduction of scientific and technical progress in machine-building industry of Ukraine, increasing the knowledge-intensity of the industry, modernization of domestic products of metal-cutting equipment.

Our activities are focused on the distribution of domestic enterprises of advanced technologies, developed using the latest advances in science, support machine building enterprises with modern machines and equipment, including foreign production, the introduction of innovative technologies, modern methods of analysis and simulation of manufacturing processes and the behavior of structures.

We offer our customers an individual approach, maximum realization of customer requests, expansion potential. Our ability to speak fluent English and to read the technical literature in English allows work with foreign equipment.

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The company SENSI was founded in 1993. It started its activity as an industrial and commercial company in the machinery industry. The production area is 2,000 square meters and includes a mechanical area (20 units of metalworking equipment), metalwork assembly station, argon welding area, the control systems and automation assembly area. The design department of the company makes equipment design in the AutoCAD system.

Equipment produced by our company is successfully operated on the territory of Ukraine and CIS (Commonwealth of Independent Countries) countries. Our company offers the supply of CNG equipment with a wide range of input pressures. Together with the systems of gas treatment equipment CNG stations can be installed on marginal gas wells of local importance, the wells for the extraction of methane from coal beds and oil wells with associated methane. For station installation it is enough to connect it to the gas and electricity networks. We provide a full range of activities to introduce CNG stations: equipment supply, installation, commissioning, warranty service, assist in the design of the station and advising customers.

In May 2009, the supervisory audit was successfully conducted on a new version of the standard ISO 9001:2008 auditors Bureau Veritas Certification Ukraine. The drawbacks identified during the audit were promptly removed. On the results of the audit the certificate for the new version of ISO 9001:2008 was issued.

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The Industrial Company "Energomash"

The industrial company "Energomash" is a reliable and steadily developing company that has established itself as a team of professionals in the field of industrial equipment. Due to the considerable scientific and technical potential, our specialists will help you to quickly solve the problems of any complexity, which concern the choice, design, delivery and installation of the equipment you need.

The main principle of the company is professionalism in work and individual approach to the requirements of each customer, which allows achieving the maximum result from joint work. Over the years, Energomash has made significant efforts to gain the reputation of a reliable and competent partner in the field of supply of industrial equipment.

✉ 111 Kharkivska St., Sumy, 40007, Ukraine
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AMC Bridge

AMC Bridge was formed by a team of experienced industry professionals who focus on computer aided design, engineering and manufacturing. Since 1999 we have been delivering innovative solutions for CAD, CAE, CAM, PDM and PLM applications. We now help companies from all over the world because we believe that guaranteed high-quality solutions can only be realized through long-term cooperation with our clients and partners.

Understanding key business processes and grasping advanced technologies allows us to create software that meets the unique requirements of different fields. AMC Bridge guarantees high-quality services that go through several levels of quality control and are compliant with the latest industry standards, and successfully operates an internal research department, working on in-house project development. AMC Bridge values its clients and partners, that is confirmed by the frequency of customer return and only invites the most talented employees to join the team and helps them constantly improve their skills.

AMC Bridge named to the Inc 5000 list of US fastest growing private companies in 2016–2017 as well as listed on the Software 500 2017, a worldwide ranking of software and software services companies, and the 2018 IAOP Global Outsourcing 100 List.

Company headquarters are located in the USA, and four development centers are operating in Dnipro, Khmelnitsky, Sumy and Chernivtsi.

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Monthly international magazine «Industry in FOCUS» has already attracted attention of many companies who work at the industrial market. Time of feverish activity made our edition the most popular among the similar journals.

The editorial policy of «Industry in FOCUS» consists of prompting information bridges between developers of technics and technical processes, producers of the industrial output, providers and consumers. Since our market develops dynamically and our technical specialists should be well-informed we use the authority and status of our edition to cover the field broadly and give irreversible character to those processes which are taken place in our country now.

As was observed, our edition is useful for the big circle of engineers, businessmen, and main specialists of industrial enterprises.

The Circulation of our journal is 10 thousand copies. It is circulated with the subscription in Ukraine, Russia, Czech Republic, Poland, France, Germany, Israel and Belarus. Besides that, «Industry in FOCUS» journal takes active part in different profile exhibitions, seminars, conferences in many countries of the world where your advertisement can be matched.

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- “RELEVANT” (economic news, exhibitions, seminars, conferences);
- “COVERAGE SECTOR” (enterprise news, branch problems, market reviews);
- “EQUIPMENT” (advantages and specifications of different mechanisms, machines, devices);
- “TOOLS” (Characteristics of the metal cutting tool, specification of manufacture and use);
- “AUTOMATICS” (means of industrial automation, analysis and estimation of the automation system);

- “TECHNOLOGIES” (advanced technologies, modern means of manufacture);
- “TECHNO-plus” (“magazine in magazine”, topical selection of articles);
- “TRADING HALL OF INDUSTRIAL EQUIPMENT” (information about metal cutting equipment, which was in use, accessories to it, and announcements of repair, restoration and modernization the equipment);

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Conference Program

Day 1 – **June 12, 2018** – Tuesday	
8^{00}–14^{00}	Registration
14^{00}–15^{00}	University Tour
15^{00}–17^{00}	City Tour
Day 2 – **June 13, 2018** – Wednesday	
8^{00}–9^{00}	Registration
9^{00}–9^{30}	Opening Ceremony
9^{30}–9^{40}	Photo Session
9^{40}–11^{10}	Keynote Session 1
11^{10}–11^{30}	Coffee Break
11^{30}–13^{00}	Keynote Session 2
13^{00}–14^{00}	Lunch
14^{00}–15^{30}	Conference Session 1 – Manufacturing Engineering I
15^{30}–15^{45}	Coffee Break
15^{45}–17^{30}	Conference Session 2 – Mechanical Engineering I
17^{30}–18^{30}	Exhibition and Poster Session
19^{00}–22^{00}	DSMIE-2018 Welcome Dinner
Day 3 – **June 14, 2018** – Thursday	
9^{00}–10^{45}	Conference Session 3 – Manufacturing Engineering II
10^{45}–11^{00}	Coffee Break
11^{00}–11^{45}	Conference Session 4 – Mechanical Engineering II
11^{45}–12^{30}	Lunch
12^{30}–13^{30}	Conference Session 5 – Chemical Engineering I
13^{30} – 16^{00}	Industry Tour
16^{00}–16^{45}	Conference Session 6 – Mechanical Engineering III
16^{45}–17^{00}	Coffee Break
17^{00}–17^{45}	Conference Session 7 – Chemical Engineering II
Day 4 – **June 15, 2018** – Friday	
9^{00}–10^{30}	Conference Session 8 – Manufacturing Engineering III
10^{30}–10^{45}	Coffee Break
10^{45}–11^{45}	Conference Session 9 – Mechanical Engineering IV
11^{45}–12^{00}	Coffee Break
12^{00}–13^{00}	Conference Session 10 – Chemical Engineering III
13^{00} – 13^{30}	Closing Ceremony, Awards and Farewell

Day 1: June 12, 2018, Tuesday

Venue: Sumy State University, Main Building
2 Rymskogo-Korsakova St., Sumy, 40007, Ukraine
http://sumdu.edu.ua/int/en/)

8^{00}–14^{00}	**Registration**
14^{00}–15^{00}	**University Tour**
15^{00}–17^{00}	**City Tour**

Day 2: June 13, 2018, Wednesday

Venue: Congress Center of Sumy State University
9/1 Pokrovska St., Sumy, 40000, Ukraine
http://congress-center.business.site/

8^{00}–9^{00}	**Registration**
9^{00}–9^{30}	**Opening Ceremony** *Vitalii Ivanov* Conference Chair of DSMIE-2018 *Anatoliy Chornous* Vice Rector for Scientific Work of Sumy State University *Oleksandr Gusak* Dean of the Faculty of Technical Systems and Energy Efficient Technologies of Sumy State University *Oleksandr Kovtun* Chairman of the Board, JSC "NASOSENERGOMASH Sumy"
9^{30}–9^{40}	**Photo Session**
9^{40}–11^{10}	**Keynote Session 1** Session Chair: Vitalii Ivanov, Sumy State University, Ukraine **Industry 4.0 – Smart Factory: Challenges and Trends** *Olaf Ciszak* Faculty of Mechanical Engineering and Management, Poznan University of Technology, Poland

Creation of the Intellectual Property Protection System at Universities

Jozef Zajac and Michal Hatala

Faculty of Manufacturing Technologies with a seat in Presov, Technical University of Kosice, Slovak Republic

Quo Vadis, Technical Education – Preparation for Professions That Are Not Yet = Education 4.0

Milan Edl

Faculty of Mechanical Engineering, University of West Bohemia, Czech Republic

Smart Education for Smart Enterprises

Slawomir Luscinski

Faculty of Management and Computer Modelling, Kielce University of Technology, Poland

11^{10}–11^{30} **Coffee Break**

11^{30}–13^{00} **Keynote Session 2**

Session Chair: Ivan Pavlenko, Sumy State University, Ukraine

Strategies of Professional Engineering Education for Modern Machine-Building Industry

Dmytro Kryvoruchko

Center of Technological Initiatives, Ukraine

Muscle-Based Actuators for Pneumatic Manipulators

Jan Pitel and Alexander Hosovsky

Faculty of Manufacturing Technologies with a seat in Presov, Technical University of Kosice, Slovak Republic

Design and Study of Conical Pressure-Swirl Atomizers

Marek Ochowiak[1], Olha Lytvynenko[2], Sylwia Wlodarczak[1], Magdalena Matuszak[1] and Andzelika Krupinska[1]

[1]Poznan University of Technology, Poland; [2]Sumy State University, Ukraine

	Combining Additive Manufacturing with Proven Metal Casting Processes *Eugene Kozhukhovsky* Smartprint LLC, Ukraine
	European Engineering Card: Implementation in Ukraine *Nikolay Kiryukhin* Union of Scientific and Engineering Associations of Ukraine, Ukraine
13^{00}–14^{00}	**Lunch**
14^{00}–15^{30}	**Conference Session 1 – Manufacturing Engineering I** Session Chair: Justyna Trojanowska, Poznan University of Technology, Poland
	Implementation of Material Flow Simulation as a Learning Tool *Jozef Husar, Lucia Knapcikova and Michal Balog* Technical University of Kosice, Slovak Republic
	Information and Communication Technologies within Industry 4.0 Concept *Dragan Peraković, Marko Periša and Rosana Elizabeta Sente* University of Zagreb, Croatia
	Variation Coefficient and Some Distribution Laws in the Context of Cutting Tools and Other Technical Objects Reliability Modeling *Mykhaylo Frolov* Zaporizhzhya National Technical University, Ukraine
	Combined Laser-Ultrasonic Surface Hardening Process for Improving the Properties of Metallic Products *Dmytro Lesyk[1], Silvia Martinez[2], Bogdan Mordyuk[3], Vitaliy Dzhemelinskyi[1] and Oleksandr Danyleiko[1]* [1]National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Ukraine; [2]University of the Basque Country, Spain; [3]G.V. Kurdyumov Institute for Metal Physics of the NAS of Ukraine, Ukraine

Provision of the Quality of Manufacturing Gear Wheels in Energy Engineering

Vladimir Lebedev, Vladimir Tonkonogyi, Alexey Yakimov, Liubov Bovnegra and Nataliya Klymenko

Odessa National Polytechnic University, Ukraine

Computer Modeling Application for Predicting of the Passing of the High-Speed Milling Machining Hardened Steel

Alexander Permyakov, Sergey Dobrotvorskiy, Ludmila Dobrovolska, Yevheniia Basova and Maryna Ivanova

National Technical University "Kharkiv Polytechnic Institute", Ukraine

Technology of Effective Abrasive Jet Processing of Parts Surfaces

Viktor Sychuk, Oleg Zabolotnyi and Dmytro Somov

Lutsk National Technical University, Ukraine

Ansys Simulation of the Joint Strength with the Interference Fit in the Presence of the Shape Geometry Error

Oleksandr Kupriyanov

Ukrainian Engineering Pedagogics Academy, Ukraine

15^{30}–15^{45}	**Coffee Break**
15^{45}–17^{30}	**Conference Session 2 – Mechanical Engineering I** Session Chair: Jan Pitel, Technical University of Kosice, Slovak Republic

Experimental Investigation of Physical and Tribological Properties of Engine Oil with Nano-Particles Additives

Manoj K. Gaur[1], Sumeet K. Singh[1], Akash Sood[1] and Dharamveer S. Chauhan[2]

[1]Madhav Institute of Technology and Science, India;
[2] Rustamji Institute of Technology, India

Selection the Method of Radial Thrust Calculation in Centrifugal Pump Using Computing Experiment

Polina Ignateva and Svitlana Lugova

JSC "NASOSENERGOMASH Sumy", Ukraine

Effect of Abnormal Operation of Turbine Generator on the Resource of Steam Turbine Shafting

Anatoliy Bovsunovsky

National University of Food Technologies of Ukraine

Determination of Transfer Functions for Electrohydraulic Servo Drive of Technological Equipment

Volodymyr Sokolov and Oleg Krol

Volodymyr Dahl East Ukrainian National University, Ukraine

Constitutive Equation for Numerical Simulation of Elastic-Viscous – Plastic Disperse Materials Deformation Process

Evgenii Shtefan, Bohdan Pashchenko, Serhii Blagenko and Serhii Yastreba

National University of Food Technologies, Ukraine

Optimal Management of Small Hydroelectric Plants Power Generation in Local Electrical Systems

Petro Lezhnuk, Olexander Rubanenko and Iryna Hunko

Vinnytsia National Technical University, Ukraine

Selection of the Geometry of the Leader Edge of the Impeller to Reduce Cavitation Failure

Svitlana Lugova, Polina Ignateva

JSC "NASOSENERGOMASH Sumy", Ukraine

Effect of Phase Composition on Cavitation Resistance of Ceramics

Alexander Litvinenko[1], Yuriy Boyko[1], Bohdan Pashchenko[1] and Yuriy Sukhenko[2]

[1]National University of Food Technologies, Ukraine; [2]National University of Life and Environmental Sciences of Ukraine, Ukraine

17^{30}–18^{30}	**Exhibition and Poster Session** Session Chair: Oleksandr Liaposhchenko, Sumy State University, Ukraine
19^{00}–22^{00}	**DSMIE-2018 Welcome Dinner**

Day 3: June 14, 2018, Thursday

Venue: Congress Center of Sumy State University
9/1 Pokrovska St., Sumy, 40000
http://congress-center.business.site/

9^{00}–10^{45}

Conference Session 3 – Manufacturing Engineering II
Session Chair: Jozef Zajac, Technical University of Kosice, Slovak Republic

Methods for Calculating the Grain Boundary Adsorption Capacity of Nanostructured Copper based Condensates
Maria Zhadko, Oleg Sobol, Galina Zelenskaya and Anatoly Zubkov
National Technical University "Kharkiv Polytechnic Institute", Ukraine

Choice of the Optimal Parameters of the Ultra-Fine Grained Cooper Machining
Anastasiia Symonova[1], Valerii Havin[2] and Dmitrii Savelov[1]
[1]Kremenchuk Mykhailo Ostrohradskyi National University, Ukraine; [2]National Technical University "Kharkiv Polytechnic Institute", Ukraine

Adaptive Profile Gear Grinding Boosts Productivity of this Operation on the CNC Machine Tools
Vasily Larshin[1] and Natalya Lishchenko[2]
[1]Odessa National Polytechnic University, Ukraine
[2]Odessa National Academy of Food Technologies, Ukraine

Influence of the Scale Factor of Fibers and the Temperature of Structuring on the Physical and Mechanical Characteristics of Hemp Fiber Biocomposites

Mykola Melnychuk and Oksana Andrushko
Lutsk National Technical University, Ukraine

Model of Thermal State of the System of Application of Coolant in Grinding Machine

Mykhaylo Stepanov[1], Larysa Ivanova[2], Petro Litovchenko[2], Maryna Ivanova[1] and Yevheniia Basova[1]
[1]National Technical University "Kharkiv Polytechnic Institute", Ukraine; [2]National Academy of National Guard of Ukraine, Ukraine

Forecasting Real Option Price Model by Means of Evolutionary and Genetic Algorithms

Mykyta Zubrii, Anastasia Mazur and Vitaliy Kobets
Kherson State University, Ukraine

Computer Simulation of the Processes of Mixing in Multilayer Nitride Coatings with Nanometer Period

Oleg Sobol, Andrey Meylekhov and Anna Postelnyk
National Technical University "Kharkiv Polytechnic Institute", Ukraine

Measurement of Non-Rigid Tools Action Force During Finishing

Natalia Honchar, Oleksiy Kachan, Dmytro Stepanov, Mark Kuchuhurov and Olena Khavkina
Zaporizhzhya National Technical University, Ukraine

Obtaining of Porous Powder Materials by Radial Pressing Method

Oleg Zabolotnyi, Viktor Sychuk and Dmytro Somov
Lutsk National Technical University, Ukraine

10^{45}–11^{00} **Coffee Break**

11^{00}–11^{45}	**Conference Session 4 – Mechanical Engineering II** Session Chair: Olaf Ciszak, Poznan University of Technology, Poland **System Dynamics Model for Continuous Review Inventory System in Demand Shock Conditions** *Sławomir Luściński[1] and Dariusz Dobrowolski[2]* [1]Kielce University of Technology, Poland; [2]Maria Curie-Sklodowska University, Poland **A Semi-Implicit Generalized Finite Differences Approach to Simulate Natural Convective Viscous Flows** *Felix Raymundo Saucedo-Zendejo and Edgar Omar Resendiz-Flores* Technological Institute of Saltillo, Mexico **Comparative Tribological Tests for Face Impulse Seals Sliding Surfaces formed by Various Methods** *Viacheslav Tarelnyk[1], Ievgen Konoplianchenko[1], Vasyl Martsynkovskyy[1], Aleksey Zhukov[1] and Piotr Kurp[2]* [1]Sumy National Agrarian University, Ukraine; [2]Kielce University of Technology, Poland **Movement of the Particle on the External Surface of the Cylinder, which makes the Translational Oscillations in Horizontal Planes** *Sergiy Pylypaka[1], Mikola Klendiy[2] and Tatiana Zaharova[3]* [1]National University of Life and Environmental Sciences of Ukraine, Ukraine; [2]Beregany Agricultural Institute of National University of Life and Environmental Sciences of Ukraine, Ukraine; [3]Sumy National Agrarian University, Ukraine
11^{45}–12^{30}	**Lunch**
12^{30}–13^{30}	**Conference Session 5 – Chemical Engineering I** Session Chair: Vladimir Zavialov, National University of Food Technologies of Ukraine, Ukraine **Modeling of the Heating for Cladded Powder in Plasma Jet at Spraying of Coating** *Andrii Andreytsev[1], Igor Smirnov[2], Andrii Chornyi[2], Mykhailo Yelysieiev[2] and Nikolay Dolgov[3]*

[1]State University of Infrastructure and Technology, Ukraine; [2]National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Ukraine; [3]Pisarenko Institute for Problems of Strength of the National Academy of Sciences of Ukraine, Ukraine

The Use of Waveguides with Internal Dissectors in the Process of Regeneration of Industrial Adsorbents by means of the Energy of Ultrahigh-Frequency Radiation

Sergey Dobrotvorskiy, Ludmila Dobrovolska, Borys Aleksenko and Yevheniia Basova

National Technical University "Kharkiv Polytechnic Institute", Ukraine

Simulation and Design of Welded Plate Heat Exchangers with Channels of Different Corrugation Height

Gennadii Khavin

National Technical University "Kharkiv Polytechnic Institute", Ukraine

Investigation of Hydrodynamics during Continuous Vibroextraction in a Liquid–Solid Body System

Vladimir Zavialov, Taras Misyura, Nataliya Popova, Yuliya Zaporozhets and Vadim Dekanskiy

National University of Food Technologies of Ukraine, Ukraine

Mathematical Model of Corrosive-Mechanic Wear Materials in Technological Medium of Food Industry

Yuriy Sukhenko[1], Vladislav Sukhenko[1], Mikhailo Mushtruk[1] and Alexander Litvinenko[2]

[1]National University of Life and Environmental Sciences of Ukraine, Ukraine; [2]National University of Food Technologies of Ukraine, Ukraine

$13^{30} – 16^{00}$ **Industry Tour**

Session Chair: Kristina Berladir, Sumy State University, Ukraine

"TRIZ" Ltd.

http://www.triz.sumy.ua/

$16^{00} – 16^{45}$	**Conference Session 6 – Mechanical Engineering III** Session Chair: Milan Edl, University of West Bohemia, Czech Republic **Experimental Study of the Power Characteristics Influence on the Hydraulic Efficiency** *Pavlo Andrenko[1], Iryna Grechka[1], Sergey Khovanskyy[2] and Maksym Svynarenko[3]* [1]National Technical University "Kharkiv Polytechnic Institute", Ukraine; [2]Sumy State University, Ukraine; [3]Kharkiv National University of Civil Engineering and Architecture, Ukraine **Numerical Study of Outlet Blade Angle Effect on Impeller Characteristics of Double Entry Centrifugal Pump** *Viktoriia Miltykh and Mykola Sotnyk* Sumy State University, Ukraine **Influence of the Stochastic Nature Parameters of Throttle Channels on Characteristic of Automatic Balancing Device of the Centrifugal Pump** *Yuliia Tarasevych, Nataliia Sovenko and Ievgen Savchenko* Sumy State University, Ukraine **Influence of the Passive Flow Initial Parameters on the Efficiency of Liquid-Vapor Ejectors** *Serhii Sharapov, Vyachslav Arsenyev, Maxim Prokopov and Viktor Kozin* Sumy State University, Ukraine
$16^{45}–17^{00}$	**Coffee Break**
$17^{00}–17^{45}$	**Conference Session 7 – Chemical Engineering II** Session Chair: Marek Ochowiak, Poznan University of Technology, Poland **The Carrier Development for Biofilms on the Basis of Technogenic Wastes for Pollutants Treatment in the Environmental Protection Technologies** *Yelizaveta Chernysh and Leonid Plyatsuk* Sumy State University, Ukraine

Information Support of Optimization Calculation of Vortex Type Granulation Devices

Artem Artyukhov

Sumy State University, Ukraine

Investigation of the Process of Saturation of the Filter Liquid of Soda Production with Ammonia and Carbon Dioxide in the Production of Ammonium Chloride

Inna Pitak, Valery Shaporev, Oleg Pitak, Alina Hrubnik and Viktor Moiseev

National Technical University "Kharkiv Polytechnic Institute", Ukraine

Modelling of Liquid's Distribution and Migration in the Fibrous Filter Layer in the Process of Inertial-Filtering Separation

Vsevolod Sklabinskyi, Oleksandr Liaposhchenko, Ivan Pavlenko, Olha Lytvynenko and Maryna Demianenko

Sumy State University, Ukraine

Day 4: June 15, 2018, Friday

Venue: Congress Center of Sumy State University
9/1 Pokrovska St., Sumy, 40000
http://congress-center.business.site/

9^{00}–10^{30}

Conference Session 8 – Manufacturing Engineering III
Session Chair: Michal Balog, Technical University of Kosice, Slovak Republic

Process-Oriented Approach to Fixture Design
Vitalii Ivanov
Sumy State University, Ukraine

Modeling of Foundry Processes in the Era of Industry 4.0
Jacek Kozlowski[1], Robert Sika[2], Filip Gorski[2] and Olaf Ciszak[2]
[1]Warsaw University of Technology, Poland; [2]Poznan University of Technology, Poland

On the Application of N-2-1 Locating Principle to the Non-Rigid Workpiece with Freeform Geometry
Hadi Parvaz and Seyyed Ali Sadat
[1]Shahrood University of Technology, Iran
[2]K. N. Toosi University of Technology, Iran

Implementation of CALS-Technologies in Quality Management of Product Life Cycle Processes
Yuliia Denysenko, Oksana Dynnyk, Tetiana Yashyna, Nina Malovana and Viliam Zaloga
Sumy State University, Ukraine

Technological Assurance of Complex Parts Manufacturing

Vladyslav Karpus[1], Vitalii Ivanov[2], Ivan Dehtiarov[2], Jozef Zajac[3] and Viktoria Kurochkina[2]

[1]National Academy of National Guard of Ukraine, Ukraine; [2]Sumy State University, Ukraine; [3]Technical University of Kosice, Slovak Republic

Investigation of the Influence of Electro-Impulse Current on Manganiferous Liquid-Alloy

Olena Zhbanova, Levan Saitgareev, Igor Skidin, Nonna Shapovalova and Genadiy Gubin

State Higher Educational Institution Kryvyi Rih National University

Application of Mechanical Activation for Obtaining the Polytetrafluoroethylene Composites

Kristina Berladir

Sumy State University, Ukraine

10^{30}–10^{45} **Coffee Break**

10^{45}–11^{45} **Conference Session 9 – Mechanical Engineering IV**

Session Chair: Slawomir Luscinski, Kielce University of Technology, Poland

Simulation and Analysis of Passive vs. Magneto-Rheological Suspension and Seat Dampers

Sulaymon Eshkabilov, Hamdam Jumaniyazov and Davron Riskaliev

Tashkent Institute of Design, Construction and Maintenance of Automobile Roads, Uzbekistan

Effect of the Parameters at the Inlet to the Rotor of the Jet-Reactive Turbine on its Efficiency

Serhiy Vanyeyev, Stanislav Meleychuk, Vadim Baga and Tetiana Rodymchenko

Sumy State University, Ukraine

Method of Predicting the Operating Characteristics of Small-sized Stages of High-speed Centrifugal Pumps

Sergii Antonenko

Sumy State University, Ukraine

Increase of Efficiency of Turbine Setting based on Study of Internal Flows

German Bondarenko, Serhiy Vanyeyev, Vadim Baga, Tetiana Rodymchenko and Iryna Bashlak

Sumy State University, Ukraine

Application of Artificial Neural Network for Identification of Bearing Stiffness Characteristics in Rotor Dynamics Analysis

Ivan Pavlenko[1], Vitalii Simonovskiy[1], Vitalii Ivanov[1], Jozef Zajac[2] and Jan Pitel[2]

[1]Sumy State University, Ukraine; [2]Technical University of Kosice, Slovak Republic

11^{45}–12^{00}	**Coffee Break**
12^{00}–13^{00}	**Conference Session 10 – Chemical Engineering III** Session Chair: Jozef Bocko, Technical University of Kosice, Slovak Republic

Light and Heavy Pollutant Removal by Modified Swirl Sedimentation Tank – Design and Study

Sylwia Wlodarczak, Marek Ochowiak, Malgorzata Markowska, Szymon Woziwodzki and Magdalena Matuszak

Poznan University of Technology, Poland

CFD Simulation of Ammonium Nitrate Melt in a Perforated Rotating Bucket

Maksym Skydanenko[1], Vsevolod Sklabinskyi[1] and Saad Saleh[2]

[1]Sumy State University, Ukraine;
[2]Tikrit University, Iraq

Granulation Process of the Organic Suspension: Fluidized Bed Temperature Influence on the Kinetics of the Granule Formation

Ruslan Ostroha[1], Mykola Yukhymenko[1], Andrii Lytvynenko[1], Jozef Bocko[2] and Ivan Pavlenko[1]

[1]Sumy State University, Ukraine; [2]Technical University of Kosice, Slovak Republic

Obtaining of Multilayer Granules in a Vortex Gas Flow: Automated Complex for Technological Calculation

Andrii Ivaniia and Artem Artyukhov
Sumy State University, Ukraine

Resource-Saving Technology for Obtaining the Organo-Mineral Fertilizers

Viktoriia Vakal[1] and Larisa Gurets[2]
[1]Government Enterprise «Sumy Scientific-Research Institute of Mineral Fertilizers and Pigments», Ukraine;
[2]Sumy State University, Ukraine

$13^{00} – 13^{30}$ **Closing Ceremony, Awards and Farewell**

Keynote Speakers

Olaf Ciszak,

Dean of the Faculty of Mechanical Engineering and Management,
Poznan University of Technology, Poland

DSMIE 2018

Olaf Ciszak received an MSc degree in mechanical engineering in the field of machine technology in 1994, four years later he completed his Ph.D. thesis "Modern issues of machinery construction and operation and technical systems" at the Faculty of Mechanical Engineering and Management of Poznan University of Technology. From 2008 to 2012 he was the Director for scientific research of Institute of Mechanical Technology. He was awarded the degree of habilitatus doctor of technical sciences in 2013. From 2013 to 2014 he was a Vice Dean for research at Faculty of Mechanical Engineering and Management. Since 2014 he has been the Dean of Faculty of Mechanical Engineering and Management at Poznan University of Technology. He serves as an Editor-in-chief of a scientific journal Archives of Mechanical Technology and Materials, published by De Gruyter.

His research interests cover the area of machinery construction and operation, particularly robotization of technological processes, assembly technology and Industry 4.0. He is the author of publications, monographs, academic scripts and patent applications. He has implemented a number of research projects co-financed by the European Union, Ministry of Science and Higher Education, and the National Centre for Research and Development.

He was awarded the bronze medal for Long Service conferred by the President of Poland for long and honorable service for Poland. He was also awarded by the Rector of Poznan University of Technology for his scientific, educational and organizational achievements. He was awarded by Ministry of Science and Higher Education in Poland for the international invention achievements.

Keynote Speech Topic

Industry 4.0 – Smart Factory: Challenges and Trends

Today, “Industry 4.0” is not only an abstract concept, but a reality we are beginning to have direct contact with. Concept of Industry 4.0 has been implemented in many areas by leaders of global automation, including robotics. In the contribution conclusions from surveys and experiences of enterprises in this area are presented. The paper covers the following points: What is meant by the concepts of Industry 4.0, Factory 4.0 and Smart Factory?; What areas cover the 4th industrial revolution called Industry 4.0?; If, and to what extent, investments in technologies related to Industry 4.0 are planned?; Benefits and fears related to Industry 4.0; What are the forecasted effects and key technical innovations treated as factors enabling the fourth industrial revolution. In Industry 4.0, Smart Factories, are treated as a solution in which cyber-physical systems communicate with each other via the Internet of Things (IoT) and assist people and machines in performing tasks. New digital technologies allow better process control and integration of production chains to an extent that has so far been unattainable. Such solutions open new directions leading to growth and optimization of production and, consequently, entire economic systems. As an example of the implementation elements of smart factory, solutions in the field of direct human, machine, and robot cooperation will be presented. Modern industrial robots, called “cobots”, thanks to their openness of the system, security and sensory functions, design based on the human hand, and special communication interfaces, redefine the possibilities of industrial robotics and are fully prepared for the Industry 4.0 era. Cobots allow close cooperation between machines and humans including high-precision tasks, such as in manufacture of medical or electronic equipment. According to forecasts, the industrial robotics market will increase by almost three times within a decade, and the sales of cobots will constitute as much as 1/3 of all delivered robots in 2025. Cobots are also cheaper (on average two to four times) than traditional robots and can replace traditional robots in some applications. For example, these robots are used in the automotive, metal, food and many other industries. Due to lower implementation cost, for suppliers of cobots, an important group of recipients are small and medium enterprises. The use of cobots enable these enterprises to robotize part of the production tasks without high investment in traditional robots.

Jozef Zajac,

Dean of the Faculty of Manufacturing Technologies with a seat in Presov, Technical University of Kosice, Slovak Republic

DSMIE 2018

Throughout his professional life, his work is closely linked to the transfer of knowledge from his own science school into practice. He is characterized by engaging young researchers in all activities and working to create interdisciplinary teams, including the participation of practitioners in application research. He lectured his knowledge at many distinguished conferences both at home and abroad and in scientific journals. He was and currently is the leader of the scientific teams of the APVV, KEGA and VEGA projects. Professor Zajac is responsible for solving educational and research projects, international projects and applied research projects, as well as mobility programs ERASMUS and CEEPUS

In the pedagogical field, he lectures the subjects Progressive Technologies, Manufacturing Technologies, and Innovation and Technology Transfer. The Industrial Property Office is the guarantor of the Intellectual Property Protection Course and lectures are focused on creativity in science. He was the supervisor of 63 diploma theses. He was supervisor of 16 defended dissertation theses, one of them was foreign. Currently he is supervising 5 PhD students, three of them after rigorous exam.

Jozef Zajac is member of scientific boards of Technical University of Kosice, Slovak Technical University, University of Zilina and others, and chair member of KEGA (Cultural and education grant agency MŠVVaŠ SR) and vice chair of commission no. 2; member of the Technical Science Council APVV; member of the Commission for Technological Development and Innovation of the National Council of the SR; member of the Commission for the Business Environment, Support of SMEs and Tradesmen of the National Council of the Slovak Republic. In 2017 Professor Zajac awarded the honorary degree Doctor Honoris Causa of Sumy State University for his significant contribution to the international and scientific activities.

Keynote speech topic

Creation of the intellectual property protection system at universities

Presented contribution deals with experiences of the intellectual property protection and transfer of knowledge into the practice of research institutions and creation of a functional system at universities. Not only technical, but also humanities universities have broad contacts and cooperation in education, research and development with various institutions at home and abroad. Through its activities, it covers a wide range of education needs not only for the region, but in many fields, it is the only center of science, research and education not only in the country but also in the European space. Universities are committed to innovative research projects linked to the European Research Area and to excellent education in all fields of science at the individual faculties at University. Huge amount of universities in current state do not have a systematically secured intellectual property protection system, but often this issue is systematically addressed by the various organizational components of the institution. The contribution presents the basic philosophy of building and operation within the Technical University of Kosice as a pilot project designed in Slovakia. Article identifies internal and external competencies in the field of intellectual property protection from two fundamental perspectives. The primary aim is to identify and secure the link between the UC intellectual property protection and the IPR Intellectual Property Rights (IPR Intellectual Property Rights) national and international competencies, and the secondary creation of the concept of a consistent system of legal aid for the protection of copyright and proprietary rights of university staff.

Milan Edl,

Dean of the Faculty of Mechanical Engineering,
University of West Bohemia,
Czech Republic

Milan Edl has his professional life connected with the education of specialists in mechanical engineering and industrial engineering. After graduating from the Faculty of Mechanical Engineering in 1997, he became a researcher and later an academic worker at the University of West Bohemia. At first, he was professionally oriented on the problems of applied informatics, especially on visualization and processing of data in the field of manufacturing systems. He dealt with the development of authoring systems for the creation of on-line e-learning courses, the phases of analyzing and preparing HTML outputs. His interest gradually shifted to the issue of sustainable production systems and product lifecycle management, where future bachelors, engineers and doctors lead in this issue. In the last two years he is also the Dean of the Faculty of Engineering of the University of West Bohemia in Pilsen. He is a reviewer of several international journals, a member of eight Scientific Councils in the Czech Republic and Slovak Republic, a member of the expert advisory body of the Provider for Research, Development and Innovation, a member of the Industrial Engineering and Management Board, coordinating the Industry 4.0 assets at the University of West Bohemia in Pilsen. He focused on the development of advanced industrial engineering concepts, the implementation of industrial engineering methods as a tool for the competitiveness of enterprises, the sustainability of advanced production systems with high added value. Other areas of expertise include application of mathematical and economic approaches to problem solving and applied informatics.

Keynote speech topic

Quo Vadis, Technical Education – Preparation for Professions That Are Not Yet = Education 4.0

Vision of Industry 4.0 reflects the general trend of moving towards a knowledge-based society, increasingly accentuated by the computerization and cybernetization of all manufacturing, service and state processes. These changes will have a major impact on the required qualifications and the labor market in general, and the social aspects of these impacts will also need to be considered. New principles of work organization will be promoted, the role of the employee will change, changes in the structure and occupation of most professions, new skills will be required, impact on employment and unemployment will be reflected. As a result, new labor market policies, education and social policies will be necessary. Education is the most important pillar of knowledge development in the 21st century. At a time that can be called the time of Company 4.0, it is very necessary to emphasize the change of the education system, which will reflect on the dynamic changes of the current society.

Slawomir Luscinski,

Assistant Professor of the Department of Production Engineering, Faculty of Management and Computer Modelling, Kielce University of Technology, Poland

Sławomir Luściński earned his degree of Master of Science in Engineering in Electrical Engineering, Automation and Electrical Metrology at Kielce University of Technology (1986) and the Postgraduate Diploma in Banking and Finance (1995). After a period of employment in the industry in the years 1986-1995, as an information systems manager and a software developer, he joined the KUT as an academic teacher and researcher in 1995. In the years 2004-2008 he was vice-chancellor of the Kielce University of Technology responsible for economics and computerization of administration. He received his Ph.D. degree in Economics in Management Science from University of Warsaw (2011) based on the doctoral thesis on the influence of information systems on organization development. His current research interests include various aspects of production engineering, in particular: information systems (business informatics, business information management), computer modelling and simulation in production and logistics, data engineering, physical computing. The originator and creator of the project of the Laboratory of Modeling Intelligent Manufacturing Systems in the newly-built Science and Implementation Center of Intelligent Specialization in the Świętokrzyskie Region, the launch of which is scheduled for the year 2020. Sławomir Luściński is a member of Polish Society for Production Management, Polish Information Processing Society, Polish Society for Innovations Management. To date, activities for professional growth undertaken abroad include teaching mobility assignment in Portugal, Italy, United Kingdom, and Slovak Republic.

Keynote Speech Topic

Smart Education for Smart Enterprises

How to follow Industry 4.0 in industrial engineering education? Industry 4.0 is one of the most challenging themes as well as for engineering design as for engineering education, particularly for industrial engineering education (IE). The vision of the future in manufacturing, according to Industry 4.0 initiative expressed in the high-tech strategy of the German government, includes massive use of Information and communication technologies (ICT) in designing and managing both production systems and smart products. Thus, the wave of initiatives such as the Industrial Internet, Factories of The Future, Internet of Things, Physical Internet, Internet of Services, Cyber-Physical Systems, Additive Manufacturing, Augmented Reality, Big Data. Those technologies are expected to be used to achieve a high degree of flexibility in production and shifting productivity rates to a higher level. Those improvements will be possible through real-time monitoring, information-based connection, data-based predictive maintenance and a lower wastage rate of resources in production systems. This complex vision of the future for the industry is interdisciplinary and should be supported, by nature, through the development of new skills in the education of IE. The new learning strategies should be based on the latest industry global trends integrated with the academic approach and engineering practices, employing physical infrastructure of learning factories as an environment for active learning approach. We should find the renewed professional profile of IE, based on traditional, multidisciplinary approach but with a new vision of composition of hard and soft skills for including new challenges. It is widely recognized that because of dynamic nature of changes, the partnerships between industry and higher education institutions will be more important in the future than ever before. The efforts in developing the physical infrastructure of learning factories for research and education should be aimed to incorporating as much real hardware and software, as possible to achieve the carefully designed set of transferable skills – from the industry point of view.

Dmytro Kryvoruchko,

Associate Professor of the Department of Manufacturing Engineering, Machines and Tools of Sumy State University, Ukraine;
Director of the Center of Technological Initiatives, Ukraine

DSMIE 2018

Dmytro Kryvoruchko graduated from Sumy State University in 1999 where he studied machines, tools and theory of machining process. After three years of research of cutting with thin chips he achieved his Ph.D. degree from V. Bakul Institute for Superhard Materials of the National Academy of Sciences of Ukraine. Later his research interest put into modelling of cutting metals using finite element method. He developed methodology of application of explicit dynamics LS-DYNA finite element software for prediction of forces, form and dimension of chips, cutting temperature during turning and milling operations. These allowed Dr. Kryvoruchko to receive a DSc. degree from National Technical University "Kharkiv Polytechnic Institute" in 2011 and to publish some books about finite element modeling of machining operations later. Current research interests of Dr. Kryvoruchko cover finite element modeling of FRP machining, multiaxis CNC programming and optimization of machining operations.

Today he puts great attention for practical application of his research results in industry. Developing methodology of practical teaching of engineering disciplines, he gives his students and postgraduate students ability to get practical skills and to deep their knowledge in manufacturing engineering, CNC programming and machine tools design and servicing.

He took part in trainings at University of Leeds (Great Britain), Politecnico di Torino (Italy), Royal Institute of Technology (Sweden). Dr. Kryvoruchko carried out researches in Institute for Machine Tools, University of Stuttgart (Germany).

Dr. Kryvoruchko is an Editor-in-Chief of the Journal of Engineering Sciences (Ukraine).

Keynote Speech Topic

Strategies of Professional Engineering Education for Modern Machine-Building Industry

Modern engineering education has faced new challenges. It is global trend. Production is moving towards specialization and professionalism, requiring not only highly skilled jobs, but also advanced training in traditional workplaces. From one side students prefer specialties, which are not difficult to study. From other side total automatization makes low qualified workers unnecessary. Emigration opportunity results in high salary growth, sometimes to the levels that the business could not offer. The big gap between salary in Ukraine and other countries motivates people to emigrate more than career growth through knowledge and skills development and increasing of labor productivity. New strategies of professional engineering education should change situation in modern machine-building industry. These strategies should pursue following goals: (1) realization of practice oriented education with high specialization; (2) realization Industry 4.0 concept based on multidisciplinary training courses; (3) giving students ability to get practical experience in industry during period of studies at university; (4) motivation students to creative activity and application of their inventions in industry and/or through start-ups. The presentation shows advantages and disadvantages of realization of professional engineering education in various educational institution and analysis possibility of their application in Ukraine.

Jan Pitel,

Vice Dean for Development and External Relations of the Faculty of Manufacturing Technologies with a seat in Presov, Technical University of Kosice, Slovak Republic

Ján Piteľ currently works as vice-dean and head of the Institute of Production Control. His research activities include modelling, simulation and automatic control of machines and processes. He is author of more than 50 papers registered in databases WoS and Scopus with more than 150 SCI citations. He is inventor and co-inventor more than 50 patents and utility models. He was leader of national and international projects. Currently he participates in 2 EU projects (Horizon 2020, Erasmus+).

Ján Piteľ received his MSc degree in Electrical Engineering at the Technical University of Košice (1985). After a period of employment in the industry (1985–1992) as research and development worker of robot control systems, he joined the Faculty of Mechanical Engineering of the Technical university of Košice as an academic teacher and researcher in 1992. He received his PhD degree in Automation and Control (2004) based on the doctoral thesis on the heating process control. He joined the Faculty of Manufacturing Technologies of the Technical University of Košice in 2005, where he defended his habilitation thesis "Automation of Manufacturing Technologies Using of Manipulators Actuated by Artificial Muscles" (2008). In the period 2009–2013 he was a head of Department of Mathematics, Informatics and Cybernetics. He was a vice-dean for science and research of the Faculty of Manufacturing Technologies with a seat in Prešov (2013–2016). In 2017 he was appointed by the President of the Czech Republic as a Professor in Machine and Process Control of the Tomas Bata University in Zlín (Czech Republic). Now he is a Full Professor in Automation at the Technical University of Košice (Slovak Republic). He was supervisor of 4 successfully defended PhD theses, currently he is supervising 3 PhD students.

Keynote Speech Topic

Muscle-based Actuators for Pneumatic Manipulators

Most of the currently used industrial robots use electric actuators giving them high positioning accuracy, relatively high motion speeds and quiet operation. On the other hand, the weight of current high-performance electric robots is significant also due to a relatively low power-to-weight ratio of electric actuators. Using pneumatic actuators for robotic applications has its advantages in lower costs, decreased weight and safe operation. However, extensive use of this type of actuator in industrial robots is hindered by low positioning accuracy, low power and leakage problems when traditional pneumatic actuators (like pneumatic cylinders) are considered. Pneumatic artificial muscles (PAM) belong to the group of nonconventional pneumatic actuators intended for use in industrial and biomedical areas. Pneumatic artificial muscles possess all the advantages of conventional pneumatic actuators (low price and weight, simple and safe operation) but in contrast to them they have much better power/weight ratio, they do not require lubrication and they lack stick-slip effect. The research of PAM-based systems is often aimed at actuators with a pair of pneumatic artificial muscles connected through a pulley or a sprocket. The kinematic configuration of such a system is relatively simple, comprising one degree of freedom. When construction of a robotic arm is considered, such configuration represents a subset of kinematic configuration of the whole robot. Nowadays the research is focused to increase the number of degrees of freedom and on control level new intelligent methods should be looked for to meet the requirements on PAM-based system performance.

Marek Ochowiak,

Head of Department of Chemical Engineering and Equipment, Faculty of Chemical Technology, Poznan University of Technology, Poland

DSMIE 2018

Marek Ochowiak earned his degree of Master of Science in Chemical Technology at the Department of Applied Electrochemistry of Poznan University of Technology (1998). His Ph.D. thesis “The study of the gas-liquid flow phenomena in modified spray absorber” was made under supervision of Professor Lubomira Broniarz-Press at the Department of Chemical Engineering and Equipment of Poznan University of Technology (2002). He received his Habilitation degree in Chemical Engineering from Silesian University of Technology, Gliwice, Poland (2014). The title of scientific achievements for habilitation degree was “The analysis of liquid atomization process in effervescent and effervescent-swirl atomizers”. He is the author and co-author of numerous works in the field of chemical engineering, atomization and nebulization processes, as well as separation processes and visualization.

His research interests include multiphase systems, atomization process, design of atomization systems, purification of gases and liquids, separation processes, and computer analysis of images.

Keynote Speech Topic

Design and Study of Conical Pressure-Swirl Atomizers

The contribution shows results of experimental studies for two-phase swirl atomizers with two inlet ports differing in terms of design. The effect of volumetric liquid and gas flow rate and the height and diameter of mixing chamber on the discharge coefficients, histograms, radial distributions of mean droplet diameters in the drop stream and the mean Sauter diameter were determined. The studies were conducted within the air flow rates not exceeding $5.6 \cdot 10^{-4}$ [m^3/s] and water flow rate $1.11 \cdot 10^{-5}$ [m^3/s]. It was shown that the discharge coefficient increases with the higher Reynolds number for liquid and decreases with the higher gas flow rate. The increased liquid flow rate caused greater drop diameters and increased gas flow rate allowed to obtain droplets with smaller sizes. The value of Sauter mean diameter is dependent on the ratio of height to diameter of mixing chamber. The rapid increase in the mean droplet diameter occurs above the value of $H_S/D_S \approx 2.75$. It was further noted that the higher gas flow rate within the aerosol axis gives rise to drops with smaller diameters and there is a clear difference in the size of droplets between the central stream area and its edges. Also, the empirical correlation was proposed for discharge coefficient as a function of work characteristics and geometric dimensions of the atomizer. The obtained data can be used for designing new atomizers and are essential from the viewpoint of agriculture or combustion processes.

Eugene Kozhukhovsky,

Founder and CEO of Smartprint LLC, Ukraine

Mr. Eugene Kozhukhovsky received a higher engineering education in the Odessa State Academy of Construction and Architecture in 1997 and an education in psychology management at the St. Petersburg State University in 2005.

He devoted many years to work in the field of polymer processing. Participated in the launch of the production of polycarbonate sheets in the Dnieper. Has gained a lot of experience in the production and supply of polymeric raw materials, equipment for polymer processing, the production process for manufacturing products from polymers.

Since 2011, began the development and promotion of additive technologies in Ukraine. In 2013 he founded the company Smartprint – today, the leading provider of additive technologies in Ukraine and Europe.

With the initiative and direct involvement of Mr. Eugene Kozhukhovsky, together with the Ukrainian Chamber of Commerce and Industry, the first exhibitions of additive technologies were organized and held in 2014 and 2015.

Today Mr. Kozhukhovsky is the leading speaker representing additive technologies at various events, such as exhibitions, industry conferences and seminars. Regularly conducts speeches in Ukrainian educational institutions, introducing students and teaching staff with the latest achievements in additive technologies. He constantly participates and visits the leading exhibitions of additive technologies both in Ukraine and around the world.

Keynote Speech Topic

Combining Additive Manufacturing with Proven Metal Casting Processes

The light weighting trend in design and manufacturing grows stronger every day. In automotive and aerospace, it is driven by rising global demands to improve fuel economy and lower emissions in ground vehicles and aircraft. In the medical industry, using smaller devices with less material increases design flexibility and improves the patient experience. Two areas of significant promise in the light weighting world are generative design and additive manufacturing. Generative design helps engineers come up with design solutions that would be virtually impossible to imagine and impractical to model with traditional CAD software. Additive manufacturing brings these previously "unmakeable" designs to life. Together, the two technologies are beginning to help engineers across numerous industries radically reduce total weight or significantly improve the strength and durability of components without adding weight. Where this approach has been limited, however, is with larger products. Additive manufacturing can print the complex, high-performance structures created by generative design, but 3D printing with metal is restricted to relatively small objects and only certain alloys. Metal casting, on the other hand, can be used to make very large structures of virtually any metal or alloy. But traditional mold-making processes used in metal casting limit the shape and complexity of what can be made with casting. Today, these limits are disappearing as experts in generative design, additive manufacturing, and metal casting collaborate to make the most of all three technologies. This report explores how and why this is happening and provides a detailed look at an award-winning example of the innovation that is possible when these ideas converge.

Nikolay Kiryukhin,

President of the Union of Scientific and Engineering Associations of Ukraine, Ukraine

Nikolay Kiryukhin received an engineering diploma in the field of nuclear physics in 1978 in Kharkiv National University. In 1987 he defended his PhD thesis “New materials design for application in irradiation environment” in Kharkiv National Polytechnic University. From 1978 till 1993 he worked in National Scientific Center “Kharkiv Institute of Physics and Technology” consistently occupying positions from junior researcher to the head of the department. He obtained scientific title “Senior Researcher” in 1989. From 1993 till 2006 he was deputy director and director of Research and Production Company “Plasmed”. In 2006 he got position of deputy executive director of Union of Scientific and Engineering Associations of Ukraine (USEAU). He was elected as president of this organization in December 2012.

Nikolay Kiryukhin research interests cover the area of new materials design for nuclear and airspace applications. He is the author of publications, academic scripts and patent applications. In 2007–2010 he was co-author of chain of manuals for physics for schools (7–11 classes). He was project manager and leading expert in many research projects funded by US DOE, European Commission, Ministry of Education and Science of Ukraine, State Space Agency of Ukraine, Ministry of Health Care of Ukraine. His main area of activity since 2009 is the implementation of European procedures of certification of engineers in Ukraine. Nikolay Kiryukhin was the main organizer of many national and international conferences since 2000. He was elected as full member of Academy of Technological Sciences of Ukraine in 1996 and is its Board member since 2001.

Keynote Speech Topic

European Engineering Card: Implementation in Ukraine

Human being/engineer is still the "key element" of any manufacturing chain or innovation in spite of rapid automation and robotic development. The same time, there are at least two challenges for present-day engineers: (1) Period from university graduation till retirement is 40+ years. Present technique is absolutely differing compare to the one of 40 years ago. There are appeared not only new industrial sectors, like solar energy or unmanned cars, but also new concepts, like Industry 4.0; (2) Global world requires engineering mobility from Singapore to Chile, from Canada to New Zeeland etc. The new standards for engineering qualification were appeared as the reaction on above challenges and were initiated by world/European engineering federations. These standards include two parts: engineering program accreditation (a) and certification of individuals (b). The first part is the "area of responsibility" of International Engineering Alliance – Washington Accord (world level) and European Network for Accreditation of Engineering Education (European level). Details about this part require additional description. Key objective of this topic is to describe part b and to present procedures for certification of individual engineers, which was developed by European Federation of Engineering Associations (FEANI), namely, Engineering Card and EUR ING title. The Engineering Card is a professional card, which is applied for voluntarily and of which the associated record can be retrieved in the National Engineering Register. The card shall be a standardized format approved by FEANI for the documentation of relevant qualifications for the engineering profession. The EUR ING title delivered by FEANI is designed as a guarantee of competence for professional engineers, in order to facilitate the movement of practicing engineers within and outside the geographical area represented by FEANI's member countries and to establish a framework of mutual recognition of qualifications in order to enable engineers who wish to practice outside their own country to carry with them a guarantee of competence. Union of Scientific and Engineering Associations of Ukraine (USEAU) started contact with FEANI in 2009. USAEU became FEANI member in 2015 and realized all FEANI requirements concerning Engineering Card and EUR ING title. 20+ Ukrainian engineers already received Engineering Cards.

Abstracts
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Implementation of CALS-Technologies in Quality Management of Product Life Cycle Processes

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The aspects of the usage of CALS-technologies in support of the life cycle of products are considered in this research. The identification of problems and the main ways of creating a unified information space in the quality management system are focused on, due to the principles of ISO standards series 9000. Based on the analysis, a unified methodological approach to the construction of quality management systems for the application of CALS-technologies is introduced. As an example, a conceptual model of the information system for lifecycle management of instrumental production based on the process approach was suggested. The algorithm of construction and implementation of the introduced model with the consideration on the features of this system is developed. It is shown that observance of the recommendations set forth in the research work will allow to improve the quality of technological equipment as well as to facilitate the optimization of its processes, then it will lead to an increase in labor productivity, reducing resource dependence and costs.

Keywords: CALS-technologies, Implementation, Effectiveness, Life Cycle.

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Variation Coefficient and Some Distribution Laws in the Context of Cutting Tools and Other Technical Objects Reliability Modeling

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Abstract. In the paper some practice of the usage of three distribution laws: Gauss, Gamma, and Weibull for reliability modeling of technical objects in general and metal cutting tools in particular are analyzed and arranged. Selection of distribution law and estimation of its parameters based on empirical data are the main tasks in reliability simulation. It is stressed that selection of the above-mentioned laws should be made taking into account the process mechanism; otherwise, it leads to some false conclusions such as equivalence of Gamma and Weibull distribution. Mentioned distribution laws and their usage are analyzed from the position of physical interpretation. The conditions are shown when the above-mentioned distribution laws are similar. The simplified dependence that connects the shape parameter of Weibull distribution and variation coefficient is obtained and confirmed statistically. The variation coefficient defines the shape parameters for both Gamma and Weibull distributions uniquely and reflects the mechanism of the process. The variation coefficient and failure rate in addition to formal criteria are shown to be the main indicators for the distribution law selection.

Keywords: Failure Rate, Weibull Distribution, Gamma Distribution, Shape Parameter, Scale Parameter, Gauss Distribution, Metal Cutting Tool, Reliability Modeling, Empirical Data, Object Failure

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Measurement of Non-Rigid Tools Action Force During Finishing

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The purpose of the research was to design a device (dynamometer) for measuring the action force on work surface (cutting force) during the finishing process with non-rigid tools such as flap wheels, mechanical brushes with metal and nonmetal fibers, or using jet processing with various fillings – sand, grinding materials, metal shot, glass microbeads, etc. The information about force level is used, for example, to select a tool or a method for finishing of thin-walled parts or edges as well as for determination of rational processing modes of the method selected. This device considers special features of action force of some tools and methods: distributed type of loads; rapidly changing force intensity; possibility of rocking sensitive device element; furthermore, different level of loads needs increased sensitivity on the one hand, and on the other hand, the universality of the device. The proposed device provides measuring constant, inconstant and harmonic loads in wide range as well as measuring concentrated and distributed forces with high accuracy. It allows registering information in real time, saving and processing data in a comfortable form. The results of research determined that force is 20…100 N depending on processing modes and tool options, therefore polymer-abrasive brushes can be used for thin-walled parts.

Keywords: Dynamometer, Action Force, Cutting Force, Finishing, Polishing, Brush Polymer-Abrasive Tool.

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Implementation of Material Flow Simulation as a Learning Tool

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The paper is focused on the possibility of implementation the simulation of the production process into the education process. Recently, emphasis has been placed on digitizing the production process, using Industry 4.0 and, last but not least, optimizing and minimizing production times. The paper is organized as follows into two sections. Section 1 describes the concrete possibilities of implementation the simulation software and section 2 describes the evaluation of results on a concrete example from production process. After defining the same input data for 4 types of rolling bearings (production times, material flow and Gantt chart), the variety of simulation was followed in order to achieve an optimal distribution of production, transport and storage ratio in the 50:30:20 range. Due to the application of the simulation students are taught how to benefit of a thorough analysis of production process, and all the time the students are very close to the real work environment of the production company.

Keywords: Plant Simulation, Education, Student's Simulation.

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Process-Oriented Approach to Fixture Design

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Machining of parts on the metal-cutting machine tools could not be ensured without the use of fixtures. They are an integral part of the closed-loop technological system "machine tool – fixture – cutting tool – workpiece" and make the significant impact on the accuracy and quality of machining of machine parts surfaces. The work presents the structural stages of computer-aided fixture design and determines the data flows between them to ensure the comprehensive approach. The process-oriented model of fixture design process has been developed, which provides the manufacturing analysis of the workpiece, synthesis and optimization of fixture configurations, verification of the mechanical system "fixture – workpiece" for set production conditions, and functional links and data flows between stages have been determined. The above-mentioned allows realizing a comprehensive approach to the computer-aided fixture design in multiproduct manufacturing.

Keywords: Machine Tool, Fixture, Computer Integrated Manufacturing, Data Flow, Manufacturing Analysis, Multicriteria Optimization, Verification, Computer-aided Fixture Design, CAFD System.

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Technological Assurance of Complex Parts Manufacturing

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The article describes ways of intensification of machining complex parts of vehicles on the modern metal-cutting equipment were described. The classification of parts such as levers was developed on the basis of design and technological features. Based on the developed classification the structural code that allows to encode any lever design was proposed. The structural code can be used in computer-aided fixture design and in information retrieval systems for selecting optimal fixture for levers. The reasonability of intensification of parts machining such as levers was substantiated, the typical manufacturing process was analyzed, and opportunities for optimization subject to current trends in machining and technological capabilities of modern equipment were identified. The adjustable module characterized by high level of flexibility was proposed for CNC multiaxis machining operation. Comparative analysis of manufacturing processes by labor content, quantity of fixtures and machine tools, number of setups, and production area was performed.

Keywords: Classification, Lever, Manufacturing Process, Fixture, Locating, Labor Content, Setup Time.

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Modeling of Foundry Processes in the Era of Industry 4.0

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The paper presents main areas of Industry 4.0 concept with regard to specificity and complexity of foundry processes. Data mining tools are discussed in terms of the possibilities and limitations of their application in Smart Factories. Data acquisition methods are described and the potential areas of restrictions in Internet implementation of things are identified on the example of foundry processes. The methodology of data preparation is also presented, including key tasks and actions to be taken, so that the collected production data are valuable from the point of view of Data Mining tools. As a result, the concept of CPS (Cyber-Physical Systems) / CPPS (Cyber-Physical Production Systems) tool allowing effective implementation of Data Mining tools in complex production processes is presented.

Keywords: Industry 4.0, Data Acquisition, Data Mining, Foundry Processes.

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ANSYS Simulation of the Joint Strength with the Interference Fit in the Presence of the Shape Geometry Error

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The effect of the shape geometry error on the strength of a cylindrical joint with interference fit was investigated. The strength of the joint without a geometry error was compared with the strength of the joint in the presence of conicity, saddle shape, barrel shape, ovality. The calculation is carried out by the finite element method in Ansys. It is established that for small-bore diameters the strength of a cylindrical joint with interference decreases significantly, i.e. one-third of the initial one. The most unfavorable is a saddle shape, followed by ovality and conicity, and the barrel shape does not lead to a significant decrease. For large diameters, the influence of the shape geometry error on the strength of a cylindrical joint with interference is less significant. It is recommended tightened standardization of the shape geometry error in manufacturing of parts of critical joints with interference.

Keywords: Strength Decrease, Cylindrical Joint, Finite Element Method, Conicity, Saddle Shape, Barrel Shape, Ovality.

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Adaptive Profile Gear Grinding Boosts Productivity of this Operation on the CNC Machine Tools

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The paper is devoted to solving an important scientific and technical problem of increasing the productivity of defect-free profile gear grinding on CNC machines through computer subsystems of grinding operation automated design, monitoring, and grinding diagnostics. The corresponding methodology and theoretical preconditions for these computer subsystems developments are provided to solve the following scientific problem. Despite of the increase in the productivity of gear grinding on CNC machines, many attendant factors have appeared that limit the gear grinding productivity: the time of the grinding stock, the lack of methods for accounting the information about the grinding stock, etc. In this connection, the objective of the paper is to indicate the ways of increasing the productivity of the profile defect-free gear grinding on CNC machines. For this purpose, a set of purposeful methods and means of innovative adaptive gear grinding technology has been developed. For example, a method for restoring information about the grinding stock is proposed with a limited number of measurements to ensure, for example, that the feed can be switched from accelerated one to working and vice versa. Mathematical models have been developed to convert the grinding stock uncertainty into the deterministic value of the grinding wheel retraction from the workpiece.

Keywords: Adaptability, Gear Grinding System, Gear Grinding Stock, Grinding Stock Model, Designing, Monitoring, Diagnostics.

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Provision of the Quality of Manufacturing Gear Wheels in Energy Engineering

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Mathematical modeling of thermal processes during grinding and of the process of formation of residual stresses and cracks is done. On this basis the technique of calculation of thermal processes and of internal residual stresses arising during grinding of wheels made of cemented steels is offered. It is shown that the grinding temperature when machining gears from cemented steels should not exceed the temperature at which the reverse martensitic transformation occurs-the formation of austenite. The formed austenite during grinding does not completely turn into martensite, since the cooling temperature does not overlap the interval Ms-Mf as a result the so-called burnings of hardening are formed. Burnings of hardening 3-4 times reduce the strength and durability of the ground surface, and therefore of the whole part. On the basis of performed calculations, ways of improving the quality of manufacturing of work surfaces of teeth of tooth gears, which are used in aggregates of thermal and nuclear power plants, are proposed and substantiated.

Keywords: Cemented Layer, Residual Stresses, Solid Lubricant, Intermittent Circle.

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Combined Laser-Ultrasonic Surface Hardening Process for Improving the Properties of Metallic Products

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Combined laser-ultrasonic hardening and finishing process of large-sized products using laser heat treatment (LHT) followed by the ultrasonic impact treatment (UIT) is proposed. A medium carbon and chromium tool steels were heat treated by a 1 kW fiber laser with scanning optics and heating temperature control system to improve their surface hardness. A number of experiments are carried out by changing the heating temperature and specimen feed rate while keeping a constant scanning speed and width. The specimen surfaces were severely deformed by an ultrasonic tool equipped with a seven-pin impact head supplied by a 0.3 kW ultrasonic generator and controlled by a computer-driven machine to form a regular surface microrelief and compressive residual stresses. The results indicate that the combined treatments provide more than triple increase in the surface hardness and formation the compressive residual stresses.

Keywords: Laser-Ultrasonic Hardening, Scanning Optics, Multi-Pin Impact Head, Temperature Control, Regular Microrelief, Hardness.

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Influence of the Scale Factor of Fibers and the Temperature of Structuring on the Physical and Mechanical Characteristics of Hemp Fiber Biocomposites

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According to sustainable development approaches in the world, there are tendencies to save renewable resources, or resources with a long recovery time. This research aims to develop new composite materials based on the renewable resource in the form of hemp fibers. The article shows the results of research of mechanical characteristics (impact toughness, tensile strength, hardness) of polymer composite that is fiber-reinforced by technical hemp. The effect of size of fibers and method of structuring the polyester matrix on the mechanical properties is studied. The optimal composition of the composite, which provides better mechanical properties, is defined. It is determined that the investigated composites can be used as construction material based on renewable source.

Keywords: Technical Hemp, Fiber, Polymer Composite, Mechanical Properties, Renewable Resources.

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On the Application of N-2-1 Locating Principle to the Non-Rigid Workpiece with Freeform Geometry

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Fixture design for non-rigid workpieces is performed based on the N-2-1 locating principle (with N>3 base locators). Determination of the position and orientation of the application points of the locators are among the most challenging processes that fixture designers are encountered with, especially in case of the freeform work piece without specific datum features. In this paper, the N-2-1 locating principle has been applied to a non-rigid freeform workpiece. Four distinctive locating plans have been designed by alternating of two parameters: the quantity of the base locators (N) and the position of the locating points on the base locating surface. Numerical analyses have been conducted using finite element software to investigate the effects of the mentioned parameters on the fixturing characteristics under the application of the clamping forces. The output parameters can be elaborated as workpiece deformation, displacements of the locating points, stress values and the reaction forces generated on the locating agents. The best locating plan has been chosen by the application of the suggested decision-making model by incorporation of the calculated fixturing characteristics. Based on the results, reductions of almost 41.6% and 66% were observed respectively on the workpiece maximum deflection and cumulative locating points' displacements by switching from the 3-2-1 to the N-2-1 (with N=6) locating system without sensible change in the stress values.

Keywords: Fixture Design, Fixturing Layout, Finite Element Analysis, N-2-1 Locating Principle, Sheet Metal Part.

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Information and Communication Technologies within Industry 4.0 Concept

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Internet of Things provides connectivity and interoperability between transport entities, transported entities and product entities in Industry 4.0 concept. The market requirements are changing on daily basis and for the business processes of manufacturing organizations to be successful, it is necessary to link all the supply chain stakeholders and ensure their real-time informing, by forming an ecosystem for connecting stakeholders of Industry 4.0 concept. By implementing contemporary information and communication technologies in the production line it is possible to ensure the flexibility of production and adaptation of product entities to end user requirements. The problem of providing real-time information to all participants in supply chain has been identified by analyzing the traditional supply chain in the manufacturing industry. Based on the analysis of information and communication technologies in Industry 4.0 concept, the aim of this research is to propose optimal information and communication technologies for connecting stakeholders of logistic production chain. This extends the opportunity for all logistic production chain participants to inspect the stage of product entities from the stage of the development of product materials to the delivery stage of the product to the end users.

Keywords: Internet of Things, Logistic Production Chain, Stakeholders.

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Computer Modeling Application for Predicting of the Passing of the High-Speed Milling Machining Hardened Steel

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A high-speed milling of hardened steels at multi-coordinate machining centers in individual and small-series production has become of special interest because of the ability to provide high-quality characteristics of products. To ensure the surface layer quality with extremely small values of residual roughness, surface microhardness, and structural phase composition, a computer-aided simulation of the high-speed milling process by computational-logical algorithms based on the finite element method was performed. The experiments with computer simulation research of high-speed milling were done for two objectives: the process of rectangular cutting and the process of oblique-angled cutting of materials. Two-dimensional and three-dimensional computer modeling was used for the research. The connection between the chip formation process, the stress-strain state of the material, and the angle of inclination of the chip-forming groove of the end mill was established. The maximum value of the energy contribution to the cutting process was offered to choose for the determination of the maximum limit cutting conditions in high-speed milling.

Keywords: Computer Simulation, Finite Element Method, High-Speed Milling, Cutting Conditions.

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Computer Simulation of the Processes of Mixing in Multilayer Nitride Coatings with Nanometer Period

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Using the complex of methods for the structural state attestation in combination with the computer simulation and measurement of mechanical properties (hardness), the influence of the period Λ on the mixing process on the interlayer boundaries of multilayer coatings TiN/ZrN, CrN/ZrN and MoN/ZrN is studied. The coatings were obtained by the vacuum arc method on the upgraded "Bulat-6" installation. By means of the computer simulation method the depth of impact was estimated, which for the systems under investigation is about 2 and 3.5 nm, respectively. It is established that for the period Λ = 20 nm the highest hardness is 44 GPa. At Λ less than 20 nm, the hardness decreases, this can be related to the formation of a solid solution in the border regions due to the radiation-stimulated mixing. Computer simulation results obtained in the work allow to define the regimes for the optimal structural state. This is the basis of the direction of the structural engineering of nonequilibrium systems.

Keywords: Computer Calculation, Multilayer Coatings, Bias Potential, Structure.

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Model of Thermal State of the System of Application of Coolant in Grinding Machine

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A high grinding performance and ensuring the accuracy and quality of processing depend on a stable thermal regime in the cutting zone, which is carried out by efficient removal of the released heat. Application of lubricating and cooling fluid allows reducing the power and cutting forces, accelerates heat transfer, provides a reduction in temperature in the cutting zone. It's found out, that the most instability is characteristic for the heat entering the machine tool from the coolant system. Potentialities of decreasing of heat fluxes influence at the grinding machine on the accuracy by improving cooling ability of coolant tank are researched. The heat exchange processes in the coolant tank of the grinding machine are studied. A mathematical model describing the temperature regime of coolant in the grinding machine tank is proposed. The model makes it possible to estimate the steady-state and non-stationary temperatures of the coolant in the tank, depending on the course of the stages of the grinding cycle and to define the rational volume of the coolant, considering the cooling of cutting zone, the grinding parameters, and the characteristics of the grinding wheel.

Keywords: Coolant Application System, Stationary Mode, Nonstationary Mode, Temperature Gradient, Heat Transfer Coefficient.

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Technology of Effective Abrasive Jet Processing of Parts Surfaces

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Presented scientific work is devoted to increasing the efficiency of abrasive jet machining through the development and implementation of a new, wear-resistant and progressive abrasive jet tool, namely a new designed assembled Venturi type nozzle. A developed design of a nozzle provides the formation of a special air layer on its internal working surface, which allows significantly decrease the contact of the abrasive air blast with the working surface of the nozzle, which increases its durability and the efficiency of the abrasive jet machining. Such kind of effect was reached by using a permeable porous insert in the narrowest part of Venturi type nozzle. An additional air flow is fed in radial direction to the outer surface of the insert and then penetrates through porous wall to the inner working surface of the nozzle. The desired design of developed product was obtained using titanium powder metals which were pressed and sintered in conditions of self continues high temperature synthesis because of its energy-efficient properties. Besides, if one of components of assembled nozzle is worn off, it is easy to fix by replacing to a new one.

Keywords: Sand Blasting, Nozzle, Porous Material.

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Choice of the Optimal Parameters of the Ultra-Fine Grained Cooper Machining

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This article is focused on the features of the structure of ultra-fine grained metals and the influence of the machining on its changes. The search for optimal parameters was carried out for machining of pure copper, obtained by the method of several plastic deformations. The objective function, which includes a new criterion of optimization, was proposed. Limitations of the function for turning ultra-fine grained copper were obtained from experimental data. As a criterion of optimality, a general combining criterion is proposed, which is based on the linear convolution, two particular criteria the productivity and size of the grain size of nano- and ultra-fine grained metals, each with its own weight coefficients. The optimization problem was solved by the penalty function method in the MATLAB software environment using the method of unconditional mini-mization of several variables. Optimal decisions on the selection of the cutting speed and feed during the rotation of ultra-fine grained copper with different initial grain sizes are obtained.

Keywords: Ultra-Fine Grained, Pure Copper, Machining, Optimization, MATLAB.

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Obtaining of Porous Powder Materials by Radial Pressing Method

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The article presents the results of theoretical and experimental investigations of the radial-isostatic pressing process of powder materials (PM) in order to improve its effectiveness, to create the new and improve the existing technologies, equipment, tools and PM with the improved properties. For analytical description of the pressing processes we propose a new improved equation of pressing, which takes into account the properties of PM, powder consolidation during pressing, the loading schemes and allows general authentical description of the deformation behavior of the porous material. We improved the construction of the machine press-block for dry radial-isostatic pressing of enclosed volume and also developed a number of new technical solutions which can solve the problem of obtaining high-quality and long powder products (simple and complex shapes) with a uniformly distributed density by volume. Proposed solutions also allow reducing the volumes of intermediate environments, power inputs of the pressing process, sizes and metal content of equipment, costs, which raises the productivity of work and reduces the cost of manufactured products.

Keywords: Powder Metallurgy, Porous Powder Material, Dry Radial Isostatic Pressing, Yield Surface, Plasticity Model.

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Methods for Calculating the Grain Boundary Adsorption Capacity of Nanostructured Copper based Condensates

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The structure of vacuum Cu-Ta and Cu-Mo condensates in the form of foils approximately 50 μm thick was studied by transmission electron microscopy and X-ray diffractometry. The samples were obtained by electron-beam evaporation from various sources in vacuum of ~ 10^{-3} Pa. It is established that alloying of copper condensates with tantalum or molybdenum in the amount of 0.4-0.5 at. % disperses the grain structure of copper matrix from micro- to nanoscale dimension. It is shown that this effect is due to the blocking effect of adsorption layers of tantalum or molybdenum atoms formed on the surface of growing copper grains during the condensation of two-component vapor. Based on the experimental data and theoretical calculations carried out in different approximations, the conclusion about the monolayer character of grain-boundary segregations of tantalum or molybdenum atoms on the grain boundaries of copper matrix was made. Numerical methods for calculating the concentrations of tantalum or molybdenum that are necessary for the formation of monoatomic adsorption layers at grain boundaries of matrix metals of specified sizes are developed. Concentration dependencies of grain sizes of copper matrix calculated theoretically by the proposed method are in good agreement with the experimental data.

Keywords: Thermal Stability, Grain Size, Grain Boundary Segregation.

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Investigation of the Influence of Electro-Impulse Current on Manganiferous Liquid-Alloy

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The article shows that for improving the quality of castings, more and more often, technical solutions are used related to the influence of electric current on the melt during its crystallization. The positive results of such a modification are improved processes of heat and mass transfer and structuring. However, these results only concern the electrical treatment of non-ferrous metals and alloys, as well as some castings. The influence of the electric current limits on the degree of modification of manganese-containing steels during their crystallization in the foundry, as well as on the physical and mechanical properties of the casting requires careful research that would be close to real conditions. The authors compared the macro and microstructures of steel 35GL doped with manganese and modified during crystallization in the foundry form of the electro-impulse current with different current parameters: intensity, duration of impulses, frequency, squinting. It has been established that the modification of an alternating polarity with an electric pulse current of more than 10–3 s, a frequency of 5–33 Hz, a force of 30-40 A, a vacuum of 5–24, at a voltage in the power line of 180–240 V provides a reduction in structural inhomogeneity (the crystallite of the metal base and manganese carbides are reduced respectively from 280 to 82-85 microns and from 6.7 to 0.3-0.5 microns).

Keywords: Electroprocessing, Alloy, Microstructure of Steel.

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Forecasting Real Option Price Model by Means of Evolutionary and Genetic Algorithms

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Research goals and objective: to predict real option prices using evolutionary and genetic algorithms which affect the accuracy of price forecasting. The object of research: real option price model. The subject of research: forecasting evolutionary and genetic algorithms for real option price model. Research methods are genetic algorithm, evolutionary algorithm, statistical technique. Results of the research: in options trading one of the main tasks is to determine the fair price option, using which we can estimate what options are undervalued, and which ones are overvalued at the moment. The decision on the purchase or sale of a particular option is made according to these algorithms. In this paper we apply genetic and evolutionary algorithms in the areas of financial instruments in order to create software intended for analysis and forecast of real price option.

Keywords: Genetic and Evolutionary Algorithms, Options, Financial Instruments, Optimization, Forecasting.

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Application of Mechanical Activation for Obtaining the Polytetrafluoroethylene Composites

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Modification of polymer matrices and mixtures of polymer compositions by means of mechanical activation technology is an effective and economically advantageous method for increasing its operational properties due to low energy and metal capacity of the equipment, the simplicity and safety of this process. An approach of preparation of a matrix and fillers of various chemical nature for obtaining polytetrafluoroethylene composites by the reasonable choice of a ratio of ingredients and technology of their modifying is offered. Special features of developed technology for the production of composite based on polytetrafluoroethylene with the required operational properties include a preliminary separate preparation of the matrix and the fillers before their mixing by means of mechanical activation under different modes of equipment, as a result of which an increase in the indices of wear resistance by (3,7–6,0) times, strength at break – by 1,4 times compared to industrial analogs. Piston rings and packing seals of piston-type compressors, made of the designed composite, allowed us to increase working resource of equipment of compressor engineering by (1,8–2,3) times.

Keywords: Polytetrafluoroethylene, Mechanical Activation, Antifriction Composite, Strength at Break, Wear Resistance.

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Abstracts
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Experimental Study of the Power Characteristics Influence on the Hydraulic Efficiency

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The hydraulic unit of rotation control system is improved. It is based on the use of a hydraulic distributor with a hydraulic vibration circuit and the injection of a hydraulic feedback for pressure. Due to this, the efficiency during winding operations increases. A model of the experimental installation for hydraulic unit of rotation for winding is developed and made. It provides a constant wire tension force. Hence, the hydraulic stiffness and reliability are increased. The influence of the working parameters for hydraulic unit for winding of the electric motors wound on its efficiency is investigated. The results of a two-factor active experiment are presented. It was conducted using a rotatable plan of the second order. The response function is obtained and its adequacy is proved. The graphic dependencies of the hydraulic motor shaft moment from the wire tension force at different values of its shaft rotational speed are built. The optimum values of the wire tension force and the hydromotor shaft rotation frequency are defined. The hydromotor linear mathematical model is developed. The operating time for the hydraulic unit of rotation is set.

Keywords: Hydromotor, Two-factor Experiment, Wire Tension Force, Rotational Speed, Operating Time, Optimization.

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Increase of Efficiency of Turbine Setting based on Study of Internal Flows

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Turbo efficiency largely depends on the internal overflows. To determine their flow characteristics a simplified calculation model of the opening with a sharp edge is used. It is supplemented with the experimental coefficients obtained under conditions which are significantly different from as-build. These ratios do not consider the ring gap shape, flow vortexes on the inlet, eccentricity, shaft rotation, scale factor. When designing, simplification data do not allow using a labyrinth seal with a minimum leak value. The aim of this work is to upgrade knowledge about the workflow in the labyrinth seals using the modern methods of computational fluid dynamics (CFD), which are going to increase the efficiency of the internal labyrinth seals. At the same time, the numerical and experimental studies of the labyrinth seal element were carried. The research tasks are to establish the correctness of CFD methods application for studying the flows in the essentially narrow slits and obtaining the visualizations of the workflow under various geometric and regime parameters, to give practical recommendations on the design of such seals. Velocity fluctuations in the labyrinth seal are identified. They result from the uneven distribution of pressure along its length. The seal design with a variable pitch that allows reducing the leakage to 30% is proposed. Shaft rotation causes leakage reduction to 20%.

Keywords: Labyrinth Seal, Physical and Numerical Study, Performance Characteristics, Defining Parameters.

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Effect of Abnormal Operation of Turbine Generator on the Resource of Steam Turbine Shafting

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The results of evaluation of fatigue damage caused by the intense vibrations of steam turbine shafting at abnormal operation of turbine generator are presented. The abnormal operation of turbine generator may be caused by the sudden short-circuit in turbine generator or by the connection of turbine generator to the electric network. The evaluation of fatigue damage is based on the 3D finite element model of turbine shafting of steam turbine K-215-130. The fatigue properties of rotor steel were experimentally determined and used in the model. The fatigue damage of steam turbine shafting was evaluated for different scenarios of connection of turbine generator to the electric network and in account for experimentally determined damping properties of turbine shafting in operation.

Keywords: Turbine Shafting, Fatigue Damage, Torsional Vibrations, Coarse Synchronization.

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Experimental Investigation of Physical and Tribological Properties of Engine Oil with Nano-Particles Additives

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Experimental Investigation of physical and tribological properties of engine oil was performed on SAE20W40 lubricant containing CuO and FeO nano-particles and their combination (content of metal 0.875g/350ml of oil). This presents an analysis of the variation in properties of lubricants by adding nano-particles and further enhancement in its operational quality. This work also presents a review of the addition of copper and iron metallic nanoparticles in engine oil and the evaluation of changes in their respective physical and tribological properties. Later analysis of the variation in tribological properties has been carried out by conducting tests on the bearing test apparatus. FFT (Fast Fourier Transform) and other operational parameters are used to analyse vibration characteristics for different samples of lubricants. Through comparative analysis, the use of the base oil (SAE20W40) with the mixture of CuO and FeO provides the most effective improvement of physical properties via viscosity, flash and fire point as well as vibration in tribological properties.

Keywords: CuO Nanoparticles, FeO Nanoparticles, SAE20W40 Lubricant, Tribological Properties, FFT.

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Simulation and Analysis of Passive vs. Magneto-Rheological Suspension and Seat Dampers

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This paper presents some analyses and simulation results of the passive and magneto-rheological (MR) suspension and driver's seat dampers. The damper with the MR liquid is modeled via the Bingham model due to its simplicity and high efficiency in comparison with other models. The simulation models of the passive and MR damper suspension and driver's seat models are developed in MATLAB/Simulink. Two road profile data sets are used in simulations, one of which is the road roughness data, collected from the roads, that is interpolated with respect to the vehicle speed, and the time spent to cover the chosen road distance. The other is the Heaviside step function generated numerically. The numerical simulation results have shown that the MR based suspension and seat dampers have outperformed the passive suspension and seat dampers considerably.

Keywords: Bingham Model, Comfort Ride, Road Profile, MATLAB/Simulink.

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A Semi-Implicit Generalized Finite Differences Approach to Simulate Natural Convective Viscous Flows

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The purpose of this work is to carry out a Lagrangian semi-implicit Generalized Finite Differences (GFDM) implementation to simulate transient natural convective viscous flows. The solution of the incompressible Navier-Stokes equations is formulated through the first order Chorin's projection method whilst the energy equation is implicitly discretized with the first order Euler scheme. The semi-implicit set of discretized equations is solved with the Finite Point set Method where the incorporation of the boundary conditions is done in a direct and simple manner without requiring any special treatment or stabilization. The main features behind this mesh free approach as well as details of its implementation are shown. The suitability and the accuracy of this approach for the numerical simulation of the transient natural convective viscous flows are demonstrated through the solution of the two-dimensional benchmark problem. Finally, the stability of this FPM approach is studied through the variation of parameters in the two-dimensional benchmark problem, which shows that this formulation is a promising numerical tool for the simulation of the processes involving convective thermal flows.

Keywords: Mesh less Method, GFDM, Thermal Flow, Finite Point set Method.

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Optimal Management of Small Hydroelectric Plants Power Generation in Local Electrical Systems

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The number of renewable energy sources is growing rapidly. They transfer the generated electrical energy through the distribution networks of power supply companies. Therefore, the problem of calculating the normal modes of such electrical networks is urgent. The given paper presents a mathematical model of active power losses of local electrical systems - electrical systems of power supply companies. The sources of electricity for such systems are not only powerful electric stations, but also renewable energy sources. Often these are distributed sources of energy. The article shows the determination of insensitivity zones of the optimal points deviations in which the power fluxes are distributed to the change in the load power and generation in the nodes of local electrical systems. The mathematical expression is proposed where similarity criteria are used, it allows to analyze the influence of generation of the investigated renewable energy source on the losses of active power. The significance of these similarity criteria can be determined from the optimality conditions of the dual criterion programming problem with respect to the direct problem. It is expected that the account of calculation results of dead zones will enable to determine a renewable energy source.

Keywords: Renewable Energy Sources, District Electric Networks, Power Lines, Distributed Sources of Energy, Electricity Losses, Mathematical Model, The Country's Energy, Matrix of Branches in the Nodes.

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Effect of Phase Composition on Cavitation Resistance of Ceramics

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The results of the tests of technical ceramics in conditions of cavitation wear are presented. The ultrasonic frequencies of 22 and 44 kHz were used. The influence of the structural constituents of ceramics on the rate of failure is shown. Wear features are noted. The effect of additives on the durability of materials is analyzed. The nature of ceramics wear and its similarity to the mechanism of damage of metals are demonstrated. It is proposed to use the critical destruction power for the determination of intensity of ceramics wear. On the basis of structural energetic theory, an adapted formula is proposed for comparing the intensity of destruction of ceramics of different types. The results of calculations are correlated with the experimental data. In addition, the proposed approach makes it possible to use for the known materials the known dependences of the evaluation of the wear resistance of metals.

Keywords: Ceramic Materials, Vibration, Wear, Specimens.

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System Dynamics Model for Continuous Review Inventory System in Demand Shock Conditions

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This paper deals with applying a control loop based on PID controller algorithm to dynamically setting the components of the continuous review system (Q-system) for inventory management to avoid demand shock unrequired influence on a customer service level. Through Vensim software platform, the system dynamic model of feedback system was developed, consisting of the Q-system for single echelon logistics and PID controller. Finally, operational performance results are analyzed using data of performed simulation experiments.

Keywords: System Dynamics, Demand Shock, Simulation.

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Numerical Study of Outlet Blade Angle Effect on Impeller Characteristics of Double Entry Centrifugal Pump

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The characteristics of pump performance are depended strongly on the impeller geometry. Changes in some impeller geometric parameter can improve pump performance. It is well known that outlet blade angle is one of those parameters, which has significant effect on the impeller work characteristics. This work is connected with the effect of blade outlet angle changes on the performance of double entry centrifugal pump impeller. This process is investigated via Ansys computational fluid dynamics (CFD) software. CFD method can predict well the complex internal flows in centrifugal impellers. The present paper describes the simulation of four impeller working process. The outlet blade angle was changed from 26° to 32° while all other geometrical impeller parameters were kept constant. The head-flow rate, hydraulic efficiency-flow rate and shaft power-flow rate curves are compared and discussed for each impeller. The obtained results show that even insignificant changes of the blade outlet angle effect on the impeller performance.

Keywords: Characteristic Curve, Impeller Geometry CFD, ANSYS-CFX, Efficiency.

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Application of Artificial Neural Network for Identification of Bearing Stiffness Characteristics in Rotor Dynamics Analysis

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In this article the implementation of the mathematical model for rotor oscillations on non-linear bearing supports for the multistage centrifugal compressor is considered by using the computer program "Critical frequencies of the rotor". It realized the finite element mathematical model, which allows taking into account the non-linear dependence of bearing stiffness on the rotor speed, as well as gyroscopic moments of inertia of impellers and shell-type parts. The artificial neural network "Virtual Gene Developer" software is proposed for evaluating the operating parameters of the approximating curve "bearing stiffness – rotor speed" by the dataset of numerical simulation results in the abovementioned software. Actual parameters of non-linear bearing stiffness are obtained by the results of the experimental research of rotor critical frequencies for the multistage centrifugal compressor 295GC2-190/44-100M on the experimental accelerating-balancing stand "Schenck". The main advantages of the proposed approach and methodology for application of Artificial Neural Networks are stated.

Keywords: Rotor Vibrations, Artificial Intelligence, Non-linear Support, Critical Frequency, Mode Shape.

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Movement of the Particle on the External Surface of the Cylinder, which makes the Translational Oscillations in Horizontal Planes

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Differential equations of relative displacement of a particle on the external surface of an inclined cylinder, which performs oscillatory motion, are obtained in the article. All points of the cylinder describe circles in horizontal planes. The equation has been solved numerically and trajectories of relative motion of a particle along the cylinder surface have been constructed. Graphs of other kinematic characteristics in time function are presented. Partial cases, when the axis of the cylinder is located horizontally or at an angle of friction to the horizontal plane, are considered. An experimental research to determine the soil separation efficiency by a sloping cylinder, which performs fluctuations, depending on the influence of individual factors (the coefficient of friction of the soil and the angle of inclination of the cylinder) was conducted in the article. After processing the experimental data, the regression equations were obtained to determine the separation quality and the response surface was constructed.

Keywords: Relative Motion, Differential Equations, Kinematic Parameters, Trajectory, Angle, Friction.

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Influence of the Passive Flow Initial Parameters on the Efficiency of Liquid-Vapor Ejectors

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The article deals with the issue of creating a vacuum in various industries and equipment using two-phase jet devices, namely liquid-vapor ejectors working on principle of stream thermal compression. The principle of stream thermal compression implies boiling of the working fluid in the expanding part of the active flow nozzle. The influence of the initial parameters of the passive flow on the efficiency of the mixing process is based on extensive literature analysis of the works of modern domestic and foreign authors. The character of the influence of temperature, relative humidity and the content of the passive flow at the entrance to the receiving chamber on the geometric and regime parameters of the mixing chamber is established. The results of numerical and experimental investigations of the influence of the passive flow initial parameters on the efficiency of liquid-vapor ejectors are presented. Exergetic analysis of the efficiency of these devices with various passive flow environments is performed.

Keywords: Liquid-Vapor Ejector (LVE), Two-Phase Jet Device, Active Flow, Passive Flow, Receiving Chamber, Mixing Chamber, Exergetic Efficiency.

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Constitutive Equation for Numerical Simulation of Elastic-Viscous - Plastic Disperse Materials Deformation Process

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During the investigation it was made the methodology of elastic - viscous - plastic disperses materials (DM), deformation processes, creation of constitutive equation. The two levels of DM structural analyses are used, such as microanalysis (separated micro-fragment (particle) of a disperse system consideration) and macro-analysis (the parameters averaging the representative element macro volume). It is considered that the parameter of the local (at micro level) energy deformation speed of the solid phase with its subsequent over the representative element volume is averaged. The constitutive equation general structure is formulated by the components of stress and deformation rates tensors due to the chosen material model. The peculiarity of this model is that the equilibrium flow concept elastic-viscous-plastic material is an alternative to its elastic-plastic deformation The proposed equations are suitable for their effective practical using for digital models creation that based on existent software for the of equilibrium processes of compact materials deformation finite-element analysis. It can be used for calculating of technological processes and designing equipment of food and other productions.

Keywords: The Mathematical Simulation, Non-equilibrium Deformation, Mechanical Behavior, Dispersible Materials.

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Determination of Transfer Functions for Electrohydraulic Servo Drive of Technological Equipment

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An electrohydraulic servo drive with throttling regulation of technological equipment is considered. The following basic elements are distinguished in the drive: hydraulic cylinders, the electrohydraulic amplifier including the electromechanical transducer and the hydraulic amplifier, the feedback gauge, the electronic block. To study the dynamic characteristics of the drive a typical mathematical model of non-stationary work processes occurring in the drive is presented. The linearization of the mathematical model is carried out, the structural scheme of the drive is constructed, the transfer functions are obtained for the control signal and the loading influence. The main parameters of the drive are the time constant of the control winding, the time constants of the electrohydraulic amplifier, the time constants of the hydraulic cylinder, the coefficient of relative damping of the hydraulic cylinder, the feedback coefficient, the drive transfer coefficient by the control signal, and the drive transfer coefficient by the loading influence. The proposed linear mathematical model and transfer functions are adapted to the drives of the technological equipment. The main advantage of the presented mathematical description of the characteristics of the electrohydraulic servo drive with the throttle regulation is the ability to perform the stability evaluation, quality of control and correction of the dynamic properties of the drive using the technical certificate data of the drive elements and devices.

Keywords: Electrohydraulic Servo Drive, Throttle Regulation, Structural Scheme, Transfer Functions.

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Influence of the Stochastic Nature Parameters of Throttle Channels on Characteristic of Automatic Balancing Device of the Centrifugal Pump

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Automatic balancing device is used to balance the axial force. Moreover, this device acts as an end-seal of centrifugal pump and about 5% of whole power can be lost on it. Operating characteristics of automatic balancing device are determined by cylindrical and face throttles geometrical characteristics that have stochastic nature. It caused by the real constructional form of inlet in annular and face throttles, possible deformations, initial manufacturing, and installation misalignment and deviations depend on different stochastic factors. Using the example of static characteristic calculating of an automatic balancing device for a centrifugal pump, it is shown that considering the stochastic nature of the geometric characteristics of the throttle channels, the losses in the face throttle, gives a random character to the variation of the balancing device parameter. Obtained results showed not only the qualitative but also quantitative influence of the random changes of the hydraulic resistances on the values of the balancing axial force and the face gap (about 10-13%). The deviation of the gap value from the calculated one leads in any case to negative consequences: a decreasing - to scuffing and a complete failure of the whole device, increasing - to reducing the volume efficiency of the pump.

Keywords: Face Throttle, Cylindrical Throttle, Axial Balancing Force, Random Parameters, Static Characteristic, Coefficients of Local Losses.

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Comparative Tribological Tests for Face Impulse Seals Sliding Surfaces formed by Various Methods

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The article shows the analysis of change of face impulse seal rings, which are completely made of expensive wear-resistant materials, such as tungsten carbide, silicon carbide, various kinds of graphite on rings, which are made of less expensive but not less qualitative materials. It has been established that the seal rings surfaces are in contact for a very short time, only at the time of starting and stopping the unit. It is proposed to use metal base-coating composite materials for such surfaces, which combine the protective properties of coatings and the mechanical strength of the surface base. Metallographic and tribological research were carried out on samples of heat-resistant steel, high-speed steel and stainless steel. It was found that the greatest thickness of hardened layers (up to 500 μm) is achieved with hardening of 41CrAlMo7 steel by ion nitriding and carbonitriding methods; the greatest of the surface layers microhardness for samples of steels HS6-5-2C and X6CrNiTi18-10KT, which were subjected to hardening by the method of condensed ion bombardment (18.3 and 16.4 GPa, respectively).

Keywords: Face Seal, Strengthening, Ring, Wear, Surface Layer.

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Effect of the Parameters at the Inlet to the Rotor of the Jet-Reactive Turbine on its Efficiency

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The article shows that the amount of motive force of the traction nozzle is directly affected by the total pressure recovery factor in the flow part of the jet-reactive turbine and its elements, which characterizes the energy losses. The effect of various gas-dynamic and geometric parameters on the total pressure recovery factor in the flow part of the jet-reactive turbine is studied. In order to increase the total pressure recovery factor in the flow part of the jet-reactive turbine, it is necessary to install a diffuser sleeve with a cylindrical part where there is a transition from a supersonic flow velocity to a subsonic flow and a diffuser part where a further subsonic flow velocity decreases. Element-by-element analysis of gas flow in the flowing part of the jet reactive turbine with a diffuser sleeve at the entrance to the rotor is performed. It is established that the reduced flow velocity at the inlet to the rotor should be as low as possible, based on the location of the shock wave in the inlet part of the diffuser sleeve, and the opening angle of the diffuser part of the diffuser sleeve should be no more than 10^0.

Keywords: Jet-Reactive Turbine, Flow Part, Diffuser Sleeve, Total Pressure Recovery Factor, Reduced Velocity, Available Pressure Ratio.

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Method of Predicting the Operating Characteristics of Small-sized Stages of High-speed Centrifugal Pumps

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The article presents the material on the study the working process of pumping highly viscous fluids with small-sized working stages of centrifugal pumps with a rotational speed of the drive rotor in the range from 3000 rmp to 6000 rmp. The relevance of scientific research is based on an analysis of existing methods for predicting the performance characteristics of dynamic pumps operating on high viscosity liquids. It is described that each method has been developed for a certain type of impeller design, mainly of medium and large size, with a rotor speed of up to 3000 rpm, and about small-size pumps wheels, give a large error in predicting their characteristics on viscous fluids. The results of the study the structure of the flow of a high-viscosity fluid within the flow channels of these operating stages and its effect on the reduction of head, capacity, power and pump efficiency are presented. It is established a relationship between the recalculation of the working characteristics of dynamic pumps operating on water for their operation when pumping viscous liquid with Reynolds number. Based on the obtained conclusions has been developed a methodology for predicting the main energy parameters of high-speed small-size oil centrifugal pumps.

Keywords: High Viscosity Liquid, Centrifugal Pump, Oil Pumping, Recalculation Method, Reynolds Number, Prediction of Pump Characteristics.

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Selection the Method of Radial Thrust Calculation in Centrifugal Pump Using Computing Experiment

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Basically, radial forces are caused by not symmetrical distribution of pressure at the impeller outlet. Radial thrust is acting on the rotor of the pump. Therefore, it could facilitate vibration on the bearing components, as a result – breaking bearings and destroying pump. Near the best efficiency point when the pressure distribution is uniform the radial force gets its minimal value. In cases when the pressure distribution at the impeller outlet is non-uniform and the flow loaded partially the value of radial force increases and gets its maximum when the magnitude of capacity is null. There are many different methods of measurement radial forces in the pump but most of these methods are too expensive and not available for application. For today get its popularity computing investigations, which give a possibility to research radial forces considering all the factors of the flow in the pump. Having an opportunity to compute various simulations of the flow in pump, this research review influence of the gaps between impeller and case on radial force magnitude. Therefore, this analysis solves the problem of effects of the gaps on the magnitude of radial thrust which was found using a numerical experiment.

Keywords: Radial Thrust, Centrifugal Pump, Computing Experiment

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Selection of the Geometry of the Leader Edge of the Impeller to Reduce Cavitation Failure

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The cavitation damage is one of the factors limiting the permissible range of operation of centrifugal pumps. This is especially important for boiler feed pumps, which are required to work in a large working range. Increasing the unit capacity of boiler feed pumps leads to the need to increase the energy intensity of the stages. In this case, the peripheral speeds at the entrance to the impeller increase. The operation of feed pumps at underload conditions is accompanied by a recirculation of the flow at the impellers inlet, which leads to a significant local decrease in pressure at the leading edges and the appearance of cavitation caverns. One of the criteria determining the operating conditions of the pump without cavitation failure is the NPSHi value. It is believed that the geometry of the input section of the impeller blade has a significant effect on the magnitude of NPSHi. This work dedicates to the study of the influence of the geometry of the input section of the impeller blade on the cavitation criteria and the choice of the most favorable geometry to reduce the cavitation erosion in the centrifugal pump. The research was carried out numerically. Various variants of the geometry of the input sections of the impeller blades were investigated. The most acceptable configuration of the entrance area was chosen in the research results.

Keywords: Cavitation, NPSHi, Impeller, Leader edge.

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Abstracts
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Modeling of the Heating for Cladded Powder in Plasma Jet at Spraying of Coating

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The paper is devoted to solving the problem of determining the temperature of cladded particles with a shell in a plasma jet taking into account the change in their aggregate state. The features of heating of the cladded particles during plasma spraying of functional coatings are considered. The analytic solution of the boundary problem for the heat equation in the case of a variable temperature of the plasma jet, which was approximated by cubic splines, was obtained. The mathematical model of heating of powder particle with a sheath during plasma spraying taking into account the time matching of plasma jet temperature and particle is generalized. Formulas for determining the melting time of the metal sheath and the ceramic core were given. Influence copper sheath thickness on heating of alumina kernel of the cladded particle by an analytical solution is set. The results of testing coated samples confirmed that the developed cladded powder improves the physical and mechanical properties of the plasma sprayed composite coatings.

Keywords: Plating Sheath, Coated Particle, Cladded Powder, Plasma Jet, Heat Conductivity, Boundary Problem.

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Information Support of Optimization Calculation of Vortex Type Granulation Devices

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The paper studies the hydrodynamic conditions of gas flow motion and vortex granulator workspace design optimization. A comprehensive approach for determination of the hydrodynamic characteristics of a vortex gas flow and their visualization is proposed. The mathematical approach, based on Reynolds equations for turbulent flows solution, is presented. The mathematical model of equations solution with the definition of gas flow velocity components in any point on the radius and height of vortex granulator is obtained. The value of gas flow components of velocity, received by the results of analytical solution, and experimental data has a high degree of compliance. There is mutual rejection that numerical value of velocities and overall graphic image of diagrams of components of gas flow velocities have the same character. For rate and radial velocity components of gas flow for the initial conditions and changing set of geometrical and technological conditions does not cause such significant change of quantitative distribution value along the radius and height for angular velocity component gas stream. The obtained results form the basis of original algorithm for calculating of vortex granulator hydrodynamic calculation and its basic dimensions optimization selection.

Keywords: Software, Modeling, Vortex Granulator, Hydrodynamics, Optimization.

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The Carrier Development for Biofilms on the Basis of Technogenic Wastes for Pollutants Treatment in the Environmental Protection Technologies

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The advantages of the environment protection systems operated with the use of cell immobilization were analyzed. This paper focuses on the determination of the formed features of mineral carrier based on the technogenic secondary resource use (phosphogypsum and fly ash) for hydrogen sulfide removal technologies. The results of research show that oxygen diffusion was difficult at a depth of penetration of a bacterial matrix around 1.5–2.5 mm in the phosphogypsum granules of large size (diameter > 5 mm). The main processes of aerobic conversion occurred in the granules from 3 to 5 mm with the oxidation of sulfur compounds, hydrogen sulfide and sulfur oxides, to produce biosulfur. The depth of bacterial matrix penetration increased with diameter increase, because the components of the granules were transformed as a mineral substrate. Various mechanisms of fixing biomass on carriers based on technogenic mineral resource was studied for assessment of biomass productivity out of the carrier layer. The optimal hardening time for the granules stabilization was determined under an internal interlayer of the immobilized biomass conditions and the efficiency of sulfide oxidation was estimated.

Keywords: Environmental Protection, Technogenic Secondary Resource, Phosphogypsum, Immobilization.

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The Use of Waveguides with Internal Dissectors in the Process of Regeneration of Industrial Adsorbents by means of the Energy of Ultrahigh-Frequency Radiation

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Waveguide structures that can be used in the adsorption columns of compressed air dehumidifiers for molecular sieve regeneration by using microwave energy in the process of desorption are considered. Mathematical models of the electromagnetic field in waveguides of various designs are constructed. A study was carried out to select the best design of the waveguide irradiating the volume of the adsorbent in the cavity of the adsorption tower of the adsorption desiccant. In general, the conducted studies have shown the possibility and expediency of using X-shaped waveguides with excitation from an exciting waveguide or a coaxial cable in the construction of adsorption columns with microwave regeneration of the adsorbent, as well as the applicability of an internal dissector installed inside the waveguide to create a traveling wave in the column cavity with different the intensity of the microwave radiation of the electric field in order to increase the uniformity of the influence of microwave energy on the volume of the adsorbent. Theoretically, the possibility of using internal dissectors has been confirmed.

Keywords: Heating, Microwave, Adsorption, Desiccant, Silica Gel, Computer Modeling.

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Obtaining of Multilayer Granules in a Vortex Gas Flow: Automated Complex for Technological Calculation

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The article describes theoretical bases of the process of obtaining multilayer granules and mathematic model for software realization. The program Multilayer Granules® that carries out technological calculation of the solution for the filming process of the granule surface, is represented in the article. The optimal construction of the vortex granulator is achieved, based on technological calculation results of the granulating process and hydrodynamic calculations, using the computer modeling (based on the author's model for calculating the hydrodynamic conditions of gas flow and granules movement, classification and separation processes of granules in a vortex granulator, kinetics of granules heating and removing moisture from the granules). The calculation results become the base for vortex granulators engineering calculation methodology to obtain the multilayer granules. The work shows industrial application of the investigated software products – production of the porous ammonium nitrate. A porous multilayer granules sample, obtained in the vortex granulator, is demonstrated in the article. Multilayer Granules® allows conducting optimization of vortex granulator calculation according to the criteria of minimum required residence time of granules in device workspace.

Keywords: Software, Modeling, Vortex Granulator, Multilayer Granules, Optimization.

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Simulation and Design of Welded Plate Heat Exchangers with Channels of Different Corrugation Height

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A method of using a different height of the corrugation along the side of the heating and incalescent heat carriers to intensify the heat transfer process in the channels of heat exchangers with a circular plate is proposed. The use of such construction leads to equalization of the flow rates in the channels, a reduction in the number of channels, and an increase in the shear stress on the heat transfer surface of the plates. The search for the solution is based on the determination of the velocity of the heat carriers in the channels of the heat exchanger, when the pressure drop in the channels is complete satisfaction. The algorithm for solving the problem of finding the best solution is combinatorial. The problem of finding the optimal integer value (number of plates) is solved on a limited set of possible combinations of continuous design parameters – the height and angle of corrugation. The influence of the geometric parameters of the corrugation on its heat transfer capacity is investigated. A specific application for the calculation of the heat exchangers with different height channels of the corrugation was considered.

Keywords: Plate Heat Exchangers, Height of Corrugation, Heat Transfer Analysis.

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Granulation Process of the Organic Suspension: Fluidized Bed Temperature Influence on the Kinetics of the Granule Formation

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The authors of the article present and prove the possibility of reducing the economic and environmental indicators in the processes of mineral fertilizers granulation by means of recycling and using organic agricultural waste. It is shown that such waste products are in the form of very moist suspensions, therefore, in order to minimize energy consumption for their processing, the optimal technology for granular product preparation is granulation in the fluidized bed apparatus. For this purpose, there has been conducted the physical modelling of the granule formation process and one found out the conditions of suspended layer formation, which determine the nature of the dispersed suspension and dispersed solid phase interaction. One has experimentally established the temperature regimes of organic suspensions granulation and determined the operating parameters of the process. The kinetics of coarsening of granules was studied depending on the temperature of dehydration of organic suspensions. Analytical dependencies that are determined by the heat transfer coefficient are obtained to determine the time and temperature of granule heating.

Keywords: Nitrogen Fertilizers, Encapsulation, Carbamide, Chicken Manure, Temperature Regime, Parameter, Granule.

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Design and Study of Conical Pressure-Swirl Atomizers

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The paper shows the results of experimental studies for two-phase swirl atomizers with two inlet ports different in terms of design. The effect of volumetric liquid and gas flow rate and the height and diameter of mixing chamber on the discharge coefficients, histograms, radial distributions of mean droplet diameters in the drop stream and the mean Sauter diameter were determined. The studies were conducted within the air flow rates not exceeding 5.6·10-4 [m^3/s] and water flow rate 1.11·10-5 [m^3/s]. It was shown that the discharge coefficient increases with the higher Reynolds number for the liquid and decreases with the higher gas flow rate. The increased liquid flow rate caused greater drop diameters and increased gas flow rate allowed to obtain droplets with smaller sizes. The value of Sauter means that the diameter is dependent on the ratio of height to the diameter of mixing chamber. The rapid increase in the mean droplet diameter occurs above the value of $H_S/D_S \approx 2.75$. It was further noted that higher gas flow rate within the aerosol axis gives rise to the drops with smaller diameters and there is a clear difference in the size of droplets between the central stream area and its edges.

Keywords: Construction of Atomizer, Discharge Coefficient, Droplet Size Histogram, Sauter Mean Diameter.

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Investigation of the Process of Saturation of the Filter Liquid of Soda Production with Ammonia and Carbon Dioxide in the Production of Ammonium Chloride

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This paper is focused on the saturation process of the filter liquid of soda production with ammonia and carbon dioxide in the production of ammonium chloride. In the world practice, there are many ways to produce ammonium chloride from the filter liquid. These ways of ammonium chloride production suppose progressive saturation of the filter liquid with ammonia and carbon dioxide. This paper is focused on identifying the optimal conditions for conducting the process. For this purpose, the saturation of the filter liquid with gases both in sequential and simultaneous feeding to the apparatus at total flow of 1.5−6.0 dm^3/min and at temperature of test solution of 15−50 °C was studied. The comparison of material balances of consecutive and simultaneous supply of ammonia and carbon dioxide shows that the process in one apparatus allows reducing the gas consumption factor by approximately 14.4 %. Thus, as a result, the method for simultaneous supply of gases is proposed in order to obtain high degree of saturation with ammonia and carbon dioxide of the filter liquid followed by the production of ammonium chloride by the salting out method.

Keywords: Process, Liquid of Soda, Ammonium Chloride.

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Modelling of Liquid's Distribution and Migration in the Fibrous Filter Layer in the Process of Inertial-Filtering Separation

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The obtained solution of the mathematical model of liquid's distribution and migration in the filter layer as flow model in the fibrous environment, which describes the non-pressure filtration motion in the gravity field of the separated liquid film from the gas-drop flow, allows to determine the saturation conditions of the free volume of the filter layer, distribution of speed and pressure under the conditions of free liquid's movement in the filter layer, as well as to calculate the required cross-sectional area of the thin-layer fibrous filter element and the optimum height of the location of the overflow chutes for draining the separated liquid from the inertial-filtering to the drainage channels in order to avoid the secondary removal of droplets with the turbulent gas flow. As a result, the application rate of the separated liquid which falls from the filter element of the inertial-filtering separation channel to the drainage channels is obtained, as well as the dependence for the overflowed gutter of diverting the separated liquids from the inertial-filtering to the drainage channels is presented.

Keywords: Separation, Filtration, Gas-Liquid Flow, Filter Element, Thin Layer, Drainage Channel.

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CFD Simulation of Ammonium Nitrate Melt in a Perforated Rotating Bucket

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In this paper, a computational fluid dynamics (CFD) model was developed to study the influence of the flow pattern of ammonium nitrate melt on the jet emerging from the perforations located on the wall surface of the rotating bucket. The numerical simulations were carried out using ANSYS CFX software in which a three-dimensional model closed via a k −ε turbulence model was adopted. To improve the performance of the bucket, design parameters such as a number of blades setting up in the bucket and selecting their geometrical shape were examined in depth. It was found that these parameters had a crucial impact on the velocity of the melt jet. While increasing the jet velocity, the probability of plugging and alteration of geometrical sizes of perforations decreases. This enables using the bucket for dispersing melts with solid impurities. The results of CFD simulation were applied for developing a modified rotating perforated bucket of the melt with nitrogen fertilizers, which has passed experimental and industrial tests.

Keywords: Priller, Blades, Design, Monodispersity, Hydrodynamics.

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Mathematical Model of Corroosive-Mechanic Wear Materials in Technological Medium of Food Industry

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Using the thermodynamic methods of the irreversible process proved that the speed of corrosive-mechanical metals wear in the technological media of electrolytes of food industry depends on the linearly loads and speed of the slip and depends parabolically on the loss of strength of the materials by a corrosive-active medium. The influence of the electrode potential of metals in technological environments of food industries and the magnitude of their change in the friction of contacting surfaces of parts on the intensity of wear are determined. The methods of control over the process about corrosive-mechanical wear are pointed. The validation of a mathematical model of wear for adequacy was conducted in the technological medium of food industry. The methods of controlling the intensity of the process of corrosion-mechanical wear due to the strengthening of the friction pairs in the cathode or anode area, the selection of the composition of contact materials, and the inhibition of technological environments are proposed.

Keywords: Corrosion, Wear, Mechanical Factors, Catalyst, Fatigue, Durability, Electrochemistry, a Potential of the Metal.

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Light and Heavy Pollutant Removal by Modified Swirl Sedimentation Tank – Design and Study

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The paper shows the effect of volumetric flow rate of liquid and diameters of solid particles in the sedimentation tank for the water contaminated with sediment and oil substances on the effectiveness of the tank. The effect of liquid flow rate on liquid damming has been studied. It has been shown that the liquid damming in the tank increases with increasing a volumetric flow rate of liquid at the inlet. The determined value of the loss coefficient is 3.06. The effectiveness of sedimentation tank for heavy fraction increases with the diameter of solid particles. It has been shown that an increase in the liquid flow rate reduces the effectiveness of the tank, both for the heavy and the light fractions. The vortex sedimentation tank of the proposed construction allows for the simultaneous removal of the heavy and light fractions from water and their partial separation.

Keywords: Swirling Flow, Separation Process, Oil Fraction, Solid Particle, Construction Effect.

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Investigation of Hydrodynamics during Continuous Vibroextraction in a Liquid–Solid Body System

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Results of investigations of the hydrodynamics of flows in a counterflow continuous column-type vibroextractor for a liquid–solid body system and their generalization in the form of a mathematical description are presented. An equation for calculating the distance of propagation of pulsating turbulent jets formed by original vibrating transporting elements in a nonflowing medium, which can be taken as a scale factor in modeling the process, has been obtained. An analysis has been carried out, and a mathematical model of the structure of real flows in the vibroextractor has been developed on the basis of a combined model for the conditions of pulse perturbation of the hydrodynamic system of the apparatus. The mathematical description of the structure of flows can be taken as a base for the solution of optimization problems. We propose a new design of a vibratory extractor with a transporter for industry, which provides efficient separation of phases under the conditions of counterflow vibratory extraction of desired components from vegetable raw materials.

Keywords: Extraction, Intensification, Plant Raw Material, Hydrodynamic Flow, Longitudinal Mixing, Mathematical Modeling.

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Resource-saving Technology for Obtaining the Organo-mineral Fertilizers

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Involvement the native phosphate raw materials in the domestic production is possible when creating organo-mineral compositions of prolonged action together with alkali metal humates, that allows to reduce the doses of fertilizers, pesticides, growth stimulants, improve the structure of soils and, thus, reduce the man-made environmental load. The organic constituent of OMF was obtained from a pilot plant from a peat previously dried to moisture (25-30) %. A mixture of the obtained raw materials, alkali and water was supplied to a cavitation disperser where the physico-chemical decomposition of peat occurred at the molecular level. Cavitation treatment of the slurry was carried out until the total yield of humic acids at a temperature of (90-95) °C. The lowland peat of the Glukhov deposit (Sosnovka village, Sumy region) was used. Experimental batches of humates of sodium, potassium and calcium in the form of paste-like mixtures have been developed. The results of agrochemical tests of products showed a reliable increase in biomass and the possibility of a quantitative reduction in the application of fertilizers. In connection with the special role of calcium in activating the growth of the root system and the carbon metabolism of plants, calcium humate have applied in further studies.

Keywords: Organo-mineral Fertilizers, Humates, Peat, Alkali, Calcium Humate.

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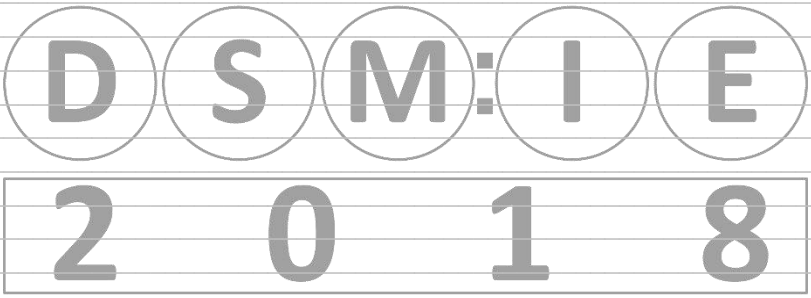

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