ceer 2020

BOOK OF ABSTRACTS

1st International Conference on the Clean Environment and Energy Research

December 2-4, 2020 | Poland

Institute of Sustainable Energy

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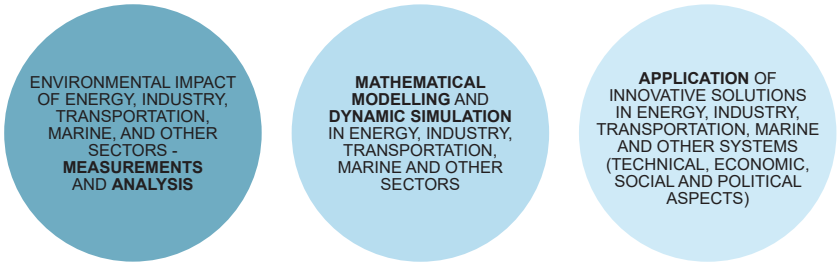
The content

Introduction

The main goal of the **International Conference on the Clean Environment and Energy Research (CEER2020)** is to present and discuss the latest advances in research related to clean environment and energy from technical, economic, social and political aspects.

CEER conference is an event adressed to scientists, professional engineers, social workers, policy makers and other stakeholders from all over the world. The main goal of the conference is to present and discuss the latest advances in research related to clean environment and energy from technical, economic, social and political aspects.

Conference scope covers the following areas:



Due to the Covid-19 situation, the first edition of the CEER conference was held virtually on December 2-4, 2020. The conference was organized by Institute of Sustainable Energy in cooperation with Università degli Studi di Napoli Federico II, Faculty of Oceanography and Geography (University of Gdansk), and Mineral and Energy Economy Research Institute of the Polish Academy of Sciences in Krakow.

More information about the conference: www.ceerconference.org.

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Hybrid renewable energy systems for the sustainable production of electricity, heat, cool and water

FRANCESCO CALISE[1)], Maria Vicidomini[1)]
[1)] University of Naples Federico II

This work aims at presenting the current works concerning the polygeneration plants, by specially focusing on the potential integration of different technologies into a single system. Polygeneration allows one to produce energy vectors (power, heating and cooling) as wells as other useful products (hydrogen, syngas, biodiesel, fertilizers, drinking water etc.) by converting one or multiple energy sources. Polygeneration system can be fuelled by renewable sources (geothermal, solar, biomass, wind, hydro), as well as fossil fuels (natural gas, coal, hydrogen, etc.). In this paper different hybrid renewable energy systems are taken into account, by also focusing on the control strategies implemented for the proper management of polygeneration systems in general. Polygeneration systems based on combined cycles, internal combustion engines, gas and steam turbines, including organic Rankine cycle, fuel cells, H2 and CO2 production are also illustrated.

Origin of PAHs in precipitation in the Antarctic region (Arctowski station) at the turn of 2017 and 2018

ANITA LEWANDOWSKA[1)], Marta Staniszewska[1)]
[1)] University of Gdansk

Studies aimed at determining the sources of origin of polycyclic aromatic hydrocarbons (PAHs) in rainfall and snowfall carried out in the Antarctic region, at the Arctowski station at the turn of 2017/2018. Moreover, an effort was made to estimate the deposition fluxes of 5 priority PAHs with both, snow and rain. Rainfall was collected using a Hellman rain gauge, and snow using a polyethylene cuvette. After sampling, the volume, pH and precipitation conductivity were measured. The samples were then filtered through a QMA quartz filter, a fragment of which was used for PAH analysis by high performance liquid chromatography (HPLC, Dionex UltiMate 3000). The highest median concentrations among all five PAHs determined in precipitations were for fluorontene (Flu) (0.28 ng/dm^3) and for benzo(a)anthracene (B(a) (0.25 ng/dm^3). The lowest values were obtained for benzo(a)pyrene (0.07 ng/dm^3), which among all analyzed PAHs is characterized by the highest toxicity to living organisms, including humans due to their strong carcinogenic and mutagenic properties. Analysis of the obtained results showed that the concentrations of all PAHs analysed in precipitations collected at the Arctowski station were higher in snow than in rain. The trend was reversed in the case of PAHs fluxes. Obtained values of diagnostic indicators allowed us to conclude that in the area of the measuring station PAHs in precipitation were mainly of local origin. It was associated with daily activities at the station and in its surroundings (coal, wood and liquid fuel combustion processes and diesel engines use).

A novel approach for the calculation of the energy savings of heat metering for different kinds of buildings

MARIA VICIDOMINI[1)]; Francesco Calise[1)], Francesco Liberato L Cappiello[1)], Diana D'Agostino[1)]

[1)] University of Naples Federico II

The aim of this paper is to propose a novel approach in order to accurately calculate the energy and economic savings due to the use of heat metering and thermostatic valves in residential buildings. The study is developed for four different typologies of buildings located in the city of Naples (South of Italy), including their geometrical and thermophysical properties. The buildings are first modelled in Google Sketchup and subsequently linked to the TRNSYS environment, which also includes a detailed model of the piping systems. The models allow one to evaluate, for every period of the year, energy demand, energy supplied by radiators, heat gains, transmission, etc. The developed models were used to calculate energy demand for three scenarios for each typology of building: centralized heating systems not equipped with heat metering; thermostatic valves without heat metering; heat metering and thermostatic valves. The possible savings related to thermostatic valves and heat metering are estimated using. The results were compared with the ones provided by the Italian Standards. Results show that the thermostatic valves adoption leads to a significant reduction, also up to 50%, of the thermal energy demand of the residential buildings and that all the proposed systems exhibit a remarkable economic profitability, with payback period also lower than 1.7 years.

Assessment of agricultural tractors energy consumption and toxicity indicators as measured during field works

Łukasz Rymaniak[1)], Piotr Lijewski[1)], Michalina Kamińska[1)], NATALIA SZYMLET[1)], Paweł Fuć[1)], Jerzy Merkisz[1)]
[1)] Poznan University of Technology

Manufacturers of vehicles and agricultural machinery equipped with internal combustion engines are constantly working to reduce the negative environmental impact of their products. To achieve this, research works are carried out on the methods of assessing the real ecological indicators using portable emission measurement systems. The paper presents the proposed proprietary M exhaust toxicity indicator, which is based on the assumption that CO2 emissions are a measure of the correctness of the combustion process. The measurements were performed using a farm tractor meeting the Tier 3 emission norm, operated in real conditions during plowing work. The tests were carried out for a given land section at three speeds (the quality of work performed was also assessed). In the analysis of test results, the net engine work (determined using the value of the moment transmitted to the crankshaft) was used, as it is carried out in the type approval procedures. When measuring in real operating conditions, the torque read from the OBD (On-Board Diagnostics) system is overstated because it takes into account the engine's internal resistance. This distorts the obtained information on true toxicity indicators. In the analysis of test results, the fuel consumption, toxicity indicators of gaseous compounds and particulates were determined, and the best conditions for conducting agricultural works (in the scope of works undertaken) were indicated in terms of their impact on the natural environment.

Removal of cyanobacteria and microalgae present in the atmosphere with dry and wet deposition in the coastal zone of the Gulf of Gdańsk

KINGA WIŚNIEWSKA[1)], Anita Lewandowska[1)], Sylwia Śliwińska-Wilczewska[1)]
[1)] University of Gdansk

Atmospheric research often focuses on particles of the anthropogenic origin, however, components from natural sources also play a significant role in the atmosphere. Among them, bioaerosols including bacteria, viruses, fungi, and their fragments, as well as cyanobacteria and microalgae are commonly present. This work covers only microalgae and cyanobacteria as they are the least studied organisms in aerobiology. The presence of these organisms in the atmospheric air has been documented by many researchers worldwide. Airborne microalgae and cyanobacteria participate in clouds formation, influence on the hydrological cycle and Earth's climate, but also impact human health. However, there is little research on removal these organisms from the air with rain. The purpose of this study is to determine whether cyanobacteria and microalgae present in the atmospheric air are effectively washed out with rain. To achieve this, rain samples were taken from July to October 2019. The number of cyanobacteria and microalgae in the rain was estimated at between 0 and 342 cells▫ml-1. In addition, the quantitative and taxonomic composition of cyanobacteria and microalgae present in aerosols before and after the precipitation was determined. The research indicates that the atmosphere is a carrier of cyanobacteria and microalgae, both of which quantity and taxonomic composition change significantly over time.

Refrigerant fluids: Status review and comparison of alternative refrigerant options

Nicola Massarotti[1)], Laura Vanoli[1)], CLARA VERDE[1)]
[1)] Universita degli Studi di Napoli "Parthenope"

Nowadays, climate changes and environmental impacts constitute a crucial challenge that humanity will face over the next decade. For this reason, Europe must adopt new strategies to achieve climate-neutral impact in 2050 and so to reach this ambitious target several actions are needed, such as the greenhouse gas emissions reduction, the increase in energy efficiency and the use of renewable energy sources. Recent statistics have, in fact, reported that heating and cooling can play a role in the decarbonization processes since the greenhouse gases emissions related to the civil sector represent 17,5% of the total ones. In order to reduce greenhouse gas emissions, traditional refrigerants should be replaced with low GWP (global warming potential) refrigerants. This work reviews the progression of refrigerants from the inception of mechanical refrigeration and the alternative synthetic refrigerants that could replace the HFC (hydrofluorocarbons), R410A and R134a, used in air conditioning systems and characterized by a high value of GWP. The analysis was performed taking into account environmental compatibility, applications, costs and safety group. The review has highlighted that the refrigeration market is addressed towards low GWP HFCs and HFO (hydro-fluoro-olefine) compounds, environmentally friendly though flammable. Regarding this issue, the Italian Legislation allows the use of these refrigerants only for some specific applications. Therefore, in order to not penalize the Italian market of heat pumps and refrigeration technologies compared to the European one, it is necessary to review the Italian regulations concerning flammability.

Assessment of the nuclear fuel utilization efficiency in selected generation IV nuclear reactors

TOMASZ BURY[1)]
[1)] *Silesian University of Technology*

The nuclear power engineering nowadays is based on water cooled and moderated nuclear reactors. Such units are also the vast majority of currently built nuclear reactors of generation III or III+. The situation looks quite different while looking at the generation IV designs. There is only one water reactor type, among six technologies being considered in this generation: very high temperature reactors (VHTR), sodium cooled fast reactors (SFR), super critical water reactors (SCWR), gas cooled fast reactors (GCR), lead cooled fast reactors (LFR), and molten salt reactors (MSR). It is also important to mention that electricity is not always considered as the main product for generation IV nuclear reactors. Considering environmental aspects it is worthy to note that some generation IV reactors are foreseen to burn out actinides contained in spent fuel from older generations reactors. Moreover, there is nuclear fuel breeding planned in the fast reactor systems. An estimation analysis of the spent fuel amount and the efficiency of use the nuclear fuel in selected power nuclear reactors of generation IV is the aim of this work. The analysis for most of the considered units was done based on design data, so it should be recognized just as some estimation. Comparison of the results to a third generation unit clearly shows improvement in the nuclear fuel utilization efficiency. There are also some other possibilities to reduce the amount of the spent nuclear fuel, like using the recovered fuel or breeding the fuel. Although these solutions are not quite new, there is a wide application of them planned in the generation IV reactors. Summarizing, it can be observed that development of nuclear reactor technology improves also environmental aspects, not only the safety. It should be also noted that many of the generation IV project are rather long-term programs, mainly due to material constrains.

Climate solutions for the problem of smog in Poland

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Polish anti-smog programs treat biomass as a source of low emission problem on a par with coal and lead to its elimination from the energy mix. Does Poland have to go against the European Union's climate policy? What if we tried to solve the problem of air pollution in Poland using renewable biomass?

The methane emissions and hard coal output changes in the Brzeszcze mine (Poland) in 1997 – 2018

MARCIN DREGER[1)]
[1)] *University of Silesia*

The paper presents the variability of methane emissions into mining excavations in the Brzeszcze mine (Poland) against the background of hard coal output, geological and mining factors. The geological building of the Upper Silesia Coal Basin (USCB) is very diverse. The Brzeszcze coal deposit is located close to permeable Jawiszowice fault which increases the methane danger in mining activities close to this fault. The studies period 1997 – 2018 overlaps with hard coal output decrease with rapid increase in methane emission at the same time. Through entire studies, hard coal output decreased more than twice (from 2.86 to 1.22 million Mg). When we consider coal production from 1988 to the 2018, coal output decreased three times (3.86 to 1.22 million Mg). Coal extraction in high content beds (e.g. 510, 405/1, 364, 352) increases the total methane (CH_4) emission into mining excavations, enlarging the methane danger – because CH_4 is a highly explosive gas. To protect miners, coal workings need to be ventilated all the time, dragging harmful gas out of the mine (Ventilation Air Methane emission) or capturing it by the underground methane systems (outgassing). In every year over 34 ml m^3 of CH_4 is captured by the drainage and over 70 ml m^3 CH_4 goes out by ventilation (average).

On-line measurement of elemental mercury Hg(0) removal from flue gas and sulfur species influence of mercury Hg(0) reduction

YINYOU DENG[1)], Mariusz Macherzyński[1)]
[1)] AGH University of Science and Technology

Mercury, especially Hg(0), is one of pollutants that are not completely removed with conventional exhaust gas controlling devices, e.g. in power plants. Activated carbon injection (ACI) method is an example of active removal of mercury from flue gas, but has some important disadvantages. Some inorganic modified sorbents and potential regenerating properties are promising options. The Hg(0) capture in flue gas, with the use of different kinds of sorbents, in presence of sulfur species was studied. Flue gas originated H_2S may adsorb onto sorbent's surface, where decomposes into hydrogen ions and sulfur ions under metal/metal-sulfide catalysis. The sulfur ions bind with Hg(0) from flue gas to form a solid phase onto adsorbents [1]. On the other hand, flue gas originated SO_2, present in excess, may compete with mercury surficial sorption process. For this purpose the measurement stand was redesigned on the base of the one presented in [2]. Flue gas from energetic fuels is filtrated on a fabric filer, and mixed with controlled portions of Hg(0). Then it is divided into two equal streams: reference line and adsorbent line, both are directed into thermostatic oven. Selected adsorbents can be placed inside a glass tube in the adsorbent line. An empty glass tube of the same kind is used in the reference line. When necessary, flue gas is cleaned from SO2 by laboratory-scale WFGD. Flue gas at four different points can be on-line measured by Testo 350 (Testo). Mercury concentrations are measured on-line and simultaneously in both lines by two EPM-2 analyzers (NIC), equipped with flue gas pretreatment scrubbers. The utility of the newly designed measurement stand has been tested. Interdependencies between fuel load, temp. of combustion and exhaust flow rate as well as all important technical functions of the system were discussed. Preliminary study on mercury reduction effectiveness from flue gas by using chemically impregnated adsorbents and other reference materials was done.

Energy Recovery from Sewage Sludge by Gasification: An Opportunity for Italy

Simona Di Fraia[1)], Nicola Massarotti[1)], Laura Vanoli[1)], MOHAMMAD RAKIB UDDIN[1)]
[1)] Universita degli Studi di Napoli "Parthenope"

The current work aims at investigating energy recovery from sewage sludge (SS) by gasification, considering the case of Italy. The analysis is carried out by using a model developed through the software Aspen Plus. A combined heat and power (CHP) system based on SS gasification-internal combustion (IC) engine is considered for energy recovery. SS generation rate is estimated considering the current data as well as the improvement in the wastewater collection and treatment expected for the next years. According to these assumptions, 680 kt SS as dry solid (DS)/year are expected by 2030 in Italy. Current SS management practices are agricultural use, landfill, and incineration, which release greenhouse gases (CH_4, N_2O, CO, SO_2 etc.) to the environment and cause global warming. Thermochemical treatment of the SS for energy recovery can solve the problem. Among all the thermochemical treatment techniques, gasification is considered as best to harness energy from SS as syngas due to its relatively low costs, high efficiencies and mild operating conditions. A gasification model was calibrated and validated on Aspen Plus by collecting experimental data from the literature on syngas generation from SS in a bench scale rotary kiln under laboratory conditions. The average deviation of the model result from the literature was 2.65% during calibration and 13.7% for validation. Some sensitivity analyses were carried out to investigate the optimum operating conditions of the gasification process. Syngas generated at optimum operating conditions of 900 0C temperature and equivalence ratio of 0.2 has lower heating value (LHV) of 4.12 MJ/Nm^3 and gas yield of 1.83 Nm^3/kg SS as DS. Based on the developed model, the potentiality of energy recovery as CHP from SS is estimated to reach around 1870 GWh/year within 2030 in Italy with an electrical efficiency of 29.75% and cogeneration efficiency of 52.67%.

Dynamic modelling and analysis of a novel hybrid layout based on cogeneration and photovoltaic for hospital facility

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The aim of this work is the development of a dynamic simulation model of a novel hybrid layout based on internal combustion engine cogeneration and photovoltaic. The studied hybrid layout is designed for meeting the energy demand of a real hospital, including energy demand for building space heating and cooling and domestic hot water preparation. The system is based on an internal combustion engine cogeneration unit of 2.0 MW and a photovoltaic field of 0.5 MW. The cogeneration unit is designed for operating according to the base-load operation strategy, constantly producing the rated power for whatever power demanded. Moreover, the developed plant also includes two auxiliary natural gas condensing boiler of 5.22 MW and 2.10 MW, an absorption chiller of 0.77 MW and an electric driven chiller of 3.0 MW. The dynamic model is developed in TRNSYS18 environment. The 3D building thermo-physical model is calibrated against the measured energy demand of the hospital. The results point out that despite the low solar availability in Stuttgart the hybridization of a cogeneration layout with photovoltaic is promising, achieving a payback period of 1.45 years. The proposed layout is resulted almost grid independent: the self-consumed energy meets 92% of the electric energy demand of the hospital. Conversely, the thermal energy recovered by the internal combustion engine cogeneration unit is not able to completely match the thermal energy demand of the hospital. Indeed, the auxiliary condensing boiler meets about 26% of the thermal energy demand of the hospital. Further analyses are need for better understanding the performance of this kind of novel layout.

A new indicator for minimizing size of ORC power plant based on heat exchanger and turbine design parameters

MARCIN JANKOWSKI[1)], *Aleksandra Borsukiewicz*[1)]
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Organic Rankine cycle (ORC) power plants are capable of converting low and medium-temperature energy sources into electricity. A wide variety of the source types (geothermal, solar, biomass, waste heat) that can be utilized results in multitude possible implementations of these systems. For each application, an adequate model must be developed to optimize the operation of the ORC. This is strictly related to evaluating the system from different perspectives using mathematically defined objective functions. Apart from criteria providing viability or sustainable work of the ORC, the size of a system is also an important aspect in performance analysis. This is particularly relevant for ORCs that operate on units with limited space (on ships, aircrafts, automotive vehicles) or in case of domestic applications. Moreover, it is always desirable to design the ORC which provides high performance while maintaining the system size as compact as possible. In this study, a novel indicator for minimizing size of the ORC power plant is proposed. The system size index (SSI) is calculated based on the total heat transfer area of the heat exchangers and diameter of the turbine rotor. To examine the SSI effectiveness in terms of minimizing the system size, the results obtained using the developed index are compared to the outcomes achieved by applying well-known size-related indices, such as: UA or size parameter (SP). Furthermore, the multi-objective optimization using Non-dominated Sorting Genetic Algorithm (NSGA-II) is conducted to verify the potential for applying SSI as one of the objective functions.

Dynamic simulation and optimization of a micro-scale trigeneration system based on biomass fired steam cycle and wind turbine

RAFAŁ FIGAJ[1)]
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Renewable energy sources, as solar, wind, biomass and geothermal energy, start to be adopted in small and micro-scale distributed generation systems. In this context, different configurations and layouts can be adopted, and among them hybrid plants represent a special category, where more than one renewable energy is used. These hybrid systems make advantage of the coupling of the characteristics of each renewable source allowing to create benefits in terms of energy, environmental and economic performance improvement. In micro-scale hybrid applications, biomass and solar energy sources are more frequently investigated in literature compared to other combinations as biomass and wind energy The analysis of the performance of a novel small-scale trigeneration system including biomass combustion, water steam turbine, absorption chiller and wind turbine is presented this paper. The system is linked to the grid by means of a bidirectional connection with the electric grid. In this way, the electrical energy produced in excess is virtually stored and may be used when needed. For the proposed system, a farm and residential buildings are considered as case study. In particular, the system is designed to properly manage its energy flows in order to match the user heating, cooling and electrical energy demand. The TRNSYS software is used to model, simulate and investigate the system performance under real operation conditions. Energy and economic performance of the system is assessed by means of a weekly, yearly and Design of Experiments analysis. The proposed system is investigated adopting different scenarios for the reference system for comparison of the performance. The investigations show that the Simple Pay Back time of the proposed system is below 5 years, when capacities of steam and wind turbines lower than 5 kW are selected. The system allows one to achieve a significant Primary Energy Saving ratio (> 70 %) for any combination of steam and wind turbine powers.

Novel catalyst carrier for volatile organic compounds combustion: CFD simulations of transport coefficients

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Atmospheric emissions of volatile organic compounds are a serious problem for the chemical industry, during, for example, the production of paints, fuels, plastics, and so on. The harmful gases generated in these processes can be removed from the air by catalytic oxidation. One way to optimise catalytic afterburners is to select an appropriate catalyst carrier. The main features of an efficient carrier are high surface area and low flow resistance, but, above all, intensive transport properties. In laminar flow regime, enhancement of heat and mass transfer can be achieved by shifting the reactor's operation to the developing laminar flow. This can be done by dividing the catalyst carrier into several shorter segments (slices), which increases the transport rate even several-fold compared to developed flow. Further modification of the channel shape may lead mainly to a decrease of pressure drop. The focus of this work are results obtained from CFD simulation (ANSYS Fluent) of a short hexagonal channel (edge length 2.31 mm; channel length 3, 6 or 12 mm) with modified wall shape. Innovation in this case is the streamlined shape of the cross-section of the channel wall (aerofoil shape). The simulations were performed for air. The momentum and energy calculations were performed using the laminar flow model, the pressure-based solver and the second-order upwind discretisation scheme were applied. At the inlet, constant velocity with uniform (flat) profile was specified, as was constant temperature at the walls. The acquired results show that shortening the channel length improves the heat and mass transfer rates. This unique shape of the channel walls caused a decrease of the inertia forces compared to classic monolith with flat walls. This reduced flow resistance with simultaneous intensification of the transport rates due to removal of the stagnant zones.

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Structured catalyst carriers in air protection processes

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Rising demand for improved air quality has led to an intensive search for ever more effective solutions that limit emissions. One of the most effective ways of neutralizing the main air pollutants, such as methane and volatile organic compounds, are the catalytic afterburning processes carried out in structured reactors. The classic solution in air protection is a monolithic reactor with a catalyst deposited usually via "washcoat". This arrangement is characterized by low mass and heat transfer rates, which cause problems in fast catalytic reactions, like for example catalytic combustion of methane or volatile organic compounds (VOCs). The solution may be to use very short monoliths (short channel structures, SCS) and/or change the straight shape of the channel walls into the streamlined ones (wing structures, WS). The proposed catalyst carriers (classic monolith, SCS and WS) have been tested in the catalytic combustion of methane at low concentration. Such a situation occurs e.g. in the mine's ventilation air and is a big problem from the environmental point of view. The process was carried out using the Pd/Al_2O_3 catalyst prepared by sonochemical method. Effect of the reactor structure on the process yield (process conversion) was determined taking into account the kinetic parameters of the process, heat and mass transfer and flow characteristics of the structures tested. The results have shown that the short channel structure and wing structure require shorter reactor length to achieve 90% conversion of methane, hence lower mass of catalyst. Moreover, the changes in the channel wall shapes into streamlined shapes result in lower flow resistance, hence lower pumping cost. Higher heat and mass transfer coefficients for WS were also observed compared to classic solution (SCS). In summary, shortening the monolith channels highly intensifies the process. Moreover, the streamlined channel walls further increase process yield.

Expanded metal meshes as reactor internals for catalytic processes of air pollution reduction

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Design and optimisation of the performance of structured reactors is crucial for environmental catalytic processes such as catalytic combustion of volatile organic compounds and selective catalytic reduction of NO_x. It is highly desirable to ensure a large surface area to volume ratio and high heat/mass transfer rates to maximise the process yield, minimise the catalyst consumption and at the same time ensure low flow resistance to reduce pumping costs. Monolithic reactors are well known in the automotive industry as catalytic converters for the after-treatment of exhaust gases. They ensure low pressure drop and large surface area for fluid-catalyst contact. However, their heat/mass transport is weak due to the existence of fully developed laminar flow in long capillary channels. A certain compromise between heat/mass transfer intensity and flow resistance could be obtained using short-channel structures. Wire meshes also offer better heat/mass transport rates than monoliths, with acceptably low pressure drop. Three expanded metal meshes of different geometry have been examined in terms of their thermal and hydraulic behaviour. Single mesh, placed in the test reactor perpendicular to the flow direction, was heated electrically. Air was the working fluid. Several thermocouples measured the temperatures of the flowing air and mesh surface. The pressure drop was measured using a Recknagel micromanometer. ANSYS Fluent 19.1 software was applied for the CFD modelling of fluid flow and heat transfer through the metal meshes. Computational domain contained constant heat flux boundary conditions at the mesh wall, initial flow velocity and temperature at the inlet, atmospheric pressure on outlet. Steady-state, laminar and incompressible flow condition was assumed. The comparison of experimental and numerical results gives good agreement of around 15%. Expanded metal meshes indicate greater heat transfer coefficients than monoliths, with a slight increase in pressure drop.

Analysis of indicators used for measuring sustainability in supply chains: A systematic review

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The purpose of this paper is to analyze indicators used for measuring sustainability in supply chains. A systematic review was conducted to explore indicator-based frameworks and identify the associated gaps within published peer-reviewed articles that are relevant to sustainability performance measurement of supply chains. A total of 628 indicators were analyzed: 202 for economic, 208 for environmental and 218 for social dimensions of sustainability. The majority of the indicators were used only once, which indicates a lack of consistency and consensus on how sustainability should be measured in supply chains. Four indicators, product quality, energy consumption, occupational health and safety, and employment/job opportunity, were found to be the most frequently and consistently used indicators. Multi-criteria decision analysis (MCDA) techniques are the most widely applied research methods for analyzing the indicators. Case studies were mostly conducted in automotive and food industries compared to other industrial sectors. Majority of previous research focused on linear multi-echelon supply chain than closed-loop supply chain. The indicator-based frameworks proposed by previous research did not consider context-based sustainability. Unlike previous long-lists of indicators in the literature, this papers analyzed the most consistent and frequently used indicators for measuring sustainability in supply chains. Moreover, it provides a comprehensive view of indicators by including all the three dimensions of sustainability. This paper presents in-depth analysis of the use of indicators in sustainability measurement of supply chains. It proposes a preliminary research agenda by highlighting gaps in the existing research and this will provide a strong basis for future academic and practitioner work.

Assessment of a geothermal energy system for sludge drying in wastewater treatment plant and electricity production in a small island

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Electric energy consumption and sludge disposal account for most of the operating costs in wastewater treatment plants. Therefore, there is an interest in improving the energy efficiency while minimizing sludge production, especially in disadvantaged areas, like small islands. For this reason, in this work, geothermal energy is proposed to be used in a parallel cascade configuration: the geo-fluid is extracted from the production well and then it is split into two parts. A part of it is used to power an Organic Rankine Cycle, which produces electrical energy to supply the wastewater treatment plant facilities. The other fraction of geo-fluid is employed to produce thermal energy to dry the sludge separated during the wastewater purification, allowing the reduction of the sludge to be transported on mainland for final disposal. An energy and economic analysis for the system is implemented. The study is carried out for a district wastewater treatment plant on the island of Ischia (Italy), which presents diffused low-medium enthalpy geothermal sources. The proposed system reduces sludge by around 70% and covers 100% of the electrical demand of the plant. Despite the high investment, the revenues deriving from the avoided sludge disposal and the electricity production, make the system convenient, with a simple payback of about 5 years and a saving of CO_2 equivalent emissions equal to 628 tons/year. A sensitivity analysis showed that increasing the recycling desiccant flow improves the energy performance of the system, without affecting its economic profitability. Higher geo-fluid temperatures improve the energy efficiency of the system, but increase the electrical energy required for geo-fluid pumping. Therefore, geothermal source can be considered a viable solution to produce electrical and thermal energy for wastewater treatment plants, especially when electric energy supply and sewage sludge treatment are critical challenges.

The application of modified green clay in selective catalytic reduction of nitrogen oxides with ammonia

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Nitrogen oxides (NO_x) are extremely hazardous pollutants of the atmosphere. Selective catalytic reduction of NO with ammonia (NH_3-SCR) is one of the most effective methods of NO_x removal from flue gases from stationary sources. The commercial catalyst based on V_2O_5-TiO_2 exhibits high catalytic activity only in a narrow temperature window of 300-400 degrees Celsius. Moreover, utilization of the spent catalyst is complicated due to the toxicity of vanadium. Clays are considered to be promising precursors of the new catalyst due to both considerable amount of inorganic oxides in their structure, such as Fe_2O_3 or Al_2O_3 and adsorption properties. The aim of the work was to modify green clay and test it as a catalyst of NH_3-SCR. The commercial black clay was transformed into Na-form to increase its ion exchange capacity. Subsequently, it was treated with H_3PO_3 and $C_6H_8O_7$, intercalated with Al_2O_3 pillars and modified with Fe or Cu by co-precipitation. The catalysts were characterized by low temperature N_2 sorption, XRD, FT-IR and UV-vis and tested in SCR in the temperature range of 150-450 degrees Celsius. It was found that intercalation with Al_2O_3 significantly improved the catalytic activity. The pillared clay doped with Cu exhibited 89% NO conversion at 250 degrees Celsius, while for non-pillared it was only 47%. The concentration of N_2O (by-product of SCR) was below 100 ppm for all samples, which indicates satisfactory selectivity of the catalysts. The catalytic performance is additionally improved by leaching of metal cations from the internal structure of clay onto its surface. The obtained results indicate that modified green clay is a promising precursor of novel NH_3-SCR catalyst.

Coal waste management in Poland - deposits and current waste production

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Waste from mining production constitutes approx. 60% of industrial waste, which is used to a large extent. However, it should be noted that it is still worth looking for innovative technologies. This is particularly important considering the fact that hard coal mining in Poland is to be completed by 2049.The study presents information on selected directions of waste management from hard coal mining (HCM) from the period of 3 decades, including: hydrotechnical and earth construction, land reclamation, liquidation and protection works in HCM, production of aggregates and ceramics, and recovery of carbonaceous substances. The authors present additional possibilities of using fine-grained and post-flotation coal waste from current production and deposits as a source of carbon substance. It can be used as a fuel, additive in pyrometallurgical processes or as a reducing agent for the recovery of metals from slag materials. The use of deposit coal (HD) contained in post-production waste is important for the implementation of the circular economy and for strategic reasons, especially since the European Commission has re-entered coking coal on the list of strategic raw materials, the use of anthropogenic resources in steel production or metal recovery is an interesting and innovative an alternative to traditionally used coke.

EU climate neutrality by 2050 and CO_2 emission reduction in residential heating sector

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Achieving climate neutrality in the European Union by 2050 is a very difficult challenge. We are used to technologies based on fossil resources and, despite their availability and technological maturity, we must gradually move away from them in favour of low-carbon and RES technologies. The dependence of the entire EU on fossil fuels in the residential heating sector amounted to 70% in 2015, 69% of which was imported from outside the EU. The share of natural gas in a statistical household in the EU-28 in 2018 for heating was 24.2%, oil and petroleum products 9% and solid fuels 3%. These fuels will have to be replaced when heating equipment is changed to RES (mainly aerothermal energy and solid biofuels). The paper will address the possibility of achieving NET-ZERO CO_2 neutrality in EU-28 in the household sector by using modern biomass boilers for heat production. The emission factors of harmful substances in comparison with other sources and CO2 emissions will be presented.

AGH Solar Boat as innovative solution to marine transportation and an opportunity to develop engineering skills

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Nowadays the vast majority of boats are powered by conventional sources of energy. It has a negative impact on water quality as well as on people's life. One means of combating the issue is to replace boats that are powered by conventional energy sources with boats that are powered by solar energy. This paper considers to apply that solution by the example of a solar boat built by students from AGH University of Science and Technology in Cracow, Poland. Our purpose is to build not only an ecological boat, but to build a hydroplane boat whose hull will be light, durable and innovative in terms of technology and materials used. So far we have managed to make Baśka, which for us was the first opportunity to develop our engineering skills in making composite elements. Her hull was made of carbon fabric and foam, but the composite made in this way is too heavy for the boat to fly steadily, therefore the idea was born to make a new boat, which will be a hydroplane boat. To achieve this we decided to test a new solution – a sandwich made of carbon prepreg and honeycomb. Each component produced by us is preceded by computer simulations and series of strength tests to check our assumptions. After that we decided that making the hull from prepreg and honeycomb is a much better solution compared to foams and carbon fabric, mainly due to the weight of the whole hull, which is extremely important. The experience gathered during the improvement of Baśka made us decide to build new boat from more advanced materials. Our experience was additionally enriched by consultations with specialists in the field of composite materials.. Prepreg and honeycomb came up to be the best solution to build our new boat. In addition, these materials are of higher quality and make it easier to achieve the assumed geometry and rigid and durable construction.

Steam generation in the prototypical biomass-fired micro-cogeneration system

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This paper shows the results of experimental and numerical works conducted on the prototypical micro scale cogeneration system. This system operates according to modified Rankine cycle and it is powered by 100 kW_{th} biomass-fired batch boiler. Heat generated during straw combustion in the boiler is transferred by an oil to evaporator and superheater (two shell and tube heat exchangers connected in series). Generated and superheated steam is used to power steam engine. Then, it is condensed in the another one shell and tube heat exchanger (which operates as condenser). Cooling water heated up in the condenser is utilized in the two air heaters or stored in the buffer tank. The system is equipped with the dedicated control and measurement system based on the WAGO PLC controller. Conducted so far research allowed to analyze the selected operation aspects of the developed system. This paper includes an analysis of the heat generation process in the boiler, steam generation process in the evaporator and superheater as well as steam engine operation. Actually, the power generated in the system is lower than projected (about 1% of the boiler's heat capacity), what is caused by construction restrictions. Based on the obtained results, a list of required modifications was developed. Experimental results were supported by dynamic simulations performed in TRNSYS software. The simulations include both the current configuration of the system and suggested modifications. Simulation results show, that expected power generation in the final version of the system should be at a level of 10 kW_e.

Distributed measurement system for smart city energy management

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Nowadays, various methods of improving the operation of renewable energy sources (RES) and environmental monitoring are being considered and applied. It is very important to maximize total energy generation from RES and deliver environmental data (e.g. concentration of dust) allowing for better knowledge about the possible danger for inhabitants. Varied sensor networks can be used for remote sensing of such installations gathering data related to solar intensity, wind parameters, temperature, humidity, etc. The paper presents the case study of two integrated measuring installation: (i) extended monitoring system for two small wind turbines integrated with the Center of Energy AGH building and (ii) dust concentration monitoring station allowing for measuring particulate matter (PM) with size PM1.0, PM2.5, and PM10. Data from the measuring installation allowed for generation complex patterns of atmosphere condition important for the operation of wind turbines (wind velocity and direction) and the same for dust concentration (including also air temperature and humidity). Some correlations were presented (e.g. dust concentration – wind velocity and dust-concentration – air temperature). These correlations illustrate the abilities of further processing of registered data to determine the range of ambient conditions important for the proper operation of wind turbines and at the same time – for dust concentration. The performed measurements provide data for elaborate specific location conditions and support CFD analysis extending sensor data and design new RES devoted to a specific location. Sensor data are an excellent basis for building an advanced prediction system providing estimation for future energy generation and expected condition of air quality.

Other CEER2020 conference presentations

ROBERT KUBICA, Mariusz Filipowicz, Tomasz Mirowski, Mateusz Szubel, Wojciech Goryl

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ANNA KORZENIEWSKA, Katarzyna Szramowiat-Sala, Krzysztof Sornek, Marta Marczak, Faustyna Wierońska, Karolina Kołczyk-Siedlecka, Dawid Kutyła, Janusz Gołaś, Mariusz Filipowicz

Influence of residential wood combustion processes on the emissions

ALEKSANDRA JEŻO

Breathable insulating composites from textile industry wastes

NIKOLA GÓRAL

Dragonflies (Oodonata) – potentials and threats of antropogenic habitats

Arkadiusz Chyczyński, DOROTA KALISZ, Anna Młynarczykowska

Computer simulation of iron oxides reduction with hydrogen during converter slag recycling process

MICHAŁ ZAJĄC, Kamil Pięta, Anna Pałac, Rafał Gąsior

Parametric analysis of airflow through a variable-diameter diffuser

WOJCIECH GORYL, Maciej Żołądek, Dawid Piszczek

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Anna Baszczyńska, Karol Zawadzki, Wiktor Snarski, ANGELA FLISZEWSKA, Szymon Molenda, Marcin Pisarski, Michał Sikorski

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