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PTNSS-2023-001

Potential of ethanol and butanol in reducing deposits of SIDI engine injectors

Ireneusz Pielecha, Zbigniew Stępień, Filip Szwajca

The operation of conventional (hydrocarbon) fuels causes certain effects in the internal combustion engine. Despite the satisfactory efficiency of internal combustion engines, their fuel systems, particularly the injectors, are subject to constant fouling. The article analyzes the possibility of reducing the deposit of high-pressure gasoline injectors using the alcohol addition of ethanol and butanol. The study was conducted under the engine and non-engine conditions. Fuel injection timing was analyzed when fueling with different mixtures, and non-engine analyses were conducted to determine changes affecting the injectors. The results indicate the possibility of reducing injector hole coking using ethanol and butanol as a 20% additive to the base fuel.

PTNSS-2023-002

Crankshaft geometry modification and strength simulations for a new design of diesel opposed-piston engine

Paweł Magryta, Konrad Pietrykowski

The article presents simulation strength calculations of a newly designed crankshaft for a PZL 100 engine with a reciprocating piston design. This engine is the subject of a research and development project co-financed by NCBiR. The article presents four successive versions of the crankshaft geometric changes, which were subjected to strength calculations. Within the framework of the successive geometric versions, such elements as the outer and inner parts of the crank arm were changed. The geometry of the shaft was changed using Catia v5 software, while strength calculations were carried out in Abaqus software. In summary, one of the presented models was selected for further work, due to the possible simplification of the fabrication process and the reduction of mass and stresses. This model was the subject of subsequent work in the project.

PTNSS-2023-003

Analysis of speed limit and energy consumption in electric vehicles

Mariusz Graba, Jarosław Mamala, Krzysztof Prażnowski, Patryk Stasiak, Jovan Mitrovic

This paper presents an analysis of the mileage energy consumption for an electric passenger vehicle in terms of the introduction of numerous speed limits. Regulations concerning the limiting of vehicle speed to 30 km/h in cities or residential areas are particularly common. This restriction is intended to increase traffic safety, but at the same time introduces increased mileage fuel or energy consumption in electric drive train. Regardless of the energy carrier, any increase in energy causes negative effects for the environment. The analysis was focused on the mileage energy consumption of electric passenger cars for a constant speed under real traffic conditions. During the tests, the tested vehicles' speed on a specially designated road section was changed gradually by 10 km/h, with simultaneous recording of the car's traction parameters and mileage energy consumption. An analysis of the mileage energy consumption was then carried out for the assumed fleet of cars travelling one after another (in a so-called traffic jam), while maintaining a safe distance. This allowed for the calculation of the environment's energy burden caused by a fleet of vehicles travelling on a given road section, indicating that a reduction in vehicle speed causes an increase in the vehicles' energy consumption. Both total and mileage energy consumption of electric vehicles were analysed during the tests

PTNSS-2023-004

Analysis of passenger car powertrain system measurements in road conditions

Jarosław Mamala, Krzysztof Prażnowski, Andrzej Bieniek, Andrzej Augustynowicz, Michał Szczepanek

The paper is focused on presenting a methodology for measuring power and torque based on diagnostic equipment available in most diagnostic workshops, such as OBD interfaces or the CAN Bus on-board data transmission network, under real-world road conditions. The publication presents an algorithm for calculating the drive unit's torque and power based on measurements of changes in vehicle speed or acceleration recording during a two-phase road test. The results presented, based on the method described, apply to both the internal combustion and electric vehicle. Common drive unit operating indices, such as maximum power, maximum torque and the drive unit's flexibility indices described in the literature are proposed for the final evaluation of the vehicle's traction system.

PTNSS-2023-005

Environmentally sustainable off-road vehicle for people with disabilities

Anna Janicka, Zbigniew Sroka, Adriana Włóka, Monika Magdziak-Tokłowicz, Maciej Zawiślak

Sustainable design of a complex object such as a self-driving vehicle requires the involvement of an interdisciplinary team of specialists whose task is not only to develop a safe and reliable structure, but also to minimize the negative impact of the vehicle on the environment at every stage of its existence. Ergonomics and specific boundary conditions must also be taken into account in the case of structures designed for people with disabilities. The article presents an assessment of the environmental impact of an off-road vehicle designed for people with disabilities at the design and operation stages of the powertrain. It also presents a method for assessing user exposure to harmful substances potentially emitted by the vehicle.

PTNSS-2023-006

Research on the effect of low-sulfur marine fuels on the dynamic characteristics of a CI engine

Zbigniew Korczewski

Significant tightening of the regulations of the International Maritime Organization limiting the amount of harmful, including toxic, chemical compounds emitted to the marine atmosphere in the exhaust gases of marine engines requires, among others, the application of low-sulphur, so-called modified marine fuels. Their implementation into operation requires prior laboratory engine tests to assess the energy, emission and structural effects of their usage. This type of research has been carried out for several years at the Marine Power Plant Department of the Gdańsk University of Technology on the test bed of a diesel engine as a small-scale physical model that reproduces the adequate design and process (parametric) features of a full-size marine engine. Their key stage is to determine the energy characteristics of the engine in the steady state of operation determined on the basis of the analysis of the developed indicator diagram and the dynamic characteristics of the transient processes from idling to the reference steady state of load – and vice versa. Particularly important diagnostic information on the energy quality of the tested type of fuel and its impact on functioning the injection apparatus is provided by the examination of the dynamic characteristics of the engine in the process of forcible load increase. In this way, the basic diagnostic parameters of the built ranking of the usable quality of the tested marine fuels are determined: the rate of pressure increase in the cylinder and the average deceleration of the engine crankshaft in the transient process. This article presents representative results of this type of research carried out on six different, low-sulphur marine fuels used to feed marine engines. The technology of measuring diagnostic parameters, as well as the measuring equipment used, have been also presented.

PTNSS-2023-007

Application of the F-statistic of the Fisher-Snedecor distribution to analyze the significance of the effect of changes in the injector opening pressure of a diesel engine on the specific enthalpy value of the exhaust gas flow

Patrycja Puzdrowska

This article discusses the effect of changes in injector opening pressure on the operating parameters of a diesel engine, including the temperature of the exhaust gas. A program of experimental research is described, considering the available test stand and measurement capabilities. The construction of the test stand on which the experimental measurements were realized is presented. The method of introducing real changes in injector opening pressure to the existing test engine was characterized. It was proposed to use the F statistic of the Fisher-Snedecor distribution to evaluate the significance of the effect of changes in injector opening pressure on the specific enthalpy of the exhaust gas stream. Statistical and qualitative analysis of the results obtained from the measurements was carried out. The specific enthalpy of the exhaust gas for one cycle of the diesel engine, determined from the course of quickly changing exhaust gas temperature, was analyzed. The results of these analyses are presented and the utilitarian application of this type of assessment in parametric diagnostics of diesel engines is discussed.

PTNSS-2023-008

Study on selected parameters of engine with the Active Combustion Chamber

Krzysztof Siczek, Michal Glogowski, Tomasz Szydlowski, Marek Wozniak

The present study was focused on the combustion engine with a variable compression ratio (VCR), namely the four-stroke air-cooled engine with the active combustion chamber (ACC). An indicated pressure, torque, power, and specific fuel consumption of that engine were investigated experimentally and using simulations. Experiments were conducted using two versions of an engine. Two parameters particularly influencing the ACC engine performance including the maximum compression ratio CRmax and the indicator γ_{fm} determining the correct operation of the ACC system, were described. It was found that the ACC engine allowed avoiding detonation combustion without changing the amount and composition of the combustible mixture, and even without delaying the ignition advance angle. In addition, the possible range of control of the combustion process allowed the ACC engine to operate with different types of hydrocarbon fuels, for example, in the form of petrol with various alcohol admixtures. The very intense flow of the combustible mixture inside the cylinder of the ACC engine allowed describing the combustion in the ACC engine with zero-dimensional mathematical models with the dual Vibe function providing the proper characterization of the heat release process. The use of very high maximum compression ratios allows the ACC engine to operate to a certain extent as a Homogeneous Charge Compression Ignition (HCCI) engine with high lambda coefficients.

PTNSS-2023-009

Evaluation of the energy consumption of conventional (CI) and alternative (EV) delivery vehicles in real traffic conditions

Wojciech Cieślik, Natalia Szymlet, Weronika Antczak, Mateusz Nowak

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 intensity of a vehicle especially in the areas of urban, suburban and highway driving. Therefore, the following paper 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.

PTNSS-2023-010

Assessment of the impact of electrification of the fleet of public transport buses on air quality on selected area in Wroclaw

Maria Skrętowicz, Aleksandra Herok

In the paper the assessment of the impact of electrification of the fleet of public transport buses on air quality will be presented. The study was carried out on the selected area in Wroclaw, based on real fleet and traffic data. In analysis were used a specialized tools and models such as emission factors database, emission and dispersion models, GIS system, etc. The results of analysis will show if fleet replacement realized in the range determined by the electromobility act would be sufficient to improve air quality in the city.

PTNSS-2023-011

Research of pollutant emissions from automotive internal combustion engines in conditions corresponding to the actual use of vehicles

Monika Andrych-Zalewska

The subject of the article is the study of pollutant emissions from automotive combustion engines that operate in conditions corresponding to the actual use of vehicles. The work includes information on the properties of exhaust gas parameters characterizing the following features: energy, economic, environmental impact and serviceability, additional and constant. Among these properties, emission was distinguished as the subject of the article. The influence of the operating states of the internal combustion engine on pollutant emission was analyzed. The operating states of the internal combustion engine include rotational speed, the charge of the engine, and its thermal state. In turn, the thermal state is characterized by the thermal state parameter, i.e. usually the temperature of the operating medium: engine oil or engine cooling liquid. Emissions can be affected by both static and dynamic exhaust emission operating states. For the automotive exhaust gas system, the process of vehicle speed determines the operating state of the engine. The article presents the systematics of creating driving tests on the basis of: faithful simulation in the time domain and the synthesis of the arbitrarily adopted zero-dimensional characteristics of the vehicle speed process. Examples of driving tests created in accordance with the presented system of both homologation and special tests that are used. The article presents the results of research on pollutant emissions from a passenger car during the RDE test. The emission of carbon monoxide, hydrocarbons, nitrogen oxides, particulate matter and carbon dioxide, as well as the number of particulate matter, were examined. The process of pollutant emission intensity and particle number intensity was presented. Tests were carried out on the statistical properties of the car speed, the intensity of pollutant emissions, and the intensity of the number of particulate matter. Correlation studies were carried out on the speed of the vehicle, the intensity of pollutant emissions, and the intensity of the number of particulate matter.

PTNSS-2023-012

Combustion stability for early and late direct hydrogen injection in a dual fuel diesel engine

Ksenia Siadkowska

The paper presents an analysis of the experimental results of direct hydrogen injection in a dual-fuel diesel engine. The test object is a four-cylinder, four-stroke ADCR engine. An analysis of the following parameters was carried out: indicated mean effective pressure, peak pressure, angle of maximum pressure and released heat. Statistical analysis of the obtained results was carried out for each cylinder separately for four different hydrogen doses. Both early and late direct hydrogen injection were analyzed. The significance of the differences for each of the analyzed parameters and type of injection was determined. The stability of the combustion process was evaluated using the coefficient of variation CoV(IMEP).

PTNSS-2023-013

Fuel systems of high power stationary engines

Zbigniew Kneba

The use of alternative fuels and, in the future, synthetic fuels has forced changes in the design of fuel supply systems in internal combustion engines. When operating a stationary engine at constant load, the possibility of using lean fuel mixtures appears. Selection of a precisely operating mixture ignition system requires changes in traditional fuel systems. The article presents the current designs of fuel supply systems and their properties. Attention was paid to operating parameters resulting in acceptable emissions of toxic exhaust gas components.

PTNSS-2023-014

Analysis of the potential of electro-waste as a source of hydrogen to power low-emission vehicle powertrains

Mateusz Wesołowski, Mohamad Hamid, Piotr Mońka, Anna Janicka

The decarbonisation of transport is one of the key aspects in the context of environmental protection. These emissions are particularly noticeable in highly urbanised areas, where the possibility of dispersal of harmful substances is much lower. A way to improve emission factors is the introduction of hydrogen vehicles. Burning hydrogen in engines significantly reduces emissions of harmful substances into the atmosphere compared to the combustion of conventional fuels used today. Hydrogen can be obtained by gasifying waste in a steam atmosphere. Electronic waste is a special type of waste characterised by a high degree of commingling, which makes it difficult to treat. The volume of this type of waste is increasing year on year. As a result of this process, we are able to obtain syngas. This gas, after separation processes, can be a source of hydrogen, an energy carrier that could prove crucial in low-carbon energy or transport applications. This paper presents the results of the gasification of electronic waste, the composition of the syngas obtained in the process and an assessment of the potential of this waste treatment technology to power means of transport.

PTNSS-2023-015

The research of the locomotive internal combustion engine

Andrzej Kaźmierczak

This paper describes the part of a larger programme to reduce wear the set working parts (piston, piston ring, and bearing surface). The project is implemented through the development of new designs of piston rings with anti-wear coating that contains synthetic diamond in the form of loose embedded in a coating of chromium (PRC). The main purpose of the coating is to reduce ring wear while maintaining or reducing wear of the cylinder sleeve. The application for this part of the research is the EMD 645 engine. The engine used in this study was manufactured by the Electro-Motive Division of General Motors Corporation (EMD). It is popular for locomotive applications in North America, as well as in marine, industrial, and power generation applications.

PTNSS-2023-017

Efficiency optimization of a vehicle combustion engine by the adjustment of the spark advance angle

Adam Kamiński, Konrad Krakowian, Mateusz Kupski, Maria Skrętowicz

Changing the ignition advance angle has a significant impact on the performance of a combustion engine. Optimization of ignition advance angle is a major task of adjusting engine concerning emission standards, fuel consumption, torque value, etc. The results of the research showed that the process of optimizing ignition advance curve can noticeably increase engine efficiency, as well as torque and power output from the engine, while reducing fuel consumption as a result of lower indications of the air flow mass per second from MAF sensor (mass air flow sensor). The highest impact of the ignition advanced angle modifications can be seen in the area of the highest volumetric efficiency of the tested combustion engine. Almost no impact is observed within high engine speed levels. Simultaneously increasing engine load and rotation speed increases the possibility of engine knocking, which has devastating effect on engine durability.

PTNSS-2023-018

Evaluation of the influence of electrochemical hydrogen penetration on the properties and microstructure of austenitic steel

Małgorzata Rutkowska-Gorczyca, Mateusz Dziubek, Marcin Wiśniewski

The subject of hydrogen embrittlement seems to be more and more up-to-date and needed to be explored. World research teams working on this issue have not developed a clear method of preventing this process. The conclusion is that this issue should be approached individually, depending on the type of material, its structure and operating conditions. The problem will escalate in the near future as a result of the planned replacement of the traditional energy sources used so far with hydrogen energy. The paper presents the method of electrochemical hydrogenation, which reflects the conditions of galvanic coating of metallic materials used in the automotive industry. The aim of the research was to determine the influence of the time of hydrogenation on the properties and microstructure of austenitic steel.

PTNSS-2023-019

Market positioning of internal combustion engines and battery electric motors

Aleksandra Kęska, Mateusz Dziubek, Dawid Michalik

In order to examine the current market situation of combustion and battery electric engines in vehicles and to determine the type of strategy for the development of the automotive market, a SWOT analysis was carried out. Internal strengths and weaknesses as well as external opportunities and threats on the market of internal combustion and electric vehicles were assessed. The most important areas of their operation have been designated. A weighting system and a rating scale were selected. The results of the analysis showed that combustion vehicles belong to a conservative market area which promotes the designs that have been thriving for years and maximizes their advantages. Battery electric vehicles belong to an aggressive market area, with the strategy based on a quick response to consumer needs, allowing for the maximization of profits while maintaining innovation. The future of the transport sector will be determined by the focus on the promotion of ecological transport elements.

PTNSS-2023-020

The economic aspects of vehicle operation in the context of electromobility strategies

Mateusz Dziubek, Aleksandra Kęska, Dawid Michalik

The transformation of the automotive industry towards electromobility is a key step in achieving a sustainable transportation system. To analyze the economic feasibility of electric vehicles (EVs) compared to internal combustion engine vehicles (ICEs), this study assessed the operating costs of both types of vehicles, including fueling and charging costs on a selected theoretical route. The analysis of economic aspects also examined the development of fueling and charging infrastructure and the impact of government programs promoting electromobility. The study employs a comparative analysis of ICE and EV based on fuel and electricity prices, insurance costs, and servicing expenses. The results of the analysis indicate that adopting EVs can lead to significant economic benefits, especially when coupled with government incentives and well-developed charging infrastructure. The network of charging stations and fuel infrastructure serves as an indicator of the market conditions for vehicles equipped with either internal combustion engines or electric powertrains, and forecasts help anticipate their future directions. The decreased pace of new petrol stations being established may indicate a weakening market for internal combustion engine vehicles compared to previous periods. This study highlights the economic aspects of electromobility strategies aimed at accelerating the transition towards a sustainable transportation system.

PTNSS-2023-021

Combustion of LPG / DME gas mixtures in an SI engine with correction of the ignition advance angle

Grzegorz Kubica

The paper presents the results of tests on a SI engine fueled with an LPG/DME blends of various composition. A number of experimental studies and calculations using a mathematical model were carried out to examine the suitability of this fuel. These tests allowed for the analysis of the changes taking place in the combustion process and the assessment of the main operating parameters of the engine. The results of the analysis of the combustion process make it possible to observe how the heat is released and how the indicated pressure changes, depending on the share of DME in the fuel mixture. The scope of the tests performed included engine and vehicle tests on a chassis dynamometer and a series of simulation tests conducted on the basis of the obtained results. The engine was powered by an LPG/DME fuel mixture with different proportions of components. The share of DME ranged from 0% to 30% of the fuel mass. The obtained results reflect the operation of the engine in the full load range and selected rotational speeds. Measurement series were made for different settings of the ignition advance angle. Based on the obtained results, a corrected map of the ignition advance angle was developed. The obtained results confirm the usefulness of using the LPG/DME mixture to power the SI engine.

PTNSS-2023-023

Problems with cooling fluid – a review

Marek Wozniak, Maciej Kuchar, Tomasz Szydlowski, Mateusz Szymczyk, Gustavo Ozuna, Lukasz Stajuda, Dmytro Levchenko, Grzegorz Boguslawski, Przemyslaw Kubiak, Kamil Siczek, Krzysztof Siczek

Vehicle coolant is one of the most important operating fluids. Along with changes in the design of engines, the composition of the coolant has also changed. The main function of the coolant is heat transfer. It absorbs up to one-third of the heat energy generated by the engine. The coolant is also responsible for protecting the cooling system from damage caused by corrosion, scaling and deposits. The unfavorable working environment of the engine is also affected by smaller capacities of the cooling systems of the drive units, extreme temperatures and increased pressure in the cooling system, which is why the composition of the fluid is very important. The coolant must be replaced every three years or 100,000 kilometers or every five years or 250,000 kilometers with OAT technology. It is worth remembering that coolant of unknown composition or low quality used for a long time can expose the system to engine overheating, corrosion, deposits and restriction of liquid flow. This can lead to engine failure, in extreme cases even engine seizure. Currently, there are many types of fluids, including nanocoolants with different compositions, that are available on the cooling market. The article presents these fluids, describe the most common failures of cooling systems, present the currently used methods of fluid replacement in the engine and proposes an innovative method based on the pressure method, which allows both replacing the fluid in the entire system and cleaning it.

PTNSS-2023-024

Analysis of the fuel spray atomized structure with marine Diesel engine injector in the early stage of injection

Joanna Grochowalska, Piotr Jaworski, Łukasz Jan Kapusta

One of the main issues influencing the combustion process in the cylinder of the marine Diesel engine is the process injection and atomization of the fuel spray. The fuel injected from one hole of the fuel injector in the marine Diesel engine cylinder, creates fuel spray with characteristic conical shape. The formation of atomization fuel spray in the cylinder is described with the parameters of the macrostructure: spray tip penetration and spray cone angle. The macrostructure parameters of the fuel spray determine the shape and area occupied by the fuel into the cylinder. Knowledge of these parameters may be a key information to conduct further optimization of the combustion process in marine Diesel engines. This article presents the experimental research results of the fuel spray atomized with the marine Diesel engine injector in the constant volume chamber. The specificity of the phenomena occurring in the marine engine cylinder was the reason to use the optical visualization method in the studies. A measurement technique Mie scattering was used to register the diesel oil injection. Fuel injection was realized with the marine injector through the common rail system. The fuel pressure in installation is about 50 MPa. In this work presented an analysis of the influence of different hole outlet injector geometry, the opened pressures and the backpressures into constant volume chamber on the macrostructure of diesel oil spray. In the results it was observed that the change of hole outlet injector geometry influenced the macro parameters of diesel oil spray in the early stage of injection. Furthermore, in the analysis of macro parameters taken into consideration the changes in pressure of fuel in installation. It should be mentioned that the fuel pressure in installation was measured before the fuel injector.

PTNSS-2023-025

Evaluation of the energy efficiency of electric vehicle drivetrains under urban operating conditions

Jacek Kropiwnicki, Tomasz Gawłas

In electric vehicles, as in hybrids vehicles, a very important factor affecting the energy efficiency of the powertrain is the ability to use the regenerative braking energy. Depending on the settings available in electric vehicles, the driver can choose different modes of operation: switch off the regenerative braking mode altogether, select the intensity of regenerative braking, or leave the control system in automatic mode. The last mode is often the only one available on eclectic vehicles, so the driver cannot decide whether to switch off or increase intensity of the regenerative braking. This paper presents a new method for evaluating the energy efficiency of electric vehicle powertrains under urban operating conditions. The presented method uses a procedure for mapping the operating conditions allowing to determine the reference level of energy consumption in relation to those recorded during the identification tests. Identification tests were carried out in the Tri-City area using electric vehicles of different purposes and operating parameters.

PTNSS-2023-026

Energy expenditure optimization in electric urban service vehicles

Mariusz Izdebski, Marianna Jacyna

The article deals with the problem of estimating the energy expenditure of low-emission cars (electric cars) in urban service companies. One of the most critical problems of today's transport policy of many city authorities is the ecological safety of its inhabitants. The primary measures aim to ban high-emission vehicles from city centres and promote the introduction of zero-emission vehicles, such as electric or hybrid cars. The authors proposed an original approach to the vehicle routing problem in urban service companies, in which the energy expenditure of electric vehicles was defined as a criterion function of the optimization model. The boundary conditions considered limitations typical of an electric car, e.g., maximum range or battery charging time. The authors proposed an efficient hybrid algorithm based on the ant colony and genetic algorithm to solve the routing problem. The verification was made for the example of a utility company serving a medium-sized city in eastern Poland.

PTNSS-2023-027

Comparative analysis of emissions of electric and internal combustion vehicles

Maciej Gis, Piotr Wiśniowski, Anna Borucka

Global cumulative sales of zero-emission passenger cars reached 19 million units. This is almost three times more than in 2020 (6.8 million units). In Europe, the passenger fleet of BEVs and FCEVs has 4.6 million units - twice as much as two years earlier. In Poland, at the end of February 2023, there were 66,685 electric passenger cars on Polish roads. Fully electric vehicles (BEVs) accounted for 33,902 units of this part of the fleet (51%), and the rest were plug-in hybrid electric vehicles (PHEVs) – 32,783 units (49%). The increasing number of electric vehicles and the approved vote of the European Council on reducing CO2 emissions by 100% by 2035 indicates the need for better recognition in terms of energy consumption and comparing these results to the fuel consumption of conventional vehicles. For this reason, a number of vehicles were compared in real traffic conditions and a comparative analysis was made between conventional and electric drives in terms of fuel and energy consumption and life cycle emissions, taking into account the current national energy mix. The conducted analyzes showed the level in which electric vehicles have an impact on the environment in comparison to cars powered by conventional drives. In the era of drive transformation, it is necessary to determine the benefits of switching to electric vehicles and what can be done to minimize their impact on the environment. In addition, proposals for changes were made to accelerate the pursuit of climate neutrality.

PTNSS-2023-028

Study of lubricating properties of modified base oil operating by preparations with a chemical effect in terms of lubrication of internal combustion engines

Albert Lewandowski, Władysław Papacz

The article presents the results of research on the lubricating properties of the SN-150 base oil modified with CERAMO, CERATEC, MOLIBDENUM and TURBO operating agent with chemical action. The tests were performed on the T-02 four-ball apparatus in accordance to PN-76/C-04147, ASTM D 2783, D 2596, D 4172, D 2266. The following indexes of lubricating properties were determined: welding load P_z, seizing load Pt, maximum non-seizing load P_n, wear index under load I_h and limit wear load G_{oz}. The obtained test results confirm the assumptions in line with the authors' earlier research on another exploitation agent with a chemical effect, MotorLife Professional. The tests showed that the operating preparations with a chemical effect, accepted for testing and added to the SN-150 base oil, improved its anti-wear and anti-seize properties. The obtained results confirmed a significant increase in wear resistance, especially when using the preparation called TURBO. According to the authors, modification of engine oils with operating agents may be beneficial in difficult working conditions, e.g. overloads, frequent starts and load changes, work in a polluted environment (e.g. transport of ores and spoils, mining machines, construction machines and devices, marine engines). In the case of internal combustion engines, operating preparations will protect the engine from seizing in the event of lack of lubrication.

PTNSS-2023-029

Evaluation of the impact of supplying a marine diesel engine with a mixture of diesel oil and n-butanol on its efficiency and emission of toxic compounds

Paweł Socik, Marcin Zacharewicz, Ryszard Zadrąg, Artur Bogdanowicz, Paweł Wirkowski

The article presents the results of research on the impact of feeding marine reciprocating internal combustion engines with blends of diesel fuel and n-butanol on their performance parameters. The study includes a research plan and empirical results, in which the engine efficiency and emissions of harmful compounds in the exhaust gases were determined. A promising aspect is also the decrease in the concentration of NO_x, which has a positive impact on reducing the toxicity of exhaust gases. An important aspect of the passive defence of a vessel is the reduction of exhaust gas temperature under nominal loads.

PTNSS-2023-030

Evaluation of the thermal state of a marine diesel engine on its efficiency

Marcin Zacharewicz, Ryszard Zadrąg, Paweł Socik, Artur Bogdanowicz, Paweł Wirkowski

The paper presents the results of model and empirical research on the influence of the thermal state of a diesel engine (oil temperature) on its indicated (thermal) efficiency. The paper contains a test plan including a description of the test object, test equipment and measurement points on a real object. In the following part, the results of tests carried out on a real object (laboratory single-cylinder engine) and the results of model tests obtained on the original engine model are presented. The results are presented both in tabular and graphical form. The obtained test results allowed to determine the relative value of the influence of the engine's thermal state on its efficiency for various operating conditions (load and rotational speed).

PTNSS-2023-031

PESTEL macroscopic analysis of the rightsizing concept for motor vehicle drives

Zbigniew Sroka

The PESTEL analysis, commonly used in management, enabling the assessment of the development trends of the organization, this time was referred to one of the development trends of motor vehicle drives, which is rightsizing. The manuscript collects and systematizes political, economic, social and legal indicators, but above all technological and environmental indicators related to the development of the concept of rightsizing the drive of a motor vehicle. The conducted studies made it possible to make time-different predictions of changes taking place in the automotive environment, indicating the directions of development of the standard internal combustion drive and the alternative hybrid drive. The strengths and weaknesses of the alternative drive were demonstrated, taking into account the threats and development opportunities of alternative drives.

PTNSS-2023-032

Characteristics of filling in a spark-ignition engine in terms of rightsizing concept

Zbigniew Sroka, Monika Magdziak-Tokłowicz, Mateusz Gandyk

The downsizing of the internal combustion engine, which has been in operation for many years, has been transformed in favor of the technological concept of rightsizing. It assumes that the engine is adjusted in terms of displacement change to a specific load style, resulting from the vehicle model or version. This means the ability to both reduce and increase engine displacement with all structural and functional upgrades to reduce fuel consumption, meet environmental legislation and satisfy the user. The manuscript defines the basic phenomena shaping the filling characteristics of the engines, and on this basis, a series of bench tests with the use of a real engine and model tests with the use of computational systems were carried out. Among other things, the boost pressure and flow resistance were considered. Based on the conducted studies and tests, various dependencies have been shown. One of them is the dependence of changes in the temperature of the charged air along with the degree of rightsizing, which reduces the useful efficiency of the engine. Another indicated issue is the statement that the rightsizing engines, due to the fact that they have short intake manifold ducts, do not fully use the possibilities of dynamic supercharging. An important identification of the research is the fact that the pressure drop of the flowing air due to flow resistance in engines after rightsizing is significantly greater than in naturally aspirated engines. However, it has been noted that the relative reduction in filling ratio is less for rightsizing engines. The end result of the research is the development of a method for shaping the relationship between the filling efficiency and engine rotational speed in the conditions of changing the displacement volume.

PTNSS-2023-033

Experimental verification of changes in the control software of a diesel engine operation for fuel consumption

Zbigniew Sroka, Monika Magdziak-Tokłowicz, Rafał Heda

Improving the internal combustion engine in order to increase its useful efficiency is a reflection of broadly understood energy constraints, which are, among others, the basis for modifying means of transport towards hybrid drives. For many years, ecology has been the dominant feature of the development of internal combustion engines. The introduction of pollution standards by exhaust gases has contributed to the creation of many technical solutions that are linked together by the control system. The paper describes an experiment related to the introduction of changes in the control software of a supercharged diesel engine in order to reduce fuel consumption as a measure of useful efficiency. The software map that shapes the torque in the range of low and medium engine speeds has been modified. The size of the fuel dose for a rotational speed at maximum engine load was changed and the boost pressure was increased. Modification of the supercharger was possible thanks to the variable geometry turbocharger. The control software also contains maps in which the permissible ratio of fuel and air to engine load and rotational speed as well as the maximum fuel dose for a given air mass flow and boost pressure are specified. But none of these maps have been modified as the engine is equipped with a diesel particulate filter, which would mean faster filter fouling, resulting in more frequent self-regenerations, and thus, most likely, premature wear. A vehicle meeting the EURO 5 standard from the 13–14 age group – typical for the automotive market in Poland – was selected for the experiment. The experiment was carried out on a chassis dynamometer (according to the NEDC test – characteristic for this group of vehicles) and in road traffic conditions. The average fuel consumption is 0.4 liters per 100 km lower than the factory target. The currently produced vehicles are subjected to the RDE and WLTP tests, which ensures that the results are closer to reality, therefore, in the near future, it is planned to repeat the experiment with a modern vehicle using PEMS measuring equipment.

PTNSS-2023-034

Analysis of harmful compounds concentrations in the exhaust behind a vehicle with compression ignition engine

Michalina Kamińska, Natalia Szymlet, Piotr Lijewski, Paweł Fuć, Łukasz Rymaniak, Rafał Grzeszczyk

The article presents issues related to the assessment of concentrations of harmful substances in the exhaust gas cloud behind a compression-ignition passenger vehicle. The introduction discusses the subject of optical measurement methods and refers to Lambert Beer\'s law describing the phenomenon of absorption of electromagnetic radiation when passing through a partially absorbing and scattering medium. The vehicle used during the tests was characterized by a four-cylinder drive unit with a maximum power of 110 kW at 4000 rpm and a maximum torque of 320 Nm at 2000 rpm. The vehicle was type-approved in accordance with the Euro 4 standard. Exhaust gas dispersion tests behind the vehicle were carried out both in stationary conditions (a specially prepared laboratory stand) and in real operating conditions. PEMS testing equipment was used for this type of measurements. During the measurements, concentrations of harmful exhaust gas compounds were analyzed in relation to the distance of the measuring probe from the exhaust system. In stationary conditions, the influence of the engine speed on the dispersion of pollutants was also studied. The tests carried out show that the concentrations obtained behind a moving vehicle significantly decrease with the distance of the measuring probe, and their dispersion in most cases is much smaller than in the case of stationary tests. This is the basis for recognizing that thanks to this, it is possible to analyze the concentrations obtained and conduct tests using the emission gate.

PTNSS-2023-035

Evaluation of a pressure sensing glow plug in terms of its application possibility to control the combustion process of a hydrogen-powered spark-ignition engine

Marcin Noga, Tomasz Andrzej Moskal

The article contains the results of an analysis of the suitability of a pressure sensing glow plug for use in a hydrogen engine control system. Due to the properties of hydrogen, the process of its combustion in spark-ignition engines is significantly different from the classic fuels. It is planned to use the pressure sensor signal to control the combustion process to obtain high power and efficiency, with the lowest possible emission of nitrogen oxides, which is the main harmful component of hydrogen engines. After an initial assessment of suitability, it was decided to use a pressure sensing glow plug. This choice is dictated by the low price, good availability and high durability of these sensors. The preliminary tests were carried out using a low-power single-cylinder SI engine coupled with a 48V generator. The tests were carried out for several values of engine speed and load of the generator and for classic gasoline with a research octane number (RON) of 95. In order to obtain an increased pressure rise rate in the cylinder, as for hydrogen fueling, the engine operation was also tested with unmodified light gasoline used as solvent, which is characterized by a significantly lower RON value. The use of a reference pressure sensor in the cylinder made it possible to determine the behavior of the PSG in various operating conditions. The tests revealed that the differences in the pressure waveforms registered with both sensors can be systematized depending on the engine speed and its load.

PTNSS-2023-036

Research and analysis of the operation of vehicles with various propulsion systems, including costs and CO_2 emissions

Michał Lasota, Aleksandra Zabielska, Marianna Jacyna, Jolanta Żak

The rationale for banning internal combustion vehicles in major cities in Europe, or worse, phasing them out altogether, is prompting companies to think about changing their fleets to greener ones.

The purpose of this article is a comparative analysis of the operation of commercial vehicles, depending on the type of propulsion used on a given section of the route. The introduction to the topic is an introduction to the general problem of road transport using internal combustion engines and their alternative counterparts, which have a more favorable impact on the environment. A comparison was made between a diesel-powered vehicle and an electric vehicle in terms of the cost of tolls, fuel consumption, environmental fees, and service costs of the selected means of transportation. The study was carried out based on a selected domestic transport relationship.

Based on the analysis, it can be pointed out that both diesel and electric vehicles have numerous characteristics, which are determined by the individual preferences and needs of buyers.

In conclusion, the use of electric and internal combustion vehicles has various consequences that affect the environment, health, economy, and lifestyle. An important element during the organization of road transport, using electric vehicles is meticulous planning of routes according to the adopted schedule, which is based on the location of available charging points and adjustment. On the other hand, transportation using internal combustion means of transport generates numerous environmental problems and inconveniences due to excessive noise emissions..

PTNSS-2023-037

Evaluation of performance parameters of an engine fueled with LPG-DME mixture

Paweł Fabiś

The study aims to approximate the assessment of parameters in connection with the use of various fuels supplying the internal combustion engine. The article presents the influence of gaseous fuels being mixtures of LPG and BioDME on vehicle flexibility for various engine load values. Previous studies have not paid much attention to the problem of changing vehicle performance when using different fuels to power the engine. This is a new approach that allows to determine the advantages and disadvantages of using alternative fuels, including mixtures using BioDME. In the work, tests were carried out for a four-cylinder SI engine with a displacement of 1.6 dm^3, installed in an OPEL vehicle. The mixture of LPG and DME was evaluated and the results were compared to the parameters obtained for an LPG-powered engine.

PTNSS-2023-038

Dynamic parameters of a car with a SI engine fueled with LPG/DME blends

Grzegorz Kubica, Paweł Marzec

The paper presents an analysis of the dynamic parameters of a compact class passenger car powered by LPG/DME blends. The presented results are part of the research cycle of this vehicle, the purpose of which was to check the possibility of using DME (dimethyl ether) as an additive in the fuel mixture with LPG. In the presented part of the experimental research, the acceleration times of the vehicle under specific conditions were measured. Two series of tests were carried out: • Acceleration from 40 to 70 km/h in 3rd gear, • Acceleration from 60 to 90 km/h in 4th gear. Each series included 48 measurements; for eight fuels with different DME content and six engine load levels. The fuels used for the tests contained from 0% (LPG only) to 30% DME. The proportions of fuel components were determined by the gravimetric method. The selected engine load stages: 21%, 33%, 48%, 69%, 90% and 100% correspond to the position of the accelerator pedal and are determined by the TPS signal. The experiment was carried out on a chassis dynamometer, using the mode with simulation of road conditions. This ensured repeatability of conditions for all measurements. On the basis of the obtained results, the relations between the average acceleration in the tested speed ranges, the fuel composition and the degree of engine load were developed. The results of the analyzes indicate that in the examined range of changes in the DME share in the fuel, comparable or higher acceleration values were obtained for all engine load levels. This confirms the usefulness of DME as a fuel component used to power SI engines.

PTNSS-2023-039

Modelling the dynamics of changes in CO_2 emissions from Polish road transport and the requirements for decarbonisation

Anna Borucka, Edward Kozłowski

Emissions from transport account for 20–25% of global carbon dioxide emissions, of which 71.7% are from the road transport, but taking into account the production of cars and the construction of road infrastructure, this number increases to 37% of all emissions. Transport uses 30% of the world\'s energy. Although only 7% of the population owns cars, this translates into 40% of the world\'s petrol production. Cars are considered the most polluting means of transport. They are also the largest emitter of toxic chemical compounds not subject to legal regulation, such as butadiene, benzene and others. The area necessary to build a road (30 to 40 m on average) is much larger than the requirements for railway traction (10 to 14 m). The share of Polish road transport in the total emissions of the European Union is significant. Poland has been occupying leading positions for years. Moreover, due to the intensive increase in passenger and transport activity, CO2 emissions are constantly growing, increasing in 2020 by almost 150% compared to 2000, while emissions throughout the EU remain relatively constant. Therefore, the transport sector is a challenge on the way to achieving climate neutrality, related to the reduction of greenhouse gases emissions, which is the result of the European climate policy. Currently, the European Parliament requires a 40% reduction in greenhouse gas emissions by EU countries by the 2030, compared to the level of 2005. Therefore, the article analyses the current dynamics of changes in CO_2 emissions from road transport, including various types of transport means. Mathematical identification of the examined time series and determination of the forecast was aimed at relating the current level of CO_2 emissions to the requirements imposed by the EU in this regard.

PTNSS-2023-040

Comparative analysis of a conceptual hybrid propelled light sports aircraft performance against piston powered versions

Michał Kuźniar, Maciej Kalwara, Kamil Kucharski

A continuously increasing number aircraft designs equipped with hybrid propulsion is appearing on the aviation market. Depending on the degree of hybridization, the aircraft\'s performance – the range and endurance in particular, may improve, reducing total fuel consumption simultaneously. The emissions of harmful and toxic compounds into the atmosphere may reduced as well. The paper presents an analysis of the utilization of a parallel hybrid propulsion of low degree of hybridization. The research object adopted for the calculations is the Artus Lighter Light Sports Aircraft in the basic version equipped with the Rotax 912iS internal combustion engine. In the analyzed case, the piston engine will be replaced by the Wankel AG 807TGI rotary engine coupled with the Emrax 188 electric auxiliary engine. The system power of the hybrid propulsion is 110 kW and is equivalent to the maximum take-off power. The maximum power of the hybrid unit is 40 kW higher than that of the Rotax 912 iS engine. The achieved performance was compared to the performance of the Lighter aircraft equipped with a turbocharged Rotax 915iS engine with a maximum take-off power of 100 kW. The analysis determined the fuel consumption and energy expenditure of the propulsion for a specific mission profile. The mass analysis of the aircraft was made for the three considered engine versions. For each of the engine versions, a constraint of the maximum take-off weight of the aircraft of 600 kg was established, which is the limit of applicability of less rigorous law regulations regarding the design, build and operation of aircraft.

PTNSS-2023-042

Effect of DMC blend ratio on emission characteristics for diesel engine generator fueled with DMC/diesel blend fuel

Jinru Liu, Tadashige Kawakami, Meiling Jin, Kuniyoshi Eto

Energy shortage and environmental problems are two dominant subjects. The diesel engine is well-known for its high thermal efficiency but severe emission problems. For the urgent fossil fuel resources, the substantial surrogate fuel, dimethyl carbonate (DMC) is attracting attention for its high oxygen content. Its application in diesel engines has won increasing focus. However, it is difficult to fuel diesel engines directly with DMC due to its low cetane number and high latent vaporization heat. In this study, the DMC/diesel blend with 5%, 10%, 15% DMC by volume are prepared to investigate the emission characteristics. Since the combustion process is strongly influenced by the addition of low boiling point DMC boosts the atomization and liquid fuel mixture, the emissions of hydrocarbons and particulate matter are significantly reduced by the DMC addiction especially on the high-load conditions. Also, the nitrogen oxide emission has slight reduction on the high-load conditions. The scope for balancing NOx and PMx emissions exists.

PTNSS-2023-043

Operational experience and new developments for industrial gas engines fuelled with hydrogen fuels

Marek Sutkowski, Michał Mareczek

Since 2012 Horus-Energia has been developing the technology for the hydrogen fuelled industrial gas engines. First three units were commissioned in 2014 and in 2019 reached the forty thousand running hours milestone. The success of the first hydrogen project encouraged Horus-Energia to focus on further developments and improvements of the technology. Several R&D projects have been carried out since 2016 and resulted in two granted patents and another ones currently processed. The recent development project, carried out together with PGNiG Grupa Orlen, is in its final stage. The technology being developed creates a solid base for many new solutions that will cover wide range of fuels and applications. The paper reports experience from 40.000 hrs operation of the hydrogen fuelled industrial gas engines and presents the developments carried by Horus-Energia with its research partners as well as the future development paths for the technology.

PTNSS-2023-044

Influence of water content in diesel oil-water microemulsion on smoke opacity

Piotr Haller, Agata Haller, Andrzej Kaźmierczak, Jędrzej Matla, Zbigniew Sroka, Radosław Wróbel

The development of internal combustion engines is focused at solving problems like: fulfillment with increasingly stringent requirements regarding exhaust emissions and elimination of threats to the natural environment. The subject of this thesis is to assessment the impact of supplying a compression-ignition engine with hydrocarbon mixtures and to examine the impact of water on external parameters of the engine, such as smoke opacity. The tests were carried out using a innovative mixture of hydrated fusel oils, ethyl alcohol and ionic and/or non-ionic emulsifiers, from which was made of microemulsions with a water content in diesel oil of 5, 10, 15, 20 and 25%. The main tests were carried out on a 4-cylinder VW 1.9 TDI internal combustion engine at a constant engine crankshaft speed of 3000 rpm and variable load of 0, 30, 60, 90, 120, 150 and 180 Nm. The tests carried out showed a beneficial effect of the water content in the diesel oil on the reduction of the average value of smoke opacity, which systematically decreases with the increase in the percentage of water in the diesel oil.

PTNSS-2023-045

Assessment of oil change intervals in urban buses based on the selected physicochemical properties of used engine oil

Wojciech Gołębiowski, Grzegorz Zając, Marie Sejkorová, Artur Wolak

The paper presents the results of the analysis of selected physicochemical parameters of engine oils after their use. The oils were obtained both from urban buses belonging to the fleet of a municipal transport company in Lublin, Poland but also from the city of Pardubice in the Czech Republic. Five samples of 10W/40 semi-synthetic oil and four samples of 5W/30 synthetic oil were tested. Oxidation degree, nitration degree, sulfonation degree, water content, glycol content, total base number (TBN), total acid number (TAN), remaining antiwear additives, and kinematic viscosity at 40°C and 100°C were assessed using infrared spectroscopy (FTIR). The tests were carried out based on the ASTM E2412-10 standard. The article also presents the exceedance of the limit values results for the selected parameters. The results of the research can be used in optimizing the engine oil change interval so that the decision to replace the oil is justified both in economic and technical terms, taking into account the need to maintain the service life of the bus.

PTNSS-2023-046

The problem of emission of total particulate matter and heavy metals from tribological systems in vehicles

Piotr Laskowski, Magdalena Zimakowska-Laskowska

The article presents the problem of emission of particulate matter and heavy metals from tribological systems of cars with internal combustion engines, electric vehicles, self-renewing hybrids and plug-in hybrids. The results of mathematical modelling of TSP and heavy metal emissions from the abrasion of tires, brakes and road surfaces depending on the average speed and depending on the type of traffic (traffic in the city, outside the city and on the highway) as well as the type of vehicle are presented.

PTNSS-2023-047

Comparison of pollutant emissions from various types of vehicles

Magdalena Zimakowska-Laskowska, Piotr Laskowski

This article compares the equivalent emissions from electric vehicles with those of internal combustion engines and hybrid vehicles. The considerations focused on the dependence of the equivalent emission from electric cars on the Polish energy mix (which is still mainly based on hard coal). The results of mathematical simulations of the fuel type and Euro standards' impact on emissions are presented. The article also focuses on the study of the impact of the fuel used (LPG, CNG, petrol, diesel and biofuels) and the energy mix for electric cars on CO_2, NO_x, TSP and SO_2 emissions.

PTNSS-2023-048

Comparative analysis of theoretical cycles of independent valve control systems of the SI engine

Zbigniew Żmudka, Stefan Postrzednik

One of the important ways to improve the efficiency of SI engines, especially in the range of part loads, is to reduce the charge exchange work. This can be achieved by introducing modifications to the regulation and control systems of the charge exchange process, the essence of which is the use of independent valve control. The objects of the study were theoretical cycles of the load control systems and charge exchange process realization of the SI engine, including: 1. classic, quantitative throttling control, using a throttle valve (Seiliger-Sabathe open cycle), 2. system with late intake valve closing (the Atkinson-Miller open cycle), 3. system with early intake valve closing, 4. system with early exhaust valve closing, enabling internal exhaust gas recirculation, 5. system of fully independent valve control that enables internal exhaust gas recirculation with full fuel dosage control (general variant, which is a combination of variants 3 and 4, i.e. the systems EIVC and EEVC) In the analysis carried out, the classic control system (1) was the reference for all the other (2 to 5) studied systems for the charge exchange, using independent valve control. This approach to the analysis was due, among other things, to the fact that the aim of using independent valve control algorithms is to eliminate the throttle as an actuator for load and filling control of the SI engine, while retaining quantitative load control. In the proposed systems of independent valve control, the role of the throttle in terms of load regulation and engine filling is taken over by the valves that control the complete charge exchange process. The role of the intake valves is to match the mass of fresh charge supplied to the cylinder to the current engine load. The task of the exhaust valves, on the other hand, is the controlled implementation of internal exhaust gas recirculation. Eliminating the throttle through the use of independent valve control leads to a decrease in charge exchange work, an increase in the internal work of the engine and effective work, and consequently to an increase in the effective energy efficiency of the engine.

PTNSS-2023-049

Development of measurement apparatus of piston assembly friction in a small motorcycle engine

Kohei Nakashima, Kota Matsunaga, Yosuke Uchiyama, Masao Yoshida

This study developed a friction measurement apparatus with a floating cylinder liner, using a small motorcycle engine. In this measurement apparatus, joint plates were installed in the grooves on the outer periphery of the floating liner, and then the plates, as well as load washers of piezo type were mounted in the cylinder block, at both the thrust and the anti-thrust sides. A stepped cylinder protruding inward was mounted on the top of the floating liner so that cylinder pressure acting on the stepped portion was balanced in the vertical direction. In addition, to suppress lateral displacement due to piston thrust force, circular thin-disk springs were attached to the upper and lower sides between the floating liner and cylinder block. Thus, it was possible to measure the friction in the sliding directions of the piston. Using this apparatus, the effect of engine operating period on friction in a micro-dimpled piston (ceramic beads 45 μm in diameter were injected onto a commercially available piston with compressed air) was investigated. Results indicated that, in the low engine speed range, friction decreased with operating period, but in the high engine speed range, friction decreased for up to 10 hours of operation, but friction at 20 hours of operation was almost equal to or increased from that at 10 hours of operation.

PTNSS-2023-050

The effect of natural deterioration on selected properties of rapeseed oil methyl esters and diesel oil

Jan Monieta, Magdalena Szmukała, Florian Adamczyk

The article presents research results into the properties of rapeseed biofuel and distillation fuel subjected to a deterioration process at room temperature for 20 years. The heat of combustion and heating values have been measured in laboratory conditions using an automatic calorimeter. The results show a slight decline in energy properties, with an average change of 3.45%. Images analysis has been used to evaluate the effects of aging and combustion quality to compare the two fuels. An additional objective of the study was to the determine selected performance properties of the tested fuels. Changes in density, kinematic viscosity, acid value, and water content at the beginning and end of the experiment have also been examined. Deposits formed after combustion in a calorimetric bomb in crucibles and on the injector nozzles in an engine have been examined using the weight method and image analysis. After a very long period of storage, the density and acid number of rapeseed oil methyl esters have been slightly changed, while kinematic viscosity and water content increased significantly to exceed the permissible values. The acid value of diesel oil increased by 75% as a result of natural deterioration.

PTNSS-2023-051

Comparative analysis of a conceptual hybrid propelled light sports aircraft performance against piston powered versions

Michał Kuźniar, Maciej Kalwara, Kamil Kucharski

A continuously increasing number aircraft designs equipped with hybrid propulsion is appearing on the aviation market. Depending on the degree of hybridization, the aircraft\'s performance - the range and endurance in particular, may improve, reducing total fuel consumption simultaneously. The emissions of harmful and toxic compounds into the atmosphere may reduced as well. The paper presents an analysis of the utilization of a parallel hybrid propulsion of low degree of hybridization. The research object adopted for the calculations is the Artus Lighter Light Sports Aircraft in the basic version equipped with the Rotax 912iS internal combustion engine. In the analyzed case, the piston engine will be replaced by the Wankel AG 807TGI rotary engine coupled with the Emrax 188 electric auxiliary engine. The system power of the hybrid propulsion is 110 kW and is equivalent to the maximum take-off power. The maximum power of the hybrid unit is 40 kW higher than that of the Rotax 912 iS engine. The achieved performance was compared to the performance of the Lighter aircraft equipped with a turbocharged Rotax 915iS engine with a maximum take-off power of 100 kW. The analysis determined the fuel consumption and energy expenditure of the propulsion for a specific mission profile. The mass analysis of the aircraft was made for the three considered engine versions. For each of the engine versions, a constraint of the maximum take-off weight of the aircraft of 600 kg was established, which is the limit of applicability of less rigorous law regulations regarding the design, biuld and operation of aircraft.

PTNSS-2023-052

The concept of hydrogen powering an internal combustion engine

Marek Brzeżański, Michał Mareczek

The article deals with issues related to the adaptation of a piston internal combustion engine to run on hydrogen. Previous works related to the development of a new combustion system, hydrogen fuel injection system and ignition system were presented. The basic features of the electronically controlled, adaptive engine operation control system, which allows for the current selection of the excess air ratio of the engine mixture and the individual selection of the ignition advance angle, are described. The result of these activities is the ability to achieve the best operating parameters of the engine without the occurrence of combustion anomalies. The results of operational tests of the developed hydrogen-powered engines were also presented. In addition, another developmental concept of adapting the piston engine to hydrogen supply was presented.

PTNSS-2023-053

Experimental identification of the electrical discharge on a surface gap spark plug

Filip Szwajca, Krzysztof Wisłocki

In internal combustion engines, the combustion process initiation significantly affects the burning of the fuel-air mixture. This initiation of combustion closely related to the s.c. activation energy, determines the energy released and environmental performance of the power unit. Increasing the primary ignition source energy concentration seems to be essential for the development of ignition systems. It results with the possibility of efficient combustion of increasingly leaner mixtures or flame-resistant fuels. This study focuses on the analysis of arc discharge on a spark plug with a surface gap between the electrodes as a solution to increase the concentration of arc energy. In particular, the sensitivities of the discharge to ignition coil charging time and ambient pressure were evaluated. The results were related to the effects of using a conventional side electrode spark plug and compared with such results obtained for the spark plug with the flat ground electrode. An optical method involving high-speed imaging and recording of electrical parameters was used to record the discharge. The tested spark plug was installed in a constant volume chamber with optical access. The discharge process has been evaluated according the spark area development history and spark energy concentration based on the spark luminance was analyzed for different values of back pressure in the chamber and for different charging times of the ignition coil. Tests were also carried out for a conventional spark plug. Consequently, it was confirmed and graphically illustrated that the arc luminous intensity and surface area was increasing with increasing ambient pressure. For the pressure variation, there was no observed any significant change in discharge duration. The arc phase is most influenced by the charging time of the ignition coil corresponding to the supply of more energy. Subsequently, a high instability of the electric arc was found under higher back pressure in a constant volume chamber. The change in arc geometry correlates with rapid voltage changes in the secondary circuit of the ignition coil. Relative to a conventional spark plug, an increase in energy concentration was noted.

PTNSS-2023-054

Toward sustainable air transport – zero-emission challenges and technological advances

Marianna Jacyna, Konrad Lewczuk

Air transport is a key mode of global passenger transport that is constantly gaining importance. It is also one of the most regulated modes of transport, which is additionally subject to heavy environmental pressures related to minimizing the harmful impact of this transport on the environment and making it sustainable. The article reviews and evaluates the latest technological, organizational, market and political trends related to achieving the goal of zero-emission from air transport in the foreseeable future. The paper discusses issues related to new engine technologies, new construction and coating materials, advances in the manufacturing process and aircraft construction, land-side carbon capture technologies, supersonic flights, noise reduction techniques and the use of artificial intelligence and machine learning as current challenges of air transport, which will shape it in the coming years.

PTNSS-2023-055

Simulation studies of fleet vehicle selection in terms of pollutant emissions

Emilian Szczepański, Tomasz Rudyk, Roland Jachimowski

This article presents the vehicle selection problem in the vehicle fleet of a retail and service company. In practical solutions, fleet managers focus on minimising TCO (total cost of ownership) while ignoring the impact of the fleet on the environment. Therefore, a literature review of current solutions in fleet selection and their determinants is presented. Considering the latest trends and regulations, an optimisation model for vehicle selection was developed, considering the issues of emissions and external costs. The developed model was implemented in a simulation environment, and a sensitivity analysis of the solutions obtained was carried out. The research made it possible to indicate the impact of the pollutant emission factor on the fleet structure.

PTNSS-2023-056

Prospects of replacing hydrocarbon fuels with hydrogen by means of a new combustion system in a spark ignition engine regarding to Polish market

Jędrzej Matla,. Andrzej Kaźmierczak, Piotr Haller, Marcin Trocki

Accelerating process of the transport and energy sectors increases the interest in fuels derived from renewable sources. The predicted three-fold increase in hydrogen production by 2050, driven by its falling production costs, justifies the direction of research aimed at its popularisation as a fuel for internal combustion engines (H2ICE). Presented article provides an overview of the state of knowledge on hydrogen combustion systems, which are currently the most attractive development path, mainly due to the well-developed production technology and relatively low recycling cost compared with fuel cells. The paper contains a comprehensive analysis of currently available solutions covering issues related to the production, storage, and transmission of hydrogen, with particular emphasis on the Polish market, which is one of the largest in Europe in terms of its production. The authors also propose their own concept of a hydrogen combustion system for application in an internal combustion engine. The presented solution is based on the idea of prechamber introduction in order to improve combustion process parameters and hence overall engine efficiency.

PTNSS-2023-057

Hydrogen as a fuel for turbine aircraft engines

Andrzej Majka, Michał Kuźniar

Air transport is one of the most important branches of transport, generating emissions of carbon dioxide and other compounds into the atmosphere. Emissions in airport-proximate zones during LTO missions and during flights at high cruising altitude have a particular impact on the natural environment. The desire to reduce CO_2 emissions implies attempts to find more efficient ways of operating the aircraft, using SAF fuels or using hydrogen The work will present the prospects of using hydrogen as an aviation fuel, both pure hydrogen and hydrogen admixtures to hydrocarbon fuel. Design trends, potential benefits from the use of fuels that are a mixture with hydrogen or pure hydrogen will be indicated. Potential limitations of the use of alternative fuels and the impact of fuel change on the degree of complexity of aircraft construction and its operational characteristics will be shown and discussed.

PTNSS-2023-058

Analysis of using the fluid catalyst in CI engine fuel to reduce toxic substances in exhaust emissions

Tomasz Osipowicz, Karol Franciszek Abramek

The article discusses the possibilities of using a catalyst in Fuel Shot fluid for CI engine fuel to reduce toxic substances in exhaust emissions. The use of catalysts in fuel can improve the organization of the combustion process and reduce the emission of toxic substances into the atmosphere in exhaust emissions. Toxic compounds such as nitrogen oxides, particulate matter, and hydrocarbons adversely affect flora and fauna. Various methods are known to reduce their concentration in engine exhaust gases. One of them is a catalyst in Fuel Shot fluid. The authors conducted studies on Fiat 1.3 JTD engines with a Common Rail system and 4CTI90-1BE6 engines with a mechanical injection system. Measurement results show that the use of liquid catalyst reduces the content of nitrogen oxides and hydrocarbons in exhaust emissions and reduces fuel consumption. Additionally, tests were conducted on the engine injection system, which was fueled with modified fuel. They showed that the fuel additive does not affect the consumption of precision fuel injectors and high-pressure pumps.

PTNSS-2023-059

Analysis of vibration in the research electric propulsion system for aircraft rotors

Rafał Kliza, Ksenia Siadkowska, Karol Ścisłowski

The paper presents an analysis of vibrations in the electric propulsion system for a test stand for a prototype helicopter main rotor. The propulsion system includes an induction electric motor to provide power to propel a main rotor equipped with prototype blades of variable geometries. Mounted in the blades, the actuators made of shape memory material are capable of changing the geometric twist angle of the blades during the main rotor operation. Such an element can additionally affect the vibration of the entire propulsion system. The resonance phenomenon can lead to the disintegration of the entire structure of the test stand or the rotorcraft. The dynamic instability phenomenon results in machinery, vehicle or aircraft malfunctions. In the investigated high-speed system, vibrations have a key diagnostic role, which explains the need for their detailed analysis.

PTNSS-2023-060

Analysis of the influence of fuel contaminants on the operation of the injection system in modern CI engines

Tomasz Osipowicz, Karol Franciszek Abramek

The article discusses the issue related to the impact of fuel contaminants on the operation of modern fuel injection systems. Improperly functioning injection systems affect the operating and ecological parameters of internal combustion engines. The authors studied an engine with damaged fuel injectors. In the first stage of laboratory research, the operating parameters of the fuel injectors and injection pump were verified. The fuel supply components were disassembled into their constituent parts and examined under an electron microscope. The research showed that many contaminants came from outside and entered the fuel system with the fuel. They caused damage to precision components and disrupted the operation of fuel injector control valves. Emissions and current parameters of the engine were analyzed. The engine tests showed that injection system failures mainly affect engine smoke emissions.

PTNSS-2023-061

Improving the performance of diesel engines fueled with water-fuel emulsion

Dmytro Samoilenko, Anatoliy Savchenko, Serhii Kravchenko

Due to unique properties, production and operation features, water-fuel emulsion (WFE) could be considered as one of the most promising type of alternative fuels for diesel engines. Experimental research showed that comparing to traditional diesel fuel, application of water-fuel emulsion allows to reduce nitrogen oxides and soot emissions, which is due primarily to a decrease in the level of maximum temperatures in the engine cylinder, as well as a more uniform distribution of fuel over the combustion chamber volume thanks to its secondary dispersion (micro-explosion phenomena). To control the stability of water-fuel emulsion properties during engine operation it is recommended to install water content sensor in the fuel supply system.

PTNSS-2023-062

Study of the effect of ignition advance angle and mixture composition on the performance of a spark-ignition engine fueled with ethanol

Piotr Jakliński, Jacek Czarnigowski, Karol Ścisłowski

The publication presents the results of performance measurements of a Holden C20LE gasoline engine fueled with unleaded 95 gasoline and 95% ethanol. Measurements were carried out at a constant speed of 1500 rpm. Two series of measurements were carried out for each fuel. In the first, the ignition advance angle was varied in the range of 0–40˚, while in the second, the mixture ratio λ was varied in the range of 0.85–1.25. Engine performance parameters such as torque, intake manifold pressure, intake air temperature, exhaust gas temperature, fuel consumption and exhaust gas composition were recorded. The study showed that at higher ignition advance angles, the ethanol-fueled engine has an efficiency that is 4 percentage points higher. At the same time, ethanol also shows an efficiency higher by up to 4.5 percentage points when the engine is fed with rich mixtures for λ = 0.85. The composition of the exhaust gas from the ethanol-fueled engine also showed a significantly lower content of harmful exhaust components. The amount of hydrocarbons in the exhaust gas decreased threefold. The content of nitrogen oxides and carbon monoxide also decreased.

PTNSS-2023-063

Influence of hydrogen addition on performance and ecological parameters of a spark-ignition internal combustion engine

Maciej Paluch, Marcin Noga

The presented research was conducted in order to determine the effect of hydrogen as an addition to the air-fuel mixture supplying a spark-ignition internal combustion engine. To carry out the tests, slight modifications were made to the engine structure, consisting in enabling the use of the necessary measuring equipment and adapting the engine to perform tests on the test stand. The applied modifications made it possible to measure the operating parameters generated by the engine, as well as to determine the composition of the emitted exhaust gases. The tests were carried out for a gasoline-powered engine, for a gasoline-powered engine using external exhaust gas recirculation (EGR) and for an engine fueled with gasoline with the addition of hydrogen and using external exhaust gas recirculation (EGR). In order to illustrate the results, they were summarized basing on a series of tests performed, and the effect of exhaust gas recirculation, hydrogen addition and a combination of exhaust gas recirculation and hydrogen addition on the performance and ecological parameters of the tested engine was determined. The conducted research and the obtained conclusions allowed for an unequivocal determination of the legitimacy of using hydrogen as a fuel additive for a conventional spark-ignition internal combustion engine in terms of utility and ecology.

PTNSS-2023-065

Development of a multi-platform SCR aftertreatment system for large-scale series production

Łukasz Jan Kapusta, Bartosz Kaźmierski, Rohit Thokala, Łukasz Boruc, Jakub Bachanek, Rafał Rogóż, Andrzej Teodorczyk, Sebastian Jarosiński

Urea-SCR (selective catalytic reduction) has become the principal technology to limit NO_x emissions from automotive compression ignition engines. The crucial element to achieving efficient NO_x reduction is to form a spray to evenly distribute urea-water solution (UWS) over the exhaust gas stream, effectively evaporate water, and convert urea into ammonia before the inlet to the catalyst. Thus, this process is strongly dependent on spray properties, static mixer and the whole system design. These aspects must be matched together to reach desired mixing characteristics, which is especially challenging in multi-platform designs. The study presents the development of a multi-platform SCR system with a short mixing length intended for mobile applications. The study is focused on the mixing process in the SCR system. However, other aspects of the development related to the application on a large scale are also discussed. The major part of the work was performed using CFD simulations. However, the experiments needed to obtain input data for modelling are also presented. The initial system's design was characterised by the severe deposit formation near the mixer's outlet, which was attributed to the intensive cooling in the mounting area. Moreover, as the simulations suggested, the spray was not appropriately mixed with the surrounding gas in its primary zone. The considered system's modifications were aimed at reducing the deposit amount and improving the spray-gas mixing. The proposed measures to reduce the wall film formation needed to account for the large-scale production capability, and all the systems components needed to be thermal-shock and vibration resistant, which was continuously monitored during the development process. The performed simulations led to the creation of the system providing excellent UWS-exhaust gas mixing without a solid deposit formation. In further steps, the system was designed to be manufactured and implemented into large-scale series production.

PTNSS-2023-066

Evaluation of pollutant emissions from a railbus in real operating conditions during transport work

Łukasz Rymaniak, Sławomir Wiśniewski, Krystian Woźniak, Maciej Frankowski, Monika Mąka

The article discusses issues related to the assessment of pollutant emissions from a railbus during transport work. The test object was a rail vehicle equipped with two diesel engines with a total power of 780 kW, Stage IIIB homologated. Measurements were carried out on the route Poznań–Wągrowiec in two directions. During the tests, the vehicle performed a transport service, where the number of passengers was counted. For the completed cycles, the average number of people was 82 and 18. On the basis of the obtained data, the vehicle operating conditions and emission indicators were analyzed, which were related to the number of passengers. A dimensionless toxicity index was also determined.

PTNSS-2023-067

Possibilities of reducing road transport costs by using HVO fuel to diesel engines

Mateusz Bednarski, Maciej Gis, Mieczysław Sikora, Piotr Orliński

Restrictions related to increasingly higher exhaust gas purity standards result in an increase in transport costs due to road taxes and the cost of fuels and additives such as ureas for SCR systems. The use of HVO fuel has an impact on reducing the emission of harmful substances, reducing fuel or urea consumption, which may prove the legitimacy of using HVO fuel interchangeably in older trucks, in order to reduce the total transport costs.

PTNSS-2023-068

Possibilities of using HCNG fuel as fuel for combustion engines

Mateusz Bednarski, Piotr Orliński, Maciej Gis, Mieczysław Sikora

Mixtures of natural gas and hydrogen as fuel can contribute to the reduction of concentrations of harmful substances and increase the efficiency of an internal combustion engine adapted to be powered by natural gas. The authors analyze the legitimacy of using HCNG fuel as a substitute fuel to power internal combustion engines (SI and CI) used in passenger cars and trucks, in which internal combustion engines operate in variable operating conditions (variable load and rotational speed).

PTNSS-2023-069

Studying the influence of multilayer nanocoatings on the efficiency and durability of a hybrid power unit in ultralight aircraft: an experimental approach

Piotr Wróblewski

This scientific article presents an innovative concept of a hybrid power unit designed for ultralight aircraft with the use of hybrid nanocoatings. The article presents the results of research on the use of multilayer nanocoatings, including the analysis of the impact of these coatings on the mechanical and thermal properties of drive components. These studies are aimed at understanding the possibility of using such coatings to further increase the efficiency and durability of the hybrid drive unit. In order to conduct experimental research on the developed system, a special test stand was built on which a prototype drive unit was mounted and hybrid coatings were introduced. Research is focusing on the development of new low-friction and high-wear materials that could help reduce internal friction and extend the life of engine components. In terms of thermal protection, research is focused on the development of nano-coatings with high heat resistance and low thermal conductivity that can improve cooling performance and extend the life of engine components exposed to high temperatures. The article also summarizes the conclusions regarding further work on improving this innovative solution, including research on the use of multilayer nanocoatings.

PTNSS-2023-070

Development of a system for measuring a braking energy recovery rate in a hybrid electric vehicle

Marcin Noga, Mateusz Szramowiat

The article presents the first stages of the development of a system for real-time testing of the braking energy recovery process of a vehicle with a hybrid drive system (HEV). The use of the system is aimed at adjusting the car\'s braking style to maximize the amount of energy returned to the battery depending on the traffic conditions. The system is built on the basis of pressure sensors in the brake calipers of all wheels, a battery current and voltage sensor as well as speed measurement. An important signal for the operation of the system is the information that the driver has pressed the brake pedal. Ultimately, it is planned to visualize the measured and calculated braking parameters on a tablet or smartphone device placed in the vehicle. The manuscript presents the concept of the system and the results of preliminary studies conducted with the use of target signals, but with their recording using a data acquisition card. The analysis of data collected in different vehicle traffic conditions and with the use of different braking styles allowed to determine the impact of the braking style on the amount of energy transferred to the battery. The prototype of the system is being built for HEV, but it can also be used for other types of propulsion systems having the feature of regenerating braking where the energy is given back to the storage system. It is expected that the use of the developed system will significantly reduce the vehicle\'s energy or fuel consumption.

PTNSS-2023-071

An example of adoption of the model-based design (MBD) methodology in the development process of an LPG fuelling system

Maciej Sidorowicz

The research aims to recognize the potential of adopting the model-based design methodology to the development process of an LPG fuelling system. Changing regulations often force the modern development of internal combustion engines (Euro 7, CO_2 reduction measures, etc.). With the definitive ban on new registrations of vehicles powered by internal combustion engines in Europe (planned for 2035), there is still ongoing development of the adaptation of the fuelling system to LPG. There is still market potential in adapting new internal combustion engines, usually equipped with direct injection systems, to reduce customers' cost of ownership of a vehicle. As the engineering process should be accelerated in the face of the variety of direct injection systems offered by OEMs, the model-based design methodology is proposed to make the development more effective. The article presents the SWOT analysis of this approach in the engineering process and the potential of the method in an LPG system development is concluded.

PTNSS-2023-072

Development and research of a hybrid power unit for ultralight aircraft: An innovative approach to energy efficiency and operational flexibility

Piotr Wróblewski, Piotr Świątek, Stanisław Kachel, Tomasz Zyska

This scientific article presents an innovative concept of a hybrid power unit designed for ultralight aircraft, with the aim of improving energy efficiency and operational flexibility. As part of the development of the system, the construction of the combustion unit and the electric motor/generator, which are the key elements of this solution, was described. The advanced internal combustion engine controller and the bi-directional energy conversion converter have been developed and built to enable optimal cooperation of both energy sources. In order to carry out experimental research on the developed system, a special test stand was built on which a prototype drive unit was mounted. The results of the research include preliminary performance characteristics of the prototype drive unit and an analysis of the achievements that indicate the potential benefits of using such a hybrid drive unit. The article also summarizes the conclusions and recommendations for further work on improving this innovative solution.

PTNSS-2023-073

Comparison of exhaust emission results obtained from Portable Emissions Measurement Systems (PEMS) and a laboratory system

Borys Adamiak, Andrzej Szczotka, Jerzy Merkisz, Joseph Woodburn

Exhaust emissions testing of vehicles in real driving conditions (real driving emissions, RDE) using portable exhaust emissions measurements systems (PEMS) was introduced a few years ago by the European Commission as a mandatory test during type approval and later also for in-service conformity. This paper compares results from two different mobile systems (by different manufacturers) for measuring exhaust gas emissions (PEMS) with a stationary laboratory (BOSMAL's Exhaust Emissions Testing Laboratory). The tests were carried out using a passenger car equipped with a spark ignition engine, which was tested on chassis dynamometer over the WLTC cycle. The results showed that the differences between PEMS analysers and stationary analysers range from a few percent to a dozen or so percent, depending on the component and the measurement method.

PTNSS-2023-074

Tests of the proposed new type of biofuel – Bioxdiesel

Mieczysław Struś, Wojciech Poprawski, Przemysław Amrozik, Mohamad Hamid

The advanced biodiesel fuel used for the research was made of Fatty Acid Ethyl Esters, bioethanol with addition of standard mineral Diesel fuel. The biofuel contains about 75% of component with plant and waste origin (FAEE and bioethanol). The Fatty Acid Ethyl Esters were prepared by the research team from the waste vegetable and animal fats, mainly from food processing industry and from vegetable (rapeseed) oil. The FAEE are produced in transesterification reaction in the presence of alkali catalyst. The biofuel has been tested to evaluate emission and engine performance and compared to the standard Diesel fuel. The engine performance (efficiency and fuel economy) is comparable for testing biofuel and mineral Diesel. The Emission of CO, HC and smoke is significantly less for the biofuel, with slight increase of NOx emission in certain engine load condition. The fuel blended in such way was used in normal, on-road operation tests using fleet of parcel delivery vehicles. The research carried out so far prove that the biofuel could be successfully used as alternative for Diesel engines, especially for fleets of transportation vehicles due to firm operation regime.

PTNSS-2023-075

Selected vehicle emissivity assessment issues in passenger transport services

Piotr Pryciński, Róża Wawryszczuk, Jarosław Korzeb, Piotr Pielecha, Jakub Murawski

This paper presents an analytical method for determining the emissivity of transport modes, based on emissivity indicators for various vehicle types and statistical data. The method developed enables the determination of the emissivity of various vehicle types without the need to carry out tests on real vehicles. The purpose of this paper is to compare the vehicle emissivity results obtained using the developed analytical method with the real-world results obtained in RDE tests based on a case study, i.e. an analysis of the emissivity of passenger transport modes in Warsaw. The paper contains a summary of the results of measurements and calculations, as well as an analysis of potential areas of application for the developed analytical method.

PTNSS-2023-077

Preliminary assessment of the possibility of using the FTIR exhaust gas analyzer for measurement of lubricating oil consumption in a diesel engine

Grzegorz Koszałka

The aim of the work is to develop a method for quantitative engine oil consumption assessment using the FTIR exhaust gas analyzer. In the first stage of the work, the results of which are presented in this article, a sulfur compound was added to the fuel and sulphur dioxide and carbonyl sulphide concentrations in the exhaust gas were measured using the FTIR analyzer. The measurements were carried out on an engine dynamometer test stand in various operating conditions of a diesel engine fueled with diesel containing various amounts of sulfur additive. The results indicate a good correlation between the concentration of the above-mentioned sulfur compounds in the exhaust gas and the concentration of the sulfur additive in the fuel. In the next stage of research, similar measurements will be carried out, however, the sulfur compound will be added to engine oil.

PTNSS-2023-078

Dynamic numerical analysis of compression ignition engine crankshaft strength

Kacper Cieślar, Tomasz Knefel, Jacek Nowakowski

The article presents a dynamic numerical analysis of compression ignition engine crankshaft strength. The object of study is the engine for light road traction, subjected to a load for different values of engine control parameters. The load from the gas force was taken into account and additionally the thermal load and inertia forces resulting from the rotational speed of the crankshaft were taken into account. The analysis was carried out in order to obtain stress distribution and to indicate critical places where stress concentration may occur. The solid model of the crankshaft was developed in the NX program, and then in the stp format used for data exchange in CAD systems, it was exported to the ANSYS WORKBENCH software. The calculations were carried out in the Transient Structural module used to determine the dynamic response of the system under the influence of time-varying loads. Calculations and analyzes were carried out for six values of engine rotational speed: 1000, 2000, 3000, 3500, 4000, 4500 rpm and two temperatures of engine structural elements: 50, 80 degree Celsius. Numerical analyzes without the influence of temperature showed a relieving effect of the inertia force on the crankshaft. With the increase in rotational speed from 1000 to 4500 rpm. the displacement of the center of the crank pin decreased and the maximum stress according to the Mises theory decreased from 312.81 MPa to 300.85 MPa, i.e. by 3.9%. In addition, a significant effect of temperature on the displacement of the center of the crankpin was demonstrated. This has a significant impact due to the selection of fits between the crank pin and the bearing bush. The effect of temperature is much greater than the effect of rotational speed.

PTNSS-2023-080

Problems related to the operation of autonomous vehicles in adverse weather conditions

Michał Brzozowski, Krzysztof Parczewski

The paper presents and discusses the sensors used in autonomous cars. The paper demonstrates the key reliability of these devices for the proper operation of autonomous driving systems. The most important literature related to the issue of the operation of autonomous sensors in adverse weather conditions is discussed. The negative effects caused by different weather conditions are presented. Own scientific research on the effects of rain, snow and fog on LiDAR performance is presented. The results are presented, detailing the most important risks from each weather phenomenon. Attempts currently being made to address these issues are presented. The paper concludes with a summary of the research results, the current state of knowledge and suggestions for future developments.

PTNSS-2023-081

Analysis of lubricating oil degradation and its influence on brake specific fuel consumption of a light-duty compression-ignition engine running a durability cycle on a test stand

Rafał Sala, Kamil Węglarz, Andrzej Suchecki

The Euro 6 emission standard required compliance with tough legal exhaust emissions limits for newly registered vehicles and obligates light duty vehicle manufacturers to respect the 160,000 km durability requirements for in-service conformity. Although there is no legal limit set for fuel consumption, manufacturers are obligated to decrease the carbon footprint of vehicle fleets in order to obtain carbon neutral mobility beyond 2035. This aim of this paper is to analyse the impact of various oils' and viscosity grades' degradation on the change in specific fuel consumption (SFC) measured over a standardized durability test cycle. Each oil candidate underwent 300 h of durability test running performed on a test bed, without any oil changes. The purpose of the laboratory test was to reproduce – in an accelerated manner – the worst-case operating conditions and degradation process of the long-life engine oil type that can be experienced during extreme real life driving of a vehicle. In order to define the influence of the engine oil deterioration on the SFC profile, the engine operation parameters were continually monitored throughout the test run. Additionally, chemical analysis of the oil was performed and the solid deposits formed on the turbocharger's compressor side were evaluated. The test results revealed differences up to 3.5% in the SFC values between the oil candidates tested over the durability cycle. The observed SFC increase was directly related to the decrease in engine efficiency and can cause higher fuel consumption of the engine, which in turn has an adverse effect on environmental protection goals.

PTNSS-2023-082

Dual-fuel engines using hydrogen-enriched fuels as an ecological source of energy for transport, industry and power engineering

Mirosław Karczewski, Janusz Chojnowski, Grzegorz Szamrej

Thanks to the analysis of data on compression ignition (CI) engines used in the world, it is possible to prepare ready-made solutions for the most common engines in selected industries or for those whose greenhouse gas emissions will be the largest and most expensive for their owners in the coming years. The basic solution presented by us gives the possibility of powering the engines with the most ecological currently known alternative motor fuels. Their greatest advantage is their availability and low carbon content, which allows us to minimize carbon dioxide emissions, both by burning hydrogen-enriched fuels and by increasing the efficiency of the engines modified by our team. Properly made external dual-fuel installation allows to improve the thermal efficiency of the self-ignition engine. Work on this issue may help in the development of, for example, high-efficiency flex fuel power generators, which, as the current situation in Ukraine shows, are worth their weight in gold. Thanks to the diversification of power sources for power generators, the country is able to increase the reliability and security of energy supplies even in difficult conditions, such as armed conflict or natural disasters.

PTNSS-2023-083

Analysis of the influence of substitute fuels on properties operating conditions of military hybrid drive systems

Janusz Chojnowski

The energy density of chemical batteries makes it difficult to rely solely on cheap and eco-friendly electricity for power in many applications, such as airplanes, long-distance trains, ocean vessels, and heavy equipment. Limited charging infrastructure and power generation capacity are also problematic. However, hybrid powertrains provide a solution by combining electric and internal combustion engines to achieve better fuel economy and similar operational characteristics to traditional engines. Hybrid systems can also use alternative hydrocarbon fuels , with all advantages of conventional engines. This study aimed to determine the impact of alternative fuels on the performance of a hybrid drive system for a military wheeled platform developed for operation in urban areas. The experiment found that substitute fuels, such as, F-34, and Jet A-1, were compatible but could result in increased fuel consumption, decreased energy efficiency, and negative environmental impacts due to higher exhaust emissions.

PTNSS-2023-084

Analysis of toxic emissions during the wood transport process

Maciej Bednarek, Andrzej Ziółkowski, Aleks Jagielski, Piotr Lijewski, Władysław Kusiak

Forest management and the timber industry are important sectors of the national industry. In the case of Poland, the last two decades have been characterised by an increase in timber harvesting. At the same time, the country's forest area has remained at a relatively high level. As in almost every sector of the economy, forest management is closely linked to transport, which determines its development. In the case of the timber industry, road transport plays a key role. Its main disadvantage is that road transport emits harmful compounds into the atmosphere due to fuel combustion, which have a negative impact on the environment, including human health. Currently, much research is focused on determining the actual emission of harmful compounds and how to reduce it. This article analyses the emissions of harmful compounds by a HDV (Heavy Duty Vehicle) used for the transportation of timber. The research was carried out under real operating conditions. The analysis covers the overall transport process. It took into account the loading processes of the wood raw material and its transport on roads of different categories. The proposed research cycle reflected the standard process of exporting timber from the forest to a processing company. Axion RS+ mobile instrumentation from the PEMS (Portable Emission Measurement System) group was used for the study. On the basis of the results obtained, the emissions and mileage fuel consumption of each stage of the test cycle were determined. The basic emission factors of CO, CO_2, NO_x, HC were also calculated. The effect of the test route conditions on the performance characteristics of the vehicle's powertrain was also analysed.

PTNSS-2023-085

Analysis of vehicle powertrains using hydrogen as a power fuel

Aleks Jagielski, Paweł Fuć, Maciej Bednarek, Andrzej Ziółkowski, Szymon Konieczka, Jacek Bogusławski

The climate change we are seeing is challenging scientists around the world. Alternative energy sources are currently being developed using technologies that ensure maximum efficiency and low toxic emissions into the atmosphere. More and more manufacturers of vehicles, machines or equipment are abandoning conventional propulsion systems and replacing them with alternatives using, for example, electricity or hydrogen. In addition, hydrogen fuel cell cars, in which hydrogen is combined with oxygen and a chemical reaction produces electricity to power electric motors, have been in production for some years. Today, designers are trying to develop new solutions to increase efficiency, simplifying the design of fuel cells. Currently, technology using hydrogen as an energy source is mainly used in light-duty vehicles; analysing the directions of global trends, it can be concluded that in a few years' time, significant development will take place in heavy-duty and commercial vehicles. This article reviews hydrogen production methods, fuel cells and design solutions for use in propulsion systems.

PTNSS-2023-086

Selection of energy storage systems for a special purpose rail vehicle based on simulation analysis

Wojciech Jakuszko, Karol Bryk, Dawid Gallas, Paweł Stobnicki, Piotr Tarnawski

The issue of power supply to electric rail vehicles leads to a separation of the rail network into electrified and unelectrified portions, where the sections lacking electrification exclude the operation of electric rail vehicles powered from the overhead lines. The potential solution to this problem was found in adding energy storage systems to electric rail vehicles, to allow them some range of travel beyond the electrified lines. A simulation analysis of a special purpose rail vehicle travelling across a non-electrified section of railway line was conducted to assess the energy consumption rate and the necessary energy storage capacity. Three energy storage solutions were simulated, showing the travel range they can provide. The final selection of energy storage system capacity was done based on the assumed expected range outside electrified railway weighed against the mass and cost of the extra energy storage system added to the vehicle.

PTNSS-2023-087

Technical aspects of the selection of a engine-generator set for a dual-drive locomotive

Piotr Michalak, Patryk Urbański, Wojciech Jakuszko, Dawid Gallas, Paweł Stobnicki, Piotr Tarnawski

The use of dual-drive rolling stock is a relatively new solution on the railway market. Vehicle with such type of a powertrain is more versatile because it combines the advantages of using a diesel vehicle and an electric vehicle that consumes energy from overhead electric traction. The concept of using such vehicles is highly innovative and has many advantages, however, the design and construction process is more complicated and requires more work than in the case of conventional systems. This article presents the methodology and process of selecting an engine-generator set for a dual-drive locomotive. Indicators and procedures, crucial in the process of selecting a dual-drive system for a locomotive, were described and evaluated. All the aspects discussed in the article were used during the real design process of a fully Polish locomotive powered by a combination of both diesel and electric drives.

PTNSS-2023-088

Effects of injection parameters and injection strategy on a two-stroke opposed-piston diesel engine

Mirosław Wendeker, Paweł Karpiński, Grzegorz Barański

The performance of the engine strongly depends on the parameters of the combustion process. In compression ignition engines, the fuel injection timing has a significant influence on this process. The moment of its occurrence and its duration should be chosen so that the maximum pressure value occurs several degrees after TDC. In order to analyse the effect of the fuel injection advance angle on the performance of the two-stroke compression-ignition reciprocating engine under study, bench tests of the aircraft engine were carried out on an engine dynamometer under steady-state and transient conditions. Based on the obtained results, a statistical analysis was performed to evaluate the significance of the differences between these two injection strategies. This analysis showed significant differences between the dual- and single-injector strategies for the selected pressure parameters, combustion-related parameters and fuel-air parameters. Finally, the engine characteristic was made as a function of the start of combustion angle.

PTNSS-2023-089

Evaluation of the antiwear properties of timely changed engine oils

Daria Skonieczna, Oleksandr Vrublevskyi, Piotr Szczyglak

The oil replacement system commonly used in Poland, especially in passenger cars, is based on the number of kilometres driven or the annual operating period imposed by the manufacturer. To date, there are no research results describing what anti-wear properties characterise oils that are changed on a scheduled basis. The article presents the results of tests, replaced according to the vehicle manufacturer\'s recommendations, of engine oils. The sample of engine oils in service came from spark-ignition and compression-ignition vehicles used in urban or mixed mode. During their collection, the type of drive unit, the mileage of the car and the number of kilometres the oil was used for were recorded for each sample (this was the main criterion for differentiating samples). In addition, a control group of samples consisting of fresh oils of the same viscosity grade and distributed by the same producer was set up to observe changes in the parameters of individual lubricants after the operating period. The first part of the empirical study consisted of determining the physico-chemical properties of the lubricants, i.e.: kinematic viscosity, density and water content. The second part involved anti-wear tests using a T-02U tribotester. The use of the tribotester made it possible to record the anti-wear parameter, i.e. moment of friction, and also the load imposed on the friction node, as a result of which it was possible to calculate the friction force and friction coefficient. The research was complemented by an analysis of worn surfaces of the friction node on a microscope. The tests carried out can be used for predictive purposes, in terms of assessing the condition of a lubricant subjected to an operating process in an internal combustion engine.

PTNSS-2023-090

Evaluation of corrosion resistance of connector ends of wires used in electric car harnesses

Anna Cieśla, Dominika Grygier

A study has been carried out to evaluate the corrosion resistance of connector cables, which are used in electric car harnesses for grounding. Microscopic and tribological methods were used in the study to determine the influence of corrosion factors on the corrosion processes of connectors. Battery acid spillage and driving on a salted surface were simulated. For this, 5% solutions of sulfuric acid (VI) and table salt were used. In addition, the article presents the results of wear on mesh connectors. Wear on these automotive parts is often subjected to mechanical damage from transportation and production. The possibility of damage is much greater than it may seem. Serious damage is caused by vibrations, the most vulnerable are connectors located close to the vehicle\'s engine, it causes vibrations during operation, which are transferred to other parts of the vehicle. Vibrations also occur during the car itself when the vehicle moves over an uneven surface. These vibrations cause the connectors to make small movements, which, however, are enough to speak of the fretting phenomenon occurring. Motor vehicles are often exposed to corrosive factors such as varying temperatures (negative temperatures in winter, very positive temperatures in summer) and varying humidity, to which, if vibration and mechanical wear are added, the mesh connectors can be damaged to such an extent that there are major problems associated with starting the internal combustion engine, improper operation of the steering brakes, battery discharge and other problems that are fed from the electrical system. The conclusions of the research draw attention to pay special attention to the quality and durability of connectors used in automobiles to be able to ensure reliable operation of electrical systems and avoid failures that have consequences for vehicle safety and performance.

PTNSS-2023-091

Hydrotreated vegetable oil fuel within the Fit for 55 package

Mieczysław Sikora, Piotr Orliński

28 March 2023 the EU Council has adopted a regulation setting stringent carbon dioxide emission standards for new cars and vans. Under the new law, new vehicles with a 100 per cent reduction in carbon dioxide emissions will be able to be registered after 2035. The new EU legislation sets the following targets: a 55 per cent reduction in CO_2 emissions for new cars and 50 per cent for new vans between 2030 and 2034 compared to 2021 levels; a 100 per cent reduction in CO_2 emissions for both new cars and vans from 2035. This will result in only electric or hydrogen-powered cars and vans being able to be registered after 2035. The fuel omitted from the Fit for 55 package within cars and vans is hydrotreated vegetable oil. According to the research carried out so far, it is possible to replace diesel with HVO fuel even without interference with the fuel injection control system. If an internal combustion engine is fuelled with HVO fuel instead of diesel, the greenhouse gas emissions can be reduced by up to 90 per cent. What is more, the technology for using HVO fuel has many more possibilities for reducing CO_2 emissions, if only by refining the exhaust aftertreatment process. The exclusion of this fuel from the Fit for 55 package raises serious doubts about the quality of the analyses on the basis of which HVO fuel was not included in the Fit for 55 package.

PTNSS-2023-092

Fuel consumption and CO_2 emission analysis of hybrid and conventional vehicles in urban conditions

Adriana Skuza, Emilia M. Szumska, Rafał Jurecki

Passenger vehicles equipped with conventional drives, in which the internal combustion engine is the only source of energy, dominate on Polish and European roads. Despite the trend of electrification of means of road transport, conventional vehicles are still the most frequently purchased by customers. An alternative are vehicles with a hybrid drive system. They are characterized by lower fuel consumption and lower emission of harmful exhaust compounds compared to conventional vehicles. The aim of this paper is to examine the dependence between route parameters and fuel consumption and emissions of harmful exhaust components of vehicles with a conventional and hybrid drive system.

PTNSS-2023-093

Technological developments in vehicles with electric drive

Emilia M. Szumska, Rafał Jurecki

Many passenger car manufacturers are already reporting that after 2030, vehicles equipped with electric propulsion will account for half of the models produced. Among electric vehicles, there are battery-powered electric vehicles, hybrid vehicles in which an internal combustion engine works with an electric drive, and vehicles with fuel cells and a battery. Over the years, these vehicles have undergone constant change. The aim of this paper was to review trends in the development of pure electric vehicles and plug-in hybrid vehicles. The development of energy storage technology has extended the range of electric vehicles. Over the years, the energy capacity of the battery has also increased with a slight growth in the curb weight of the vehicle. In recent years, the plug-in hybrid has also undergone continuous improvement. The energy capacity of the battery and the power of the electric motor have been increased with a slight increase in the curb weight of the vehicle. This results in a longer electric range and lower fuel consumption.

PTNSS-2023-094

Possibilities to modify the properties of the AW7075 aluminum alloy for the automotive industry

Grzegorz Chruścielski, Robert Jasiński

The paper analyzes the structural aluminum alloy AW7075 used in the automotive industry, which is widely applied, among others, in the production of heads or engine blocks. The work compares the possibilities of obtaining various properties of the AW7075 alloy (material states) by appropriate heat treatment (saturation and aging). It is assumed that the optimal properties of AW7075 are obtained for the T651 condition, in which, as a result of stretching and artificial aging, the residual stresses are eliminated and dimensional stability after machining is ensured. However, in some applications, other states of AW7075 are preferable, in which the material exhibits greater ductility, and thus, as shown in tests, higher fracture toughness. Such properties are of particular importance in elements burdened with the occurrence of notches. Therefore, this paper presents the results of tests on the strength, hardness, resistance to abrasive wear and fracture toughness of the AW7075 material in the T651, T73, RRA and HTPP states. The results prove the wide and diverse possibilities of using the AW7075 alloy, depending on its state, which should be used consciously in the design and production processes of automotive drivetrain components.

PTNSS-2023-095

Comparative studies of hybrid passenger cars in real traffic conditions

Wojciech Gis, Jacek Pielecha

The purpose of this article is a comparative assessment in domestic real traffic conditions (RDE tests – Real Driving Emissions) of exhaust emissions and fuel consumption as well as the energy intensity of hybrid passenger cars (PHEV, HEV), in the existing RDE tests (Euro 6d) and the revised RDE tests (Euro 7), as well as a comparative estimation of CO2 emissions in the life cycle for the tested cars using the above results. The article includes: 1) test results in RDE tests according to the Euro 6d standard, 2) amendment of the Euro 7 standard in terms of road tests of passenger cars, – test results of hybrid cars (HEV and PHEV) in RDE tests (Euro 6d), 3) test results for hybrid cars (HEV and PHEV) in RDE (Euro 7) tests, 4) comparison of the results of emissions and energy consumption for the tested variants of hybrid cars, in the above research conditions), 5) comparative estimation of CO_2 emissions in the life cycle of the above-mentioned of the tested hybrid cars, taking into account the above research conditions.

PTNSS-2023-096

Testing the safety systems of public transport vehicles equipped with an electric drive

Ewa Siemionek, Piotr Hołyszko, Aleksander Czajka

Studies of the safety systems of public transport vehicles equipped with an electric drive have shown that there are some challenges related to ensuring the safety of passengers and drivers. The article discusses the main problems, such as the risks associated with fire, electrical discharges and failures of security systems. The results of testing the electric bus and trolleybus safety systems were presented, as well as fire prevention methods and methods of dealing with safety challenges, including the use of appropriate insulating materials, insulation levels and systems for monitoring and implementing safety procedures. The authors of the article point out the need for continuous improvement of safety systems in electric vehicles to ensure maximum safety for users of urban transport.

PTNSS-2023-097

Relation between engine load profiles of agricultural tractor in real work conditions and their actual environmental impact

Tomasz Kalociński

Emission of exhaust gases produced by internal combustion engines have been identified as an significant concern to public health and natural environment since 1960s. That concern have been recognized by most of the industrialized countries and resulted in introduction of respective emission norms across different sectors. Agriculture environment have been also largely impacted since introduction of internal combustion engines in to farming operations. Reduction of pollutants generated by non-road machinery during farming operations can be decreased by detail research and understanding of internal combustion engine work profiles within agriculture sector. Non-road machinery, widely used in agriculture vary significantly among each other. Also, their operational parameters within different farming operations can differ depending of work type. Agriculture tractor alone as one of the most popular non-road machinery within agriculture sector works under many different work patterns and operational types. Understanding of those work scenarios and estimating their influence on natural environment is crucial for appropriate emission reduction and technologies applied. Presented paper discusses certain internal combustion engine work patterns for agriculture tractor within various operational scenarios and relate them to known emission standards and procedures to assess their relevance in real working operations and conditions.

PTNSS-2023-098

Combustion comparative analysis of pyrolysis oil and diesel fuel under constant-volume conditions

Magdalena Szwaja, Arkadiusz Szymanek

The article discusses the research results on the combustion of pyrolysis oil derived from the pyrolysis of HDPE plastics after its distillation. The tests were carried out in a constant-volume combustion chamber in conditions similar to those in a compression-ignition engine with a compression ratio of 17:1. The phases of premixed and diffusion combustion and the ignition lag were determined. Then, diesel fuel combustion tests were performed under similar pressure-temperature conditions. Comparative analysis was used to draw conclusions as follows: the percentage fraction of heat released from the premixed combustion phase to total heat for pyrolysis oil was nearly 22%, whereas this parameter is 15% for diesel fuel, the maximum combustion rate for the premixed combustion phase for pyrolysis oil was approximately 27% higher than the premixed combustion rate for diesel fuel, the ignition lag for pyrolysis oil was slightly longer compared to that for diesel fuel. The presented parameters have a significant impact on both the development of combustion and the thermal efficiency of the internal combustion engine. Summing up, one can conclude, that pyrolysis oil can be applied as a substitute for diesel fuel both as a single fuel or blend component with it.

PTNSS-2023-099

Investigations into the efficiency of the powertrain of a city bus

Łukasz Grabowski, Mirosław Wendeker

Research work on the energy efficiency of vehicles is driven, among other things, by limits related to fuel consumption carbon dioxide emissions. This also applies to city buses, where fuel consumption averages between 25 and 30 dm^3 per 100 km, which can be converted into approximately 87 kg CO_2 per dm^3. This article therefore presents the results of a study of the total efficiency of the power train of a city bus, taking into account the internal combustion engine, transmission, hydrokinetic clutch, and tyre friction on the rollers. The test object was a 12-metre city bus equipped with diesel engines and an automatic gearbox. The tests were carried out on a chassis dynamometer by implementing the World Harmonised Transient Cycle (WHTC). The WHVC driving test is a synthesis of the vehicle\'s on-road speeds and consists of three stages: Urban, Rural and Motorway. During the tests, the fuel consumption, vehicle speed and power generated at the wheels of the bus were recorded. From this, efficiency was calculated as the ratio of the power measured at the wheels of the bus to the power contained in the fuel supplied to the engine. Efficiency was shown to range from 5 to 22%.

PTNSS-2023-100

Comparison of operational parameters and stability of operation of an automotive SI engine powered by methyl and ethyl alcohols

Zdzisław Stelmasiak, Dariusz Pietras, Piotr Pietras

The article presents research results performed using automotive spark ignition engine run on methyl and ethyl alcohols as well as gasoline as reference fuel. The research was performed on automotive engine of Fiat 1100 MPI type. The subject of the performed analysis was to compare operational parameters of the engine such as: engine power output, overall efficiency, emission of toxic components of exhaust gases, as well as comparison of course of combustion process calculated on the basis of recorded and averaged indicator diagrams, and on the basis of individual combustion cycles. The averaged diagrams were used in analysis of the pressure course during combustion, in analysis of pressure growth rate and heat release rate. Diagrams of individual combustion served for assessment of operational smoothness of the engine when fueled with alcohols. As the reference, parameters measured in case of gasoline fueling were used. The experiments have confirmed stable engine operation on methyl and ethyl alcohols. Increase of engine power output with o 3.8–7.7% was confirmed for methanol and with 1.7–3.3% for ethanol, while increase of the efficiency with 1.5–7.5% was confirmed for methanol and with 1.2–2.5% for ethanol, comparing with gasoline fueling. Obtained results are pointing at possibilities of fueling of modern SI engines with alcohols only, especially including water-logged ethyl alcohol, obtained directly from distillery. This should increase share of alcohols in overall balance of consumed engine fuels.

PTNSS-2023-101

Influence of oil service life on selected performance parameters of an aircraft piston engine

Michał Trendak, Jacek Czarnigowski

This article presents an analysis of the influence of oil service life on the performance parameters of an aircraft piston engine lubrication system used in an ultralight aircraft. The ageing of oil between oil changes causes a change in its parameters (such as density, viscosity...). These parameters have a strong influence on the level of protection of the lubricated components. Currently, in aircraft, oil changes are carried out according to a time schedule - oil is changed every fixed period (residual life) regardless of its actual condition. The task of this article is to test the possibility of indirect assessment of oil condition based on analysis of changes in selected parameters of engine lubrication system operation during normal operation. The oil warm-up speed during the pre-start procedure and the dependence of oil pressure on engine speed were assumed for the analysis. The study was conducted on an ultralight rotorcraft during normal operation. Selected first daily flights directly after oil change, and after 17, 32, 50, 66 hours of operation were analysed. It was shown that the warm-up rate changes in the samples analyzed, but that this change may also be due to factors other than oil operating time. In the case of the oil pressure vs. speed characteristics, different characteristics were shown for different operating time, but no specific dependencies were found.

PTNSS-2023-102

Modern methods of test bed modernization – reverse engineering

Michał Rawecki, Wojciech Cieślik, Dawid Mielcarzewicz

The pursuit of increasing the efficiency of internal combustion engines is an ongoing engineering task that requires numerous research efforts. New concepts of injection or combustion systems require preliminary investigation work using research engines. These engines, usually single-cylinder, make it possible to isolate a single variable in a complex combustion mixture preparation process, thus enabling analysis of the changes being made. However, these engines are relatively expensive and their designs are offered by a limited number of manufacturers. The authors of the presentation will present the reverse engineering process of the currently used test stand in terms of its modernization for future research on alternative fuel combustion. The process of reverse engineering, together with design assumptions that finally contributed to the construction of the assumed solution has been described in this research.

PTNSS-2023-103

Use of a Stage V engine in an upgraded SM42 diesel locomotive

Maciej Andrzejewski, Maciej Frankowski, Łukasz Stępniewski, Zbigniew Cichoński

This paper describes the comprehensive retrofit of 13 SM42 series diesel locomotives (factory designation 6D) carried out by H. Cegielski – Fabryka Pojazdów Szynowych Sp. z o.o. for PKP INTERCITY S.A. on the basis of the results of an open tender. According to the terms of reference, the customer required the replacement of the A8C22 diesel engine and specified the basic performance of the locomotive after the upgrade. In order to fulfil the task and meet the requirements of the ToR, the contractor used two Deutz-type TCD 16.0 V8 internal combustion engines of 480 kW each. The drive train configuration was designed to allow the vehicle to be used as a shunting locomotive as well as hauling and powering light passenger trains. The use of a dual drive train allowed these requirements to be met, as each of the main generators could be used for traction or to supply power to passenger coaches. As part of the upgrade, the vehicles were fitted with modern, energy-efficient combustion engines that meet the latest Stage V RLL emissions standard. The vehicle's traction characteristics have been improved, fuel consumption has been reduced, safety has been enhanced and the reliability of the locomotive's operation has been increased. The locomotive has also gained the ability to haul passenger trains on diesel traction, adding this type of vehicle to the operator's fleet.

PTNSS-2023-104

Development of a new generation of turbochargers for large engines that meet market requirements and the latest emission standards

Wojciech Tasior, Marcin Reiman, Tomasz Zajdel, Michal Zatek

Global sales situation for the internal combustion engines in the commercial vehicles/machines segment is dynamically changing which drives market demand for new generation of turbochargers. The existing solutions do not meet the latest, demanding emission standards, quality and dimensions (optimization of size and weight). The underlying technology dates back to the 1980s and the possibilities for optimizing it have been exhausted. The materials used have been withdrawn from the market and cannot be used in current applications. This mainly applies to lead-free materials for plain bearings and thrust bearings. Designing a completely new product required the use of the latest design techniques and analytical tools for rotor dynamics, CFD flow analysis and thermomechanical fatigue. The newly designed solution was comprehensively tested in a specialized R&D center in the United States. The use of SAE 0W20 oil should be emphasized. Physical tests of the turbochargers proved the correctness of the design process and confirmed or significantly exceeded the assumed parameters. A significant increase in the efficiency of the turbocharger was observed with a simultaneous reduction in the weight and axial length of the rotors, combined with a reduced level of oil flow, which is a positive phenomenon in terms of environmental protection. The stability of the rotor operation in extreme configurations of the size of the compressor and turbine wheels has been improved. The bearing system is capable of carrying axial loads more than three times greater than the previous solution.

PTNSS-2023-105

Comparison of selected materials of high-pressure pumps' delivery sections

Wojciech Karpiuk, Marek Idzior, Rafał Smolec

In this paper, a comparative analysis of structural materials used in the construction of high-pressure pumps' delivery sections was carried out. The focus was on a comparison of the ceramic materials: corundum (alumina, Al2O3) and silicon carbide (solid-state sintered) – SSiC with bearing alloy steel 100Cr6, i.e. the most common material used to make piston and cylinders of the delivery section of common rail injection pumps. Simulations performed using FEM have proven that ceramic materials have a number of advantages and could therefore be an interesting substitute for materials traditionally used in this area.

PTNSS-2023-106

Modifications to an engine lubricating system improving lubrication at engine cold-start

Stanisław Szwaja, Mirosław Szymkowiak, Szymon Szymkowiak, Magdalena Szwaja

The subject of research is a device for lubricating an internal combustion reciprocating engine or compressor before starting it up. This device can be used for pre-lubrication immediately prior to start-up of the engine equipped with an oil lubrication system fed by an oil pump. From the state of the art review, there are engines that can be lubricated before starting by an additional oil pump driven by an electric drive. Such a solution is implemented at the engine or compressor construction stage and is characterized by a more complex design and possibly higher costs than the proposed invention. It has been found that pre-lubrication prior to engine start-up is beneficial for the durability and reliability of its operation. The principle of operation of the proposed device is based on the accumulation of potential energy in the form of high pressure in an additional hermetic tank filled with lubricating oil. The lubricating oil from this tank will be pushed into the engine or compressor lubrication system due to its high hydrostatic pressure. Starting the lube oil outflow from the tank and pumping it into the engine lubrication system occurs at the request of the engine operator or automatically immediately before starting the engine.

PTNSS-2023-107

The effect of ecological agents added to lubricating oil on selected operating parameters of an internal combustion engine

Rafał Krakowski, Tomasz Marut

The article presents the influence of ecological agents, i.e. the effective microorganisms and silver compounds addition to lubricating oil on operating parameters of an internal combustion engine. The basic diagnostic parameters of a piston engine determining its technical condition were described. In the further part, the research stand and materials were presented. In the main part of this article for pure oil compared to oil with the effective microorganisms and silver compounds addition were shown. It was found that the addition of effective microorganisms and silver compounds to the oil reduces the emission of toxic components into the atmosphere along with the exhaust gases, while the remaining engine operating parameters for each load value show that these additives do not cause deterioration of the technical condition of the tested engine. Of all the agents used, the best results are obtained with the addition of ceramic tubes, because it is an additive that does not affect the properties of the oil in its composition. The advantage of ceramic tubes is the slow release of effective microorganisms, which has an effect on the parameters of the oil and thus on the operation of the engine. In further research, it will be checked how these additives affect the anti-seize and anti-wear properties of the lubricating oil used, which should give a broader view of the impact of these additives on the technical condition of the operated piston engine.

PTNSS-2023-108

Analysis of uncertainty of the exhaust emission measurement on chassis dynamometer

Bartosz Puchałka, Jacek Nowakowski, Andrzej Szczotka

Legislation on the reduction of exhaust emissions, greenhouse gases and fuel consumption is one of the strongest drivers of the development of the automotive industry. Emission standards around the world define maximum allowable emission factors, but also (more importantly now) emission test methods and laboratory design. The article describes the methodology and indicates possible sources of errors, as well as factors affecting the exhaust gas emission related to the emission measurement methodology.

PTNSS-2023-109

FEM analysis application in identifying the causes of brake disc failure

Wojciech Ambroszko, Włodzimierz Dudziński, Sławomir Walczak

This article presents the results of brake disc tests aimed at identifying the causes of its failure. The first part of the article presents an analysis of the damageability of selected vehicle components, which showed that among the reported failures, the most failure was the braking system. The assessment of the brake disc worn "properly" as a result of operation and the deformed brake disc after a very short period of operation, which was the subject of further analysis. The next part of the article presents issues related to the modeling of thermal loads, and then, trying to assess and search for the cause of abnormal wear of the brake system element, the use of the Finite Element Method for the analysis and assessment of brake disc wear was proposed. In the final part of the article, conclusions and directions for further work were formulated.

PTNSS-2023-110

Investigations into the efficiency of the powertrain of a city bus

Mirosław Wendeker, Łukasz Grabowski

Research work on the energy efficiency of vehicles is driven, among other things, by limits related to fuel consumption carbon dioxide emissions. This also applies to city buses, where fuel consumption averages between 25 and 30 dm^3 per 100 km, which can be converted into approximately 87 kg CO_2 per dm^3. This article therefore presents the results of a study of the total efficiency of the power train of a city bus, taking into account the internal combustion engine, transmission, hydrokinetic clutch, and tyre friction on the rollers. The test object was a 12-metre city bus equipped with diesel engines and an automatic gearbox. The tests were carried out on a chassis dynamometer by implementing the World Harmonized Vehicle Cycle (WHVC). The WHVC driving test is a synthesis of the vehicle\'s on-road speeds and consists of three stages: Urban, Rural and Motorway. During the tests, the fuel consumption, vehicle speed and power generated at the wheels of the bus were recorded. From this, efficiency was calculated as the ratio of the power measured at the wheels of the bus to the power contained in the fuel supplied to the engine. Efficiency was shown to range from 5 to 22%.

PTNSS-2023-111

Determination of the effect of the addition of FAME biocomponents to diesel fuel on selected parameters of biofuels of type "B"

Grzegorz Wcisło, Leśniak Agnieszka, Pracuch Bolesław, Dariusz Kurczyński, Piotr Łagowski

The aim of the research was to determine the effect of FAME biocomponent additives produced from used cooking oils on selected parameters of "B" type biofuels. For this purpose, using our own technology and the GW-200 reactor, FAME methyl esters were produced from two types of oils. One was a mixture of various post-frying oils, and the other was rapeseed oil on which the fish was fried. Then biofuels of type B20, B40, B60 were composed. Five types of fuels were used during the tests. In addition to the above VERVA B0 diesel oil and pure Biodiesel, i.e. B100, were used as the reference fuel. The following fuel parameters were determined: heat of combustion and calorific value, fractional composition, ignition temperature, kinematic and dynamic viscosity as a function of temperature. In the transesterification process, it was possible to obtain high-purity FAME esters that meet the requirements of the PN-EN14214 standard. The conducted analysis also showed that both Biodiesel RME B100 from rapeseed oil and biofuel type "B" with its participation as a biocomponent were characterized by all slightly better parameters than biofuels with a biocomponent made of a mixture of oils.

PTNSS-2023-112

Exhaust emissions from a direct injection spark-ignition engine fueled with high-ethanol gasoline

Miłosław Kozak

Ethyl alcohol is a known additive to automotive gasoline. In commercial gasolines, its content is 5 and sometimes even 10%. Since ethyl alcohol can be produced as a renewable fuel, efforts are being made to further increase its content in gasoline. The article describes the results of experiments on a direct injection spark-ignition car engine with fueled by comparison with conventional gasoline (E5) and gasoline with ethyl alcohol content increased to 30% (E30). The test results showed that a significant share of ethanol in fuel did not affect the emissions of toxic gaseous components (CO, HC, NO_x), i.e. three-way catalyst effectively removed these components, regardless of the fuel. Slightly lower CO_2 emissions with E30 fuel are noticeable. A significant difference, however, was clearly lower particulate number emissions (PN) for the fuel of high ethanol content.

PTNSS-2023-113

Preliminary tests of a Diesel engine powered by diesel and hydrogen

Rafał Longwic, Dawid Tatarynow, Gracjana Woźniak-Borawska, Michał Kuszneruk

This article discusses the possibilities of powering a commonly used diesel engine with renewable fuels. It analyses scientific studies that clearly indicate that the use of hydrogen is a potentially future-proof option due to its potential to reduce specific fuel consumption and improve performance and increase thermal efficiency. The research was carried out on a laboratory bench designed to test a diesel engine fueled by different fuels. A proprietary hydrogen injection system with dedicated control software was used. Hydrogen injection pressures of 1.5, 1.8, 2.0 MPa and hydrogen injector opening times of 2.5, 3.0, 3.5 ms, respectively, were set as control parameters. The rapidly varying engine operating parameters were recorded and the parameters calculated from them were analysed

PTNSS-2023-114

Comparative analysis of pressure waveforms in the cylinder and before the injector of a compression-ignition engine

Tomasz Knefel

The article describes issues related to the operation of a compression-ignition engine in static conditions. The results of tests carried out at measurement points covering the entire range of engine operation are presented. The tests consisted in indicating the engine and measuring the pressure before the injector, for various rotational speeds and loads. Based on the measurement data, the centers of gravity of the pressure waveforms were determined. An attempt was made to determine the relationships between the calculated quantities and to describe the differences between them. Linear and non-linear regression models were used for collective summaries of the centers of gravity of the runs. Thanks to the use of such a procedure, high values of the coefficient of determination were obtained. Areas of supplying the largest amount of energy in the injection process were determined.

PTNSS-2023-115

Method of assessing the fuel consumption of mining machines

Monika Magdziak-Tokłowicz, Zbigniew Sroka, Lech J. Sitnik

The following article describes the Fuel Consumption Model (FCM) of mining machines and the method of its assessment a given system. FCM was divided into three separate models: Environment, Vehicle, Human. The basic parameters for the Environment model were detailed, such as: terrain, temperature, pressure, humidity, dust, type of road infrastructure in the mine. By indicating the wheel loader as the type, the assessment basis for the Vehicle model was defined. Age, health, well-being, skills and driving style, which are parameters in the Human model, were verified. Statistical analysis of the data was performed to determine the dominant parameters in specific fuel consumption, and then the Fuel Consumption Model of mining machines was created on the basis of multiple regression. An important achievement of this study is the construction of the MLP 3-8-1 neural network that forecasts the average specific fuel consumption of a wheel loader in the described system.

PTNSS-2023-116

A comparative study on selected physical properties of diesel–ethanol–dodecanol blends

Artur Krzemiński, Paweł Woś, Hubert Kuszewski, Artur Jaworski

The article presents findings of the comparative analyses of the selected physicochemical parameters of commercial diesel fuel and diesel-ethanol blends with addition of dodecanol, used in order to stabilise the blend Diesel fuel and the blends were tested for density, flash point and cold filter plugging point. The study was conducted to assess the selected physicochemical properties of diesel-ethanol blends with addition of dodecanol and to compare these with commercial diesel fuel.

PTNSS-2023-117

Empirical modelling of synthetic fuel combustion in a small turbofan

Andrzej Kulczycki, Radosław Przysowa, Wojciech Dzięgielewski, Tomasz Białecki, Bartosz Gawron, Jerzy Merkisz, Ireneusz Pielecha

Drop-in fuels for aviation gas-turbine engines have been introduced recently to mitigate global warming. Despite their similarity to mineral fuel Jet A-1, their impact on the combustion process in traditional combustors should be thoroughly analysed to maintain engine health and low emissions. The paper introduces criteria for assessing the impact of the chemical composition of fuels on the combustion process in the DGEN 380 turbofan. Based on the test-cell emission measurements published earlier by the authors, the following power functions of carbon monoxide and its emission index were adopted as the model of the combustion process: CO = a_{CO} m_f^n CO and EI_CO = a_{EI_CO} m_f^n EI_CO. Based on the general notation of chemical reactions leading to the production of CO in the combustion process, the coefficients a_{CO}, n_{CO} and a_{EI_CO} and n_{EI_CO} were given a physical meaning by linking them with the parameters of the kinetic equations, i.e. the rate constants of CO and CO_2 formation and the concentration of O_2 in the exhaust gas, as well as stoichiometric combustion reactions. The obtained empirical functions show that in the entire range of engine operating parameters, synthetic components affect the values of the rate constants of CO and CO_2 formation.

PTNSS-2023-118

Comparative studies on the effect of biofuel additives of various origins on combustion and emissions in diesel engine

Paweł Krzaczek, Jacek Hunicz, Michał Gęca

The constant increase in the demand for energy caused by the global civilization and demographic development leads to a dynamic increase in the popularity of waste recycling in order to obtain useful energy sources. This means that the transformation of waste into useful energy is becoming one of the leading directions of replacing commonly used energy carriers. In the case of diesel engines, regular diesel is most often replaced with a cleaner alternative in the form of biodiesel. Typically, biodiesel is made from vegetable and animal oils and their mixtures in the transesterification process. The different origin of the raw materials for the production of biodiesel affects its physicochemical properties, and thus has a significant impact on the process of creating the mixture and the subsequent combustion process. This does not always result in favorable changes in emissions and operating parameters of a diesel engine. In order to determine the level of these changes, comparative tests were carried out on a single-cylinder engine equipped with a Common Rail injection system fueled with mixtures of diesel oil with esters of higher fatty acids from rapeseed oil, cooking oil, poultry oil and beef oil, and diesel oil as a reference. The scope of measurements includes the analysis of exhaust gas concentration and engine efficiency parameters at various fuel pressures in the fuel supply system. In addition, cylinder pressure measurements are performed to gain insight into the differences in the combustion characteristics of the tested fuel mixtures. The addition of biofuel, regardless of its origin, reduces PM emissions, especially at low injection pressures. On the other hand, slight changes in the level of NO_x emissions for mixtures were found, especially at higher fuel injection pressures.

PTNSS-2023-119

Influence of exhaust manifold modification on engine power

Monika Andrych-Zalewska, Bartosz Bober, Piotr Boguś

The article deals with the subject of the impact of an exhaust system on the power of the internal combustion engine. In particular the article shows the possibility of increasing a power of the gasoline drive unit, interfering only with an exhaust system. The purpose of the tests carried out is to compare the results of measurements from the chassis dynamometer before and after the modification, and additionally to perform simulations for the key parts of the system in terms of shaping the power and torque curves. The analysis includes a simulation model of the exhaust gas flow through the serial manifold and also the sport manifold, especially the pressure distribution and the course of the velocity vectors at the characteristic points of the element. Before obtaining the final results of power measurements on the sport units, the roughness of the steel from which the collectors were made was also measured. The final stage is the measurement of power on the new exhaust system. The obtained results of power measurements and simulations were presented in the form of a summary, which focused on the impact of individual fluid mechanics phenomena on the formation of power and torque curves and detailing the advantage of the new exhaust system in comparison with factory system in terms of increasing the performance of the tested vehicle.

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