8th joint doctoral students conference
POZ-MAR 2024

POZ-MAR 2024

BOOK OF ABSTRACTS

Maribor, Slovenia, April 25–26, 2024

POZ-MAR 2024
April 25–26, 2024
Maribor, Slovenia

Organizing committee

Nejc Novak, University of Maribor, Slovenia
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Editors of Book of Abstracts

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Venue

University of Maribor
Dvorana Severni stolp/North tower hall
Slomškov trg 15, Maribor
Slovenia

Conference Program

Thursday, 25.4.2024

09:00 – 09:30	Registration
09:30 – 10:00	Word of organizers
10:00 – 11:00	Section #1 (Chairman: Nejc Novak)
11:00 – 11:30	Coffee break
11:30 – 13:00	Section #2 (Chairman: Anja Mauko)
13:00 – 14:00	Lunch
14:00 – 15:00	Section #3 (Chairmans: prof. Andrzej Tomporowski and prof. Robert Kasner)
15:15 – 18:00	City guided tour and wine tasting Meeting time: 15:15 in front of University building
18:00 –	Tour of Maribor

Friday, 26.4.2024

10:00 – 11:00	Section #4 (Chairman: Wojtek Cieslik)
11:00 – 11:45	Coffee break
11:45 – 12:30	Section #5 (Chairman: prof. Zbigniew Kłos)
12:30 – 13:00	Conclusion remarks (Nejc Novak and prof. Zbigniew Kłos)
13:00 – 14:30	Lunch

Word of the organizers

For the eight time an international PhD students' conference connecting students from two European university cities is held. This time around, PhD students from the Faculty of Mechanical Engineering, University of Maribor, are pleased to host the 8th Joint PhD Students Conference Poznan - Maribor.

The main objective of the conference is to promote the exchange of ideas between PhD students from the Faculty of Mechanical Engineering, University of Maribor (FME), the Faculty of Machines and Transport (FMT), Poznan University of Technology (PUT). In the year 2024, the conference will also be joined by a students from Bydgoszcz University of Science and Technology.

The conference contributions address topics in the field of mechanical engineering, mechatronics, transport engineering, industrial engineering, agricultural engineering, logistics, thermal engineering, motor vehicles and machines and internal combustion engines, making the conference an amplifying node point for social and scientific development.

The ultimate goal of the conference is to bring together an international professional community consisting of young researchers from academia, to discuss the status of different engineering fields and to drive the future of engineering practices and applications.

We are proud to announce a very positive feedback and sincerely thank all authors for their contributions, making the conference a continuing success.

Organizing committee

Maribor, April, 2024.

Contents

ANALYSIS OF CHANGES IN THE HARMFULNESS OF THE BOTTLE PACKAGING PROCESS DEPENDING ON THE TYPE OF HEAT-SHRINKABLE FILM

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Faculty of Mechanical Engineering, Bydgoszcz University of Science and Technology, al. Prof. S. Kaliskiego 7, 85-796 Bydgoszcz, Poland
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Keywords: technological process, heat-shrinkable film; life cycle assessment (LCA)

ABSTRACT:
This study concerns the analysis of selected stages of the machine's life cycle environmental impact in the specific case of the machine packaging bottles in thermo-shrinkable film. As part of the analysis, laboratory tests were carried out to compare the performance properties of polyethylene films (with and without recycled material). Then, a life cycle assessment (LCA) was carried out within the specified system boundaries using the SimaPro program. Using the ReCiPe 2016 method, differences in the impact of the mass bottle packaging process on three categories (human health, ecosystems and resources) were determined depending on the shrink film used in the process. The tests showed that the tested batch of film with the addition of recyclates has similar functional properties to traditional ones and can therefore be used in the mass packaging process. Environ-mental analysis showed that changing the film type reduced damage in all three damage categories tested.

UAV PILOTS' GAZE BEHAVIOR AND WORKLOAD IN SIMULATION FLIGHTS

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Keywords: UAV, eye tracking, NASA TLX, workload, fixation

ABSTRACT:
Effective processing of information from the sense of sight affects the efficiency and safety of flight operations [1,3]. Differences in visual behavior and workload between UAV operators with various flight experience during basic flight maneuvers were identified as the research problem. The participants' visual behavior was recorded using a eye tracker and their workload was measured using NASA TLX questionnaire [2]. The research subjects' task was to performed a simulation UAV flights with different difficulty levels. The aim of research are preliminary study to make conclusions about differences in gaze and workload level according to operators experience and due to two simulation scenarios. Eye tracking and NASA TLX variables differentiate the difficulty levels of the simulations performed. For experts group values of eye tracking variables was similar during each level of task. However NASA TLX results in experts shows the difference between each task. Based on the result can be seen, that experience differentiate the level of subjects' workload during the operations performed. The results of the eye tracking study suggest that performing basic maneuvers develops strategies for scanning the space. It is advisable to conduct further research with larger groups of operators taking into account the division into groups with varying different licenses.

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SIMULATION OF THE COLLAPSE OF A VAPOR BUBBLE

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Keywords: cavitation, bubble dynamics, cavitation modelling

ABSTRACT:
The objective of this study is to compare three different methods to simulate the collapse of a vapor bubble. First, the Rayleigh –Plesset simplified equation was numerically integrated using the 4th order Runge-Kutta (RK4) method. Then, the multiphase mixture model of Ansys Fluent was used with two different cavitation models: Zwart-Gerber-Belamri [1] *and Schnerr-Sauer* [2]*. The radius of the bubble obtained is plotted against time in Figure 1. The Zwart-Gerber-Belamri and Schnerr-Sauer cavitation models have a similar result until the first rebound which is more pronounced with the Zwart-Gerber-Belamri model. With the numerical integration of the Rayleigh –Plesset equation, a shorter collapse time is obtained.*

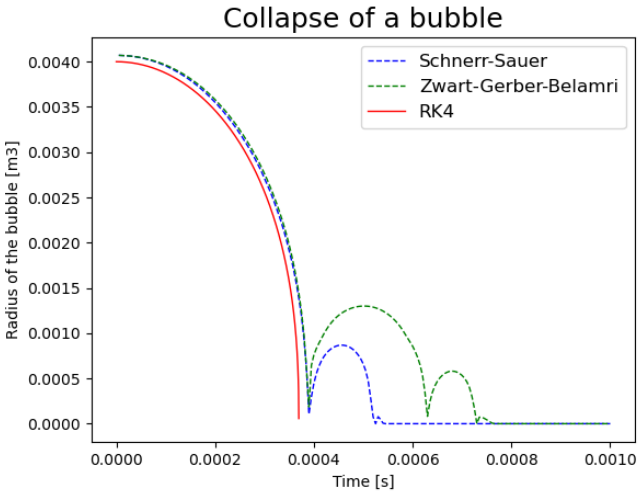

Figure 1: Simulation of the radius of a vapor bubble over time using 3 different methods

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FLOW DISTRIBUTION ANALYSIS IN A FLUIDIZED BED USING TFM-KTGF AND COUPLED CFD-DEM MODELS

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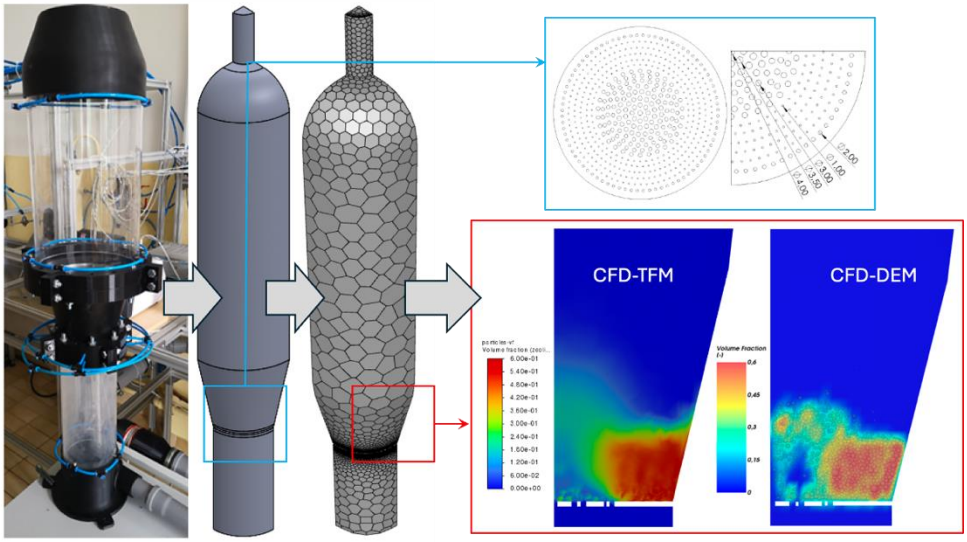
Keywords: Fluidized bed, Two Fluid Model, Kinetic Theory of Granular Flow, Discrete Element Method, Flow Distribution

ABSTRACT:
In fluidized bed systems, the distribution of the gas flow is an important factor for the efficiency of the process. The main objective of this study was to analyze the effects of the particles inside the laboratory size fluidized bed on the gas flow distribution using numerical simulations. Two of the most commonly used numerical models for simulating multiphase flows were used, namely the two-fluid model with additional kinetic theory of granular flow and the coupled CFD-DEM model. The flow distribution was simulated with the non-uniform gas distribution plate shown in Figure 1. Our numerical models were verified against the experimental results of Buijtenen et al. [1] for a fluidized bed with a spout.



Figures 1: Fluidized bed geometry, model and mesh with numerical results.

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PORTABLE INDENTATION SYSTEM FOR TESTING SOFT ELASTIC MATERIALS

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Keywords: indentation test/deep tonometry, large deformations, mechanical properties descriptors, soft elastic materials

ABSTRACT:
In the literature, it is possible to find numerous examples of testing soft flexible materials using indentation devices [1-3]. One of the first was a simple mechanical tonometer, while the alternatives were the indurometer and electronic digital tonometer, in which the measurement was limited only to reading a single, maximum force. The system discussed in this presentation is shown in Figure 1 and allows continuous observation of changes in the indentation force and depth. The same module mounted in the mobile holder can be useful in tissue studies. The indenter with a flat end penetrates the material to a depth of 10 mm, at a constant speed of 1 mm/s. At the same time, thanks to communication via the USB interface and specialized software with its own library, the full relaxation curve is recorded. Selecting data intervals using cursors allows determining several parameters characteristic for the tested material, the so-called descriptors.

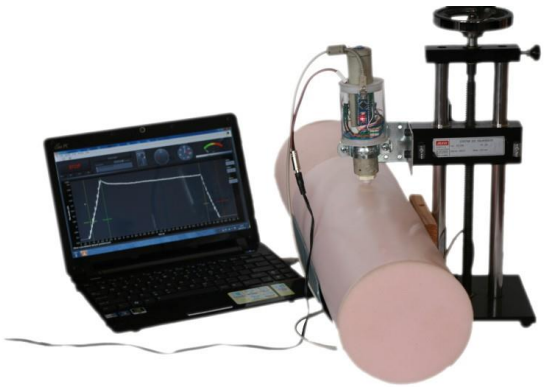

Figure 1: System for stationary tests on susceptible materials

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THE USE OF 3D PRINTING IN PROTOTYPING AND CITY AREA PLANNING

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Keywords: 3D printing, CJP, FDM, prototype buildings

ABSTRACT:
3D printing is known as 'additive manufacturing' i.e. a technology that involves creating three-dimensional objects by adding layers of material on top of each other. Currently, it is used in many areas, including: prototype production, medicine, aviation and cosmonautics[1]. In prototyping, 3D printing allows to significantly speed up the design process and reduce costs thanks to the possibility of early testing of different versions of the prototype. In planning urban infrastructure, 3D printing allows on production of realistic models of entire cities or individual elements, such as bridges, roads or housing estates. This makes a possibility to quickly modify projects later and adapt them to the changing needs of the city [2]. This work presents examples of the use of selected printing technologies (FDM and CJP) in prototyping and spatial planning.

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ANALYSIS OF LIFE CYCLE EMISSION OF SELECTED SUSTAINABLE AVIATION FUELS

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Keywords: LCA, life cycle assessment, emission, SAF, aviation

ABSTRACT:
Sustainable aviation fuel are one of the most promising mid-term solution to reduce GHG emission from aviation sector. This article focus on Life Cycle Assessment of sustainable aviation fuels and CORSIA eligible fuel and analyzes the life cycle emission factors of CORSIA eligible fuel harvest from CORSIA document, but also compare that values for HEFA with other studies [1,2]. Article shows the importance of Land Use Change factor in life cycle emission assessment, which can significantly change the final LCA value [3]. Results from the analyses are that the lowest life cycle emission factor has miscanthus from Fischer-Tropsch conversion process, which is equal to -22.5 gCO2e/MJ, but also from Alcohol to Jet conversion process, which is -10.7 gCO2e/MJ (ATJ based on isobutanol) and -6.8 gCO2e/MJ (ATJ based on ethanol). For HEFA, which is the most used SAF pathway, the lowest life cycle emission factor for CEF has jatropha oil and the value was 10.4 gCO2e/MJ. The results analyzed in the article show also how different life cycle emission factors for the same feedstock and the same pathway could be depending on the cultivation, transport and other stages of feedstock's life cycle.

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THE CERTIFICATION PROCESS OF INTERNAL COMBUSTION ENGINES FOR RAIL VEHICLES COMPARED TO REAL OPERATION

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Keywords: rail vehicles, internal combustion engines, approval tests, exhaust emission

ABSTRACT:
The railway is an important element in both European and Polish transport network. This type of transport, despite being the most energy efficiency among all types of transport, largely uses diesel combustion engines. High-power compression ignition engines are characterized by high exhaust emissions, including the problematic NOx and Particulate Matter. The paper presents, among others, current exhaust emission standards and approval tests required in the certification process of combustion engines for rail vehicles. The analysis concerned engine operating points during the real vehicle operation on the railway line and operating points in tests required in the certification process.

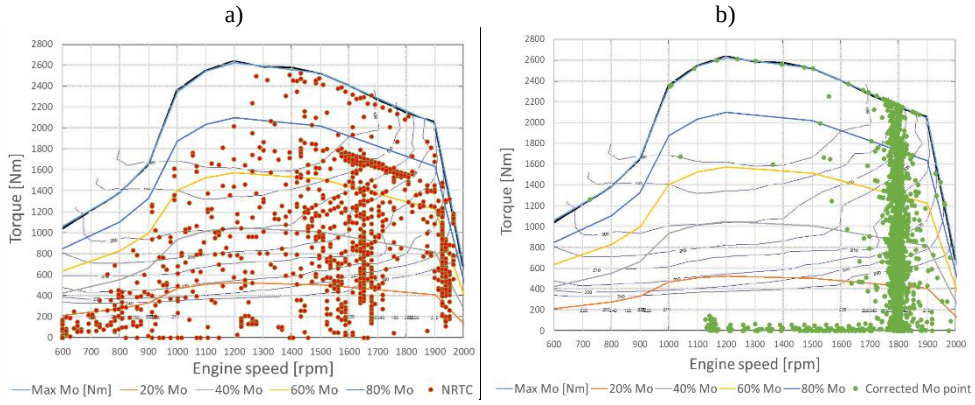

Figure 1: Engine characteristics with a) NRTC test, b) real engine operating conditions.

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NEURAL NETWORK MODELS FOR FLOW INDUCED DRAG ON PARTICLES IN STOKES FLOW

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Keywords: Stokes flow, particle-laden flow, boundary element method, neural networks

ABSTRACT:
In particle-laden flows, the particle drag force is dependent not only on flow regime, but also on the presence of nearby particles. This effect is important in creeping flow (Stokes flow) regime, Re << 1, where fluid viscous forces are dominant. Particle-laden Stokes flow was simulated using boundary element method (BEM) [1]*, to compute particle forces. The obtained results were used to train a neural network model, for particle force prediction. A total of 6000 particle-laden flow simulations, with varying particle volume fractions, were carried out for neural network training data acquisition. The particle volume fraction was accounted for as the actual distance between particles. Multiple neural network models were tested to evaluate neural network model parameters' influence on the accuracy of model prediction. The compared neural network model parameters include activation function, optimizer, and number of hidden layers. The combinations of neural network model parameters were tested for a wide range of artificial neuron quantities* [2].

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NUMERICAL MODELING OF FOURIER AND NON-FOURIER HEAT TRANSFER

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Keywords: numerical modeling, bioheat transfer, inverse problem, dynamic thermography, boundary element method

ABSTRACT:

Numerical modeling of bioheat transfer has proven itself in various medical fields as a powerful tool for predicting the thermal behavior of biological tissue [1]. Recently, the opinion has emerged that, considering the specific internal structure of the biological tissue, the equations containing the temporal lag between the heat flux and the temperature gradient somewhat better describe the actual behavior of bioheat transfer [2]. In this work, an algorithm based on the subdomain boundary element method for numerical simulation of heat transfer in biological tissue using Fourier and non-Fourier heat transfer is presented. The algorithm was also tested on various cases performed by other authors for validation. From the results, we conclude that the developed algorithm successfully solves both Fourier and non-Fourier heat transfer in biological tissue and we identify a significant difference between the two models, which depends on the relaxation time used.

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THE MOTION OF SOFT DEFORMABLE PARTICLES SUSPENDED IN DILUTE FLOWS

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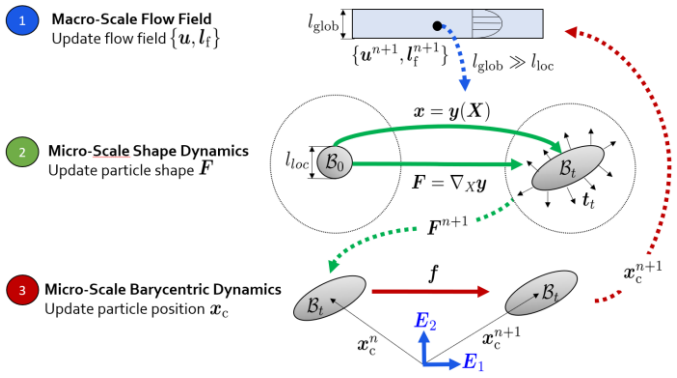
Keywords: soft particles; deformation; lagrangian particle tracking

ABSTRACT:
Particles in flows are ubiquitous. They range from airborne pollutants, which may originate from pollen, fibers and respiratory activities, to sludge flocs in wastewater treatment to drug carrier particles in the medical field. Therefore, understanding the translational and orientational dynamics of various particles is crucial for a large variety of applications. A common simplification is to assume rigid particles. However, there are particles, such as liquid capsules, vesicles, bacteria and biological cells, that can deform due to the action of the fluid flow, which significantly increases the complexity of particle tracking. In recent years, these soft particles have gained considerable importance in science, especially in the field of targeted drug delivery. However, research in this area is still sparse to date. In this talk, we will focus on our novel computational model for tracking soft, deformable, non-spherical particles in dilute fluid flows using the point-particle approach in combination with Lagrangian particle tracking. In this context, we assume affine deformation and creeping flow around the particle, [1]. The novel approach is validated in the limit of quasi-rigid particles as well as for soft deformable, initially spherical particles by using results available in the literature, [2], where we obtain excellent agreement. The model is further applied to simple flows, focusing on the influence of deformability on the particle trajectory.



Figures 1: Sketch of the novel approach for tracking soft deformable particles in flows.

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THE IMPORTANCE OF SAFETY CULTURE IN AN ORGANIZATION TRAINING PILOTS: BUILDING AWARENESS AND ENGAGEMENT

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Keywords: safety management system; aviation; safety culture; human factors

ABSTRACT:
Safety management system is essential component of the aviation industry, serving as the foundation for aviation operations. Through them, aviation organizations can mitigate risk, improve safety culture, and sustain their commitment to minimizing the probability of hazardous events. The research presents the significance of safety culture within an organization dedicated to pilot training, focusing on the cultivation of awareness and engagement. Safety culture plays a pivotal role in the aviation sector, particularly within institutions tasked with shaping the next generation of pilots. The research delves into various aspects of safety culture, including adherence to procedures, open communication channels, collaboration, and learning from mistakes. It discusses strategies and tools utilized to foster awareness and engagement among personnel, emphasizing the pivotal role of instructors as role models for safe behavior. Furthermore, it highlights the importance of promoting safety culture from the onset of pilot training and suggests direct engagement with stakeholders to better understand their needs and concerns. Through empirical research and industry best practices, it aims to provide a comprehensive overview of the significance of safety culture in organizations training pilots, advocating for continuous improvement in training processes to ensure the highest possible level of safety and efficiency of flights by future pilots.

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MEASUREMENT AND ANALYSIS OF THE ENERGY CONSUMPTION STRUCTURE OF AN FACTORY PRODUCING ALUMINIUM COMPONENTS FOR THE AUTOMOTIVE INDUSTRY

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Keywords: energy efficiency; manufacturing; digitalization; data analysis; carbon footprint

ABSTRACT:
The progressive global drive for continuous improvement of energy efficiency has influenced manufacturing companies to implement processes that enable precise forecasting of utility consumption and identification of potentials for improving energy efficiency. The project aims to implement the solutions developed during the course of the PhD into the practice of improving energy efficiency. improving energy efficiency.
Data was collected on the energy consumption of individual pieces of equipment in the aluminium components manufacturing plant for the automotive industry through the installation of metering equipment and network infrastructure.
By analysing the collected data, it is possible to draw conclusions about the current structure of energy consumption. This is a necessary step to plan and implement projects and activities to improve the energy efficiency of the processes taking place in the factory. This presentation outlines the measurement method, the data collected, the conclusions drawn, and proposed further actions to reduce energy consumption and the carbon footprint of the production facility.

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The concept of improving the onboarding process for glider training

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Keywords: onboarding, glider training

ABSTRACT:

The rise in the fuel prices has resulted in aviation courses becoming more expensive, leading to many pilots in general aviation foregoing additional training. This causes a decrease in their competences. Research indicates that the majority of accidents result from human error. The aim of this conducted study was to develop a procedure to enhance glider pilots' competences while minimizing the number of flights.
The first step of the research involved conducting interviews with experienced instructors and student pilots. They shared their expectations and highlighted the challenges that hinder training. Building upon this feedback, a new procedure was developed, tailored to meet their specific needs.
In order to evaluate the introduced procedure and new methods, research was conducted at the Aero Club. Since this club specializes in glider training for young people, the methods were adapted to generation Z. The training participants assessed the procedure using a survey. Additionally, the impact of the new methods on students and training was constantly monitored.
The research has shown that the implemented changes allowed for a reduction in the number of flights, training time, and costs, while simultaneously improving pilots' skills.

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CONCEPT OF CO_2 COOLING INSTALLATION WHICH USES A DOUBLE HEAT RECOVERY SYSTEM

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Keywords: cooling installation, refrigeration systems, heat recovery, CO_2,

ABSTRACT:
The subject of the article is the development of a concept for an ecological refrigeration installation using the refrigerant CO2. The presented installation will be equipped with two heat exchangers, one of them is intended to recover heat from the cooling installation and use it to produce hot water, while the second exchanger will be connected to a heat pump system whose task is to heat the facility. New solutions allow for minimizing the use of traditional fossil fuels, such as coal or natural gas, most often used to heat this type of facilities, while minimizing the carbon footprint. Safety standards when using pressure equipment were presented and analyzed. The development of such a concept was created in response to the needs of investors related to the operation of modern, environmentally friendly, high-pressure refrigeration installations.

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POTENTIAL FOR REDUCING AERODYNAMIC RESISTANCE IN ELECTRIC 2-WHEELED VEHICLES IN TERMS OF REDUCING THE ENERGY CONSUMPTION BY THE POWERTRAIN

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Keywords: aerodynamic resistance, drag reduction, motorcycle powertrain, CFD simulation, vehicle dynamics.

ABSTRACT:
This paper presents the analysis of the potential for reducing aerodynamic drag in electric twowheeled vehicles in the context of reduction the energy consumption of the powertrain system. The effect of the motorcycle's shape on the aerodynamic resistance generated, which in turn affected the increased energy intensity of the drive was discussed.
The CFD analysis involved several steps: geometric model, mesh generation, setup, and solver configuration. The boundary conditions included several parameters that were necessary for CFD simulation in the context of reducing aerodynamic resistance in electric two-wheelers: the velocity parameter and atmospheric pressure in open space, which significantly affected vehicle dynamics. The correct execution of each step enabled precise modeling of the airflow around the vehicle. It also facilitated the identification of potential areas of optimization to reduce aerodynamic resistance and energy consumption in the electric twowheeler's powertrain.
Another aspect discussed in the paper concerned preliminary analysis of the impact of two-wheeled vehicle's shape, which directly affected the energy intensity of the powertrain. The paper presents results of testing the energy intensity of the vehicle on a chassis dynamometer, where increasing energy consumption by increasing the load was simulated.
The work emphasizes the need to combine real-world testing with CFD simulation results to fully understand and use the potential for reducing aerodynamic resistance in electric two-wheeled vehicles.

EVALUATION OF THE CARGO WEIGHT IMPACT IN ALTERNATIVE DELIVERY VEHICLES ENERGY CONSUMPTION DURING REAL DRIVING CONDITIONS – GUIDELINES FOR ELECTRIFICATION OF THE URBAN TRANSPORT SECTOR

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Keywords: real driving conditions, on-board diagnostic, powertrains, electric motors, load impact

ABSTRACT:
Electromobility is developing rapidly in all areas of transportation, starting with small personal vehicles, passenger cars, public transportation vehicles as well as its expansion is noticeable in the area of urban transportation services. So far, however, there is a lack of research determining under real conditions how the effect of load weight defines the energy consumption of a vehicle especially in the areas of urban, suburban and highway driving. Therefore, the following research presents an analysis of a representative delivery vehicle and its energy consumption in two transportation scenarios where cargo weight was a variable value. The energy consumption evaluation of the electric vehicle was compared with tests of a conventionally diesel-powered vehicle. These tests make it possible to determine the advantages of each powertrain under specific operating conditions.
Analysis of the cargo weight of the electric delivery vehicle indicated, as predicted, an increase in the energy consumption of the powertrain system as the loading weight increased (a 19% increase in urban driving conditions). However, it was found in these research that also with an increase in load weight increases the amount of energy recovered - up to 35% more energy was recovered in urban conditions. The results of this research were used to develop guidelines for the electrification of commercial vehicle fleets. Providing less energy in the high-voltage battery during the initial phase of a delivery vehicle's journey, which will be characterized by a significant amount of braking, can reduce energy consumption. Future work will focus on quantitatively assessing the impact of varying loading weight over the course of a driving test to further map the actual operation of a delivery vehicle especially in courier services.

INTRODUCING AUXETIC BEHAVIOR TO SYNTACTIC FOAMS

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Keywords: auxetic cellular structures; syntactic foams; experimental testing; mechanical properties; Poisson's ratio

ABSTRACT:

This paper proposes an innovative multi-material approach for introducing auxetic behaviour to syntactic foams (SFs). By carefully designing the size, shape, and orientation of the SFs, auxetic deformation behaviour was induced. Re-entrant hexagon-shaped SF elements were fabricated using expanded perlite (EP) particles and a plaster of Paris slurry first. Then, an auxetic pattern of these SF elements was arranged within a stainless-steel casting box. The empty spaces between the SF elements were filled with molten alu minium alloy (A356) using the counter-gravity infiltration casting technique. The cast auxetic composite had a bulk density of 1.52 g/cm3. The cast composite was then compressed under quasi-static loading to characterise its deformation behaviour and to determine the mechanical properties, especially the Poisson's ratio. The cast composite deformation was auxetic with a Poisson's ratio of -1.04. Finite Element (FE) simulations were conducted to understand the deformation mechanism better and provide means for further optimisation of the geometry.

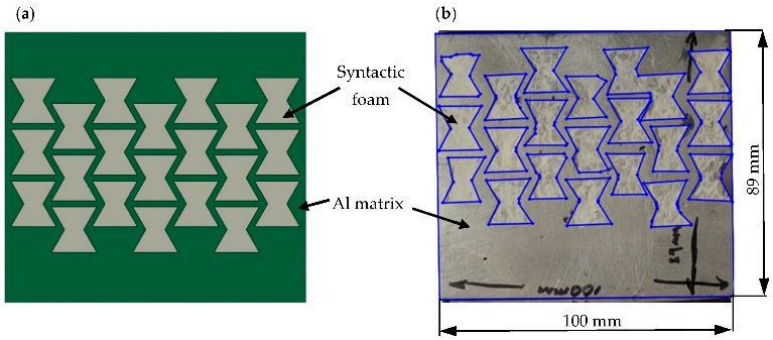

Figure 1: The geometry of the ideal (a) and fabricated (b) sample with marked (blue lines) actual sample geometry.