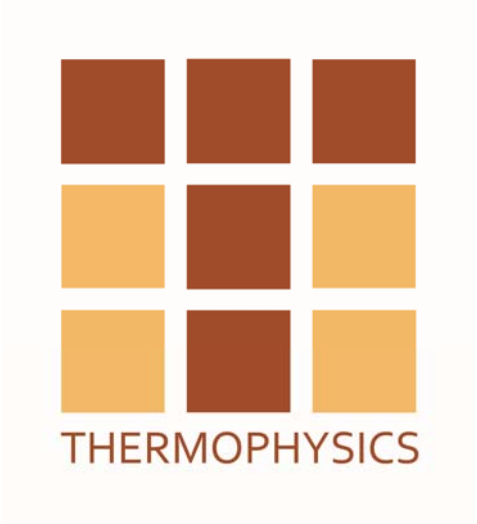

Book of abstracts

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001

Thermal Properties of Oak High Density Board Measured By the Pulse Transient Method for Different Heat Pulse Energy

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Abstract. The energy efficiency of buildings is assessed on the base of thermal insulation properties that can help to save energy costs as well as environment. The wooden materials are widely used as they become significantly recyclable and nature-friendly. Their thermal insulation properties have to be known for construction purposes. The modern experimental methods for the Thermophysical measurements are highly desired in this field. The methodology for the experimental measurement setup has to be optimized and possible disturbing effects at measurements have to be taking into account. The first more sophisticated method is to include disturbing effect into the model or to use the second one by arrangement of the sample set geometry as close as possible to the ideal state. The pulse transient method is relatively fast in comparison with stationary methods. It is simple for experimental arrangement and reliable for large scale of materials. Measurement reliability in this paper was tested by increasing the heat pulse energy, as the estimated Thermophysical parameters have to be independent on used power. The data scattering found for all measurements was found below 2% for all Thermophysical parameters.

002

Analyzing Crack Deflection Behavior of Refractories by Digital Image Correlation

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Abstract. This study investigates the potential of digital image correlation (DIC) to analyze energy dissipation occurring during wedge splitting tests. Two alumina refractories showing a different matrix density with a maximum grain size of 3 mm were investigated. The denser matrix showed higher widths of delamination between aggregate grains and matrix. The DIC analyses were performed with two resolutions. One allowed to evaluate the fracture process zone (FPZ), the other visualized the macrocrack (MC) path (incl. branching) without the FPZ. In both samples, multiple strain concentration sites occurred, but more in the denser sample. In this sample, the following connection of these sites during propagation of the MC led to MC deflection, but only a small FPZ developed. For the less dense sample, the developing FPZ was larger. This indicates a higher contribution of events outside the crack tip to the fracture process. Consequently, it showed a higher fracture energy than the denser material.

003

The Humidity Field Approximation in Porous Materials

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Abstract. During the identification of the humidity field through some of the non-destructive methods, e.g. by using microwave radiation, we obtain discrete data that are often negatively influenced by irregularities in the structure of non-homogeneous materials. While it can be recommended to disregard some of the divergences, some of them, conversely, are substantial. In order to execute the subsequent mathematical modeling of both the temperature and humidity fields, it is necessary to approximate such discrete fields. The approximation of the humidity field in porous materials has to adhere to

numerous conditions. Non-negligible is also the required amount of cohesiveness. A suitable humidity field approximation then becomes the foundation for subsequent modeling, e.g. for determining the moisture conductivity coefficient of construction materials.

004

In-Situ Thermal Fabrication of Photodetectors Based on Methylammonium Lead Bromide Perovskite

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Abstract. This paper presents low cost fabrication method of $MAPbBr_3$ crystalline structures directly on the polylactic acid (PLA) carbon-coated substrates. Fabrication was carried out using three different crystallization processes: inverse temperature crystallization (ITC), anti-solvent vapor-assisted crystallization (AVC) and combination of both methods. This paper also includes the study of crystallization kinetics for both the perovskite and its precursors. Moreover, temperature modulated space-charge-limited current method (TM-SCLC) was applied to the measured current-voltage characteristics in order to determine the concentration of free and trapped charge carriers, the microscopic mobility of free charge carriers, the thermodynamic position of the Fermi level, and the position of localized states and their concentration. Based on the acquired data we determined following microscopic carrier mobilities and thermodynamic Fermi level positions: μ^+/μ^- $\approx 0.2/4.0$ cm^2/V/s, $\Delta E_F \approx -0.48$ eV for $PbBr_2$, $\mu^+/\mu^- \approx 10/10$ cm^2/V/s, $\Delta E_F \approx -0.575$ eV for MABr, and μ^+/μ^- $\approx 10/300$ cm^2/V/s, $\Delta E_F \approx -0.57$ eV for $MAPbBr_3$). By comparing our model with literature data (bandgap width, permittivity, effective mass of carriers, etc.) we found and characterized the monoenergetic (bi-exponential) localized states near Fermi level of the studied materials (deep traps for $PbBr_2$, shallow traps for $MAPbBr_3$, and states at the Fermi level for MABr).

005

Analysis of Temperature Profile Changes of Ground with Heat Pump Horizontal Heat Exchanger

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Abstract. The aim of the article is the analysis of the ground temperature distribution to a depth of 2 m, and long term ground temperature changes in which horizontal heat exchanger is arranged. Moreover, the temperature changes of glycol, which is supplied to the heat pump connected to the ground exchanger, were analyzed. The horizontal heat exchanger is made of PE 32 mm pipes arranged at a depth of 1.5 m in the form of 4 meandering loops, each about 100 m long, arranged on an area of approximately 780 m^2. The ground heat exchanger supplies a 10kW heat pump, which provides heat for central heating and hot tap water for a single-family building. The facility is located in transitional climate of Lublin province, Poland. The temperature profile was measured with 2 m long probes, each with 5 temperature sensors enabling to perform measurements at ground depths of 0, 50, 100, 150 and 200 cm. The temperature and mass flows of the glycol flowing through the ground exchanger were measured at the heat pump metering equipment. The research covered the heating season from November to March. The results showed a slow and systematic reduction in the temperature of the glycol supplied to the heating installations during the season on average from 10 °C to 4 °C, as well as the temperature of the ground at each analyzed depth. At a depth of 50, 100, 150 and 200 cm, the temperature reduction was 9.7-3.0 °C, 11.0-3.5 °C, 11.9-4.0 °C and 12.3-4.5 °C, respectively. There was no risk of ground freezing in the vicinity of the heat exchanger. The influence of the outside temperature to the ground temperature fluctuations is insignificant at a depth of 150 cm. Ground temperature changes on heat exchanger depth are proportional to the time of low outdoor temperatures during the season and the total energy derived from ground by the heat exchanger.

006

Modelling of mold growth on pine and spruce by the logistic equation

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Abstract. This paper deals with modelling of mold growth on wood using the logistic equation. Macroscopic mold coverage fraction was used in the model to express development of molds. Unknown parameters of the logistic model were estimated by finding the best agreement with the current state-of-the-art Finnish mold growth model. Calculations were performed for constant ambient boundary conditions. The estimated values of model parameters were finally expressed as functions of relative humidity and moisture content. The reliability of the proposed logistic model should be tested in the future against the experimental mold growth data.

007

Magnesium Oxychloride Cement Composites Filled with Martian Soil Simulant

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Abstract. This contribution deals with design and development of magnesium oxychloride cement (MOC) composites for extraterrestrial application. For the design of the composite, Martian soil simulant MGS-1 was used as a filler, in order to form a composite, which uses materials available at the locality of application. The designed composite contained 5 wt. % of MGS-1 (relatively to the content of MgO) and was prepared with two types of raw MgO powder with different purity. Overall four types of MOC-based material were prepared, analyzed using multiple types of analytical methods and mechanical tests and compared with each other. The influence of the Martian soil simulant on the MOC matrix was assessed, showing the high potential of such material in its intended environment of application.

008

Comparison of superconducting properties of YBCO and EuBCO single-domain bulks

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Abstract. Requirements for the production and properties of superconductors are constantly increasing, and currently, it is necessary to prepare these materials not only in larger diameters but also in large series. It is important to know what type of superconductor to choose for a particular type of application. The trapped field is a property that can be used in NMR/MRI devices, super strong hybrid electromagnets or vibration stabilizers. The levitation force of superconductors can be used in devices such as high-speed bearings, horizontal or vertical conveyors and high-speed trains. Preparing superconductors in larger series reduces the total required time and energy consumption. I this work the two larger batches of single-domain superconductors with diameter 28 mm based on YBCO and EuBCO were prepared and their superconducting properties such as levitation force and trapped magnetic field were measured and compared.

009

Stresses in a Functionally Graded Rotating Disk Subjected to Thermal Loading

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Abstract. The thermo-elastic solution of Functionally Graded (FG) annular disc subjected to constant angular velocity is presented. The power gradation law follows the variation of elastic modulus, density, coefficient of thermal expansion and thermal conductivity parameter along the radius of the disc. The temperature field in the FGM disk is obtained by solving the non-linear energy balance equation using homotopy perturbation method (HPM). Classical elasticity theory coupled with HPM solution for temperature field is employed to obtain the stress field. The results obtained from the present solution are compared with the ANSYS based FEM solution. A good agreement is found between the two solutions. The effects of various thermo-mechanical parameters are systematically addressed.

010

Thermal properties of PLA with conductive admixtures for photo-electric applications, prepared by 3D printing

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Abstract. Currently, 3D printing is used in various industries from the production of prototypes to final products. From the point of view of sustainable development, materials based on polylactic acid (PLA) are suitable, for which it is possible to ensure controlled degradation. In terms of aesthetics, but also applicability, it is important to know the thermal properties of filaments, but also the final products with different types of additives. In the present paper, PLA samples with various pigments and conductive materials are studied. The transient step wise method was used to study the thermal properties. This method allows determining all three basic thermal parameters (thermal conductivity λ, specific heat capacity c_p, and thermal diffusivity a). It was found that for samples with pigments, these parameters were in the range of values $\lambda = (0.15 – 0.25)$ W/m/K, $c_p = (900 – 1100)$ J/kg/K, and $a \approx 0.15$ mm^2/s. For samples with electrically conductive admixtures, are the equivalent parameter in range $\lambda = (0.22 – 0.30)$ W/m/K, $c_p = (400 – 600)$ J/(kg.K), $a \approx 0.17$ mm^2/s. It turned out that electrically conductive materials (PLA with metal admixtures) show a very good coefficient of thermal conductivity and lower specific heat capacity, while materials with admixtures of pigments show a lower thermal conductivity and higher specific heat capacity. These materials we use, in present time, for construction of boxes for measuring thermal properties of low temperature PCM materials (up to 50 °C) and an electrode systems for measuring the electrical properties of thin film semiconductors and crystals.

011

Thermal Properties of Lightweight MKPC Composites

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Abstract. Magnesium based cement known for over than 150 years is a clinker-free binder with low environmental impact which is in contrast with widely used Portland cement. Its main advantage is fast setting, durability and high early strength accompanied by a strongly exothermic reaction, which makes the material applicable also at temperatures below zero. On the

other hand, fast setting connected with workability restricts the material use on large-scale structures. Therefore it finds use in restoration works, repair of streets and pavements or retrofitting. Moreover, the high durability and chemical inertness allow apply material for encapsulation of hazardous waste. Nowadays effort to reduce the energy consumption of building stocks resulted in a design of new thermal insulation materials. The way how to scale up thermal insulation ability is to use alternative, highly porous aggregates as a replacement of commonly used silica sand. In this study, MKPC (magnesium potassium phosphate cement) was mixed with expanded glass granulate and waste tire rubber. For the hardened composites, structural and thermal properties were experimentally assessed. The results pointed to the considerable decrease in thermal conductivity when using lightweight filler. Additionally, thermal characteristics were observed for 50% and 100% water saturated samples. The obtained data evinced greatly reduced thermal insulation ability due to the moisture presence.

012

Ceramic 3D print

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Abstract. In the Czech Republic, ceramic 3D print is not a common technology for industrial production. Currently, the department is testing print ceramic materials in laboratory conditions. The potential of this method is great for printing of complex shapes, production speed etc. 3D printing is an additive process of creating three-dimensional objects based on digital data. Printer can work on different principles depending on the print material and final product. The custom-made set of 3D printer is supplemented by necessary devices as screw press and pressure vessel. The device it´s built on an open-source RepRap architecture. Setting parameters such as nozzle diameter, shape, layer, and wall thickness, print speed predetermine the printing of both simple and complex components. The experiment compares the resulting properties of ceramic samples which were prepared by pressing, casting and 3D printing method. This type of ceramic materials is commonly available on market Czech Republic designed for modeling and pottery.

013

Effect of Water Vapor Adsorption Capacity on Thermal Properties of Lime Mortars doped with Graphene Nanoplatelets

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Abstract. Although the non-hydraulic slaked lime has been already discovered in ancient times, it finds use in repair applications nowadays. However, compared to other generally used binders, i.e., hydraulic lime and Portland cement, slaked lime is characteristic by a low hardness. To improve the overall performance of lime-based materials, the enhancement with graphene nanoplatelets as nanoadditive has been tested. In addition to control lime-based mortar, two mixtures enriched with 0.5 wt.% and 1.0 wt.% of graphene were prepared and tested. Hardened mortars were subjected to variety of tests to analyze their basic structural characteristics, mechanical performance, and water absorption. The particular tests were conducted for 28-days and 360-days samples. Additionally, heat transport and storage parameters of 360-days samples were measured with a hot-disk transient plane source technique (TPS) and the effect of mortars hygroscopicity, thus moisture content, was considered. Before the heat transport and storage testing, the samples were exposed to humid environment using a static desiccator method. The obtained data gave evidence of improvement of mechanical performance of mortars with used nanoadditive. On the other hand, low dosage of graphene nanoplatelets combined with their imperfect distribution had no substantial effect on water absorption and mortars hygroscopicity. Both tested thermal parameters were moderately affected by moisture presence.

014

The Influence of Expanded Polystyrene on Properties of Cement-based Materials

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Abstract. Concrete is a versatile composite material which due to its beneficial properties e.g., form ability, fast construction process, relatively high compressive strength available in short term, considerable long-term durability, etc. may find usage in many applications throughout different sectors. Dense composite matrix which is, on the one hand, responsible for good mechanical resistance can be, on the other hand, counterproductive in view of excessive dead loading of bearing structures and its high thermal conductivity. In this paper waste expanded polystyrene as a replacement of traditional dense aggregate in concrete production was used. Polymer-based alternative, in the fraction of 2.0/4.0 mm, was applied in the amount of 0-100 vol.%, and its effect on structural, strength and thermal-physical properties on 28-days aged concretes was monitored. Obtained experimental data confirmed combined considerable lightening of produced composites accompanied with improvement of their thermal-insulation function. High dosages of lightweight aggregate in concrete mixes led to significant reduction of their mechanical resistance, however, at balanced portions of polymeric material structural grade concrete may be manufactured.

015

Sorption isotherm of spruce wood – multiple measurements and brief comparison with other sources

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Abstract. The sorption isotherm of spruce wood has been studied many times. However, there were found differences among data found in literature. These differences can be important in terms of accurate numerical modelling, and especially in the context of mould growth predictions. Therefore, we performed several measurements of sorption isotherm of spruce wood at ca. 22.5 °C and within the hygroscopic range of 0-97% RH. The measurements were performed over the years by three operators with good mutual agreement of the results. The data were further extended to absorption measurement at humidity level approx. 99.7% RH. This measurement agreed well with suggested value of the fibre saturation point – 30.8 %MC. Based on measured data an absorption and desorption functions were generated and compared with data from other sources. Our measurements fit in the middle of the curves found in literature.

016

Dynamic moisture transport in spruce wood – experiment in hygroscopic range under isothermal conditions

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Abstract. The moisture behaviour of wood has been naturally studied since ancient times. Despite being commonly used in almost all industries, some of its moisture properties are still not precisely defined. Inaccuracies of the measured properties are reflected in numerical simulations and can lead, to some extend to its improper use. Although the wood can often handle minor errors in use, in the future will be beneficial to use it more consciously and sustainably. Therefore, it is needed to

understand its moisture behaviour more accurately. This article presents an experiment of dynamic moisture transport in spruce wood in high levels of ambient relative humidity and constant temperature. Only one-dimensional moisture transport in the tangential and radial directions was studied. The results show the rate of the stabilization of moisture content of samples after the step change of boundary humidity and influence of the sorption hysteresis during repeated cycles. The results can help to better understanding of the moisture behaviour of wood and to further improvement of some numerical simulation tools.

017

Topological entropy calculations on the molecular sequences

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Abstract. We worked on the energy contained in the molecules arranged in genetic molecular sequence. The binding energy of the genetic alphabet, i.e., A, C, G, T have been taken from experimental data and they are used in the calculation of the entropy along the sequence. This is termed as topological entropy on the molecular sequence. The topological entropy of various species is used for principal component analysis, which is a tool to reduce the multidimensional data to less dimension for data visualization. Further the output of the analysis is used for the determination of dissimilarity between the sequences. The technique is verified using HEV and MPVX molecular sequences.

018

Measurement of Evaporating Thin Film Thickness of a Microfluidic Channel Using Reflectometer

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Abstract. The current work is an experimental insight of the evaporating thin film, observed when a wetting liquid comes in contact with the microchannel walls, using the principle of reflectometry. The evaporating thin film formed consists of three regions: adsorbed, the evaporating thin film meniscus, and the intrinsic meniscus region. The maximum heat flux is prominent in the evaporating thin-film region, also referred to as the transition region. The previous method with an interferometer can only measure the intrinsic meniscus region and fails to measure thickness in the transition region, which brings the need to use instruments like reflectometers that can capture the thickness beyond the interferometer's ability. The work stands unique in measuring the thickness in the adsorbed and transition region, unlike the previous works, which measure thickness only in the intrinsic meniscus region, thus eliminating the existing measurement gaps in previous works. The study investigates the entire procedure to be followed in estimating the thickness using a microscope-based reflectometer with specifications and dimensions and detailed descriptions.

019

Scale-up method for comparative heat capacity measurement of liquids

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Abstract. The current situation in the energy sector is reflecting the demand for electricity saving and advanced energy storage systems. As a promising option for energy storage, high-temperature media, often doped with nanoparticles, leading

to the formation of nanofluids, are finding usage. The key property of these systems is the specific heat capacity, which is commonly being improved by the addition of nanoparticles. A simple specific heat capacity comparative method suitable for larger sample volumes is hereby introduced, applicable especially for the relative comparison of heat capacities. The development of the experimental setup, as well as the advantages and disadvantages of the method, are described and discussed.

020

Sorption hysteresis of spruce wood – measurement and modelling

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Abstract. This paper focuses on the sorption hysteresis of spruce wood (*Picea Abies*). First, its hysteretic behaviour was measured under laboratory conditions at a constant temperature in several steps covering the entire hygroscopic range. The measurement had the form of loops with the same relative humidity at the beginning and end of each step. Then two hysteresis models, the independent domain theory based IPM model and empirical Frandsen's model, were successfully fitted to the measured data. To do so, modifications to their shape parameters have been proposed. Only a minor change was necessary in the case of the IPM model, more extensive in the case of Frandsen's model. Testing and application in dynamic simulation showed that the IPM model is able to capture more accurately and reliably the hysteretic behaviour of spruce wood. The use of the Frandsen's model should be preceded by a critical analysis due to the risk of pumping error.

021

Thermal Properties of Low-Density Alder Wood (Alnus cordata Loisel) under Room Ambience

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Abstract. The study aimed to examine the thermal properties of volumetric density and the wood samples were exposed to a controlled environment under the influence of 65% air humidity at 20°C. This paper focuses on the results obtained by comparing the values of thermal diffusivity (κ), thermal conductivity (λ) and specific heat capacity (ρc_p) measured at normal atmosphere and room pressure. The experiment was performed using the pulse transition method and all three basic thermo physical parameters were estimated from the measured temperature response to the heat pulse using a theoretical model derived for the cuboid geometry of the samples (cuboid model). The uncertainty of the estimated parameters using cuboid model is in the range of 1-3% depending onset of the experimental conditions and sample geometry. The model also includes the temperature of the heat exchangers as well as the effect of heat loss from the sample-free surface in the lateral direction, which is represented by the heat transfer coefficient α from the sample surface to the surroundings. Thermo physical parameters obtained by regression analysis of thermal responses using a cuboid model prove the prediction of linear dependence with the volume density of Alder wood.

022

Application of BIM for Analyzing the Energy Consumption of Technical Buildings

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Abstract. The building sector is responsible for 32% of global energy consumption and 19% of all energy-related greenhouse gas emissions. Uninsulated existing buildings, including industrial ones constitute the greatest threat to reducing greenhouse gases. The requirements for some of them are difficult to fulfill, resulting from the age of these buildings, which are treated as historic buildings and require preservation of the facade in an unchanged form. The process of performing a full energy audit is long and expensive; hence, the authors present the methodology supporting the reduction of the energy consumption of buildings implemented in BIM design programs. It has been shown that working in this environment allows performing a multivariate thermal simulation of an object based on the analytical 3D models. As a result of these work it is possible obtain reports divided into zones and spaces which contain detailed loads analysis for the project. It is expected that the proposed analysis tool will assist researchers and practitioners in better understanding BIM environment, as an application supporting the reduction of the energy consumption of buildings.

023

Effect of Intensification of the Dendromass Combustion Process on Corrosion of High-alumina Refractory Linings

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Abstract. The study and evaluation of thermo-chemical, physico-chemical and thermo-mechanical properties of ashes is important for maintaining the smooth operation of boilers. Ash fusibility is a characteristic parameter of the fuel. The evaluative criteria predicting the behavior of ash are based on its chemical composition. The criteria used to characterize coal combustion are also used for the biomass combustion ash. Using these criteria the effect of the magnesite addition to dendromass ash was evaluated. The slagging, fouling and fusibility parameters of the original and modified ash with $MgCO_3$ additive were compared. The ash fusibility index (fusibility temperature) increased significantly, and reactivity of the slag decreased with increasing MgO content in ash. Next, on the high-alumina refractory material, the corrosion test (static crucible corrosion test at 1450 °C/ 7 h) was carried with the dendromass ash with and without magnesite additive. The corrosion was visually evaluated from the degradation of (l-s) interface, and corrosion profile, and changes in the chemical and phase composition of the corrosion medium. The microstructure of the melt-refractory interface was studied by SEM/EDS. The slag preferentially attacks the binder phase of the corundum refractory castable, and a lesser extent the corundum grains. The change in the chemical composition due to the $MgCO_3$ addition to ash manifested an increase of slag viscosity (slag viscosity index decreased), the wettability reduction of the corundum castable. The presented experiments are an introductory study aimed to reducing the corrosion of refractory materials by the modifying the composition of biomass and waste during their combustion.

024

On the Computational Heat Transfer Evaluation in Buildings with Controlled Temperature

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Abstract. New trends in sustainable building development require e_ective control of building energy consumption. In several last decades people's demands for residential buildings have changed from the original survival type to the preference of the comfortable one, thus the much more detailed physical and mathematical analysis and related computational simulations are required, together with the implementation of advanced building materials, structures and technologies. This short paper demonstrates such generalized approach on a quasilinear model problem of heat transfer, open to natural generalizations, including further thermal, mechanical, etc. processes, with some references to practical applications.

025

Effect of Salinization on Hygroscopicity of Lightweight Mortars with Zeolite

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Abstract. Rendering and plastering mortars designed for repair of masonry are often exposed to harmful conditions, whereas salt weathering represents serious risk for mortars durability and functional performance. Due to their nature, inorganic salts are highly hygroscopic substances which must be always considered in the case of the salt-contaminated building materials. In the presented research, structural and thermal parameters of lightweight mortars made of lime, natural hydraulic lime, lime-cement blend, and zeolite use as aggregate were tested. Specific attention was paid to the assessment of sorption and desorption isotherms which were experimentally measured and analyzed. Fort the measurement, the static desiccator method combined with precise laboratory balances was used. Before the hygroscopicity testing, the samples were subjected to the salt crystallization test which was conducted by the use of NaCl water solution. In this way, salinization of samples was reached. The obtained results gave evidence of significant enhancement in sorption capacity due to the use of zeolite as lightweight aggregate and salt presence in pores of mortars.

026

Influence of 3D printing parameters on the mechanical properties of the samples manufactured by means of the FDM method using thermoplastic polymers

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Abstract: The manufacturing of machine parts with additive methods (AM) is of significant importance in modern industry. The development of 3D printers and all 3D printing technology is impressive. The ability to make parts quickly and relatively cheaply with AM gives great opportunities in terms of e.g. shortening the production preparation time. Proper selection of printing parameters allows for a significant reduction of printing time, as well as reduction of production costs. Unfortunately, this has different consequences. Due to the course of the printing process and the parameters that can be set, the same product manufactured with different parameters has different mechanical properties – mainly strength. This paper presents the impact of 3D printing parameters on the strength of the samples manufactured by using the Fused Deposition Modeling method (FDM) using thermoplastic polymers. The strength tests were carried out on the samples made in accordance with DIN EN ISO 527. The samples were printed from PLA (completely biodegradable). The tested samples were prepared in three levels of print filling – 10%, 30% and 60% and with different types of filling – line, mesh and honeycomb. A series of static tensile tests were carried out to find out the strength of the samples produced with different printing parameters. Owing to the obtained test results, it is possible to select the optimal printing parameters depending on the forecast load of the manufactured parts.