SEED conference

BOOK OF ABSTRACTS

3rd International Conference on the Sustainable Energy and Environmental Development

October 16-18, 2019 | Krakow (Poland)

Institute of Sustainable Energy

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PREFACE

Processes occurring in environmental ecosystems and the rapid energy sector development result in a high demand for combination of both Energy and Environment research fields. A multitude of topics: energy production and storage, simulations in modern energy systems, alternative and traditional fuel production, environmental causes of these actions, waste management, environmental policies and many others befitted in the thematic scope of the 3rd International Conference on the Sustainable Energy and Environmental Development (SEED2019 Conference), which took place at Kosciuszko Mound in Krakow on October 16th-18th, 2019. The Conference was dedicated to Scientists from around the world representing academic institutes, research and development institutes as well as the industrial fields from energy and environmental sectors. This book presents the abstracts of topics presented by the participants at the SEED2019 Conference.

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THE CONTENT

THE LONG-TERM USE OF SOLAR ENERGY FOR COOLING IN THE ADSORPTION CYCLE

Roman Aleksander Duda[1,*]

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The main objective of this article is to show the usage of solar energy with regard to the powering of the adsorption cooling cycle over the course of a few years. The test stand is installed in the Laboratory of Thermodynamics and Measurements of Thermal Machines at Cracow University of Technology and has been constantly working since 2013. In this case, the adsorption cycle is applied as a high temperature stage for cooling a carbon dioxide condenser in the subcritical stage of low-temperature compression refrigeration. However, the main attention of this article is focussed on the issue of how, in the Polish climate, solar heat can be used for the production of cold in the adsorption cycle. The adsorption cycle can work either as one of the two stages of the refrigeration cycle or directly for air conditioning purposes. The temperature of chilled water during our research was 6-10°C. The aim of the presented analysis is to show how much solar radiation could be used over the course of several years of operation in the real anticlockwise cycle conditions. During the hot season 2019, due to the high variability of environmental conditions, the discontinuities in the tracking control algorithm were the main issue. The algorithm using a neural network approach was designed for system operation control. The spraying system in the wet cooling tower is also controlled using an inverter for the feed pump. This solution allows for the reduction of the averaged power required for the wet cooling tower up to 70%.

IDENTIFICATION OF THE FACTORS AFFECTING THE SCALE OF THE PARTICULATE EMISSION IN GASOLINE VEHICLES

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The popularity of the gasoline vehicles has been increasing for a several years. The production of the light duty and passenger vehicles is also increasing, exceeding 10 million new units every year, adding to the total of over 1 billion vehicles in the world [1]. In the last decade the emission limits become more restrictive, yet the methods of emission decreasing must be improved [2,3]. Even seemingly insignificant amount of emission from single vehicle multiplied by the colossal number of cars might be a serious threat to the health and environment. The identification of the factors influencing the scale of emission is divided into the four groups:

1. Pre-combustion – that includes gasoline and engine oil production
2. During combustion – that combine type of the fuel supply, quality of combustion, engine architecture and control
3. Driving style – including driving style and proper driver habits
4. Exhaust aftertreatment – that focus on the efficiency of the three way catalyst and the gasoline particulate filter.

The aim of this work is to collect complex information about factors that are influencing the particulate emission and from that point set the most favoured direction of the further research. Beside particulate emission factors this work also shows anions emission from two similar gasoline vehicles from the 2017 and 2019 conducted on the Ion Chromatograph The comparison include Euro 6d implementation and differences between two 100 kW engines from two manufacturers.

[1] IHS Markit, “Light Vehicle Sales Forecasts,” 2017.
[2] N. Sharma and A. K. Agarwal, “Gasoline Direct Injection Engines and Particulate Emissions”, in Air Pollution and Control, N. Sharma, A. K. Agarwal, P. Eastwood, T. Gupta, and A. P. Singh, Eds. Singapore: Springer Singapore, 2018, pp. 87–105.
[3] European Commission, “Commission Regulation (EU) 2017/1151,” Off. J. Eur. Union, 2017

THE AIR DIRECT-CONTACT, GRAVEL, GROUND HEAT EXCHANGER - APPLICATION IN SINGLE-FAMILY RESIDENTIAL PASSIVE BUILDINGS

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The paper presents proposals for the possibility of using of the air direct-contact, gravel, ground heat exchanger in single-family residential buildings with a passive house standard, according to the Passive House Institute (PHI). The methodology of their application consists in using heat and cold form the ground at an insignificant depth, through a aggregate, which is buried in the ground. Above solution of simple installations is used for preheating and cooling fresh air drawn into the building through a mechanical ventilation system with heat recovery. In more complex applications it can be integrated with the source of heat and cold of passive buildings to create complete heating, cooling and ventilation systems. In both cases the air flowing through exchanger is cooled and dried in summer, heated and humidified in winter and filtered from pollen from plants and bacteria all year. Direct contact of the deposit with the surrounding native soil facilitates rapid regeneration of the bed temperature. The article presents several proposals for integration with systems ensuring climatic comfort in a passive building, as exemplary applications.

The paper presents preliminary estimates of energy, economic and environmental benefits related to the implementation of the above solution in various configurations of technological systems for buildings located in Poland. The integrated solutions of technical systems presented in the article are an interesting alternative to traditional heating, cooling and ventilation systems.

EXPERIMENTAL ANALYSIS OF THE PROTOTYPICAL MICRO CHP SYSTEM POWERED BY BIOMASS-FIRED BOILER AND OPERATES ACCORDING TO A MODIFIED RANKINE CYCLE

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Nowadays, renewable energy based micro cogeneration systems (micro-CHP) are becoming more and more popular. Due to many advantages, such systems may be succesfully used e.g. in domestic, commercial, and agricultural sectors. On the other hand, there are still several problems which have to be solved before their commercialization. This paper discusses challenges related to the design and construction of micro-CHP units on the example of prototypical micro-CHP system. This system is powered by a 100 kWth biomass-fired batch boiler and operates according to a modified Rankine Cycle. Steam is generated and superheated in two shell and tube heat exchangers and powers a steam engine. Next, it is condensed in another one shell and tube heat exchanger and pumped to the degasifier. Electricity is generated in a power generator connected to the steam engine.

Presented results include an analysis of the operation of oil and steam-condensate circuits in different conditions. There are discussed e.g. temperature, pressure and power variations (both in the boiler, oil and steam-condensate circuits), which directly impacted on the steam engine operation. As was shown, actual configuration of the developed system allows only for power generation at a level of 1.15 kW_{el}. Such a low value results, e.g. from the limitations in maximum oil temperature, not optimised evaporator heat exchange surface, large pipe capacity, and low power generator capacity. These limitations were discussed and guidelines for further system improvements were elaborated.

ENERGY AND ENVIRONMENTAL ASPECTS OF OPERATION OF THE MICRO-CHP UNIT WITH WOOD-FIRED STOVE AND THERMOELECTRIC GENERATOR

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Nowadays, micro-scale cogeneration systems, powered by renewable energy sources, are considered to be a promising option e.g. for residential sector and off-grid installations. They allow to recover waste heat from domestic heat sources (such as boilers and stoves), increase energy security of buildings and ensure power supply for objects not connected to the grid. Among currently available technologies, thermoelectric generators (TEGs) are characterized by relatively low costs, simple installation and wide availability.

This paper shows energy and environmental analysis of introducing TEG to the wood-fired stove. Experiments were carried out using dedicated test rig equipped with stove, air-cooled TEG, flue gas and dust analyser, infrared camera and advanced measurement and control system. The first part of the tests focused on determining the CO, CO_2, O_2, SO_2, NO_x emissions and particular (PM) emission during wood and briquette combustion in typical conditions. Then, modifications in the furnace's construction were introduced – inlet ceramic fitting was removed and TEG was mounted on the external stove's surface. Emissions obtained in this part were compared with previous values. Beyond environmental analysis, the operation characteristics of the studied TEG were performed. They were carried out for various temperature levels, resulting e.g. from fuel input, phase of the combustion process and a way of controlling combustion process. At the end of investigation, also the economic analysis was conducted - investing costs and operation benefits were discussed.

TECHNO-ECONOMIC ANALYSIS OF A STRAW-FIRED CHP SYSTEM

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Heating installations based on biomass, especially straw, are interesting option for rural areas. The wide availability of straw and the simplicity of the construction of batch boilers, combined with its low operating cost, allow to generate heat in an ecological and economically viable manner. The most common solutions include the use of batch boilers with an oil jacket, which enables to reach the temperature level at the outlet up to 200°C. Thermal oil at this temperature can be the power supply for both steam systems and for heating spaces or to generate cold. The paper presents experimental analysis and validation of a similar installation model with a 100 kW_{th} boiler and 20 hp steam engine. The temperature of oil leaving the boiler is kept at the level not exceeding 220°C, and heats, and then evaporates and overheats medium from the water-steam circuit in two heat exchangers – evaporator and superheater. Basing on data collected by the PLC system, a dynamic model of the installation was prepared with the use of TRNSYS software. After that it was validated, and the improvements were proposed. The economic parameters of the installation were determined basing on the carried out tests.

SYNERGETIC EFFECT OF BLACK LIQUOR AND HARD COAL BLENDING FOR FUEL REACTIVITY DURING STEAM GASIFICATION

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The Kraft process is a backbone of modern papermaking technologies. Introduced in it opened a new quality to pulp and paper industry by creating a process circle with sodium solvent continuous recovery and therefore, the minimized waste stream. The impact of the technology was substantial but did not reinvent one of the main challenges of the sector – the waste treatment. Obtaining cellulose from woody biomass requires dissolving the other constituents in Na_2S solvent. As wood generally consists of less than 60% of cellulose and hemicellulose, the waste (known as Black Liquor) is about equal in dry mass to the amount of pulp produced. The need to recover the reagent with subsequent waste utilization resulted in onsite waste incineration of organic wastes. Gasification for decades served as one of the possible solutions. Unlike combustion, the process aims for the conversion of the feedstock into a multi-purpose gaseous mixture, allowing for fuel and chemical production. As the most popular medium for the process, steam, is present in the Kraft cycle in large quantities, the pulp mills could be granted an option to become biorefineries rather than just energy producer. The recent advances suggest, however, that using only black liquor is not viable enough due to low quality of fuel and excess alkali content present and suggest blending it with other fuels for the better economy of the process and potential catalytic effects of alkali. This research chooses low-rank hard coal as the most economical choice for gasification based chemical production. The hard coal was blended with black liquor in quantities known to provide a catalytic effect. Observations on changes in fuel conversion and synthetic gas were observed with variable blends in temperature conditions (800-1000^{o}C) were observed.

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INDUSTRIAL WASTES AS A SUBSTITUTE FOR CATALYTIC MATERIAL DURING STEAM GASIFICATION

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Catalytic gasification is an industrial technology devised several decades ago with merit to enhance the overall performance of the process. The new element in the whole concept was the addition of specific compounds to the fuel in limited quantities to increase the solid feedstock conversion and its yield into a gaseous mixture that is later used for energy production or chemical processing applications. The research at that time has shown that apart from well-known catalysts, such as platinum or iron, there are also relatively affordable and easily accessible alkali and alkaline earth metals, such as Na, Ca, K, Mg. What is more, the effect works not only with typical methods of implementing catalysts on the feedstock, such as a wet precipitation method, but the direct addition of the catalyst is also viable. Despite the potential, the catalytic gasification technologies began their implementation only recently, but have managed to reach industrial level relatively quickly and place itself as a new path for processing technologies to explore. The research presented concentrates on the new potential iteration of the technology that combines catalytic conversion of coal feedstock with industrial waste management. The measurements utilised alkali-rich industrial wastes in a co-gasification process with hard coal with the evaluation of the catalytic performance. The conclusion included a comparison to the conventional catalytic process, featuring wet impregnation of an alkali catalyst.

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DEDICATED STRAW DRYER: MEASUREMENTS OF STRAW DRYING AND THERMOGRAPHY

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In many European countries, notably in Poland, there is a significant demand for space heating. This could be largely satisfied by biomass, primarily in rural areas, where biomass is locally available, mainly as agricultural residues. In Poland, this is mainly straw, which is often burnt uselessly in the fields, although it may become an environment friendly fuel for heating the rural holdings, if burnt in dedicated biomass boilers. One of the main problems of the energy use of biomass is the bulk density as well as the calorific value. One of the most important factors influencing on the biomass calorific value is humidity. The higher humidity of the biomass the calorific value of biomass is lower. It should be mentioned that there is a lower and upper limit of humidity, which should not be exceeded in energy use of biomass. This has negative effect on biomass combustion process and biomass boiler construction elements. The paper presents experimental results of the heat and mass transfer in a round bale of straw during the straw drying in three different configurations. The experimental measurements were made in a specialized stand of straw driers. Flue gasses, comes from straw combustion in biomass boiler, are used as a drying agent. There were made measurements of humidity and temperature inside the round straw bale during the drying process. Moreover, the temperature, humidity and flow of the drying medium were measured. In addition, a thermographic analysis of the straw bale surface was made to determine the best method of straw drying in the form of round bales. Finally, the best configuration of straw drying was chosen. It is possible to get a better fuel in a very short time and more energy production during straw combustion in biomass boilers.

ENERGY-ECONOMIC ANALYSIS OF A SMALL-SCALE HYBRID TRIGENERATION SYSTEM INCLUDING BIOMASS-FIRED STEAM CYCLE AND WIND TURBINE

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Many types of distributed generation systems based on renewable energy sources, as solar, wind, biomass and geothermal energy, are proposed and investigated in literature. In particular, a special category of such systems consists of hybrid plants where more than one renewable energy is used. Such systems allow one to exploit the advantages of each renewable energy source crating synergistic interactions from the energy, environmental and economic point of view. In small-scale hybrid applications, the investigation of biomass and wind energy is scarcely addressed in literature with respect to other hybrid configurations, as biomass and solar. The paper presents a novel small-scale trigeneration system based on biomass combustion, water steam turbine, absorption chiller and wind turbine. The system configuration includes a bidirectional connection with the electric grid allowing one to virtually store the electrical energy produced in excess and its use when needed. For the proposed system, residential buildings and a farm are considered as the case study. The investigation of the system is performed by means of the TRNSYS software and includes the analysis of the dynamic operation of the system and the energy and economic assessment of its performance. The model of the installation is developed using build-in and user developed components based on manufacturer data as well as realistic user demand. Particular, the system is designed to properly manage its energy flows in order to match the user thermal and electrical demand. The dynamic operation of the system is investigated on a weekly basis while the assessment of the global system performance is performed on yearly basis. The performance system is investigated for different design parameters (components capacities and set-point temperatures) and in case of a capital investment incentive strategy.

COAL FLOATABILITY – INVESTIGATION ON HYDROPHILY OF SURFACE

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Hard coal is a heterogenic material, it consist of organic matter, mineral water and it is very porous. Chemical structure of coal is (among the porous structure) the most essential factor for the sorption characteristic. Degree of the surface expansion (porous volume, specific the surface) has a big role for the sorption from gaseous phase. In this case chemical structure of the adsorbent the surface has less influence, especially for the polar adsorbents. The chemical structure means three-dimensional location of particle and kind of chemical bond between atoms which build substance. It belongs to remember (at estimate of carbon from structural estimation) about significant heterogeneity of structure of carbon substance, which presents mixture components (macerals) and minerals components.Presence of inorganic substance has unmistakable influence on behavior in processes of enrichments of coal methods of flotation, oil agglomeration and in other processes. The paper shows the results of steam sorption on the samples of hard coal. The process of absorption of steam depends on composition of chemical the surface layer, presence of reactive functional group, degree of oxidizing, physical structure of researched coal. Change of concentration of reactive functional group cause changes in their degrees of polarity. It places the simple scheme describing the surface acid-alkali dissociation of the functional group and forming of the surface association at the nature of ion pair. It proposes of definition of hydrophilic index WH for definite the hydrophobility. It appoints the active the surface of coal with a view of steam sorption.

MONTE CARLO METHODS FOR NUMERICAL SIMULATIONS OF THE LEAD-COOLED FAST REACTOR

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Closed nuclear fuel cycle is one of the most promising options for the efficient use of nuclear energy resources with full recycling of long-lived transuranic elements. However, it can be implemented only in innovative fast breeder reactors of Generation IV. The paper shows methodology applied in the analysis of the lead-cooled fast reactor equilibrium fuel cycle using the Continuous Energy Monte Carlo Burnup Code – MCB. The implementation of novel modules for nuclear transmutation trajectory folding allows to trace the life cycle of crucial minor actinides from the beginning of the reactor's life towards the state of adiabatic equilibrium. Changes in the mass contribution to gateway isotopes 242Pu, 243Am and 244Cm during 124.2 years were considered in the study. Numerical demonstration was performed for the reactor core designed within the European Lead-cooled System (ELSY) project and redefined in the follow-up Lead-cooled European Advanced Demonstration Reactor (LEADER) project. The results show that mass of 242Pu is continuously decreasing cycle-to-cycle over the considered period of fuel operation from the initial 371 kg to 207 kg (by 56%), the mass of 243Am at the end of operation equals 69.6 kg, which is about 17% higher compared to the initial mass of 57.9 kg and the mass of 244Cm has increased almost three times from 10.9 kg to 30.6 kg.

THE VALUATION OF THE OPERATIONAL FLEXIBILITY OF THE ENERGY INVESTMENT PROJECT BASED ON GAS POWER GENERATION TECHNOLOGY

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Energy technologies using natural gas for power generation, including electricity, are increasingly used in national power industry. This is because of their numerous advantages and changes taking place in the global energy markets. One of the major advantages of gas technology is its high operational flexibility defined as the availability of actions (decisions) that can increase the benefits from the use of gas technology. The power station can operate in a wide range of power, and be switched on and off depending on the energy demand. Start-up time ranges from several seconds to tens of minutes, depending on the system used and the capacity of power generation units. Traditional methods of assessing the economic efficiency of investment projects neglect their decision-making flexibility, understood in terms of the availability of specific options. The option value can be significant and significantly impact the valuation of the project. The high fuel prices are the reason why gas power plants are considered unprofitable. The paper presents the thesis that the flexibility, resulting from the dynamic (optional) switching on and off gas blocks in the process of electricity generation, increases the economic efficiency of the entire production process. The flexibility was defined as an option to dynamically turn on and off the gas units. The switching is a combination of two options – turning on and off the production. Valuation of the operational flexibility – the strategic (option) value of gas-steam power generation technology is based on real options analysis.

For this purpose, the operational flexibility measurement model, taking into account the Monte Carlo simulation, which is discussed later in the article, has been made. The obtained results of the analysis indicate the existence of “added value”, resulting from taking into account the option that has a significant impact on the valuation and development of the risk profile of the entire project investment.

MINING IN NATIONAL ACCOUNTS

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The mining industry is one of the most important economic sectors of many countries in the world, having a significant impact on the global economic situation. Quantitative estimation of raw materials production is a key determinant to analyze the influence of mining sector for local economic growth. The authors attempted to present the role of mining in economic growth in this article by providing definition and measurement methods used in economics for economic development: rate of growth for real social production or real national income. Authors utilize terms: Gross National Product and Gross Domestic Product, used to measure the total value of production and total revenue in the national economy. Particular attention was paid to the parameter GDP its evolution over the years both on a scale world, European and national. Authors discussed on mining industry participation in Gross Domestic Product for the Polish economy and approximate the Mining Contribution Index (MCI) as a measure of mining input in economy. The last part of the article contains a summary. The whole article stays closed by a list of literature.

THE IMPACT OF THE WIND FARM ON THE VOLTAGE LEVEL IN THE POINT OF CONNECTION TO THE POWER GRID

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Increasingly restrictive exhaust emission standards and the European Union policy aimed at increasing the share of renewable energy sources in the energy mix of the Member States result in an ever faster increase in the capacity installed in renewable energy sources. The increase in the installed capacity of distributed energy sources in the power system requires their inclusion in the processes of voltage and active and reactive power regulation. Depending on the generators they are equipped with, wind power plants may have a different impact on the voltage level at the point of connection to the power grid. Wind power plants with doubly-fed induction generators have wide possibilities of voltage and active and reactive power regulation. This makes it possible to use wind farms in the process of voltage regulation. The paper presents an analysis of the influence of a wind farm equipped with doubly-fed induction generators on the voltage level at the point of connection to the power grid depending on the generated active and reactive power.

THE USE OF STRAW FOR ENERGY PURPOSES

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Currently, much attention is paid to the use of biomass as an energy source. Replacement of some fossil fuels with biomass is aimed at reducing the consumption of conventional fuels and greenhouse gas emissions. Straw is agricultural waste, available in almost every region of Poland. The resources of unnecessary straw in our country amount to about 11.5 million tons annually. Practically all kinds of straw can be used for energy purposes. Straw as an energy carrier reduces the costs of heat generation, improves the profitability of agricultural generation and has a positive impact on the environment. In order for straw to be a valuable fuel, it must be properly stored and transported. Here, too, there are certain barriers. The first limitation in the use of straw in the power industry is its dispersion. Small farms do not have high crushing presses because of the high price, and intermediary companies between agriculture and energy are not interested in contracting straw from small areas. Another barrier is the differentiation of straw as a raw material. Its composition depends on the plant species, variety, fertilization, soil and weather. The heterogeneity of straw causes special requirements for the regulation of air in boilers for its combustion. In addition, straw is a volumetric material, which affects transport and storage costs. To reduce these costs, it is advisable to convert the straw into briquettes or pellets. This publication focuses on showing how straw can be extracted and processed to make it a fully fledged fuel.

COMPARISON OF ENERGY AND COST EFFICIENCY OF SELECTED TYPES OF LOW HEAT SOURCE HEAT EXCHANGERS FOR HEAT PUMP

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Poland is the leader of the infamous World Health Organization ranking - we have the most polluted cities in Europe. It is caused mainly by negligence in modernization of installations and heating systems, whose fuel is mainly coal - the largest source of pollution in the air. Increasing public awareness leads to increased interest in alternative energy sources, and thus also in ground heat pumps. Thanks to the installation based on a heat pump, it is possible to manage waste heat and low-temperature heat. It should be noted that house heating, hot water preparation and ventilation in cooperation with ground heat pump is the most efficient and modern method of delivering heat to the house. Such a solution practically does not have any weaknesses. Thanks to such a solution it is possible to minimize the costs of heat necessary for meeting the needs of the building. The paper compares the operating and investment costs for selected solutions of the lower heat source in the form of vertical, horizontal and basket collectors, resulting in the possibility of optimizing the demand for the area of the plot for the installation of heat exchangers, as well as the estimated time of return on investment costs in comparison to the traditional heat source based on gas fuel.

INFLUENCE OF TIO_2 FILM THICKNESS ON PHOTOVOLTAIC PROPERTIES OF DYE-SENSITIZED SOLAR CELLS

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Generally, the dye-sensitized solar cells DSSCs are composed of a photoanode, a sensitizer, a redox-coupled electrolyte, and a counter electrode. The nanocrystalline porous TiO_2 film is one of the most employed photoanode materials in this type of solar cells due to its excellent optoelectronic properties. It significantly influences the photon-electron conversion efficiency of the solar cell, because of its good photo-excited electron transportation and dye adsorption. The surface morphology, crystalline phase, particle size, surface area, porosity, and dispersion of TiO_2 nanoparticles are the various influencing factors which determine the properties of DSSCs. In particular, the thickness of the photoanode is known to be one of the crucial factors determining the efficiency of solar cells. These properties strongly relate to the TiO_2 electrode method of fabrication and its parameters. Dye-sensitized solar cells based on TiO_2 films with different printing layers were fabricated by screen printing method. The prepared samples were characterized by scanning electron microscopy and UV–Vis absorption spectroscopy. The effects of film thickness on the current-voltage characteristics of DSSCs were also investigated.

ENERGY SAVING DURING FAN OPERATION BASED ON PREDICTION OF INTERNAL CO_2 CONCENTRATION GROWTH

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The paper presents the possibility of learning the fan performance in dependence on CO_2 concentration. A mathematical calculation is made of the prediction of the electric energy consumption for a variant control algorithm. The most advantageous algorithm is programmed into the actual fan control system, and its real power consumption is measured. Finally, the saving of the adaptive control is compared to the classical control over time. To program the control algorithm, the CO_2 mass balance equation is used. The equation depends on the input values, namely the number of CO_2 sources, the room volume and the supply air. Due to the infinitely variable of fan control, it is possible to adjust the power setting depending on the expected development of the logarithmic rise of CO_2 concentration in the room. This prediction is programmed with the C ++ code to the Arduino control unit, which controls the EC fan power with a 0-10 V signal. Although significant savings over a short period of time can not be expected, the ventilation system where the fan runs for a significant part of the year will be substantial. Therefore, the result will be presented by graphical diagrams of different ways of controlling the fan per year of operation.

THE MAJOR FACTORS INFLUENCING A SECURITY OF THE CRITICAL RAW MATERIALS SUPPLIES FOR THE RENEWABLE ENERGY SECTOR IN THE EU

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The EUs strategy aiming at preventing climate changes set the ambitious targets in terms of the energy from renewable sources. The share of these energy in the total gross energy consumption should reach 20% in 2020 (Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009; as part of the EU climate and energy package), and in perspective of 2030 increase to at least 32% (Directive 2018/2001 of the EP and of the Council of 11 December 2018). Achieving these goals will be not possible without access to mineral resources that are essential for the development of wind and solar energy production. The highest risk of supplies refers to raw materials classified as critical for the EUs economy due to high economic importance and limited internal supplies in relation to volume of demand. The greatest importance for the wind energy sector have metals from the REE group (neodymium, praseodymium and dysprosium) and niobium, while for the solar energy indium, gallium and silicon metal. REE find an application for the production of permanent magnets for the offshore wind turbines, niobium for the high strength steel, while silicon metal, indium and gallium for various types of photovoltaic cells. In the framework of the currently ongoing MinLand project, implemented under the Horizon 2020 program, the analyses of the major factors affecting the security of these raw materials supplies to the EU has been carried out, coupled with an estimation of the total volume of demand. Among the identified risks factors the most important have been a strong concentration of the CRMs world's production in the non-European countries, poorly diversified extra-EU import sources, increasing numer of export restrictions, the lack/low level of recycling and substitution. Limited supplies of these raw materials on the world's market resulted in significant fluctuations of prices and in the future may restrain development of the industry sectors in which they are applied.

RANKING OF ENERGY POTENTIALS OF AGRO-INDUSTRIAL WASTES: BIOCONVERSION AND THERMOCONVERSION APPROACH

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The rising amount of organic wastes (biomasses) generated annually constitute serious environmental concerns, but hold enormous potentials in solving the increasing global energy demand. When properly harnessed, they are good renewable energy sources with capabilities of bridging the energy demand gaps and ameliorating environmental concerns of developing climes. In this study, the mixed-method approach of anaerobic digestion and thermogravimetry were used in the ranking of eighteen selected agro-industrial biomasses based on their energy (biomethane or thermochemical conversion) potentials. After the ultimate and proximate characterization, the experimental biomethane potentials (BMP), which is the maximum amount of methane producible from substrates, were carried out by anaerobically digesting feedstocks at mesophilic conditions for 30 days. The biomasses were also degraded thermally within a temperature range of 50 and 800^{o}C, torrefaction and the pyrolysis char yields determined. The calorific values and the theoretical biomethane potential (TBMP) were calculated from the elemental compositions of substrates. The biodegradability of both TBMP and BMP were determined. Lignocellulosic plant materials and the animal manures recorded lower methane yields and biodegradability. Although the animal manure had high HHVs, it had poor BMP yields. Based on ranking criteria, waste samples from animal carcasses and oil crop came top in both thermal and bioenergy conversion as well as in calorific value. Okra waste in the fruit and vegetable category, which was the second in rank, performed better than the others. Co-digestion/degradation of high ranked biomass with others and enhancements of the substrate before energy conversion is recommended.

SINTERED NITRIDE NANOPOWDERS IN THE SYSTEM ALN/GAN/$AL_XGA_{1-X}N$ – NEW MATERIALS FOR HIGHLY EFFICIENT LIGHT EMITTERS

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The extraordinary semiconductor and ceramic properties of gallium nitride GaN and aluminum nitride AlN make them promising materials for the production of LED emitters with high efficiency of converting electricity into light. The nitrides can form solid solutions $Al_xGa_{1-x}N$ $_{(0<x<1)}$ with indirect optoelectronic characteristics, constituting base layers in the nanostructures of efficient light emitting diodes and lasers. An economical way of producing base layers/supports made of such aluminum-gallium nitrides is the high-temperature and high-pressure (HT-HP) sintering of the nitrides nanopowders. For the synthesis of nanopowder composites in the system $AlN/GaN/Al_xGa_{1-x}N$, a mixture of the metal dimethylamides $\{M[N(CH_3)_2]_3\}_2$, M = Al/Ga, Al:Ga = 1:1, in hexane solution was used under various equilibration conditions. Reactions of the equilibrated dimethylamides with liquid ammonia resulted in the formation of the amide-imide precursors. Their pyrolysis at 800 and 950°C under an ammonia atmosphere yielded nitride nanopowders with average crystallite sizes ranging from several to several dozen nanometers. XRD studies showed that the products are multi-component mixtures of nanocrystalline nitrides h-AlN, h-GaN/c-GaN, and h-$Al_xGa_{1-x}N$ (h – hexagonal, c – cubic). The product nanopowders were HT-HP sintered mostly at 650 or 1000°C and at 7.7 GPa. Solid, sintered pellets of nanoceramics of high hardness and high density were produced. In this regard, the Vicker's hardness of the nanoceramics was advantageously compared with the hardness indices of both constituent metal nitrides. The phase composition of pellets from the lower sintering temperature was similar to the composition of starting powders. Sintering at the higher temperature resulted in a significant increase of the aluminum-gallium solid solution nitride phase up to the point of reaching the pure h-$Al_{0.5}Ga_{0.5}N$ phase composition.

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APPROACH TO MAKE KESTERITE QUANTUM DOTS – A PERSPECTIVE MATERIAL FOR PHOTOVOLTAICS

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The specific electronic properties of quantum dots (QD) depend on their composition, shape and, particularly, on particle size. In this regard, semiconductor properties can conveniently be controlled for QDs by crystallite size in the nanoscopic range of the so-called Bohr radius. The smaller is a QD, the wider is its bandgap. Kesterite Cu_2ZnSnS_4 has suitable semiconductor properties for photovoltaic applications: the direct bandgap of 1.4-1.5 eV and high absorption coefficient. Kesterite QDs will combine these advantages of the material and particle size-related effects. This work describes an experimental approach to make quantum dots of kesterite via the simple and efficient mechanochemical synthesis. Two different metal sulfide systems were used. The first system was composed of such sulfides as Cu_2S, ZnS, SnS, and elemental sulfur S whereas the second one of the sulfides CuS, ZnS, and SnS, all in the stoichiometric proportions. Both mixtures were milled with oleylamine (OLA) in the high energy planetary ball mill (Pulverisette 7, Fritsch) for 10-40 h at 900 rpm to promote the mechanochemical synthesis of kesterite. Subsequently, the materials were washed with hexane to remove excess OLA. The final powders were examined by XRD, FT-IR, and UV-vis spectroscopy. Compared to other relevant systems, the kesterite synthesis in the presence of OLA is found to be much slower. For instance, materials milled less than 30 hours contained mainly starting sulfides. After 40 hours, small amounts of the regular pre-kesterite phase were detected. Materials had no semiconductor properties. The strongly coordinating nature of OLA appears to prevent from efficient reactions among the sulfides towards kesterite. Variations in some experimental conditions (amounts of OLA, an additional solvent) are still planned to be applied to facilitate kesterite QD formation.

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SILICON NITRIDE-BASED MATERIALS PREPARED BY THE AEROSOL-ASSISTED SYNTHESIS METHOD AS POTENTIAL COMPONENTS OF SOLAR ENERGY GAIN SYSTEMS

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Silicon carbide SiC semiconductor due to its excellent mechanical, thermal, and electrical properties has found numerous applications. SiC used as a filling material of volumetric receivers in solar thermal power plants with optical concentration technology is an example of its application in the field of alternative energy sources. Similarly, silicon nitride Si3N4-based materials are useful in photovoltaic systems as antireflective coatings improving light absorption of solar cells. We confirmed earlier the great potential of the two-stage aerosol-assisted synthesis (or spray pyrolysis) method to prepare pure SiC nanopowders or C/SiC nanocomposites of spheroidal particle morphology from O-bearing liquid organosilicon precursors. In the first stage, a precursor aerosol mist is transported through a heated tube reactor undergoing complex changes before passing the exit filter. Short residence times usually result in raw products on the filter still containing some oxygen. The latter could be "removed" in the second stage of pyrolysis at higher temperatures.

Herein, presented are initial results of a study on the preparation of silicon nitride (or oxynitride) nanopowders by the two-stage aerosol-assisted method from readily available organosilicon precursors. First, raw powders were produced in the tube reactor from the mist of selected precursors reacting in flowing ammonia NH3 at 1000 °C and 1200/1400 °C. This stage was found to be relevant to the previously studied SiC and C/SiC systems under argon. Second, the raw powders were pyrolyzed at 1400 °C for 6-15 hours under NH3 to enforce the ammonothermal reduction of Si–O groups and assist the formation of Si–N bonds. The final agglomerated nanopowders were characterized at this stage with powder XRD, SEM, and FT-IR spectroscopy. The results were compared with those collected for powders made at similar temperatures in a neutral argon atmosphere.

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SUITABLE SITES FOR CSP POWER PLANTS INSTALLATION IN ALGERIA

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A variety of renewable energy applications have been undertaken using multi criteria decision-making approach and geographical mapping models (Geographical Information System GIS). Using GIS and Multi-Criteria Decision-making Analysis (MCDA) together will provide a narrowing down for the optimal site selection for the contracted solar power installing. This endeavor will be beneficial to explore the possibility of commissioning such energy systems. The objective of this study is to identify sites that are potentially viable for the contracted solar power installing for Algeria using multi criteria decision-making approach and geographical mapping models GIS. The problem is designed through set of criteria. Selecting a site for optimal production and generation of photovoltaic electricity without harming environmental, social, political and economic factors that may ensue conflicting objectives is based on a typical and complex process requiring careful studying. Algeria in general and its southern region in particular has become one of the target regions for investors in the field of solar energy. Tamanrasset one of Algerian state was chosen as a target area to study the potential application since it hosts the three CSTPP systems; parabolic trough (PT), solar tower (ST) and Dish Stirling (DS). Algeria is very rich in solar energy resources and possesses large wasteland areas in the Sahara that represent 80% of the total area. Currently, Algeria envisages the substitution of the fossil energies by the renewable energy; especially solar energy. The interest on renewable energies is growing day by day and become the world's main alternative energy sources. During the last two decades, the PV panels or Concentrated Solar Power (CSP) technologies has accelerated in the countries situated in the solar energy belt, despite their prohibitive costs. For this, the focus is now shifting from conventional to renewable energy sources.

LEGAL AND TECHNICAL BARRIERS FOR NON-WOOD BIOMASS FUELS USED IN 5-CLASS SMALL BOILERS

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Solid fuels produced from locally bio-based materials are a good alternative to hard coal-based fuels. While wood-based pellet is very popular and used widely, there is a growing need to invent new formulas for other second-generation pellet based on non-wood biomass. There is considerable availability of non-wood biomass – planted on energetical purpose as well as of a waste nature. Use of waste biomass as a raw material for pellet (in majority cases after pre-treatment) can be very beneficial for local communities as well as for business and last but not least environment. Production of a pellet from non-wood biomass faces several challenges. Main of them are of a technological and legal nature. Non-wood biomass requires several technological processes mainly to reduce humidity and to carbonize biomass in many cases. Technical problems with boiler operation during industrial tests have also been indicated. Legal issues relate to the new waste to energy technologies, which require changes in ecological regulations. EU-countries have set their own targets to replace fossil fuels by biofuels. Regarding hard coal, a good replacement is pellets produced from biomass with a short circulation of carbon element. Due to the air quality challenge Poland is currently facing - increasing the share of renewable energy in fuel consumption is a real solution.

INFLUENCE OF THE POT AND LID TYPE ON THE AMOUNT OF ENERGY CONSUMED FOR COOKING DISHES

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Cooking meals is the third, most energy consuming source after heating rooms and water in the households. The most commonly used devices for this purpose are gas, electric-gas and electric cookers. For direct cooking, a variety of pots and lids are used, or dishes are prepared without covering them. There are various pots on the market: made of steel, stainless steel, aluminium, cast iron, clay and others. Therefore the question is: whether the type of pot and lid used for cooking meals can contribute to energy saving in the household? The aim of the study was to compare the power consumption of electric energy of two types of pots: made of enamelled steel (ES) and of stainless steel with an acothermic bottom (AB). Energy power consumption was compared at the time of between heating pots without a pots covered. Four different lids were used: made of enamelled sheet steel, two glass lids without a gasket of different masses and a universal glass lid with a silicone gasket. Ten combinations of pots and lids were accessed. In each variant 1l water was heated from 22°C to 95°C. An electric, steel 1000 W powered plate was used in the research. The time of heating and the unit consumption of energy were determined. The designated heating time of 1 l of water ranged from 9min 07 s to 14 min 24 s and was much shorter in the case of the ES. It has been found that using lid may reduce the heating time in case of the AB by 47% and in case of ES by 40%. Electricity consumption was higher when heated in the AB and reached from 0.15 to 0.21 kWh, in the ES was from 0.15 to 0.19 kWh. The electricity consumption was higher when heated water in the AB and ranged from 0.15 to 0.21 kWh, in ES was from 0.15 to 0.19 kWh. The results showed that the largest saving of electricity during heating is provided by covering the pot with the steel enamel lid.

ASSESSING THE IMPACT OF DEMAND RESPONSE ON PEAK DEMAND IN A DEVELOPING COUNTRY: THE CASE OF GHANA

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Peak demand on electricity grids is a growing problem that increases costs and risks to supply security. Residential sector loads often contribute significantly to seasonal and daily peak demand. Demand response refers to consumer actions that change the utility load profile in a way that reduces costs or improves grid security by applying price signals and automated load shedding technologies. Currently, the technologies that are used for demand response implementation are not readily available in many developing countries, including Ghana. Also, the methodologies that are used to achieve demand response can hardly be applicable in developing countries. Peak pricing of electricity, for instance, can hardly be implemented in many developing countries as high prices would disproportionately affect low-income households who do not have the capacity to take action to avoid paying high peak prices. These households constitute a majority in developing countries. Again, households in developing countries may lack the competence to understand and to respond to the price signal (e.g. may not understand the pricing system due to education limitations). This study aims to develop demand response methodology that can be applied in developing countries to achieve residential peak electricity demand reduction.

The study uses a consumer preference survey to come up with a demand response deployment methodology for developing countries. The diversified demand modelling method along with energy audit is used to estimate the potential peak load reduction that can result from the proposed methodology. The study uses Ghana as a case study because it is among the most successful countries in the sub-Saharan region in improving electricity access. Data collection is easier as consumers easily identify with this study because of their concerns in relation to the perennial electricity supply challenges. Analysis done provides a learning curve for other countries.

THE EFFECTS OF FINANCIAL INCENTIVES AND SUBSIDY POLICIES ON THE OPTIMAL DESIGN OF STAND-ALONE HYBRID ENERGY SYSTEMS

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Stand-alone hybrid energy systems constitute an attractive solution for the electrification of areas where grid extension is not technically feasible or prohibitively expensive. In recent years, national governments have implemented various support policies to encourage the deployment of renewable energy systems (RES) and hybrid energy systems (HES). A fundamental aspect during the design and disposition of these type of units is the determination of the optimal configuration and sizing of each power generation component. Furthermore, the optimal design of HESs is strongly dependent on technology parameters, local meteorological conditions, among other factors. In this context, this paper investigates the effects of financial incentives and subsidy policies on the optimal design of stand-alone hybrid energy systems. A linear programming model is used to generate various scenarios and assess the impacts of technology costs and fuel prices on the capacity sizes of HES components. The model used for this study minimizes the total life cycle costs (TLCC) of the system over the lifetime of the project. Besides, as meteorological conditions are crucial parameters to consider while designing HES, a sensitivity analysis is conducted to examine the effect of wind speed and solar irradiation on the optimum configuration. Results indicate that falling power generation costs, as well as fuel prices variations, have a substantial effect on the final design of a stand-alone hybrid energy system.

PRE-FEASIBILITY ASSESSMENT OF A GEOTHERMAL POLYGENERATION SYSTEM IN THE SUB-URBAN AREA OF NAPLES

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This paper presents a thermodynamic, economic and environmental analysis of a Renewable Polygeneration System connected to a District Heating and Cooling network. The system is designed for a district in Naples (Italy) and it is powered by a geothermal source available in the area. The system producing electricity, heat and cooling energy, is calibrated and modelled – including the control strategy - by considering manufacturer data and to match the appropriate operating temperature levels in each component. Cooling and thermal demands of the connected users are calculated by suitable building dynamic simulation models. The District Heating and Cooling network is designed and simulated by taking into account variable ground temperature throughout the year, accurate heat transfer coefficients and pressure losses of the network piping. The results are based on a 1-year dynamic simulation and analysed on daily, monthly and yearly basis. The performances are evaluated in terms of the main economic indexes and avoided CO_2 emissions. A parametric analysis is proposed by varying the geothermal well depth, in order to consider uncertainty related to the geofluid temperature with depth. The economic analysis is performed by considering two different scenarios - with and without feed-in tariffs.

OPERATIONAL FLEXIBILITY OF COMBINED HEAT AND POWER PLANTS WITH THERMAL ENERGY STORAGE

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Combined heat and power (CHP) plants play an important role in the reduction of carbon dioxide emissions and the future decarbonization of the European energy system. Besides providing useful heat, CHP units have the versatility of generating electricity with high fuel efficiencies. Generally, CHP plants have been deployed to supply industrial steam or hot water to residential customers. Over the last few years, the increase in the share of renewable energy sources and the volatility of electricity prices have unlocked the opportunity for CHPs to earn additional revenues from electricity sales. In this context, the objective of this paper is to present a scenario-based analysis of the impact of thermal energy storage (TES) on the operation of a CHP plant and its effects on the economic performance and flexibility of the system. An optimization model based on a Mixed Integer Linear Programming (MILP) approach is employed to simulate the behavior of a CHP system integrated with thermal energy storage. A large-scale CHP unit is considered and tested under different scenarios of heat demand, fuel prices, carbon allowance prices, and energy prices. An analysis is carried out to evaluate the flexibility of the system and the magnitude of heat load variability associated with the integration of a TES.

Results show that a thermal energy storage plays an important role in decoupling electricity and heat in a CHP system. Furthermore, depending on the load following strategy, a TES might reduce operational costs while increasing the system's flexibility.

PROBLEMS OF ENERGY RECOVERY IN THE PROCESS OF PLASTICS GASIFICATION

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Plastics are currently widely used materials of many industries such as: automotive, construction, and above all, packaging production. A special advantage of plastics is the possibility of recycling them. However, the recycling process requires high physicochemical compatibility of the material. Recycling of plastics is not possible without primary segregation at source and selection of materials for material and raw material recycling. The purity condition of plastic waste intended for recycling is consequently difficult to achieve. A large share of plastic waste goes to landfills, which are creating a huge ecological threat. Depending on the physio-chemical composition, plastics have a relatively high calorific value from 15 to 25 MJ/kg. Therefore, it is necessary to use energy recovery processes for plastic waste that is not recyclable. Thermal energy recovery processes in the form of plastic waste incineration are associated with the emission of harmful compounds contained in the gases generated in the conventional oxidation process. That is why scientific and research work is being carried out to search for other thermal technologies for energy recovery from plastic waste. One of them is RDF (Refused Derived Fuel) plastic gasification technology. The article presents an analysis of several known methods of energy recovery from plastic waste, focusing on the issues of process efficiency evaluation.

CFD ANALYSIS FOR AN ECO-FRIENDLY ALDEN TURBINE SYSTEM

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The concept of an environmentally-friendly Alden turbine was developed in 1993. Intensive work led to a radically new design for the turbine runner. The number of blades was decreased – thus the pressure and velocity gradients were reduced, the clearance between the runner and the stay vanes was minimized while the flow passage width was maximized. Despite all the efforts, the operation area of a system with an Alden turbine includes locations that fail to meet environmental criteria and standards. Attention is focused on operation of the Alden turbine, the scroll inlet, and the bent draft tube. A 3D model of the system was developed for a CFD (Computer Fluid Dynamics) simulation. Modelling was conducted using the Flow3D, using Reynolds-averaged Navier-Stokes equations. The study contains an analysis of the most acute problems in the operation of a hydroelectric system: cavitation, vorticity, hydrodynamic loads and pressure fluctuation. A spectral analysis was performed to indicate the prevailing frequencies of pressure fluctuation.

The study also examines distributions of stresses and contains images of deformations in selected system components: the scroll inlet and draft tube. The FSI (Fluid Structure Interaction) model with von Mises' tension theory were used to obtain those results. Considering the disastrous adverse effect of hydroelectric systems on fish populations, unfavourable locations were identified in which limit values set in environmental protection requirements are exceeded. A fish model was constructed to perform biomechanical analyses using FSI theory. The study gives values of stresses in the fish body and describes the regression relationship between stress and pressure. The last section of the study deals with pressure and velocity fluctuations taking place in fish swimming areas, beginning with the scroll inlet, the turbine, and ending with the draft tube.

CFD ANALYSIS FOR AN ECO-FRIENDLY AHS TURBINE

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The last decade has seen a growing number of applications of the Archimedean turbine. The principal advantages of this turbine include significantly lower costs of implementation than in the case of Kaplan turbine at a comparable efficiency. The AHS (Archimedes Hydrodynamic Screw) is also highly recommendable because it may be installed under low-head conditions (< 10 m), in creeks and flumes – artificial channels of hydroelectric plants. Its growing popularity may strengthen the policy of distributed generation and contribute to a growth in the number of small plants. The study contains an assessment of efficiency (optimization) of the AHS turbine as a function of its geometry. The decision variables adopted include: the number of helices, the ratio of external to internal diameter, screw pitch and the angle of inclination of the axis, using a defined criterion of power as a function of torque and angular velocity.

The analysis was fully performed using CFD (Computer Fluid Dynamics) in the Flow3D software and Reynolds equations. Biomechanical analyses of a fish model placed in various locations of the turbine operation area were made for the best turbine geometry, using FSI (Fluid Structure Interaction) theory. The study gives values of stresses in the fish body and describes the regression relationship between stress and pressure. The last section of the study deals with pressure and velocity fluctuations taking place in various areas when fish swim through the AHS.

METHANOL REFORMING AS A SOURCE OF HYDROGEN FOR VEHICLE PROPULSION

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The concept of using hydrogen as fuel for vehicle propulsion involves many consequences that are closely related to its physical and chemical properties. The issue of the use of hydrogen begins with the process of its production, ways of its storage and distribution, ending with the installations of the final use for generating energy. All these processes require the use of an installation that is energy-intensive and expensive to operate and requires special supervision. In connection with these problems, the concept of hydrogen production has been developed for several years depending on the demand that the device converting energy from the chemical energy contained in hydrogen into the required form of energy. Such solutions in terms of the whole process of fuel production as a chemical hydrogen storage, its storage and distribution, reforming for the needs of production of energy have the potential also for the use of various types of vehicles. The article attempts to estimate energy indicators that allow to determine the qualitative possibilities of using this type of energy generation systems and to assess the importance of the methanol reforming process in the overall process.

EVALUATION OF THE POSSIBILITY OF USING A HYBRID ENERGY GENERATION SYSTEM WITH FUEL CELL FOR DRIVING DIESEL LOCOMOTIVES

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The operational conditions of vehicles are crucial for the selection of the energy generation system needed to drive it. The solutions of hybrid propulsion systems used in the rail vehicles like combustion engine-electric generator-electric motor have been associated with ensuring the transfer of a large amount of mechanical energy to the drive when moving the vehicle. The current tendency to improve the impact of vehicles on the natural environment translates into searching for new solutions for energy generation systems for vehicle drives that eliminate the combustion engine. A fuel cell becomes a kind of replacement for an internal combustion engine. However, its specific operating conditions aimed at achieving high efficiency and long service life require the development of new systems for managing these systems depending on the operating conditions of the vehicle.

Therefore, it is necessary to assess the operating conditions of the vehicle indicating the energy demand and determining the size of the energy generation system. The authors have addressed the issue of this assessment in this article.

IMPROVING THE POWER EFFICIENCY OF SOLAR POWERED ELECTRIC BOAT ON AN EXAMPLE OF AGH SOLAR BOAT

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One of the biggest constraints in powering vehicles or boats with solar energy is especially very limited area for PV panels installation. It directly affects the available power of the boat's propulsion system. Our solar boat with an area of 8,4 m^2 can generate no more than 1500 Watts of energy, because of used type of panels - monocrystalline silicon panels. However, the constant improval in PV modules technology and their efficiency can systematically increase the power output of the system by a small percent. A larger area for improvement in boat propulsion efficiency is the complex optimization of boat design. Based on the boat construction designed by the AGH Solar Boat Team, it is possible to show how modifying and improving the electrical system, electronic components, software, propulsion system and shape optimization of many elements can improve the overall performance of the boat during more than two years. Aiming to achieve even the smallest possible efficiency increase is a very big challenge. It requires a complex and precise approach, involving many calculations, test, and conducting series of simulations to verify and judge applied modifications before they are implemented in real life. All these factors contributed to a significant reduction in the energy consumption of the boat when moving with the identical parameters. After researches and analysis of the data, it turned out that at lower speeds, the hydrofoils themselves reduce energy consumption even by 25%.

AGGLOMERATION AND COMBUSTION OF PLUM STONES

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The aim of the presented research was to determine the suitability of plum stones as a solid fuels. Mixtures of plum stones with the addition of 10, 15 and 20% of rye bran as a binder were subjected to the pressure agglomeration process in a rotary matrix working system. The speed of the matrix was 170, 220 and 270 rpm. The density of pellets, its kinetic strength and power demand of the granulator's divice for each mix and rotary speed were determined. The increase in rye bran in the agglomerated mixture from 10 to 20% affected the pellet kinetic durability by 30% and slightly affected the granulator demand for power. Increasing the rotational speed of the matrix from 170 to 270 rpm resulted in a decrease in the quality of the obtained pellet. The highest quality was characterized by pellets containing 20% rye bran added and this sample was combusted in a 25 kW boiler with a retort grate. For comparison purposes, whole plum stones were also subjected to combustion. The concentration of CO, CO_2, NO, SO_2, HCl and O_2 in the exhaust gas was tested. The paper shows significant differences in emissions from the combustion of pellets and whole plum stones, with pellets reaching almost four times lower CO emissions.

On the basis of the results of combustion, HHV, LHV and elemental analysis, it was found that pellets from plum stones with the addition of rye bran can serve as a substitute for wood pellets in low power installations.

A NOVEL EXERGY INDICATOR FOR MAXIMIZING ENERGY UTILIZATION IN LOW-TEMPERATURE ORC

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An increasing interest towards utilization of the renewable and waste energy sources has led to in-depth research and development of technologies that are suitable for an efficient production of electricity employing these types of energies. In the last decade, particular attention has been paid to organic Rankine cycle (ORC) power plant – a technology that implements a classical steam Rankine cycle using low-boiling fluid of organic origin. Depending on the specific application and the choice of the designer, the ORC can be optimized using one or several criteria. The selected objectives reflect various system performance aspects, such as: thermodynamic, economic, environmental or other. In this study, a novel criterion called exergy utilization index (XUI) is defined and used to maximize the utilization of an energy source (hot water) in the ORC system. The maximization of the proposed indicator is equivalent to bring the heat carrier outlet temperature to the ambient temperature as close as possible. In the studied case, the XUI is applied along with the economic criterion and the multi-objective optimization is performed in order to determine the optimal operating conditions of the ORC. Moreover, to reveal the relationship between the XUI and important ORC parameters, a parametric study is conducted. The advantages and drawbacks of the proposed index are identified as well.

ENERGY EFFICIENCY IN THE SETTLEMENT TEXTURE THROUGH THE USE OF BIM

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New residential areas that are growing day by day are increasing the amount of energy consumed by the residential buildings, which are already having a large share in the world energy consumption. In the emerging new and densely settled areas, rapid construction and unplanned urbanization where energy efficiency approach is ignored, cause rapid destruction of natural environment and depletion of energy resources. In terms of economic and environmental aspects, the reduction of energy consumption is a matter of priority in the settlement texture design. The settlement texture is a design variable significant to control energy consumption. The dimensions of the buildings, their spacing and the arrangement of buildings with respect to one another are the design parameters which define the settlement texture. On the other hand, nowadays, BIM systems, which are used in the design process and which are up-to-date software, allow for easy inclusion of different approaches to design processes with the conveniences and innovations. This study aims to determine the energy efficient settlement texture design parameters by the using Revit that software of BIM. In this context, the first step of the method of the study is to develop different settlement texture alternatives which benefit from the solar energy. In the second step, annual energy consumption for a selected residential building in the developed alternatives is calculated.

Finally, calculated annual energy expenditures are analysed and the appropriate of the settlement texture design parameters in terms of energy efficiency are determined. As a result, this study is focused on determining the appropriate settlement texture in terms of energy efficiency by using BIM in order to take the right decisions in the design stage. Especially in the settlements that affect large number of users, minimizing the errors that may occur later, is also very important in terms of the construction economy and the country's economy.

UNIT COMMITMENT AND DISPATCH MODEL OF THE POLISH POWER SYSTEM

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The article presents the results of preliminary work on the construction of a model of the Polish electricity generation sector used to solve the problem of unit commitment. The model is built on the basis of linear programming using mathematical programming language GAMS (the General Algebraic Modeling System). The code describing the model is implemented as a Mixed Integer Programming (MIP) problem. The structure of the model includes the existing power plants, mainly based on hard coal and lignite, which are presented in a unit breakdown including individual boilers in a given power plant. The main inputs describing the model are the data characterizing the boilers, for example: operational and maintenance costs, fuel costs, start up and shut down costs, minimal up and down time, ramp up and down rates and the minimum and maximum of power and etc. In addition, the parameters such as electricity prices and electricity demand are set by the user for each hour as the hour resolution is implemented in the model. The main outcomes are information about on/off status of power generation units and information on their operation. The objective function is represented by the total costs which are minimized by the model.

PERFORMANCE AND EMISSION CHARACTERISTICS OF SINGLE CYLINDER DIESEL ENGINE FUELED WITH ORGANIC GERMANIUM

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The recent revolutionary progression in powder technology made the researchers explore for appropriate organic powder as a diesel additive with the purpose improve the performance and minimize the emission. An effort is made in this research to investigate the engine performance and emission characteristics of the 5, 8 and 10 mg concentration of organic germanium Ge-132, mixed with the diesel fuel. The single cylinder diesel engine set up was at constant full load and engine speeds from 1200 to 2400 rpm. The results show the brake power with all Ge-132-diesel fuel blends were increase due to its high energy content. The averages of brake power attained over the entire engine speed range were at 1.1% (DGe5), 2.2% (DGe8) and 3.7% (DGe10) higher than diesel fuel. However, significant reduction in BTE and increment of BSFC measured due to the thermophysical properties such as high density and kinematic viscosity of Ge-132-diesel fuel blends. The emission result showed the CO_2, NO_x and CO emissions for all mixtures slightly increase and HC emissions decreased at high speed due to the spray quality of the fuel.

LOW-TEMPERATURE THERMAL TREATMENT OF POLISH BROWN COALS

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The article deals with mercury release during low-temperature thermal treatment (LT3) of Polish brown coals. These coals contain much more mercury and moisture than hard coals, which makes them an ideal fuel that can be subjected to the low-temperature thermal treatment process. During LT3 the fuel was heated to temperatures high enough to release moisture and mercury but at the same time low enough to prevent the devolatilization and significant decrease of the fuel heating value (LHV). The advantage of the LT3 is much higher mercury removal efficiencies, up to 95%, and much smaller volumes of the mercury-containing exhaust gases for eventual further treatment. Furthermore, the concentration of mercury vapor in the off-gases are higher thus making the cleaning process more efficient. The processing was carried out in the temperature range 200-400°C, for two selected Polish brown coal fractions 500-1000mm and 1000-2000mm. LT3 was carried out at the fluidized bed stand. LT3 was conducted in various atmospheres (air, and a mixture of 16% CO_2 and the rest of N_2). After the coal was fed into the fluidized bed the mercury compounds in the sample decomposed and evaporated. The gas composition was then determined on-line by mercury spectrometer LUMEX RA-915+. The experimental results indicated that the mercury release was strongly depended on the gas atmosphere. The highest mercury release was determined in the CO_2/N_2 atmosphere than in air atmosphere, and it was 36-84% of the mercury at temperatures of 200-250°C. In temperature range 250-300°C mercury release was almost 90%. In temperature range 300-350°C mercury release from coals were over 95%. Except for mercury release also loss of volatile matter and change of lower heat value of brown coal was investigated. Loss of volatile matter was relatively small in temperature range 250-300°C in was below 10% and in temperature 400°C it was below 22%.

STUDIES ON DISPERSION OF FUGITIVE EMISSIONS OF BAUXITE PARTICLES RELEASED FROM HANDLING OF CARGO AT LOWER HEIGHTS

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Mormugao Port Trust handles 368 tons/hr of bauxite with the help of 6 mooring dolphins situated around 400 meter in sea from the port next to the city of Vasco da Gama, Goa, India. During the said operations, the particles are released at lower height (2 to 5 meters from water level in sea) unlike other emissions. Since city is situated next to the port, particles released during the handling of bauxite reach the Vasco city due to dispersion and affects health of the people in the city. The objective of this study was to identify the key variables which affect the dispersion of the particles released during bauxite loading and unloading operations. Detailed simulation studies are carried out to study the effect of wind speed, atmospheric temperature, atmospheric humidity, moisture content of bauxite and the release height of the material from cranes, on dispersion of particles. For this purpose AERMOD software was used. All the necessary data required for the study was collected from MPT, Vasco, Goa. Wind velocity and moisture content of materials are key variables identified as they influence the dispersion significantly. With wind velocity greater than 8 m/s, the concentrations of PM 10 and PM 2.5 exceeds beyond permissible limits up to 1 km radius. Bauxite moisture content beyond 9% and variation in release height from 1 to 5 m does not have significant effect on particle dispersion. Variation in atmospheric temperature and atmospheric humidity has no influence on dispersion of particles.

LOW ENERGY NUCLEAR REACTION IN DEUTERATED CRYSTAL STRUCTURES - POTENTIAL CLEAN ENERGY?

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Low energy nuclear reactions (LENR) now is refered to what was initially and poorly called “cold fusion”. The discovery of cold fusion by Fleischmann & Poins in experiments with elecrolysis of heavy water using palladium electrodes was a great scientific "discovery", however soon were depreciated and treated now as a scientific humbug. The paper presents a review of nuclear fusion experiment like muon-catalyzed fusion, pyroielectric fusion, application of method based on sonolumiscence, antimmater and some hypothetic methods. Discussion includes historical development and some achiewements obtained during 30 years after the Flerischmann paper. Some method now are threated as not perspective in future. Discussion of the perspectives and scientific challenges is also included.

As a case study - results obtained in few types of plasma accelerators experiments with the author participation are briefly discussed. Accelerator like linear, plasma, ion sources etc were applied to experiments in metalic hydrides, deuterides, heavy water etc. Some interesting results appears - e.g. electron screening of nuclei charge, channeling in cristals etc.

NUMERICAL SIMULATION OF A SEWAGE SLUDGE GASIFICATION-BASED CHP SYSTEM

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Presently, sewage sludge from wastewater treatment systems has become a critical problem in many regions of the world because it can inflict harm on human beings and the environment. Common management strategies stabilize sludge for land disposal by microbial processes or heat. Such approaches require large footprint processing facilities or high energy costs. A new approach considers converting sludge to fuel which can be used to produce electricity on-site. Gasification technology is widely held to be a suitable and convenient approach to convert waste materials to energy with minimal greenhouse gas emissions. This paper presents a study of sludge to energy conversion using gasification and internal combustion engine for power generation. A modified equilibrium model was developed by Aspen Plus® to simulate the whole conversion process based on the Gibbs free energy minimization applying the restricted equilibrium method. The gasification of sludge is carried out in an atmospheric fluidized bed reactor (FBR) using air as a gasification agent. The model includes the steps of sludge drying, sludge gasification, syngas cleaning and power production in gas engine. Heat integration is considered all over the process for internal consumption. The detailed mass and energy balances are handled by the model as well as heat exchangers sizing and gaseous emissions (e. g. NO_x, CO).

The results indicated that the Equivalence Ratio (ER) and Moisture Content (MC) have a direct influence over the gasification temperature on the composition of the produced syngas quality and energy efficiency of the gasification process. Based on the sensitivity studies carried out, we have selected the best configuration process for the best syngas composition to feed the internal combustion engine. The influence of syngas fuel properties on the engine is studied through the net electrical power produced, thermal power and electrical efficiency.

EVALUATION OF USING GAS TURBINE TO INCREASE EFFICIENCY OF ORGANIC RANKINE CYCLE (ORC)

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Energy is considered as one of the basic factors conditioning the growth of individual countries, as well as one of the basic goods, without which the economic development is inhibited. It can be already noticed an increased demand for electric energy and problems related with it, including using efficiently low and medium-temperature renewable energy sources for this purpose. Geothermal energy is one of the alternative energies that is widely used in the world - to a large extent its use is limited by the temperatures of the geothermal water available in a given region. The conversion of geothermal energy into electric energy plays an important role in saving energy resources. However, the output power of such a system is directly related to the parameters of steam entering the turbine, and thus with the quality of utilized geothermal brine. In case of high temperature geothermal resources there is no problem with efficient electric energy production, however utilization source with lower parameters can be inefficient in some cases. This paper focuses on utilization low- and medium temperature geothermal resources by using modified Organic Rankine Cycle (ORC). A modification of conventional binary power plant is conducted by combining gas turbine to increase efficiency of overall system.

An analysis has been conducted for different working fluids used in modified Organic Rankine Cycle (ORC) – the paper discusses the influence of the use of various working fluids on the operating parameters of such systems as well as the problems associated with their use. The results were compared with a conventional geothermal Organic Rankine Cycle (ORC).

AN ASSESSMENT OF SOLAR-POWERED ORGANIC RANKINE CYCLE SYSTEMS FOR COMBINED HEATING AND POWER FOR POLISH CONDITION

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Nowadays energy seems to be one of the most basic needs necessary for functioning society. The economic development of countries depends on supplying simultaneously different energy services such as electricity, district heating and cooling. This demand creates a good opportunity for using different energy sources, including a use of renewable ones. The growth in global demand for energy services and at the same time awareness of greenhouse gases (GHG) emissions and fossil fuel depletion give a chance for the renewable energy options. Proper utilization of renewable energy sources (from solar thermal, geothermal, etc.) or waste heat sources (from industry, gas turbines, etc.) can decrease a fossil fuel consumption but also help reduce the global warming. In the light of that, a combined solar heat and power (CSHP) system can have the potential to provide clean energy in the form of electricity and a useful heat. In this paper, combined solar heat and power (CSHP) system based on an Organic Rankine Cycle (ORC) has been investigate.

The work focuses on performance analysis a combined solar heat and power (CSHP) system based on Organic Rankine Cycle (ORC) for Polish conditions. The potential of this technology is strongly related to cost of components (both solar and ORC systems elements can highly influence a cost) and as well as seasonal variability of solar irradiation.

NORWEGIAN ELECTRIC VEHICLE MARKET: BARRIERS AND ENABLERS TO GROWTH

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Norway is a leading global market for low emission vehicles, where battery electric and plug-in hybrid light vehicles currently hold a 50 % market share. Many political instruments have been implemented to encourage the purchase of low emission vehicles, and charging infrastructure has been rolled out across the country for public use. Although the uptake of low emission heavy duty vehicles lags behind light vehicles (as in other countries across Europe), pilot schemes for these vehicles are being carried out and there are ambitious targets for their future implementation. This article gives a snapshot of battery electric vehicle technology in Norway at the current time, and draws comparisons to the rest of Europe. The national conditions (including vehicle market and political climate) that have enabled the rapid growth in light battery electric vehicle use are discussed, and compared to those for heavy duty vehicles (HDV). Subsequently a) specific experiences of Norwegian battery electric HDVs (including trucks and buses) at the pilot stage, as well as b) a comparative description of total cost of ownership (TCO) of these is given. In this way, barriers and enablers to battery electric vehicle use are described, providing an outline of the factors that need to change to speed up phase-in.

Results show that political instruments have played a substantial part in allowing battery electric passenger vehicle growth, but the TCO – and particularly vehicle investment costs themselves - remains the greatest challenge for battery electric heavy duty vehicles. Results are relevant not only for Norway, but elsewhere in Europe.

VARIANT ANALYSIS OF HYBRID SOLAR COLLECTOR CONSTRUCTION USING CFD

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This scientific paper is focused on a variant analysis of two hybrid solar collectors constructions: the first one with winding channels arrangement and the second with the spiral shape of pipes. The first stage of this study included experimental research which was conducted on existing prototype of winding collector. Then the obtained data was used as boundary condition and as the parameter of model validation. The numerical study was carried out with usage Computational Fluid Dynamics (CFD) methods and ANSYS Fluent 19.0 software. In order to simulate the laboratory conditions more precisely, the User Defined Function (UDF), which describes the distribution of solar irradiance on the absorber plate and energy losses through covection, radiation and reflection was implemented. For both geometries, the thermal parameters were examined and based on this, the set of recommendations regarding the collector construction and numerical simulations was prepared.

The main conclusions are: the spiral channels arrangement provides better heat transfer than the winding one, so the average temperature of the absorber is lower about 8K. This allows to reduce power temperature losses from the PV cells about 3,8%. Nevertheless, the winding collectror allows to obtain higher temperatures of working fluid at the outlet, so it is better solution for heat production applications.

POLISH LNG TERMINAL INFLUENCE ON NATURAL GAS QUALITY AVAILABLE IN THE POLISH GAS TRANSMISSION NETWORK

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Technical start of LNG terminal in Swinoujscie, was a significant milestone in the history of Polish natural gas network development. Polish gas market is now open for suppliers from all over the world. Energy security has been significantly increased. LNG terminal availability may guarantee security of supply and also stabilize composition and other physicochemical NG parameters. The analysis of NG characteristic changes after the start of deliveries from LNG terminal is presented in this document. Concentration of methane, ethane, propane, nitrogen and parameters like gross calorific value and Wobbe index for 16 regularly distributed exit points were investigated. The chosen parameters and ingredients were matched with gas from vaporization process. 913 days before and 912 days after the terminal launch were chosen. Quality measurements of NG were made by Gas Transmission Operator GAZ-SYSTEM S.A. with chromatographs and published on their official website. Volumes of LNG vaporized during the tested time were consumed by increased demand of end users and developing underground gas storages. NG from terminal was not a substitute of fuel from other import directions. It has been proven that gas from LNG terminal could have direct and indirect influence for gas collected in exit points. Indirect influence appeared with increasing distance from Swinoujscie entry point. South-east parts of Poland were totally free of LNG regasification process influence. High purity and higher energy density of NG from vaporization process has positive influence for transmitted gas quality. Gas mixture from interconnection points, LNG terminal and domestic production meets the standards of NG quality. This mixture can be used by all end users without complaints.

THE LIGHT-ON PROJECT: DESIGN AND CONSTRUCTION OF A SUN-TRACKING SYSTEM USING IMAGE PROCESSING

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Solar energy is one of the fastest growing energy industries around the world. One of the main problems faced by PV installations is the diversity of solar energy supply during the day. To increase the efficiency of providing this energy, use solar tracking.A solar tracking system is a specific device intended to move the PV modules in such a way that they continuously face the sun with the aim of maximizing the irradiation received by the PV array. Increase in efficiency is crucial in the case of India, which increased its energy production from solar panels by 8 times in 4 years. In this article we present the results of joint work of students from Poland and India. Based on the work, they designed and constructed a solar tracking system based uniquely on image processing. Basing on the paper "Design of a Solar Tracking System Using the Brightest Region in the Sky Image Sensor" Instead of the common photoresistors, to determine the position of the sun in the sky, the image from the camera was used, which was then subjected to appropriate filtration to quickly and efficiently determine the brightest point of the image - assuming that this is the position of the sun. Then, based on the coordinates of the brightest point, servo motors position the panel at the right angle, perpendicular to the sun, on the vertical and horizontal axis. The control unit is Raspberry Pi , to which both the servos and the camera are connected. Research in laboratory conditions, under artificial light, confirmed the correct operation of the system. The system should be able to follow the sun also under various weather conditions which are occurring in Nagpur where system is located.

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BEHAVIOUR OF POLYLACTIDE DURING DEGRADATION IN NATURAL AQUEOUS ENVIRONMENT

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Polymer materials are more commonly used in a wide range of everyday applications, especially in the packaging. High plastic humans consumption generates plastic waste, which is responsible for the environmental pollution. Biodegradable polymers are seen as a potential alternative to the solution of environmental problem. In the family of biodegradable polymers, polylactide is one of the most frequently used polyesters. This is mainly due to its many favourable properties, including its easy availability, relatively good strength, biocompatibility, and biodegradability. Degradation of polyester depends on both physical-chemical and biological factors of environment. Most of the articles available in the literature describe the degradation tests in controlled laboratory condition. The natural environments are more complicated, very often require longer time of polymer incubation and do not guarantee visible effects of decomposition. Therefore environmental degradation can go on from several days or months and even to several years. The purpose of this study is the estimation of the degradation process of polylactide (PLA) in natural aqueous environments. Biological degradation of PLA took place in The Baltic Sea and in the natural pond over a period of 1-16 month. The characteristic abiotic parameters of both environments were monitored during incubation time and their influence on the PLA degradation was discussed. The changes of weight, mechanical properties and surface morphology of investigated samples were also tested during incubation. The obtained results indicate that polylactide is not very susceptible to an enzymatic attack of microorganisms present in natural aqueous environments.

COMPARISON OF DEGRADATION TIME OF SELECTED PACKAGING MATERIALS IN THE BALTIC SEA

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Plastic debris is a worldwide problem. Marine debris is essentially any waste that ends up in a marine environment. It originates from a wide variety of locations. The main sources of plastic waste in the marine environment are waste from coastal tourism, households, fishing and marine industries. Marine litter is not just an issue for the surface of the sea. Debris is also found on deeper zones and on the sea floor. Marine environment not only accumulate plastics but also transfer them to distant regions. Marine debris is a global pollution problem that impacts human health and safety, endangers wildlife and aquatic habitats. It should be noted that the most of found plastics in the marine environment are not degradable with lack ability to decompose or mineralize. Fully biodegradable plastics are an alternative to nondegradable, but must be safety for living organisms. Despite of the abundance of living organisms in marine environment only limited number of microorganisms have an influence on degradation processes of plastic waste. Additionally various abiotic factors related to environmental conditions have an impact on plastics degradation. The object of the present study is to demonstrate the behaviour of selected packaging materials (polyethylene terephthalate, polycaprolactone, cellulose) during exposure in natural marine environment. The environmental degradation of these materials took place in The Baltic Sea and lasted for a period up to 80 weeks. The macro- and microscopic observations of polymer surface, weight changes and mechanical properties were tested during experiment. The characteristic parameters of natural environment were also controlled during incubation time and their influence on the rate of degradation process was discussed. The environmental degradation rates of investigated packaging polymers in The Baltic Sea decreased in order: cellulose > polycaprolactone > polyethylene terephthalate.

TOXIC AND HAZARDOUS SUBSTANCES IN PM1 AND PM2.5 AEROSOLS OVER GDYNIA

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PM1 and PM2.5 aerosols were collected between 1st of January and 31st of December 2012 in the urbanized coastal zone of the southern Baltic Sea, in Gdynia. The main aim of the study was to recognize annual, seasonal (heating and non-heating) and daily concentration variability of B(a)P, OC, EC, BPA, OP and NP in aerosols, these being the most dangerous constituents to human health. The average annual concentrations of B(a)P turned out to be alarming for the health of the inhabitants of Gdynia and its surroundings. Significantly, statistical relationships between concentrations of all analysed PM1 and PM2.5 compounds suggest their common source of origin in the region of the southern Baltic Sea. In both aerosol fractions the highest concentrations of organic carbon were noted. Among the phenol derivatives, the highest concentrations obtained 4-nonylphenol and its concentration in the least degree depended on the direction of advection. Parallel measurements of PM1 and PM2.5 made it possible to determine that in Gdynia concentrations of all species were highest, up to 6 times, during the heating period.Then the dominant pollutant source were combustion processes in the communal-utility sector due to the use of coal and wood for heating purposes. Highest concentrations of all species were reported under local or regional land advection and at low air temperatures. During the non-heating period the role of transportation, both land and marine, increased and could be important for creating higher concentrations of analysed compounds in PM1 and PM2.5. Under the advection from harbor B(a)P concentration increased in particular and reached two to three times higher values. It was probably a result of daily activity in the Port of Gdynia, as well as the entrance fairway of ships and ferries to the port.

ASSESSMENT OF THE AERMOD DISPERSION MODEL IN A COMPLEX TERRAIN WITH DIFFERENT TYPES OF DIGITAL ELEVATION DATA

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The AERMET/AERMOD (American Meteorological Society (AMS)/EPA Regulatory Model) dispersion modeling system constitutes a tool recommended by the United States Environmental Protection Agency (U.S. EPA) both for flat and complex terrain in a local scale, i.e. with a distance of 50 km. This model requires the application of numerous different input data. These include meteorological data, emission source information, emission rates and the digital elevation model (DEM). Referring to the latter, currently, there is a considerable number of available data that can be implemented in the modeling process. As part of the research, the effectiveness evaluation of the AERMOD model was conducted based on two of the model evaluation databases (Martin's Creek, Lovett) depending on different available DEM sources. The analysis involved comparison of different modeling results obtained with the application of different DEM datasets, i.e. NED (National Elevation Dataset), ASTER (Aster Global Digital Elevation Model), SRTM (Shuttle Radar Topography Mission) and USDEM (US GeoData Digital Elevation Models). Achieved outcomes indicated, that the use of different elevation datasets did not influence the evaluation results of the AERMOD model in a local scale and complex terrain significantly.

CHEMICAL COMPOSITION OF PRODUCTS EMITTED IN RESIDENTIAL HEATING

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Recent studies proved that the energy production in domestic devices is one of the major sources of atmospheric fine particle pollution in many parts of the world and particularly in Europe. The technology used in a domestic biomass combustion has a crucial influence on the observed emissions. Incomplete combustion of the biomass can result in the emission of pollutant gases and particulates to the atmosphere as well as the production of bottom ashes. The combustion of biomass is a complex physical and chemical process. The formation and emission of small particulates to the atmosphere depends on many factors, such as fuel particle size and fuel distribution. Quality and composition of wood fuels, which affects emissions from combustion, can vary enormously depending on their characteristics as well as the production processes. This study aimed at investigation of the chemical composition as well as physical properties of solid particles and bottom ashes collected from the residential combustion processes of biomass. For these purposes the analysis of the chemical characteristics of solid particles was carried out. These analyses included inorganic components like metals and non-metals as well as ions. There was also carried out the analysis of metal content in bottom ashes. Authors also investigated the morphology of solid particles and bottom ashes collected in the experiment.

COMPARISON OF CHEMICAL PROPERTIES OF SOLID PARTICLES EMITTED IN RESIDENTIAL HEATING OF WOOD AND BRIQUETTE

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In the recent years, combustion and co-firing of wood fuels has been a great focus as they are known to combust efficiently with high heat transfer and lower gaseous emissions in comparison with solid fossil fuels. The technology, which is used in a domestic biomass combustion has a crucial influence on the observed emission profiles. Scientists have observed the differences in the emissions from manually and automatically operated systems. There has been reported a high variability between manual and automatic systems. They also found a variability in the composition of the emitted particles. For manually operated equipment, it was shown that 70% of the PM10 mass consisted of total carbon (TC), while for the automatic combustion equipment, the emitted particles consisted mostly of potassium inorganic salts. When conventional fireplaces were used, 40 to 100% of the mass of emitted fine particle consisted mostly of organic material, including polycyclic aromatic hydrocarbons (PAHs) and their nitric and oxidative derivatives. The aim of this study was to develop a characteristics of solid particles arising as a result of stationary combustion processes occurring in domestic heating units (DHUs), in which different solid fuels were burned. Obtained results provide the information about the chemical composition of solid particles emitted in the stationary combustion processes, which creates opportunity in further research to propose the most environmental friendly solution of domestic heating system with an application of a popular fuel and some innovative, possibly cheap, concepts to reduce emission of harmful compounds.

MITIGATION OF SEA ACCIDENT CONSEQUENCES

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The sea transport of dangerous goods is pretty safe at normal environmental conditions. However, the transported goods may sweep out to the sea as a result of unexpected events such as collision, grounding, fire, damages of ship machinery, etc. These events may bring about the release of hazardous chemicals into the sea environment. Then the substances may occur the marine environment threats such as: explosion, fire of these chemicals, as well as toxic, corrosive, bioaccumulative and other dangerous chemical substances presence in the ship accident area. Next, these threats may have disastrous influence on the human health, the ship and the marine ecosystem and lead to the environment dangerous degradations such as: the increase of temperature, the decrease of oxygen concentration, the disturbance of the pH regime, the aesthetic nuisance (caused by smells, fume, discoloration etc.) and the pollution in the accident area. The losses associated with the environmental degradation are involved with negative consequences in the accident area e.g. the closure of port or fishery area and people death. These losses can be expressed by the cost of the negative consequences in case like the closure of port and closure of fishery area wherease in the case of negative consequences like people death and injured, the losses can be expressed as the number of victims. In the paper the model of shipping critical infrastructure accident consequences is applied to the forecasting of environment losses associated with chemical release generated by dynamic ship critical infrastructure network operating at the Baltic Sea waters. Next, minimal values of these environment losses obtained through their optimization are presented and compare with previous ones. Finally, suggestions on the strategy assuring lower environment losses concerned with chemical releases generated by an accident of ships are proposed.

EFFECT OF TEMPERATURE ON GAS-PHASE MERCURY ADSORPTION PROCESS WITH THE USE OF ORGANIC SORBENTS

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The research presented by the author in this paper concentrates on understanding the behaviour of mercury during coals combustion and flue gas purification operations. The goal was to determine the flue gas temperature on the mercury emissions limits for the combustion of lignites in the energy sector.

Hence that the largest source of anthropogenic mercury emissions to the atmosphere are fuel combustion processes, and taking into account the unique role of atmospheric environment in the process of circulation and of mutual transformations of mercury and its compounds with variable toxicity, it was crucial to determine the distribution of mercury between the various products of combustion of bituminous coal and lignite by determining the chemical composition of combustible fuels and to determine the impact of technological factors.

Based on the knowledge of the impact of aspects tied to and utilised technology and raw materials on the speciation of mercury in the flue gas, the authors have undertaken the task of examining the process of sorption of mercury from flue gases using fine-grained organic materials. The paper presents the results of laboratory tests of mercury sorption from the flue gases at temperatures 90°C, 125°C, 155°C, 185°C. The active method selected by the authors serves as a cheap substitute for expensive activated carbons that are thus far the most efficient sorbent for mercury concentration in the flue gas.

INVESTIGATION OF THE MODE OF OCCURRENCE OF ARSENIC IN COAL

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Determination of the mode of occurrence of toxic elements in coal is important in order to determine their behaviour in the combustion process. The research was carried out for 12 coals used for power generation purposes (11 hard coals, including 2 mixtures of hard coal burned in power plants and 1 brown coal). The method of selective leaching in ammonium acetate, hydrochloric acid, hydrofluoric acid and nitric acid (V) was applied to determine the mode of arsenic occurrence in coal. The arsenic concentration in the residue was also examined. The research showed that arsenic in coal was mainly associated with monosulphides, disulphides and carbonates (30% - 84%). In the case of three coals, the highest share of As in coal was in the residue (even more than 50%). On the one hand, this may suggest that the arsenic was mainly associated with the organic part of the coal, but on the other hand, not all forms of pyrite could be washed out. For this reason, additional tests have been carried out to determine the iron content in the residue. The iron concentration in these three coals was significant (6.6 - 8.2 g/kg). Moreover, the percentage of iron that was determined in the residue in relation to the initial Fe content in these three coals was in the range of 39% - 58%. This may indicate that not all the pyrite has been washed out from the coal and the part of the arsenic that has been determined in the residue may be related to the unwashed pyrite.

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IMPACT OF URBAN, SUBURBAN AND INDUSTRIAL BACKGROUND ON AIR POLLUTION LEVELS OF DUST SUBSTANCES IN NORTH-EASTERN PART OF KRAKOW (POLAND)

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Air pollution in urban-industrial areas is caused by simultaneous impact of many factors, including different types of emission sources. Ambient air quality in Krakow is a crucial problem regarding the regularly occurring exceedances of limit values of particulate matter and some of its chemical compounds. This paper presents quantification of urban, suburban and industrial background of dust substances concentrations that are present in the industrialised area, located in the vicinity of scattered household and road traffic emission sources. There were included the concentrations of such substances as: particulate matter (PM10), benzo(a)pyrene, arsenic, cadmium, lead and nickel. The impact of daytime and season of the year (especially heating and non-heating season) on variability of air pollutant concentrations was examined. In order to distinguish between local and inflow background of air pollutants the additional meteorological data concerning wind speed and direction was considered. The performed analyses included application of statistical methods, among others principal component analysis (PCA). Some of the results were visualised via R programming environment, providing tools for air pollution data processing (openair package). The backward trajectories modelling using HYSPLIT model, allowed the validation of wind direction analyses. The conducted research revealed the strong dependence of air pollution background type influencing the measurement results on instantaneous wind direction.

POSSIBILITIES OF OPEN-CAST MINING ACTIVITY IN LANDSCAPE PARKS IN POLAND – CASE STUDY

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In Poland, landscape parks cover around 8,1% of land area, what in recent years has been the cause of conflicts involving mining entrepreneurs and limit the possibility of mining activities by them. Due to the growing problems in this issue, in the article, domestic base of mineral resources, within the boundaries of currently existing landscape parks, has been analyzed. The list of restrictions, that can be established within each of them, is included in the Nature Conservation Act. However, detailed guidelines in this regard are determined by the regional assembly of province. Among the restrictions are those that directly prohibit mining activities, or those that can significantly limited it. The list of prohibitions, suggested by the law, particularly hits the deposits, exploitation of which is possible only by the open-cast method. They constitute the vast majority of all deposits documented in Poland. Among them are all deposits of rock materials and lignite. Currently in Poland, 651 documented deposits are located within 95 landscape parks and one buffer zone of the landscape park. The most numerous group are deposits of rock minerals with total resources exceeding 17,5 million tonnes. Subsequently, these are deposits of energy minerals, metal ores and chemical minerals. The mining license covered only 152 deposits, the vast majority of which are deposits of rock materials. The extraction volume usually does not exceed 100,000 tons, and only in three deposits exceeded the level of 1 million tons. Among them is Czatkowice Limestone Mine, which produces 40% (available on the domestic market) sorbents used for flue gas desulfurization. This case study address a good practice of smoothly and effective decision-making process in the field of obtaining a new mining license in boundary of landscape park. Czatkowice Mine was presented as a case study of good practices on different steps of mining activity in EU funded MinLand Project.

INVESTIGATION OF PHYSICOCHEMICAL AND ANTIMICROBIAL PROPERTIES OF MODIFIED KUZU STARCH FILMS FOR WOUND DRESSING

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Huge amounts of waste, mainly from the plastics industry is considerable burden on our environment. The solution of this problem may be biodegradable materials from renewable polymers, such as starch, proteins, cellulose etc. Increasing interest in these materials also takes place in biomedical applications. Polysaccharides are readily available, non-toxic, inexpensive and biocompatible materials. Starch has good film-forming properties; however, it depends on amylose/amylopectin ratio. The content of amylose determines film-forming capacity of starch-based films. Biodegradable and renewable composite films from kuzu starch and glycerol with addition of colloidal solution of nanosilver and natural extracts with antibacterial properties were obtained by casting method. The objectives of the present work were to analyze the effects of addition of natural active substances such as extract of rooibos, chili pepper extract on physical properties (thickness, hardness, density), barrier properties (permeability of water vapor) and thermal properties of starch films. The ability to incorporate silver nanoparticles into the starch film matrix and study of obtained films properties has also been carried out. Natural extract of rooibos, chili pepper extract and nanosilver solution are relevant for the antibacterial and antifungal capacity of films, so disk-diffusion agar method of examined samples were also done. The results show that the natural extracts in kuzu films limited recrystallization of starch. Incorporation of rooibos extract and chili pepper extract to the starch film insignificantly increases water vapor permeability. Therefore, kuzu starch films with natural extract will be a potential candidate for wound dressing with antibacterial properties.

INITIAL COMPARATIVE ANALYSIS OF GAS POLLUTION CONCENTRATIONS OF AN ENGINE RUNNING ON LPG AND GASOLINE

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Internal combustion engines have long been trying to adapt to fuels other than petrol or diesel. The choice of the right fuel is determined by the requirements of the engines and the economy. The most popular fuel used in gasoline engines that meets the above criteria is LPG - a mixture of hydrocarbons, mainly propane (C_3H_8) and n-butane and isobutane. Lower costs of fuel purchase (even by 60%) from the economic point of view, they contributed to the development of the LPG installation market and related infrastructure. Propane-butane gas has many beneficial features that can lead to lower emissions from the car exhaust system, inter alia, sulphur and carbon compounds. The article collects available information on gas installations installed in cars. Using exhaust gas analysers, a preliminary comparative analysis of selected concentrations of pollutants in the exhaust gases of LPG and gasoline fuelled engines was carried out. As a result, ecological effects of using LPG as a fuel were initially determined. The presented results and analyses are a prelude to further research related to the measurement of exhaust fumes in internal combustion engines fuelled with petrol, LPG and in the future also with diesel oil.

EMISSION REDUCTION PROCESS FOR THE ENERGETIC USE OF BIOGENIC RESIDUES

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The transformation from a fossil-based to a bio-based economy is evolving worldwide. This is associated with an increased use of wood assortments and agricultural plants for material purposes. Therefore, a further expansion of energetic biomass use is only possible based on biogenic residues. During the combustion of biogenic residues small particles, NO_x, Cl and SO_2 compounds occur in elevated concentrations depending on the respective fuel composition. Corresponding abatement technology is only available for the power plant sector and cannot be used economically on small biomass plants. The aim of the presented work is to demonstrate an exhaust gas purification procedure which can be used economically in decentral biomass plants. The core of the exhaust aftertreatment process is a fabric filter with catalytically active filter bags which enables a combined reduction of dust and NO_x. An additional precoating of the fabric filter removes acidic exhaust gas components such as SO_2 and HCl from the exhaust gas. Cost advantages compared to conventional exhaust gas cleaning technology have to be achieved through space savings, energy savings and the use of components from the automotive industry. Experiments were conducted on three different scales. On a laboratory scale the precoating processes were investigated. On a pilot plant (100 kW) combustion experiments for the investigation of the precoat- and reducing agent- dosing units were performed with straw pellets. A field installation (300 kW) is in operation in order to demonstrate the effectiveness under practical conditions. A monitoring system for NOx based on sensors from the automotive industry were developed and tested. Field measurements showed a reduction in dust emissions of over 95 % and a significant reduction in NOx, SO_2 and HCl. Further optimization of the quantities of reducing agent and precoating material injected is necessary in order to improve the performance of the exhaust gas cleaning process.

A PROPOSAL OF LOW-COST TECHNOLOGY FOR NUTRIENT RECOVERY FROM LEACHATE OF ANAEROBIC DIGESTER AT A BIOLOGICAL WASTEWATER TREATMENT PLANT

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Removal of nitrogen (N) and phosphorus(P) from wastewater is one of the priorities of wastewater treatment plants (WWTPs). A large part of nutrients is removed together with the excessive sludge or emitted to the atmosphere. P may also be precipitated by coagulants in the form of insoluble compounds. When using iron compounds as a precipitant, the resulting precipitate binds P in a form difficult to access for plants. Thus, fertilization with composted sludge increases the accumulation of P permanently bound in soil. Removal of nutrients from wastewater with simultaneous recovery of P and N in the form assimilable by plants is possible by the precipitation of ammonium magnesium phosphate (struvite). This method, benefits environmental protection but has not been widely implemented in WWTPs. One of the reasons is the high costs of available technologies. The aim of the work is to investigate the low-cost methods of reduction and recovery of nutrients from wastewater. It involves the precipitation of struvite from phosphate-rich leachates from WWTP fermentation chambers. The reaction was carried out in the prototype of a simple horizontal reactor, ensuring the possibility of collecting sediment in the funnel. A cheap waste magnesium salt was used to precipitate the struvite, which significantly reduced the costs of its acquisition. The reduction of P exceeded 80% in all performed tests in leachate waters. The precipitant removed from the reactor has the character of sludge with a significant degree of hydration (85%). After drying, it is a dusty powder with an average P content of 40% and a total N content of 8% and a trace of heavy metals. It was proposed to mix the obtained aqueous form of struvite sediments with compost produced from excessive sludge, without drying it. Studies have shown that one percent of struvite admixture in compost results in an increase of P and N content by 13% and 2,7%, respectively.

MEASUREMENT AND ANALYSIS OF ACOUSTIC PHENOMENA OCCURRING IN PUBLIC TRANSPORT BUSES BASED ON SURVEYS AND FIELD STUDY

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The article presents the results and analysis of noise measurements in the passenger compartment of public transport buses. City buses of twelve metres in length, operating in a large urban agglomeration, were selected for research. The research related to the assessment of the acoustic climate in buses was conducted in two stages: in the first stage, a questionnaire survey was carried out, followed by a field study in the second stage. The aim of the research carried out was to identify places inside the bus with potentially high sound levels, and then perform a proper assessment of the noise affecting passengers. The survey was related to the assessment of vibroacoustic comfort in the buses during travel. The questions answered by the respondents concerned places inside the vehicle where the noise and vibrations could be felt the strongest and vehicle movement phases during which they were the most intense. Additionally, the respondents made a subjective assessment of the noise and vibrations inside the bus during travel. The survey conducted revealed that the noise and vibrations generated during travel on public transport buses cause moderate discomfort and are mostly felt in the same way across the entire vehicle. The field study was conducted with the use of ten measuring microphones placed in the passenger compartment of the bus and consisted in simultaneously recording the sound levels and the speed at which the vehicle was moving. The measurements were taken both during standstill and while the bus was moving. When the diesel engine was running at idle during standstill in the buses selected for the research, the recorded sound level ranged from 60 dB to 73 dB. During travel, it increased from 71 to 76 dB. Moreover, the measurements taken made it possible to identify places in the vehicle with the highest and lowest sound levels during standstill and while on the move.

ENERGY POTENTIAL OF RESIDUAL BIOMASS FROM AGRO-INDUSTRY IN CAMPANIA REGION (SOUTHERN ITALY)

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The feasibility of energy recovery from residual biomass depends on its availability, as well as on the sustainability of its use. For these reasons, it is necessary to define a methodology that allows a preliminary evaluation of the bioenergy potential at local scale. In this paper, the energy potential of residual biomass from agro-industry in Campania region (southern Italy) is investigated. Such a region presents a significant production of agro-industrial residues, mainly from olive oil and wine industries. The main by-products of these industries useful for energy production are olive pomace and grape marc. Beyond olive oil and wine production, dairy industry is predominant in Campania region. Livestock farming is extensively diffused, therefore manure valorization for energy production may be attractive.

Depending on their chemical-physical characteristics, residual biomasses may be converted through biochemical or thermochemical systems. This paper presents a methodology to define the energy potential in Campania region of the residues coming from olive oil, wine and dairy industries considering the economic and environmental feasibility of their use. The residual biomass availability is estimated considering the production rate of olive oil and wine industries and the livestock amount.

Then, the energy potential is assessed taking into account the properties of the residual biomasses and the most suitable energy conversion system. Finally, a regional map for each energy source is derived to assess the feasibility of energy production from agro-industrial residual biomass at different spatial scales.

A NOVEL METHODOLOGY TO EVALUATE THE POTENTIAL BIOMASS FROM AGRICULTURAL AND FOREST RESIDUES FOR A SOUTH MEDITERRANEAN REGION

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According to the national Energy strategy elaborated in 2017, the biomass sector has got one of the most important strategic roles in energy renewables policy. Planning a specific and clear estimation of this resource for energy purposes, it's crucial for authorities, entrepreneurs and industrial groups who want to invest in this sector. Biomass is generally available in large amounts in the south of Italy, due to the large production from agriculture associated with the large availability of forest of resources. Despite this potential, high investment costs, conversion losses reaching up to 30–40% and overall the uncertainty of the amount of resource potentially are major barriers to higher penetration of this resource. The authors, in this paper, aim at defining a novel methodology to identify the potential energy recovery from agricultural and forest residues biomass of the Campania region. The new methodology makes use of the GIS tools to define the area suitable for biomass recovery and makes a comparison with the literature data. Three different scenarios have been analyzed in order to analyses the different level of exploitation of the resource: low, medium and high. A survey on the sustainability and the greenhouse gas savings has been carried out for each scenario analyzed. The results obtained with this methodology has shown the most suitable kind of crops in terms of energy content and its profitability.

THE LEGITIMACY OF USING THE MILD HYBRID SYSTEM IN PASSENGER CARS EQUIPPED WITH DOWNSIZED ENGINES

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The restrictions related to the reduction of emissions of harmful exhaust emissions, among others from passenger cars are becoming a bigger problem. To meet the requirements, not only construction changes in combustion units, exhaust gas treatment systems are used, but also Mild Hybrid or classic hybrid systems. In order to verify the legitimacy of using Mild Hybrid systems in passenger cars equipped with downsized combustion engines, the authors of the article performed comparative tests of two vehicles, classic and having a Mild Hybrid system. The first one was equipped with a classic spark-ignition engine and the second one with a spark-ignition engine and a Mild Hybrid - 48V electric system. Road emissions of pollutants were performed in real traffic conditions (RDE), using mobile PEMS type measuring equipment. In the article, the authors discussed the differences resulting from the construction of propulsion systems vehicles, as well as results showing differences in road emissions resulting from the vehicle systems used, in terms of emission of harmful exhaust gas such as carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NO_X). On the basis of the obtained test results, it was possible to respond to the determination of activities related to reducing emissions of harmful exhaust substances with these kinds of improvements in passenger cars.

COMPARATIVE STUDIES OF ROAD EMISSION OF POLLUTION EMISSION OF URBAN CITY BUS WITH AN ENGINE POWERED WITH COMPRESSION IGNITION POWERED BY DIESEL FUEL AND, AN ENGINE WITH SPARK IGNITION POWERED BY CNG IN REAL TRAFFIC CONDITIONS

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There is a growing appreciation for using buses powered by alternative fuels in urban transport. Considered as such are city buses with SI engines fuelled with natural gas. This article provides a comparison of road pollution emissions from two city buses: one with a compression-ignition engine powered by diesel fuel, and the other with a spark-ignition engine fuelled with CNG. Both vehicles conformed to Euro VI emission standard, and the tests were carried out in real traffic conditions. Equivocal opinions about differences in emissions from those types of buses, among others - CO_2 and NO_x emissions, were the underlying cause of the tests. The comparative study was carried out along the same urban routes during bus trips over the following days in similar traffic conditions. Exhaust road emission was determined based on the vehicle's mass and route length, and operating fuel consumption. Also, the study was consistent with the most recent requirements laid down in the directive regarding estimates of emission conformity factors during road tests from heavy-duty vehicles. For that reason, it was necessary to determine the conformity factor for relevant exhaust harmful substances in combustion gases in window functions, based on which the assumption on the fulfilment of emission requirements for both buses in real traffic conditions was verified. The values thus established of emissions of exhaust harmful substances from combustion gases in tested city buses did not exceed permissible legislative values, and the ascertained differences provided a basis for their ecological classification.

THE EVALUATION OF NOX EMISSIONS IN RDE TESTS INCLUDING DYNAMIC DRIVING CONDITIONS

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Reducing emissions of nitrogen oxides and carbon dioxide, especially in urban agglomerations, is still a challenge for the European Commission. The article presents the evaluation of exhaust emission results of passenger cars obtained in road emission tests. The tested objects were passenger cars equipped with a gasoline engine and meeting the Euro 6 emission norm. The measurements in real driving conditions were carried out in compliance with the latest legislative procedures of RDE tests applicable to passenger cars. Test drives were carried out on the same research route divided into urban, rural, and motorway sections. The obtained results of RDE test procedure's requirements and the Euro 6 emission norm were analyzed. Then the impact of dynamic parameters on the obtained values of nitrogen oxides and carbon dioxide emissions intensity were determined. The values of the 95th percentiles of nitrogen oxides and carbon dioxide mass in each section of the test and the impact of the dynamic parameters on them were pointed out. As a result, it was possible to determine the correlations between dynamic conditions and the 95th percentile of nitrogen oxides and carbon dioxide mass.

THE ECOLOGICAL EVALUATION OF EURO 5/EURO 6 PASSENGER CARS REGARDING PARTICULATE EMISSIONS

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The article presents the ecological evaluation of passenger cars that meet the latest emission norms, the development of which has so far been dictated by requirements of downsizing. The comparison was made based on the selected vehicles equipped with spark-ignition engines, which are an example of reducing the displacement volume while maintaining the operational parameters of the drive units. The change in the vehicle's emission category caused an increase in requirements regarding emitted particles number from these engines. As a result, the introduction of particulate filters into exhaust aftertreatment systems of gasoline engines (so far only three-way catalytic converters have been used) became necessary. Comparisons of the mass and particles number and their dimensional distribution for vehicles of different ecological classes, and also engines before and after downsizing were the basis for making conclusions about the direction of changes in traditional propulsion units in modern vehicles.

METHODOLOGY OF ULTRAFINE PARTICLES EMISSION ASSESSMENT FROM COMBUSTION ENGINES FOR VARIOUS APPLICATIONS

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Exhaust emissions negatively affect human health and one of the most harmful exhaust components are particles with diameters smaller than 100 nm (ultrafine particles). Their main source are internal combustion engines, where in the case of jet engines, the nanoparticles dominate in the total emission of particles. Piston engine's after-treatment systems allow to reduce majority of particulate matter emissions, while the smallest size particles still accounts for a significant share in the total emitted number. The paper presents a proposal for a uniform methodology for assessing the emission of ultrafine particles from internal combustion engines of various applications. The research was conducted for diesel and spark ignition engine as well as jet engine. The obtained results of the number and emission of particles were referenced to the emission of carbon dioxide and the work made by the engine. Both the emission of primary and secondary particles forming at a specific distance from the engine were taken into account.

KEY PARAMETERS OF FLY ASHES GENERATED FROM INDUSTRIAL ENERGY SECTOR DECISIVE FOR THEIR PRO-ECOLOGICAL APPLICATIONS

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Fly ashes belong to the important by-products, accompanying conventional industrial energy production. Depending on the nature of the used fuels as well as on combustion technologies and conditions, fly ashes may exhibit different physicochemical properties, limiting their potential applications as raw materials. Burned hard and brown coals or heavy oils may generate fly ashes of various chemical, mineral and phase compositions. Combustion conditions and humidity can strongly alter final properties of ashes too. Exhaust gas cleaning technologies also cannot be neglected as important factors affecting their textural and functional properties. For example, deNOx processes, where NH_3 is used as a reducer, can result in the ammonia slip and lead to a formation of ammonia salts. The current research was focused on the detailed, hierarchical analysis of chemical, mineral and phase compositions of fly ashes received from the Polish and the Czech power plants. Their in-depth structural, textural and functional characterization has been performed by XRF, XRD, SEM/EDS, BET, RS and DRIFT. The concentration of NH_3(aq) in aqueous effluents was determined by UV/Vis technique. Basing on the obtained results, the algorithm for selecting the most important parameters for large-scale pro-ecological applications was proposed. The ratio of Si/Al - the main constitutive elements, content and speciation of iron and other transition metals, occurrence of alkali and carbonaceous residuals, NH3 content, mineral and phase compositions, grain diameter and morphology as well as an affinity of water to ash surfaces were selected as crucial parameters, remaining decisive for the successful exploitation of ashes. Even if the presented results have been obtained for fly ashes received from power stations localized in Central Europe, the proposed strategy and range of potential pro-ecological applications may be taken into consideration also in the case of fly ashes acquired from other sources.

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CHALLENGING PATHWAYS OF EXPLOITATION OF FLY ASHES GENERATED FROM ENERGY SECTOR AS THE PROMINENT EXAMPLE OF CIRCULAR ECONOMY

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Mass combustion of fossil fuels such as hard coal or brown coal for purposes of energy production in power plants is always related with the formation of various tale gases and solid residuals. Fly ashes, leaving the combustion chamber together with exhaust gases, are next captured in the dust removal sections, usually by electrostatic precipitators. About 4 million tons of ashes are generated annually in Poland in energy sector. A storage of this type of materials is associated with a plethora of problems, starting from the costs of transportation and deposition, via formation of hazardous leachate and ending on the risk of dusting and gaseous emissions. Reusing of fly ashes seems to be thus an attractive and generally recommended solution, consistent with the priorities of a circular economy, in which waste of a given technological process becomes a raw material consumed in another one. It is however challenging to close such a material circle and to propose technologically feasible and economically reasonable pathways of industrial transformation of fly ashes. Currently they are frequently used as components to concretes or cements, improving durability of such products. Intensive studies have been also carried out on the synthesis of advanced materials starting from fly ashes as substrates. Structured sorbents, functional and catalytic materials exhibiting wide range of potential applications remain of particular interest in this context. Ashes can also be used in environmental technologies, for example as exchanging sorbents for water and wastewater treatment.

The paper presents the results of in-depth characteristics of fly ashes, chemical and phase composition (XRF, XRD, RS), structural and textural properties (BET, SEM-EDS) and functional characteristics (DRIFT) in the context of possible paths for their pro-ecological uses. Particular attention was paid to the possibility of using fly ashes for the synthesis of structured materials of catalytic relevance.

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IMPACT OF REDUCTION OF CO_2 EMISSIONS IN THE HOUSEHOLDS AND TERTIARY SECTOR ON AIR QUALITY AND HUMAN HEALTH

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Significant efforts are being made in the world to reduce greenhouse gas emissions. In the households and tertiary sector, where energy is mainly used to heat space, one should also expect a shift away from fossil fuels (including natural gas) to renewables. In the REFLEX project the energy and emission scenarios for various sectors with the use of ASTRA, ELTRAMOD, TIMES-HEAT-EU and FORECAST models were developed for analysing the long-term situation up to 2050. The current study focuses on the evaluation of air quality and health impacts associated with direct emissions of air pollutants from households and tertiary sector based on the Driver-Pressure-State-Impact-Response framework. Ambient concentration of air pollutants in Europe was calculated with the use of Polyphemus Air Quality System. Health impacts were estimated based on the concentration-response functions for PM2.5, which is responsible for the most significant impacts to human health. The study shows that particulate matter (PM2.5 and PM10) emissions from residential and tertiary sector in Europe will decrease by 30 times till 2050 compared to 2015. These emission reductions lead to improve air quality. The largest reduction in PM2.5 ambient concentrations is observed over Poland. Consequently, both the lower impact of air pollution on human health and the reduction of external costs should be expected in 2050 in Europe.

The analysis was executed within the EU project REFLEX (Analysis of the European energy system under the aspects of flexibility and technological progress), which received funding from the European Union's Horizon 2020 research and innovation programme [GA-No. 691685]. For further information, see: hhttp://reflex-project.eu/

ANALYSIS OF PHOTOVOLTAIC CELLS FOR POWERING A SOLAR AIRPLANE AND EVALUATION OF THE IMPACT ON THE ENVIRONMENT

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The duration of the flight of an unmanned aerial vehicle is very limited due to the amount of energy that can be stored in the storage system – in our case, it caps at 24.5Ah. Whilst in the air, the only available source of energy is the sun. Photovoltaic cells allow us to harness that energy and extend the flight time by 9h and thus give a possibility to stay in the air overnight. Using a research stand, analysis of various photovoltaic cells was carried out, among others polycrystalline and monocrystalline, current-voltage characteristics, comparison of mass, efficiency and fill factor in conditions simulating the flight of the model (much attention was paid to the back contact cells) monocrystalline cells with 24.7% efficiency were selected. In order to secure the constructed modules, tests of laminated photovoltaic cells in laboratory conditions were carried out on the station constructed for this purpose. The stand checks the effectiveness of the work of previously laminated photovoltaic cells in aircraft flight conditions (wind speed, variable solar intensity). The tests used temperature changes, laminate thickness and number of layers. It is not possible to power the aircraft propulsion directly from photovoltaic cells. This is due to the variable performance of the panels and the fact that the engine during the flight may need more energy than the panels are able to produce. This problem was solved using energy storage - lithium-ion batteries. Batteries of this type are characterized by a very good ratio of capacity to mass, which is very desirable in the case of drones. The model is characterized by the possibility of storing 12.95Wh weighing only 48g. An additional problem is the optimal balancing of the mass and components used - the more they are, the better to optimize the construction, while each additional gram increases the power needed to drive the model.

INITIAL ASSESSMENT OF THE LEGITIMACY OF LIMITING THE MAXIMUM PERMISSIBLE SPEED OF VEHICLES ON THROUGHWAYS AND MOTORWAYS BASED ON TESTS OF ROAD EXHAUST EMISSIONS THESE VEHICLES IN REAL TRAFFIC CONDITIONS

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The reduction of exhaust emissions of harmful substances is one of the main aspects in broadly understood automotive sector. Representatives of the European Union cheer of vehicle manufacturers to fulfill increasingly stringent standards related to the emission of harmful substances from passenger cars. From 2020, the new standard for CO, HC and NOX road emissions from these vehicles will come into force. It also assumes average CO_2 emissions from car fleets of producers at the level of 95 g/km. There are big challenges. The emission of harmful substances is also a problem during the operation of vehicles. In real traffic conditions, a big challenge is the need to reduce driving max. speed of vehicles due to emissions of exhaust emissions. With increasing driving speed, this emissions increases. Therefore, the authors of the article decided to investigate above emissions of vehicles on the throughways and motorways. In research, mobile device type PEMS was used for tests of vehicles with emission standards: Euro 4, Euro 5 and Euro 6. The tests were carried out in real traffic conditions on throughway and motorway with speeds of vehicles 110, 120, 140 and 160 kph. The research was aimed at showing differences in the level of exhaust emissions of tested vehicles resulting from the speed of travel. In the article, on the basis of the tests max. speed of vehicles was determined and recommended, which from the point of view of exhaust emissions is optimal for efficient and ecological movement of vehicles on discussed type of roads.

HYDROGEN PRODUCTION POTENTIAL FROM THE PAPER AND PULP INDUSTRIES WASTEWATER IN INDIA

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Energy-water nexus holds the key for sustainable development amidst rising population and global industrialization. Rapid growing industries have left an indelible mark on the ecosystems. In the view of addressing the top two crisis (energy and water), this review is divided into two parts; discussion on phenol remediation; second on hydrogen production. A complete Statistical analysis of phenol generation around the world and also in India are discussed by taking paper and pulp industry as the source or reference point. Similarly, H_2 production from various non-renewable and renewable energy sources are compared in terms of cost and sustainability. With AOPs going in full swing, the focus has been dedicated to photo-catalysis for efficient degradation and also the energy production from it. Besides, the underlying mechanisms for OH radical and H_2 generation are detailed to explore the factors that influence their production rate. The shortcomings in the technology such as low optical response in the visible region, high recombination of photo-generated charge carriers and their transport are reviewed and proposed some emerging ways to overcome them with a systematical approach. Construction of composite catalysts that offer higher quantum yield, hydrogen production under sunlight and making it more cost-effective and long-lasting is the gist of this work.

DETERMINATION OF CARBON FOOTPRINT OF AUTOMOBILE ORIGIN IN IZMIR CITY

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Global warming and climate change, which are one of the most important agenda items of recent years, have become one of the biggest threats to life. Measures need to be taken to reduce the greenhouse gas emissions that cause global warming and climate change, and to prove that they will benefit from the research. The global success of these measures was achieved through the Kyoto Protocol. According to this protocol, countries are responsible for emissions, and they should take measures and try to minimize them. These oscillations must be calculated in order not to exceed the emission limits specified by the protocol.

The carbon footprint, which is a measure of the damage to the environment, is an indicator of greenhouse gas emissions and the unit is expressed in terms of carbon dioxide equivalent. While determining the carbon footprint, IPCC, GHG Protocol, UNFCCC, ISO 14064 STANDARD are taken into account.

In this study, the number of automobiles in Izmir was taken from TÜİK (Turkey Statistics Institution) data, and their carbon footprints were classified according to the type of fuel they used. IPCC Tier-1 method was used in the calculations and IPCC 2006 guide was used for the values based on fuels. As a result of the calculations, the total CO_2 emissions of 821.391 cars in Izmir, in terms of gasoline, diesel and LPG CO_2 emissions were calculated also and it was found 1,857.845 tons of CO_2 equivalent per year.

WASTEWATER TREATMENT PLANT: MODEL OF AN ACTIVATED SLUDGE PROCESS FOR THE ENERGY DEMAND ANALYSIS

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The aim of the present paper is to develop a reliable and accurate simulation model of the wastewater biochemical treatment in order to integrate it in a general dynamic simulation environment, namely INSEL, for the analysis of the energy demand of the whole wastewater treatment plant. In particular, the presented model pays special attention to the chemical kinetics involved in the activated sludge process for the reduction of nitrogen and carbon compounds. According to the best practices, the plant configuration considered in this work includes the denitrification-nitrification process, performed by completely mixed reactors. In particular, the process analyzed in this paper is based on the Ludzak-Ettinger process. The biological process is simulated according to the well-known method widely used in literature, namely the Activated Sludge Model No 1 (ASM1), by means of a user-developed code. The model includes a set of equations for the calculation of: aerobic growth of heterotrophs, anoxic growth of heterotrophs, aerobic growth of autotrophs, decay of autotrophs, ammonification of soluble nitrogen, hydrolysis of entrapped organics, hydrolysis of entrapped organic nitrogen. All these equations, along with energy and mass balances, form a system of ordinary differential equations (ODE) solved by the Runge-Kutta technique. The developed model is validated using literature data, showing a great accuracy (deviation below 1 %). As for the temperature, results show that, between 15 and 25°C, in the initial part of the process, transport effects dominate the consumption ones. When the temperature is higher than 30°C, nitrate consumption is so fast that biomass growth is limited by this effect. Conversely, in case of low temperatures (5-10°C), biomass growth is not limited by nitrate availability. Finally, results also showed that temperature significantly affects the denitrification process, whereas the effect on the oxygen is lower.

THE INFLUENCE OF THE FUEL ON THE EXHAUST EMISSIONS AND FUEL CONSUMPTION OF A VEHICLE EQUIPPED WITH A LARGE DISPLACEMENT SPARK IGNITION ENGINE

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Fuel is one of the most important factors which have an influence on the results obtained during vehicle emission testing. With the change of the emission testing procedure (change from NEDC cycle to WLTP cycle, etc.) in September 2017 the fuel specified for EU vehicular homologation tests was also changed. Before that date, all vehicles equipped with spark ignition engines were fuelled with E5 gasoline (5% ethanol content) and after that date, test vehicles are fuelled with E10 gasoline (10% ethanol content). The fuel used during homologation tests is a very specific reference fuel, whose tightly controlled parameters have been specified in the standard. The change of the fuel type required for homologation is caused, among others, by the fact that the use of ethanol in gasoline is one of the solutions to reduce fuel lifecycle CO_2 emissions. Chemically, E5 and E10 show important differences, most notably in terms of carbon weight fraction and oxygen and energy content. In this paper, the emission results (THC, CO, NO_x and CO_2) obtained during chassis dynamometer testing according to the WLTP procedure, of the vehicle equipped with a large displacement spark ignition engine fuelled with two types of reference fuel: E5 gasoline and E10 gasoline are presented. It was found that the influence of the fuel on the exhaust emission results is low. Comparing results obtained for the E10 gasoline to those from E5 gasoline, emissions of the CO and CO_2 are almost at the same level. Emissions of THC and NO_x were found to be higher (by 23% and 33%, respectively), but the absolute difference in the emissions level was very small and these changes are therefore insignificant. Thus, a 5% increase in fuel ethanol content (i.e. from 5% to 10%) did not have a substantial impact on regulated exhaust emissions, CO_2 or fuel consumption for the vehicle tested.

THE DIFFERENCE IN CHEMICAL PROPERTIES OF PARTICULATE MATTER FROM STATIONARY AND MOBILE SOURCES – THE PRELIMINARY CASE STUDY

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The knowledge about the chemical composition of particles emitted from various sources is significant to properly apportion the ambient air pollution by particulate matter. The study presents the chemical characterisation of particles emitted from residential and industrial processes of combustion of solid fuels (representing the stationary emission sources) and particles emitted from Diesel engines of passenger cars and medium-duty vehicles. Solid fuels were combusted in a domestic stove, under the similar conditions of the process during each sample collection. Particle samples from the engines were gravimetrically measured on dyno and engine test beds during the New European Driving Cycle and European Steady Cycle emission tests. The samples were analysed for the presence of elemental and organic carbon, inorganic ions, metalloids and metals, including heavy metals. The content of analysed chemicals differed depending on the emission source. With respect to stationary combustion sources, the main factor determining the emission of solid particles are related principally to the fuel quality. The duty of vehicles was also a factor influencing the chemical characterisation of particulate matter emitted from engines. The current efforts to control fine particles also result in the appreciable reduction of the total number of particles emitted by both diesel and gasoline engines.

GLOBAL DEVELOPMENT OF EMISSIONS REDUCTION FROM LIGHT DUTY VEHICLES AND ITS IMPACT ON PROPULSION TECHNOLOGY

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The automotive industry is currently under unprecedented pressure from a wide range of factors, particularly in terms of environmental performance and fuel consumption. Long-established test procedures are changing and standards are becoming much harder to meet, especially in Europe, where new WLTP and RDE test procedures were implemented in 2017, but also on other continents, necessitating changes in testing methodology, powertrain development, aftertreatment systems and strategies and calibrations. Concern over gaseous and solid pollutants has become a central issue for all major global markets. There is also considerable pressure to reduce fuel consumption and CO_2 emissions – around 80% of all new LDV sold globally are subject of some kind of energy efficiency regulation. The EU has planned the most challenging targets for reducing CO_2 emissions from LDV in the world. PC cars and LCV now account for 13% of greenhouse gas emissions in the EU. But by 2021, CO_2 emissions from new cars coming onto the roads should be 42% less than the new cars in 2005. This is in fact ahead of the targets set by the EU for 2030. CO_2 emissions reduction has been achieved in conjunction with decreases in NO_x by 90% and PM by 84% through the introduction of the Euro 6 rules. As a result of stringent regulations on emissions, vehicle and powertrain technology is also developing very quickly and new propulsion systems will soon be present on the main automotive markets. Fundamental changes to the propulsion strategy for on-road vehicles (e.g. fuel types/the implementation of advanced electromechanical systems – hybrids and development of new powertrain types such as fully electric vehicles (BEV) or fuel cell) represent a revolution in the industry. All these advanced technologies must be developed, tested, approved and certified. In the case of hybrid or fully electric powertrains, accurately quantifying the full, real world CO_2 emissions benefit is of particular importance.

IMPACT OF SELECTED FACTORS ON THE PARTITIONING OF THALLIUM IN COAL COMBUSTION PROCESS

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Thallium is one of the most toxic elements, next to mercury, lead or cadmium. One of the main anthropogenic source of Tl emission into the atmosphere is coal combustion processes. The behaviour of thallium in these processes and the factors determining the emission have not been sufficiently understood jet. The article presents research on the partitioning of Tl between products of hard coal combustion and the impact of selected factors (i.e. combustion temperature, fuel composition and mode of Tl occurrence in the combusted coal) on this partitioning. The study was conducted on a laboratory scale for three hard coals and one blend of coals burned in an industrial plant. Thallium content in gaseous products and solid residue after combustion of examined coals were determined. The analysis of thallium content in gaseous products was carried out using the US EPA Method 29. The combustion process was carried out at two temperatures: 850 ºC and 1200ºC. In addition, the mode of thallium occurrence in examined coals was determined using the selective extraction method and correlation with other coal components. The results obtained in the laboratory conditions were referred to the thallium content in products (fly ash, slag, flue gas desulphurization products) obtained from the combustion of the coal blend in an industrial installation.

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ASSESSMENT OF THE RISK OF POISONING BY COMBUSTION PRODUCTS FROM GAS APPLIANCES USING CFD MODELING

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Gas appliances, including water heaters, are widely used in households and may have a significant impact on their gas atmosphere, i.e. reduction of oxygen concentration and appearance of toxic oxides (especially CO). Therefore, the paper deals with the assessment of the risks of poisoning by combustion products from a gas appliance using CFD modeling. A numerical three-dimensional CFD (Computational Fluid Dynamics) model of a real apartment was developed, in which the gas flow water heater with a standard power of 20 kW works in the bathroom. The model enabled performance of non-stationary simulation calculations for various air inflows to the abovementioned apartment (60 - 120 m^3/h) as well as for various concentrations of carbon monoxide in exhaust gases (0.1 - 1 %). It was assumed that exhaust gas inflows entirely into the room for 10 minutes. Based on the calculations performed, it was shown that the main threat occurs in the bathroom. Changes in concentration of carbon monoxide and oxygen over time, and depending on the room height, were also analyzed. In addition, an analysis of the impact of exhaust gases inflow on the temperature in the bathroom and the whole apartment was made.

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