Abstract Book of the

12th International Conference of Young Scientists on Energy Issues CYSENI-2015

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INTRODUCTION

We are pleased to present the Abstract Book of the 12th International Conference of Young Scientists on Energy Issues (CYSENI-2015), which will take place on 27-28 May 2015 in Lithuanian Energy Institute, Kaunas, Lithuania.

The Abstract Book consists of 60 relevant abstracts accepted for the Conference. Each of the abstract fits to one of twelve scientific toipics approved for the Conference.

The scientific topics are as follows:

I Hydrogen and fuel cells

II Renewable energy sources

III Smart energy networks

IV Energy efficiency and reliability

V Knowledge for energy policy making

VI Investigations in the fields of thermal physics, fluid mechanics and metrology

VII Material sciences and Technology

VIII Investigations of combustion and plasma processes

IX Global change and ecosystems

X Fusion energy

XI Nuclear fission and radiation protection

XII Cross-cutting energy issues

We would like to thank Young Scientists for suggesting scientific issues for the Conference, for writing and revising abstracts based on the Reviewers' comments. As well we are grateful to the Board of the Reviewers who found time to read the ideas of Young Scientists and shared their experience how to better strucutre abstracts and formulate the scientific issue / question.

We hope that the Abstract Book provides a good review of scientific issues raised and suggested by Young Scientists for the Conference.

Sincerely,

dr. Viktorija Bobinaitė

dr. Diana Meilutytė-Lukauskienė

CONTENT

I HYDROGEN AND FUEL CELLS

PHASE-STRUCTURAL TRANSFORMATIONS AND ELEMENTAL COMPOSITION ANALYSIS IN THE TiO_x FILMS EXPOSED IN WATER VAPOUR PLASMA

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ABSTRACT

Hydrogen production from water by using semiconductors as photocatalysts provides a potential efficient way to obtain hydrogen, due to its ecological production process by utilizing solar energy. Currently TiO_2 has been considered as one of the best photocatalysts due to its good photoactivity, nontoxicity and low cost, but practical applications of the TiO_2 is still quite limited, mainly because of broad bandgap responding only to UV light. However, we are still looking for the ways to improve photocatalytic TiO_2 properties in order to activate it by daylight.

In the presented work the titanium (Ti) films were deposited on crystalline silicon substrates by using non-balanced magnetron sputtering technique and then in order to form photocatalysts it was oxidized in water vapour plasma. Because of photoelectrochemical water splitting, that occurs on the TiO_x film surface, phase-structural transformations and elemental composition changes in the films were expected. In order to analyse those processes, deposited films were investigated using modern, high-performance physical research methods: scanning electron microscopy (SEM), energy dispersive spectroscopy (EDS), X-ray diffraction analysis (XRD), X-ray photoelectron spectroscopy (XPS), optical microscopy, as well as the measurements performed using profilometer. Obtained results confirmed that titanium films were oxidized up to TiO_2 and it was found that films were able to accumulate hydrogen. Also it was found that the reactions were influenced by used bias voltage, plasma power and also depends on the thickness of films.

Keywords: water vapour plasma, thin films, oxidation, hydrogen, TiO_2

IN-SITU LOW TEMPERATURE PLASMA HYDROGENATION OF PURE Mg THIN FILMS

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ABSTRACT

MgH_2 can store essential amounts of hydrogen (up to 7.6 wt%) and can be used for direct hydrogen storage in solid state or as material for hydrogen production using $MgH_2 + 2H_2O \rightarrow Mg(OH)_2 + 2H_2 +$ 277 kJ reaction approach. Despite of long research history there are no economically and technologically feasible ways to produce MgH_2 on industry level. Usually pure Mg is covered by natural layers of magnesium oxides and hydroxides at atmospheric conditions. These layers prevent direct reaction of hydrogen with magnesium and it is one of the main causes of slow kinetics of hydrogenation reactions. Palladium or Platinum is used to prevent pure magnesium from direct oxidation during the contact of atmospheric air. Despite of all benefits use of Pt/Pd increases the cost of MgH_2 essentially. We tried to apply in-situ low temperature plasma hydrogenation technologies in this work for direct hydrogenation of pure Mg thin films. SEM+EDS, XRD and high resolution profilometry applied for the received materials investigation. It is shown that plasma based hydrogenation approach leads to partial hydrogenation of pure Mg films and developed materials can serve as a basis for further hydrogen production using $MgH_2 + 2H_2O \rightarrow Mg(OH)_2 + 2H_2 +$ 277 kJ reaction approach.

Keywords: hydrogen production, MgH_2, plasma hydrogenation

REACTION BETWEEN PLASMA ACTIVATED ALUMINUM POWDER AND WATER UNDER VARIOUS CONDITIONS

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ABSTRACT

In-situ hydrogen generation is a potential technology for pollution-free electronic gadgets and areas with no energy infrastructure. It could be used to provide hydrogen for fuel cells powered portable devices. Therefore aluminum reaction with water becomes especially attractive. Approximately 1245 cm^3 of hydrogen could be collected after water reaction with 1 gram of aluminum and directly fed to fuel cell power system. However, a thin protective natural surface layer of alumina (Al_2O_3) inhibits the reaction. This research focused on the removal of this oxide layer and activated aluminum powder reaction with water by changing reaction conditions.

Aluminum powder was treated and activated under hydrogen plasma at 300 W. Activated aluminum powder becomes hydrophilic and after immersion into the water goes to the bottom instantly. After a certain time hydrogen production was observed. Some amount of sodium hydroxide was used as a promoter of aluminum-water reaction. The reaction (H_2 generation) was investigated under various conditions, such as: pH (different amount of NaOH); water and aluminum powder amount; temperature of water. Aluminum powder samples were characterized by scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDS) for elemental analysis and X-ray diffraction (XRD) for microstructure analysis. XRD analysis of reaction by-products (white color) which are stable and non-corrosive shows many peaks of aluminum oxides and hydroxides.

Keywords: aluminum powder, plasma, hydrogen generation, water

II RENEWABLE ENERGY SOURCES

BARRIERS AND MARKET FAILURES THAT INFLUENCE THE DEVELOPMENT OF RENEWABLE ENERGY SOURCES

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ABSTRACT

While various military conflicts brewed across the world, energy has become the center of discussion. Back in the year 2000, United Nations and the World Energy Council published the survey named "Energy and the Challenge of Sustainability", where it was observed that the key attribute of the modern energy system unsustainability – world's population unequal access to commercial energy and environmental, economic and geopolitical energy discontinuity results that will affect the future. Around that time, when the dispute between Russia and Ukraine arouse over natural gas, and the war in Iraq happened, it became clear that energy systems of different countries depend too heavily on other states, and that this is extremely dangerous.

The most important long-term scenario element of Lithuania and the EU, for the implementation of sustainable energy, is the replacement of the current energy to renewable energy sources. And although the benefits of renewable energy are obvious, the cheapness of fossil fuel generated energy-efficient systems prevents renewable energy to occupy dominant position. Nonetheless significant market barriers and market failures exist that hamper the development of renewable energy system (RES). The paper aims to systematise, analyze and generalize the newest existing literature about market failures and barriers which impede the wider integration of RES in the general energy sector.

Keywords: renewable energy sources, RES technology, barries and market failures

PRODUCTION OF PRODUCER GAS FROM BIOMASS IN GASIFIER OF DOWNDRAFT TYPE

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ABSTRACT

It is known that Ukraine has one of the highest potential among European countries in amounts of alternative solid biofuels that in quantitative equivalent makes around 25 million tons of standard coal. So it is obvious that in Ukraine implementation of energy technologies with use of named solid biofuels are more preferable compared with other types of alternative energy sources, such as solar, wind, etc. Gasification is one of popular type of technologies producing energy from alternative solid fuels. In this work we considered gasification of different types of alternative solid biological fuels (biomass) in gasifier of downdraft type. As the fuels there were considered local species of biomass, namely wood chips, wood pellets, sunflower and rice husk, sunflower husk pellets. Gasification was carried out with the aim of producer gas production as alternative gaseous fuel, which was subsequently burned in industrial water steam boiler in admixture with natural gas. During the experiments and laboratory tests the following parameters of gasifier were under control: fuel load capacity, operating temperature of the gasifier, indicators of consumed air and gas, air pressure and producer gas pressure, also there were taken gas samples for composition analysis. During experiments different operational modes of gasifier were determined, depending on the kind of initial fuel, the given results had led to changes in the whole operation rules of the gasifier complex. Also advantages of producer gas were determined, and eliminated some shortcomings of previous complex maintenance. As a conclusion it is possible to point out that described gasification technology with downdraft gasifier allows substituting of 30% of natural gas, which confirms the efficiency of technology.

Keywords: gasifier, downdraft type, biomass, gasification, producer gas

SMALL SCALE WIND TURBINES – FEASIBILITY AND CASE ANALYSIS

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ABSTRACT

The field of wind energy as the most promising from all the renewable resources is led with giant developments and comprehensive researches. Moreover it confronts with restrictions and disadvantages as well. Great discussions of social acceptance still exist. Large scale wind turbines being a tool of economies of scale have already reached a peak in manufacture, solid state parts development but are still in progress in control and communication with grids techniques. Small to medium scale wind turbines are relatively weakly developed and have more restrictions. However the potential to generate electricity close to the load or as stand-alone systems increases.

The case study reveals small to medium scale wind energy status, key initiatives and prospects of it toward appropriate integration into the country/regional daylife. A multi-objective discussion involve economic, social, technical and legislation issues of the wind energy. Disputable contradictions and ambiguities arise during the development of the renewables locally but the this size of wind turbines is destined to grow in the next decades due to the shift to micro-generation electricity and distributed generation trends. This paper identifies challenges and developments in the achievement of intelligent control algorithms on the small-to-medium scale levels. Therefore, increasing levelized wind electricity costs in urban and suburban areas is explored and discussed. Comparison of several type of small wind turbines in the context of yield and economic calculations is presented.

Keywords: small scale wind turbines, restrictions, multi-scale strategy, urban sites

INVESTIGATION OF WIND SPEED FORECASTS ERRORS FOR WIND POWER GENERATION

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ABSTRACT

Installed wind power capacity reached 282 MW in Lithuania in 2014. Recent study prepared by researchers suggests ambitious targets - to have installed wind power capacity of 840 MW by 2030. To achieve this target it is very important to analyze the impact of wind power integration in Lithuanian power system. To decrease negative impact of wind turbines on the grid it is very important to reduce wind forecasts errors as much as possible.

The paper analyses seasonal, diurnal and hourly wind speed forecasts errors and discusses main obstacles for wind speed and wind power prediction. Research was carried out by using Microsoft Excel and Matlab 13 software. The data were provided from HIRLAM (*High Resolution Limited Area Model*) run in Lithuanian Hydrometeorological Service and wind turbines operating in Lithuanian coastal region.

Results indicate that wind prediction errors for the first 24 hours remain stable and tend to increase for longer prediction horizons (24-48 h). Analysis of seasonal indicators presents large scale error dependence on temperature volatility, and the largest deviation exists in winter. Diurnal prediction errors depend on local conditions, mostly on the frequency of weather changes.

Keywords: wind speed and power prediction, wind turbines, HIRLAM

PECULIARITIES OF SMALL SCALE WIND TURBINES USE IN URBAN AREAS

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ABSTRACT

Environment's degradation at globalscale encourage integration and development of renewable energy sources, also new research areas and technological innovations in the world. Recent wind power was among the fastest growing energy industry sectors. Due to technical and social conditions only a small part of wind energy resource can be exploited, however, this part would be sufficient to cover most of world's energy needs. Therefore wind energy is considered a perfect alternative to fossil fuel power. Recently small scale wind turbines are gaining increasing popularity as they are able to cover part of the energy demand in urban territories. These turbines are intended for private and public buildings local energy supply and for street lighting.

Urban wind conditions are specific, because buildings and differences of their height lead to formation of gusts and cause higher turbulence. Also mean wind speed in urban areas is lower comparing to open areas, therefore wind turbines must be adapted for local wind conditions and their location must be selected with care. In this paper experience of small scale wind turbines use is reviewed, statistical analysis of wind characteristics in urban areas is provided, methodologies of wind flows modelling and efficiency calculations are analyzed. It was determined that efficiency coefficient of small scale wind turbine depends on wind speed and reaches the value of 0,16 on average.

Keywords: small scale wind turbine, wind conditions, energy efficiency coefficient

SUPPORT MEASURES FOR RENEWABLE ENERGY ASSESSING THE DEVELOPMENT EFFECTIVENESS

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ABSTRACT

Currently there are many discussions related to renewable energy (RE) not only among to scholars, but also includes others stakeholders – enterprises, residents, policy makers. However, the main topics of many discussions of RES are the following: sustainability, price and energy independence. Lithuania as well as other EU states have to achieve energy targets defined by European Parliament until 2020. Therefore, Lithuanian energy strategy related to RE shall be clearly understandable in accordance with successful practices of RE strategy from developed countries, but also pay attention for a long time period benchmarking of energy sustainability indicators that are as follow: *economy, energy security, climate change*, *energy efficiency*. In general, RE technologies satisfy a strict energy targets, but also cover environmental compliance, economy growth and is mainly driver for sustainability. Eventually, by doing this in successful way it is necessary to involve one more thing – support measures.

This paper analyses different support measures for RE such as: *regulations*, *feed-in tariff*, *investment subsidies*, *structural funds*, not only in Lithuania but also covering neighbour states as well. Effectiveness of measures for developing RE technologies' is a vital that brings a huge impact on the above mentioned sustainable indicators.

Keywords: Renewable energy, sustainability, support measures

COHERENT POLICY OF RENEWABLE ENERGY SOURCES SUPPORT IN LITHUANIAN DISTRICT HEATING SECTOR

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ABSTRACT

European Union 20-20-20 goals have made a significant influence for the changes in national Member States' energy policy. Renewable energy sources (RES) will have to play the main role for the movement towards sustainable development in all energy sectors. Implementation of RES technologies is restricted by slow demand rates that are mainly influenced by underestimated externalities of fossil fuels. District heating may be appropriate infrastructure for the implementation of RES technologies on the production and demand sides. Therefore this paper aims at coherent policy of RES methodology formation, based on analysis of Scandinavian experience and application of the possible support measures on the territorial aspects. After comparative analysis of Scandinavian countries and Lithuanian energy strategies influence for district heating sector, scenario method was used to justify the possibility for the use of diversified RES, such as solar collectors and heat pumps, on district heating system's demand and supply sides. The calculations were done by the use of EnergyPro modelling tool and levelised cost of energy method. The results have showed that coherent energy policy is a key aspect that influences the preeminent position of different types of fuels, and after evaluation of externalities in fossil fuel costs RES might become the attractive technology for the generation of energy.

Keywords: district heating, renewable energy sources, energy policy

NATIONAL RENEWABLE ENERGY SUPPORT SCHEMES IN THE EU LEGAL FRAMEWORK

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ABSTRACT

Currently, renewable energy gains more and more attention from the environmental perspective. Unfortunately, despite many efforts to support the development of renewable technology, fossil fuel still has an upper hand in terms of energy price and market share. The most popular measures to promote renewable energy (RES) in European Union are operational devices. An issue arises to determine whether support measures are designed in accordance to EU law. In this paper I will examine if these support mechanisms do not contradict to the principle of European Union of the free movement of goods.

Firstly, the paper presents legal framework with regard to RES. Therefore the provisions and case-law governing the principle of the free movement of goods is laid down. Due to the pursuance of the objective of this paper, examination encompasses primary (Treaties of the EU) and secondary law (regulations, directives and case-law).

Secondly, the paper indicates main features of each support measure. The most popular measures of the Member States to promote RES are tradable green certificate, feed-in tariff and premium. Even though the objectives of these measures are quite the same, the frameworks are designed taking into account different climate conditions, local energy market structure and legal commitments at EU level.

The last section of the paper analyses if support mechanisms design by local governments correspond to the principle of the free movement of goods. The methods used in the paper are comparative and analogy.

Keywords: renewable energy policy, promotion schemes, EU law

EXPERIMENTAL RESEARCH ON SWELLING AND SHRINKING OF WOOD AND STRAW PELLETS DURING PYROLYSIS

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ABSTRACT

Nowadays renewable energy sources is widely used for electricity and heat production. The growing demand for these stocks and their price results in searching for ways how to use low-quality biofuels. Gasification is one of the options to turn low-quality biofuel into higher quality gas, which is used to generate heat or electricity. However, use of granulated biofuel for the gasification results in fuel agglomeration that stops the entire process. It occurs when the biofuel pellets are moving from the pyrolysis zone to the oxidation zone and pellets stick together in lumps, which disrupts the movement of fuel. In order to investigate the cause and regularities of fuel agglomeration, experimental research of wood and straw pellets thermal deformations during pyrolysis was performed.

Experimental studies were performed in an electrically heated tubular furnace from 300 °C to 1000 °C temperature in an inert atmosphere capturing biofuel pellet thermal deformations by a digital camera. During investigation, the centre temperature of the pellet was also measured. Analysed results showed that biofuel pellet final diameter decreased when the heating temperature increased, but wood pellet diameter shrank 10 % more than straw pellet diameter. It was also established that the wood pellet expanded from 400 °C to 900 °C while straw pellet expanded from 300 °C to 900 °C heating temperature at the beginning of pyrolysis process. The maximum swelling effect was reached at 550 °C temperature for wood pellet and at 650 °C for straw pellets and after it, swelling intensity was decreasing till 900 °C temperature for both particles. Over heating temperature of 900 °C, the expansion phenomenon was no longer visible. The obtained results explain the reason for agglomeration of biofuel pellets in the gasifier and reveal regularity of biofuel pellet size changes with increasing heating temperature.

Keywords: pyrolysis, wood pellet, straw pellet, shrinking, swelling

BIOMASS QUALITY OF TALL FESCUE GRASS UNDER DIFFERENT FERTILIZATION AND IN-FIELD LEACHING SYSTEMS

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ABSTRACT

Utilization of bio-based resources to replace fossil fuels has the potential to make progress because of their variable composition and properties which depend on the systems applied. Tall fescue grass (TFG) was investigated in an experiment conducted on an Endocalcari-Epihypogleyic Cambisol. The study was aimed to determine the gross calorific value and ash content of biomass as influenced by different fertilization and in-field leaching systems. The composition of the biomass in per cent weight of silica (Si) and potassium (K), which are the major components of ash, was established. Gross calorific value was a measure of the energy content of biomass samples expressed in MJ kg-1. Energy content was measured with a colorimeter IKA C200. The data suggest that non fertilization and fertilization of plants and in-field leaching 2 weeks wit additional precipitation and without them substantially increased the calorific value of TFG compared with fertilized and non fertilized samples and in-field leaching for one week. The highest gross calorific value (almost 19 MJ kg-1) was obtained from tall fescue grass fertilized with N90 with the application of a two-week in-field leaching system with additional precipitation imitation. The biomass of grass fertilized with N90 and N0 and exposed to in-field leaching for one week contained the lowest concentration of ash, which is a desirable feature for combustion process. In this experiment, Si reduction occurred only in in-field leaching and non-leaching systems with mineral and digestate fertilization. A significant difference of fertilization and in-field leaching reduction of the concentration of potassium in ash were founded especially in fertilized with digestate and non fertilized samples with one week in-field leaching system with and without additional precipitation level.

Keywords: Tall fescue grass, biomass, fertilization, in-field leaching

HEAVY METALS CONCENTRATION IN STEMWOOD OF ENERGETIC TREES FERTILIZED WITH SEWAGE SLUDGE

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ABSTRACT

Energetic trees have been grown in areas fertilized with different amount of sludge: 180, 360, 720 t/ha, and in a reference non-fertilized area. Hybrid poplar (*Populus tremula x Populus tremuloides*), developed for energetic plants, three local trees species, potentially promising for energetic plantations, and one introduced species have been investigated. This plantation was established by Institute of Forestry branch of Lithuanian Research Centre for Agriculture and Forestry in 1993.

During the investigation concentrations of heavy metals (Cd, Cr, Cu, Ni, Pb and Zn) in stemwood of trees grown in fertilized and non-fertilized fields were determined. Cd and Cr were found only in several wood samples and its concentration was close to the limits of detection or qualification. Consequently, closer analysis of these metals was not carried out.

An inductively coupled plasma optical emission spectrometer ICP-OES was used to measure the concentration of these metals. The processing of the research data was carried out using STATISTICA 7 software.

It was determined that significant amount of Zn, Cu and Cr as well as the less amount of Pb, Ni and some other enter the soil with sludge and their high level concentration remains for a long time. During 20 years, total concentration of such metals in the soil decreased only by 17, 26 and 40 % when intensity of fertilization was 180, 360 and 720 t/ha, respectively. However, trees accumulated very limited amount of heavy metals in their stemwood regardless of intensity of fertilization. The following sequence of accumulation factor of heavy metals in the analyzed trees stemwood was found: Zn > Pb > Ni > Cu > (Cr, Cd).

Keywords: sewage sludge, heavy metals, inductively coupled plasma optical emission spectrometer, energetic trees plantation, stemwood, accumulation factor, saturation limit

INVESTIGATIONS OF NOISE GENERATED BY SMALL WIND POWER PLANTS

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ABSTRACT

Investigations of small wind power plants for wind speed varying from 4 m/s to 10 m/s show that the intensity of noise generated by wind power plants depend on absorption of sound pressure pulsations in atmosphere and land surface, reflection, topographic land surface effect, meteorological conditions and many other determinants and factors. Data of the investigation show that small as well as large wind power plants generate some noise. When distance from the power plant increases, noise intensity decreases. Noise is absorbed better in soft land surface than hard surface. Also, absorption in the surface substantially depends on noise frequency. In the noise frequency range from 100 Hz to 1000 Hz the best noise absorption is observed. Noise oscillation is made by decreasing its level in its generation source, and also, using architectic constructional means, also sprouts.

An analysis of data found in the literature shows that a noise level above 40 dB(A) can be irritating for some people. Limitations for construction of wind power plants near residential houses and public buildings are set due to noise generated by operating wind power plants.

Keywords: wind power plants, acoustic noise

KEY MODEL OF PV SOLAR COOLING

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ABSTRACT

Widespread installations of solar energy systems and price reduction of solar energy absorbing equipment opens new opportunities for solar energy application. Solar radiation is available at the same time as cooling demand is needed in buildings. In this case solar cooling is a reasonable energetic and economic solution. Solar cooling systems have their main tasks of reducing peak electricity power demand and in general is an environmentally friendly – nature protecting – energy conversion method. In the current market situation Photo-Voltaic (PV)-electric driven compression chillers are favourable compared to solar thermal driven sorption cooling because some of the system components like the compressor and the heat rejection subsystem have a smaller footprint. A Solar Cooling concept with Photo-Voltaic electric energy and compression chiller (SCPV) is developed. The definition and the analysis of the working parameters and the system yield are described.

The investigations of the SCPV are based on two parts: 1st a dynamic simulation of a system model in the Polysun® program software, and 2nd a real system driven in a moderate climatic zone weather conditions. This system will also be compared with sorption-type solar cooling technology.

The system was developed and optimised by assessing results of pre-simulations of a solar PV-electric driven compression chillers system. The SCPV contains a cold tank for close the gap between solar energy gain and cooling demand. The energy from the heat rejection part is used to pre-heat the domestic hot water. This concept has two advantages, on one hand it increases the heat rejection efficiency, and on the other hand it allows the use of indoor heat for hot water preparation. In addition, for a higher efficiency of the heat rejection subsystem during night time, a hot tank was implemented in the system. To fulfil the domestic hot water demand in the non-cooling season the system is operated in the reversed mode for pre-heating.

The cooling load of the solar cooling system was adequate to the cooling loads of buildings in certain climatic conditions. The investigations include the analysis of a reference system and the working parameters in cold and hot temperate as well as in the Mediterranean climatic zone. Three types of buildings are taken into the simulation templates for a comparison of the cooling loads. After definition of the simulation template a validation will be done to assess the influence of the components on the system yield.

Keywords: renewable energy, solar energy, solar cooling, photo voltaic

III SMART ENERGY NETWORKS

DEVELOPMENT OF A RISK MATRIX CONSIDERING SPECIFIC FEATURES OF THE POWER TRANSFORMER PARK OF LATVIA

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ABSTRACT

The power transformer is an important element of the power system on a national as well as international level. The different structures and features of the transformer park create the necessity for individual risk assessment development to increase reliability of the power system. This paper presents the development of a risk matrix for the power transformer park of Latvia. Data collection and situation analysis are a few of the challenges on the path to create a universal risk matrix which suits individual power transformer park. The analysis of the power transformer park of Latvia has provided the conclusion that the park has a large reserve base but it is noticeably aged. The age, regularity of replacement, diagnostic periodicity and other specific features of the power transformer park have to be taken into account during the development of a risk matrix with a suitable mathematical model.

Keywords: risk matrix, diagnostic methods, life cycle, power transformer

IV ENERGY EFFICIENCY AND RELIABILITY

ADVANCED THERMO-ELECTRICAL ANALOGY MODEL FOR PELTIER ELEMENTS

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ABSTRACT

Thermo-Electrical analogy method is very powerful instrument for transient heat-flow simulation and analysis. Therefor to analyse Peltier element as a part of cooling or heating system it is necessary to evaluate thermo-electrical analogy model that would describe Peltier element as close as possible. There are various successful approaches developed for the moment however most of them tend to ignore various properties of Peltier elements due to little impact on final results or to maintain simplicity. This paper attempts to develop model that would include specific, previously ignored thermal and electrical effects to describe Peltier element more precisely. Although these effects have small impact on conventional operation of Peltier element, one can find certain conditions or applications that should not ignore them. The model can also serve as educational material that helps to understand Peltier elements or thermoelectric effects better or serves as base in other research. Developed model is compared to other thermo-electrical analogy models for Peltier coolers.

Keywords: Peltier element, thermoelectric effect, Thermo-Electrical analogy, modeling, heat flow simulation

HEAT TRANSFER ENHANCEMENT IN SHELL-AND-COIL HEAT EXCHANGER

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ABSTRACT

In the paper authors presented their own constructions of shell and tube heat exchangers with intensified heat transfer. The shell and coils heat exchangers are in common use in heat ventilations and air conditioning systems. Those types of recuperators are quite simple constructions, the low value of pressure drops and good conditions of heat transfer. The present study shows an experimental investigation of the heat transfer in a shell-and-coil heat exchanger. Data are reported for various Reynolds numbers, and various surface modifications as in fig 1. The purpose of this article is to assess the influence of the surface modification over the performance coefficient and modified effectiveness of vertical helical coiled tube heat exchangers. The calculations have been performed for the steady conditions and the experiments were conducted for both laminar and turbulent flow inside coil. Gathered experimental data are compared with correlations from literature.

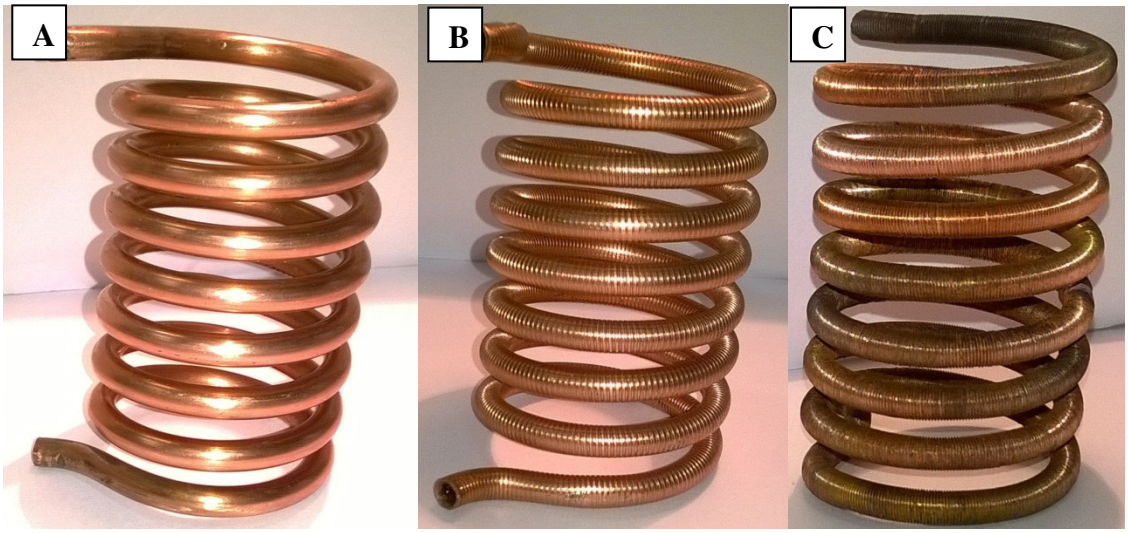

Fig.1 The different coils surfaces: A – smooth pipe, B - normal thread fins, C – extra-fine thread

Keywords: heat transfer enhancement, shell and coil heat exchanger

COMPUTER PROGRAMS AND MATHEMATICAL MODELS IN ENERGETIC POWER SYSTEM DEVELOPMENT

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ABSTRACT

A mathematic models is discussed in the paper with a view to correct development of the Power systems of Georgia. The model envisages the use of the apparatus of linear programming. Power system is complex and for analysis of a complex system the use of a cybernetic model is advisable, where attainments of an optimal structure of Power stations of diverse types may be determined, as well as their construction at needed periods and economic use of available capacities.

Because power stations work in the regime of oscillating load and cost per unit during the change of fuel and load changes nonlinearly, by reducing the equality to linear type the following approach is adopted:

At the three periods of work (shallow water, off-season, high water), for each *i* power station in the power system of Georgia the specificity is provided for of the station (thermo-station, season at its, regulating his).

There are solved the problems of maximization of electric power and maximization of electrical energy for the basic parameters of the mentioned power system, providing the corresponding limitations.

On the basis of mathematical model of determination of optimal structure of new powers of electric system there is investigated the development of concrete electric system for the future four decades.

The used method, with the use of accidental prototypes, gives us the prediction of peak values of processing of electrical powers.

For static systems there is realized the effectiveness criteria analysis, and for dynamical systems there are analyzed effectiveness criteria in conditions of development of specific years.

On the basis of this model problems of the following types may be solved by means of the computer system ”MATLAB”: problem of maximization of electric capacities, problem of maximization of electric power, problem of minimization of investments, problems of minimization of exploitation expenses. The models can also be used in any other country's energetic power system.

Key words: effectiveness, transmission, capacities, optimal

AIR FLOWRATE AND TEMPERATURE CONSIDERATIONS FOR EFFICIENT WARM AIR SUPPLY INTO SINGLE OFFICE ROOM

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ABSTRACT

In mixing ventilation systems indoor air quality is highly dependent on air mixing effectiveness. However, it is necessary to control air distribution in order to prevent excessive air velocity and draught rate occurrence in human's occupancy zone. With warm air supply systems, there is a risk of air stratification in the room, when a layer of fresh and warm air mass builds up right below the ceiling, whereas layer of stuffy and relatively cooler air mass stays in human's occupancy zone.

Most often there are convectors, radiators or space heaters used for heating the office rooms, instead of airborne heating via air terminal devices. In this study, a research on air stratification was carried out and possible ways to prevent it were analyzed, when warm air is supplied via air supply diffusers from the ceiling.

Supply air flowrate and supply air temperature can be varied to maintain room temperature set point according to the air temperature conditions outdoors and heating loads indoors. Increasing the supply air temperature and decreasing supply air flowrate can save energy, but it causes reduced air circulation and thus leads to low indoor air quality risk. Increasing the supply airflow will improve air circulation and mixing effectiveness within the room, but it will increase energy consumption.

The objective of this study was to identify the correlation between the minimum airflow and supply air temperature that would maintain a satisfactory thermal comfort in the human's occupancy zone when introducing warm air into the room. The study was conducted in the full-scale test chamber that represents a typical single office room. 24 air velocity and temperature measuring probes were positioned in different levels and locations of human's occupancy zone. Supply air diffuser prototype with a perforated faceplate was integrated into the ceiling and tested to see how the warm air is distributed within the test chamber. Numerous different supply air temperature and flowrate variations were analysed during the study and 6 scenarios are presented in this paper.

Keywords: energy efficiency, ventilation, heating, air mixing, air stratification, temperature gradient

CRITICAL FLOW VELOCITY DETERMINATION FOR TUBE-BUNDLE WITH APPLICATION OF NUMERICAL EXPERIMENT METHOD

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ABSTRACT

The work is devoted to creation and application of mathematical models for the most dangerous oscillations excitation of tubes and cylindrical form bluff structures in liquid or gas flow, as well as to creation of efficient computational methods for description of these models.

Numerical investigation method of hydrodynamic forces arising from separated flow, and tube bundles oscillations excited by these forces was worked out by authors.

Method is based on application of created original tube-bundles hydroelastic oscillations excitation in cross flow mathematical model. Hydroelastic excitation problem is reduced to the stability analysis of elastic tubes undisturbed state. Analysis is conducted with the assumption of linearity of the destabilizing forces. On basis of mathematical model theoretical studies of necessary and sufficient condition for the stability, expressed through the dimensionless system parameters (mass, damping, velocity), was obtained.

Numerical identification of the linear hydrodynamic connection matrix algorithm for particular tube-bundles was elaborated. Algorithm and based on it programs verification were performed by results of test computations and bank of available experimental data correlation.

Method for determination of linear hydrodynamic connection matrix for tube-bundles with cross section regular arranging was offered. It is based on computation of relatively small, but sufficient for reliable results, part of tube-bundle.

Keywords: tube-bundle**,** numerical experiment, hydroelastic excitation, separated flow, linear hydrodynamic connection matrix

ENERGY EFFICIENCY MEANS ACCORDING TO ENERGY EFFICIENCY 2012/27/EU DIRECTIVE TO DECREASE ENERGY CONSUMPTION FOR A FINAL CONSUMER

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ABSTRACT

As the energy consumption increases, the energy efficiency measures must be found and implemented. 2012/27/EU Energy efficiency Directive aims the targets to decrease energy consumption for a final energy consumer by 1,5 % annually, but do not defines how these targets can be achieved by member state. Article presents the analysis how these targets can be reached by the means of individual heat metering for every flat decreasing energy consumption for a final consumer. Statistical analysis of identical buildings with heat cost allocators and without them is presented. Heat cost allocator do not decrease energy consumption by itself, so this article presents a technical solution and a set of additional equipment as thermostatic valves, balance valves, hot water meters and remote system must be installed. The final results shows that the targets of 2012/27/EU Energy efficiency Directive can be reached as the buildings with individual heat cost allocators consumes about 20-30 % less of heat energy.

Keywords: energy efficiency, heat meters, heat cost allocators, 2012/27/EU Energy Efficiency Directive, buildings

ACHIEVING ENERGY EFFICIENCY IN THE BUILDING SECTOR IN SELECTED CEE COUNTRIES: POLICY BASED ENERGY DEMAND SCENARIOS UNTIL 2030

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ABSTRACT

The most significant instrument to achieve energy savings in the European building sector is the Energy Performance Building Directive 2010/31/EU (EPBD, recast of 2002/91/EC).The directive has to be implemented on the national level setting up policy instruments to trigger investments in energy efficiency measures.

In this paper, policy instruments to achieve energy efficiency in the building sector will be analysed in Bulgaria, Czech Republic and Romania. Moreover, the impact of the existing policy instruments on the final energy demand until 2030 is modelled.

The following steps are carried out: (I) data on the building stock, renovation solutions, prices and policies are collected (II) current energy demand for space heating and hot water in the whole building sector are calculated (III) scenarios until 2030 are modelled implementing existing national policy instruments. The scenarios are modelled by using a bottom-up, techno-socio-economic approach in Invert/EE-Lab model. Invert/EE-Lab is a dynamic building simulation tool that evaluates effects of economic and regulatory incentives on the energy demand in the whole building sector in a country.

The final energy demand for space heating and hot water in the residential and service buildings in 2008 is 27 TWh in Bulgaria, 89 TWh in Czech Republic and 82 TWh in Romania. The implementation of existing policy measures shows energy demand reduction of 9%, 14% and 17% from 2008 to 2030 in Bulgaria, Czech Republic and Romania respectively. The results show different energy saving potentials among the countries. These differences are due to different policy instruments, different climate conditions, energy prices and costs of investments which have an impact on the effectiveness of renovation measures and the corresponding renovation rate of the building stock, which is often considered as the main indicator for an effective policy. The full paper will also include an economic comparison of renovation activities in the selected countries which will form the basis regarding conclusions for economic incentives of policy making.

Keywords: Energy efficiency, building sector, energy modelling, EPBD, policy instruments

USE OF ENERGY SOURCES IN RESIDENTIAL SECTOR IN THE DEVELOPING COUNTRIES OF CENTRAL EU AND SWEDEN

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ABSTRACT

The comparative analysis of energy consumption in residential sector has been done for 11 countries: Bulgaria, Estonia, Croatia, Hungary, Lithuania, Latvia, Romania, Slovenia, Slovakia, Sweden and Ukraine. Analysis was carried out by following criteria: total primary energy consumption, taxes and prices of gas and electricity, type of energy sources, energy consumption in district heating, CO^2-emissions, population, climate. Data for analysis were taken from the official databases of international organizations. Energy consumption by energy sources were analysed based on the energy balance tables of International Energy Agency (IEA), France, and on the statistical data of the U.S. Energy Information Administration (EIA), Washington. Statistical information for district heating is taken from EUROHEAT & POWER Association, Belgium and information on prices for electricity and gas was getting from Eurostat – statistical office of the European Union. Results of research show that the dependence on fossil fuels such as coal, oil and natural gas of many European countries exept Sweden are very high. From the investigation Sweden was determined as one of the leading countries actively used alternative energy sources.

Keywords: energy consumption, energy sources, carbon dioxide emissions, climate, comparative analysis, residential sectors, Sweden, EU countries

COMPREHENSIVE APPROACH TO THE EVALUATION OF THERMAL INSULATION PROPERTIES OF THE VENTILATED FACADES

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ABSTRACT

Ventilated facade of buildings is a complex structural system with ventilated air layer along the facade surface. Because of the wide variety of ventilated facade systems, the common methodology for all systems does not exist. In this article it was proposed to carry out the evaluation of systems divided them by structure of external cladding into three groups: I - the constructions with solid external cladding, II - the constructions that have breaks in external cladding, III - the constructions with evenly air-permeable external cladding. Such factors like thermal heterogeneity and air infiltration are the main factors that decrese thermal insulation properties of wall systems. The influences of these factors are analyzed and discussed considering to the construction group.

Keywords: ventilated facade, external cladding, thermal insulation properties, air infiltration, thermal heterogeneity

V KNOWLEDGE FOR ENERGY POLICY MAKING

METHODOLOGICAL AND PRACTICAL ASPECTS OF THE ADEQUACY ASSESSMENT METHODOLOGY FOR ENTSO-E SYSTEMS

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ABSTRACT

To ensure the sustainable development of power systems, ENTSO-E is increasingly concerned with security of energy supply and, in particular, the adequacy of system generation and demand in ENTSO-E member countries. Each member country develops its adequacy outlook reports, consisting of questionnaires in spreadsheet forms, and submits them to the ENTSO-E, separately for summer and winter periods. The ENTSO-E processes the received country adequacy outlooks using the *Adequacy Assessment Methodology* and releases the Outlook Reports.

The paper aims at improvement of the Methodology and analyzes the methodological and practical application aspects of the Methodology, with regard to the Guidelines for Completing the Country Spreadsheets. Also the review of some country cases from the ENTSO-E Summer/Winter Outlook reports is presented. The Methodology is based on structuring the National Generating Capacity to a number of components. Special focus is given to the structure of generating capacities and their relation with cross-border exchanges, to the load factors for renewable in-feed and to the differences between normal and severe conditions, between "downward" and "upward" adequacies. Also exportable and importable capacities, system service reserves, and load and generation constraints under severe conditions are referred to and discussed in the context of the Methodology. In result, the conclusions and recommendations are presented for the interest of electrical power system operators, regulators and other stakeholders.

Keywords: ENSO-E, Adequacy Assessment, electrical power system, generating capacities, renewable, country cases

REVIEW OF METHODS FOR MEASURING SUSTAINABLE DEVELOPMENT

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ABSTRACT

Sustainable development is a popular and important concept, which can be understood as meeting the needs of present generations without compromising the ability of future generations to meet their needs. But one that is difficult to define with precision and, therefore, difficult to measure. The last two decades have seen a proliferation of methods and indicators to measure sustainable development. An indicator is a special index, which provides numerical values to important factors of the investigated sector. The emphasis on sustainability indicators has multiple motivations, which include decision making and management, advocacy, participation and consensus building, also research and analysis. The aim of this paper is to review the methods for measuring sustainable development. There are two popular methods: barometer of sustainability and integrated sustainability indicator.

Also, it is advisable to have tools to predict sustainable development. In this article is proposed to use dynamic model. However, it is appropriate analyse all sustainability indicators together, included investigation and determination of their interdependence. Furthermore created dynamic model enables us to forecast the dynamics of the indicators according to new factors.

Keywords: sustainable development, sustainability indicators

THE ENTSO-E CENTRAL INFORMATION TRANSPARENCY PLATFORM (REGULATION (EU) NO. 543/2013). MILESTONE FOR THE IMPLEMENTATION OF THE EU INTERNAL ENERGY MARKET

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ABSTRACT

The paper deals with the The ENTSO-E Central Information Transparency Platform (further – the Platform) – the Platform created according to Regulation (EU) No. 543/2013 to provide market participants and Transmission System Operators (further – TSOs) with timely information on the expected consumption and generation, power transmission lines and power generators outages, physical and commercial power flows, balancing and countertrade data, etc. in order to create more transparent, liquid and well functioning power marked as well as to increase security of power supplies and give TSOs possibility to control their networks in a better way.

The paper gives in-depth overview of the Platform from the perspective of data provider (mainly – from Transmission System Operator perspective) as the author of the paper was the main manager of the Platform's go-live preparation works in Latvia – in Latvian TSO "Augstsprieguma tikls".

Taking into account that before the Platform's go-live date (on January 5th, 2015) several local transparency platforms have already been in operation, in the paper there is also given comparison of the Platform with other existing Transparency platforms and the web-sites with Power market data.

And mainly – overall analysis of The Platform, it's Benefits and drawbacks for Power Market participants, EU Internal energy market, and power sector researchers and analysts is given in the paper.

Keywords: Central Information Transparency Platform, ENTSO-E, Power market

WILL IMPROVED PALM OIL YIELDS SUFFICE TO THE DEVELOPMENT OF SUSTAINABLE BIODIESEL FEEDSTOCK IN INDONESIA?

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ABSTRACT

By the expansion of oil palm plantations, Indonesia has become a world leading producer of crude palm oil. However, Indonesia has also been largely criticized due to issues of land use change and deforestation. Indonesia now promotes the use of palm oil for biodiesel production, as one part of achieving their new renewable energy targets. However, the current yields on palm oil plantations are far from optimal. Do new policies promoting biodiesel production address the issue of yields properly?

This study analyzes the driving forces for the expansion of palm oil plantations in Indonesia and the palm oil yields obtained in the country. Data is collected through a multi-disciplinary structured literature review of relevant palm oil publications from the last 15 years. We identify the policies that were in place and the strategies used to establish palm oil plantations in the past years. We look at the newly defined policies of the Indonesian government towards renewables and climate mitigation, in particular, targets for biodiesel production and fuel substitution. The idea is to verify whether the new policy will address the low yield issue.

Presently, palm oil yields are much lower in Indonesia than in neighboring Malaysia, also a major producer. Particularly, smallholders have lower yields than private and government estate plantations. Expanding production has been focused on covering new areas with palm oil plantations and less on developing farming methods. In earlier stages, the establishment of plantations included proper education of farmers and incentives to maintain production. Smallholders nowadays start palm oil production with little or no previous experience; still they favor oil palm over traditional crops. New policies have to address farming improvements to guarantee sustainable feedstock for biodiesel. A comparison with the achievements in Malaysia may provide insights and help the development of the Indonesian biodiesel industry.

Keywords: Palm Oil, Oil Palm Plantations, Biofuel, Policy

VI INVESTIGATION IN THE FIELDS OF THERMAL PHYSICS, FLUID MECHANICS AND METROLOGY

AN EXPERIMENTAL STUDY ON THE PERFORMANCE OF THE AIR SOURCE HEAT PUMP WATER IN CENTRAL EUROPE'S WORKING CONDITIONS

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ABSTRACT

Great advancements have been made in air source heat pumps due to concerns for water and consciousness of sustainable development; however there is still a serious shortcoming that limits their widespread applications, especially in sub-zero regions. The working parameters of an air source heat pump (ASHP) in Central Europe is considered and the influence of the heat source air on the heating efficiency of the heat pump is investigated. In addition, the impacts of frosting on the operational performance of an ASHP unit was also evaluated. The ASHP was validated and ran a whole winter in Gdansk, Poland. The relevant dynamic-performance functions were tested and the outcomes show that this new kind of ASHP can work very well under ambient temperatures as low as –9 °C.

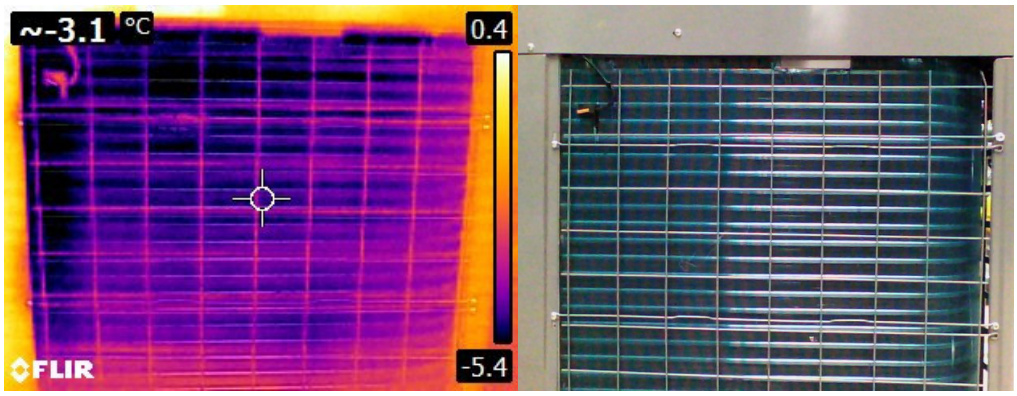

Fig. 1. Thermal image of working air source heat pump evaporator (left), and unit view (right)

Keywords: heating, air source heat pump, renewable energy

BINARY VAPOR CONDENSATION ON THE WETTABLE NANOPARTICLES

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ABSTRACT

An efficient method for the registration of nanoparticles is detecting of heterogeneous droplets, which are formed by means of the supersaturated vapor condensation on nanoparticles. Laminar flow diffusion chambers are widely used for investigation of such processes. The heterogeneous condensation of vapors of water and alcohol on nanoparticles and the growth of formed droplets are numerically studied under conditions of laminar flow diffusion chamber. A new mathematical model of a laminar flow diffusion chamber performance has been developed. The model represents a boundary-value problem for a system of ordinary differential equations, describing a change in the temperature field of the vapor-gas mixture and the field of the numerical vapor density, and an equation for droplet growth in a supersaturated vapor. The results of a numerical simulation of vapor condensation on nanoparticles introduced in laminar diffusion chamber for a mixture of air and vapors of water and alcohol are presented. Particularly, it was found that the heterogeneous droplets containing a nanoparticle inside grow to an optically detectable sizes (tens of microns), which allows the efficient use of this technology to the detection of the nanoparticles and trapping them from vapour-gas mixture.

Keywords: laminar flow diffusion chamber, heterogeneous condensation, temperature field, field of the numerical vapor density, numerical simulation, nanoparticle

THE INFLUENCE OF UNIQUE WATER PHYSICAL PROPERTIES ON THE CALCULATION OF WATER-VAPOR INTERFACE CONDENSATION

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ABSTRACT

A short review is presented on some of the unique water physical properties that cause anomalous behavior of water, affecting the condensation process intensity. The hydrogen bonding is one of such properties that cause water molecules to form into clusters. Hydrogen bonds are presented to prevent water molecules from evaporating by just two particles interaction. Condensation process is even more complex. Therefore it is suggested that the condensation rates cannot always be described by Maxwellian distribution, also in cases under turbulent conditions. The resulting errors in the classical calculations and modeling are proposed to be caused by inaccurate initial assumptions about the physical reality.

Keywords: Condensation coefficient, Condensation rate, Hydrogen bonding, Water clusters

EXPERIMENTAL STAND DEVICE MODELING FOR IEAC THERMAL PERFORMANCE STUDY

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ABSTRACT

This paper reported a review, calculations and measurements based study into Indirect Evaporative Cooling (IEC) stand device parts which have influence on thermal performance, which was undertaken from a variety of aspects including background, history, current status, concept. Experimental stand device parts have been described as equations of heat and mass transfer in primary and secondary air and water flows. Model has been validated with self-made device measurements located in laboratory. The main goal have been to made working stand device for future researches of IEAC device cooling efficiency, which mostly depends on mass flow rates ratios of primary and secondary air flows and spacing between plates of wet and dry passages.

Keywords: IEAC stand device, indirect evaporative air cooler, cooling efficiency, heat and mass transfer from water to air trough thin wall

REVIEW OF CONDENSATION MODELLING IN VERTICAL CHANNELS

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ABSTRACT

Condensation is a very common phenomenon in various heat exchangers of biofuel plants where hot gases and cold wall interacts. When the dew point is reached, the water vapor in the hot gases starts condensing and gives off latent heat. Modelling of the condensation process is necessary to understand heat transfer processes in heat exchangers. It is important to completely analyze two-phase flows in order to simulate the condensation phenomenon. This review analyses papers of other authors about modelling condensation in vertical channels, the methodology and software they used. Great attention is paid to the CFD commercial code ANSYS Fluent and its various models and capabilities that allow modelling of condensation phenomenon, especially the Volume of Fluid (VOF) model, which is a simple and powerful approach based on the concept of a fractional volume of fluid and is more flexible and efficient than other methods for treating complicated boundary configurations; also great attention is paid to other software, mathematical models, governing equations, creation of geometry and meshing, boundary conditions used by other authors. Two conditions are analysed in this review: when gases used in modelling contain only steam and when gases used in modelling contain non-condensable gas and steam.

Keywords: condensation, heat exchanger, CFD, review

NUMERICAL STUDY OF TIME DEPENDENT BLOOD FLOW IN OPHTHALMIC ARTERY WITH APPLIED EXTERNAL PRESSURE

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ABSTRACT

Fast and accurate measurement of intracranial pressure (ICP) is crucial after a head trauma or stroke. These aforementioned situations are one of the leading causes of disability and death. Too high or too low ICP could cause severe brain damage and even can result in death. One way of ICP estimation is new non-invasive Two Depth Transcranial Doppler (TDTD) method, which is based on measurement of blood flow velocity in ophthalmic artery (OA). This method had already been certified in many countries such as USA, Japan and EU. The further improvement of the device, increase in precision and extension of capabilities and applicability require fundamental understanding about pulsatile blood flow in the elastic ophthalmic artery and its interaction with the surrounding tissues when the outer wall of OA is exposed to varying pressure. Commercial COMSOL module Fluid-Structure Interaction (FSI) was used numerically to simulate arteries system, which consisted of Internal Carotid Artery (ICA) and Ophthalmic Artery. External Pressure (Pe) was applied as a function of time Pe(t) (range: [0, 40] mmHg) on OA's Extra Cranial (EC) part while ICP on OA's Intra-Cranial (IC) part was being held constant at {10, 15, 25, 35} mmHg. Simulations proved the possibility to measure ICP through differences in blood velocity on OA's IC and EC parts.

Keywords: hemodynamics, fluid-structure interaction, intracranial pressure, ophthalmic artery

TWO PHASE THERMOSIPHON TO UTILIZE GROUND HEAT IN DOMESTIC BUILDING APPLICATIONS

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ABSTRACT

Paper presents experimental investigations of passive heat elements such as thermosiphons, in use in domestic building applications, as in sidewalk deicing Fig. 1. Main goal of this article is to find the best working fluid to utilize low grade ground heat source, instead of high temperature heat source [1]. The paper presents an experimental test rig which was constructed to carry out investigations of two phase thermosiphon with new generation of refrigerants as working fluids. Sample experimental results for acetone as working fluid are presented on fig 2. Experimental data for acetone and HFE7100 were gathered. Conducted experimental research, will be used to verify the applicability of the existing correlations describing heat transfer coefficient for two-phase thermosiphons.

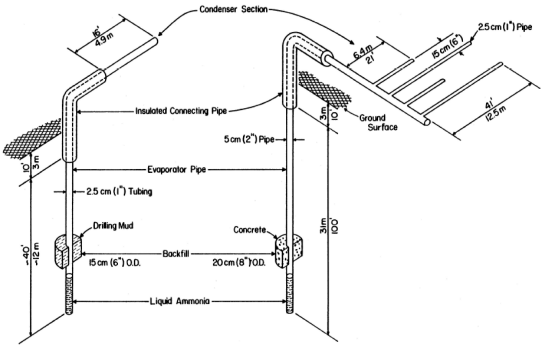

Fig.1 Deicing system [1]

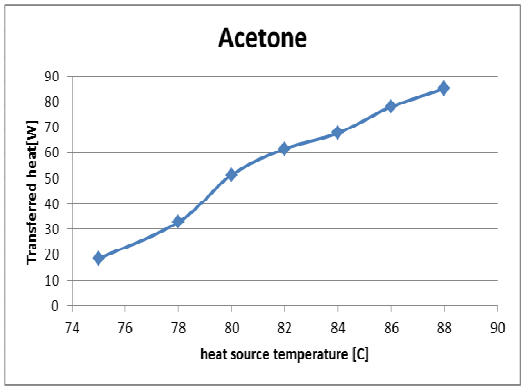

Fig.2. Sample experimental results for aceton

Keywords: heat pipe, thermosiphon, deicing

[1] Nydahl, J., K Pell, R. Lee and J. Sackos, 1984. Evaluation of an Earth Heated Bridge Deck, USDOT Contact No.DTFH61-80-C-00053, University of Wyoming,Laramie.

VII MATERIALS SCIENCES AND TECHNOLOGY

LITHIUM SALT CONCENTRATION EFFECT ON ELECTRICAL RESESTIVITY AND THERMAL PROPERTIES OF POLYETHYLENE OXIDE COMPOSITE POLYMER ELECTROLYTE

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ABSTRACT

Paper actuality is based on growing need for non-combustible and safe batteries, which operate portable electronic devices and much more. Influence of lithium salts concentration on the electrical properties in ambient temperature of Polyethylene oxide (PEO) composite films was investigated. Differential scanning calorimetry (DSC) and thermogravimetric analysis (TGA) measurements are made to determine composite's crystallinity, thermal properties and thermal stability too. Different amounts of lithium chloride (LiCl) and lithium trifluoromethanesulfonate ($LiCF_3SO_3$) were added to the PEO polymer. The salts affected the crystallinity degree and thus electrical properties of the composite. Electric conductivity increased with respect to the enhancement of the filler, however 20 % amount of $LiCF_3SO_3$ caused the conductivity to decrease. This behavior was related to the different interactions between PEO and Lithium salts, as confirmed by DSC analysis. By increasing Lithium salt concentration in PEO composite, crystallinity decreased. TGA analysis show, that 5% of LiCl give maximum thermal resistance between pure PEO and PEO composites.

Keywords: composites, polyethylene oxide, lithium chloride, lithium trifluoromethanesulfonate, conductivity, TGA, DSC

ASPECTS OF INCORPORATING THE PRUDUCTION OF LEVOGLUCOSAN INTO A WOOD-BASED BIOREFINERY

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ABSTRACT

The principle of a biorefinery is the sustainable production of valuable products from renewable resources, namely, biomass. Biomass is the only carbon containing renewable resource, therefore it can be used to produce not only energy, but fuels, materials and chemicals as well. This study focuses on a wood-based biorefinery with levoglucosan or 1,6-anhydro-β-D-glucopyranose as one of the products. Levoglucosan is among the main products of the fast pyrolysis of lignocellulosic feedstock after acid pretreatment, but despite its abundance and potential application in several fields, there are certain impediments for producing levoglucosan on an industrial scale. The most serious issue is the purification of levoglucosan, because the products of pyrolysis form a very complex mixture of numerous individual compounds. Therefore research has been done to evaluate ion exchange resins as sorbents for fractionation of the liquid products of pyrolysis. It has been concluded that cation exchange resin columns are more suitable for industrial fractionation of pyrolysis liquids and concentration of levoglucosan up to 80%, than anion exchange resin columns, because of the difficulties to regenerate the anion exchange resin column. Furthermore, the strongly acidic cation exchange resin in Ca^{2+} form can be used to additionally separate the isomer of levoglucosan - 1,6-anhydro-β-D-glucofuranose, which would increase the profitability of a biorefinery.

This work was supported by the Latvian National Programme (ResProd) Project Nr. 3 ''Biomaterials and products from forest resources with versatile applicability''.

Keywords: biorefinery, renewable chemicals, levoglucosan, ion exchange chromatography

KINETIC ANALYSIS OF OIL PALM EMPTY FRUIT BUNCH (OPEFB) PELLETS AS A FEEDSTOCK FOR PYROLYSIS

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ABSTRACT

The inefficient disposal and management of oil palm waste has resulted in increased greenhouse gas (GHGs) emissions in Malaysia. In addition, this has increased the environmental burden of palm waste; thereby reducing the sustainability and life cycle of palm oil production in the country. Conversely, the biomass pre-treatment and thermal conversion technologies such as pyrolysis can be utilized to convert oil palm waste via into clean environmentally friendly biofuels. Consequently, a comprehensive understanding of the thermal properties of palm wastes is required to design, optimize and scale up future palm waste conversion systems. This study is therefore aimed at investigating the thermal behaviour and decomposition kinetics of oil palm empty fruit bunch (EFB) pellets using a thermogravimetric analyser. The pellets were heated from room temperature to 1000 ºC at three different heating rates (5, 10 and 20 C/min) under inert atmosphere. The TGA-DTG curves showed that the degradation of sample occurred in three distinct stages namely; drying, devolatization and decomposition of lignin. The decomposition kinetics of the sample was evaluated by applying the Popescu method to the TGA results from thermal analysis. Consequently the activation energy E, was deduced for different degrees of conversion, α, from 0.05 to 0.7. The value of E ranged from 59.51 kJ/mol to 233.90 kJ/mol with high values of correlation. In addition, the drying and decomposition of lignin reactions displayed lower E values compared to the devolatization stage which was characterized by high values of E (125 – 233 kJ/mol). This indicates that the devolatization of the EFB pellets is the slow or rate determining step during thermal degradation.

Keywords: decomposition, kinetics, oil palm, empty fruit bunch, pyrolysis

HYDROTHERMAL SYNTHESIS OF MOLYBDENUM DISULFIDE / MESOPOROUS CARBON NANOCOMPOSITE

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ABSTRACT

Porous carbon materials are widely used in separation, catalysis and energy storage and generation. However, its application in high-energy Li-ion batteries (LIBs) is largely hampered by the relatively low theoretical capacity (even for graphite it is 372 mAh/g). Regarding molybdenum disulfide (MoS_2), which belongs to layered transition-metal dichalcogenides, as an electrode material for the same purpose, the feature of MoS_2 layered structure allows the Li+ ions to diffuse without a significant increase in volume expansion, but although its specific capacity is much higher than for graphite (approximately 700 mAh/g), there is still an effort of low ion/electron conductivity. According to latest tendencies the composite structure based on MoS_2 and carbonaceous matrix materials solved this problem and is highly promising as high-performance electrodes for LIBs. This paper presents the results devoted to the hydrothermal synthesis of molybdenum disulfide / mesoporous carbon composite using cations of cetyltrimethylammonium bromide. As precursors were used previously prepared ammonium tetrathiomolybdate, hydrazine hydrate, cetyltrimethylammonium bromide and mesoporous carbon obtained from raw plant origin and activated with orthophosphoric acid. Further the obtained material was annealed in Ar atmosphere at 500°C for 2 h. The samples were characterised by XRD, TEM, SAXS and porosimetry. It was confirmed that in the composite MoS_2 has a structure of multilayer sheets dispersed in amorphous carbon. The sizes of nanoparticles of molybdenum disulfide and pores are in the vicinity of 52 nm and 5-25 nm respectively. The value of specific surface of synthesized composite is 430 m^2/g that is much lower than for mesoporous carbon material, which is 2200 m^2/g, but electrical conductivity of the composite is 3 times higher (0.51 mS/m and 0.18 mS/m, respectively). The annealing has not significant effect on composite structure, that indicating the temperature stability of the material.

Keywords: molybdenum disulfide, mesoporous carbon, hydrothermal synthesis, nanocomposite

HIGH SURFACE ELECTRODE FOR ELECTROCHEMICAL ENERGY STORAGE DEVICES BASED ON NANOPOROUS TIN OXIDE

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ABSTRACT

A high surface electrode for ionistors and electrochemical power sources based on open nanoporous tin oxide architectures has been done. Self-organized nanoporous tin oxide matrixes were synthesized through electrochemical anodizing procedure of the tin metallic films deposited on the dielectric substrates. Volume and surface morphology of the nanoporous matrixes was investigated by scanning electron microscopy. An electrochemical properties of the tin oxide electrode was measured by using galvanostatic charge/discharge technique and cyclic voltammetry. Open nanoarchitectures of the high surface area tin oxide electrode showed fast ions penetration and charge transport inside porous matrix films. Obtained results demonstrated promising applications of the nanoporous tin oxide films as electrodes for electrochemical energy storage devices.

Keywords: high surface electrode, ionistor, electrochemical power source, nanoporous tin oxide

FORMATION OF SIO2 LAYER ON THE SURFACE OF EXPANDED POLYSTYRENE FOAM

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ABSTRACT

Structure expanded polystyrene foam is generally flammable material. This article presents the results of fireproof coating SiO_2 formation on the surface of expanded polystyrene foam. Expanded polystyrene was treated with argon plasma in order to achieve better surface adhesive. Pressure of plasma treatment process was 9×10^{-2} mbar. Voltage – 400 V. Plasma was generated using pulsed DC power source (frequency – 20kHz). Formation of SiO_2 layer was done using magnetron sputtering in reactive atmosphere without extraction of polystyrene samples into the atmospheric pressure. Mixture of argon and oxygen gas was used in order to form SiO_2 layer (argon – 80 %, oxygen – 20 %). Pressure of SiO_2 formation process was 7×10^{-3} mbar. All samples were analysed using scaning electron microscope, X-ray energy dispersive spectroscope and X-ray photoelectron spectroscope. Results shows that atomic suraface concentration changed dramatically after SiO_2 formation. Also, Si and O particles are distribute uniformly. However, SiO_2 particles not only form separate layer on the surface of polystyrene, but also penetrate into the interface layer between surface and the bulk. Depth of SiO_2 penetration is about 130 µm. Morphology results show negligible changes after SiO_2 formation. These results show that SiO_2 layer might potencially work as a fireproof coating.

Keywords: SiO_2 layer, expanded polystyrene, penetration, plasma treatment

VIII INVESTIGATIONS OF COMBUSTION AND PLASMA PROCESSES

EXPERIMENTAL INVESTIGATION OF CATALYTIC FIBERS PRODUCED BY PLASMA SPRAYING METHOD

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ABSTRACT

Plasma spraying method can be used to deposit a wide range of metals, ceramics and even composite materials for many different applications. In this research the most attention has been focused on the deposition and investigation of micro- and nanostructured fibres and films from metal and metal oxide materials and their mixtures: zeolites, Cu, CuO, Cr_2O_3, VO_5 and etc., for catalytic application. Dispersed particles and coatings have been deposited employing atmospheric pressure plasma flow. Determination of microstructure, element and phase composition of the obtained products was carried out using the scanning electron microscopy (SEM), X–ray diffraction (XRD), energy-dispersive X-ray spectroscopy (EDX) and surface area analysis (BET). The investigation of catalytic properties of produced different reactors was performed employing a specific and newly designed test bench. The experiments and measurements were performed at atmospheric pressure under chosen conditions of gas temperatures, flow rates and concentrations. All of the samples of fibres were tested as catalysts in CO oxidation. The best results were achieved by Cu supported catalysts when the conversion rate of CO gas was nearly 80% at the temperature range of 300-400 ^{o}C. More obtained results are analysed and presented in this paper.

Keywords: catalytic fibre, plasma spray deposition, catalytic oxidation of CO

INVESTIGATION OF RUBBER WASTE PROCESSING IN SCREW REACTOR

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ABSTRACT

Investigation of modified technology for thermal processing of rabber waste is based on analis of different methods described in literatere and results of experimental research of steem conversion carried out in A. V. Luikov Heat and Mass Transfer Institute.

Designed equpment for technological process reduces energy costs of processing of used tires and decreases harmful emissions into the environment.

As raw material rubber crumb is used. Temperature of the process is 400-500 °C. Medium in reactor is nitrogen with some amount of light hydrocarbons (non-condensed part of products of pyrolysis). As a resalt of rubber waste processing we obtain 35-40% solid carbon residue, 45-50% liquid phase and 10-15% non-condensed gases. Moreover, non-condensed gases are used as a fuel for reactor heating and process realization.

Results of analis of liquid phase composition show that it can be used as a heating oil after distillation at 100 °C. The liquid phase contains over 50 individual components that can separated but in many cases it is economically inexpedient and technically not always possible. Solid part may be used in two ways: after steam activation of lump carbon residue at 200 °C, the product can be used as a technical carbonaceous sorbent; it is possible to regenerat original active soot for reuse in the industry while distilling off the resins in an inert atmosphere at 700-800 °C.

Keywords: rubber waste, screw reactor, technology of treatment

SPEED MEASUREMENTS OF MACRO PARTICLES LAUNCHED BY MAGNETOPLASMA ACCELERATOR

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ABSTRACT

Energy, aviation, rocket and other industries require an experimental study of the phenomena occurring during high-speed collisions of bodies with barriers and the motion of bodies with high speeds in different gas mixtures, as well as other similar processes. To study these phenomena the plasma accelerators of particles (one of accelerators types) are widely used. Such throwing systems allow to accelerate small bodies (~mm) up to several km/s. The development of noise immunity method for simple and reliable detection of thrown particles velocity is an actual problem.

This paper presents two optical methods for measurements of high velocities of small bodies thrown by magnetoplasma accelerator. These methods were used in the testing of the gas-discharge installation for acceleration of micro and macro particles, which provide an increasing of the temperature and pressure of the working gas by the discharge energy in magnetoplasma compressor. A throwing of particles occurs in vacuum. The velocity in the range of 0,8 – 2,6 km/s was measured by the using of the developed methods. The velocities of thrown particles were also evaluated by using the ballistic limit equation. The deviation of velocity measured by optical methods and evaluated using the ballistic limit equations is no more than 20%.

Keywords: velocity measurement, magnetoplasma accelerator

PLASMA METHOD FOR MINERAL AND GLASS FIBERS PRODUCTION

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ABSTRACT

Mineral fibers are fibers obtained from inorganic compounds. Glass fiber is the fiber made of thin glass threads. Glass of such form shows unusual properties: it doesn't crash, doesn't break, and it is easy to bend. It allows weaving fiberglass cloth. Properties of the mineral fibers are determined by their chemical composition and characterized by a combination of high heat resistance (e.g., heat resistance of quartz, silica, kaolin fibers is above 1000 °C), low thermal conductivity and high mechanical strength. Mineral fiber hygroscopicity is almost equal to zero.

Plasma reactor has a number of advantages in compare with equipment, used for inorganic materials processing. Firstly, equipment is very compact, secondly, the feed material is used almost without preparation, except of mechanical fractional treatment, thirdly, the melting of raw materials and fibers production is combined in one device, thus providing a single-stage production.

Plasma set for mineral fiber producing was designed to do tests of possibility to use different minerals as raw material for fine or superfine fiber production. The device contains plasma torch and plasma reactor with rectangular resection combined in one unit. DC arc plasma torch that generates turbulent plasma flow with temperature 4000-6000 K is used for heating and melting of mineral row materials. Tests show good results of producing fine and superfine fiber from glass and minerals that contain 50-60 % of silicon oxide.

Keywords: plasma, plasma torch, plasma set, mineral material melting, glass fibers, mineral fibers

FLOW VISUALIZATION IN A TEST CHAMBER OF RAPID COMPRESSION MACHINE BY OBSERVATION OF BURNING PARTICLES DISPLACEMENT

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ABSTRACT

The rapid compression machine (RCM) is important experimental tool for investigation ignition and combustion processes. The question about uniform temperature distribution in test volume of RCM is one of the most serious because there is no possibility for direct temperature measurements. It can be only estimated from pressure measurements using assumption of adiabatic compression process. A complex flow of gas generated during compression stroke can significantly effect on adequacy of this assumption application. It is well known that during piston motion the roll-up vortex can be formed in cylinder. It causes mixing of cold gas from boundary layer with hot gas from core region. To minimize this phenomenon it is necessary to study it dependence on different operation parameters of rapid compression machine and gas mixture properties. One of the most convenient experimental methods for studying gas flows is Particle Image Velocimetry (PIV), but it is rather difficult to integrate it in RCM study. Moreover, this method gives information in one cross-section and application of Stereo Scanning PIV is probably impossible task. In this work the perspectives of new similar to PIV experimental method were considered. It was previously found that at definite conditions in test volume of RCM the ignition of small particles is always preceded to the ignition of reactive gas mixture. Moreover, the motion of with particles is not stochastic and probably correlates with motion of gas media. As result addition of easily reactive particles in oxygen contained gas media is a simple method to obtain bright trackers in all test volume. The proposed method was tested in this study and data analysis algorithm was developed. Experiments were carried for heated by compression coal dust-air mixture. Direct light emission from test chamber of RCM was visualized by high speed camera. Velocities of burning particle were measured using every two successive frames from video. The distributions of radial velocities along chamber radius obtained at different time moments clearly showed changes of gas flow structure. It is believed that proposed method will be subsequently used for optimization of aerodynamics inside RCM.

Keywords: rapid compression machine, roll-up vortex, auto-ignition, burning particles

IX GLOBAL CHANGE AND ECOSYSTEMS

REVIEW OF HYDROLOGICAL EXTREMES RESEARCH IN LITHUANIAN RIVERS

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ABSTRACT

The main hydrological extremes in the Lithuanian rivers are spring floods, summer and autumn flash floods, summer and winter low flows. All these extremes differ from each other according to conditions of river runoff formation. Spring floods in rivers usually formed at the beginning of this season, when snow melting water flow increased discharge, and rivers severely overflowed. This is an annual phenomenon of Lithuanian rivers, but only in exceptionally cases makes serious damage. For flash floods formation the most important conditions are intensive rain, heavy rainfall or sudden winter snow melt. Flash flood is spatially and temporally variable hydrological extreme. The basic characteristics of spring and flash floods are maximum discharge and its occurrence date. The low flow is 30 days average of the lowest river discharge rate.

The task of this study is the review of references in which are analyzed the changes of hydrological extremes in the Lithuanian rivers. After summarizing the results of the researchers, general tendencies of hydrological extremes were determinated. The maximum discharges of spring floods in the Lithuanian are decreased in the last years, floods occurred earlier and in some cases floods move from spring to winter season. Flash floods tendencies remain unchanged in long term period. There are no significant changes in low river discharge rates during the long term period, except western part of Lithuania, where low discharge rate had positive trends, associated with increased precipitation amount.

The largest floods in the Nemunas and Neris rivers during the period 1925-1926 were analyzed in more detail. Detailed analysis of floods characteristics enabled to evaluate the flooding extent, made damages and conditions of flood formations.

Keywords: flood discharge, low flow discharge, change of hydrological extremes

GREEN OFFICES: COST SAVING AND ENVIRONMENTAL BENEFIT

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ABSTRACT

Regarding the nowadays increasing consumption it is vital important to focus people to energy saving. And since people are becoming more and more distrustful so, it is important to prove the financial interest in order to reach their attention. So, one of the major challenge that households face is the integration of theoretical solutions to the practical level. Therefore, this particular article provides the selection of suitable suggestions which can serve as an effective tool that fulfil fruitful strategy for energy saving integration, and also greenhouse gas emission reduction. In this study paper, the author undertook examination of research studies in order to reach a broad overview and understanding what kind of factors are influencing energy saving, how it is considered within the households, what energy consumption trends are captured and what possible solutions can be incorporated. So, it could be constituted that the current study is extensive in terms of presented latest energy consumption trends, also defined factors and solutions. Hence, the significance of the article lies on the fact that it is a systematic approach which puts forward an important foundation for future theory and practice investigations.

Keywords: energy saving, greenhouse gas, household, factors

X FUSION ENERGY

ADJUSTMENT FACTORS IN BAYESIAN RELIABILITY ASSESSMENT FOR DEMO FUSION TECHNOLOGY

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ABSTRACT

DEMO fusion plant is supposed to be the first fusion reactor to generate electrical power. Therefore many of its technologies will be first of its kind. As a consequence, there is little or no knowledge about the reliability characteristics of such systems. There is a possibility to reuse statistical data and expert knowledge accumulated by nuclear power plant community, especially since many designs will be adapted from NPP systems. However, many differences will be present as well. This leads to consider approaches of reliability assessment other than already in use. In this paper we will consider analysis of failure rates of Primary Heat Transfer System for Helium Cooled Pebble-Bed blanket, one of several concepts under consideration for DEMO reactor. Failure rate adjustment factors will be considered as the main vehicle to translate the impact of different conditions in DEMO plant. For example, the failure rates of pipelines – there is a vast amount of data from NPP industry for reliability of pipelines with water as a cooling fluid, but in DEMO it might be helium. In addition, all analysis will be carried out by employing Bayesian approach due to its abilities to incorporate different kinds of information and an intuitive treatment of uncertainty.

Keywords: Fusion, DEMO, reliability, Bayesian, HCPB, Cooling system

XI NUCLEAR FISSION AND RADIATION PROTECTION

DEFINITION OF THERMAL STATE OF SPENT NUCLEAR FUEL ASSEMBLY AT DRY STORAGE

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ABSTRACT

The safety of Dry Spent Nuclear Fuel Storage Facility (DSNFSF) consist of three main components – Nuclear safety, Radiation safety and Safe thermal condition. This work is devoted to third part of this complex conception. In particular to the definition of thermal state of spent nuclear fuel assembly. For definition of thermal state of spent fuel assemblies the multi-stage approach was proposed. On each level of multi-stage approach the solving of conjugate heat transfer problems were used.

The multi-stage approach for current problem consists of following. On first stage the thermal state of storage container is defined and on this stage the storage basket with spent fuel assemblies was considered as solid body with equivalent thermal properties. On next stage the heat transfer conditions on surface of basket were obtained and this information was used for next (third) stage where thermal state of storage basket was calculated. On third stage of investigation the detailed structure of storage basket was considered and the received numerical information was used for definition of boundary conditions on surfaces of guiding tubes. On the current (forth) stage these boundary conditions are used for calculation thermal state of spent fuel assemblies.

The maximal temperatures are observed in fuel assemblies which are placed in center of storage basket. The results of investigation allow to detect fuel rods with maximal temperatures and the next stage of calculations should be carried out for these fuel rods for detecting temperature of fuel cladding during all period of storage. The results which were presented in this work will be used for estimation and the improving of safety level of DSNFSF on Zaporizhska NPP.

Keywords: thermal fields, conjugate heat transfer problems, spent nuclear fuel assembly

BURN-UP CREDIT APPROACH FOR CRITICALITY ASSESSMENT OF NEW RBMK-1500 SPENT NUCLEAR FUEL STORAGE CASK

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ABSTRACT

Criticality calculations of spent nuclear fuel in CONSTOR RBMK-1500/M2 cask, foreseen to be used in a new interim spent nuclear fuel storage facility near Ignalina NPP, were performed using pre-generated ORIGEN-ARP spent nuclear fuel composition libraries and first novel results of RBMK-1500 burn-up credit impact on effective neutron multiplication factor (k_{eff}) and its uncertainties were obtained and are presented in the paper. SCALE 6.1 code package with STARBUCKS burn-up credit evaluation tool was used for modelling. ARP (Automatic Rapid Processing) cross-section libraries based on ENDF/B-VII cross section library were used for fast burn-up inventory modelling for criticality safety calculations. CONSTOR RBMK-1500/M2 SNF cask consists of a cylindrical basket 32M containing 102 fuel bundles, a surrounding ring basket containing 80 fuel bundles and other structural and shielding elements. Detailed geometrical model of CONSTOR M2 SNF cask for Monte Carlo simulations of neutron transport was created. Different conditions in SNF cask were modelled: 2.0-2.8 % initial enrichment fuel of various burn up and water density inside cavities of SNF cask. Fuel composition was chosen taking into account main actinides used in burn-up credit calculations. Results show decrement of k_{eff} due to change of fuel composition during burn-up. Water density inside SNF cask is significant factor affecting k_{eff} value.

Keywords: CONSTOR RBMK-1500/M2, nuclear fuel, burn-up credit, criticality safety

ENVISIONING A SUSTAINABLE FUTURE FOR EUROPE: THE LEAD FAST REACTOR AND THE ALFRED PROJECT

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ABSTRACT

Energy availability is needed for development, the primary condition for aiming at wellness. This legitimate ambition is growing along with the vision of a sustainable scenario, for which affordable, acceptable and environmental-friendly energy sources are deemed necessary.

In this perspective, nuclear energy can play a relevant role, provided it overcomes the social concerns blasted out after the Fukushima events, with safety enhancement and waste management in the spotlight of public opinion. For this, breakthroughs are to be conceived, developed and qualified in view of the deployment of a fleet of Nuclear Energy Systems (NES) of a new Generation.

Among the candidate concepts identified by the Generation-IV International Forum, Lead-cooled Fast Reactors (LFRs) are a very promising option, thanks to the exploitation of the favorable intrinsic properties of lead for safety (practically eliminating severe accidents), sustainability (coping with extreme flexibility with the closure of the fuel cycle), proliferation resistance (allowing long-lived battery cores) and physical protection (retaining into the coolant almost the whole potential radioactive inventory).

In the roadmap towards the deployment of commercial LFRs, the Advanced LFR European Demonstrator (ALFRED) is envisioned to prove the viability of lead technology for use in a future Gen-IV NES. All the achievements of ALFRED and of its supporting program, will allow significant advancements for Europe in mastering the nuclear lead technology. Indeed, the ALFRED reactor together with all its supporting infrastructures, to be built in Romania, will be offered to the whole Europe as a unique open-access technology park, for universities, research organizations, industry, safety authorities and utilities all together to get prepared to the advent of a safe, secure and sustainable energy future.

In this paper the ALFRED Project, the ALFRED reactor and the features of the European LFR concept are presented, and the perspectives discussed.

Keywords: Nuclear Energy System, Generation-IV, Sustainability, Safety, ALFRED

VALIDATION OF CODES DRAGON4 AND DONJON4 BY CALCULATING K_{EFF} OF A SLOWPOKE-2 REACTOR

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ABSTRACT

Neutronic behavior of a nuclear reactor is governed by the neutron flux which is a distribution in space, speed and function in time that describes the behavior of neutrons traveling all over the different regions of the core.

This flux is derived from the transport equation on the whole core. With the structural complexity of a reactor and the angular dependence of the transport equation, it is impossible to compute the flux directly.

And several neutronic calculation codes must be used to solve the equation for different levels of discretization which all necessitate a specific modelisation. This chain of successive models, known as a calculation scheme, leads to the knowledge of the neutron flux in a reactor from its own geometry, its isotopic compositions and a cross-section library. Being small in size, the “slowpoke-2” reactor is difficult to model due to the importance of the leaking neutrons.

The aim of this work is to develop and validate a complete calculation scheme, using new versions of the lattice code dragon4 and of the reactor code donjon4, firstly to calculate the effective multiplication factor (K_{eff}) of the reactor slowpoke-2, and secondly to extend the calculation to the other parameters of the reactor such as the power distribution and the control rod reactivity weights.

Keywords: transport equation, dragon4, donjon4, transport equation, effective multiplication factor

UNCERTAINTY ANALYSIS OF SEVERE ACCIDENT IN THE SPENT FUEL POOL

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ABSTRACT

The more wider research of the phenomena of severe accidents in the spent fuel pools due to the loss of water was started after the accident in Fukushima Daiichi NPP. The main measure to prevent an occurrence of such an accident is a restoriation of a water supply. Moreover, it is extremely important to restore cooling function until fuel bundles are not yet dangerously overheated, when the temperature of fuel rods exceeds the threshold of the intensive steam-zirconium reaction. Otherwise, exothermic steam-zirconium reaction will take place and significant amounts of additional heat will be released, which accelerates breaching of the fuel rods, as well as generation of significant amounts of hydrogen, which can cause an explosion.

The purpose of this paper is to analyze phenomena that occur in a spent fuel pool during a severe accident due to loss of collant and to determine the impact of uncertainties of spent fuel pool model parameters on the amounts of generated hydrogen and radionuclides released from a damaged fuel rods.

This paper presents a numerical analysis of phenomena that occur during a severe accident due to loss of water in the spent fuel pool. The analysis was performed with ASTEC programe package. Processes which take place during a restoration of a water supply as well as uncertainties of spent fuel pool model parameters and it's influence on accidents consequencies are also discussed.

Keywords: spent fuel pool, hydrogen generation, ASTEC computer code

INVESTIGATION OF DEMO STRUCTURAL MATERIAL CHARACTERISTICS INDUCED BY NEUTRON IRRADIATION

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ABSTRACT

In this work examination of possible structural materials for Demo nuclear fusion reactor is being carried out. Main subjects of interest are reduced activation ferritic/martensitic and other steels that are used in reactor design (divertor, first wall and breeding blanket). Simulation of neutron irradiation in bulk material is being performed by using activation system program "FISPACT". Neutron flux is selected in accordance with real neutron flux of the Demo fusion reactor. After the irradiation certain properties of materials are being analysed such as induced total activity, fission heat output, gamma dose rate as well as possible ingestion and inhalation doses by released radionuclides. Research is concluded by comparison between different materials as well as experiment validation with regards to other scientific works.

Keywords: nuclear fusion, Demo, FISPACT, neutron activation, irradiation

OVERVIEW OF LIFE CYCLE ASSESSMENT METHOD IN NUCLEAR ENERGY FIELD

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ABSTRACT

Energy production by nuclear systems is considered as one of the most sustainable options. Sustainability of nuclear systems is expressed by environmental-friendly technology, safety and reliability, and by reasonable economic costs. Nuclear energy production is going through significant progress mainly by the development of new reactor technologies. It means shifting from currently most used technologies of Generation II Light Water Reactors (LWR) to Generation IV Fast Reactors (FR) which is promising a steep increase of nuclear technology sustainability once achieved their technical, economic and industrial viability. A suitable tool for sustainability evaluation of any energy system is LCA (Life Cycle Assessment). Using LCA method for nuclear power plants and their processes is a rare approach in comparison with LCA studies in other energy sectors (e.g. fossil fuels). Some commonly known LCA studies (usually not complete) in nuclear field were made for construction of a plant, for operation of sub-systems in once-through fuel cycle, for plant decommissioning and also for the back-end of the fuel cycle (reprocessing, storage/disposal). The better understanding of using LCA in the nuclear field and the identification of the gaps in the analysis require an overview of currently published LCA studies. This overview paper summarizes in which phases of nuclear energy production was LCA already applied and where further could the individual results lead to. This analysis is also essential for pointing out the required and missing data for subsequent complete LCA analysis.

Keywords: Life Cycle Assessment, Nuclear energy, Sustainability, Reactor technology

EVALUATION OF RADIATION CONSEQUENCES OF RELEASES IN ACCIDENTS WITH SPILLS OF LIQUID RADIOACTIVE MATERIALS IN AREAS WITH FORCED VENTILATION

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ABSTRACT

This report focuses on assessment of radiation consequences of releases in accidents with spills of liquid radioactive materials in areas with forced ventilation. During the study, characteristic dependences between parameters of liquid radioactive materials and air exchange in areas with forced ventilation and associated radiation consequences for the public were determined.

The proposed approach is based on the theory of non-stationary heat and mass transfer in surface evaporation of liquid heated below the boiling temperature. The physical model includes: active liquid medium, steam-gas mixture (humid air in the area), air media of forced ventilation, airborne filters, and basic civil structures. The key aspects of the model are evaporation of liquid material, its removal with exhaust ventilation and partial trapping on airborne filters. It is considered that the steam–gas mixture is released to the environment after filters.

The advantage of this model is the possibility to determine integral release of radionuclides to the environment, residual weight of liquid radioactive material and activity concentration of humid air in the emergency area at any moment after beginning of the accident for a wide range of input thermodynamic and geometrical parameters, different operating modes of the ventilation system and different productivities of the filtering system.

Results from assessment of radiation consequences for the selected accident are presented and the associated effect of filtering systems is analyzed.

Keywords: liquid radioactive materials, radiation consequences

XII CROSS-CUTTING ENERGY ISSUES

NUCLEAR FUEL DEMAND EFFECT ON THE FRONT-END URANIUM MARKET

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ABSTRACT

This paper demonstrates the effect of a major demand shock to the natural uranium (NU) market based on real market supply and demand analysis. The uranium market is modelled as front-end nuclear fuel cycle, where the final low-enriched uranium (LEU) consumers are nuclear reactors which have relatively stable demand. Enrichment facilities are provided with NU, which comes from uranium mines.

NU enrichment facilities have an option to vary NU demand by adjusting the separative work unit (SWU) rate. When the price of NU increases enrichment facilities demand less NU and use more SWU to produce the same amount of LEU. And the opposite, when NU becomes cheap, enrichment facilities consume more NU and use less SWU to produce the same amount of LEU.

For simulation we use a mine-based uranium market clearing model. The mine-based uranium model is built around databases of primary and secondary uranium supply as a time-dependent simulation that determines the uranium and enrichment market conditions by calculating the intersection between the supply and demand curves in each user-defined time period (usually one year). The model simulates a time period from 2010 until 2030.

The market supply of NU is the sum of the supply functions of all individual uranium producers with their respective marginal costs. Uranium mines' operational decisions are based on the economic characteristics of individual mines. A new mine will not begin to operate unless its average total cost of producing uranium is less than or equal to the mine's marginal costs (MC). Through this approach, this work models nuclear fuel demand effects on the front-end uranium market, and the results are relevant for uranium producers, consumers, as well as policymakers.

Keywords: market modelling, nuclear fuel cycle economics