

Book of Abstracts from 9th International Scientific Conference on Advances in Mechanical Engineering



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Scientific Books of Abstracts

Full text available online at <https://www.scientific.net>

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Welcome Message

On behalf of the ISCAME Scientific and Organizing Committee I am pleased to welcome you to Debrecen for the 9th International Scientific Conference on Advances in Mechanical Engineering organized by the Department of Mechanical Engineering, Faculty of Engineering of the University of Debrecen.

The main goal of ISCAME is to yearly bring together engineers working on research, development and practical application in the field of mechanical engineering. Furthermore, the purpose of this Conference is to provide opportunities for scientists and engineers to meet and to discuss current research, new concepts and ideas and establish possibilities for future collaborations in all aspects of mechanical engineering.

I am pleased to inform you that 202 experts from higher education have registered for this year's conference from altogether 12 countries. In the framework of ISCAME 110 presentations were given and 49 posters were exhibited.

This year, the theme of the plenary lectures was artificial intelligence (AI) and material testing. Accordingly, the head of the Material and Process Analysis Laboratory of the BMW Group Plant Debrecen gave lecture about their activities and the representatives of Mathworks introduced the AI solutions of Matlab. Furthermore, the researcher of the host Department of Mechanical Engineering presented the application of artificial intelligence and the related material testing in the context of a case study. Accompanying programs of ISCAME was a Matlab Workshop and the Exhibition of Creative Mechanical Engineers.

We invite you to be an active participant in this Conference and to contribute to any topic of your scientific interest. We hope that the 9th International Scientific Conference on Advances in Mechanical Engineering will have an important impact on the research in all topics included in its program.

It is also an honour for us to have a privilege to give a report about the 9th Mechanical Engineering Industrial Exhibition and Job Fair. The Department of Mechanical Engineering of the University of Debrecen hosted – parallel to ISCAME – the event, called “Mechanical Engineering Industrial Exhibition and Job Fair” where 27 companies were exhibited. This professional program benefited the visitors who wanted to get up-to-date knowledge with the latest technology.

We want to express our appreciation to all members of the committees involved in the preparation of this Conference and to all the staff who were managing the different aspects of the Conference and to all the contributing authors and participants who created the real Conference. We hope that all of you feel awarded for your participation and contribution.

Website of the Department of Mechanical Engineering, Faculty of Engineering, University of Debrecen:

www.mecheng.unideb.hu

Website of ISCAME:

<https://konferencia.unideb.hu/en/iscame-home-page>

Yours Sincerely,

Tamás Mankovits
Chair of ISCAME, Head of Department
Department of Mechanical Engineering
Faculty of Engineering, University of Debrecen

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ISCAME 2023

Table of Contents

Welcome Message	iii
Free Vibration of Composite Rectangular Plates with Internal Crack M. Abd ul-Zahra Dookhi	1
Analysis of Spur Gear Design Parameters and Surface Finish for Robotic Applications S.K.A. Abdelfattah.....	2
An Efficient Hybrid Metaheuristic Algorithm Rede-nm for Solving Industrial Optimization Problems H. Abderazek, A. Laouissi, M. Nouioua and I. Atanasovska	3
Moisture Content and Measurement Methods of Polymers T. Ábri, T.J. Szabó and K. Marossy.....	6
Modeling and Measuring Residual Stresses in a Thick-Walled Pipe Structure Welded with a Buried-Arc Technique: A Comparative Study M. Alhafadhi, M. Alsigar, H. Vemanaboina and F. Mohanad.....	7
Investigation of the Impact of Surface Roughness on Vehicle's Resistance Z. Ali and G. Bogнар.....	8
Fuzzy Logic Integration for Enhanced Mobile Robot Path Planning and Navigation S. Al-Kamil, E. Laufer and R. Szabolcsi	9
Lattice Structured Hip Implant Optimization Using the Linear Regression Method R. Alkentar and T. Mankovits.....	10
Study the Internal Corrosion of Petroleum Pipes A. Al-Mosawi and S.A. Abdulsada.....	11
Optimizing Grinding Cycle Times for Maximum Efficiency through Dynamic Programming M. Alsigar, M. Alhafadhi, P. Pereverzev and F. Mohanad.....	12
Design of Equipment Suitable for Jigsaw Testing S. Apáti and G. Hegedűs.....	13
Modeling the Interaction of Air and Aluminum at the Free Surface in High-Pressure Die Casting Using CFD K. Arrif and R. Laouar	14
Analysis of the Evolution of Pressure Losses in a High Pressure Hydraulic System B. Azzedine and G. Mounir	15
The Influence of the Superficial Plastic Deformation by Rolling on Double Layer Sintered Materials Based on NC100.24 and Astaloy Mo G. Batin and B. Kasal.....	16
Using Bayesian Optimization for Charge-Mixing can Reduce Density Functional Theory Simulation Time M. Benaissa, T. Ouahrani, D. Sébilleau and A. Madouri	17
Natural Frequency Examination in Industrial Robot D. Bodnar and K. Jarmai.....	18

Analysis of Horizontal and Vertical Grinding Technologies	
S. Bodzás.....	19
The Influence of Different Grain Refining Fluxes and Master Alloy Addition on the Melt Quality of an Aluminum Casting Alloy	
L. Bogoly, T. Mende, G. Fegyverneki and G. Gyarmati	20
Analysis of Parameters Affecting Fire Protect in PUR Foam Systems	
V. Bordás, A. Polyákné Kovács and T.J. Szabó	21
Electrochemical Corrosion Resistance of a Wire and Arc Additively Manufactured Duplex Stainless Steel	
C. Breznay, D. Kemény, B. Varbai and L. Katula.....	22
Evaluation and Comparison of Machine Learning Algorithms for American Sign Language Recognition	
A. Chen and C. Liu	23
What is Raman Spectroscopy Good for? From the Perspective of Research, Development, and Innovation	
I. Csarnovics.....	24
Optimizing the Clamping Components of a Vibrating System on a Plow	
L. Daniel and V. Gabriel.....	25
Uniform Torsion of Bar Having Cross Section Bounded by Two Hyperbola Arcs	
I. Ecsedi, A. Baksa, Á.J. Lengyel and D. Gönczi	26
Optimal Number of Cells in a Numerical Grid for Fluid Flow around the Body	
M. Gavrilovic, R. Radulovic, M. Milic and N. Trisovic.....	27
Thermoplastic Elastomers from Recycled Ground Tyre Rubber	
Á. Görbe, I. Halász-Kutasi and T. Bárány	28
Analysis of Different Commercial Solid Fluxes Used for the Melt Treatment of Casting Aluminum Alloys	
G. Gyarmati, Á. Pálóczy, D. Somfai, T. Ferenczi and Z. Kéri	29
Optimization of Springback and Thinning during Deep Drawing Process	
M. Habbachi, A. Baksa and K. Jarmai.....	30
Getting Prepared to Understand and Also to Jointly Prepare the Harmonized Foresight Views on the Future of Manufacturing in Europe	
G. Haidegger, K. Bárdos and J. Váncza.....	31
Segregation Simulation Study of Metal Powders in Additive Manufacturing Technology	
D. Halapi and L. Varga	32
Reduction of Energy Requirements of the Extrusion of Clay Masses with Additives	
A. Hamza and I. Kocserha	34
The Effect of Inorganic Based Plasticizers on Clay Bodies	
A. Hamza and I. Kocserha	35
Material Characterization by Magnetic Barkhausen-Noise Method	
L. Harasztosi	36
Applicability of High-Entropy Alloys	
F. Hareancz, G. Juhász, E.R. Fábán and Á. Vida	37
Dual-Purpose Solar Collector	
M. Hasan and K. Hriczó.....	38

Semi-Empirical Method to Approximate the Poincaré-Lyapunov Constant for the Delayed-Liénard Equation	
D.A. Horváth and T. Kalmár-Nagy.....	39
Literature Review of Vibroacoustic Simulation in Vehicle Power Transmission Systems for the Reduction of Radiated Noise	
K. Horvath and A. Zelei.....	40
Predictive Maintenance and Fault Diagnostics of Automotive Steer-by-Wire Steering Systems Based on Digital Twin Method	
G. Hunyady and D. Fodor.....	41
Model Fitting for Determining the Parameter of the Pore Size Distribution	
E. Imre, D.K. Mwinken and D. Barreto	43
Refinement of the Finite Element Model for Enhanced Structural Analysis	
O. Jeremic, W. Li, N. Trisovic, A.V. Socalici, C.B. Birtok, T. Lazović and A. Petrović	44
Production Methods of High-Entropy Alloys	
G. Juhász, F. Hareancz, E.R. Fábián and Á. Vida	45
Investigation of the Acoustically Excited Bubble's Nonlinear Shape Deformation in a Massive Parameter Range with GPU Applications	
P. Kalmár, K. Klapcsik and F. Hegedűs	46
Manufacturing of 17-4PH SLM Parts with Different Scanning Angles and Sample Orientations	
M.Q. Kareem, T. Mikó, G. Gergely and Z. Gácsi	47
Investigation of Heavy Vehicle Underrunning Guard Focusing for the Energy Absorbing Issue	
J. Kertész, J. Menyhárt, Z. Békési and T. Kovács	48
Mechanical Characterization of Sustainable Mortar Based on a Prepared Sand and Superplastizier	
B. Khemissi, B. Larbi, T. Bachir, B. Nassima and N. Linda	49
Design Optimization of Intake Manifold for Dual Fuel Ic Engine	
A. Kiss, D. Mihály and Z. Weltsch.....	51
Mechanical Testing and Orientation Optimisation of 3D Printed 17-4PH Stainless Steel Alloy	
S.E. Kovács and L. Varga	52
Plasma Surface Treatment of Aluminium Sheets	
P.I. Kovács, M. Berczeli and Z. Weltsch.....	53
Comprehensive Measurement and Simulation of Prototype Injection Moulds	
S. Krizsma and A. Suplicz	54
Bubbles and Producing Ammonia	
F. Kubicsek and F. Hegedűs	55
Particular Aspects Regarding the Radiative Heat Transfer in Thermal Analysis of Steel-Concrete Composite Structural Elements	
I. Lajos and C. Cosmin.....	56
A Comparative Study of the Predictive Capabilities of SVM and RSM for Estimating Heat Treatment Parameters	
A. Laouissi, E. Raouache and Y. Chetban	57
A New Concept of n-Dimensional Machine Design	
T. Lazović, I. Atanasovska and M. Sedak	58

Evaluation of Machine Learning Algorithm for Facial Recognition and its Applications

Y.Z. Ling and C. Liu..... 59

Impact of Ball Bearing Geometry and Operational Load on the Volume of the Lubricant in the Bearing's Loaded Zone

P. Ljubojević, A. Čoćić and T. Lazović..... 60

Testing Surface Properties of 3D Printed Metals

P. Ljubojević, A. Marinkovic and T. Lazović 62

Treatment of Polluting Oil Drilling Waste, Proposal of a Green Economy Process, Drill Cuttings Case

O. Lounas and A. Malek 63

Optimizing the Geometric Design of a Helical Gear through Simulation and Surface Roughness Measurement Analysis

S. Mammadbayli and S. Bodzás 65

Object-Centric Process Mining for Inspection and Maintenance Error Detection in Sustainable Manufacturing

M.M. Matonya and I. Budai..... 66

Damage Analysis on Tooth Gear Ring of a Bucket-Wheel Excavator

M. Miladinov, S. Sedmak, B. Đorđević, A. Petrović and F. Vučetić 67

Fracture Analysis of Composite Beam Element: Case Study

M. Milic, R. Radulovic, N. Trisovic and M. Gavrilovic..... 68

Investigating the Mechanical Properties of PVC Based Ternary Blends

Y.F. Minale, M. Kálmán, A.Á. Major and A. Polyákné Kovács 69

Advancements and Technological Optimization in Yacht Design Osmosis Treatment and Rehabilitation

T. Mitkov and T. Dovramadjiev 70

A Review of Aerodynamic Analysis of Commercial Automotive-Materials and Methods

B. Mohamad, M.Q. Ali, S. Dutta and F. Zarda..... 71

Produce Foam Glass Aggregate Utilizing Waste Glass from Cathode-Ray Tubes

S.K. Mohammed, R. Géber and A. Simon..... 72

Comparative Analysis of Wettability of Metals and Ceramics by Oil

F. Mohanad and P. Baumli..... 73

Shopfloor-Level Material Flow Analysis to Determine the Readiness of a Company for Industry 4.0

P. Molnár-Major and K. Bóna 74

Fractal-Fractional Analysis and Numerical Simulation for the Heat Transfer of ZnO+Al₂O₃+TiO₂/DW Based Ternary Hybrid Nanofluid

S. Murtaza and P. Kumam 75

Design and Model of Portable Gantry Crane Machine

B. Namomsa and D. Demeke..... 76

Longitudinal Dynamic Modeling of Electric Vehicle by Using Matlab Simulink

D. Nemes and S. Hajdu..... 77

Computational Fluid Dynamics Simulation of the Cooling of a Vehicle Alternator's Stator Winding

D. Nemes, N. Szűcs and B. Fodor 78

Integrating Metaheuristic Optimization into Numerical Simulation	
A. Némethy, T. Mankovits and D. Huri.....	79
Investigation of Surface Roughness Determination Problems in Additive Manufacturing Technologies	
L. Noémi and P. Ficzer.....	81
The Issues of Surface Roughness Measurement in Case of Plastic Vehicle Parts Produced by FFF Additive Manufacturing	
L. Noémi and P. Ficzer.....	82
Review of Connected Autonomous Vehicles Platooning: Technologies, Challenges, and Future Directions	
T. Oarga, B.O. Varga, I. Barabás and G. Prunean	83
Evaluation of New and Traditional Numerical Methods for Long-Term Simulations of Heat Transfer in Walls to Study the Effect of Different Shapes of Thermal Bridges	
I. Omle and E. Kovács	84
Innovative Method for Producing Glass Foam Granules with Intact Surfaces	
M. Osfour and A. Simon.....	85
Geometric Modelling and Finite Element Analysis of a Sprinkler	
B.R. Pamphil and S. Bodzás	86
Case-Study: Mechanical Properties of Welded Joint Regions Effects on Structural Integrity Assessment	
A. Petrović, N. Momčilo and M. Arandjelović	87
Analysis of the Effect of Injection Molding Temperature on Mechanical Properties in the Case of PBT	
A. Polyákné Kovács, T.J. Szabó and M. Szabóné Kollár	88
Investigation of the Tribological Properties of Aliphatic Polyketone	
A. Polyákné Kovács, T.J. Szabó and M. Szabóné Kollár	89
Analysis of the Effect of Injection Molding Temperature on Mechanical Properties in the Case of PET(Polyethylenterephthalate)	
A. Polyákné Kovács, T.J. Szabó, M. Szabóné Kollár, V. Bordás and Y.F. Minale	90
Investigation of the Effect of UV in the Case of PLA Composites Filled with Natural Fillers	
A. Polyákné Kovács, T.J. Szabó, M. Szabóné Kollár, V. Bordás and Y.F. Minale	91
Determining the Fluidization Curve for Zeolite at Different Moisture Contents	
T. Poós and K. Katona	92
Operational Sizing of a Wet Scrubber	
T. Poós and N. Szávics.....	93
Mechanical and Architectural Regulations for Cleanrooms with Proposed Solutions	
T. Poós and L.M. Végh.....	94
Additive Manufacturing of a Flat Form Tool	
S. Rahman	95
Formability and Surface Quality of Medical Grade Titanium in Incremental Sheet Forming	
D.M. Sadiq and I.J. Al-Shaibani	96

Numerical Parametric Study on the Effect of EMS on the Segregation Behavior during the Solidification of Sn-10wt.%Pb Alloy	
K. Safia, L. Hachani, A. Abdelhafid and N. Abdellah.....	98
Phase Change Material Melting Modeling Using Ansys Fluent	
A. Saliby and B. Kovács	100
3D Printing Failure Detection	
A. Shadid, M.T. Birosz, B. Szekeres and M. Andó	101
Surface Modification with Ions to Improve Properties of Tools	
B. Skoric, P. Terek, L. Kovacevic, V. Terek and Z. Bobic	102
Efficiency of the Machining Process in Wire EDM of Hard Metals	
L. Straka	103
Possibilities of Preventing Roundness Errors of the Machined Surface in WEDM	
L. Straka and J. Hajduk.....	104
Production of Engineered Cellular Structures	
A. Szoboszlai and I. Budai.....	105
Novel Approaches of Indoor Flow Assessments	
F. Szodrai	106
Li-Ion Battery Cell Bonding Technology Development	
F. Tajti, M. Berczeli and Z. Weltsch.....	107
Real-Time Facial Recognition Based on the Local Binary Pattern Histogram Algorithm	
Q.Y. Tan and C. Liu.....	108
Numerical Modeling of Turbulence Flow Employing Vortex Generators and Comparing Various Corrugation Channel Types	
A. Tanougast and K. Hriczó.....	109
Cold Sintering of Zinc Powders for the Manufacturing of Porous Zinc Materials	
G. Thalmaier, M. Nasui, N.A. Sechel, C. Kádár and I. Vida-Simiti.....	110
Simulation of Industrial Processes Using Digital Lean Tools	
S.B. Tóth and I. Budai.....	111
Innovations in Water Treatment	
Z. Trisovic, T. Lazović, A.V. Socalici, Z. Jeli and T. Trisovic	112
Sensitivity Analysis in Dynamic Systems: Exploring Insights	
N. Trisovic, W. Li, O. Jeremic, O. Ristic, M. Sedak and A. Petrović	113
The Modern Approach to Optimizing Mechanical Systems	
N. Trisovic, W. Li, T. Lazović, M. Gavrilovic, R. Radulovic, M. Milic and C.B. Birtok	114
Innovations in Wastewater Treatment	
Z. Trisovic, T. Trisovic, A.V. Socalici, Z. Jeli and C.B. Birtok	115
Determination of Flash Points of Flammable Mixtures for Explosion Protection	
L. Tugyi, Z. Siménfalvi and G.L. Szepesi	116
Study on the Mechanical Properties of Natural Rubber Mixtures Plasticized with Selected Plant Oil	
A.A. Usman, K. Tamasi and O. Awogbemi	117
Calculation Algorithm of Air Humidification for Laboratory Equipment	
E. Varju and T. Poós	118

**Development of Bonding Technology for Composite Materials with High Energy
Density Surface Treatments**

Z. Weltsch and M. Berczeli 119

Tensile Strength Investigation of Polyamide 6.12 Reinforced by Glass Fiber 30%

S.H. Yoshanlouei, R. Geber and A. Polyákné Kovács 120

Keyword Index 121**Author Index** 126

Free Vibration of Composite Rectangular Plates with Internal Crack

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Keywords: Composite materials, Internal cracks, Fracture, Natural frequency, ANSYS

Abstract. In this work, rectangular sheets of composite materials consisting of epoxy with a single layer of fiberglass were studied with the internal crack at angles (0° , 90°) with the x-axis in the presence of nanomaterial TiO_2 in proportions (1 wt%, 2 wt%, and 3 wt%), the study was experimental and numerical using the ANSYS. The sample mold was made from plastic using a CNC machine. One case was studied in both the experimental and numerical parts, which is clamped-clamped-free-free (CC-FF). After conducting the test, it was found that the crack negatively affects the rectangular composite plate, as it reduces the value of the natural frequency and increases the value of damping. However, in the case of adding the nanomaterial, it was found that the natural frequency increases with the increase in the percentage of nanomaterials, and the maximum value of the natural frequency was at 3% because it works to increase hardness rectangular plate stiffens and reduces damping. The error rate between the experimental and numerical parts did not exceed (9.717%).

Analysis of Spur Gear Design Parameters and Surface Finish for Robotic Applications

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Keywords: Manufacturing, Spur Gear, Geometric Parameters, Surface Roughness, Robotic Applications, Gear Performance

Abstract. The improvement of gear performance and durability improves the performance of various manufacturing industries. Spur gears are used for their simplicity and reliability, however, their performance is significantly influenced by surface finish and geometric parameters. This study focuses on the spur gear as a component in robotic transmissions, and how its functionality is pivotal to the performance of robotic applications.

This study aims to analyze the impact of the surface roughness and geometric parameters with the intention of investigating gear manufacturing errors such as tooth runout, tooth flank errors, and center distance errors, for these errors pose a great impact on performance, durability, and quality. Understanding such errors makes optimization possible, for gear design parameters for robotic applications are a critical aspect of achieving high precision, low speed, durability, and load-carrying capabilities.

Experimental studies on a spur gear were conducted in a laboratory, in which the gear's characteristics were measured. The device used to execute the measurements of the surface roughness for this work was the Smartic M device, which is a portable instrument designed to provide accurate and reliable measurements. Measurements were taken along the gear's teeth. This made a total of 129 measurements and data acquired. The data was then carefully studied to determine the three best values obtained, and the three worst. The findings revealed that smoother surfaces showcase lower friction and wear. Geometric parameters are essential factors in optimizing gear meshing and alignment, for they directly influence torque transmission and noise levels.

The results have shown that the three least optimal results came from the pitch diameter, where gears typically mesh. The study concluded that surface roughness and geometric parameters of spur gears are essential factors to study and analyze for robotic applications. Optimizing them has the potential to improve performance significantly by enhancing the efficiency of robotic applications, which entails to higher precision, quieter operation, and longer lifespan.

An Efficient Hybrid Metaheuristic Algorithm ReDe-NM for Solving Industrial Optimization Problems

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Keywords: Metaheuristic Algorithm, Nelder-Mead, Multi-Objective Optimization, Eco-Friendly Machining, Turning.

Abstract. To address the pressing demand for effective solutions to complex optimization challenges, researchers have increasingly focused on pioneering novel methodologies. In this study, a novel hybrid optimization approach termed 'Roulette Wheel Selection and Nelder-Mead-based Improved Differential Evolution' (ReDE-NM) is introduced to optimize real-world industrial problems. Initially, the proposed method is validated by applying it to tackle two mechanical engineering design problems. Subsequently, we compare the optimization results obtained with ReDE-NM against those achieved by state-of-the-art methods featured in the existing literature. Our findings reveal that the proposed method demonstrates rapid convergence and outperforms most benchmark problems in terms of solution quality and computational efficiency. Moreover, ReDE-NM is applied to fine-tune crucial cutting parameters during the turning operation of X210Cr12 steel, leveraging a multilayer-coated carbide insert (GC-4215). The fitness functions are derived for tangential cutting force, and surface roughness, with mathematical expressions for these objectives generated using the Response Surface Methodology (RSM).

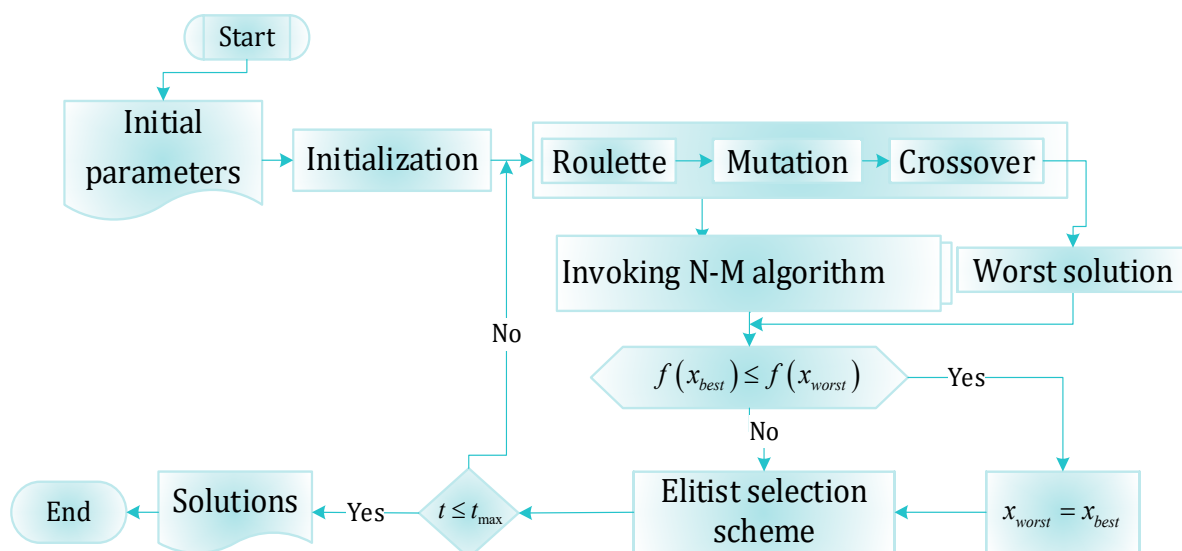


Figure 1. Flowchart of ReDE-NM.

Optimum design of multiple disc clutch brake and spur gear system

In this section, the resolution of two intricate mechanical design problems (multiple disc clutch brake and spur gear system) has been addressed to assess the efficacy of our newly developed algorithm. We benchmark the optimal outcomes achieved through ReDE-NM against those obtained by other optimization algorithms.

Table 1. Statistical results of the used algorithms for the multiple disc clutch brake problem.

Algorithms	Best	Mean	Worst	SD	SR (%)
ReDE-NM	0.313656611	0.313656611	0.313656611	5.60747E-17	100
PVS	0.313657	0.328163	0.392071	NA	NA
GA	0.313657	0.330712	0.401873	NA	NA
WCA	0.313656	0.313656	0.313656	1.690E-16	NA
TLBO	0.313657	0.3271662	0.392071	0.6700000	NA

Table 2. Statistical results of the used algorithms for the step-cone pulley problem.

Algorithms	Best	Mean	Worst	SD	SR (%)
ReDE-NM	1538.9446818	1538.9446818	1538.9446818	0.000E+00	100
NAMDE	1538.94468	1538.94468	1538.94468	1.6904E-08	-
MVO	1538.95376564	1539.02756935	1539.16664793	0.04791177	32
EBO	1538.94468183	1544.54893767	1570.07778507	12.0822412	82
QSA	1538.94468183	1539.56734390	1570.07778507	4.40288568	98

Optimization of machining parameters during the turning operation of X210Cr12 steel

ReDE-NM algorithm was employed to optimize the primary cutting parameters during the turning process of X210Cr12 steel. These critical parameters include cutting speed (V_c), feed rate (f), nose radius variation (r), and depth of cut (ap). We conducted a total of twenty-seven tests to measure the two optimized outputs, specifically the tangential force (F_z) and surface roughness (R_a).

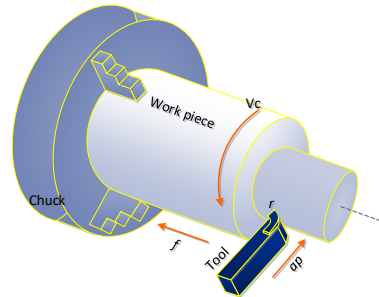


Figure 2. Turning operations.

To model the objectives effectively, we employed response surface methodology (RSM). The objective functions can be expressed as follows:

$$F_z = 120.81 - 0.36 * V_c - 45.17 * f - 67.77 * r + 2.63 * ap + 0.03 * V_c * f - 0.05 * V_c * r - 0.06 * V_c * ap + 295.62 * f * r + 2573.75 * f * ap + 17.62 * r * ap + 7.98 * 10^{-4} * V_c^2 - 1819.27 * f^2 + 25.44 * r^2 + 20.97 * ap^2$$

$$R_a = -3.77 + 5.26 * 10^{-3} * V_c - 3 * V_c * f + 29.38 * f + 3.21 * r + 0.60 * ap - 9.37 * 10^{-3} * V_c * f + 1.31 * 10^{-3} * V_c * r + 4.5 * 10^{-3} * V_c * ap - 4.06 * f * r - 3.12 * f * ap + 0.18 * r * ap - 1.55 * 10^{-5} * V_c^2 - 67.96 * f^2 - 1.28 * r^2 - 2.25 * ap^2$$

The two objectives are evaluated under four distinct experimental conditions. Where $V_c \in [150, 350]$, $f \in [0.08, 0.16]$, $r \in [0.8, 1.6]$ and $ap \in [0.2, 0.6]$.

Table 3. Best solution achieved for the turning operations through the application of ReDE-NM.

Variables				Functions	
V_c (m/min)	f (mm/rev)	r (mm)	ap (mm)	R_a (μm)	F_z (N)
256.216393	0.08366701	0.85700971	0.21639342	0.40000000	84.0000000

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Moisture Content and Measurement Methods of Polymers

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Keywords: Polymer, Moisture Content, Measurement Methods

Abstract. Polymers can be grouped according to many aspects. One way of grouping it is related to its ability to absorb water. Some polymers are capable of absorbing water called hydrophilic polymers while the other was given the hydrophobic indicator. The extent to which a polymer can absorb water depends on the following factors:

- Chemical composition.
- The nature of environment.
- The type and concentration of additives.
- From the temperature and the relative humidity of the air.

The biggest essential difference between the two types of polymers is that hydrophilic polymers are able to bind and absorb water because there is a polar group on the side chain or main chain to which the water molecule can bind. Hydrophobic polymers do not have alcohol groups, so they cannot absorb water due to their apolar nature.

Hydrophilic polymers can bind water in three ways:

- Direct water absorption: the water molecule is directly connected to the hydrophilic molecule in the polymer molecule.
- Indirect water absorption: another water molecule is attached to a water molecule that was previously attached to the polymer molecule.
- Capillary water absorption: water appears in the pores of the polymers.

The presence of water has the greatest effect on the following properties:

- Processability.
- Electrical properties.
- Mechanical properties.

In the case of hydrophilic materials – if the moisture level exceeds 0.05-0.15% - the material must always be prepared and dried based on the parameters specified by the manufacturer before use. The drying time depends on the moisture content of the material, the layer thickness and the efficiency of the dryer. In many cases, the parameters given by the manufacturer are not exact, the values given here are usually significantly shorter, and they refer only to the most efficient dryers. For this reason, it would be necessary to include the measurements of the moisture content in the preparation process. There are many methods for this, and with the continuous development of technology, it is possible to determine the moisture in the granules more and more precisely. Nowadays, one of the most common measurements methods is the Karl-Fischer titrator, this is a special analytical method that can be used to determine the water content of the tested material with great accuracy. The basis of the method is a selective reaction, during which iodine, in the presence of a base, converts sulfur dioxide into sulfite. The reaction requires water; 1 mol of water is needed to convert 1 mol of iodine. The other most common method is thermogravimetric measurement: the weight of the sample is weighted, then dried until the mass is constant, and then its weight is measured again. The difference between the two measured values gives us the moisture content. However, this value is unfortunately not accurate in all cases; in the case of some polymers, as a result of longer-term heating, a part of the volatile additives also evaporates, which is also measured in the moisture content.

Modeling and Measuring Residual Stresses in a Thick-Walled Pipe Structure Welded with a Buried-Arc Technique: A Comparative Study

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Keywords: Welding, Residual Stresses, Numerical Modeling Simulation

Abstract. This study focuses on the modeling and measurement of residual stresses in a thick-walled pipe structure, specifically welded using a buried-arc technique. Employing a comparative approach, the research aims to provide insights into the effectiveness of different welding methods in managing residual stresses within the welded structure. The combination of modeling techniques and experimental measurements contributes to a comprehensive understanding of the factors influencing residual stresses, offering valuable information for optimizing welding processes in thick-walled pipe structures.

Investigation of the Impact of Surface Roughness on Vehicle's Resistance

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Keywords: Resistance, ANSYS, CFD, Roughness Height, K- ω SST

Abstract. This study conducts a comprehensive examination of the influence of surface roughness on the resistance characteristics of the KVLCC2 tanker ship, employing state-of-the-art Computational Fluid Dynamics (CFD) technology. Systematic exploration encompasses a range of parameters, including diverse roughness heights, ship velocities, and specific hull sections (bow, parallel hull segment, and stern). The study rigorously applies the RANS equations and the k- ω SST model to solve the Navier-Stokes equations, ensuring a thorough analysis. Methodological robustness is validated through a benchmark test involving a roughened plate, affirming the efficacy of CFD in yielding high-quality results. The research extends its focus to scrutinize the nuanced influence of surface roughness on individual resistance components, addressing both pressure and viscosity components.

Within the context of the increasing importance of maritime transport, renowned for its advantages in storage and transportation, shipping companies are compelled to optimize vessel fuel consumption. This imperative aligns with overarching objectives of mitigating greenhouse gas emissions and reducing operational costs to enhance company profitability. A key determinant impacting speed, power requirements, and fuel consumption is hull resistance. Leveraging the capabilities of Computational Fluid Dynamics (CFD), this research employs specialized wall functions that account for roughness effects on the boundary layer near the hull. The outcomes are meticulously compared with those derived from a smooth surface model. Moving beyond the assessment of surface roughness's impact on hull resistance to pressure, the methodology accommodates non-linear factors, including the spatial distribution of contaminants, ship movement in waves, and thrust-induced effects on hull resistance.

As a result, this research endeavors to discern the nuanced effect of surface roughness on ship resistance, considering varying roughness heights, boundary layer configurations, and the interplay of velocity, pressure, and kinetic energy fields for the KVLCC2 model hull. The numerical study entails a meticulous investigation into how surface roughness shapes the velocity field and influences kinetic energy, employing CFD with a specific emphasis on implementing the RANS equations and the k- ω SST model.

Fuzzy Logic Integration for Enhanced Mobile Robot Path Planning and Navigation

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Keyword: Mobile Robots, Path Planning, Fuzzy Logic, Navigation, Obstacle Avoidance

Abstract The intersection of mobile robot path planning and fuzzy logic has garnered significant interest in recent years. This connection leverages fuzzy logic's capacity to handle complex, imprecise, and uncertain data, thereby enhancing path planning efficiency and reliability. The utilization of training data remains a key recommendation to expedite tuning. By incorporating input/output decision data from a human operator alongside real-world sensor data, we achieve a faster and more accurate calibration of the mobile robot's navigation system. This paper presents a novel approach to enhancing mobile robot navigation within complex environments, with a particular focus on maintaining precise positions within narrow corridors. In addition to the custom cost function and tunefis integration, we introduce innovative elements to further improve the process. The approach leverages the power of fuzzy logic for advanced decision-making, considering not only obstacle avoidance, energy efficiency, and navigation speed but also incorporating real-time sensor data for more informed choices. Furthermore, we introduce a learning mechanism that allows the robot to adapt and refine its navigation strategies over time. This adaptive component significantly reduces the tuning process's duration and improves overall efficiency. This enhancement represents a substantial advancement in the field of mobile robot navigation, paving the way for more efficient and adaptable robotic systems in complex environments.

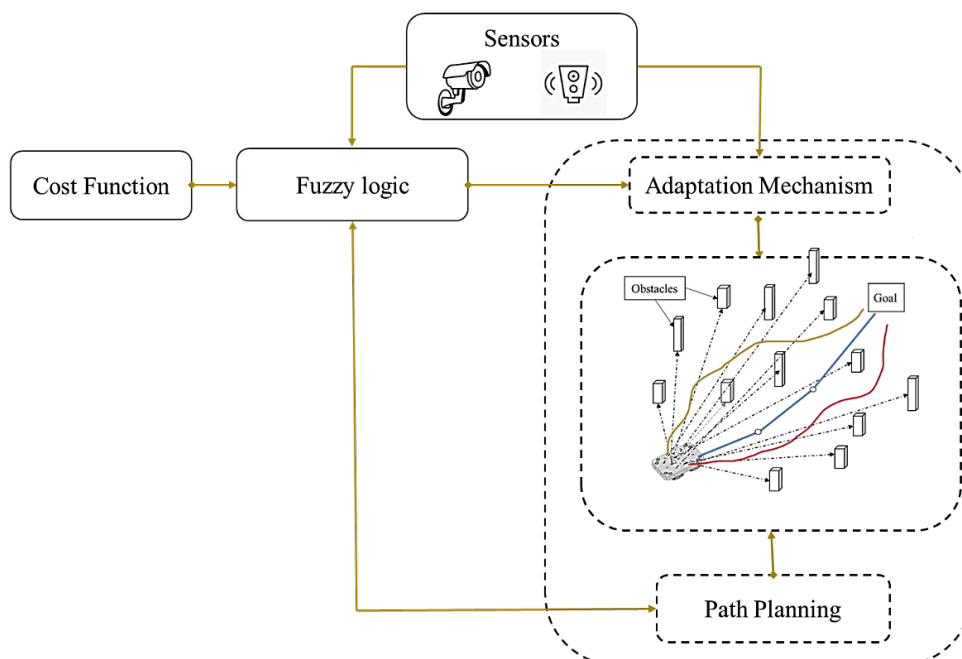


Figure 1. Enhanced Mobile Robot Navigation System.

Lattice Structured Hip Implant Optimization Using the Linear Regression Method

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Keywords: Optimization, Machine Learning, Lattice Structures.

Abstract. Many factors play a significant role in finding the optimal latticed design of the patient-specific hip implant. These factors affect the two main defining parameters of the lattice structure with which the implant is optimized. The parameters are the length and thickness, and they control the biomechanical properties of the latticed design because they affect the topological shape of the lattices. Lattice structures' porosity is not an easy measure to calculate. This study proposes building a machine-learning model using the Linear Regression algorithm to predict the porosity values out of the length and thickness values of the lattice structure's beam.

Machine learning (ML) was used to optimize the unit cell parameters to generate results that consume time and effort if done manually [1]. Jier wang and Ajit Panesar [2] have proposed a novel approach using ML to design graded lattice structures, emphasizing ML's potential in enhancing the design speed and optimality.

ANSYS software is used to create the hip implant design and apply three types of unit cells to the proposed design. The design parameters of the unit cells are optimized to get the best values that create a lattice-structured body most suitable for osseointegration. The three applied types of unit cells are 3D lattice infill, Double pyramid and face diagonals lattice and Octahedral lattice 2. The porosity was calculated for a set of many values of the length and thickness of the lattice structure beam for all three types of unit cells. The necessary libraries like Pandas for data handling, NumPy for numerical tasks, scikit-learn's Linear Regression for modeling, r2-score for R-squared calculation and plotly.graph_objs for 3D plotting were imported. In Jupyter Notebook 6.4.5, the dataset was loaded from a CSV file using Pandas. The features (length and thickness) and target variable (porosity) were extracted and stored in arrays 'X' and 'y'. Subsequently, a linear regression model was established and trained with 'X' as features and 'y' as the target.

To evaluate the accuracy of the models, a thorough comparison will be conducted between the predicted values and the data in the dataset. All three models are expected to achieve an accuracy of over 95%. The focus is on refining the porosity of the lattice-structured hip implant using machine learning algorithms.

However, predicting the porosity of the structure without having to go through the design process and calculating the volumes of the bulk and latticed design is more efficient and can save both time and cost in the design process. The full results of the research are expected to be published once all the results are ready.

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Study the Internal Corrosion of Petroleum Pipes

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Keywords: Internal Corrosion, Oil Pipelines, Corrosion Retardant

Abstract. Internal corrosion of oil pipelines is one of the problems facing the petrochemical industry, because crude oil and its products are complex mixtures containing acids, alkalis, salts and other corrosive substances, so corrosion reactions are easy to occur between them and the inner surface of the conveying pipe. Furthermore, equipment damage caused by corrosion can increase the risk of accidents and reduce the effectiveness of safety procedures. Each year, losses due to various types of corrosion represent 3% to 4% of the world's GDP, so the search for means to hinder corrosion and increase the corrosion resistance of pipelines has become an important topic in the oil production and industry sector. During the exploitation and assembly of oil and natural gas wells containing large amounts of carbon dioxide, condensate oil, hydrogen sulfide and brine, there will be serious corrosion of the oil or gas transport system. Since the medium of the oil and gas collection and transportation pipeline is gas, water, hydrocarbon, and the solid multi-stage flow medium, especially in the later stage of oil and gas field development, the water content of the transport medium will increase due to water injection exacerbating corrosion in pipelines. Therefore, the internal corrosion mechanism and technology of pipelines have received wide attention from research institutions related to corrosion resistance, and are increasingly becoming a fulcrum for research hubs seeking to increase corrosion resistance. In the present study, the corrosion environment of the internal pipeline in the laboratory was simulated according to the actual operating parameters of the oil pipelines, where the partial pressure of carbon dioxide, the speed of the corrosion medium, temperature, the time of corrosion and the corrosion retardant were selected as variables to indicate the extent of their impact on the emergence and propagation of corrosion.

Optimizing Grinding Cycle Times for Maximum Efficiency through Dynamic Programming

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Keywords: Accuracy, Mechanical, Cycles, Grinding, Feed, Optimal, Radial

Abstract. In the field of manufacturing and machining, the optimization of grinding cycle is of paramount importance, with the goal of optimizing efficiency to the fullest extent. This article will delve into the various utilization of dynamic programming as a potent methodology to achieve this objective. By applying the principles of complex mathematical modeling, aim is to minimize grinding cycle times while maintaining the standards of quality, durability and mechanical properties of the treated metals. The results of our research confirm the high potential of improving the mechanical treatment of metals in grinding operations through the mathematical use of dynamic programming.

Design of Equipment Suitable for Jigsaw Testing

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Keywords: Jigsaw, Measurment, Cutting Force,

Abstract. In this paper, we present the conceptual design of a jigsaw test bench. The testing equipment is suitable for testing sawing of soft and hard materials. The jigsaw is powered by a battery, which drives a DC motor. The rotational motion is converted into linear motion through a Scotch Yoke mechanism. With the help of this test bench, we can measure the voltage drop and current consumption of the battery during sawing, from which we can deduce how the cutting force occurring during sawing affects the performance provided by the battery.

Modeling the Interaction of Air and Aluminum at the Free Surface in High-Pressure Die Casting Using CFD

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Keywords: HPDC, Air Entrapment, VOF, Free Surface, Dynamic Mesh.

Abstract. In the metalworking industry, High-pressure die casting (HPDC) within cold room is nowadays a very important place, where the cold room for this process mainly comprises an injection cylinder for injecting the molten metal into the mold using a piston. This technique makes it possible to obtain very high quality parts with a very good surface finish, but unfortunately, the air that is in the injection cylinder can be locked in the metal during the injection phase. So the main flaws of this technique are porosity and air entrapment. The purpose of this study is to find a law of piston acceleration to minimize air entrapment during the slow injection phase and porosity in the final product, where the work was highlighted in the analysis of the effects of each of the piston accelerations, fill rate, surface tension and viscosity on the free surface wave motion. The flow of the molten metal in the casting chamber and the thermal study of the process were studied by introducing certain boundary conditions to allow an improvement and avoid the occlusion of the air. To simulate this numerical model we use the code of calculation FLUENT which is based on the equations of mass conservation, momentum and energy. The liquid volume method (VOF) was used to follow the immiscible interface (free surface). Due to piston displacement, the geometry of the domain is variable and the numerical resolution uses a dynamic mesh. The results obtained with the numerical solution show that the quantity of air trapped during filling and injection processes can be reduced or eliminated by choosing the appropriate conditions related to the piston speed and acceleration and the initial temperature of the chamber and molten metal to ensure the smooth process.

Analysis of the Evolution of Pressure Losses in a High Pressure Hydraulic System

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Keywords: Pollution, Statistical Analysis, Pressure Drop, Oil Analysis, Hydraulic Filter

Abstract. We present in our work the results of an experimental study carried out on the analysis of the influence of the clogging of the filtering element on the admissible resistance of a hydraulic filter. The filter is installed on the discharge line of a variable displacement pump, the service pressure is around 210 bar. The hydraulic system studied is used to supply hydraulic energy to a finisher in the hot rolling mill at the IMITTAL-Algeria steel complex. In this context, we tested the retention efficiency of the filter, whose mesh dimensions of the filter element are 15 μm . The influence of the service time as well as the number of polluting particles retained by the filter on the singular pressure drop ΔP of the filter have been characterized accordingly. A statistical analysis on a representative sample of the evolutionary values of ΔP , followed by adjustment tests were also presented. The statistical analysis carried out clearly shows that the evolution of the local pressure drops of the filter follows a Beta law. The knowledge of the distribution law of a parameter is an advantageous result that will help to establish a maintenance program, with the aim of acting in time, and this to remedy the failures of which the pollution of the oil is considered the main cause.

The results obtained through this study are considered as decision support tools of the hydraulic systems safety, namely the development of a conditional maintenance plan with the aim of controlling the quality of the energy transmitted by a hydraulic system.

The Influence of the Superficial Plastic Deformation by Rolling on Double Layer Sintered Materials Based on NC100.24 and Astaloy Mo

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Keywords: Contact Fatigue, Nc 100.24, Astaloy Mo

Abstract. The paper analyses the influence of superficial plastic deformation by rolling on some mechanical properties for double layer sintered materials based on NC 100.24 and Astaloy Mo.

Fatigue is a process influenced by microstructure, surface topography, geometry, frequency, stress amplitude and is one of the important failure mechanism of structural parts [1].

Samples containing two layers were produced by pressing and sintering. One layer was NC100.24 and the second layer were a mixture of NC100.24 and Astaloy Mo in different proportions (20, respectively 25 wt.% Astaloy Mo and the rest NC100.24). Compaction pressure was 300 MPa, and sintering was conducted in endogas (0.65 % C) at 1120 °C. Bone shape specimens were produced. The specimens were tested to fatigue contact to different cycles (5160, 10320, and 20640).

Tensile strength and hardness were measured. The microstructure of samples was studied by light microscopy. The depth of influenced structure was measured.

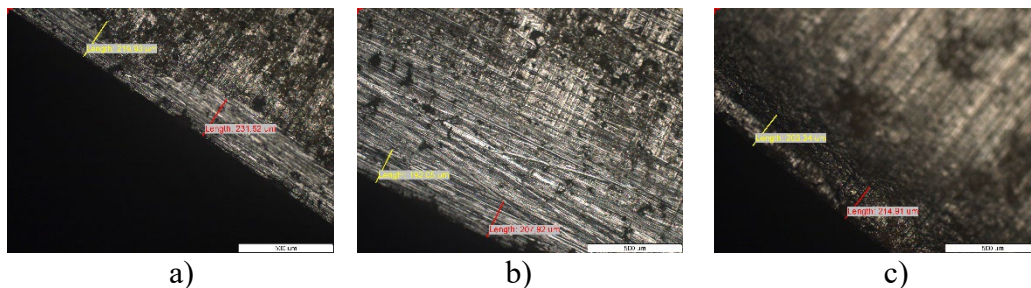


Figure 1. Depth of influenced structure for samples with structure NC 100.24/80 wt. % NC100.24+ 20 wt. % Astaloy Mo: a) 5160, b) 10320, and c) 20640 cycles

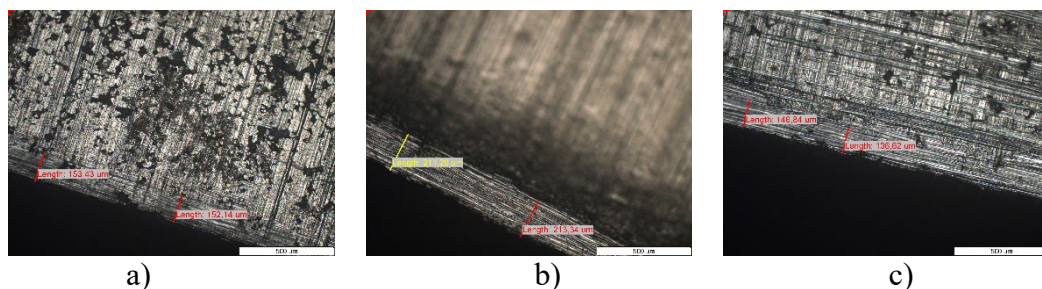


Figure 2. Depth of influenced structure for samples with structure NC 100.24/75 wt. % NC100.24+ 25 wt. % Astaloy Mo: a) 5160, b) 10320, and c) 20640 cycles

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Using Bayesian Optimization for Charge-Mixing Can Reduce Density Functional Theory Simulation Time

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Keywords: Bayesian Optimization, Charge-Mixing, Density Functional Theory

Abstract. The computational simulation of nanostructures using Density Functional Theory (DFT) has become indispensable in materials science and nanotechnology [1]. However, the high computational energy consumption associated with accurate DFT calculations remains a significant bottleneck. This extended abstract presents a novel approach that employs Bayesian optimization [2] for charge mixing optimization to mitigate the computational energy overhead during nanostructure simulations. Charge mixing is a crucial step in DFT calculations [3], responsible for self-consistently updating the electronic charge density. Bayesian optimization, a powerful machine learning-driven technique, is harnessed to intelligently search for optimal charge mixing parameters, thereby reducing the number of iterations required for convergence.

The Bayesian optimization framework efficiently explores the charge mixing parameter space, guiding the simulation towards rapid convergence and lowering the computational energy consumption. By systematically optimizing the charge mixing process using Bayesian optimization, this research not only accelerates the convergence of DFT calculations but also significantly reduces the computational energy requirements, making nanostructure simulations more environmentally friendly and cost-effective. The study showcases the impact of this approach through practical applications on a range of nanostructures, highlighting substantial energy savings without compromising the accuracy of results. To evaluate the effectiveness of the Bayesian optimization-driven charge mixing approach, several experiments will be conducted on different nanostructures, including nanoparticles, nanowires, and 2D materials. The computational energy consumption and convergence rate achieved by the proposed methodology would be also compared to traditional DFT simulations for reference.

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Natural Frequency Examination in Industrial Robot

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Keywords: Industrial Robot, Natural Frequency, Impulsive Testing, Logarithmic Decrement, Damping Factor.

Abstract. For the accurate control of an industrial robot vibrations must be damped. The damping ratio is affected by the materials used, the weight of the robot, the kinematic characteristics, and the foundation used. This study measures the damping factor of the Mitsubishi Melfa RV-2SDB using impulsive testing. The values are given for multiple axes of the robot.

Measurement method and aim of the research

The measurement is done for multiple axis of the robot in the configuration shown on Fig. 1. Impulse was given manually by the means of a rubber mallet. The vibrations were captured by the NI9234 Sound And Vibration Analog Input Module. The damping factor was calculated by the method shown in [1]. The method consists of determining the logarithmic decrement δ , and based on that the damping factor ζ . The natural frequency was determined by analyzing the frequency response captured at the same time.

The goal of the authors was to measure these values and use them to validate the digital models built to calculate the natural frequency and damping factor in advance of manufacturing a robot. This proved to be very resource heavy when using FEM analysis, and requires detailed digital models, but it is feasible. The data will be used as a basis for optimisation calculations using multi-objective optimisation, Autogenetic Design Theory (ADT) and evolutionary methods in product development. [2]

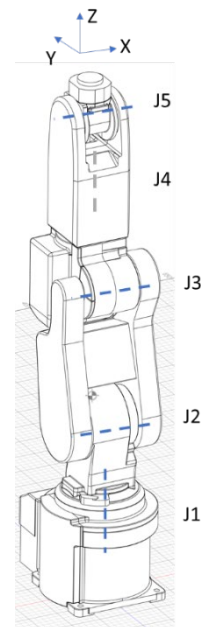


Figure 1. Measurement configuration.

Summary of the measured values

Natural frequency of the Mitsubishi Melfa RV-2SDB is 68 Hz in the given configuration, the average damping factor is 0,2725. Damping factor (ζ) per axis are: *J1* 0,39; *J2* 0,21; *J3* 0,23; *J5* 0,26. This is in line with other scientific papers, the authors of the paper [3] reported an average damping factor of 0,3 for a robot with similar construction of the Mitsubishi Melfa RV-2SDB.

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Analysis of Horizontal and Vertical Grinding Technologies

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Keywords: Manufacturing, Tool, Workpiece, Vertical, Horizontal, Grinding

Abstract. The grinding technologies are widely used for finishing operations of various types of parts to provide better surface roughness and accuracy for the selected surfaces. Those technologies are expensive and take a lot of time to execute them consequently they are used when it is reasoned. The goal of this research is to compare the manufacturing design process for horizontal and vertical grinding where the arrangement distinction between them is just the position of the tool axis compared to the machined surface of the workpiece. All of the necessary manufacturing parameters are determined to ease the design process. After the manufacturing design CAM design and CNC program writing are possible if CNC controlled machine is applied. Using of the same manufacturing parameters a comparative manufacturing analysis is done to determine the differences between the two processes.

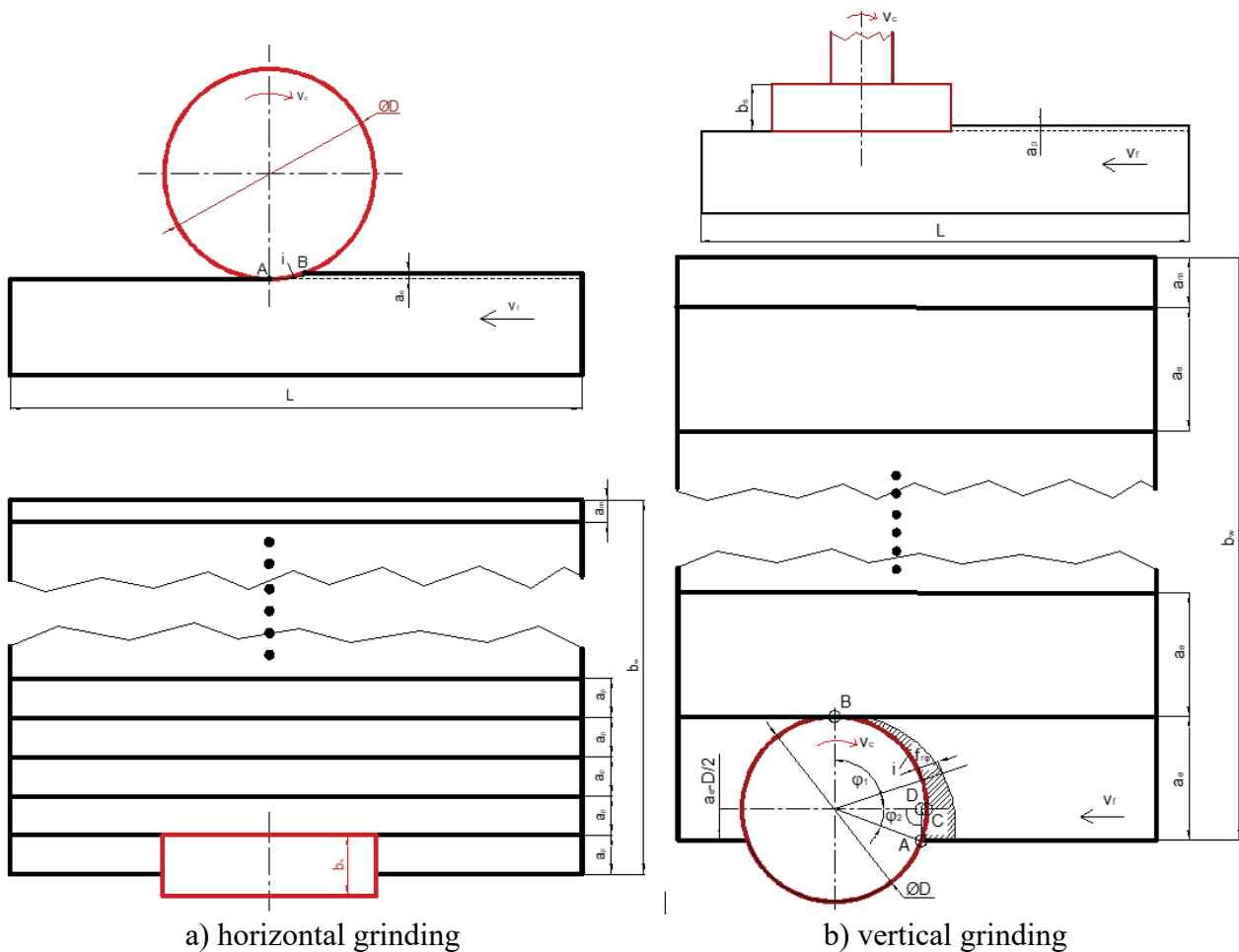


Figure 1. Grinding technologies.

The Influence of Different Grain Refining Fluxes and Master Alloy Addition on the Melt Quality of an Aluminum Casting Alloy

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Keywords: Grain Refining, Melt Treatment, Flux, Master Alloy, Aluminum Casting Alloy, Rotary Degassing, Melt Cleaning

Abstract. Rotary degassing coupled with the addition of different fluxes is the most common melt treatment method in aluminum foundries, due to its high efficiency in inclusion removal and the possibility of grain refining. In this study, the effect of different fluxes and master alloy addition was investigated on the melt and casting quality in different stages of the melt preparation.

Four experiments were conducted, which are labeled as “A”, “B”, “C” and “D”. In all cases, EN AC-45500 alloy (the standard composition in weight percentage is 7 % Si, 0.5 % Cu, 0.4 % Mg, 0.12 % Ti) was melted in a shaft-type melting furnace and then approximately 1000 kg was poured into a resistance-heated holding crucible furnace. In case “A” we applied a melt cleaning flux, whereas in case “D” we used the same flux combined with the addition of Al-5%Ti-1%B grain refining master alloy. In cases “B” and “C”, cleaning and grain refining fluxes from different suppliers were used.

Each experiment consisted of 5 melt treatment cycles with 9 minutes long treatment time, the N₂ purging gas flow rate was 20 ± 2 l/min and the pressure was 5 ± 1 bar. The rotational speed of the impeller was 490 rpm during the vortex formation and 380 rpm in the degassing phase. 800 ± 30 g of the granulated fluxes was added in all cases. The melt cleanliness and grain refinement were investigated in different stages of the melt preparation; after pouring into the crucible, right after and 15 minutes after the melt treatment, and finally before the next pouring into the holding furnace (approximately 200 kg residual melt at the bottom of the crucible).

During the experiments, the evolution of the inclusion content was investigated by the fracture surfaces of K-mold samples. The mechanical properties (elongation, yield strength, ultimate tensile strength) were measured by tensile test of samples machined from the castings, and the quality index was also calculated. The oxide inclusions found on the fracture surfaces of the K-mold samples and the tensile samples were also investigated by scanning electron microscopy (SEM) and energy dispersive spectroscopy (EDS).

The degree of grain refinement and the nucleation temperature were investigated by thermal analysis in different stages of the melt preparation. The exact grain size was measured by image analysis of the polished and Barker-etched thermal analysis samples. The susceptibility to pore formation was compared by Density Index samples, X-ray analysis, and metallographic investigation of polished surfaces from the castings.

The chemical composition of the melt was measured by optical emission spectroscopy (OES) in different stages of the melt preparation, while the phase composition of the applied fluxes was analyzed by X-ray diffraction (XRD).

“Supported by the ÚNKP-23-2 New National Excellence Program of the Ministry for Culture and Innovation from the Source OF THE National Research, Development and Innovation Fund.”

Analysis of Parameters Affecting Fire Protect in PUR Foam Systems

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Keywords: PUR System, PUR Foam, Rigid Foam, Filling Content, Filling Material Type, Flammability Test, Pir Foam

Abstract. The applications of the rigid PUR foam system are in the electronics, automotive, furniture and construction industries. Such polymers are used, for example, for heat and sound insulation materials, for dashboard covers, automotive and furniture industry composites. Their great advantage is the many technologies (molding, RIM, in situ) that provide easy manufacturing and a usability window that continues to make them important representatives of plastics. Rigid systems have the widest range of applications due to their thermal insulation properties (thermal insulating mobile wall and adhesive wall-mounted thermal insulation products). It is important that the 10 cm thick Rigid foam corresponds to a 40 cm wall. Its durability or heat resistance can be improved by using different additives. The biggest difference between flexi and rigid foam is the use of isocyanate and catalyst pack. Flexi foam typically uses toluoldiene diisocyanate (TDI) and methylene diphenyl diisocyanate (MDI). The isocyanate component of the Rigid system can be hexamethylene-1,6-diisocyanate (HDI v. HMDI), methylene diphenyl diisocyanate (MDI) and polymeric methylene diphenyl diisocyanate (pMDI). The latter is produced by partial polymerization of MDI and is mainly used for the production of cross-linked polyurethanes. It is not enough to know about the foam, that it has foamed and even that the reaction time was adequate. We need to do tests on the foam itself. This is done using physical examination methods. These include density measurement, tensile strength, tensile strength, air permeability, cell structure testing, compressive and indentation hardness, cyclic load tests, compressive strength etc. Tests according to the standard are very important, the results of which must be satisfactory for all buyers and analysts, because it is recorded how the measurement should be carried out. It is very important for industry and customers to develop materials that can withstand high temperatures. Thus, there is a lot of experimentation and research into the use of fillers in PUR systems. In addition to having a protective function, the filler can also change other parameters that are beneficial during use, such as hardness and environmental resistance.

Electrochemical Corrosion Resistance of a Wire and Arc Additively Manufactured Duplex Stainless Steel

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Keywords: Pitting Corrosion, Duplex Stainless Steel, Wire Arc Additive Manufacturing

Abstract. The wire arc additive manufacturing (WAAM) process combines gas-shielded metal arc welding and additive manufacturing. The WAAM process can reach a deposition rate of at least 10 kg/hour [1]. In our research, 2209 type (22% Cr and 9% Ni alloying) duplex stainless steel (DSS) samples were manufactured by the WAAM process. DSSs are primarily used in chloride-bearing environments, where pitting corrosion is the general form of degradation. To investigate the pitting corrosion resistance of additively manufactured 2209 type DSS, a 300x250x20 mm block was made by the WAAM process. As the microstructure is expected to be inhomogeneous in the cross-section of the wall [2], samples with different orientations were machined out (Figure 1.). Due to the thermal cycle of the subsequent welding passes in each layer, the microstructure differs from the 60% austenite and 40% ferrite in the annealed bulk material. To restore the phase balance, one sample was also heat-treated with a peak temperature of 1350°C to achieve at least 30% ferrite content, required by standards such as ISO 17781.

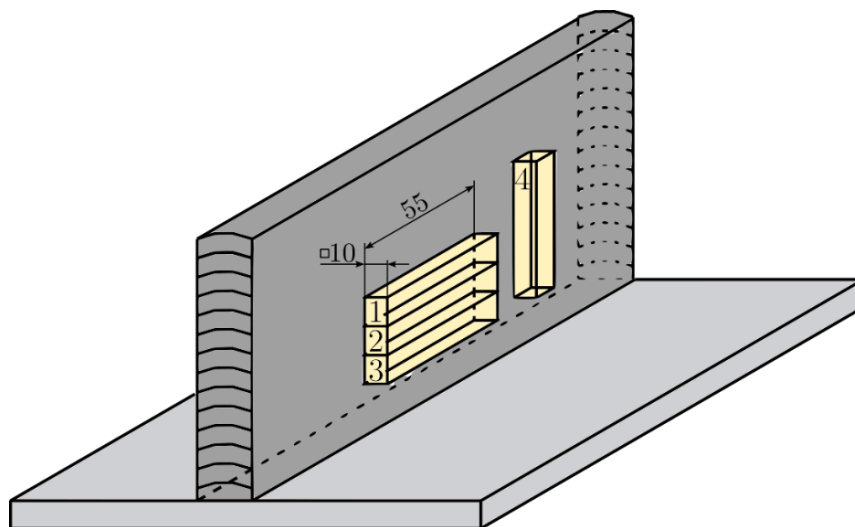


Figure 1. The 2209 type duplex stainless steel block and the sample locations, made by wire and arc additive manufacturing process.

The pitting corrosion resistance can be measured by electrochemical techniques in a standard three-electrode cell in 3.5wt% NaCl electrolyte. It was found that the microstructure and the annealing heat treatment both had an effect on the pitting corrosion resistance, and the sample with the balanced microstructure showed better corrosion resistance.

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Evaluation and Comparison of Machine Learning Algorithms for American Sign Language Recognition

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Keywords: Gesture Recognition, DNN, CNN, Machine Learning, Deep Learning, Neural Network, Random Forest, Hand Gestures

Abstract. Hand gesture communication involves fast-paced hand movements that are difficult for simple traditional algorithms to understand. Combining deep learning algorithms and computer vision technologies offers a compelling new way to comprehend sign language, enabling web accessibility users to communicate with their devices more naturally, simulating their communication in real life. In this work, we compare and evaluate three deep learning algorithms, determining which is most effective in interpreting sign language data to understand which can deliver the best results for accessibility users. For this paper, the sign language used is the American Sign Language (ASL) system to produce standardized results. The main contributions of our work are as follows: Firstly, we utilized the public ASL (American Sign Language) data set, extending the set through rotation and stretching during data preprocessing and then splitting the data set into training, validation, and testing sets. Secondly, we tested three state-of-the-art algorithms on the ASL dataset: Convolutional Neural Network (CNN), Deep Neural Network (DNN), and the Random Forest algorithm. Testing the CNN model, we obtained the results: training set accuracy of 99.99%, validation set accuracy of 99.99%, and testing set accuracy of 99.69%. For DNN, the results were 100%, 99.81%, and 97.95%, respectively. Random Forest attained 100%, 94.95%, and 90.78%. Finally, after comparing and evaluating the results, we found that the CNN model produced the highest overall accuracy among the three algorithms. Even though the DNN and Random Forest achieved 100% training accuracy, the substantive result of the testing set accuracy was lower than that of the CNN's achieved result.

What is Raman Spectroscopy Good for? From the Perspective of Research, Development, and Innovation

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Keywords: Raman Spectroscopy, Surface-enhanced Raman Spectroscopy

Abstract. Raman spectroscopy is a branch of vibrational spectroscopy that allows empathetic structural identification of various chemical and biological materials based on their unique vibrational characteristics, all without destroying the sample. It is a powerful tool for the characterization of energetic materials, biological systems, pharmaceuticals, and semiconductors. Of course, quality examination of different industrial processes as well in the main focus of its application, to obtain products with higher quality, without any contamination. So such a technique became important in industrial automation as well.

Recently, Raman spectroscopy has been successfully used for stress and temperature analysis in semiconductors, polymers, composites, and silicon-coated metal/alloy surfaces. For example, Raman spectroscopy is often used to study and/or measure the local mechanical stresses in materials, as well as their grain size and phase properties. Based on the Raman band position shift and Raman intensity ratio, Raman spectroscopy can be used to quantitatively calculate the residual stress and the thickness of the subsurface damage layer of semiconductor materials. Raman spectroscopy has been used extensively to characterize the influence of mechanical deformation on microstructure changes in biomaterials. Also, it offers powerful analytical capabilities for automated systems. For instance, dangerous samples such as trikalkyl aluminum compounds can be handled safely. Immersion Raman probes can be used in dangerous environments, such as the elevated temperature, pressure, or toxic internal environment of industrial vessels. This eliminates the need for sample extraction and analysis in the lab, improving safety and reducing process downtime, and allows operators to determine damage and quality of materials and components in a fully automated process. The presence of non-metallic inclusions such as sulfides and oxides may be detrimental to the control of the steel casting process and product quality. The need for their identification and characterization is, therefore, urgent. This study uses Raman spectroscopy for the characterization of synthetic duplex oxide-sulphide phases.

Raman spectroscopy is an effective tool for analytical studies, but the low intensity of Raman signals is a major disadvantage of the method. SERS is a commonly used technique to enhance the signal, which allows the analysis of low-concentration samples or even the detection of a single molecule. The SERS effect can occur when the analyte is in close vicinity of a nanoscale-structured metal surface. By using metal surfaces with optimal parameters, the intensity of Raman signals can be enhanced by several orders of magnitude. In this paper, I also compare the results obtained during the examination of nanostructures created by different methods. Figure 1 shows the Scanning electron microscope images of different nanostructures for the SERS application.

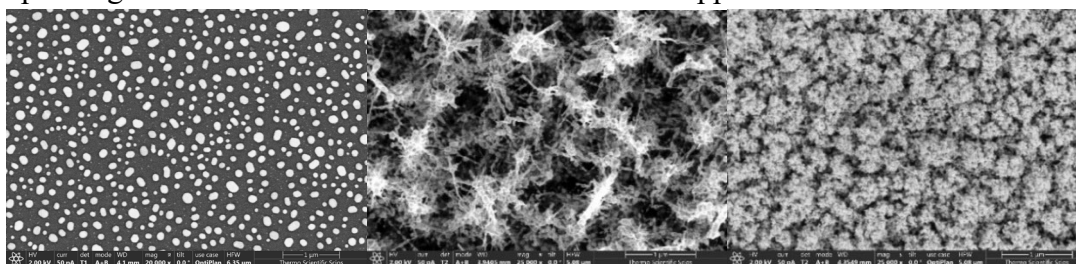


Figure 1. Scanning electron Microscope images of the created and investigated nanostructures: a) Thermal dewetted gold nanostructures, b) Carbon nanotrees covered by gold layer, c) Ag-Au gold nanostructures created by arc-discharge method.

Optimizing the Clamping Components of a Vibrating System on a Plow

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Keywords: Static Simulation, Dynamic Simulation, Design Study, Frequencies

Abstract. In this work, a method for optimizing the main clamping components for a vibration system on the working body of a plow is presented in order to reduce the forward forces. To achieve this goal, a variable geometric model is established, which considers the unique operational parameters, and a three-dimensional finite element model is generated for conducting an optimization investigation. The 3D finite element analysis is automatically refreshed for each version of the geometric model. An optimization analysis is characterized by its defined goals or objective functions, alongside design variables and constraints. To illustrate, one can adjust the dimensions of a component to minimize material usage, all the while ensuring that stresses remain below a predefined threshold. In this scenario, the volume being minimized serves as the objective function, the dimensions under adjustment represent the design variables, and the stress limitation acts as the behavior constraint. The main objective is to optimize fasteners using finite element analysis to reduce production cost with maximum efficiency.

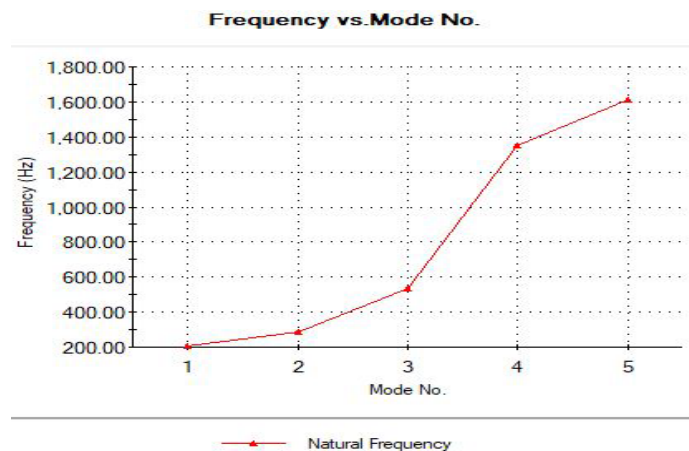


Figure 1. Mode Shapes and Frequencies of the clamping components.

The output data from the design study in order to optimize the structure are weight variation fig. and the variation of the safety factor out of 281 possible scenarios for the entered input data.

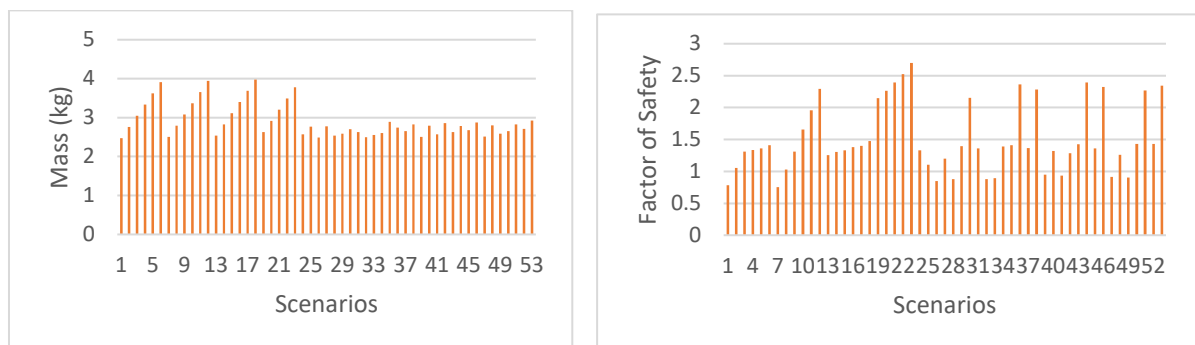


Figure 2. Weight variation for each scenario.

Uniform Torsion of Bar Having Cross Section Bounded by Two Hyperbola Arcs

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Keywords: Stress Function, Torsional Rigidity, Saint-Venant, Torsion, Prandtl, Torsion Function

Abstract. In this paper an analytical solution is presented for the Saint-Venant torsion of a bar with solid cross section. The cross section of the considered bar is bounded by two hyperbola arcs and its material is homogeneous, isotropic and linearly elastic. The presented solution is based on the theory of uniform torsion which was developed by Saint-Venant and Prandtl. Solution of this paper for uniform torsion of the bar is established on the determination of the Prandtl's stress function.

Firstly the problem is explained, the boundary curves and their parameters are described. After that the parameters of the hyperbola arcs are determined by means of the conditions in connection with the Prandtl's stress function. The shearing stresses, the torsional rigidity and the torsion function are derived as well. A numerical example represents the considered analytical solution. The level lines of the Prandtl's stress function, the torsion function and the contour lines of the resultant of the shearing stresses are illustrated in the whole cross section.

The results of this paper can be used as benchmark solution to check the accuracy of the usual numerical methods such as FEM, BEM, Finite Differences, etc.

Optimal Number of Cells in a Numerical Grid for Fluid Flow around the Body

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Keywords: Fluid Mechanics, CFD, Numerical Grid, Cells

Abstract. In this paper the optimal number of cells in numerical grid will be considered. This way of numerical grid modeling could be applied in every numerical simulation. The body that has a random shape is placed in one plane and is exposed to fluid flow around it. The body shape is random and has two characteristic dimensions: length l and height h . If we fit body in one rectangle and extend lines of rectangle's sides all over domain, our fluid domain could be divided into several zones with various dimensions. Example is shown in the Figure 1. According to our solution, every fluid domain must have eleven segments and every segment has its own number of cells with their various shapes.

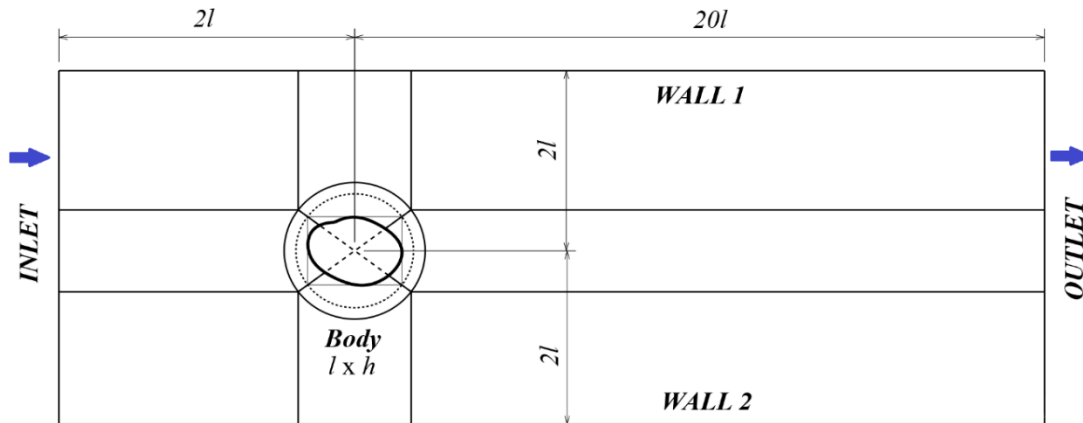


Figure 1.

We will give numerical solutions for body that has a shape of cylinder, whose domain has random inlet velocity, given as mathematical function, and compare solution with experimental one. Nonetheless, procedure of obtaining numerical grid and formula for precise number of cells in every domain part will be shown, including critical zones directly placed around the body.

Acknowledgements

This publication is based upon work from COST Action CA21106 COSMIC WISPer and CA21155 HISTRATE supported by COST (European Cooperation in Science and Technology) and research supported by the Ministry of Science, Technological Development and Innovation of the RS under Contract 451-03-47/2023-01/ 200105 dated 02/03/2023.

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Thermoplastic Elastomers from Recycled Ground Tyre Rubber

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Keywords: Devulcanization, Ground Tyre Rubber, Polypropylene, Thermoplastic Dynamic Vulcanizates

Abstract. One of the biggest challenges nowadays is the upcycling of rubber products, mainly tyres. Tyres are complex composite products made of different types of rubber (typically natural, styrene-butadiene, butadiene, and butyl rubber), combined with reinforcing and filling materials (carbon black, silica) and reinforcing pads of different materials (steel, polymer). While typically metallic reinforcing materials can be recycled by melting after tyre dismantling, this is not the case for tyre rubber: they cannot be melted due to their cross-linked structure. This is why tyre recycling is typically either energy-related or secondary, it can mostly be used to make a product of inferior quality to the original. The most modern and forward-looking direction for recycling elastomers in the material is devulcanization and reclamation, processes that aim at breaking cross-links. The first step is to grind the elastomeric part of the tyres for better handling, resulting in ground tyre rubber (GTR). This GTR then can be devulcanized typically by thermomechanical or thermochemical methods. The resulting devulcanizate can be revulcanized with typically inferior mechanical properties compared to a primary rubber elastomer due to the inevitable chain scission. For this reason, this type of recycling can only be "down-cycling", producing a product of inferior quality compared to the original material.

GTR has long been widespread as a filler for thermoplastic polymers. It is mainly used for toughening polymers, as small amounts of fine-grained rubber granules can increase the energy absorbed if they are well dispersed. If the amount of rubber phase dispersed in the thermoplastic phase is increased significantly (up to more than 50 m%), it can be called thermoplastic elastomer (TPE) if the compatibility between the two phases is good. These materials exhibit rubber-like behavior due to their physical cross-linked structure, while being reversibly meltable, thus allowing for recyclability. However, a small particle size in the micrometer range is essential for rubbery behavior, which can be achieved via dynamic vulcanization. In this process, the rubber mixture is fed into the processing equipment in its vulcanized form, where vulcanization takes place in situ during the compounding process under intensive shearing. This significantly reduces the rubber phase's particle size, resulting in a thermoplastic dynamic vulcanizate (TDV) with typically high elongation. If a dGTR-based elastomer compound can replace the elastic phase of TDVs, it can not only reduce the cost of the raw material, but also provide a new way to make value-added use of the large volumes of waste tyres generated.

The goal of this study is to examine the effect of the viscosity of thermoplastic phase in polypropylene based TDVs with devulcanized ground tyre rubber. By employing solely recycled ground tire rubber as the rubber phase, we successfully replicated TDV characteristics. Additionally, our research revealed that an elevated viscosity of the polypropylene PP matrix facilitated a more uniform dispersion of the rubber particles enhancing its rubber-like attributes.

Analysis of Different Commercial Solid Fluxes Used for the Melt Treatment of Casting Aluminum Alloys

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Keywords: Casting, Melt Treatment, Degassing, Fluxes, Melt Quality, Aluminum

Abstract. The application of casting aluminum alloys in the automotive and aerospace industry has attracted increased attention in recent decades because of their cost-efficient manufacturing, excellent castability, high strength-to-weight ratio, and suitability for recycling. Liquid metal quality is one of the major parameters during the manufacturing of aluminum alloy castings that can determine the performance of the cast part.

Due to the reactivity of liquid aluminum alloys, the creation of oxide inclusions and the dissolution of hydrogen are mostly inevitable processes during the melting, melt handling, and casting production stages. Fluxes are widely used by the foundry industry to achieve low inclusion content while degassing techniques are applied to lower solute hydrogen concentration in the liquid alloys. Flux addition is commonly combined with rotary degassing treatments to simultaneously lower the inclusion and hydrogen content of the melts. Although many researchers targeted the investigation of foundry fluxes, there are only a few works available in the literature that tested the melt cleaning efficiency and, at the same time, analyzed the phase composition of commercially available fluxes. For this reason, to get a better insight into the behavior of solid fluxes, this work aimed to combine industrial melt treatment experiments with characterization techniques that can provide information about the phase composition and thermal stability of different fluxes.

Rotary degassing treatments coupled with flux addition using 5 different commercial fluxes were conducted on batches of EN AC-46000 alloy (AlSi9Cu3(Fe)) melt. Each flux was used in 3 treatment cycles. The melt quality was assessed by the QualiFlash technique and Bifilm-Index (BI) analysis of reduced pressure test (RPT) samples. The phase composition and thermal behavior of the fluxes were investigated by X-ray diffraction (XRD) and differential thermal analysis (DTA), respectively.

Among the 5 fluxes, two had a rather similar phase composition with the main constituents being NaCl, KCl, CaF₂, Na₂CO₃, Na₂SO₄, and K₂SiF₆. These two fluxes, which contain the highest amount of fluoride components, proved to be the most effective in improving the melt quality. In all cases, the results of both Qualiflash and Bifilm-Index assessment showed a similar tendency. The most effective flux reduced Bifilm-Index values by more than 300 mm on average (with an average starting BI of 390 mm), while the average Qualiflash Q-values decreased by 4.6 from a mean initial value of 7.3.

Supported by the ÚNKP-23-4-I New National Excellence Program of the Ministry for Culture and Innovation from the source of the National Research, Development and Innovation Fund.

Optimization of Springback and Thinning During Deep Drawing Process

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Keywords: Springback, Thinning, Optimization Processes, St 14 Steel, Weighting Method

Abstract. During forming process, various geometric parameters play an important role in determining the amount of the springback. These parameters can include factors such as sheet thickness, friction coefficient, and the radii of the dies. Furthermore, it is important to note that this phenomenon is also influenced by the material selection and the applied load.

The aim of this research is to investigate the impact of radii of both lower and upper dies, as well as the blank holder force on the springback amount, and the thinning that occurs during elastic recovery of the material during deep drawing process. The investigation will be followed by the development of an optimization strategy.

Getting Prepared to Understand and also to Jointly Prepare the Harmonized Foresight Views on the Future of Manufacturing in Europe

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Keywords: Manufacturing, Foresight, Whitepaper, AI, Material, Bio-Intelligence, 3D Printing

Abstract. This conference presentation explains how the European Technology Platform named as **ManuFuture** generates and spreads white papers, consultation documents on various hot key issues related to *What comes next?* in Europe under manufacturing research, development and EU implementation issues. The Hungarian Scientific Association for Mechanical Engineering, called GTE, is the local host for the National **ManuFuture** Technology Platform. The GTE is challenging the scientific, academic and industrial ecosystem actors to get involved with the forward-looking activities on the future of the European manufacturing industries.

ManuFuture ETP presently selected 8 areas worth to investigate and to prepare harmonized long-term and mid-ranged views, that could support the EU and national decision-makers to understand the trajectory of technology developments. These areas are of most interest:

- How to support fundamental and applied research results to benefit society faster?
- How could and should national governments inspire industry (SMEs) better? Practices.
- How could and should AI in Manufacturing evolve?
- How to get prepared and apply new materials in manufacturing?
- How to manage the circular economy with sustainability?
- How to integrate efforts in Bio-Intelligent Manufacturing?
- What comes next in 3D printing, updated Roadmap?
- How to handle Distributed Intelligence in manufacturing?
- Targeting Zero-Defect manufacturing. ...

The international (EU) members in the above listed Working Groups share and integrate their ideas, and distributes the White papers, to collect more ideas and achieve joint views. The invitation is open for all, and the GTE is a suitable intermediate actor to provoke more participants from Hungary and from the neighboring regions.

The time for oral presentation allows only a very short introduction to some selected topics from the list above, but GTE offers further consultations to individuals, or university teams, engineer-groups at industrial partners and local premises.

Since many of the upcoming, emerging technologies are in development phase, industrial partners, small, medium or at large scale, are all invited to get involved with innovative application ideas. Future EU calls will focus on research and development, innovation actions, and EU funds will be offered for overcoming the barriers, addressing high TRL levels (close to implementation actions, technology deployments).

GTE and SZTAKI experts promote the spreading of the White papers and invites partners to be part in these working groups of **ManuFuture** ETP.

Segregation Simulation Study of Metal Powders in Additive Manufacturing Technology

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Keywords: Additive Manufacturing, AM, Metal Powder, Powder Segregation, DEM, DEM Simulation.

Abstract. In this article, we have looked at methods to simulate the spreading and melting of metallic powder. In the literature, several simulation models have been proposed to adequately describe the melting and thermal processes. One of the main and perhaps the most important aspects of additive manufacturing (AM) processes using powder bed technology is the uniform distribution of powder particles. The formation of a metallic powder layer of constant thickness is essential for the production of melted/sintered layers of good quality. Computer simulations can help to understand the melting process, during which the metal particles melt and solidify within a short time. The spreading of metallic particles is always influenced by the properties of the base powder. Various discrete element method (DEM) models allow this to be studied.

Introduction

Additive manufacturing (AM) is an evolving technology that enables the production of complex shaped metal products [1][2][3]. The quality of components manufactured using AM technology is significantly influenced by the properties of the raw materials [4][5]. Laser powder bed fusion (L-PBF) is one of the direct metal additive manufacturing (AM) processes. One of the most popular AM processes is Selective Laser Melting (SLM) for powder bed systems. The process uses 3D computer-aided design (CAD) data to melt and fuse powder particles layer by layer by a rapidly scanning laser beam to build metal parts [3]. The laser-powder bed fusion (L-PBF) process also allows the use of high power density lasers to fuse metal powders up to tens of microns (typically between 10 and 100 μm) layer by layer, where relative densities of up to 99.9% can be achieved [6][7]. In this process, the metal powders are completely melted by the laser beam, allowing the production of parts with high density and excellent mechanical properties [8][9][10]. In L-PBF, if the scanning speed is fast and the laser beam power is low, rapid heating and cooling are common. As a result, the solidified microstructure is typically different from the microstructure crystallized under equilibrium conditions.

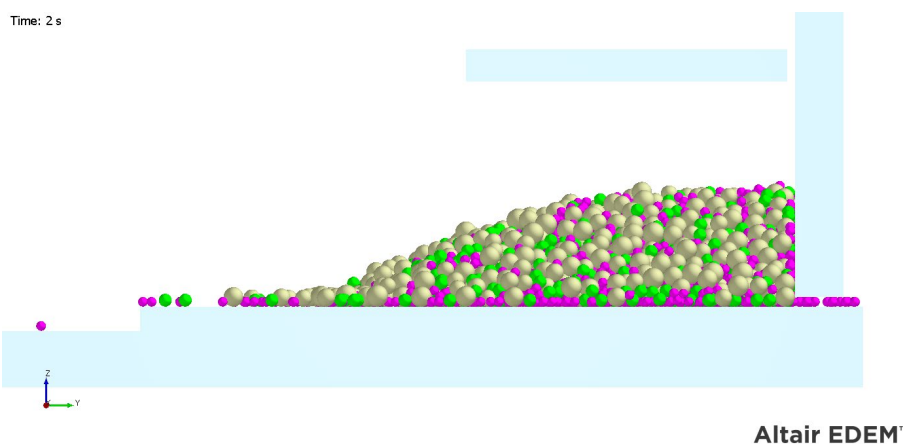


Figure 1. A basic model of powder segregation in an EDEM simulation environment.

Summary

The literature on simulation in additive manufacturing is very rich and diverse. Different fields use different approaches to describe/model the process. The movement/spreading of powders is an important element of PBF processes, this step is used to determine the thickness, uniformity and initial raw density of the layers.

In terms of processes, layer-by-layer melting is a combination of several processes, during which different physical and thermal processes take place.

The only sub-processes we are investigating are powder dosing and powder stirring. In both cases, a kind of self-segregation process takes place, which is well supported by the simulation results. In order to reduce these segregation processes, it is possible to improve the powder dosing by changing the effects on the powder.

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Reduction of Energy Requirements of the Extrusion of Clay Masses with Additives

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Keywords: Plasticity, Extrusion, Clay, Energy Demand, Additives

Abstract. When calculating the energy requirements of the heavy clay industry, often only the energy needed for drying and firing is considered. However, the specific energy consumption includes to a large extent the electricity required for preparation and shaping. The most commonly used forming method in this industrial branch is the extrusion, which usually requires an extruder head pressure of 10-20 bar, depending on the shape of the product and the plasticity of the clay. Nowadays, the internal structure of the brick core is characterised by increasingly thinner internal walls to achieve better thermal insulation. Forming increasingly thin clay walls leads to higher energy requirements. It is therefore necessary to achieve the best possible plasticity of the clay paste, which is achieved by the use of additives that improve the flow behaviour of the clay during extrusion.

In this research we used two different types of clay (a brick and a roof-tile clay) with moisture content of 18-21wt% and two commercially available clay plasticising additives (Fabutit 734, Budit 8H) were added in a range of 0-0.3wt%. The clay masses were prepared by the help of a laboratory pan mill. After mixing the masses were airtight conditioning for 24 hours. A ceramic laboratory vacuum extruder (KEMA PVP 5/s type) was used for the measurements. The experiments were carried out under the same conditions, at the speed of 35 rpm of the screw shaft speed. The effect of the additives was characterised by the electrical power demand of the extruder, which was measured by means of a measuring system connected to the extruder. The electrical signals were processed HBM Spider 8 amplifier and CATMAN software. Measurement results showed that the addition of Fabutit 734 to the brick clay can reduce the electricity demand by 7-9%, while the addition of Budit 8H plasticizer lower electric consumption of the extruder by 6-8% for the roof tile clay.

The Effect of Inorganic Based Plasticizers on Clay Bodies

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Keywords: Plasticity, Drying Sensitivity, Clay, Moisture Content

Abstract. In this study focused on the investigation plasticity properties of the clay and plasticizer compounds. The most commonly used forming method in the heavy clay industry is extrusion, where a mixture of clay and water is used as a raw material to produce a plastic clay mass. Due to the surface charge of the clay minerals present in the clay mass, a lyophilic, active layer is formed on the surface of the clay minerals by the OH radicals present in the water. This process allows the clay particles to slip on each other, allowing plastic deforming. Forming a clay mass requires an extrusion pressure of 15-20 bars. However, the extrusion energy demand can be reduced by using different plasticizers. These additives alter the surface tension, viscosity, and ionic concentration of the clay particles in the water, thus affecting the plasticity of the clay mass.

In this research, two different sodium tripolyphosphate-based commercially available clay additives (Fabutit 734, Budit 8H) were used and their effects on the plasticity of a Hungarian clay were investigated. The additives were used in the clay in amounts of 0; 0,1; 0,2; 0,3; 0,4 and 0,5 wt% relative to the weight of the dry clay. Plasticity was measured with two different methods. In addition to the plasticity of the clay mixes, the effect of the additives on the drying sensitivity was also investigated with the Macey method. The mineral composition of the clay was analyzed by X-ray powder diffraction and the plasticizers were analyzed by FTIR spectroscopy.

Results showed that the moisture content that required to shape the clay body can be reduced by 1-1.5% with the mixing 0.1 and 0.2 wt% of Budit 8H additive. For the Fabutite 734 additive, no positive change was observed in the Pfefferkorn and Cassagrande tests. Based on Macey-method test Fabutit 734 increased by 10% and Budit 8H increased by 14% the drying sensitivity. However, this increase did not result in a reclassification within the sensitivity test classes, so the clay remained in the moderately sensitive to drying category.

Material Characterization by Magnetic Barkhausen-Noise Method

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Abstract. The non-destructive testing of ferromagnetic materials, used in industry, is an important task. By detecting changes in the magnetic field – Barkhausen-noise - caused by the rearrangement of the domain structure of these materials, it became possible to determine various material properties. External magnetic field excitation allows us to investigate these types of materials in industrial field applications. The magnetic Barkhausen-noise measurement technique (MBN), based on the determination of the RMS average value of the noise packages, is a proper method to determine material microstructure, stress state, chemical composition, surface treatment state of the ferromagnetic material.

Since the late 1980s, a new MBN trend has emerged based on the analysis of individual noise pulses. After proper preparation of the sample to be tested, it is possible to extend the types of materials to be tested by determining the amplitude, width, and area distribution functions of the noise pulses, and to determine additional parameters related to the structure and state of the materials.

In this paper the MBN measurement techniques based on both the RMS average of noise packets and the individual noise pulses will be summarized. The characteristics of the measurement techniques and their applications to the determination of material parameters will be also presented.

Applicability of High-Entropy Alloys

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Keywords: Material Science, Applicability, High-Entropy Alloy, Modern Materials

Abstract. In the 21st century, a new chapter in materials science has been opened with the appearance of high-entropy alloys (HEA). These alloys, which contain five or more elements in roughly equal amounts, differ from conventional alloys, which are often based on a single main element (base metal) to which one or more other elements are added in small amounts to achieve the desired properties. In conventional alloys, there is usually a dominant phase to which secondary phases may be attached. By changing the composition, the arrangement of the atoms changes, and this affects the properties of the alloy, which can be further modified, e.g. by heat treatment, to achieve the desired phases and microstructure. High entropy alloys exhibit simple crystal structures due to high entropy, such as lattices that are body-centered cubic (BCC), face-centered cubic (FCC) or hexagonal close-packed (HCP). Secondary phases are much less common, although they can occur. The presence of a similar proportion of many elements makes the atomic arrangement of HEAs much more homogeneous and disordered.

In conventional alloys, diffusion inhibition is often achieved by using small amounts of alloying elements to increase the number of lattice defects or by creating secondary phases that inhibit atomic motion. In high-entropy alloys, the large number of different elements results in high entropy, which can lead to a slowing of diffusion due to the disorder of the atomic arrangement. This property can be advantageous in terms of corrosion resistance and use at high temperatures.

Some conventional alloys, such as titanium-based alloys, are used for hydrogen storage, but their capacity is limited. Some HEAs exhibit outstanding hydrogen storage capacity due to their complex atomic arrangement and unique microstructure. This could be important for energy storage and fuel cells.

The outstanding mechanical properties, corrosion resistance and high temperature behavior of HEAs allow them to be potential substitutes for conventional alloys in areas such as aerospace and aeronautics, where materials have to perform under extreme environmental conditions. They could also be of great importance in the energy and automotive industries, where the thermal and wear resistance of materials is crucial.

However, the economic production and processing of HEAs remains a challenge, which limits their widespread application. Further research and development are needed to realize the full potential of HEAs and their widespread replacement by conventional alloys.

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Dual-Purpose Solar Collector

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Keywords: Solar Energy, Solar Water Heating, Flat-Plate Collector, Solar Air Heating, Dual-Purpose Solar Collector

Abstract. Solar energy is a renewable and sustainable energy source with the potential to play a pivotal role in the future energy scenario of the world. Solar energy has a broad spectrum of utility across diverse domains. Solar systems are classified into three main types: solar thermal (ST), solar photovoltaic (PV), and dual (hybrid) systems. Among these systems, the solar thermal system is engineered to capture and transform the absorbed radiant heat from the sun into valuable thermal energy by utilizing an indispensable component known as the solar collector. Generally, solar collectors are categorized as either liquid or air collectors, depending on the specific heat transfer medium employed. One avenue for enhancing the efficacy of solar thermal systems entails amalgamating both air and liquid heaters into a singular facility referred to as a dual-purpose solar collector (DPSC). DPSC function as a mechanism for capturing and converting incoming solar radiation into heat, thus providing utility for both water and air heating. Essentially, this collector embodies a flat-plate solar collector (FPSC) characterized by two distinct sections: one designated for air heating and the other designated for water heating. Therefore, DPSC can concurrently generate hot air and hot water. Dual-purpose solar collectors exhibit the capacity to function as an effective and efficient means of harnessing solar energy for both water and air heating. These collectors have been the focus of numerous studies that encompass numerical simulations and experimental analyses. This attribute can prove particularly valuable in scenarios where space is at a premium. By exploiting solar energy to heat water and air, dual-purpose solar collectors can contribute to a reduction in energy expenses relative to those incurred by a solitary collector. This advantage is especially pertinent in regions characterized by exorbitant energy costs or limited access to traditional energy sources. Utilization of a dual-purpose solar collector can lead to a decrease in greenhouse gas emissions and other contaminants. Dual-purpose solar collectors have applications in a diverse array of settings, including residential, commercial, and industrial contexts. These collectors have a simplified design and require minimal maintenance, thereby facilitating a reduction in long-term maintenance expenses. Employing a DPSC enables the attainment of elevated temperatures and heightened thermal performance, while simultaneously minimizing costs and spatial requirements. The present article provides an overview of the various design configurations and applications associated with DPSC, as well as an exploration of the parameters that influence their performance.

Semi-Empirical Method to Approximate the Poincaré-Lyapunov Constant for the Delayed-Liénard Equation

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Keyword: Hopf Bifurcation, Center Manifold, Time-Delay Systems, Least Squares Fitting

Abstract. Time delay occurs in many fields including lasers [Pieroux et. al., 2001], population dynamics [Kuang, 1993] and neural networks [Beuter et. al., 1993]. The bifurcations occurring in such systems can be studied rigorously by center manifold theory [Hassard et. al., 1981]. One example of a delay differential equation is the delayed-Liénard equation, in which a Hopf bifurcation occurs that has been studied analytically [Zhao and Kalmár-Nagy, 2009]. In this paper a semi-empirical approach is given to approximate the Poincaré-Lyapunov constant of the Hopf bifurcation occurring in the delayed-Liénard equation. We employ numerical solutions at the critical value of the bifurcation parameter and replace the analytical center manifold reduction by a data-driven identification method.

Description of numerical results

The delayed-Liénard equation is the following:

$$\begin{aligned}\dot{x}_1(t) &= x_2(t) - px_1(t) + ax_1^2(t) + bx_1^3(t), \\ \dot{x}_2(t) &= -x_1(t - \tau) + cx_1^2(t - \tau) + dx_1^3(t - \tau), \\ x(t) &= x_0(t) \quad \text{for } -\tau \leq t \leq 0,\end{aligned}\tag{1}$$

where $a, b, c, d \in \mathbb{R}, \tau > 0$ are parameters. As shown by [Zhao and Kalmár-Nagy, 2009] a solution of (1) can be projected to the center manifold by employing simple analytical calculations. Regularized linear regression is employed to fit a differential equation on the center manifold. The Poincaré-Lyapunov constant is calculated from the determined coefficients. The result is shown in Table 1. for $a = 1, b = -2, c = 5, d = -2, \tau = 1, \dots, 4$. It can be observed that the relative error of the approximation is small, only barely above 5% for the first case and below 5% for all other cases.

Table 1. Comparison of the approximated and analytic Poincaré-Lyapunov constants

τ	Analytic Poincaré-Lyapunov constant	Calculated Poincaré-Lyapunov constant	Relative error
1	-4.46	-4.23	5.06%
2	-5.15	-5.37	4.22%
3	-4.36	-4.24	2.85%
4	-3.59	-3.51	2.07%

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Literature Review of Vibroacoustic Simulation in Vehicle Power Transmission Systems for the Reduction of Radiated Noise

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Keywords: Gearbox Noise, Powertrain Noise, Gear Radiated Noise, Gearbox Nvh

Abstract. The radiated noise reduction of vehicular power transmission systems is one of the most actively researched areas. Noise not only impacts the comfort and safety of the driver and passengers but also regulated by the legislators. The simulation-based prediction of radiated noise of gear-drives is a rapidly evolving area and combines gear meshing models, finite element analysis, multibody dynamics and airborne noise simulation tools. The interfacing of these tools makes virtual noise prediction challenging. In this research, we conducted a literature review on vibroacoustic simulations, with a particular focus on reducing noise in power transmission systems. Based on the reviewed articles, it became evident that, although numerous measurement data are available, the usability of the data is limited. Most research focuses on individual stages of the structure and on smaller-sized powertrains. The measurement methods contain abundant valuable information; however, the literature lack of comprehensive articles that track the simulation process from the inception of excitation to body and air noises. Moreover, the majority of articles investigate the relationship between transmission error and NVH, considering it as a primary source of noise. New methodological approaches, such as the application of FEM meshes on gears, open new horizons in this domain. Throughout the literature review, we compiled potential noise-reduction solutions and highlighted directions for future methodology development research.

Predictive Maintenance and Fault Diagnostics of Automotive Steer-by-Wire Steering Systems Based on Digital Twin Method

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Keywords: Fault Diagnosis, Predictive Maintenance, Digital Twin, Steer-By-Wire, Maintenance

Abstract. Planning the maintenance of vehicles is a challenging task due to the uncertainty of failure and lack of information about the actual condition. In general terms, four levels of maintenance can be distinguished: reactive, periodic, condition-based, and predictive [2]. Some automotive examples of these levels are illustrated in Table 1.

Table 1. Examples for different maintenance methods

Level	Method	Example
1	Reactive	Burned out light bulb, wheel puncture
2	Periodic	Oil, air, pollen, fuel filter
3	Condition based	Suspension, brake, battery, steering system
4	Predictive	-

As the table shows, there are some parts that are replaced only reactively, in case of their failure. This could be due to the relative high effort needed to predict the failure of the part compared to the benefits of the prediction. In case of a light bulb, for example, the failure could be predicted via measuring the drawn current, but the hardware and software modifications required to predict it would be expensive and the problem could be solved reactively at low cost. Some wearing, consumable parts are replaced at given intervals (e.g. 15 000 km requirement for oil and filter change), but there are safety critical parts whose condition can be checked (e.g. shock absorber measurement during mechanical inspection). In the case of steering systems, there is no measurement method available to determine their condition analytically, but the wear and increased friction can be used to deduce empirically when replacement is due.

Currently, the estimation of the life cycle of components is based on given load profiles, measurements and simulations performed on their model [1]. One of the main drawbacks of this method is that it does not consider the actual condition and use of the components. For example, the estimated service life of a steering gear is defined in 300,000 km, 15 years or 8,000 hours of operation [2]. However, this does not consider the actual load that the component is subjected to. There can be a large variation depending on whether the car is used in rural or urban areas, with the latter, greatly increasing the number of relatively high steering efforts at low speeds. In addition, the growing use of car sharing as a new form of mobility expects the car industry to provide greater availability and longer service life [2]. Fault diagnosis and preventive maintenance play a crucial role in both individual and shared car use, but much of this maintenance is currently carried out periodically in a preventive manner, in better cases considering the actual condition of the components.

The aim of the research is to develop a measurement method for the analytical determination of the condition of steering gears and its application to modern Steer-by-Wire systems. An important aspect of steer-by-wire steering systems is that by eliminating the steering column connecting the steering wheel and the steering gear, there is no physical feedback (vibrations, noise) from the steering gear, which would allow the driver to detect road conditions and a possible failure (steering feel). By monitoring the condition of critical components, an accurate estimate of expected maintenance needs could be obtained, and even provide information to car-sharing service providers independently of the driver. The Digital Twin based method could be used to define an extended model of the steering system that, in addition to the components dynamic behavior, can also provide lifetime estimate.

In the context of predictive maintenance, Fabio Arena et al. carried out a comprehensive literature survey to compare different approaches. For Steer-by-Wire systems, the starting point was the thesis of Simon Michael Hägele (Hochschule Esslingen), who presented the advantages and disadvantages of knowledge, data and model-based methods by comparing them. In addition, Jingwei Huang et al. "Towards Digital Engineering - The Advent of Digital Systems Engineering" provides a comprehensive overview of new digital design strategies.

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Model Fitting for Determining the Parameter of the Pore Size Distribution

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Keywords: Pore Size, Distribution Model Fitting

Abstract. The computation of the SWCC requires prior estimation of the pore-size distribution (POSD) which is computed from the PSD. The process described in detail by [1-3]. It needs a value of α which is a model parameter related to particle shape and orientation. On the basis of previous empirical data, the work by [4-6] suggests $1.3 \leq \alpha \leq 1.5$, while [1, 2] used $1.35 \leq \alpha \leq 1.39$ for a smaller number of soil types. In this work our SWCC data measured on fractal sand mixtures were used. The Van Genuchten model was fitted then inverted [7-8], to have suction for a given water content. Then Least Squares fitting was made for the alpha, which had a smaller value around 1. The difference was tentatively explained by the fact that the measured data also deviated from the general measured SWCC-s, were shifted on the suction axis.

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Refinement of the Finite Element Model for Enhanced Structural Analysis

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Keywords: Reanalysis, Eigenvectors, Eigenvalues, Sensitivity, Finite Element Method (FEM)

Abstract. Establishing a dependable finite element (FE) or analytical model is critical for ensuring the robustness of structural analysis. In practice, achieving a high degree of reliability relies on the congruence between the model's dynamic response and experimental data. However, the modification of an FE model or the identification of an analytical model is typically not the primary focus of structural dynamic analysis. This is due to numerous instances where the dynamic response of a mechanical structure fails to meet the analyst's requirements. In such cases, rectifying the dynamic response becomes crucial, necessitating adjustments either through load control or by modifying the structure's dynamic characteristics. Loads, often stemming from the interplay between the structure and its environment, are inherently difficult to regulate. Consequently, understanding that the dynamic response can be enhanced by redesigning (reanalyzing) the structure's dynamic characteristics becomes paramount. This paper underscores the significance of the reanalysis technique in obtaining optimal conditions for the FE model of a mechanical structure. Various techniques, including sensitivity analysis, are examined to understand the response to small modifications. The paper highlights conditions demonstrating the sensitivity of eigenvalues and eigenvectors to these subtle changes, allowing for more accurate and effective structural analysis.

Acknowledgements

The results shown here are the result of research supported by the Ministry of Science, Technological Development and Innovation of the RS under Contract 451-03-47/2023-01/ 200105 dated 02/03/2023., also COST Action CA18203 - Optimal design for inspection (ODIN) and COST Action CA21155 - Advanced Composites under High STRAIn raTEs loading: a route to certification-by-analysis (HISTRATE).

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Production Methods of High-Entropy Alloys

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Keywords: Alloy Design, Materials Science, Production Methods, High-Entropy Alloys

Abstract. High-entropy alloys (HEAs) are a new and rapidly developing area of materials science, characterized by their high entropy content. These alloys are composed of a combination of significant concentrations of five or more elements uniformly distributed in the basic crystal lattice. High-entropy alloys have received considerable attention in recent years because of their properties, such as high tensile strength, corrosion resistance and excellent heat resistance. These materials have the potential to broaden material utilization in aerospace, automotive, energy, and other industries. Computer-aided design methods, such as CALPHAD (Calculation of Phase Diagrams), play a key role in the design and development of high entropy alloys. The CALPHAD to predict phase diagrams and other thermodynamic properties of alloys before laboratory experiments begin. Predictions can aid in the optimization of the composition and manufacturing parameters of experimental alloys. In addition, the use of combinatorial and data-driven design strategies, as well as machine learning, is also gaining popularity and allows researchers to identify the most promising alloy compositions and processing conditions more quickly.

There are three main manufacturing technology group to produce high entropy alloys. These groups are melting and casting, powder metallurgy, and deposition techniques. The traditional melting and casting methods are arc melting or induction melting. A significant issue in arc melting is the difficulty in maintaining compositional integrity when elements have different melting points. Lower melting point elements may evaporate before others liquefy, complicating precise control and potentially altering the resulting material's properties. The powder-based technologies are sputtering or mechanical alloying which can be particularly advantageous as they allow control of grain size, ensure uniform composition, and achieve extreme material properties. The additive manufacturing is a promising technology group to produce these alloys, as it allows the creation of complex geometries and local control of material properties. These technologies can use wire or powder for the manufacturing process.

The manufacturing processes is essential to optimize the properties of the final product and meet the requirements of the application.

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Investigation of the Acoustically Excited Bubble's Nonlinear Shape Deformation in a Massive Parameter Range with GPU Applications

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Keywords: Cavitation, Sonochemistry, Bubble Dynamics, GPU

Abstract. Sonochemistry is an actively investigated research field where acoustic cavitation induced in the liquid domain due to periodical acoustic irradiation. The vapour bubbles arising from cavitation form a so-called cluster, in which the radial pulsation of individual bubbles can be divided into expansion and contraction phases. During the contraction phase, the pressure and temperature inside the bubbles can exceed 1000 bar and 8000 K, depending on the applied parameters. In many cases, these extreme conditions significantly increase the chemical yields, therefore, the chemical industry sees significant potential in the phenomena. However, due to the challenging scalability of the technology and the low energy efficiency, the industrial-scale application of acoustic cavitation is rare. In order to investigate the scaling difficulties, the numerical simulation of the clusters in the extensive parameter space is unavoidable, which is intricated by the nonlinear dynamics of the bubble structures. In addition, inside a cluster, the individual bubbles interact with each other, attracting or repelling the surrounding ones, which makes the calculations even more complex. The neighboring bubbles can merge if the distance between them reduces significantly, and the increased-sized bubbles with massively distorted shapes can lose surface stability, which leads to bubble fragmentation. In bubble clusters, a dynamic balance develops between the merging and fragmenting bubbles, which must be ensured during the numerical simulations as well. In contrast to bubble merge, the modelling of the stable non-spherical bubble oscillation or the bubble fragmentation, and the definition of the stability boundary between these two phenomena cause difficulties to this day. For the description of the nonspherical bubble oscillation, a system of nonlinear coupled differential equations is required where the modes, which allow the deviation from the spherical shape, can interact with each other. The authors previously developed a mathematical procedure which is embeddable into the adaptive Runge--Kutta—Cash--Karp method and able to describe the behavior of non-spherical bubble oscillations. Thus, the system of coupled implicit nonlinear differential equations derived by Shaw becomes efficiently solvable via GPU applications. The current paper aims to create a wide range parameter study in order to examine further the convergence properties of the mathematical procedure, and the nonspherical bubble dynamics.

Manufacturing of 17-4PH SLM Parts with Different Scanning Angles and Sample Orientations

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Keywords: 17-4PH, Additive Manufacturing, Selective Laser Printing

Abstract: Scanning strategy and sample orientations are crucial parameters that impact melting and reheating processes, as well as microstructural defects such as porosity of the 3D printed 17-4PH parts. This study presents the effects of scanning strategies and building orientations on the densification, metallurgical, and mechanical properties of 3D printed 17-4PH samples. Optical and scanning electron microscopy, Vickers hardness, compression test for the microstructure analysis and hardness, strength measurements were carried out. The results showed that the samples scanned at 90° with sample orientation 90° had the highest proportion and largest size of pores (4.79%). Consequently, the best results belonged to the samples scanned at 45°, which were 99.59 and 99.3% with sample orientations of 45° and 60°, respectively. It can be concluded that 45° and 60° are the best option for both scanning and sample orientation angles.

Investigation of Heavy Vehicle Underrunning Guard Focusing for the Energy Absorbing Issue

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Keywords: Energy Absorbing, Underrunning Prevention, Crashbox Aluminium, Foam Absorber

Abstract. The consequences of rear-end collision with a heavy vehicle could be significantly high risky, and the likelihood of the serious personal injury is notable high. The importance of an under-running guard is to increase the occupants survive and reduce the technical and personal injury. The lack of RUPD (Rear Underrun Protection Device) could involve fatal situations regarding to the occupants of the rear impacted personal car, therefore the application of this guard is not arbitrary option due to the strict national safety regulations. The related regulations define the guideline for the designing testing and applying of RUPD. Analyzing the role of RUPD the distinction is made between two main functions. Due to the notable clearance between the floor height of the rear and the road, at the case of rear impact the cockpit of the personal car could be essentially abolished. Therefore, the first expected role of the unit is the hindrance, namely with the proper strength and the stiffness presence in the guard inhibiting the underrunning, and the reduce the probability of the fatality. At the moment of impact, the recent kinetic energy of the participant vehicle is converted into impact energy resulting in harmful deceleration related to the vehicle. The converted energy results in deformation in the vehicle, meanwhile the deceleration involves risky personal injury. The deceleration issue of the occupants could be improved with extension of the impact duration time. Taken into account this physical coherence, the second expected function of RUPD to absorb impact energy as much as possible. At most frequently applied energy absorbing way in the vehicle safety the allowed but controlled deformation. The development a new RUPD or an improvement of recent one could be complex engineering task, since the absorbing ability and the proper strength requirement call for frequent contrast conditions during the construction designing. Taking into consideration of requirements of weight optimization the complexity of the designing could be even more complicated. The improvement task could be approached by more ways, since the absorbing capacity of the guard can be more effective using shape optimized crashbox structures, or applying new materials as absorber or the simultan application of them can reach the desired positive results. One of the most ideal impact energy absorber could be the aluminium foam. Owing to the porous structure of it, the stress-strain curve of the compressed test is characterized by linear elastic, near constant plateau range and densification zone. At the case of plateau range the energy absorbing can be considered as consistent, since the continuous deformation is happening against relative constant stress level. Recent study investigates the ways to improve the amount of absorbed energy by the closed-cell aluminium foam using radial constrain during the compression. The second half of the study introduces a finite element analyses research related to the folding behavior of thin walled structures (crashbox) as energy absorber. By structures is analyzed and compared by the peak force at the moment of impact, the folding force fluctuation and the amount of absorbed energy.

Mechanical Characterization of Sustainable Mortar Based on a Prepared Sand and Superplastizier

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Keywords: Slag Addition, Admixture, Mechanical Properties, Mortar, Prepared Sand, Durability.

Abstract. Industrial mineral addition like Slag(S) as a by product could be a valuable cement replacement for economical and environmental reasons to limit clinker consumption. The research undertaken so far are concerned with its blending favorable contribution replacing the Portland cement. However, the substitution of the inert fraction part of sand by the slag addition could be also beneficial for sustainable mortars confection based on such activated sand.

- In this context its use to substitute the finer inert sand fraction presents a great interest for researchers to improve the properties of a blend cementitious mortars based on a prepared activated-sand. Furthermore, the combined utilization of admixture might be beneficial in a such a manner to fulfill the environmental mortars requirements.
- This experimental study concerns the mechanical behavior and durability of a mortar based on a locally prepared sand with slag additive and admixture incorporation. The proposed composition comprises a substitution of the finer fraction sand (0.08-0.16 mm) up to 15 % by the slag while keeping the grain size identical to that of a standard sand. The superplastizier Medaflow SP 30 is used at dosages of 0,5 and 1 % by the weight of cement in the mixtures. The confectioned mortars performances are compared to a reference mortar without additives made of a normalized sand.
- The aim of the present research topic is to show and analyze the influence of slag addition on the mechanical response and the durability in the aggressive medium (H₂SO₄ and HCl solutions) of the mortars made of prepared sand with admixture incorporation.

The outcome of the present study let us to conclude that this combined effect; replacement of finer fraction of the sand by the slag addition once married to admixture could be advantageous for a sustainable mortar formulation. A significant improvement in the mechanical properties of studied mortars that reaches a compressive strength of around 40 MPa for at 10% and 15% slag dosages is noticed.

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Design Optimization of Intake Manifold for Dual Fuel IC Engine

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Keywords: Dual Fuel, Internal Combustion

Abstract. The pursuit of more sustainable and efficient internal combustion engines has led to a growing interest in dual fuel systems, offering the potential for reduced emissions and enhanced performance. This article explores the critical component of the intake manifold in the context of dual fuel internal combustion engines. The study focuses on the design optimization of the intake manifold to maximize fuel-air mixing and overall system efficiency. Through a combination of computational simulations and experimental testing, the research aims to identify the most effective parameters for enhancing intake manifold design. The findings reveal that a well-optimized intake manifold plays a pivotal role in achieving superior combustion performance and emission control in dual fuel engines. The study discusses the implications of this research on the field of alternative fuel propulsion and presents results that demonstrate substantial improvements in engine efficiency, particularly in terms of combustion stability and emissions reduction. On the other hand, the study presents some safety design guidelines. This article not only contributes to the ongoing efforts to enhance the performance of dual fuel internal combustion engines but also serves as a valuable resource for researchers and engineers seeking innovative approaches to dual fuel system design. By optimizing the intake manifold, we take a significant step towards cleaner and more efficient transportation technologies, aligning with the global push for sustainable energy solutions.

Mechanical Testing and Orientation Optimisation of 3D Printed 17-4PH Stainless Steel Alloy

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Keywords: 3D Printing, Stainless Steel, Printing Orientation, Laser Power Bed Fusion

Abstract. Additive manufacturing is one of the most studied and rapidly developing industry of the last two decades. It is a cutting-edge technology which can produce extremely complex geometries, without sacrificing any precision. This flexibility in production may lead the industry to certain engineering solutions which can not be achieved otherwise in terms of weight reduction and static optimisation.

During our work, firstly we made investigations on the different 3D printing orientations, in Laser Power Bed Fusion (LPBF) technology, and concluded, that the preferred load direction of parts manufactured this way is horizontal, because the load will be parallel to the plains of the deposited layers. As the 17-4PH stainless steel has exceptional heat treatability, this property can be strengthened further with annealing and subsequent aging. In the case of tensile test specimens, the amount of test pieces may vary with orientation, as horizontal ones take up more space from the building platform, making the print job less efficient. Placing the specimens vertically can mean four to six times more product per printing session, which can reduce efforts towards post-processing and not least have less residual stress. However, the direction of the load will act perpendicular to the deposited layers, making it more brittle and reducing the tensile strength as well. Our measurements were aimed towards the improvement of this orientation. We used two improvement strategies. The first, was to make an “in-situ” treatment, scanning the already solidified layers one more time, with a slower scan speed and higher intensity. The second, was the beforementioned annealing and aging treatment, which is also represented on Figure 1.

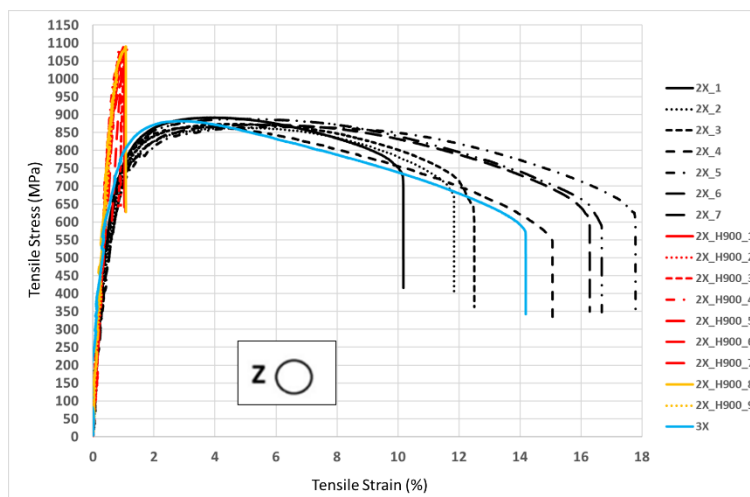


Figure 1. 3D printed 17-4PH stainless steel specimens, using vertical (Z) orientation.

The conclusion of our work was that, with classical heat treatment methods, the effect disadvantageous orientation can be emphasized more, as the pieces got even more brittle than in their original state, while a secondary, slower but more powerful heating of every layer made the integrity of the layers better, which could have been observed with the increased tensile strain values.

Plasma Surface Treatment of Aluminium Sheets

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Keywords: Surface Treatment, Aluminium

Abstract. Weight reduction is an important issue in all engineering fields. This includes the ever-evolving automotive industry, where weight reduction is essential in a variety of applications. One reason for this is that European Union regulations are imposing ever stricter emission requirements on manufacturers every year. There are several engineering solutions with different approaches to achieve pollution reduction. One suitable way to reduce the weight of vehicle bodies is to use modern material combinations. The engineering use of these materials may be limited by the requirement for different installations. Thus, in addition to the development of materials, particular attention must be paid to their bonding technology. For example, when using aluminum sheets, the surface condition of the different materials can be a problem. Adhesive bonding may therefore be an optimal technology for joining identical or dissimilar materials. Different preparation may be required to bond surface elements. My experiments aim to investigate the physical, topographical, and chemical characteristics of the surfaces. This will help me to explore the material science context, how I can influence the quality of the adhesion bonding on surfaces. The aim of my research is not only to modify the surface physics and chemistry of the raw materials from the production process, but also to modify these properties in a conscious and engineering-oriented way. I want to fill a scientific gap in the international literature on the relationship between surface modification of raw materials and bonding technology. How specific physical and chemical processes take place, their duration of action and their role in bonding technologies.

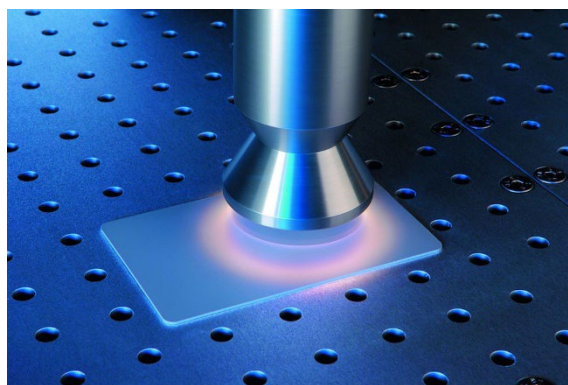


Figure 1. Surface activation with atmospheric pressure plasma [1]

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Comprehensive Measurement and Simulation of Prototype Injection Moulds

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Keywords: Rapid Tooling, State Monitoring, Injection Moulding, Simulation, Finite Element Modeling

Abstract. The injection moulding industry is dynamically developing. The growing demand for more customizable products can be served by low or middle volume production using prototype moulds and inserts. The conventional material of prototype moulds is aluminum because of its excellent machinability, acceptable strength and stiffness and outstanding thermal conductivity. Prototype moulds are gaining ground in the injection moulding industry, yet their operational behavior is largely unknown. We created a comprehensive state monitoring system that measures the operational strain, cavity pressure and temperature of different prototype injection moulds. This way, all important process parameters can be measured and the relationship between the moulding parameters and the operational pressure loads, deformations and temperatures can be quantified.

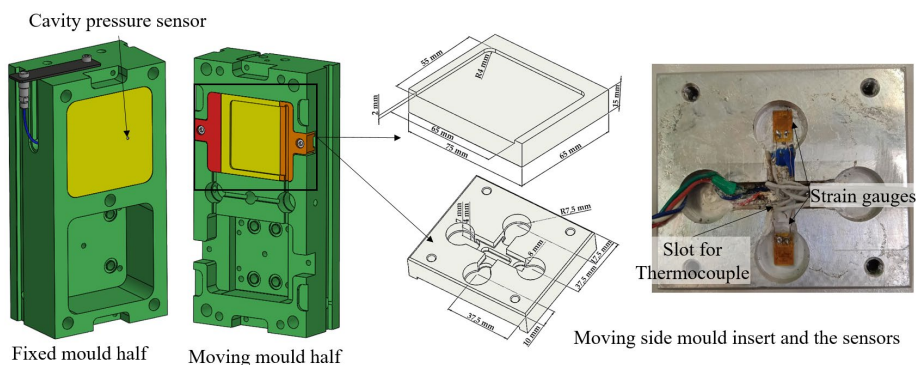


Figure 1. The measurement assembly.

We analysed the operational strains, cavity pressures and temperature distributions. We also applied finite element mechanical simulation to model the operational state of these prototype moulds with satisfactory accuracy.

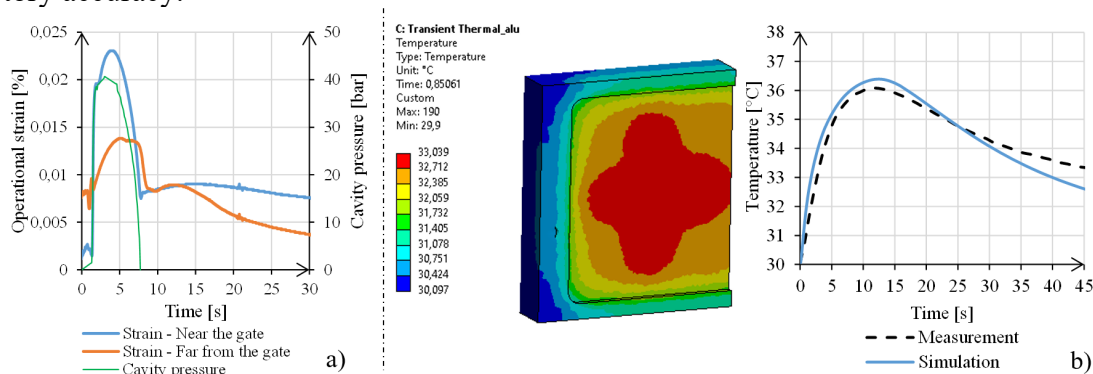


Figure 2. The measured operational deformations and cavity pressure at 200 bar holding pressure a) and the comparison of the measured insert temperature and the finite element simulation result.

Acknowledgements. Supported by the ÚNKP-23-3-II-BME-31 New National Excellence Program of the Ministry for Culture and Innovation from the source of the National Research, Development and Innovation Fund.

Bubbles and Producing Ammonia

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Keywords: Sonochemistry, Bubble Dynamics, Ammonia, Haber-Bosch-Process, Energy Efficiency

Abstract. Nowadays ammonia is an important energy carrier and one of the stocks of the chemical fertilisers [1]. Ammonia is produced using a more than one-hundred-years-old method called Haber-Bosch process [2-4]. This process needs a reactor which grants high temperature (500 °C) and pressure (400 bar) to assist with the desired chemical reactions. The equipment is very dangerous; that is why it is an important goal to produce ammonia in an alternative way for example with the help of bubbles. The small-scale bubbles are generated artificially with given initial mole fractions of hydrogen and nitrogen. Then, we decrease the pressure to expand the bubbles. In the end, the pressure is increased to the initial value, which is why the bubbles will oscillate freely, which consist of collapses and expansions. At the end of the first collapse, the pressure and the temperature in the bubble are high enough to produce ammonia, but in the bulk of the reactor, the extreme conditions are not needed. The main goal is to find the appropriate parameters to make this process energetically as effective as possible.

The modified Keller—Miksis equation is used [5] for describing the radial oscillation of the bubbles extended with the equations of the chemical reactions. This leads to a system of ordinary differential equations. In a bubble cluster, there is a lot of bubbles which can affect on each other, but for convenience, just one bubble is analysed. This system is nonlinear, that is why it is solved numerically using MATLAB. Because of the stiffness of the system, the ode15s solver is used to calculate the results.

During the simulations, the parameters were the equilibrium radius of the bubble, the magnitude of the initial expansion, the ambient pressure and the initial mole fraction of hydrogen. Results show that decreasing the ambient pressure improves the energy efficiency until a limit value and a small reducing the initial mole fraction of hydrogen also decreases it in almost all cases. In the best case, the energy efficiency was a factor of 6.78-fold of the Haber-Bosch process. However, because the energy efficiency depends on a lot of additional parameters (for example, the liquid and pressure excitation properties), this value can be increased further by varying these parameters.

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Particular Aspects Regarding the Radiative Heat Transfer in Thermal Analysis of Steel-Concrete Composite Structural Elements.

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Keywords: Radiative Heat, Flux Coupled Thermal, Analysis Participating, Medium Steel-Concrete Composite Elements

Abstract. In a coupled analysis of steel-concrete composite structural elements, radiative heat flux is the main component of the heat transfer. The majority of the available methods to model the radiative heat flux are based on prescriptive values of the surface thermal properties of the participating medium, which do not take into account the specific geometry of the system and the effective values of the thermal properties of the participating medium. The prescriptive methods assumes that the terminal properties of the participating medium are independent of the temperature and the wavelength of the electromagnetic radiation. The mentioned simplifying assumptions improve the formulation of the mathematical model which describes the physical phenomena, yet considering the number of parameters that influence the physical phenomenon, for example, the gray body assumption, or neglecting the local geometric conditions may cause the supraevaluation of the real situation. The present study assumes to establish on a quantitative and qualitative level the radiative heat flux for two situations. The first situation involves the radiative heat transfer between the flame and a solid surface, one of the first steps in the thermal analysis of composite structural elements. The evaluation of the thermal properties of the fame involves the influence of soot. The second case deals with the radiative heat transfer between two parallel solid surfaces, a particular case if one desires to model the thermal discontinuity between steel and concrete. The present study assumes to evaluate the thermal and geometric parameters that influence the radiative heat flux for a wide range of temperatures and compares the different approaches with the standard formulation. The study also assumes to analyze the radiative heat flux variation for temperatures indicated by the ISO-834 standard fire curve.

A Comparative Study of the Predictive Capabilities of SVM and RSM for Estimating Heat Treatment Parameters

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Keywords: Modeling; SVM; RSM; Heat Treatment; Mechanical Properties.

Abstract: This work presents a new statistical study on the influence of heat treatment parameters on the mechanical properties of C45 steel, as well as on the predictive modeling of these properties using the Support Vector Machine (SVM) method. The results of the analysis of variance (ANOVA) reveal that the cooling medium has a significant impact on tensile strength, hardness, and elongation, contributing 47.34%, 49.16%, and 74.3%, respectively. Furthermore, the heating temperature also exerts an influence, with contributions of 13.27%, 17%, and 1.99% for these same properties. In parallel, the mathematical models developed using the SVM approach prove to be extremely effective for predicting new results even with small datasets.

Conclusion

The cooling environment has a significant influence on tensile strength, hardness, and elongation, with respective contributions of 26.46%, 26.35%, and 42.08%. Then, the heating temperature has contributions of 11.34%, 17%, and 1.99% for these properties, respectively. The tensile and hardness tests indicate that samples quenched in an acidic solution exhibit higher resistance compared to other samples subjected to heat treatments. The best properties, including tensile strength, yield strength, and hardness, are achieved after heating to 800°C. Beyond this temperature, these properties begin to decrease, while elongation reaches its maximum after heating to 1200°C. The mathematical models developed for T_s , HV , and A using the SVM method prove to be extremely effective in predicting new results, surpassing the RSM method in terms of predictive performance.

A New Concept of n-Dimensional Machine Design

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Keywords: Machine Design, Product Development, Product Life Cycle, N-Dimensional Design

Abstract. Every industrial product should be adapted and harmonized with existing or potential needs in various areas of human activity. Basic sciences are followed by technical sciences, which lead to product development, including engineering design and related activities. After completing the engineering design, the product is manufactured using appropriate production technologies. Art, particularly through industrial design, is more or less included in product development, depending on the type of product. Last, but not least, the state and dynamics of product development are influenced by the social and economic situation, as well as politics, which create an environment for all these activities [1]. Otherwise, realized products significantly impact each of these areas of society and civilization development. A product life-cycle includes the following main stages [1]: 1) Problem/Need/Market and Company Goals/Potential; 2) Product planning; 3) Design/ Development; 4) Parts production/Assembly/Testing; 5) Marketing/Sale; 6) Use/Maintenance and 7) Energy recovery/Recycling/Disposal. The main steps of product design and development are: 1) Task setting; 2) Concept design/Synthesis; 3) Selection of shapes, dimensions and materials; 4) Analysis/Simulation/ Optimisation; 5) Corrections/Modifications and 6) Detailed drawings. In the Architecture, Engineering, and Construction (AEC) industry, there is a concept known as Building Information Modelling (BIM), which has undergone significant development over the past fifteen years. It represents a modern approach to the design, documentation, delivery, and lifecycle management of buildings by utilizing project databases in conjunction with object-based parametric modelling [2]. The primary aim of this work is to propose a comprehensive methodology for Machine Information Modelling (MIM) to the scientific community in the field of machine design. It also seeks to initiate the development of a complex methodology tailored to all aspects of machine design while incorporating valuable elements from BIM. Some certain aspects similar to BIM principles are already present in machine design and manufacturing, though they have not been systematized and standardized or unified, as they have in the AEC sector. Our current main focus is on a multidimensional (nD) modelling approach to MIM. It is necessary to create a very complex information system that would contain all the mentioned dimensions (or new ones that will inevitably emerge with industrial development) and provide instructions for their incorporation into the machine design. This is impossible without the application of modern information and communication technologies (ICT), the utilization of powerful digital resources, and the integration of artificial intelligence. Additionally, it is essential to include the process of standardization and the publication of appropriate standards for the realization of n-dimensional design, similar to those for BIM, as well as using the unique aspects of machine design, which lead to original MIM. The number of dimensions is theoretically infinite. The greater the amount of information we incorporate into a model, the more dimensions we can generate!

Acknowledgements. This work was supported by the Ministry of Science, Technological Development and Innovations of the Republic of Serbia (Contract No. 451-03-47/2023-01/200105, dated 03.02.2023).

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Evaluation of Machine Learning Algorithm for Facial Recognition and Its Applications

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Keywords: Computer Vision, Facial Recognition, OpenCV, Machine Learning

Abstract. Throughout recent eras, machine vision and facial recognition have been integrated into our daily lives more and more frequently. Whether it be unlocking mobile devices, camera documentation, or even autonomous drives, there is no doubt that machine vision is a prominent part of the current world. With this promising technology, there is almost no reason not to adopt and use facial recognition widely, in fact, it is already in the market. Big tech such as Apple, Samsung, and Google, all offer biometric encryption via facial recognition for the security of their mobile phones. In the paper, this work aims to explore the advantages and applications of facial recognition via machine vision through testing on a pre-trained FaceRecontion model downloaded from GitHub. Contributions are made by changing and retraining the model with different images for the purpose of recognizing a team of 8 individuals rather than a single person. The FaceRecontion model was fed 18 images of each 8 individuals and was asked to train to recognize these 8 people upon showing new images. These images could be unseen photos of these 8 individuals, or other unrelated personnel. Afterward, parameters are modified, and the results are optimized. To see how well this newly trained model is doing this paper compared results with its previous database to determine how well the algorithm mastered these new data. While this paper's methods may not be as advanced compared with the current industry, it shows that enthusiasts outside of the industry can also use such tools. With open-source programs such as OpenCV, facial recognition software can be developed and employed at home without much effort or expense. Furthermore, these free open-source softwares could not only be used for simple passion projects or even used for educational purposes in classrooms.

Impact of Ball Bearing Geometry and Operational Load on the Volume of the Lubricant in the Bearing's Loaded Zone

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Keywords: Ball Bearing, Load Distribution, EHL, Bearing Lubricant Volum

Abstract. This paper presents the mathematical model for determining the quantity of lubricant in contact between balls and raceways of a deep groove ball bearing. In the deep groove ball bearing, balls participate in transferring the load from one ring to another, as they pass through the contact zone [1]. In doing so, the balls are in mutual elastohydrodynamic lubrication (EHL) contact with the raceways [2]. In the EHL contact between the balls and the raceway, there is a certain amount of lubricant between contacting surfaces. The volume of lubricant in contact can be determined as the product of the contact zone's area multiplied by the thickness of the lubricant film between them. The relationship between the lubricant volume V_{Lq} ($q = 1$ for ball-outer ring contact, $q = 2$ for ball-inner ring contact) within the contact zone and the relative radial clearance e/δ_0 (e – radial clearance; δ_0 – contact deformation between ball and raceway) as well as the relative operational load F_R/C (F_R – operational load; C – bearing dynamic load rating) of the deep groove ball bearing 6206 is shown in Figure below.

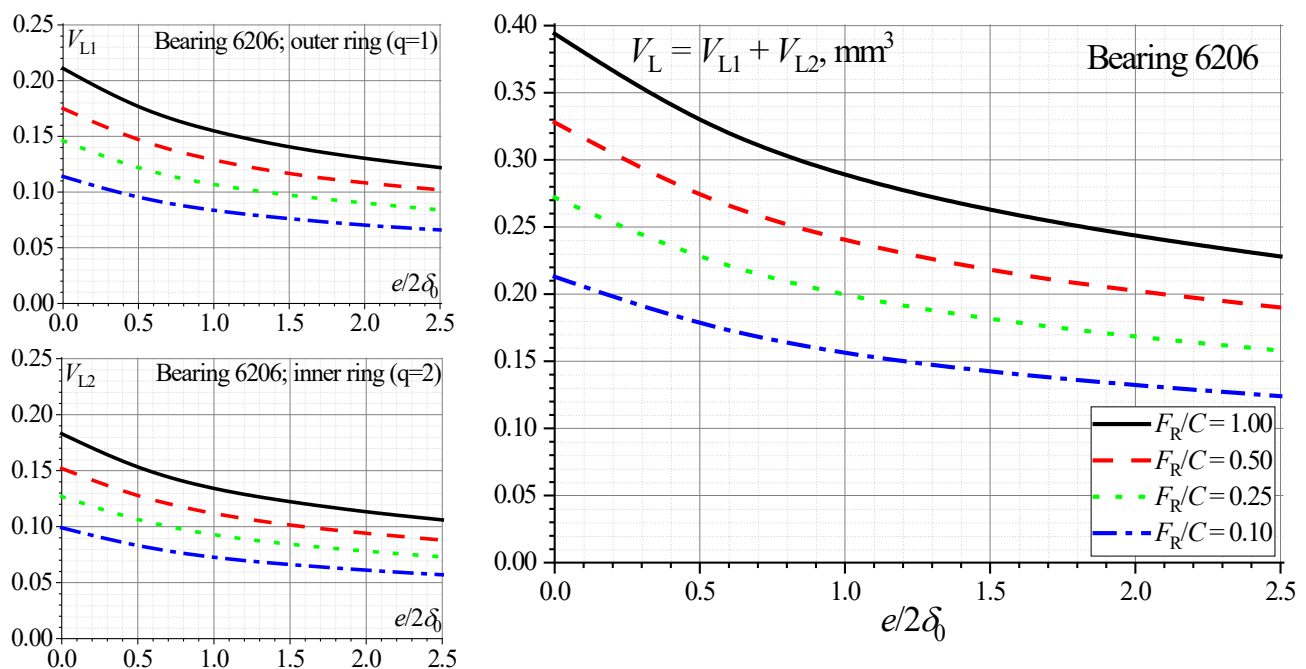


Figure 1. Amount of lubricant within the contact zone between balls and raceways.

Based on known quantity of lubricant volume V_L within the both contact zones, it becomes possible to estimate the concentration of contaminating particles that are entrapped in contact between balls raceways. This estimation can be related to the overall known concentration of abrasive particles within the bearing lubricant. Through this approach, it becomes feasible to assess and predict the level of abrasive wear occurring within bearing components during operation.

Acknowledgment

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Testing Surface Properties of 3D Printed Metals

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Keywords: Tribology, Wear, Testing Methods, 3D Printed Metals

Abstract. The rapid development of additive manufacturing technologies has opened novel opportunities for producing metal components with a variety of uses. 3D printing of metals provides the capability to produce parts with complex geometry and offers design freedom that cannot be achieved through conventional methods. That is the reason why 3D printed metal parts are increasingly finding applications in areas such as automotive, aerospace, and tool manufacturing. Surface properties of 3D printed metal components are of great importance for the functionality of machine systems, because they often operate under conditions where contact stresses occur.

There is just one standard that deals with the measurement and characterization of the surface texture of 3D printed metals – ASTM F3624-23 [1]. Generally, methods for testing surface properties are divided into two groups: non-destructive and destructive methods. The most commonly non-destructive methods for the determination of surface roughness are SEM, EDS, and XRD analysis. Also, all other ultrasonic thermographic, laser, atomic force microscopy (AFM), X-ray, magnetic, and eddy current methods (ETC) can be applied, but their limitations must be taken into account. Usually, post-processing methods are used to reduce the roughness of parts. It has been shown for stainless steel 316L that shot peening can reduce up to 50% of the average surface roughness [2]. Tribological properties are very important in cases where contacting parts is in the relative motion. For determining tribological properties well-known testing methods are adapted for 3D printed metals. The most commonly used are dry erosion, slurry erosion and high-stress abrasion tests on stainless steel 316. Testing procedures of ASTM B611 and ASTM G65 standards are used for determining wear properties of 3D printed cemented carbide, which is not metal, but that procedures can be applied on 3D printed metals [3]. For measuring the hardness of 3D printed metals the Vickers method is most frequently used. A large number of parameters such as AM technology, printing direction, post-processing, and layer thickness influence surface properties. In general, surface characteristics of 3D printed metals are not extensively researched and can represent a significant area for investigation, especially when considering all influencing parameters.

Acknowledgment.

This work was supported by the Ministry of Science, Technological Development and Innovations of the Republic of Serbia (Contract No. 451-03-47/2023-01/200105, dated 03.02.2023).

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Treatment of Polluting Oil Drilling Waste, Proposal of a Green Economy Process, Drill Cuttings Case

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Keywords: drill cuttings-Petroleum -Solidification/ Stabilization- Cementing

Abstract. During oil drilling, the polluting drill cuttings generated are generally treated by stabilization/solidification using a cement-based hydraulic binder. Then, this operation is followed by the burial of drill cuttings loaded with cement in the environment without recovery and without economic consideration. The environmental challenge facing the oil industry with increased oil production is the growing generation of contaminated drill cuttings that pollute marine and land life [1-3]. If drilling sludge is treated and recycled [4, 5], drill cuttings containing a multitude of forms of organic and metallic pollution, which are generally from underground rocks, are an acute environmental problem [2, 3, 4, 7,]. In order to make our contribution to solving this problem, we carried out an investigation focused on various objectives aimed not only at eliminating the quantities of condensed pollutants in the environment, but also to make them useful by estimating the possibility of their valuation. The main objective of our study is to develop an optimized original cement formulation that can be exploited in the fields of cement-based building materials. The formulation is based on a mixture of CEMII/A 52.5 cement with previously stabilized drill cuttings, in the presence of a superplasticizer to influence the rheological characteristics of mixtures in such a way as to approximate the rheological characteristics based on cement alone.

1. Capacity de treatment

The treatment of a drilling quagmire requires about 200 tons of cement, 50 tons of lime, 10 tons of silicate and the consumption of 750 m³ of water for an average volume of 2000 m³ of excavated material to be treated

The cost of treating a quagmire is equivalent to 40,000,000 DA

2. Tests after treatment

Sampling was carried out directly at the oil site; Manual coring was carried out, in the open air, in accordance with the French standard X31-210 The samples were collected at several points in the mire.

The description of the set of experiments carried out on the solid sample (water content and fire part) and the leaching (see fig 1) followed by a series of analyses carried out on the leachate. The analyses we conducted concerning: Heavy Metal Assay(see fig 2), BOD5(see fig 3), COD(see fig 4), Measurement of Organic Pollution Indicators



Figure 1. The leaching test.

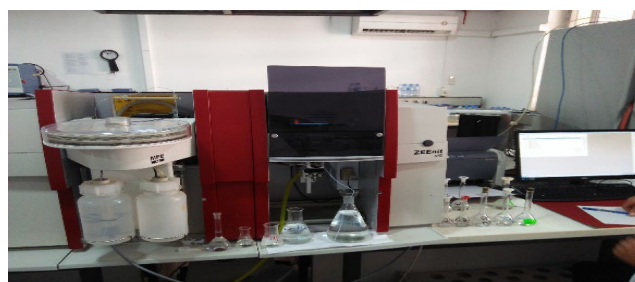


Figure 2. Determination of Heavy Metal.



Figure 3. Determination of DBO5.

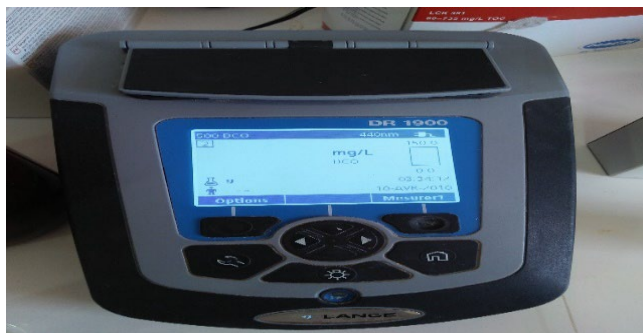


Figure 4. Determination of DCO.

3. The rheological behavior

The rheological behavior of pastes made from CEMII cement loaded with different rates in SDC and in the presence of a superplasticizer, are presented in Table 1. The results achieved through our study showed a very good stability of the powders, and an appreciable physicochemical compatibility between the two powders used. The experiment relating to the rheological behavior of cementitious pastes based on cement CEMII and SDC, showed the possibility of incorporating SDC at a considerable rate of around 30% in the cementitious matrix with obtaining cement slurry, having rheological characteristics in accordance with the data of the literature.

<i>Table 1. Results of the rheological behaviour modeling.</i>				
Dosage (%)	τ_0 (Pa)	K(Pa.sn)	n	R-square
10SDC+90CEMII	0±2.491	6.022±0.665	0.537±0.016	0.994
20SDC+80CEMII	16.980±0.882	2.431±0.126	0.700±0.008	0.998
30SDC+70CEMII	87.175±1.802	0.737±0.15	0.818±0.034	0.980
40SDC+60CEMII	0.028±4049.108	2256±4034.551	0.018±0.271	0.330
50SDC+50CEMII	83.303±24.443	59.051±16.487	0.246±0.031	0.976

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Optimizing the Geometric Design of a Helical Gear through Simulation and Surface Roughness Measurement Analysis

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Keywords: Surface, Design, Static, Gear, Helical, Optimization

Abstract. Gearing systems, especially helical gears, are efficient in transmitting rotary motion and power between shafts. In addition, these gears excel in load-bearing, reduce noise, and offer versatile speed adjustments, however, they face several challenges that are mostly related to tooth root failures and surface pitting due to the designing process. In order to enhance helical gears' performance, this study optimizes their geometrical design and efficiency by selecting the most preferable parameters for the driven gear, especially for its helical teeth. Real helical gear will be measured and its parameters are going to be modified accordingly with the use of the SolidWorks, with a complementary opposite hand pinion that would best align with the created design for further static analysis. In parallel, the surface roughness measurements are going to be taken from it and analyzed to determine how to reduce losses, improve the performance and choice of material, as well as extend the gear life. Once the optimal design has been executed for the gear pair, Finite Element Method (FEM) analysis assesses stress distribution and contact patterns, predicting gear behavior under various loads and different conditions. This research contributes to efficient, durable gear systems, benefitting various types of industries such as automotive, aerospace, and industrial machinery applications.

CAD model of the gear pair for static analysis

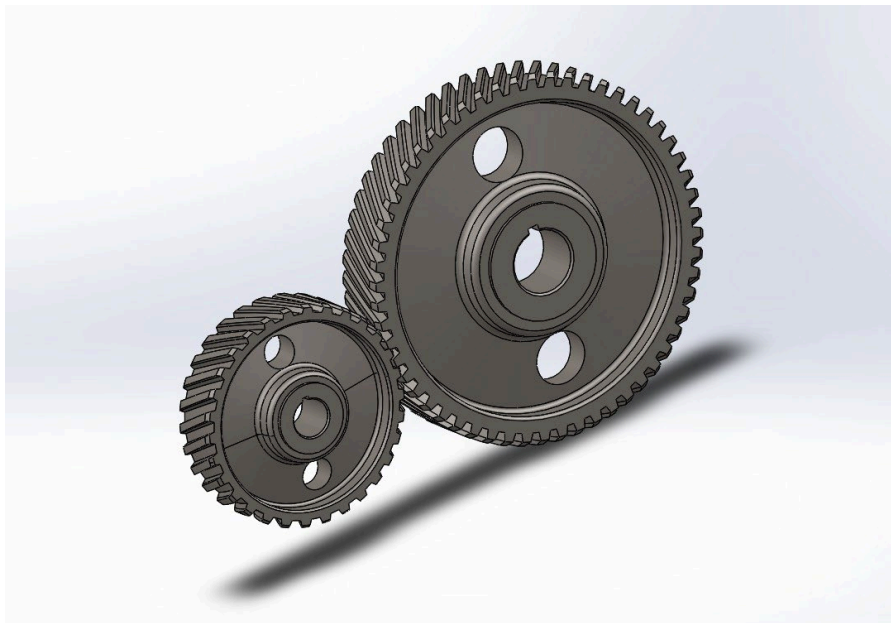


Figure 1. Gear pair designed with the use of SolidWorks

Object-Centric Process Mining for Inspection and Maintenance Error Detection in Sustainable Manufacturing

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Keywords: Inspection and Maintenance, Object-Centric Process Mining, Error Detection, Classification.

Abstract. In the pursuit of sustainable manufacturing processes, techniques for inspecting and maintaining are commonly reliant on subjective analysis and the assumptions of manufacturing process models, which frequently focus on individual object types. While traditional techniques for improving these processes may be effective, they do not always lead to quick improvements in efficiency and sustainability. In reality, there is often a mismatch between the perceived solutions of manufacturing process modeling and actual error detection during inspection and maintenance, which exhibits discrepancies across both time and space.

Object-centric process mining (OCPM) offers a groundbreaking and comprehensive approach for the analysis and improvement of sustainable inspection and maintenance error detection in manufacturing processes. OCPM considers multiple object types and events, transcending the limitations of a single-object focus, and encompassing the complexities of 3D space and time. Adopting an object-centric perspective provides organizations with a multidimensional understanding of their processes, allowing for the identification of the root causes underlying performance and compliance issues.

This study investigated the potential of OCPM to enhance inspection and maintenance error detection within the context of sustainable manufacturing, ultimately contributing to increased efficiency and sustainability.

Damage Analysis on Tooth Gear Ring of a Bucket-Wheel Excavator

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Keywords: Damage Analysis, Gear, Bucket-Wheel Excavator, Low-Alloyed Cast Steel

Abstract. This paper deals with damage analysis of gear ring after manufacturing process, just before *in-service* period. Tooth gear ring segments were made of 40MnCrSi3V low-alloyed cast steel, which chemical composition and mechanical properties were given in table 1 and 2, respectively.

Table 1. Chemical composition of low-alloyed cast steel 40 MnCrSi3V.

	C	P _{max}	S _{max}	Si	Cr	Mn	Cu _{max}
[%]	0.35-0.45	0.04	0.04	0.5 -0.75	0.5-0.8	0.6 -0.9	0.3

Table 2. Mechanical properties of low-alloyed cast steel 40 MnCrSi3V at room temperature.

Re	Rm	A ₅	Z	KCU 3
[MPa]	[MPa]	[%]	[%]	[J/cm ²]
340	640	10	20	17

Concerning parent material characteristics, in this case low-alloyed cast steel 40 MnCrSi3V, inspection and control of gear segments were necessary to be performed after manufacturing. Non-destructive testing method with magnet particles (MT) of fluorescent suspension of particle size 3 μm was performed for potential defects detection. Surface indications were observed on 8 out of 12 gear segments on these new parts, where the lengths of the cracks goes up to 110 mm. Some of the observed defects were shown in Fig. 1. Defects were located in segments main body the gear teeth, its main body etc. Taking into account aforementioned, observed defects on new gear ring segments were caused in manufacturing process i.e. by casting process and inadequate cooling rate.



Figure 1. Examples of observed defects on gear ring of a bucket-wheel excavator.

Acknowledgments

This work was supported by the Ministry of Education, Science, and Technological Development of the Republic of Serbia (Contract No. 451-03-47/2023-01/200213).

Fracture Analysis of Composite Beam Element: Case Study

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Keywords: Composite materials; UAV; Design Requirements; Finite Element Analysis

Abstract. This paper presents a fracture analysis of a composite beam element through an in-depth case study. In this research, the composite beam is a part of an unmanned aerial vehicle (UAV). In this study, the composite beam is a structural element of the UAV and must possess high strength and lightweight characteristics. However, such elements are susceptible to various forms of failure under different loads and operating conditions. The objective of this case study is to identify and analyze the factors leading to the fracture of composite beam and understand the fracture mechanisms. This is of significant importance, as there are still no clearly defined forms and regulations to be adhered to in the design of unmanned aerial vehicles. On the other hand, during the testing of control systems, missions, and flight performance, unexpected load scenarios may occur, leading to material failure. As is well-known in aviation, weight is a critical factor, and thus, over-sizing the structure is unfavorable.

The fracture under investigation in this study was a consequence of the aircraft's descent after takeoff. To understand this fracture, the research involves a thorough analysis of flight parameters recorded prior to the descent. This analysis is pivotal for establishing the load profile and replicating the precise load conditions that led to the fracture. Furthermore, the research methodology extends to encompass a wide-ranging examination of numerical and experimental data derived from real-world engineering scenarios. Beam and specimens are examined to explore the various factors contributing to structural failure, including forms of fractures such as delamination, cracks, and material fatigue.

The results of this case study provide a deeper understanding of the fracture mechanisms of composite structures, enabling engineers to improve design of composite parts of the UAV. Establishing this methodology can have broad applications in the aerospace industry, the automotive sector, construction, and various other fields where composite materials are utilized.

Through this analysis of composite beam fracture, this study contributes to enhancing the safety and reliability of composite structures, particularly in the design of unmanned aerial vehicles, while also enriching the data in this field and having broad applications in various engineering contexts.

Investigating the Mechanical Properties of PVC Based Ternary Blends

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Keywords: PVC, TPU, Dynamic Mechanical Analysis (DMA), Tensile Tests, Mechanical Properties

Abstract. Polymer blending is a method to create new materials with a diverse range of properties by combining existing polymers. The properties of these polymer blends are determined by various factors, including the composition of the blends. The aim of this research is to investigate mechanical properties of PVC/TPU/Bio plasticizer systems prepared with roll milling process at various mixing ratios. Dynamic mechanical analysis (DMA) was utilized to investigate the compatibility of the blends. DMA results showed that the blends of PVC/TPU/Bio plasticizer, PVC/TPU, PVC/Bio plasticizer and TPU/Bio plasticizer are miscible over the entire compositions. Hardness measurement and tensile tests were done to evaluate the mechanical properties. The hardness decreased with increasing bio plasticizer content in the PVC/Bio plasticizer and TPU/Bio plasticizer blends. The hardness of PVC/TPU blends also decreased with TPU content. The tensile strength of PVC/Bio plasticizer, PVC/TPU and TPU/ Bio plasticizer blends decreased with the second component content. The reduction in tensile strength of PVC/ Bio plasticizer due to the presence of bio plasticizer was more significant than the reduction in PVC/TPU due to the presence of TPU. The blend composition also influenced Young's modulus and elongation at the break. The elongation at the break of blends increased with bio plasticizer content. As expected, Young's modulus of PVC/TPU decreased with increased TPU content because TPU has elastomeric properties with significant elongation. Remarkably, it was observed that incorporating 20 phr of TPU into the PVC/ Bio plasticizer 100/50 blend increased elasticity and elongation at the break without significantly compromising tensile strength. Therefore, it was concluded that small changes in the TPU composition can effectively enhance the required properties for selected applications. And these polymer blends are miscible and technologically compatible, i.e., they can be used in industrial applications.

Advancements and Technological Optimization in Yacht Design Osmosis Treatment and Rehabilitation

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Keywords: Design, Osmosis, Technological Optimization, Yacht, Rehabilitation

Abstract. Our presentation will explore innovative solutions for yacht rehabilitation, with a primary focus on mitigating osmosis and the detrimental impact of seawater, microorganisms, and biomass solidification on yacht hulls and rudder. Through meticulous technological processes, which include blister treatment, epoxy coatings, and the application of 'Anti-Osmosis paints,' this research culminates in a positive outcome. Yachts not only fully recover but also strengthen, preparing for continued voyages. This article will prove invaluable to stakeholders invested in the longevity, performance, and sustainability of yacht designs, offering insights into transformative approaches to address and overcome these design challenges. Relevant design-enhancing materials have been applied, and the technological process has been optimized in a staged methodology, enabling the complete restoration of the yacht. The knowledge gained from this research is directly applicable in practice and is useful for interested parties, including yacht owners, companies, and individuals involved in both conventional and advanced yacht design.

A Review of Aerodynamic Analysis of Commercial Automotive-Materials and Methods

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Keywords: Drag Force, Lift Force, Computational Fluid Dynamics (CFD), Wind Tunnel, Vortex, Wake

Abstract. This paper explores the role of the computational fluid dynamics (CFD) modeling technique in the aerodynamic design and propulsion system of the formula 1 car. It provides a study of Reynolds number influences on the state of the boundary layer, unstable and steady flow, time-dependent wake structure, interacting shear layer and separate flows through literature review. As pointed out in is paper, the aerodynamics analysis is conducted to decrease the drag force. Using the computational fluid dynamics (CFD) tools, the analysis was carried out. The major objective of this review article will be to increase the car stability and reduce drag. The efficiency of the track would also increase the air resistance of the vehicle. The ideas of dimensional analysis and uniformity of flows are used to demonstrate that commercial ground cars' aerodynamics are only dependent on the transitional and trans-critical flow regimes.

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Produce Foam Glass Aggregate Utilizing Waste Glass from Cathode-Ray Tubes

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Keywords: Cathode Ray Tube, Waste Glass, Foam Glass, Foaming Temperature.

Abstract. Foam glass aggregate, typically crafted from discarded glass, is a lightweight material. It is formed by mixing powdered glass with a foaming agent and subjecting it to high temperatures, leading to a structure filled with numerous small, enclosed glass bubbles. This aggregate possesses outstanding insulation qualities, low weight, and resistance to water and chemicals. It finds widespread use in construction and civil engineering projects due to its insulation, drainage, and load-bearing advantages. In this work, foam glass was prepared by using cathode ray tube (CRT) waste glass and silicon carbide as foam agent at (1wt%). CRT waste glass pertains to the glass found in (CRT) devices, such as older television and computer monitors that were prevalent prior to the introduction of flat-panel displays. When these CRT devices are no longer used, the glass parts, including the screen, become a form of electronic waste. The appropriate recycling and disposal of CRT waste glass are crucial because these devices contain hazardous materials like lead. Recycling CRT waste glass not only helps recover valuable materials but also prevents the harmful release of these substances into the environment, addressing both environmental and health concerns. The mixture from waste glass and silicon carbide was tested with a heating microscope to determine foaming temperature and maximum height of the samples during heating. It was found that the foaming temperature is approximately equal to the maximum height that can be achieved. The mixture had a foaming temperature (800°C) with a higher foaming height (119%), the density; thermal conductivity, compressive strength, and water absorption were measured for foam glass at different foaming temperatures (725 °C, 750 °C, 775 °C and 800°C). The study revealed that as the foaming temperature raised, the density, volume expansion and porosity size of the material increased, while the thermal conductivity decreased.

Comparative Analysis of Wettability of Metals and Ceramics by Oil

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Keywords: Wettability, Surface Tension, Anti-Corrosion, Oil Separation.

Abstract. The transportation of liquids (such as crude oil) through metal conduits (like steel pipes) is a fundamental part of many industries. However, as these liquids pass through the metal bodies, they are subjected to the forces of friction, which decelerate the flow velocity. This frictional process often results in the removal of metal layers and, consequently, leads to corrosion and the potential collapse of the equipment. This issue is particularly pronounced when dealing with crude oil due to its inherent impurities and water, which further exacerbate the interaction with the metal surface. Therefore, understanding and addressing this challenge is paramount for preserving equipment, decreasing maintenance costs, ensuring operational efficiency, and extending the working lifespan of the infrastructure for any industry. The main objective of this review is to delve into prior research endeavors that have explored the enhancement of liquid (especially for oil) wettability on metal surfaces. As well as to assess the feasibility of improving corrosion resistance by meticulously controlling the level of wettability of oils by enhancing the surface properties of metals while considering the influence of various operational conditions. Additionally, a number of actionable recommendations and suggestions for future planning can prove invaluable in mitigating the deleterious effects of corrosion on equipment and infrastructure. Moreover, it promotes sustainability, reduces maintenance costs, and ensures the reliability of machining systems indispensable to various industries.

The experimental part was conducted using a set of oil types (Glycerine, Hydraulic oil (Hydro HME10) and Petroleum) that were replicated on metals and ceramics surfaces including (Ag, Al, Cu, Sn, TiC and WC). The average surface roughness (Ra) of the substrates was $0.02 \pm 0.0002 \mu\text{m}$ (MARSURF M 400 Surface Roughness Measuring Instrument). A (KSV) software is used to record and measure the change in contact angles of oil droplets for 5 minutes for each sample and analyse the results obtained. The main observations were the following. The wettability of petroleum was better than other oils we used on all types of substrates (for example on TiC surface, $\Theta_{\text{petroleum}} = 8^\circ$, but $\Theta_{\text{Hydraulic}} = 12^\circ$). It was improved on the TiC surface consistently maintaining lower contact angles throughout the testing period. Also, we observed that the contact angle of oils is increasing with increasing of the atomic radius of the pure metal substrate.

Shopfloor-Level Material Flow Analysis to Determine the Readiness of a Company for Industry 4.0

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Keywords: Digitization, Industry 4, Intralogistics

Abstract. The fourth industrial revolution has led companies to place increasing emphasis on the digitization of their processes. By digitizing production processes, they can create cyber-physical systems in which connected elements are able to make decisions about their operation in real-time based on information collected and processed by themselves and by other networked elements. However, to do this, the elements involved in the processes under study need to be equipped with different sensors and actuators, and communication and data transfer between them must be ensured so that the information processed would be available. These challenges are addressed by technologies emerging with Industry 4.0, such as the Internet of Things or cloud computing. Within the Big Data phenomenon, it is important to define what data must be collected about and how it can be properly stored and used in operations to maximize productivity efficiency. Today, we are already familiar with artificial intelligence applications that can either optimize individual material handling tasks or predict maintenance tasks resulting from operations.

To create a cyber-physical system that fully supports the production processes of a company, it is necessary to collect the right information about each process. In order to do this, primarily, companies need to use different identification and tracking solutions.

In the life of manufacturing companies, tasks related to realizing material flows are seen as necessary but not value-creating processes, which can largely be described by dynamic information. For this reason, in this study, we will look at material flow processes at the shopfloor level in terms of how ready the companies are for the digitization at this level. Our aim is to show the segments worth investigating in the value creating processes (Fig.1). In addition, the study presents an approach to discover the currently existing Industry 4.0 readiness and Industry 4.0 maturity.

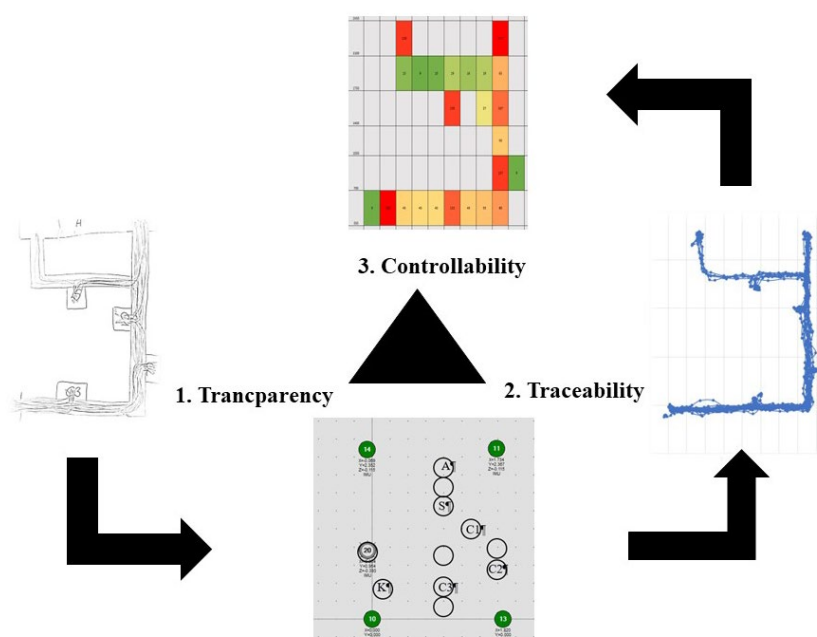


Figure 1. Segments of the investigation.

Fractal-Fractional Analysis and Numerical Simulation for the Heat Transfer of ZnO+Al₂O₃+TiO₂/DW Based Ternary Hybrid Nanofluid

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Keywords: Ternary Nanofluid, Distilled Water, Joule Heating, Viscous Dissipation, Fractal Fractional Derivative, Crank Nicolson Scheme.

Abstract. Nanofluids are used to achieve maximum thermal performance with the smallest concentration of nanoparticles and stable suspension in conventional fluids. The effectiveness of nanofluids in convection processes is significantly influenced by their increased thermophysical characteristics. However, this technology is not ended here; binary and ternary nanofluids are now used to improve the efficiency of regular fluids. Therefore, this paper aims to analyze the natural convection Newtonian ternary nanofluid flow in a vertical channel. The tri-hybridized nanoparticles of zinc oxide ZnO, Aluminum oxide Al₂O₃, and titanium oxide TiO₂ is dissolved in base fluid distilled water (DW) to form a homogenous suspension. The impact of thermal radiation, joule heating, and viscous dissipation are also assumed. The classical Newtonian ternary nanofluid model has been generalized by using Fractal-fractional derivative (FFD) operator. The generalized model has been discretized by using the Crank Nicolson scheme and then solved by using computational software. To analyze the behavior of fluid flow and heat distribution in fluid, the obtained solution was computed numerically and then plotted in response to different physical parameters. It is noted from the figure that when the volume fraction ϕ reaches to 0.04 (4% of the base fluid), the ternary nanofluid flow shows a significant amount of enhancement in heat transfer rate as compared to binary and unary nanofluid flows. This enhancement in the rate of heat transfer leads to improve the thermophysical characteristics such as viscosity, thermal expansion, and heat capacity etc. of the base fluid. It is also worth mentioning here that the thermal field is also enhance with the higher values of Eckert number Ec , radiation parameter Rd , and joule heating parameter J_h .

Design and Model of Portable Gantry Crane Machine

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Keywords: Portable Crane, Lifting, Vertical Column Bar, Crane Wheels

Abstract. This work is done on the design and model of portable gantry crane machine for workshops, garages, and other overhauling workshops. The main problem is the absence of lifting and transporting mechanism for the heavy machine parts like engine, differential, suspension system, were they are lifted and transported by manpower and this leads to reduction in production rate, quality and safety problem. To solve those problems use of chain hoist mechanism, an AC three phase induction motor combined with chain drive, four wheels, of which all of them in the front are connected to the base using permanent joint and it is possible to come up with efficient and low cost solution.

The goal of the paper is detail engineering designs, selection of material, design mobile parts of portable gantry crane which use electric power and also operate manually to simplify lifting and transporting process.

The paper is mainly focused on the detail design of the components with different software's (CATIA V5, for part drawing, Solid work 2018 for assembly drawing, ANSYS 16 for static analysis) that test bending moments, stresses, and different forces acting on the machine and including its process and maintenance activities.

Project on the portable gantry crane conducted mainly by observation through garages, industry workshops, and referring different books as a result, a portable gantry crane machine with high torque and high speed obtained from the motor speed by using chain drive mechanism at low operating cost is designed. Maximum carrying capacity and maximum lifting height is 3ton and greater than 2.75m from the ground respectively run by using 1.5KW electric motor rotating 1200/600 rpm. The maximum principal stresses in each of components tested were below the yield stresses of the respective components. Therefore, under no normal operating circumstances shall these components fail. Implementation of this design has major positive benefits to the development of the economy by decreasing import expense and protection of the natural environment by using electric system rather than fuel system.

Longitudinal Dynamic Modeling of Electric Vehicle by Using Matlab Simulink

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Keywords: Matlab, Driving Cycle, Modeling, Vehicle, WLTP, Optimization, Modularity

Abstract. The following article presents the longitudinal modeling and simulation of a generic electric vehicle. The purpose of the research is to describe the applied modeling procedures and their Matlab solutions. Furthermore, the goal was to learn how to build a framework for a Matlab Simulink model that facilitates future optimization and ensures modularity, thereby facilitating collaboration for different research groups.

Computational Fluid Dynamics Simulation of the Cooling of a Vehicle Alternator's Stator Winding

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Keywords: Thermal, Rotating Machinery, Cooling, Claw-Pole Alternator, Automotive Alternator, Computational Fluid Dynamics (CFD)

Abstract. In this paper, the cooling of a passenger car alternator's stator winding is investigated with the help of computational fluid dynamics. The need for accurate simulation of the physical processes occurring during the operation of an alternator grows as the available time for product development reduces and costs are minimized to remain competitive in the market. An accurate numerical model can help by reducing the iterations, and therefore the time needed to be spent on the test benches, and it can also help in the optimization of the product by offering a deeper understanding of the behavior of the system. In the first step, the CAD model is simplified in a way to enable a fine-quality numerical mesh generation, while keeping the important geometric features that could have significant effects on the results. The main heat sources are determined to be the stator winding and the diodes. Their respective heat loss is calculated and applied in the CFD software. In the next step, independence studies are carried out for the mesh, time-step size, and flow volume. There are two main approaches in computational fluid dynamics when it comes to rotating machine modeling: a steady "frozen rotor" approach and a transient "moving mesh" approach. A comparison is also presented between the aforementioned approaches.

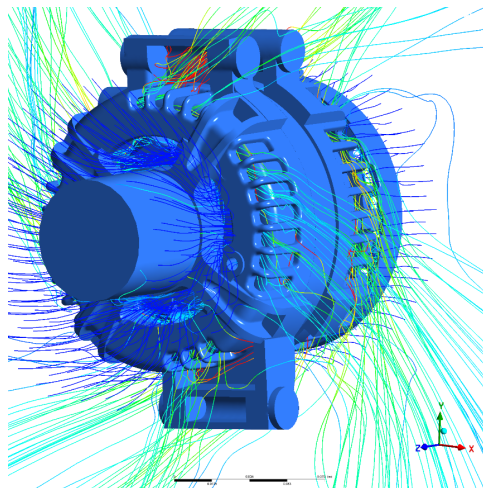


Figure 1. Streamlines around the alternator at 6000 RPM, colored according to temperature.

After conducting the transient simulations at multiple operating points, the simulation results are evaluated with velocity-, pressure-, and temperature contours, streamlines, and quantitative properties like mass flow rate, temperatures of bodies, etc. An experimental comparison is presented which shows a good correlation between the simulated and the measured data, furthermore the possible reasons for the deviations are eventually discussed. Finally, the benefits of the future applications of the simulation model are introduced briefly.

Integrating Metaheuristic Optimization into Numerical Simulation

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Keywords: FEM Numerical Simulation, Optimization, Metaheuristics, Particle Swarm Optimization

Abstract. Optimization is part of our daily lives, even if we do not realize it. We try to pick the fastest possible route to our destination or to buy products as cheaply as possible. This is how we make the best use of our resources. However, many real-world problems are extremely complex, making it difficult to find the global optimum using traditional methods, on the other hand, metaheuristic search methods are well suited to solving these problems due to their efficiency and versatility. The objective of this research is to develop a robust optimization algorithm, that can be easily integrated into an already existing design process with minimal modification. This way optimization can be seamlessly applied in most multivariable design problems.

Metaheuristics are advanced search algorithms, that are capable of finding a relatively good solution quickly and efficiently. They can be considered algorithmic frameworks applicable to a diverse set of problems with minimal modification. They often employ the combination of local and global search, which makes them effective at exploring the search space while avoiding getting stuck in a local minimum. Metaheuristics have proven to be quite effective at solving complex problems. Although the finding of global optima cannot be guaranteed with these methods, they can often outperform many other algorithms [1], [2].

The chosen metaheuristic for further research is particle swarm optimization (PSO). This search algorithm was created by James Kennedy and Russel Eberhart [3]. PSO is based on the swarm behavior of animals such as birds. It is one of the most widely used swarm intelligence algorithms due to its flexibility and simplicity [4]. The algorithm can be used to teach neural networks [5], restructure electricity networks, design with optimization and many more. Overall, the algorithm has a wide range of applications. It is important to note, as well, that particle swarm optimization has shown particular promise for problems where other algorithms have failed or where no specific search procedure is available [6]. Particle swarm optimization explores the search space using moving points, called particles, in a quasi-stochastic way. The set of particles is called a swarm. The algorithm consists of T number of cycles, during which the position of the particles is calculated using the velocity function. The velocity function consists of two main components: a deterministic and stochastic component. The deterministic component involves the particle's adherence to the global best position $\mathbf{g}^*$ (known by the whole swarm) and to the best position $\mathbf{x}_i^*$ known by the particle. Meanwhile, the stochastic component makes their motion random to a certain extent [4].

Acknowledgment

This research was supported by the ÚNKP-23-4-II. New National Excellence Program of the Ministry for Culture and Innovation from the source of the National Research, Development and Innovation fund.

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Investigation of Surface Roughness Determination Problems in Additive Manufacturing Technologies

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Keywords: Ironing, Surface Roughness, Additive Manufacturing

Abstract. Besides conventional shaping methods like injection molding and extrusion, various additive manufacturing (AM) techniques have been steadily gaining prominence due to the numerous benefits they offer. These advantages include swift and uncomplicated shaping, the capability to produce components with intricate geometries during both the design and production phases, manufacturability enhancements, and cost-efficiency.

In the context of the automotive industry, components produced often need to adhere to stringent standards. When it comes to these manufactured parts, the precision of processing and the quality of the surface represent the paramount complex metrics that dictate the performance attributes of the specific part.

The surface roughness of parts produced by 3D printing depends on many factors: from CAD to stl conversation and from the choosen method, layer thickness, printing speed, printing temperature.

It can be done surface modification by different methods: application of coatings, surface modification procedures (chemical, e.g. etching, physical, e.g. chpping (miiling, turning), ironing (software based method).

The surface roughness depends also the place of the investigation: Horizontal or vertical walls, sloping surfaces. Surface roughness also varies on the same surface by changing slope due to the staicase effect.

Morover the surface roughness depends on the method of the investigation parallel or perpendicular to the kayers and the printing or infill direction.

In the last two cases it should be a good choice to use Sa which is the extension of Ra (arithmetical mean height of a line) to a surface. It expresses, as an absolute value, the difference in height of each point compared to the arithmetical mean of the surface.

In this paper, we explore this issue

The Issues of Surface Roughness Measurement in Case of Plastic Vehicle Parts Produced by FFF Additive Manufacturing

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Keywords: FFF, Surface Roughness, Additive Manufacturing, Plastics

Abstract. In addition to traditional shaping technologies (e.g. injection molding, extrusion), several additive manufacturing (AM) processes are gaining ground these days, thanks to the many advantages provided by the technology, such as simple and fast shaping, components with complex geometries in the design and production stages manufacturability or the economy of the process.

In case of the automotive industry, manufactured parts often have to meet strict requirements. In the case of manufactured parts, the accuracy of the processing and the quality of the surface are the most important complex indicators that determine the performance characteristics of the given part. The surface roughness of parts produced by 3D printing depends on many factors: the type of printer, the chosen technology, the quality of the material chosen for construction, the printing parameters (thickness of the printed layer, printing temperature, etc.). In most cases, however, the surface quality of the parts produced by additive processing does not meet the required requirements. As a result, a number of surface modification/treatment processes (chemical etching, chipping, coating, plasma treatments) or those suitable for creating a unique structure (femtosecond laser treatment, ironing) can be used to improve the surface quality of plastic components.

A number of methods are available for the qualitative and quantitative characterization of surface quality, and surface roughness can be considered the most frequently examined surface characteristic. The most often used during roughness measuring method is the so-called confocal surface roughness tester, which provides fast results, but in many cases - for example, curved or very rough surfaces - can be used to a limited extent or not at all. At the same time, it is difficult to measure the roughness of components produced by additive processing, because the measurement orientation chosen during the measurements strongly influences the surface roughness (R_a) values. The solution can be the application of optical roughness testers, which can be used to determine 3D surface roughness characteristics in addition to 2D roughness parameters.

This study presents the surface roughness testing of PLA parts manufactured with FFF technology, from a measurement technical aspect, using non-contact and contact roughness measurement methods. The purpose of the performed tests is to reveal the advantages and disadvantages of each measurement technique, and to analyze the effect of the test method (e.g. measurement direction) through the determination of 2D and 3D roughness parameters.

Review of Connected Autonomous Vehicles Platooning: Technologies, Challenges, and Future Directions

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Keywords: Autonomous Vehicles

Abstract: The introduction of Connected Autonomous Vehicles (CAVs) is bringing a significant transformation in the field of transportation, presenting unparalleled prospects for enhancing road safety, mitigating traffic congestion, and optimizing energy efficiency. Platooning, as one of the pioneering applications of Connected and Autonomous Vehicles, emerges as a very promising approach to enhance traffic flow and mitigate ecological consequences. This review examines the integration of advanced technology and the multifaceted obstacles associated with CAV platooning. Commencing with a comprehensive examination of the fundamental technologies involved, such as sensor fusion, vehicle-to-vehicle communication, and artificial intelligence algorithms, this article explores the essential elements that facilitate the smooth coordination of CAV platoons.

Evaluation of New and Traditional Numerical Methods for Long-Term Simulations of Heat Transfer in Walls to Study the Effect of Different Shapes of Thermal Bridges

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Keywords: Transient, Heat Loss, Numerical Methods, Long-Term, Thermal Bridges

Abstract. According to previous studies, the most effective explicit and stable numerical methods to deal with heat transfer problems in building walls are the recent leapfrog-hopscotch and modified Dufort-Frankel techniques, which are used in this study to make transient and long-term simulations (three months of the winter season) of 2-D space systems to test the two best versions of the methods. Our solution to a real-world engineering challenge involves investigating thermal bridges of different forms inside multilayer walls of buildings that are exposed to environmental factors specific to Hungary's climate, such as the normal outside temperature and sun radiation, to improve energy efficiency.

The steady-state heat loss is calculated using two recently published approaches that allow us to execute long-term simulations with relatively short running periods. The temperature distributions and total heat losses (across the walls) for all cases (three layers without a thermal bridge, three layers with a straight thermal bridge, three layers with a bent thermal bridge, and three layers with an L-shaped thermal bridge) were calculated.

Innovative Method for Producing Glass Foam Granules with Intact Surfaces

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Keywords: Concrete, Aggregate, Foam Glass, Cellular Glass, Porosity, Lightweight

Abstract. Glass foam is a versatile lightweight material prized in the construction industry for its exceptional lightweight, mechanical properties, thermal insulation, and acoustic characteristics. Traditionally, glass foam is manufactured in block form, predominantly serving as a lightweight component for thermal and acoustic insulation in construction applications. However, researchers worldwide have explored the potential of glass foam granules, aiming to integrate them into concrete formulations to create lightweight concrete.

The challenge has been that the production of glass foam granules often requires costly equipment and rotary furnaces, significantly impeding laboratory investigations and experimentation for researchers. This research introduces a novel method for the laboratory-scale production of glass foam granules. This breakthrough technique allows the creation of spherical glass foam granules with intact surfaces, offering diverse applications in lightweight concrete, insulation, building materials, and the glass foam industry.

By presenting this new method, our research opens up new avenues for innovative studies in the fields of lightweight construction materials, paving the way for further advancements in the utilization of glass foam granules.

Geometric Modelling and Finite Element Analysis of a Sprinkler

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Keywords: Turbo Machine, Water Sprinkler, Power Machine, CAD

Abstract. In fluid flowing systems the machines involved can be grouped as either turbo machines or positive-displacement machines. A machine will be grouped as a turbo machine (centrifugal machine) if it adds or extracts energy from a fluid usually using a rotating component. If the fluid energy utilization is by extraction of the energy from the fluid then the machine is called a power machine. If the fluid energy utilization is by addition of energy to the fluid then the machine is called a work machine. All centrifugal machines have one or more rotating parts called rotors. [1] A sprinkler is an example of many turbo machines used.

A water sprinkler or just sprinkler is a device used for irrigation purposes in gardens, farm etc. Water at pressurized form is supplied to the sprinkler at the inlet port and the sprinkler ejects the water into the air where it then falls down in form of water droplets.

The aim of this study is to first perform a geometric modelling of the sprinkler using CAD software, then perform a flow analysis using Ansys software to study how total pressure, static pressure and water velocity can change and vary when the sprinkler model is modified. With the results we can learn how flow properties can change under certain modification in the flow paths. Figure 1 below shows a water sprinkler designed by CAD Software (SolidWorks 2022).



Figure 1. A water sprinkler (own photo).

Acknowledgment

This study has been implemented with the guidance and supervision of Sándor Bodzás.

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Case-Study: Mechanical Properties of Welded Joint Regions Effects on Structural Integrity Assessment

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Keywords: Structural Integrity Assessment, Welded Joint Regions, Plastic Deformation

Abstract. Traditional approach in construction designing and structural integrity assessment implies numerical calculations performed on the construction including construction elements that affect rigidity and strength, without welded joints. That structure is evaluated in elastic response, and the results are compared to yield strength, as shown in [1]. That approach is good enough for workloads for most of the constructions. In that scenario, sudden overloading that led to structural collapse is neglected. In those scenarios, within the plastic deformation domain, the differences in mechanical properties of welded joint regions have vast influence to structural integrity. Mechanical properties of welded joint regions are obtained using inverse methodology, that is mentioned in [2]. That methodology included tensile testing of a specimen containing welded joint. During the experiment strain field was continuously measured using stereo cameras, and results are processed using system based on Digital Image Correlation. Numerical computational model of test specimen is formed using the same parameters, as in the experiment (shape of welded joint, boundary conditions, loads, etc.). To improve numerical model, deformations of all regions of welded joint (base material, weld metal, and heat affected zone) are imported into numerical model. Consequently, material properties of all three welded joint regions were obtained. Material properties are then used in analysis of welded joint influence to structural integrity of several constructions, such as pipeline, pressure vessel, bucket wheel excavator computational models. For all those constructions, two computational models are made, the one without (classical approach) and the other containing welded joints. Results showed that there is no difference between the two computational models during service operations (elastic structural behaviour). However, within the plastic deformation domain, the differences between the models are considerable. As extension of this research, plans are to perform experiments on real constructions containing welded joints, applying the same inverse methodology. In that way, considerable influence of mechanical properties of welded joint regions to structural integrity will be confirmed. Also, dependence coefficient between tensile testing specimen and the real welded joint regions on the real constructions can be formulated.

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Analysis of the Effect of Injection Molding Temperature on Mechanical Properties in the Case of PBT

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Keywords: PBT, Mechanical Test, Injection Molding Temperature

Abstract. The most common mistake made in the injection molding of technical plastics is to try to process them under conditions similar to those used for processing PP, for example.

Extremely fast injection molding, cold tooling, narrow inlets, such as needle inlets, are usually the first direction chosen. In this case, unfortunately, most technical plastics react very poorly to the above conditions, so it is necessary to modify the parameter fields during processing. In such cases, it is worth proceeding with the use of a large cross-section inlet, a hot tool and a very long injection time. In general, it can be stated that the vast majority of technical plastics are not too sensitive to shearing - that is why we use rapid injection molding, which results in surface defects. The purpose of this study is to investigate the effect of processing temperature of PBT in the context of mechanical properties. The polybutylene terephthalate (hereinafter: PBT) is called thermoplastic polyester or saturated polyester together with PET. Parameters of the injection molding process of PBT with glass fiber filler technical plastics: melting temperature: 250-260 °C, which is a very narrow range. PBT is very sensitive to the reaction of grooves and sharp corners. Stress concentrations can easily occur in these locations, significantly reducing load-bearing capacity and prone to cracking when stressed or impacted. Pre-drying is required before pouring, and the moisture content must be reduced to 0.02% - therefore, during the experiment, I placed the granules in a drying cabinet as prescribed by the manufacturer. After that, I only changed the temperature of the injection molding, leaving the tool temperature at the same temperature. The selected temperature parameters are 230 °C and 260 °C. The mechanical tests clearly show that the magnitude of the generated stress depends on the injection molding temperature. Internal stresses are constantly acting during the lifetime of the product, and can result in warping and, in extreme cases, the destruction of the material. In all cases, the properties change with time, which is called physical aging. The properties of injection-molded objects are determined by the processes taking place in the mold cavity and the structure.

Investigation of the Tribological Properties of Aliphatic Polyketone

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Keywords: Polyketone, Tribology Properties, Engineering Plastic, Polyoxymethylene

Abstract. Tribology is a branch of science that studies the behavior and movement conditions of different surfaces that move relative to each other and are in contact. In essence, tribology deals with wear, friction and the lubrication that eliminates these phenomena. Tribology is a relatively new approach to the study of machining processes, especially the study of different frictional surfaces, for example the friction between the chip and the tool material, at different temperatures and loads. In this test, the uncharged version of the aliphatic polyketone was used as a raw material, and for comparison I chose polyoxymethylene, which is famous for its good wear resistance. Aliphatic polyketone can be classified in the group of high-performance technical plastics. In terms of production, it is a plastic with a perfect alternating structure of ethylene, carbon monoxide and propylene terpolymer system, which can be used in many places. As a result of the research, we already know that the following factors influence the formation of the edge overlay: the degree of brittle plasticity of the material to be machined, the adhesion characteristics, the degree of abrasive wear, the amount of heat generated during the chip formation process and the amount of pressure acting on the tool, as well as the thermal conductivity of the material to be machined. During the study of wear behavior, I used the following parameters: speed: 1600 rpm, torque 5.0 Nm. During the test, the values of the gears produced from the two types gave the following values: in the case of polyketone, the melt occurred after 98 minutes. In the case of polyoxymethylene, the amount of time the test specimen endured was only 60 minutes, and after that tooth break and tip abrasion occurred.

Analysis of the Effect of Injection Molding Temperature on Mechanical Properties in the Case of PET(Polyethyleneterephthalate)

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Keywords: PET, Mechanical Test, Injection Molding Temperature, DHT Analysis, Impact Strength Test, Glass Fiber

Abstract. In this study, we want to show how the mechanical properties are modified by changing the injection molding temperature of PET with glass fiber filler. PET is one of the most common polycondensation plastics. In the course of the study, I analyzed 50% glass fiber-reinforced, medium-viscosity polyethylene terephthalate (PET). This composite core offers high stiffness and toughness even at high temperatures. Due to its low absorption capacity, it is particularly dimensionally stable. The samples were produced in the Institute of Energy, Ceramics and Polymer Technology of the University of Miskolc in the form of a standard specimen, where injection molding temperatures of 150 °C and 80 °C were used. The prepared specimens were then subjected to mechanical destruction tests, such as tensile strength tests and impact tests. The testing phase also included the HDT test, where we received information on the temperature dependence of the deformation under load. The tensile strength values increased by increasing the temperature of the processing transit zone, the E-modulus changed from 17770 MPa to 19511 MPa, and its tensile strength increased from 170 MPa to 230 MPa. In terms of Charpy impact work, it decreased from 80 KJm² to 65 KJ/m² as the temperature increased. HDT's measurement result increased from 120 °C to 240 °C under a load of 1.8 MPa. During the experimental process, it was also observed on the test specimens that the sample molded at a lower temperature had a much more amorphous structure. In addition, a change in color occurred as the temperature increased. Based on the results, it can be determined how important it is to choose the right injection molding temperature to achieve the expected mechanical and surface and crystalline structure.

Investigation of the Effect of UV in the Case of PLA Composites Filled with Natural Fillers

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Keywords: Biodegradable, Mechanical Test, PLA, Natural Filler, Shore d Hardness Measurement, UV Test

Abstract. In our households, we are producing continuously large amounts of waste and it is a good source of the plastic composite. Besides nowadays, the degradable (biodegradable) materials are getting higher and higher importance. I made an experiment that certain household waste filled polylactic acid principle composite that how change the strength tensile, hardness and toughness impact to the usage. Beside the PLA it was the important part to gain knowledge and processing the examined samples and completion. My point of you that choose of the materials it can be found in huge quantity in the industry and natural also. In the case of outdoor application, polymers are exposed to different weather conditions. Different factors dominate in different climatic conditions. Among these factors, the most important are: solar radiation, temperature fluctuations, wind, rain, humidity, air pollution and the erosive effect of dust and sand grains moved by the wind. Degradation occurs in polymers due to impurities (metals left over from catalysts) or chain ends. Materials containing carbon-oxygen groups are sensitive to photochemical degradation. During the test, I filled the produced test specimens with fillers of two grain sizes (under 160 µm and over 160 µm), which in this case are coffee grounds, eggshells, potato peels, oak flour and zeolite. The produced sponge-shaped test specimens were analyzed by Shore D hardness measurement, after which I placed them in a UV chamber for one hour - which is equal to one year of outdoor UV conditions. As a next step, I measured the samples again with Shore D hardness measurement and was able to draw the following conclusion. In the case of all charges, the samples were hardened after ultraviolet light. The sample filled with 5% oak flour showed the biggest change, where the hardness increased from 77.50 to 87.20. Among the values after UV treatment, I measured the highest result for the sawdust filling, which exceeded the value of the polylactic acid sample. In this case, the hardness of the samples filled with oak flour increased by 12.51% after UV. The unfilled polylactic acid sample increased by 9.184%. The values filled with 20% eggshell showed the smallest difference compared to the hardness of the samples before UV, as the measured value only increased by 3.43%.

Determining the Fluidization Curve for Zeolite at Different Moisture Contents

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Keywords: Zeolite

Abstract. During the fluidisation process, flowing air creates a movement of particles, which consequently makes a larger mass transfer surface available for the dried material. The better contact enables a larger amount of heat and material to be transferred to and from the inside of the particles than steady bed drying would do.

The fluidization phenomenon is explained through a pressure drop diagram, often called the fluidisation curve. The fluidisation curve can be divided into three parts, one of which is the interval of fluidisation. This part of the curve forms a long, straight line at a constant pressure drop value. Different states of movement can be observed based on the geometry of the materials, their moisture content, adhesive behaviour and density. Such a type of movement is a bubbling, a turbulent state of piston-like movement of particles.

Zeolite spheres between 1,7-2,4 mm diameter distribution were examined. We give a short description of how the measurements were conducted. The fluidisation curves were derived accordingly to these, and measurements were made with different moisture content values for each case. Besides, these photographs were made of the movement of the particles at different stages of the process, show the movement of the particles over the whole period.

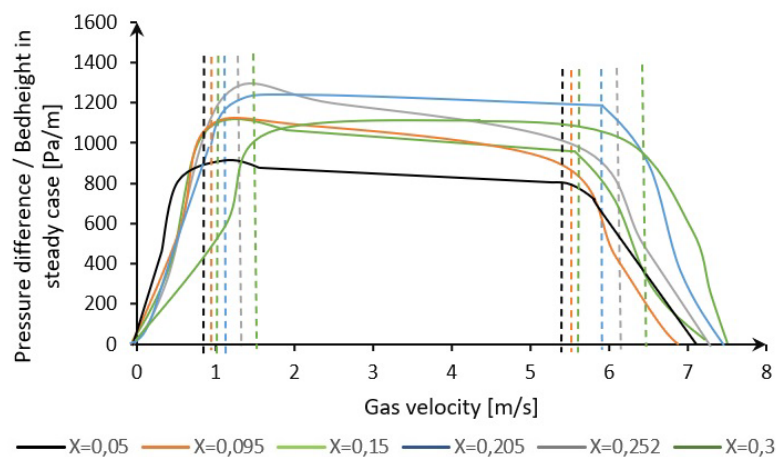


Figure 1. Fluidized curve for zeolite with different moisture content.

The results obtained from the experiments are illustrated in two sets of diagrams, and each set has a separate diagram for each moisture content. The results in one diagram were summarized, which can be seen in Fig. 1. It can be seen, that the moisture content affects minimal and maximal fluidization velocity, and the pressure drop created by the particles as well.

Acknowledgment

This work was supported by the János Bolyai Research Scholarship of the Hungarian Academy of Sciences (BO/00059/23/6) and by the Hungarian Scientific Research Fund (NKFIH FK-142204). The first author was supported by the ÚNKP-23-5-BME-411 New National Excellence Program of the Ministry for Culture and Innovation from the source of the National Research, Development and Innovation Fund.

Operational Sizing of a Wet Scrubber

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Keywords: Wet Scrubber

Abstract. The subject of our research is the investigation of an existing design of gas absorption scrubber and its operational sizing. The equipment would reduce the ethyl alcohol concentration of the gas leaving an absorber operating in an earlier stage. In devices with continuous phase contact, the correct phase contact is usually ensured by means of fillings, where the same concentration is always obtained at each location in the device, regardless of time. The purpose of the fillings is to provide and increase the contact area of the phases to improve the mass transfer. With the initial hypothesis that the mass transfer coefficient how depend on the type of filling, as a verification, the information table for fillings in the NITTETU handbook [1] was examined.

After further calculations, the data were plotted by type of charge, ring, saddle and grid, as a function of mass transfer coefficient and liquid mass flow rate. At low fluid mass flow rates, the values calculated for the saddle and the ring coincide, showing the expected result.

The plotted and calculated values are also presented together, using the equation for the discharge curve to calculate the mass transfer coefficient using the fluid volume flow rate. With this, we can calculate the needed parameters for the optional mass transfer for the scrubber what in this case contains no fillings, just spray nozzles [2]. The appropriate choice of the spray nozzle influences the droplet size formed, which is a crucial parameter for the absorption of ethyl alcohol vapour particles. In our work an applicable spray nozzle was proposed to further reduce the concentration of ethanol in the gas.

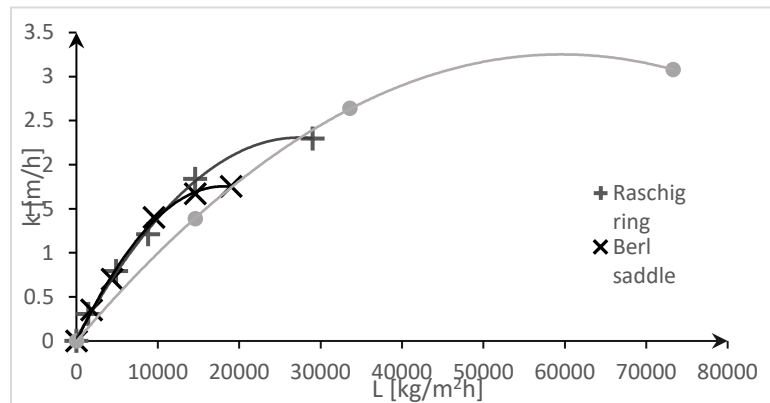


Figure 1. Values specific to the type of filling.

Acknowledgment

This work was supported by the János Bolyai Research Scholarship of the Hungarian Academy of Sciences (BO/00059/23/6) and by the Hungarian Scientific Research Fund (NKFIH FK-142204). The first author was supported by the ÚNKP-23-5-BME-411 New National Excellence Program of the Ministry for Culture and Innovation from the source of the National Research, Development and Innovation Fund.

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Mechanical and Architectural Regulations for Cleanrooms with Proposed Solutions

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Keywords: Cleanroom

Abstract. With the technological development of some industries, the cleanroom is getting more and more emphasis in more and more areas. The same expectation is everywhere regarding cleanrooms: control and minimization of the number of particles and impurities in the air space of the given room, taking into account the local pressure conditions, as well as the temperature and humidity of the air. This may sound simple, but the implementation of such a complex facility requires the expertise and cooperation of specialists from many disciplines.

One of the main basic units of cleanrooms is the heating, ventilation, and air conditioning (HVAC) system. Separate companies specialize in the design and implementation of these, as it is a very complex task. With the help of the HVAC system, the temperature, pressure, and moisture content of the air, as well as the frequency of the complete air exchange can be controlled. In high cleanliness class cleanrooms, the air exchange rate is 6/hour, but it can be up to 540/hour.

In order to reduce the number and size of particles in the space to be isolated, various air filters must be installed in addition to the HVAC system. The first step in their selection is the mapping of different types and sizes of particles. The filter system must be selected accordingly. The individual parts of the HVAC system that provides air supply and air conditioning in cleanrooms can be seen in Fig. 1.

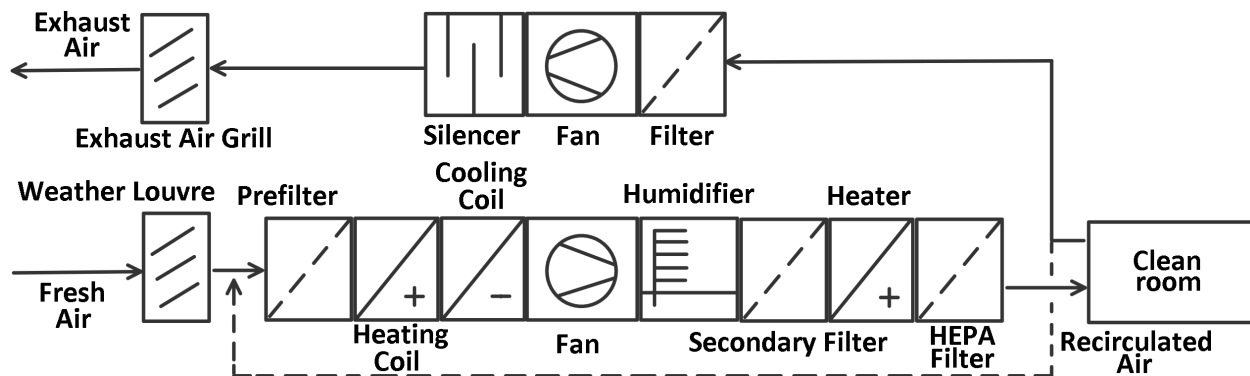


Figure 1. Schematic diagram of the air conditioning system

The aim of our work is to explain the definition of cleanrooms, the relevant standards and regulations, as well as the planning steps and detailed the specifics of the industries that use cleanrooms.

Acknowledgment

This work was supported by the János Bolyai Research Scholarship of the Hungarian Academy of Sciences (BO/00059/23/6) and by the Hungarian Scientific Research Fund (NKFIH FK-142204). The first author was supported by the ÚNKP-23-5-BME-411 New National Excellence Program of the Ministry for Culture and Innovation from the source of the National Research, Development and Innovation Fund.

Additive Manufacturing of a Flat Form Tool

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Introduction

Additive Manufacturing, also known as 3D printing, is a technology that has the potential to transform various industries. One of the areas where it is having an increasingly significant impact is in the realm of tooling. It has the potential to revolutionize the way flat form tools are designed, produced, and utilized.

Methods

In this research, we employed various additive manufacturing techniques to create a Flat Form Tool. These techniques comprised Fused Deposition Modeling (FDM), Stereolithography (SLA), and Selective Laser Sintering (SLS). The selection of the technique was based on the specific needs of the tool, such as material properties, precision, and cost-effectiveness.

Results.

Our study showed that Additive Manufacturing has significant benefits in tool production. It enables the creation of intricate geometries that were previously unachievable using conventional methods. This leads to tools with improved performance characteristics and the ability to meet the specific requirements of modern manufacturing processes.

Discussion.

Customizing tools to specific applications and industries provides a level of personalization that was previously unattainable. This not only enhances the efficiency of manufacturing processes but also reduces lead times and overall costs. Furthermore, the flexibility of Additive Manufacturing enables rapid prototyping and design iterations, making it ideal for industries that require adaptability in tooling.

Conclusion

Additive Manufacturing has the potential to revolutionize the tooling industry by enabling the production of tools with unparalleled precision and efficiency. This paper highlights the benefits of utilizing Additive Manufacturing for the production of Flat Form Tools, which can lead to a more adaptable and cost-effective tooling industry. With Additive Manufacturing, tools can be designed and produced with greater flexibility and customization, ushering in a new era of innovation.

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Formability and Surface Quality of Medical Grade Titanium in Incremental Sheet Forming

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Keywords: SPIF, Titanium, Step Size, Tool Diameter, Sheet Forming, Forming Parameters, Roughness

Abstract: The technique known as Single Point Incremental Forming (SPIF) has garnered attention for its potential in shaping intricate geometries across diverse materials. This study examines the effect of SPIF process parameters such as the step size and tool diameter on the formability and surface roughness of medical titanium sheets. The study involves testing three distinct step sizes (0.2, 0.4, and 0.6 mm) and three tool diameters (6, 10, and 14 mm). The primary goal of this study is to evaluate the impact of these parameters on four critical aspects of SPIF: thickness reduction, depth of fracture, surface roughness, and angle of formation within the fracture zone. By conducting a series of experiments, the correlation between step size, tool diameter, and these key performance metrics is comprehensively explored. The findings underscore that smaller step sizes result in greater reductions in thickness and more precise formation angles within the fracture region and it found that surface roughness decreases with increase of step size and tool diameter. Understanding the complex interactions between these parameters holds paramount importance in optimizing SPIF processes for shaping titanium sheets. This optimization insight stands to enhance both production efficiency and quality within industries reliant on advanced forming methods.

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Numerical Parametric Study on the Effect of EMS on the Segregation Behavior During the Solidification of Sn-10wt.%Pb Alloy

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Keywords: Solidification, Electromagnetic Stirring, Macrosegregation, Columnar-Equiaxed-Transition, Segregated.

Abstract. The solidification of alloys tends to have large-scale variations in the concentration of solute elements. This is called macrosegregation. It leads to non-uniform properties in the solidified metals, which reduces their performance and suitability for many applications [1]. Several investigations have proven that using an external field to control the solidification process is an efficient technique to achieve good casting quality. It is widely agreed that stirring (either directly or indirectly) can improve the CET through the dendritic fragmentation process [2-4]. Electromagnetic stirring (EMS), one of the methods mentioned, has a significant effect on the metal grains that are forming [3]. Indeed, in a particular comparative experimental series carried out by Hachani et al [5], it was demonstrated that electromagnetic mixing can significantly reduce the macrosegregation zone corresponding to the last solidified liquid, as well as favoring the mechanism of the columnar-equiaxed transition. Wang et al. [2, 6] conducted both experimental and theoretical studies that supported the alternative EMS. It was proposed that a modulation ranging from 4 to 20 s is sufficient period to transport the solute rejected at a distance supposed to be enough from the solidification front during the solidification process. Based on these experimental results, we performed a numerical parametric study in this work to identify more precisely this critical frequency of modulation and try to find the optimal time that corresponds to reducing or even eliminating the segregation problem.

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Phase Change Material Melting Modeling Using Ansys Fluent

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Keywords: Phase Change Materials, CFD, Latent Heat Storage.

Abstract. Energy consumption of buildings is the most challenging issue in the majority of nations. According to the International Energy Agency (IEA), global building energy consumption has recently increased to 40% for commercial buildings and 61% for residential structures. The largest energy users are HVAC systems (heating, ventilation, and air conditioning). If current trends continue, buildings are expected to consume up to 37% more energy in 2050 [1]. A new development in thermal management technology is thermal energy storage (TES) systems, which allow thermal energy to be stored rather than wasted. The technology can be applied in various forms, such as sensible heat storage, latent heat storage and thermochemical energy storage [2]. Integrating thermal energy storage with thermal conversion systems is necessary to maximize their use. Phase change materials (PCMs) are the best media for storing and releasing thermal energy from various basic material types. PCMs have a high latent heat of fusion, it is often viable to use these characteristics and include PCMs in building envelopes to store thermal energy.

The aim of our research was to evaluate the models set up by using CFD models and to use the CFD values to improve the design of thermal energy storage devices. Heat transmission occurs predominantly by conduction during the first 0–30 [min] of melting before transitioning to natural convection with increasing heating, as shown in *Fig.1*, according to numerical modelling and simulation of the PCM melting process under convection heat settings. With time, the melting rate rises. Initially the same, it expands in the middle and towards the end as the melting process proceeds. The melting problem has to be modelled using ANSYS (Fluent) with the proper meshing and time step selection in order to avoid convergence mistakes throughout the solution.

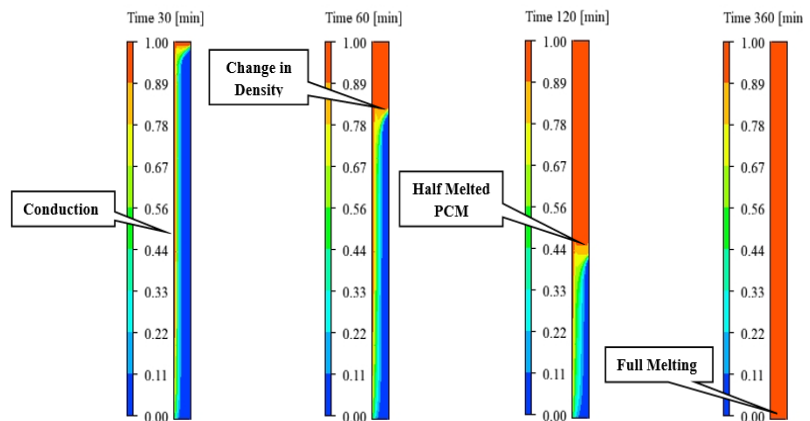


Figure 1. Changes in liquid-fraction contours.

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3D Printing Failure Detection

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Keywords: 3D Printing; Image Processing; Failure Detection; FDM.

Abstract. This study delves into the transformative world of 3D printing, specifically focusing on the Fused Deposition Modelling (FDM) process, which is widely used in industry and hobbyist applications. The primary objective is to harness the capabilities of computer vision, particularly the "YOLO by Ultralytics" software, to detect common 3D printing failures, such as layer adhesion failure, bed adhesion failure, and print detachment, colloquially termed as "Spaghetti."

By utilizing the Raspberry Pi 4 and the Raspberry Pi camera module 3, images were periodically captured during the printing process. These images were then processed using the YOLO neural network, which divides an image into a grid, predicting bounding boxes and class probabilities for each grid cell. The study also emphasized the importance of a consistent dataset, leading to the creation of a private dataset that considered various colours and lighting conditions.

Preliminary results indicated that the model, under pre-set arguments, was still in the learning phase, necessitating further training and optimization. However, the model successfully detected the extruder and two instances of "Spaghetti" with high confidence, prompting the termination of the printing process to conserve resources.

Surface Modification with Ions to Improve Properties of Tools

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Keywords: Coating, Ion Implantation, Kr, Nanomodification

Abstract. It has been recognized that many different tribological phenomena like wear (abrasive and/or adhesive), corrosion, friction, galling or sticking significantly reduce functionality and lifetime of tools. Surface properties of modern tools are usually inadequate in terms of wettability, adhesion properties etc., so they should be modified prior to application or any further processing such as coating with functional materials. Thin hard coatings deposited by physical vapour deposition (PVD), e.g. TiN and TiAlN are frequently used to improve performance in many engineering applications. Ion implantation was believed to be a revolutionary surface treatment called to solve many wear and corrosion problems of metallic tools and components. The ion implantation was applied to enhance the mechanical properties of surface. The importance of nanomodifications in technology development has been growing, especially in development of new generation of tools. The development trend of precision and ultra precision machining clearly shows that we are dealing with up to few tens of nanometers in size. Therefore, depth of modification of tools should be between 30-100nm. We will give some results of investigations of possibilities of nanomodification by Kr ion implantation. Krypton ions have been implanted in steel substrates using mVINIS Ion Source. The mVINIS Ion Source shown in figure 1 is a part of the TESLA Accelerator Installation (AIT).

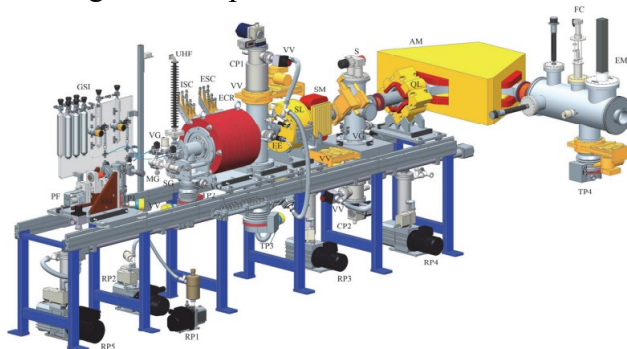


Figure 1. ECR ion source.

The mVINIS Ion Source is an ECR (electron cyclotron resonance) ion source with multiple applications. It can also work as a stand alone machine, directly delivering ion beams to the low energy experimental channels (physics of multiply charged ions, surface physics, and modification of materials by ion beams). In this paper Kr⁸⁺ ions with the energy of 120 keV and Kr¹¹⁺ ions with the energy of 180keV were used. Using the SRIM (Stopping and Range of Ions in Matter) simulation it can be calculated that the depth of surface implantation. ERDA (Elastic Recoil Detection Analysis) analyses were provided with a beam of Au ions (26+) with an energy of 350 MeV and a beam intensity of about 80 particle pA. It can be concluded that nanomodifications of surface layers can be successfully induced by implantation of Kr ions,

Acknowledgments

The authors gratefully acknowledge research support by the project entitled “Advanced materials, joining and allied technologies” in the Department of Production Engineering, Faculty of Technical Sciences Novi Sad, Serbia.

Efficiency of the Machining Process in Wire EDM of Hard Metals

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Keywords: Efficiency, Hard Metals, Quality, Electrical Discharge Machining

Abstract. The application of hard metals for parts with complex shapes, which are also subject to high quality requirements, brings a whole range of problems related to their production. In addition to the problems associated with the machining process itself, the economy of the applied machining process is also a problem. Due to the problems associated with the machinability of these high-strength materials, it is often impossible to use traditional production technologies for their production. However, for many progressive technologies, these materials set almost no limits in terms of machinability. However, in the case of their application, we often encounter problems related to the economy of the machining process itself, while the economic aspect is considered one of the essential indicators in engineering. At the same time, it is generally true that traditional technologies often show more favourable economic efficiency results in relation to progressive machining technologies. Therefore, in practice, it is often necessary to make certain compromises when choosing the method of the machining process, especially for difficult-to-machine materials. For the reasons mentioned, an experimental research was carried out, the aim of which was to obtain relevant data regarding the quantification of qualitative indicators of the machined surface during the machining of hard metals by means of progressive electrical discharge machining technology. As part of the conducted experimental research, partial data of individual elements were obtained on the basis of which complex conclusions were drawn in mutual contexts. Subsequently, complex data regarding the effectiveness of the applied electrical discharge process in the machining of hard metals were summarized. During the conducted experimental research, it was found that due to the size of the machined surface, even with such a demanding machining process as electrical discharge machining, favourable economic efficiency of the machining process can be achieved when machining hard-to-machine materials such as hard metals.

Possibilities of Preventing Roundness Errors of the Machined Surface in WEDM

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Keywords: Machined Surface, Progressive Technology, Electrical Discharge Machining, Roundness Errors

Abstract. In order to achieve high quality and productivity of production, modern engineering practice currently requires the deployment of highly sophisticated technologies, relying mainly on progressive machining technologies. At the same time, the priority is fast and cheap production, of course with an emphasis on achieving high production quality. In this regard, one of the appropriate progressive machining technologies, which meets the demanding quality requirements of current technical practice, is electrical discharge machining technology with a wire tool electrode. The technology of electrical discharge machining with a wire tool electrode is applicable mainly in the production of parts from difficult-to-machine materials and at the same time parts with a complex shape geometry. But despite the achieved relatively high geometric accuracy of the machined shape, various geometric inaccuracies occur in certain specific situations. One of the relatively frequently occurring geometric inaccuracies of the machined shape when applying progressive technology of electrical discharge machining with a wire tool electrode is roundness deviation. This geometric shape error occurs both on the outer and inner machined surfaces of parts with a roundness geometry of the shape of some of its partial parts. Therefore, the aim of the conducted experimental research was primarily to identify these deficiencies and define the causes of their occurrence. Subsequently, based on the obtained results of experimental measurements, possibilities were identified as to how these errors of geometric shape can be prevented or at least minimized. At the same time, a specific technical solution was proposed, which will make it possible to eliminate a number of these shape deviations and thus solve the problem of insufficient geometric accuracy of machined surfaces in the shape of a circle. At the same time, it is possible to substantially eliminate geometric shape errors caused by inaccuracy of interpolation, which are responsible for the emergence of a whole range of geometric deviations in the shape of machined surfaces after electrical discharge machining with a wire tool electrode.

Production of Engineered Cellular Structures

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Keywords: Production, Cellular Structure, Bio Inspired, Pharmaceutical.

Abstract. All industries, from the mechanical and aerospace industries to food production, pharmaceuticals, and the construction industry, exploit the advantages of cellular structures, as the advantages of the structures are supported by extensive research. A wide range of useful applications are available to users of this type of structure. Cellular materials include foams, honeycombs, grids and similar structures. Advantageous properties from an engineering point of view can be: high strength-to-weight ratio, excellent energy absorption, minimization of material requirements, low density, buoyancy, reduction of carrier and drug quantity, controllable active ingredient release, longer residence time.

The purpose of the research is to reveal the relationship between the material used, cell size, arrangement, and wall thickness. We find this important because there is currently no framework that helps designers choose from an infinite number of structural variations.

The pharmaceutical industry has also recognized the benefits, e.g. high strength-to-weight ratio, excellent energy absorption, minimization of material requirements, low density, buoyancy, reduction of carrier and drug quantity, controllable active ingredient release, longer residence time. Low-density suspended formulations can increase the residence time of drugs in the stomach; therefore, the release of the active ingredient will be sustained.

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Novel Approaches of Indoor Flow Assessments

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Keywords: Simulation, Meshing, LES, CFD, Indoor Flow

Abstract. The abstract showcases a summary of a previously published review paper. Further details and the citations can be read in the mentioned article [1]. To promote the simulation driven design to the building industry it was investigated how can the computational fluid dynamics assists ventilation system designers and architects in understanding the induced flow behaviour in the indoor environment. For this reason, the last five years of publications of Elsevier, SAGE, and Multidisciplinary Digital Publishing Institute were screened. The screened publications revealed three major types of simulations. In “Natural Flow Type”, wind tunnel assessments were made to examine wind-induced, natural ventilation flow patterns through certain buildings. The “Dispersion Flow Type” publication assesses particle dispersion in indoor environments. Publications of the “Thermal Flow Type” assess ventilation effectiveness by simulating buoyancy influenced airflow patterns.

There are two approaches to using CFD simulations to describe an indoor flow: the most common one is to use a steady or unsteady Reynolds-averaged Navier–Stokes (RANS or URANS) simulation, and the other one is large-eddy simulation (LES). The RANS and URANS methods are widely used because they produce accurate and quick results with low computational cost, and, furthermore, give researchers safety since it is a commonly used method. While the LES method requires significantly more computational power, URANS counterparts can be similarly accurate to some extent.

Since the LES method gives a higher level of accuracy the computational demand of these simulations was investigated. For the discretization demand, considerable differences occur. RANS employs various turbulence models, whereas LES utilizes sub-grid scale models to resolve the stress tensor $|\bar{S}|$, from which the sub-grid scale eddy viscosity (ν_{SGS}) can be calculated. The distinction between the various types of sub-grid models will be made here.

$$\nu_{SGS} = (C_W \cdot \Delta)^2 \cdot |\bar{S}| \quad (1)$$

where C_W is a constant for a certain LES method and Δ is the filter length or cell size. For the reaches in total, 182 publications were screened, 73 were mentioned, and 37 were used for the evaluation of the average cell size. Further conclusions for cell size recommendations for each flow type discussed will be derived in the presentations.

Funding: Project no. TKP2021-NKTA-34 has been implemented with support provided by the National Research, Development and Innovation Fund of Hungary, financed under the TKP2021-NKTA funding scheme.

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Li-Ion Battery Cell Bonding Technology Development

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Keywords: Laser, Steel, Li-Ion Battery, Electrically Conductive Adhesive, Surface Treatment

Abstract. The use of Li-ION battery cells is increasing due to the growth of electric cars and other wireless devices. In the case of these lower power devices, we can use stand-alone cells, but for higher power and capacity requirements, we can use battery cells in larger packs. There are several methods for joining cells together, but our aim is to develop a bonding technology using an electrically conductive adhesive with metallic content. A big advantage of electrically conductive adhesives over other methods is that there is no thermal stress on the cells during bonding. However, the bonding of metallic connectors requires proper preparation to establish a good and long-lasting connection. In this research, we are investigating high-energy density surface treatments that can be used to modify the joint surfaces to increase the adhesion force during bonding and reduce the electrical resistance of the bonded joint.

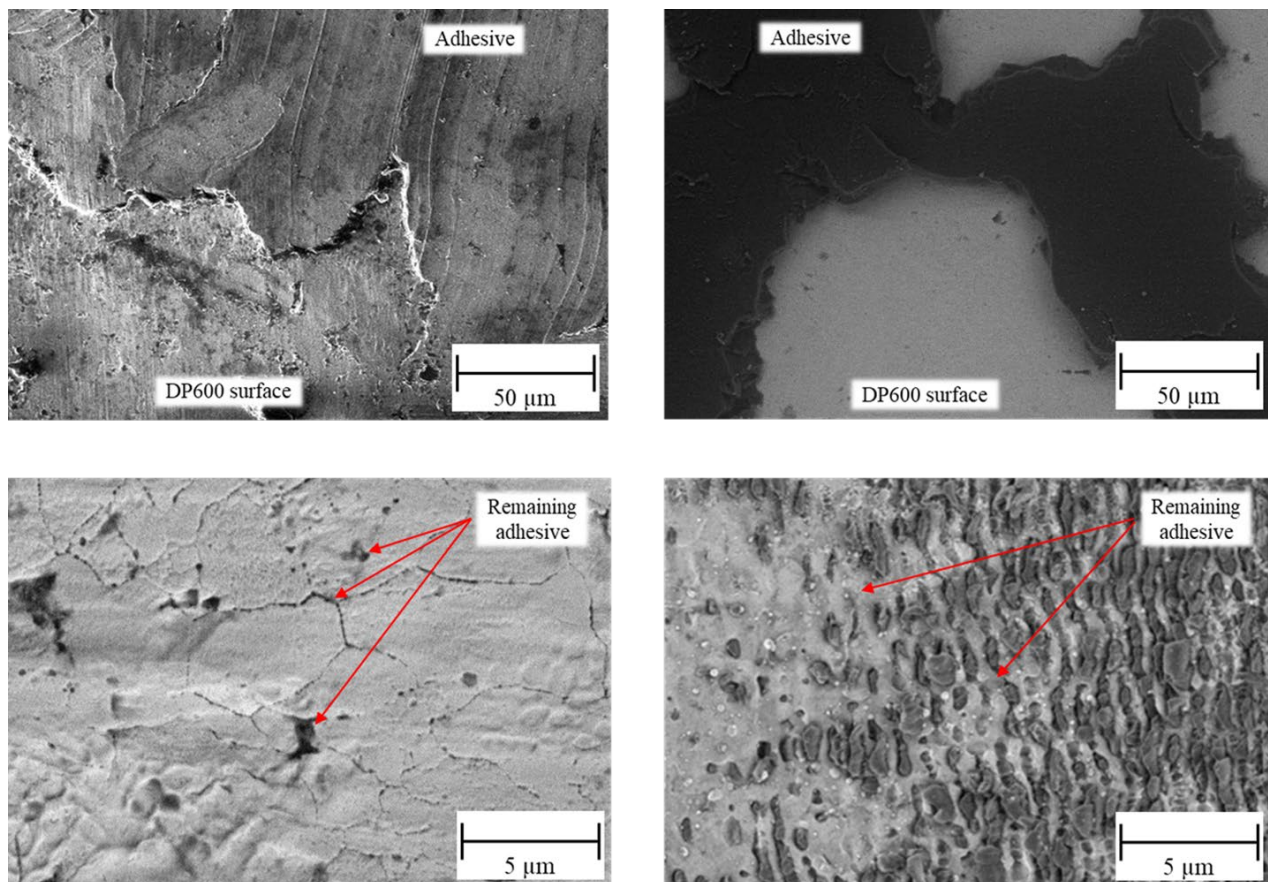


Figure 1. Remaining adhesive on untreated (left) and laser treated steel (right) after shear test

Fig. 1 shows that the surface structure created by the surface treatment helps the conductive adhesive to adhere to the surface. In the laser-treated case, there is a larger amount of adhesive on the surfaces after shear test.

Real-Time Facial Recognition Based on the Local Binary Pattern Histogram Algorithm

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Keywords: Computer Vision, Face Recognition, OpenCV, Machine Learning, LBPH Algorithm

Abstract. Facial recognition is a highly valuable technology with a range of essential applications. It enhances security by authenticating individuals in sensitive areas and aids law enforcement in identifying suspects. The technology also finds use in time and attendance tracking, customer experience personalization, and healthcare applications. Additionally, it contributes to education, accessibility, and humanitarian efforts. However, the accuracy of facial needs to be tested based on the faces from different age groups to see if the machine can obtain similar accuracy, therefore this experiment to test out the accuracy of the face recognition program based on the Local Binary Pattern Histogram method to see if there is an accuracy difference between people who are at different age. In this work, firstly, we collected the photos of two people in the dataset, one is the photos of a teenage boy, Tan. Another sub-dataset is the photos of a mature woman, Hanhan. Additionally, one thing to be noted is that the photos of Participant Hanhan were taken at very different ages. On the other hand, photos of Participant Tan were mostly taken at a teenage age. We obtained a model after pre-training the collected dataset, which will be used in the experiment. Secondly, within the LBPH method, the face detection process describes the face of a person in the input image. In feature extraction, facial landmarks are extracted to make an LBPH histogram that gives a completely unique result, and then in the recognition process, the histogram of the input image is compared with the database histogram using the CascadeClassifier in OpenCV. Thirdly, the testing of the proposed system was done in Pycharm IDE with OpenCV and Numpy libraries, and the users sat in front of the camera and used the pre-trained model to test the accuracy of facial recognition. After making sure that the program was running properly, the parameter for expected confidence was changed to observe if there were any accuracy changes. Finally, after comparing and evaluating the results, I found out that when Participant Tan was sitting in front of the Camera, the machine achieved around 97% accuracy. However, when Participant Hanhan was sitting in front of the Camera, the machine only achieved around 51% accuracy in testing data based on the LBPH algorithm. In conclusion, due to the fact that the LBPH algorithm focuses on analyzing the facial features of the person and comparing the result with the trained dataset, it can be deduced that Participant Hanhan only achieved around 51% accuracy because her facial feature is not significant enough compared to her overall analyzed dataset. Thus, it can be said that the long age span within the dataset affects the accuracy of facial recognition to a great extent due to the fact that the model can not acquire a featured result from it.

Numerical Modeling of Turbulence Flow Employing Vortex Generators and Comparing Various Corrugation Channel Types

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Keywords: Heat Transfer, Corrugations Channels, Vortex Generators, Turbulent Flow.

Abstract. Heat transfer is one of the most important industrial processes. Throughout any industrial facility, heat must be added, removed, or moved from one process stream to another. Understanding the basics of the heart of this operation is key to any engineer's mastery of the subject. The convection principle is based on the principle of moving fluid past a part or object at a velocity that allows the transfer of heat to the part. The increase in surface area gives us greater heat transfer at the same time as it leads to a pressure drop. This way is to get as much heat exchange between the fluid and channel as possible. The fluid flow in corrugated channels is a technique that is used for heat transfer enhancement. This numerical investigation is about turbulent flow through different types of corrugation channels in 2D and comparing the results. The corrugations create vortices around walls inside the channels, which decreases performance. The role of the vortex generators is to eliminate the vortex around the walls of the channel, which increases the Nusselt number. The Nusselt number, friction factor, and overall performance coefficient for the configurations are compared at various Reynolds numbers (5000–17500). This simulation was discretized and solved using the Ansys-Fluent commercial software based on the finite volume method. The standard k- ϵ model was used to model turbulence.

Cold Sintering of Zinc Powders for the Manufacturing of Porous Zinc Materials

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Keywords: Zinc, Cold/Chemical Sintering, Porous Metall

Abstract. Cold sintering, a novel and innovative approach to consolidating powdered materials at low temperatures, is gaining significant attention in materials science and engineering. This paper investigates the importance of applying the cold sintering process to zinc (Zn) powders, with a focus on its potential implications for advanced porous materials processing. The conventional sintering of Zn typically involves high-temperature treatments, which can be energy-intensive. In contrast, cold sintering enables the consolidation of Zn powders at significantly lower temperatures, broadening the scope of applications and environmental sustainability.

The interdisciplinary nature of this paper combines insights from materials science, chemistry, and engineering to underscore the broad implications and practical significance of cold sintering zinc powders. It concludes by stressing the prospects and challenges of adopting cold sintering as a sustainable and innovative method for the fabrication of advanced zinc-based materials, ultimately contributing to the ongoing evolution of materials science and technology.

This paper discusses the fundamental principles of cold sintering, including the role of pressure, chemistry, and the influence of additives, in achieving Zn compacts on a wide porosity range. It also explores the advantages and challenges associated with cold sintering as it pertains to Zn powders, such as improved energy efficiency, enhanced compatibility with temperature-sensitive materials, and the potential to engineer novel composites.

Good sintering was achieved between the Zn particles. By adding approx. 10% of a sintering aid comprised of a mixture of 50% water +25% ethanol and 25% acetic acid and kept under pressure at 500 MPa for different durations the samples presented a sintering degree of up to 0.8 even at room temperature. By increasing the temperature up to 250 °C a compression strength of 55MPa was achieved for a porosity of 40%.

Simulation of Industrial Processes Using Digital Lean Tools

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Keywords: Godot Game Engine, Codesys, TCP/IP, Industrial Process Simulation, Fischertechnik, Engineering Management, Factory I/O

Abstract. In the rapidly evolving field of industrial process simulation, my project explores the innovative integration of the Godot game engine, Codesys for TCP/IP process control and Fischertechnik components to design an advanced industrial 3D environment. Godot stands out as a formidable open-source platform for 3D modelling and visualisation, while Codesys offers a comprehensive package for automation control and programming. Fischertechnik, known for its modular architecture, further enhances the versatility of this integration, drawing attention to its widespread application in educational and industrial scenarios. The central aspect of this research is a comparative analysis of the developed Godot-based simulation system and the well-established Factory I/O software. The primary objective is not only to demonstrate the feasibility and benefits of the proposed integration, but also to evaluate its performance in comparison to Factory I/O. By emphasizing the crucial role of process simulation in modern engineering management, the paper highlights potential challenges, offers solutions, and ultimately seeks to highlight the potential of this novel approach to cost efficiency, risk minimization, and continuous process improvement.

Acknowledgments.

The research is supported by ÚNKP-23-2 New National Excellence Program of the Ministry for Culture and Innovation. This research was made possible through their generous support and funding sourced from the National Research, Development, and Innovation Fund.

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Innovations in Water Treatment

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Keywords: Water Treatment, Filtration, Nitrification, Denitrification, Sorption

Abstract. The widespread use of chlorine synthesis devices, such as HIPOGEN P, has revolutionized water disinfection by generating active chlorine from common salt directly at the point of use. Employing electrolysis with table salt, water, and electricity, the HIPOGEN system ensures efficient and affordable water treatment in various settings, including individual households, urban and rural water systems, and industrial applications [1-2].

Filtration and sorption are vital techniques in water purification, effectively eliminating impurities and microorganisms from the water. This process involves various technologies like sedimentation, sand filtration, lime softening, and activated carbon filtration, ensuring the removal of a wide array of impurities. Biological filtration facilitates the conversion of organic and inorganic matter, resulting in the production of clean water, carbon dioxide, and an increase in microorganism mass.

Nitrification and denitrification play crucial roles in the oxidation and reduction of ammonia, respectively, contributing to the removal of nitrogen compounds from water. Ion exchange processes aid in water softening and demineralization, effectively eliminating undesirable dissolved substances through the exchange of ions between the solution and ionic mass. Nanofiltration and reverse osmosis employ semi-permeable membranes to effectively remove dissolved substances, making them valuable in water treatment and environmental protection within the chemical engineering sector. Dosing device for the administration of liquid chlorine compounds, including amperometric monitoring of residual chlorine and measurement history, complete with remote control and monitoring is illustrated in Figure 1.



Figure 1.

Acknowledgements

This article/publication is based upon work from COST Action CA21112 - Offshore freshened groundwater: An unconventional water resource in coastal regions? (OFF-SOURCE), supported by COST (European Cooperation in Science and Technology).

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Sensitivity Analysis in Dynamic Systems: Exploring Insights

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Keywords: Modal Design Sensitivities, Sensitivity Analysis, Structural Design Optimization

Abstract. Structural design optimization for dynamic behavior is crucial for structures reliant on their dynamic characteristics for operational performance and integrity. Key applications of this technology include integrated controls-structures design, flutter control, and buckling load modification, elaborated in a comprehensive review by Grandhi [1]. The dynamic response of a structural system is primarily governed by natural frequencies and mode shapes, where formal modification techniques are employed to manipulate these properties by adjusting design variables. These variables can vary depending on the type of modification problem, representing factors such as spacing, size, shape, and material composition in structural components like stiffened panels and cylinders. Sensitivity analysis is increasingly recognized as a valuable tool in structural reanalysis, providing insights into potential design changes to achieve desired structural properties. While first-order design sensitivities are often used to predict the effects of proposed modifications, the use of second-order sensitivities warrants careful consideration, particularly concerning the acceptability of first-order sensitivities for predictive analysis. Modal design sensitivities refer to derivatives of the eigensystem of a dynamic system with respect to variables available for modification, such as changes in section diameter, length, or material composition (Figure 1). Shape sensitivity analysis is valuable for understanding system behavior, optimizing system responses, and identifying shapes based on measured system responses over time [2-4].

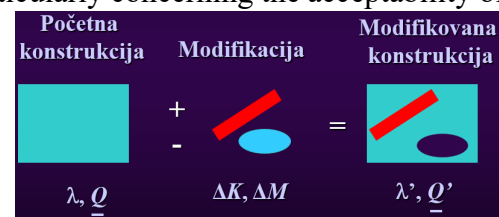


Figure 1.

Acknowledgements

The results shown here are the result of research supported by the Ministry of Science, Technological Development and Innovation of the RS under Contract 451-03-47/2023-01/ 200105 dated 02/03/2023., also COST Action CA18203 - Optimal design for inspection (ODIN) and COST Action CA21155 - Advanced Composites under High STRAin raTEs loading: a route to certification-by-analysis (HISTRATE).

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The Modern Approach to Optimizing Mechanical Systems

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Keywords: Sustainability, Optimization, Advanced Computational Modeling, Sustainable Material

Abstract. The modern approach to optimizing mechanical systems involves employing cutting-edge technologies and methodologies to enhance the performance, efficiency, and sustainability of various mechanical processes and systems. This approach typically integrates advanced computational techniques, smart automation, and innovative materials to create more effective and eco-friendly solutions. Here are some key elements related to this topic:

(a) Advanced Computational Modeling: Utilizing sophisticated computer simulations and modeling techniques to design and analyze mechanical systems, identifying potential weaknesses and opportunities for optimization. (b) Smart Automation and Robotics: Incorporating intelligent automation and robotics in mechanical systems to streamline operations, increase productivity, and reduce human error, thereby enhancing overall efficiency. (c) Sustainable Materials and Manufacturing: Implementing sustainable materials and manufacturing practices to reduce the environmental impact of mechanical systems, ensuring a more eco-friendly and energy-efficient approach to production. (d) Predictive Maintenance and Condition Monitoring: Implementing predictive maintenance strategies and condition monitoring technologies to prevent equipment failures and downtime, ensuring continuous operation and maximizing the lifespan of mechanical systems. (e) Integration of Internet of Things (IoT): Integrating IoT technologies to enable real-time data monitoring, analysis, and management of mechanical systems, facilitating proactive decision-making and optimizing system performance. (f) Energy Efficiency and Renewable Energy Integration: Focusing on energy-efficient designs and incorporating renewable energy sources such as solar, wind, or geothermal power to reduce reliance on traditional energy resources and minimize the carbon footprint of mechanical systems. (g) Adoption of Lean Manufacturing Principles: Applying lean manufacturing principles to streamline processes, reduce waste, and optimize the overall production cycle, leading to increased efficiency and improved cost-effectiveness. (h) Emphasis on System Integration and Interoperability: Emphasizing the integration and interoperability of various mechanical components and systems to ensure seamless communication and coordination, resulting in enhanced overall system performance and functionality.

The modern approach to optimizing mechanical systems is driven by a commitment to sustainability, efficiency, and technological innovation, aiming to meet the demands of a rapidly evolving industrial landscape while minimizing the environmental impact and maximizing overall performance.

Acknowledgements

The results shown here are the result of research supported by the Ministry of Science, Technological Development and Innovation of the RS under Contract 451-03-47/2023-01/ 200105 dated 02/03/2023. year, also COST Action CA18203 - Optimal design for inspection (ODIN)

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Innovations in Wastewater Treatment

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Keywords: Wastewater, Treatment Biogas

Abstract. For efficient design and reliable operation of the system, it is necessary to collect as much data as possible on the flow and composition of the wastewater in order to ensure compliance with all regulatory requirements. Adoption of new standards and regulations, along with penalties for non-compliance, encourages the use of devices and facilities for wastewater treatment to ensure safe discharge into the environment. Municipal wastewater requires complex purification processes to remove organic and inorganic substances, including surfactants such as soaps and detergents.

Wastewater from metal processing industries, which include various chemicals, require complex purification processes, including chemical treatment to remove pollutants. Treated waters (effluents) can be discharged into natural watercourses, used for irrigation of energy crops, or injected underground, while sludge can be used as organic fertilizer, and biogas for energy production (Picture 1). In this paper, new techniques and devices in the field of wastewater treatment technology will be presented.

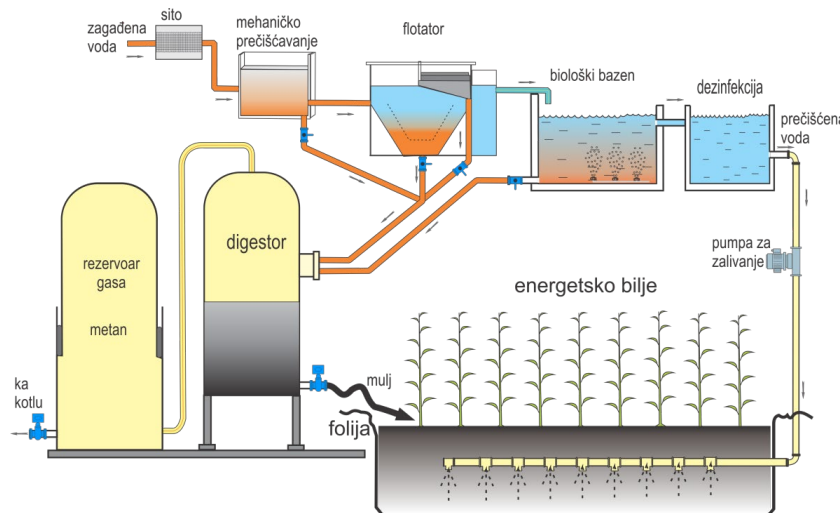


Figure 1. Utilization of sludge and effluent in plantations for the cultivation of energy crops.

Acknowledgements

This article/publication is based upon work from COST Action CA21112 - Offshore freshened groundwater: An unconventional water resource in coastal regions? (OFF-SOURCE), supported by COST (European Cooperation in Science and Technology).

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Determination of Flash Points of Flammable Mixtures for Explosion Protection

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Keywords: Flash Point, Flammable Mixtures, Hazardous Area Classification, ATEX

Abstract. The flash point is the temperature at which the surface of a flammable liquid already produces enough vapour to burst under the influence of an ignition source, such as a spark. When determining the explosion hazard areas of a technology, if it is a combustible liquid, this value is used to determine the fire hazard class according to the current BM Decree 54/2014 (XII. 5.) in Hungary. Also for storage tanks, if flammable liquids are stored, a fire hazard class is determined according to MSZ 9790:1985, which is also based on the flash point of the flammable liquid. It is true worldwide that, for flammable liquids, the flash point data is the basis for determining whether or not there is a risk of explosive vapour under normal operating conditions. In principle, there are two types of flash points, open-cup and close-cup, which should be determined according to EN ISO 13736:2021/A1:2023, EN ISO 2719:2016/A1:2021, ASTM D93:2020, IP 34:2021, ASTM D92:2018, EN ISO 2592:2018, IP 36:2002. Nowadays, they prefer to define only the close-cup flash point, as it is easier to measure than the open-cup flash point and produces a lower value, thus making the approach conservative. In many cases in the literature, online databases or material safety data sheets, simply write flashpoint, which in a very high percentage of cases is the closed-cup flash point. For a completely homogeneous liquid, the situation is straightforward because the flash point has already been determined and is treated uniformly in the literature, despite small variations. However, in the case of an inhomogeneous medium containing all percentages of combustible liquid and, for example, water, the flash point will be higher than the value determined for a completely pure combustible liquid. But how much higher? The testing methods described in the standard may not be quickly and easily available to everyone. Based on the current literature, it is possible to determine the flash point of the mixture using a relatively small number of input parameters (Antoine constant, vapour-liquid equilibrium) as a good approximation. The aim of this paper is to describe this relationship by presenting the flash points of benzene, methanol and xylene mixtures using the Perry's Chemical Engineers Handbook, 9th Edition; VLE-Calc.com - Vapor-Liquid Equilibrium Calculator and the vapor-liquid equilibrium data from Honeywell's UniSim Design process simulation software. This is important because if the flash point of a mixture is no longer within the range of explosion protection measures required by regulation or standard, there is no safety justification for the installation and use of explosion-proof designs and additional operational benefits in the EHS area.

Study on the Mechanical Properties of Natural Rubber Mixtures Plasticized with Selected Plant Oil

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Keywords: Plant Oils, Petroleum-Based Plasticizer, Natural Rubber Composites, Vulcanization

Abstract. A high number of technical elastomer products contain plasticizers for rubber compounding for tire industries and also as tailoring material properties. Some additives used as plasticizers pose a health risk and are also non-renewable resources that need to be replaced hence actively. Therefore, research as ours is going on in this field to find sustainable alternatives for conventional plasticizers that are useable for industrial purposes. The potential of naturally available oils as additives instead of processing aids and activators in carbon black-filled natural rubber was investigated in this study. Results from characterization of the mixtures like the Dynamic Scanning Calorimetry (DSC), Scanning Electron Microscopy (SEM), Shore-A hardness tests as well as UV-aging suggests that natural rubbers mixtures plasticized with plant oils or their derivatives are very similar to those plasticized with commonly applied mineral oils and that only small formulation adjustments are needed when switching from traditional mineral oils to environment-friendly natural oils. It can be deduced that the plant oils employed in this work can be used as processing aids without any adverse effect on the properties of the vulcanizates produced. The results indicate that pepper oil, palm oil and coconut oil are good processing aids in place of petroleum-based aromatic oils which have been reported as carcinogenic.

Calculation Algorithm of Air Humidification for Laboratory Equipment

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Keywords: Laboratory Equipment

Abstract. In many cases, air conditions are dictated by standard requirements or technology specifications. Among the air conditions, there may be regulations not only for temperature and velocity, but also for humidity. In comfort spaces, the temperature should usually be kept between 18-24°C, but it is equally necessary to ensure the relative humidity at a value between 40-60%. Too low or too high humidity causes discomfort to the occupants of the room, so it is necessary to moisten or dry the air. On airplanes, the air introduced into the passenger compartment must be humidified so that the air is not too dry for the passengers, which would cause discomfort. In technological spaces - such as server rooms - it is necessary to humidify the air in order to avoid static charging, thus preventing the formation of sparks and the reduction of the service life of electronic equipment. Humidification of the air in air handling units can be done in two ways: by introducing steam or water. In the case of the former, steam is produced with the help of an external energy source, and then it is directly fed into the air flow. In the case of the latter, the water is atomized into small droplets - spraying - which, when introduced into the air stream, removes the heat required for evaporation from the air, thus cooling it. In air handling units, the air goes through various heat and humidification processes, for which the Mollier diagram is most often used for graphical representation. The goal of our work was to implement a calculation algorithm that specifies the amount of moisture input and heat output required to achieve a given air condition (temperature, humidity) with different humidification methods to our laboratory equipment. For a given initial air condition, four different cases were investigated to achieve the desired air condition: spraying water before (1) or after (2) the heating unit and introducing steam before (3) or after (4) the heating unit. This can be seen in the Figure 1. The suitable method for increasing the humidity content and temperature can be selected based on the calculation algorithm.

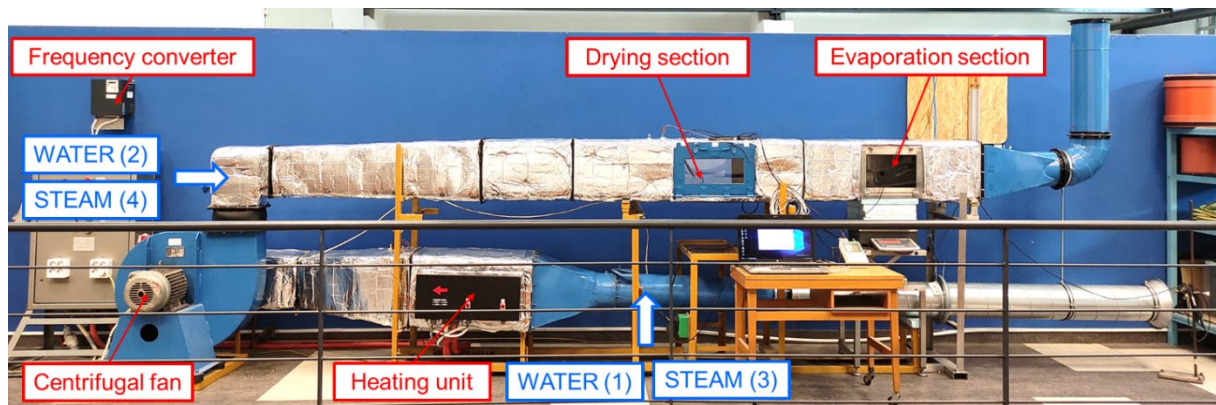


Figure 1. The laboratory equipment and the different humidification methods.

Acknowledgment

This work was supported by the János Bolyai Research Scholarship of the Hungarian Academy of Sciences (BO/00059/23/6) and by the Hungarian Scientific Research Fund (NKFIH FK-142204). The first author was supported by the ÚNKP-23-5-BME-411 New National Excellence Program of the Ministry for Culture and Innovation from the source of the National Research, Development and Innovation Fund.

Development of Bonding Technology for Composite Materials with High Energy Density Surface Treatments

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Keywords: Surface Treatment, Composite, Vehicle, Adhesives.

Abstract. Nowadays, the players in the vehicle industry focus on ensuring that the materials and technologies used for vehicle bodies meet the latest requirements. This requires continuous developments, where the primary goal is to reduce the self-weight of the manufactured vehicle, while the material properties that are important for the intended use only change slightly. The most important aspect is cost-effectiveness for the user (an important element of this is the consumption of the vehicle) and moderate environmental impact. Environmental impact and cost-effectiveness are not only important for the user, but must be taken into account throughout the vehicle's entire life cycle, i.e. from production through use to recycling. Taking these aspects into account, the most important development trends that brought or are bringing new materials into vehicle production can be characterized.

The appearance of new, modern materials and new bonding technologies pose challenges, because the bonding between body elements plays just as important a role in passenger safety as the properties of the material used. That is why it is very important to use the right bonding technology for the selected automotive materials.

There are tens of thousands of joints in a modern vehicle today. Fasteners are used by component manufacturers for the production of individual elements, and also by car factories for the complete assembly of a vehicle. Each point is a connection point, where two parts are joined in such a way that they continue to function as a unit.

Preparation of the surfaces: As a result of environmental effects or production and processing operations, various surface contaminants may be applied to or form on the surface of the workpieces. These are harmful substances from the point of view of further processing of the surface or the formation of a coating. Proper preparation of the surface of the raw material is essential before the surface treatment procedures. This includes cleaning, deoxidizing and activating the surface. In the case of surface treatment processes, during which some kind of coating is formed on the surface of the raw material (usually metal), the quality of the preparation largely determines the properties of the coating.

In this article, we aim at the bonding technology of composite materials, which are increasingly used in the vehicle industry. We improve the properties of surfaces with various high energy density surface treatment processes and optimize the surface for a favorable bonding process. The created surfaces are tested with different adhesives.

Tensile Strength Investigation of Polyamide 6.12 Reinforced by Glass Fiber 30%

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Keywords: Polyamide, Tensile, Reinforcement

Abstract. Polyamide 6.12, also known as Nylon 6.12, is a versatile polymer that can be used in different industries such as personal care and cosmetic products, automobile parts, electric and electronic appliances, and etc. The initial motivation for designing this polymer was to solve the problem of water absorption by Nylon 6. However, the primary product without any reinforcement has limited applications due to its weaker mechanical properties. The primary form of PA 6.12 is mostly applicable in the extruded tube applications. Therefore, reinforcing this material with Glass Fiber is a good industrial solution to widen the range of applications. After adding this type of reinforcement, not only we have solved the problem of moisture absorption, but also, we have increased the market size of our product and gained access to new applications and new customers in the market. This reinforcing additive makes us able to utilize this material in a different production process, “injection molding”. In this experiment, we used a sample which was a blend of PA 6.12 with GF 30%. The test was performed under ASTM D638 condition. We employed “Instron” tensile machine (system ID number 5566J9154) in the room condition (25 °C/relative humidity 50%) under the strain rate of 20 mm per minute. The test took 18.6 seconds until fracture point and the maximum strain (elastic and plastic deformation before breakage) was 4.3%. The yield force for this sample was 5295.7 N.

Keyword Index

17-4PH47
 3D Printed Metals62
 3D Printing.....31, 52, 101

A

Accuracy12
 Additive Manufacturing.....32, 47, 81, 82, 95
 Additives34
 Adhesives119
 Admixture49
 Advanced Computational Modeling114
 Aggregate85
 AI31
 Air Entrapment.....14
 Alloy Design45
 Aluminium53
 Aluminium Foam Absorber48
 Aluminum29
 Aluminum Casting Alloy20
 Am32
 Ammonia.....55
 ANSYS1, 8
 Anti-Corrosion73
 Applicability.....37
 Astaloy Mo.....16
 ATEx116
 Automotive Alternator78
 Autonomous Vehicles83

B

Ball Bearing60
 Bayesian Optimization.....17
 Bearing Lubricant Volume.....60
 Bio Inspired.....105
 Bio-Intelligence.....31
 Biodegradable91
 Biogas Treatment115
 Bubble Dynamics46, 55
 Bucket-Wheel Excavator67

C

CAD86
 Casting29
 Cathode Ray Tube.....72
 Cavitation46
 Cells27
 Cellular Glass85
 Cellular Structure105

Cementing63
 Center Manifold.....39
 CFD8, 27, 100, 106
 Charge-Mixing.....17
 Classification66
 Claw-Pole Alternator78
 Clay34, 35
 Cleanrooms94
 CNN23
 Coating.....102
 Codesys.....111
 Cold/Chemical Sintering110
 Columnar-Equiaxed-Transition98
 Composite119
 Composite Materials.....1, 68
 Computational Fluid Dynamics (CFD) 71, 78
 Computer Vision.....59, 108
 Concrete85
 Contact Fatigue16
 Cooling78
 Corrosion Retardant.....11
 Corrugations Channels.....109
 Coupled Thermal Analysis56
 Crane Wheels.....76
 Crank Nicolson Scheme75
 Crashbox48
 Cutting Force13
 Cycles12

D

Damage Analysis67
 Damping Factor18
 Deep Learning23
 Degassing.....29
 DEM32
 DEM Simulation.....32
 Denitrification112
 Density Functional Theory17
 Design65, 70
 Design Requirements.....68
 Design Study.....25
 Devulcanization28
 DHT Analysis90
 Digital Twin.....41
 Digitization74
 Distilled Water.....75
 DNN23
 Drag Force71

Drill Cutting	63
Driving Cycle	77
Drying Sensitivity	35
Dual Fuel	51
Dual-Purpose Solar Collector	38
Duplex Stainless Steel	22
Durability	49
Dynamic Mechanical Analysis (DMA)	69
Dynamic Mesh	14
Dynamic Simulation	25

E

Eco-Friendly Machining	3
Efficiency	103
EHL	60
Eigenvalues	44
Eigenvectors	44
Electrical Discharge Machining	103, 104
Electrically Conductive Adhesive	107
Electromagnetic Stirring	98
Energy Absorbing	48
Energy Demand	34
Energy Efficiency	55
Engineering Management	111
Engineering Plastic	89
Error Detection	66
Extrusion	34

F

Face Recognition	108
Facial Recognition	59
Factory I/O	111
Failure Detection	101
Fault Diagnosis	41
FDM	101
Feed	12
FEM Numerical Simulation	79
FFF	82
Filling Content	21
Filling Material Type	21
Filtration	112
Finite Element Analysis	68
Finite Element Method (FEM)	44
Finite Element Modeling	30, 54
Fischertechnik	111
Flammability Test	21
Flammable Mixtures	116
Flash Point	116
Flat-Plate Collector	38
Fluid Mechanics	27

Flux	20
Fluxes	29
Foam Glass	72, 85
Foaming Temperature	72
Foresight	31
Forming Parameters	96
Fractal Fractional Derivative	75
Fracture	1
Free Surface	14
Frequencies	25
Fuzzy Logic	9

G

Gear	65, 67
Gear Performance	2
Gear Radiated Noise	40
Gearbox Noise	40
Gearbox Nvh	40
Geometric Parameters	2
Gesture Recognition	23
Glass Fiber	90
Godot Game Engine	111
GPU	46
Grain Refining	20
Grinding	12, 19
Ground Tyre Rubber	28

H

Haber-Bosch-Process	55
Hand Gestures	23
Hard Metals	103
Hazardous Area Classification	116
Heat Loss	84
Heat Transfer	109
Heat Treatment	57
Helical	65
High-Entropy Alloy	37
High-Entropy Alloys	45
Hopf Bifurcation	39
Horizontal	19
HPDC	14
Hydraulic Filter	15

I

Image Processing	101
Impact Strength Test	90
Impulsive Testing	18
Indoor Flow	106
Industrial Process Simulation	111
Industrial Robot	18

Industry 4	74
Injection Molding Temperature	88, 90
Injection Moulding.....	54
Inspection.....	66
Internal Combustion.....	51
Internal Corrosion	11
Internal Cracks	1
Intralogistics.....	74
Ion Implantation.....	102
Ironing.....	81

J

Jigsaw.....	13
Joule Heating.....	75

K

K- ω SST.....	8
Kr	102

L

Laboratory Equipment	118
Laser	107
Laser Power Bed Fusion	52
Latent Heat Storage.....	100
Lattice Structures	10
LBPH Algorithm.....	108
Least Squares Fitting.....	39
LES	106
Li-Ion Battery.....	107
Lift Force.....	71
Lifting.....	76
Lightweight.....	85
Load Distribution	60
Logarithmic Decrement	18
Long-Term	84
Low-Alloyed Cast Steel.....	67

M

Machine Design	58
Machine Learning	10, 23, 59, 108
Machined Surface	104
Macrosegregation.....	98
Maintatance.....	41
Maintenance	66
Manufacturing.....	2, 19, 31
Master Alloy	20
Material	31
Material Science.....	37
Materials Science	45
MATLAB.....	77

Measurement Methods.....	6
Measurment	13
Mechanical.....	12
Mechanical Properties	49, 57, 69
Mechanical Test.....	88, 90, 91
Melt Cleaning	20
Melt Quality.....	29
Melt Treatment	20, 29
Meshing	106
Meta-Heuristic Algorithm	3
Metaheuristics.....	79
Metal Powder.....	32
Mobile Robots	9
Modal Design Sensitivities.....	113
Model Fitting	43
Modeling.....	57, 77
Modern Materials.....	37
Modularity	77
Moisture Content	6, 35
Mortar	49
Multi-Objective Optimization	3

N

N-Dimensional Design	58
Nanomodification	102
Natural Filler.....	91
Natural Frequency	1, 18
Natural Rubber Composites.....	117
Navigation.....	9
Nc 100.24.....	16
Nelder-Mead	3
Neural Network	23
Nitrification.....	112
Numerical Grid	27
Numerical Methods	84
Numerical Modeling Simulation	7

O

Object-Centric Process Mining.....	66
Obstacle Avoidance	9
Oil Analysis	15
Oil Pipelines.....	11
Oil Separation	73
OpenCV	59, 108
Optimal	12
Optimization	10, 65, 77, 79, 114
Optimization Processes.....	30
Osmosis.....	70

P

Participating Medium.....	56
Particle Swarm Optimization.....	79
Path Planning.....	9
PBT.....	88
PET.....	90
Petroleum.....	63
Petroleum-Based Plasticizer.....	117
Pharmaceutical.....	105
Phase Change Materials.....	100
Pir Foam.....	21
Pitting Corrosion.....	22
PLA.....	91
Plant Oils.....	117
Plastic Deformation.....	87
Plasticity.....	34, 35
Plastics.....	82
Pollution.....	15
Polyamide.....	120
Polyketon.....	89
Polymer.....	6
Polyoxymethylene.....	89
Polypropylene.....	28
Pore Size Distribution.....	43
Porosity.....	85
Porous Metall.....	110
Portable Crane.....	76
Powder Segregation.....	32
Power Machine.....	86
Powertrain Noise.....	40
Prandtl.....	26
Predictive Maintenance.....	41
Prepared Sand.....	49
Pressure Drop.....	15
Printing Orientation.....	52
Product Development.....	58
Product Life Cycle.....	58
Production.....	105
Production Methods.....	45
Progressive Technology.....	104
PUR Foam.....	21
PUR-System.....	21
PVC.....	69

Q

Quality.....	103
--------------	-----

R

Radial.....	12
Radiative Heat Flux.....	56

Raman Spectroscopy.....	24
Random Forest.....	23
Rapid Tooling.....	54
Reanalysis.....	44
Rehabilitation.....	70
Reinforcement.....	120
Residual Stresses.....	7
Resistance.....	8
Rigid Foam.....	21
Robotic Applications.....	2
Rotary Degassing.....	20
Rotating Machinery.....	78
Roughness.....	96
Roughness Height.....	8
Roundness Errors.....	104
RSM.....	57

S

Saint-Venant.....	26
Segregated.....	98
Selective Laser Printing.....	47
Sensitivity.....	44
Sensitivity Analysis.....	113
Sheet Forming.....	96
Shore d Hardness Measurement.....	91
Simulation.....	54, 106
Slag Addition.....	49
Solar Air Heating.....	38
Solar Energy.....	38
Solar Water Heating.....	38
Solidification.....	98
Solidification/Stabilization.....	63
Sonochemistry.....	46, 55
Sorption.....	112
SPIF.....	96
Springback.....	30
Spur Gear.....	2
St 14 Steel.....	30
Stainless Steel.....	52
State Monitoring.....	54
Static.....	65
Static Simulation.....	25
Statistical Analysis.....	15
Steel.....	107
Steel-Concrete Composite Elements.....	56
Steer-by-Wire.....	41
Step Size.....	96
Stress Function.....	26
Structural Design Optimization.....	113
Structural Integrity Assessment.....	87

Surface	65
Surface-Enhanced Raman Spectroscopy	24
Surface Roughness.....	2, 81, 82
Surface Tension.....	73
Surface Treatment.....	53, 107, 119
Sustainability.....	114
Sustainable Material,.....	114
SVM	57

T

TCP/IP.....	111
Technological Optimization.....	70
Tensile.....	120
Tensile Tests	69
Ternary Nanofluid.....	75
Testing Methods.....	62
Thermal.....	78
Thermal Bridges.....	84
Thermoplastic Dynamic Vulcanizates	28
Thinning.....	30
Time-Delay Systems.....	39
Titanium.....	96
Tool	19
Tool Diameter	96
Torsion	26
Torsion Function.....	26
Torsional Rigidity	26
TPU	69
Transient.....	84
Tribology.....	62
Tribology Properties	89
Turbo Machine.....	86
Turbulent Flow.....	109
Turning.....	3

U

UAV	68
Underrunning Prevention.....	48
UV Test.....	91

V

Vehicle	77, 119
Vertical.....	19
Vertical Column Bar.....	76
Viscous Dissipation.....	75
VOF	14
Vortex.....	71
Vortex Generators	109
Vulcanization	117

W

Wake	71
Waste Glass	72
Wastewater	115
Water Sprinkler.....	86
Water Treatment	112
Wear	62
Weighting Method.....	30
Welded Joint Regions	87
Welding.....	7
Wet Scrubber	93
Wettability	73
Whitepaper.....	31
Wind Tunnel	71
Wire Arc Additive Manufacturing.....	22
WLTP	77
Workpiece.....	19

Y

Yacht	70
-------------	----

Z

Zeolite.....	92
Zinc	110