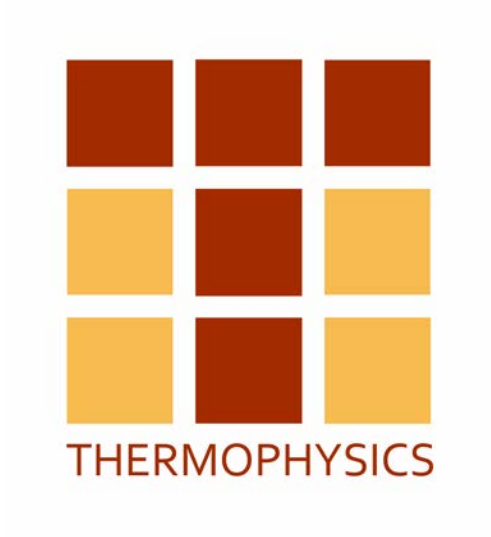

Book of abstracts

Thermophysics 2023

3rd – 5th October 2023

Dalešice, Czech Republic

Brno University of Technology

Sponsorship

Hot Disk®

BRNO UNIVERSITY OF TECHNOLOGY FACULTY OF CHEMISTRY

001

Numerical simulation of cascade latent heat thermal energy storage device thermal performance using multiple PCMs

Yerzhan Belyayev[1, a)], Amankeldy Toleukhanov[1, 2], Yelnar Yerdesh[1], Abzal Seitov[1], Abdurashid Aliuly[1], Olivier Botella[3]

[1]*Department of Mechanics, Al-Farabi Kazakh National University, Almaty 050040, Kazakhstan.*
[2]*Department of Mechanical Engineering, Satbayev University, Almaty 050013, Kazakhstan.*
[3]*Université de Lorraine, CNRS, LEMTA, F-54000 Nancy, France.*

[a)] Corresponding author: yerzhan.belyaev@kaznu.edu.kz; yerzhan.belyayev@gmail.com

Abstract. Short-term (daily) and long-term (seasonal) thermal energy storage allows efficient use of renewable thermal energy by replacing fossil fuel systems. In the present research, a three-dimensional numerical simulation of the thermal efficiency of a single-stage and three-stage cascaded shell-and-tube type latent heat thermal energy storage device is carried out using various phase change materials. The mathematical model is based on the fundamental conservation laws of mass, momentum, and energy. Numerical implementation was carried out using built-in solvers of COMSOL Multiphysics v.5.6 software. The numerical solver was verified by comparison with experimental data with acceptable agreement. A comparison of calculations between single and cascade configurations showed that the use of a multi-stage configuration allows for an increase in the temperature range of considered thermal energy storage devices. The use of the internal finned structure of containers almost halves the charging and discharging time. The developed numerical calculation tool can be used in the future to study the thermal efficiency of more complex thermal energy storage device configurations, considering three dimensions and phase transitions.

002

Energy and exergy performance study of ground source heat pump in continental climate conditions

Yerzhan Belyayev[1, a)], Amankeldy Toleukhanov[1, 2], Yelnar Yerdesh[1], Abzal Seitov[1], Tannur Amanzholov[1], Hua Sheng Wang[3]

[1]*Department of Mechanics, Al-Farabi Kazakh National University, Almaty 050040, Kazakhstan.*
[2]*Department of Mechanical Engineering, Satbayev University, Almaty 050013, Kazakhstan.*
[3]*School of Engineering and Materials Sciences, Queen Mary University of London, London E1 4NS, UK.*

[a)] Corresponding author: yerzhan.belyaev@kaznu.edu.kz; yerzhan.belyayev@gmail.com

Abstract. In the context of continental climate conditions like those in Kazakhstan, ground source heat pump heating systems are regarded as highly effective solutions for transitioning to cleaner and greener heating methods. This study undertook both experimental and theoretical investigations to develop a ground source heat pump-based heating system tailored to Kazakhstan's weather conditions and to assess its thermodynamic performance. The system, utilizing a water-to-water heat pump integrated with a ground source heat exchanger and R134a refrigerant, was designed to provide hot water for space heating needs. The results showed a close agreement, within 6.2%, between the predicted and experimental coefficient of performance values. Additionally, the study explored the use of environmentally friendly refrigerants, including R152a, R450A, R513A, R1234yf, and R1234ze, as potential replacements for R134a. While R152a exhibited promising performance in terms of coefficient of performance, its flammability raised safety concerns. The heating system employing R450A, R513A, R1234yf, and R1234ze displayed slightly lower coefficient of performance values (2-3%) compared to R134a. The analysis revealed that the compressor was the primary source of exergy destruction, followed by the expansion valve, evaporator, and condenser. Given their low flammability and reduced environmental impact, R450A, R513A, R1234yf, and R1234ze emerged as valuable alternatives to R134a.

003

Determination of Organic Electrochemical Transistor Parameters

Jan Blahut, Oldrich Zmeskal[a)], Lucie Maráčková and Jan Pospisil

Faculty of Chemistry, Brno University of Technology, 612 00 Brno, Czech Republic

[a)] Corresponding author: zmeskal@fch.vutbr.cz

Abstract. The switching transient responses of organic electrochemical transistors with four basic types of imidazolium-based ionic liquids were determined. The paper describes the method of determining four transient switching parameters. Time constants of switching processes, switching ratios, residual current when the transistor is closed and the saturated value of the current in an open transistor are discussed. The best switching ratio can be found with the ionic liquid 1-butyl-3-methylimidazolium trifluoromethylsulfonate. The time constants of fast and slow processes were determined. There is currently an effort to eliminate the occurring slow processes, which will lead to a reduction of the residual current and, in general, to an acceleration of the switching process of the transistor.

004

The Influence of the Flatness of the Particle Board Composite Samples on the Accuracy of the Measurement of Thermal Properties by Pulse Transient Method

Vlastimil Boháč[1, a)], Rupali Tiwari[1,2], Luboš Krišťák[2], Roman Réh[2], Ján Hudec[1], Vladimír Štofanik[1], Valentina Lo Giudice[3], Luigi Todaro[3]

[1]*Institute of Physics, Slovak Academy of Sciences (IP SAS), Dúbravská cesta 9,84511 Bratislava, Slovakia.*
[2]*Faculty of Wood Sciences and Technology, Technical University in Zvolen, T. G. Masaryka 24, 96001 Zvolen, Slovakia.*
[3]*School of Agricultural, Forestry, Food and Environmental Sciences, University of Basilicata, Viale dell'Ateneo Lucano 10, 85100 Potenza, Italy.*

[a)] Corresponding author: vlastimil.bohac@savba.sk

Abstract. Recently, new composite materials based on natural wood-based materials have been increasingly used in modern construction of houses because of their good physical, mechanical and thermal insulation properties. This raises the need to characterize their thermophysical properties. As part of our project 'Research of selected properties of sustainable insulating materials with the potential for use in wooden buildings', we measured samples of particleboards (PB) made from chips of Turkey oak wood and samples made from mixture of Turkey Oak wood (Oak PB) and Orange wood (Orange-Oak PB). A cuboid model for the pulse transient method was used to estimate the parameters. The model takes into account the cuboid geometry of the sample with a square base, the heat losses from the free surface of the sample to the surroundings using the coefficient of heat transfer from the surface of the sample to the surroundings in the lateral direction, as well as the infinitely large heat capacity of the heat exchangers between which the sample is placed. The heat transfer coefficient between the heat source and the sample is infinitely large. The surface of the particleboard is usually rough and porous due to the size and nature of its particles. In addition, the interfaces of the three parts of the sample set are hand-polished, so that the edges and corners are not perfectly flush with the central area of the surface. As a result of manual polishing, the interfaces at the corners and edges of the sample parts usually have air-filled gaps. Free gaps cause additional thermal resistance to heat flow from the heat source to the body of the sample. Then, the coefficient of heat transfer from the heat source to the sample is not infinitely large and does not correspond to the conditions of the cuboid model. While the Oak PB had a perfectly flat surface, the Orange-Oak PB suffered from loose gaps at the interfaces. Therefore, we filled them with silicone glue as a thermal contact agent and measured them again. The consequence of flatness differences for all results was discussed within the theoretical analysis based on sensitivity coefficients, uncertainty calculations, as well as the assumption of a thermally dependent heat transfer coefficient between the heat source and the sample. The criterion for the quality of the fitting of the thermal responses by the cuboid model was the residual graph within the thermal noise of the thermocouple ± 0.005 K.

005

Selected Properties of Thermal-Insulating Clay Mortars with an Admixture of Casein

Przemysław Brzyski[1], Łukasz Skibiński[1], Zbyšek Pavlík[2], Elżbieta Wośko[3], Sylwia Łagód[4], Grzegorz Łagód[4, a)]

[1]*Department of Construction, Faculty of Civil Engineering and Architecture, Lublin University of Technology, Nadbystrzycka 40, 20-618 Lublin, Poland*
[2]*Department of Materials Engineering and Chemistry, Faculty of Civil Engineering, Czech Technical University in Prague, Thákurova 7, 166 29 Prague, Czech Republic*
[3]*Department of Applied Mathematics, Fundamentals of Technology Faculty, Lublin University of Technology, Nadbystrzycka 38, 20-618 Lublin, Poland*
[4]*Department of Water Supply and Wastewater Disposal, Faculty of Environmental Engineering, Lublin University of Technology, Nadbystrzycka 40B, 20-618 Lublin, Poland*

[a)] Corresponding author: g.lagod@pollub.pl

Abstract. Clay mortars, as low-processed materials, are often used as internal plasters in natural construction. In order to improve their thermal insulation properties, lightweight aggregate or porous organic components are often added. Such additives as hemp shives can also improve other properties, e.g. reduce shrinkage or improve bending strength. Clay parameters can be modified, for example, using biopolymers. An example is acid casein, which in combination with lime forms casein glue used, among others, to improve mechanical strength and water resistance. The aim of the work is to perform basic tests of mechanical and physical properties of heat-insulating mortars based on a clay binder with the addition of hemp shives and an admixture of casein. Flexural and compressive strength, density, total porosity, shrinkage and thermal conductivity coefficient are measured and discussed.

006

Assessment of Magnesium Potassium Phosphate Cement Matrix for Heavy Metals Immobilization

Matěj Dolenský[1], Martina Záleská[1], Milena Pavlíková[1], Adam Pivák[1], Jana Nábělková[2], Łukasz Guz[3] and Zbyšek Pavlík[1, a)]

[1]*Department of Materials Engineering and Chemistry, Faculty of Civil Engineering, Czech Technical University in Prague, Thákurova 7, 166 29 Prague 6, Czech Republic.*
[2]*Department of Sanitary and Ecological Engineering, Faculty of Civil Engineering, Czech Technical University in Prague, Thákurova 7, 166 29 Prague, Czech Republic*
[3]*Environmental Engineering Faculty, Lublin University of Technology, Nadbystrzycka 40B, 20-618 Lublin, Poland*

[a)] Corresponding author: pavlikz@fsv.cvut.cz

Abstract. Industrial wastes are often contaminated with heavy metals and thus constitute a danger to the environment. One of the safe ways to treat such contaminated wastes is to immobilize heavy metals by using various binders. Suitable binders may include magnesium potassium phosphate cement (MKPC), which is also referred to as a low-carbon material. This study evaluates the ability of the MKPC matrix to simultaneously immobilize three heavy metals, namely Ba, Pb and Zn ions. The heavy metals were applied to the mixing water in the form of soluble salts at a concentration of 2.5% of the heavy metal by weight of the binder. The basic structural and mechanical properties of the hardened specimens were determined and an evaluation of the parameters for the transport of liquid water was carried out. It was found that the presence of metals had a negative effect on the mechanical properties. However, the MKPC exhibited an excellent low water absorption coefficient, and the addition of heavy metals further reduced this parameter by up to 60%, promoting overall immobilization. This makes MKPC a very interesting material for immobilizing heavy metals in artificially contaminated materials, which could then be used in a variety of construction applications.

007

Approximation of the Partial Pressure of Saturated Water Vapour in the Glaser Model

Ondřej Fuciman[a)], Monika Manychová

Faculty of Civil Engineering, Brno University of Technology, 602 00 Brno, Veveří 95

a) Corresponding author: fuciman.o@fce.vutbr.cz

Abstract. The question of the influence on the Glaser model of the choice of a suitable approximation of the dependence of the partial pressure of saturated water vapour on temperature turns out to be important. The central idea of the Glaser model is the construction of tangents to the exponential curve of the partial pressure of saturated water vapor, which tends to be very flat. The positions of the points of contact that define the condensation region are very sensitive to the choice of this curve.

008

Study of the Properties of Large-Scale Electroluminescent Perovskite Samples

Stevan Gavranovic, Oldrich Zmeskal[a)], Jana Holeckova, and Jan Pospisil

Faculty of Chemistry, Brno University of Technology, 612 00 Brno, Czech Republic

[a)] Corresponding author: zmeskal@fch.vutbr.cz

Abstract. The contribution deals with the preparation and characterization of large-area electroluminescent panels (16 mm × 38 mm) prepared by 3D printing on carbon interdigital electrodes. It analyzes the results of measuring the volt-ampere characteristics of thin layers of chloride and bromide perovskites and chloride and bromide perovskites mixed with perovskite nanoparticles prepared either by the method of inverse temperature crystallization (ITC) or by using an antisolvent (AS). The properties of double-layered structures prepared by successive application of the ITC method were also studied. The results show that the double-layered structures have a microscopic mobility of charge carriers up to 4 orders of magnitude higher than the single-layered structures, and that they also exhibit photoluminescence and electroluminescence.

009

Analysis of Fluid Velocity in Borehole Ground Heat Exchangers Connected in the Tichelmann System

Łukasz Guz[1, a)], Dariusz Gaweł[2], Sylwia Łagód[1], Ewa Guz[3], Zbyšek Pavlík[4]

[1] *Lublin University of Technology, Faculty of Environmental Engineering, Nadbystrzycka 40B, 20-618 Lublin, Poland*

[2] *Lublin University of Technology, Faculty of of Civil Engineering and Architecture, Nadbystrzycka 40, 20-618 Lublin, Poland*

[3] *University of Economics and Innovation in Lublin, Department of Human Science, Projektowa 4, 20-209 Lublin, Poland*

[4] *Czech Technical University in Prague, Faculty of Civil Engineering, Thákurova 7, 166 29 Prague, Czech Republic*

[a)] Corresponding author: l.guz@pollub.pl

Abstract. In this article, an analysis of the numerical results obtained during the design of ground heat exchangers (GHE) installation for a heat pump system, as well as the results of flow measurements in the installed system are presented. The GHE system consists of 24 vertical 100-meter U-tube probes made of PE-Xa material with a diameter of 40×3.7 mm. The system is connected in Tichelmann configuration. The correctly performed installation allows obtaining real operating parameters in accordance with the design assumptions. The Tichelmann connections of ground exchanger enable uniform glycol flows without the need for hydraulic balancing of the installation. The non-uniformity of the flow between the GHE loops is on average 18.8% in relation to the mean flow velocity of the glycol. The lack of throttling for control purposes translates into significantly lower hydraulic resistance of the ground heat exchanger installation, which in turn may translate into lower operating costs in the case of circulation pumps. Irrespective of the size of the stream pumped through the distribution lines, the flow of glycol through individual loops was also uniform.

010

The Model of Bound Water Diffusion in Wood

Richard Hrčka

Department of Wood Science, Faculty of Wood Sciences and Technology, Technical University in Zvolen, T. G. Masaryka 24, 960 01 Zvolen, Slovak Republic

[a)] Corresponding author: hrcka@tuzvo.sk

Abstract. The measurement of average concentration in time is used as one of the boundary conditions in inverse determination of diffusion coefficient. The diffusion coefficient is linear function of the product of speed of isostere and spatial coordinate. The nonlinear diffusion equation is transformed into its linear form in cylindrical coordinates. The speed of isostere is only one unknown in inverse problem, because the speed of average concentration isostere is twice slower than the speed of movement of the isostere at point of the second surface when the thickness is doubled.

011

Prediction of the High Temperature Crack Propagation in the AISI 304L Steel Using the Cohesive Approach

Vladislav Kozák[1,a)] and Jiří Vala[1]

[1]*Brno University of Technology, Faculty of Civil Engineering, Institute of Mathematics and Descriptive Geometry, 602 00 Brno, Veveří 331/95, Czech Republic*

[a)] Corresponding author: kozak.v@fce.vutbr.cz

Abstract. As a result of operational stress, metal materials degrade. At elevated and high temperatures, which are the operating conditions of a number of power plants, a significant process under static stress conditions is slow timedependent plastic deformation – creep, often associated with intergranular breakage. These processes lead to a limit state determining the creep life of the component and eventually to intergranular creep fracture, usually associated with very low creep strain values. Due to these very low values of strain to fracture, the process of creep deformation is very dangerous. Problem turns both to knowledge of the microscopic processes in front of the crack front and in the whole body, since these failure processes can be governed by different laws than the failure processes at large distances from the crack front. The behaviour of a dimensional crack during creep is the subject not only of experimental observation, but also of crack propagation modelling using the cohesive approach implemented in the finite element method (FEM). From experimental observations follows that macroscopic crack propagation is critically dependent on two competing processes: a) relaxation of the stress concentration at the crack front by creep deformation, leading to crack blunting b) acceleration of the cavitation process (creep intergranular failure) in front of the crack front. In the presented article, both experimental and numerical procedures are used to estimate the behaviour of these bodies with a priori crack of this austenitic steel, whose designation according Czech standard is also 18CrNi.

012

Study of Energy Accumulation Process at Phase Conversion of Paraffin Waxes

Tereza Lapcikova, Oldrich Zmeskal[a)], Premysl Mencik, and Radek Prikryl

Faculty of Chemistry, Brno University of Technology, 612 00 Brno, Czech Republic

[a)] Corresponding author: zmeskal@fch.vutbr.cz

Abstract. Phase change heat storage materials (PCM) are a class of materials with the ability to store or release a large amount of thermal energy at constant temperatures in the form of so-called latent heat, which is the heat that is necessary to supply or remove from the system to make it change the phase. Due to their energy efficiency, these materials are becoming more and more popular and offer a whole range of practical applications. It is worth mentioning, for example, their use for solar energy storage, waste heat recovery or thermal energy management in buildings. In the experimental part of this work, we focus on the study of phase transformations and energy accumulation and on the characterization of the thermal properties of new industrial PCMs from the Rubitherm® RT series. These paraffine wax based materials were developed by the German company Rubitherm Technologies GmbH. Relative thermal conductivity of these materials enables their application even in cases requiring rapid temperature changes and efficient heat transfer, such as systems for cooling electronics or thermal management of batteries. Experiments were performed with three commercially available

materials Rubitherm® RT18HC, Rubitherm® RT28HC and Rubitherm® RT35HC. These materials are chemically inert, do not subcool during phase transformations and have a long service life. Materials from the Rubitherm® RT series are available in a full range of different melting temperatures, from −9 °C to 100 °C. For this experiment, materials with melting temperatures of 18 °C, 28 °C and 35 °C were chosen, as their names suggest.

013

Thermal variations of elastic properties of solids using EoS, based on finite strain

Rupanwita Das Mahapatra[1], Bimal Kumar Sarkar[2a)], and Oldrich Zmeskal[3]

[1]*Department of Electronics and Communication Engineering, Adamas University, Kolkata, India*
[2]*Department of Physics, Adamas University, Kolkata 700126, India*
[3]*Institute of Physical and Applied Chemistry, Faculty of Chemistry, Brno University of Technology, Brno, Czech Republic*

[a)] Corresponding author: bks@physics.org.in

Abstract. Knowledge of the thermal variation of elastic properties of solids is essential for proper design and selection of solids in case of their thermal properties study. An Equation of States (EoS) based investigations have been done to characterize the thermal variations of elastic properties for solids. To make a good understanding for the equation of state for solid, the analysis of temperature dependence behaviour of elasticity is reported in this work. We have investigated the thermal variation of volume for NaCl, KCl, MgO and CaO based on Anderson model. We have evaluated the values of elastic constants C11, C44 and KT at different temperatures on the basis of Murnaghan and Tallon models. The Tallon's model with second approximation presents slightly better agreement with experimental results. It is shown that the Anderson-Gruneisen parameter may be pondered as directly proportional to the volume ratio. The Debye temperature (θD) for NaCl and KCl are close to room temperature (304 and 230 K) whereas those for CaO and MgO are much higher (945 and 670 K). We have taken a temperature range from room temperature to 950 K for NaCl, KCl and upto 2800 K for CaO and MgO. This theoretical method can be used to successfully predict the values of elastic constants for solids.

014

Evaluation of the Suitability of Using Fly Ash from Coal Combustion Containing Heavy Metals in Cement-based Composites

Alexandra Merglová[1, a)], Martina Záleská[1], Milena Pavlíková[1], Grzegorz Łagod[2] and Zbyšek Pavlík[1]

[1]*Department of Materials Engineering and Chemistry, Faculty of Civil Engineering, Czech Technical University in Prague, Thákurova 7, 166 29 Prague, Czech Republic*

[a)] Corresponding author: alexandra.merglova@fsv.cvut.cz

Abstract. The selected fly ash, by product of coal combustion in thermal power plant, was tested to analyse its potential for use as supplementary cementitious material in cement-based composites, especially for the possibility of improving properties such as resistance and durability of the material. The chemical and physical properties of coal fly ash were characterised together with the determination of pozzolanic activity which was carried out by Frattini and Chapelle tests. The investigated material can be used as a pozzolanic active mineral admixture in the form of cement blends with the potential to improve the properties of cement-based composites.

015

Evaluation of the effect of MWCNT Nano-Enhancement on Natural Hydraulic Lime Mortars

Adam Pivák[a)], Milena Pavlíková, Zbyšek Pavlík

Department of Materials Engineering and Chemistry, Faculty of Civil Engineering, Czech Technical University in Prague, Thákurova 7, 166 29 Prague, Czech Republic

[a)] Corresponding author: adam.pivak@fsv.cvut.cz

Abstract. Carbon-based nanomaterials have attracted the interest of researchers in recent years due to their characteristic properties, which enable their use in a wide variety of industrial and medical applications. In materials science, the most

studied nanomaterials are in the form of graphene and carbon nanotubes which are incorporated into coatings, polymers or cement composites. However, the preparation of these nanocomposites is technically challenging. The nanoscale additives are prone to clustering due to van der Waals forces, which prevents homogeneous distribution of nanomaterials in the composite and degrades an interaction with the binder. For this reason, the proper preparation and application technique of nanomaterials is an important factor for their correct application. The aim of this study is to find the most suitable technological procedure for the incorporation of multi walled carbon nanotubes into hydraulic lime mortar. The chemical agents were used to promote the stability of the nanoadditive/water dispersion. The effectiveness of the chemical agents supporting the stability of dispersion prior to mortar mixing was evaluated by UV light absorption. After selecting the optimum composition of mortars, the effect of the applied nanotubes at different doses was evaluated based on the results of the structural, mechanical and thermal properties testing. For an appropriate dispersion of the nanotubes, it was necessary to disperse them in a surfactant solution in combination with a defoamer to prevent excessive air bubble formation during mixing. The prepared mortars with the embedded nanoadditive achieved a more compact structure with lower porosity and higher compressive strength, which was the highest for the dosage of carbon nanotubes of 0.3 wt. % of binder, i.e. hydraulic lime. The higher dosage of nanoadditive resulted in a drop in mechanical resistance, which was still higher than that of control mortar.

016

The Effect of Ventilation in Residential Buildings on The Indoor Environment

Jan Plachý[1, a)], Pavlína Charvátová [1], Tomáš Navara [1]

Institute of Technology and Business in České Budějovice, Okružní 517/10, 370 01 České Budějovice, Czech Republic

a) Corresponding author: plachy@mail.vstecb.cz

Abstract. The paper deals with the issue of mold growth in an apartment building. It is a panel house. The ETICS contact insulation system was installed on the house and the windows were replaced. In order to find out the cause of the mold, the apartment was diagnosed. The apartment was diagnosed using thermography. Thermal bridges were detected using an infrared camera. These thermal bridges did not lead to mold growth. The cause of the mold was not the insulation of the building, but the poor use of the apartment by the tenants. The apartment was insufficiently ventilated.

017

The Effect of Recycled Aggregate on Properties of Cement-based Composites

Jaroslav Pokorný[1, a)], Jiří Šál[1] and Manuel Alejandro Pedreño-Rojas[2]

[1]*Department of Civil Engineering, Faculty of Technology, Institute of Technology and Business, Okružní 517/10, 370 01 České Budějovice, Czech Republic*
[2]*Grupo de Tecnología Edificatoria y Medio Ambiente, Universidad Politécnica de Madrid. Av. Juan de Herrera 6, 28040 Madrid, Spain*

[a)] Corresponding author: jaroslav.pokorny@mail.vstecb.cz

Abstract. In current time, there is a need for an affordable housing which must respect, on the one hand, requirements of overcrowded urban areas and, on the other hand, demands for modern buildings with low energy consumption. The number of old buildings must therefore give way to modern ones. Demolition waste emerging during pulling down of substandard buildings may after further processing constitute a potential source of filling materials which can preserve our resources of virgin aggregates. In the paper, the recycled aggregate obtained as a sub-fraction of processed demolition waste served as the substitution material instead of the natural aggregate for cement-based composites. Natural filler in the fraction 0/2 mm was replaced by the recycled one in the volumetric amount of 0-100 %, and on 28 days water cured samples physical, strength and thermal-transport related properties were assessed. Performed experiments showed a high potential of fine recycled filler which can effectively reduce the weight of produced composites but, on the other hand, partially mitigate their strength properties. Higher rate of open porosity caused by replacing material helped importantly improve thermal performance of hardened composites up to 30 %, versus plain dense mortar. There was made new type of cement-base mortars which for repairing of masonry structures can be intended.

018

Optimized TSMG of EuBCO/Ag Bulks Using Multiseeding and Buffer Pellets

Jan Sklenka[1], Filip Antončík[1, 2], Anna-Marie Lauermannová[1], Tomáš Hlásek[2], Ondřej Jankovský[1], David Sedmidubský[1], Adéla Jiříčková[1] and Michal Lojka[1, a)]

[1] *Department of Inorganic Chemistry, Faculty of Chemical Technology, University of Chemistry and Technology, Technická 5, 166 28 Praha 6, Czech Republic*

[2] *CAN SUPERCONDUCTORS s.r.o., Ringhofferova 66, 251 68, Kamenice, Czech Republic*

a) Corresponding author: Michal.Lojka@vscht.cz

Abstract. REBCO bulk superconductors fabricated in large diameters or complicated geometries are desirable for a variety of engineering applications. Initiating crystal growth from multiple seed arrangements reduces the time of the melt-growth process of individual samples and can reduce the problems with microstructure further away from the seed. However, grain boundaries between regions introduced by multi-seeding can significantly reduce the flow of current due to crystallographic misalignment and the agglomeration of impurity phases. Unfortunately, REBCO single grains have intrinsically very low growth rates, which limits the sample size that can be achieved through the top-seeded melt growth process. A melting process based on the use of two or more seeds (so-called multiseeding) to control the nucleation and subsequent growth of bulk REBCO superconductors has been developed to fabricate larger samples

019

Improved Medium-Scale Comparative Measurement of Thermal Energy Stored in Liquids

Kryštof Skrbek[a)], Vilém Bartůněk and David Sedmidubský

Department of Inorganic Chemistry, Faculty of Chemical Technology, University of Chemistry and Technology, Technická 5, 166 28 Praha 6, Czech Republic

[a)] Corresponding author: skrbekk@vscht.cz

Abstract. The need for improved energy storage systems and electricity-saving devices is growing as a result of the current energy environment. High-temperature media, which are frequently doped with nanoparticles to create nanofluids, are being used as a promising option for energy storage. The specific heat capacity of these systems is their most important characteristic, and it is frequently enhanced by the addition of nanoparticles. This article introduces a straightforward method of comparison appropriate for larger sample volumes, particularly for the relative comparison of the amount of thermal energy stored. The merits and weaknesses of the procedure are outlined and examined, as well as the evolution of the experimental setup.

020

Investigation of Thermophysical parameters of Historical Fir Wood using Hot Disk Method under room ambience

Rupali Tiwari[1,2, a)], Richard Hrčka[1, b)], Vlastimil Boháč[2, c)], Roman Réh[1, d)], Valentina Lo Giudice[4, e)], Luigi Todaro[4, f)] Lubos Kristak[1, g)]

[1] *Faculty of Wood Sciences and Technology, Technical University in Zvolen, T. G. Masaryka 24, 96001 Zvolen, Slovakia*

[2] *Institute of Physics, Slovak Academy of Science, Dúbravká cesta 9, 84511, Bratislava, Slovakia*

[3]*School of Agricultural, Forestry, Food and Environmental Sciences, University of Basilicata, Viale dell'Ateneo Lucano 10, 85100 Potenza, Italy.*

[a)] Corresponding author: tiwari@tuzvo.sk

Abstract. The study aims were to investigate the Thermophysical properties of fir wood (*Abies alba* Mill.) using the Hot Disk transient method under standard room conditions. The experiment was conducted on fir wood samples from a tree dating back to 1555 years ago examining three distinctive sample orientations: radial, tangential, and longitudinal. The motivation for working with such an ancient wood sample in addition to using a popular transient measurement device

was to study the heat transfer behavior with respect to different cut orientations and the relationship between heat penetration depth and thermal diffusivity (κ), thermal conductivity (λ) and volumetric heat capacity (c_ρ). The height of the thermal response curve in the tangential and radial direction showed significantly enhanced thermal response heights compared to the longitudinal direction of measurements. The Thermophysical properties were measured at room temperatures at relative air humidity of 65%. The samples volume density of 414.5 kg m^{-3} and 12% moisture content. The thermal conductivity values measured by the Hot Disk device were in range from 0.115 W $(m\ K)^{-1}$ up to 0.175 W $(m\ K)^{-1}$. The results obtained from the Hot Disk method were also compared to the previously published quasi-stationary method by R. Hrcka, et al., (2017). The validation of the thermal response curves was confirmed by comparing the shape of the thermal responses. The study significantly contributes to the knowledge of the thermal conductivity of fir wood when measured at different cut orientations, providing invaluable insights into the complex Thermophysical characteristics of such wood material.

021

Influence of Heavy Metals on the Properties of Coal Fly Ash-Portland Cement Composites

Martina Záleská[1], Adam Pivák[1], Milena Pavlíková[1], Jana Nábělková[2] and Zbyšek Pavlík[1, a)]

[1]*Department of Materials Engineering and Chemistry, Faculty of Civil Engineering, Czech Technical University in Prague, Thákurova 7, 166 29 Prague, Czech Republic*

[2]*Department of Sanitary and Ecological Engineering, Faculty of Civil Engineering, Czech Technical University in Prague, Thákurova 7, 166 29 Prague, Czech Republic*

[a)] Corresponding author: pavlikz@fsv.cvut.cz

Abstract. The increasing amount of toxic waste associated with growing urbanization is observed worldwide. The wastes generated in large quantities also include coal fly ash, municipal solid waste incineration ash, boiler slag, and bottom ash. In addition, these waste materials often contain heavy metals (HMs) like Pb, Zn, Cu, Cd, Cr, As, Ba and Mn, which are persistent, highly toxic and readily accumulate in various organisms. Waste containing HMs, if mishandled, can pose a serious threat to the environment, contaminating air, water and soil. A large part of the world's electricity production uses coal combustion, which takes place in classic coal-fired or thermal power stations. For the resulting coal fly ash (CFA), which is largely deposited in landfills, appropriate techniques should be found to both immobilize the present HMs and exploit its appropriate physico-chemical properties. This article is concerned with the study of the immobilization of As, Ba and Cu present in CFA. Composite building materials were produced from Portland cement (PC) to which CFA was added in amounts of 10% and 20% by weight of PC. The basic physical and mechanical parameters of the hardened samples were determined. The immobilization of As, Ba and Cu was investigated on the leachates from the prepared composites using atomic absorption spectroscopy (AAS). The experiments revealed that the concentrations of the investigated HMs in the leachates were very low, in the case of As even below the detection limit. The addition of CFA had a negative effect on the compressive strength, but it remains high enough for the use of designed composites in the construction industry.

022

A thermal imaging analysis of temperature distribution on the human skin during strength training exercises

Jarosław Zubrzycki[1, a)], Michał Staniszewski[2], Zbyšek Pavlík[3], Magdalena Matysiak[1], Grzegorz Łagód[2]

[1]*Lublin University of Technology, Mechanical Engineering Faculty; Nadbystrzycka 36, 20-618 Lublin, Poland*

[2] *Lublin University of Technology, Environmental Engineering Faculty, Nadbystrzycka 40B, 20-618 Lublin, Poland*

[3] *Department of Materials Engineering and Chemistry, Faculty of Civil Engineering, Czech Technical University in Prague, Thákurova 7, 166 29 Prague, Czech Republic*

[a)] Corresponding author: j.zubrzycki@pollub.pl

Abstract. Thermal imaging cameras are used in many fields. The paper analyses the possibility of using thermal imaging in medicine. It has been proven that the infrared camera can be used in sports medicine. The aspects of the measurement apparatus and the features which should be paid attention to during the tests were also quoted in the paper.

030

Recent advances in magnesia-based composites with carbon-based nanomaterials

Ondřej Jankovský, Anna-Marie Lauermannová

Department of Inorganic Chemistry, Faculty of Chemical Technology, University of Chemistry and Technology, Technická 5, 166 28 Praha 6, Czech Republic

[a)] Corresponding suthor: Ondrej.Jankovsky@vscht.cz

Abstract. The presented lecture is focused on the latest research in the field of eco-friendly construction materials such as magnesium oxychloride cement (MOC) as well as magnesium phosphate cement (MPC). The main focus is mainly given to the application of various carbon-based nanodopants such as graphene, carbon nanotubes, or graphene oxide. It was proved, that even a very low amount of nanomaterials significantly improved the mechanical parameters of developed composites. In addition, water resistance was improved as well, which is a crucial parameter for future real-life applications of MOC and MPC composites with carbon-based nanoadditives.

031

Composites based on reactive magnesia with carbon-rich waste materials

Adéla Kubištová[1], Anna-Marie Lauermannová[1], Adéla Jiříčková[1], Zbyšek Pavlík[2] and Ondřej Jankovský[1]

[1]*Department of Inorganic Chemistry, Faculty of Chemical Technology, University of Chemistry and Technology, Technická 5, 166 28 Praha 6, Czech Republic*
[2]*Department of Materials Engineering and Chemistry, Faculty of Civil Engineering, Czech Technical University in Prague, Thákurova 7, 166 29 Prague, Czech Republic*

[a)] Corresponding suthor: Adela.Kubistova@vscht.cz

Abstract. This study investigates the physical and chemical properties of MOC-based composite materials after introducing carbon-rich waste materials, precisely carbon spheres and magnesia carbon. Adding MgO-C recyclate led to a significant decrease in porosity, resulting in improved resistance to moisture damage. The addition of carbon spheres had a negative effect on porosity as it increased for MOC-CS. Both MOC-MgO-C and MOC-CS composites exhibited notable increases in compressive and flexural strength, outperforming MOC-REF by 4.3% and 55.3% for MOC-MgO-C, and by 5.5% and 4.3% for MOC-CS. Importantly, this study confirms that the incorporation of these carbon-rich waste materials does not significantly compromise the mechanical properties of MOC composites, demonstrating their safe and sustainable use as secondary fillers. This research contributes to the development of environmentally friendly construction materials with improved performance, aligning with the growing emphasis on sustainability and innovation in the construction industry.

032

Evaluation of thermophysical properties for energy storage materials

Daniel Lager

AIT Austrian Institute of Technology GMBH, Vienna, Austria

Corresponding author: Daniel.Lager@ait.ac.at

Abstract. Thermal Energy Storage (TES) and Electrical Energy Storage (EES) are two important technologies for energy conservation and utilizing fluctuating renewable energy sources and waste heat. While Sensible Thermal Energy Storage (STES) systems make use of the enthalpy change due to differences of heat capacity and temperature, Latent Thermal Energy Storage (LTES) systems utilize phase change enthalpies of different phase transitions and Thermochemical Energy Storage (TCES) systems use the heat of chemical reactions or sorption of the storage material. EES system designs need detailed information about the actual thermal properties of the used battery cells to understand thermal runaway situations especially in mobility applications. In this presentation the state-of-the art in measurement methodologies for thermophysical properties of energy storage materials are shown. Focusing on specific heat capacity cp(T), phase transition enthalpy Ht, reaction enthalpy Hr, thermal diffusivity a(T), thermal conductivity λ(T) and characteristic temperatures T, different already standardized but also new measurement methodologies were conducted, compared, and evaluated.

033

Composites based on MOC with tailored material properties for green construction

Anna-Marie Lauermannová

Department of Inorganic Chemistry, Faculty of Chemical Technology, University of Chemistry and Technology, Technická 5, 166 28 Praha 6, Czech Republic

Corresponding author: lauermaa@vscht.cz

Abstrakt: The research and development of eco-friendly composites for green construction focuses mostly on the search for an alternative to Portland cement- (PC-) based composites, which are generally harmful to the environment. One of the largest and most researched groups of these alternatives is composites based on reactive magnesia-based cement. In this contribution, composites based on magnesium oxychloride cement (MOC) with specific material properties precisely tuned via the addition of functional additives are studied. Among the used functional additives are layered nanomaterials (graphene, graphene oxide, molybdenum disulfide, alumina nanoplatelets), one-dimensional carbon nanomaterials (multi-walled carbon nanotubes, oxidized multi-walled carbon nanotubes), phase change materials, and tannic acid. To preserve, or even enhance the highly environment-friendly character of MOC, secondary fillers are introduced in the form of partial or full replacement of standardized fillers, such as quartz sand. The obtained composite systems are optimized in order to be highly tunable in terms of compressive and flexural strength, micro- and macrostructural properties, and, in the case of MOC most importantly, water resistance and hygric properties. The resulting construction materials can find application as a replacement for ordinary PC-based composites, but also in specified fields of application, where increased strength, durability, or thermal properties need to be ensured.

034

Thermodynamic properties of liquids from equations of state: A review of the latest development

Ivo Nezbeda

J. E. Purkinje University, Usti n. L., and Inst. Chem. Process Fund., Czech. Acad. Sci., Prague, Czechia

Corresponding author: IvoNez@icpf.cas.cz

Abstract: Knowledge of thermodynamic properties of liquids and, particularly, the determination of their phase behavior, is one of the most important tasks of chemical engineering in the process design. This knowledge comes typically from equations of state (EoS). The second half of the 20th century was the time of cubic equations (primarily for non-associating fluids), but from about late 1990's onward it has been the time of SAFT (Statistical-Association-Fluid-Theory) equations; according to Web-of-Science. more than 1,200 papers with 'SAFT" in their title have been published so far. Although the original idea upon which SAFT equations are based comes from statistical mechanical (molecular physics) considerations, the following development has slipped on a purely empirical route. Consequently, new and new equations are being developed with unjustified claims of their great accuracy. For instance, only for pure water, 54 different SAFT equations have been developed till today which definitely points to their questionable performance. Moreover, despite several reviews with a focus on particular properties or a limited range of thermodynamic conditions, no independent review assessing the performance of these equations has been published so far.

In this contribution we report on the performance of eight versions of the representative and most commonly used SAFT equations of state for water along with the Cubic-Plus-Association (CPA) equation. The equations are examined in detail both throughout the entire liquid phase region, including the vapor-liquid equilibrium (VLE), and at supercritical conditions. In addition to the temperature--pressure dependence of density, these response functions, namely, the isothermal compressibility, isobaric heat capacity, and coefficient of isobaric expansivity, have been evaluated and compared with experimental data along five isobars from P=0.1 MPa up to 1000 MPa, and along four isotherms from the melting point up to T=750 K.

It turns out that to draw a general conclusion on the quality/accuracy of these equations is practically impossible with different equations predicting reasonably well different properties and at different thermodynamic conditions but failing in other instances. Although all these equations make use of, among others, the VLE data for the parameter evaluation as a rule, it appears that their performance rapidly deteriorates when going away from the phase equilibrium region. It turns out that even the properties used in the equations' parametrizations (pressure and liquid density) are not always

reproduced with acceptable accuracy, with average errors being around two percent and errors of the individual data points exceeding in many cases even ten percent.
Properties not included in the parametrization are then predicted with much larger average errors, in general..

035

Structural Characterisation with the Hot Disk Thermal Constants Analyser

Andrey Sizov[a)] and Mattias Gustavsson

Hot Disk AB, Johanneberg Science Park, Sven Hultins gata 9A, 41258 Göteborg, Sweden

Corresponding author: [a)]andrey.sizov@hotdisk.se

Abstract: The Transient Plane Source (TPS) (Hot Disk) technique, which allows one to obtain thermal conductivity, is a commonly used tool for structural characterization and Quality Control (QC) in a non-destructive manner. This is possible because thermal conductivity is sensitive to the structural constitution of a material. The responsive electronics in the Hot Disk Thermal Constants analyser offers high sensitivity and reproducibility in estimations of thermal conductivity; hence the apparatus can track slight change in the material's microstructure. In addition, the TPS technique offers direct control of the thermal probing depth, i.e. it allows for precise control of the region of material being tested. The current presentation elucidates applications, where the Hot Disk method is successfully utilized, e.g. fatigue assessment, QC of manufactured devices, of medical tablets, of horse hooves, of human skin, etc. The recent development of the so-called Structural Probe technique allowed us to convert the temperature vs. time function to the unique thermal conductivity vs. probing depth. This technique is capable of assessment of structural variations and for detection of defects in isotropic and anisotropic materials. In addition, the potential of using the TPS method for tracking variation of the microstructure in alloys is discussed. For instance, in magnesium silicide-stannide thermoelectrics, the presence of a miscibility gap, complex phase behavior as well as temperature gradient during the spark plasma sintering process, create inhomogeneity and complicate characterization.