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The Effect of Long Term Thermal Exposure on Plastics and Elastomers Standard Test Method for Predicting Long-term Thermal Resistance of Closed-cell Foam Insulation Long Term Thermal Energy Storage in Adsorbent Beds for Solar Heating Appliations Long-term Thermal Aging of Celion/V378A Composite Materials Thermal Energy Storage with Phase Change Materials Long Term Stability of High Temperature Materials Evaluation of Long-term Thermal Resistance of Gas-filled Foams Thermal, Mechanical, and Hybrid Chemical Energy Storage Systems Effects of Long-Term Thermal Exposure on Commercially Pure Titanium Grade 2 Elevated-Temperature Tensile Properties Long-Term Thermal Resistance of Polyisocyanurate Foam Insulation with Impermeable Facers Long Term Thermal Performance and Application of Glass Fiber Core Vacuum Insulation Panels Long-term Thermal Aging of Resistance Temperature Thermal Performance of an Integrated Thermal Protection System for Long-term Storage of Cryogenic Propellants in Space Some Factors Affecting the Long-Term Thermal Insulating Performance of Extruded Polystyrene Foams Long-term Thermal Aging of 2 Graphite-polyimide Composite Materials

Thermal Use of Shallow Groundwater THE SPECTRAL EMITTANCE AND LONG-TERM THERMAL STABILITY OF COATINGS FOR THERMOPHOTOVOLTAIC (TPV) RADIATOR APPLICATIONS. Long-term Thermal Aging of Two Graphite/polyimide Composite Materials Modelling Long-term Thermal Comfort Conditions in Urban Environments Using a Deep Convolutional Encoder-decoder as a Computational Shortcut Insulation Materials, Testing and Applications, 2nd Volume Solar Thermal Energy Storage Effects of Long Term Thermal Exposure on Chemically Pure (Cp) Titanium Grade 2 Room Temperature Tensile Properties and Microstructure Effects of Long-term Thermal Aging on the Tensile and Creep Properties of Commercially Heat-treated Alloy 718 Insulation Materials, Testing, and Applications University of Minnesota Aquifer Thermal Energy Storage (ATES) Project Report on the First Long-term Cycle Effect of the Annealing Temperature on the Long-term Thermal Stability of Pt/Si/Ta/Ti/4H–SiC Contacts*Project Supported by the Special Prophase Project on the National Basic Research Program of China (Grant No. 2012CB326402), the National Natural Science Found of China (Grant No. 61404085), the Innovation Program of Shanghai Municipal Education Commission, China (Grant No. 13ZZ108), and the Shanghai Science and Technology Commission, China (Grant No. 13520502700). University of Minnesota Aquifer Thermal Energy Storage (ATES) Project Report on the First Long-term Cycle Long-term Thermal

Performance of Polyurethane-insulated District Heating Pipes Long-term Thermal Degradation and Alloying Constituent Effects on Five Boron/aluminum Composites Processing and Long-term Thermal Stabilization of Polyolefins Long-term Thermal Performance of Polyurethane Foam Study of Solid Particle Materials as High Temperature Thermal Energy Storage and Heat Transfer Fluid for Concentrating Solar Power Determination in Long-term Tests of the Thermal Conductivity of Foamed Polyurethane Used as Thermal Insulation in Sandwich Panels Effects of long-term thermal exposure on commercially pure titanium grade 2 elevated-temperature tensile properties The Long-term Thermal Evolution of Central Fennoscandia, Revealed Bij Integrated Low Temperature Thermochronometry Thermal Comfort Assessment of Buildings Long Term Energy Storage in Solar Systems Measuring the Impact of Experimental Parameters Upon the Estimated Thermal Conductivity of Closed-Cell Foam Insulation Subjected to an Accelerated Aging Protocol Recent Advancements in Materials and Systems for Thermal Energy Storage Long-Term Thermal Stability of Solithane, a Candidate TWT Encapsulant

Polyisocyanurate (polyiso) foam insulation with impermeable facers is known for its superior insulating properties in building envelope applications. The impermeable facer on both sides of polyiso foam insulation board is designed to increase and maintain the long-term thermal

resistance (LTTR) of the insulation. Currently, the Institute for Research in Construction (IRC)/National Research Council (NRC) of Canada, in association with the Canadian Polyisocyanurate Council, has embarked on a research project to develop a standard test methodology that would help to quantify the design LTTR value of polyiso foam insulation boards with impermeable facers. This paper outlines the research project and presents preliminary test results from experimental work. These preliminary results are discussed with a view to developing a methodology that will be used as the basis for a National Standard in Canada for the determination of LTTR of polyiso foam insulation with impermeable facers. Energy Storage not only plays an important role in conservinq the energy but also improves the performance and reliability of a wide range of energy systems. Energy storagp. leads to saving of premium fuels and makes the system morA cost effective by reducing the wastage of energy. In most systems there is a mismatch between the energy supply and energy demand. The energy storage can even out this imbalance and thereby help in savings of capital costs. Enerqy storage is all the more important where the enerqy source is intermittent such as Solar Energy. The use of jntermittent energy sources is likely to grow. If more and more solar energy is to be used for domestic and industrial applications then energy storage is very crucial. If no storage is used in solar energy systems then the major part of the energy demand will be met by the

back-up or auxiliary energy and therefore the so called annual solar load fract]on will be very low. In case of solar energy, both short term and long term energy storage systems can be used whjch can adjust the phase difference between solar energy supply and energy demand and can match seasonal demands to the solar availability respectively. Thermal energy storage can lead to capital cost savings, fuel savjngs, and fuel substitution in many application areas. Developing an optimum thermal storaqe system is as important an area of research as developinq an alternative source of energy. The proceedings of this symposium from the 1999 TMS Annual Meeting & Exhibition examine the effects of long-term thermal exposure and long-term service conditions on the microstructure and properties of high-temperature structural materials. A significant number of paper address nickel-based superalloys, elevated-temperature stability of intermetallic alloys, refractory metal alloys, composites, and titanium alloys. Also included are discussions on determining the degree and mechanism of property degradation, correlating laboratory exposure with actual service life, and analyzing properties and methods of component/property refurbishment. Elevated-temperature tensile testing of commercially pure titanium (CP Ti) Grade 2 was conducted for as-received commercially produced sheet and following thermal exposure at 550 and 650 K (531 and 711 F) for times up to 5000 h. The tensile testing revealed some statistical differences between the 11 thermal treatments, but most

thermal treatments were statistically equivalent. Previous data from room temperature tensile testing was combined with the new data to allow regression and development of mathematical models relating tensile properties to temperature and thermal exposure. The results indicate that thermal exposure temperature has a very small effect, whereas the thermal exposure duration has no statistically significant effects on the tensile properties. These results indicate that CP Ti Grade 2 will be thermally stable and suitable for long-duration space missions. Ellis, David L. Glenn Research Center THERMAL STABILITY; TENSILE PROPERTIES; TITANIUM; MATHEMATICAL MODELS; ROOM TEMPERATURE The thermal use of the shallow subsurface is increasingly being promoted and implemented as one of many promising measures for saving energy. A series of questions arises concerning the design and management of underground and groundwater heat extraction systems, such as the sharing of the thermal resource and the assessment of its long-term potential. For the proper design of thermal systems it is necessary to assess their impact on underground and groundwater temperatures. Thermal Use of Shallow Groundwater introduces the theoretical fundamentals of heat transport in groundwater systems, and discusses the essential thermal properties. It presents a complete overview of analytical and numerical subsurface heat transport modeling, providing a series of mathematical tools and simulation models based on

analytical and numerical solutions of the heat transport equation. It is illustrated with case studies from Austria, Germany, and Switzerland of urban thermal energy use, and heat storage and cooling. This book gives a complete set of analytical solutions together with MATLAB® computer codes ready for immediate application or design. It offers a comprehensive overview of the state of the art of analytical and numerical subsurface heat transport modeling for students in civil or environmental engineering, engineering geology, and hydrogeology, and also serves as a reference for industry professionals. The thermal conductivity of many closed-cell foam insulation products changes over time as production gases diffuse out of the cell matrix and atmospheric gases diffuse into the cells. Thin slicing has been shown to be an effective means of accelerating this process in such a way as to produce meaningful results. Efforts to produce a more prescriptive version of the ASTM C1303, "Standard Test Method for Predicting Long-Term Thermal Resistance of Closed-Cell Foam Insulation," have led to a broad ruggedness test. This test includes the aging of full-size insulation specimens for time periods up to 5 years for later comparison to the predicted results. Experimental parameters under investigation include: slice thickness, slice origin (at the surface or from the core of the slab), thin-slice stack composition, product facings, original product thickness, product density, and product type. This paper will compare the results after two years of full-thickness aging. Proceedings

of the symposium held in Bal Harbour, Florida, December 1987. Rising energy prices have been encouraging work on the use of thermal insulation to conserve energy. Here, more than 50 papers discuss new materials, assessments and properties of foams, loose-fill behavior, system performance Papers presented at the syposium of the same name held in Gatlinburg, Tennessee, October 1991, address issues connected with reflectives, radiant barriers, radiation control coatings; economics and energy impact; long-term thermal performance of foams; assessments and properties of foams; convection The long-term thermal performance of insulation products is important to ensure their suitability in applications where product life can be fifty years or more. Actual measurements of foams aged under conditions of use are helpful but can only be gathered in real time. While necessary to assure the validity of model predictions, such measurements do not allow early determination of the future performance of new systems. With the need for all users of CFCs to find alternatives, the question of how to ensure long-term thermal performance takes on immediate significance. In this paper we describe some work done in our laboratory to assure the long-term thermal performance of STYROFOAM* brand insulation foam. The technical feasibility of high-temperature (>100°C) aquifer thermal energy storage (IOTAS) in a deep, confined aquifer was tested in a series of experimental cycles at the University of Minnesota's St. Paul field test facility (FTF). This report

describes the additions to the FTF for the long-term cycles and the details of the first long-term cycle (LT1) that was conducted from November 1984 through May 1985. Heat recovery; operational experience; and thermal, chemical, hydrologic, and geologic aspects of LT1 are reported. The permits for long-term cycles required the addition of a monitoring well 30.5 m from the storage well for monitoring near the edge of the thermally affected area and allowed the addition of a cation-exchange water softener to enable continuous operation during the injection phase. Approximately 62% of the 9.47 GWh of energy added to the 9.21 × 104 m3 of ground water stored in the aquifer LT1 was recovered. Ion-exchange water softening of the heated and stored ground water prevented scaling in the system heat exchangers and the storage well and changed the major-ion chemistry of the stored water. Temperatures at the storage horizons in site monitoring wells reached as high as 108°C during the injection phase of LT1. Following heat recovery, temperatures were This book presents the latest advances in thermal energy storage development at both the materials and systems level. It covers various fields of application, including domestic, industrial and transport, as well as diverse technologies, such as sensible, latent and thermochemical. The contributors introduce readers to the main performance indicators for thermal storage systems, and discuss thermal energy storage (TES) technologies that can be used to improve the efficiency of energy systems and

increase the share of renewable energy sources in numerous fields of application. In addition to the latest advances, the authors discuss the development and characterization of advanced materials and systems for sensible, latent and thermochemical TES, as well as the TES market and practical applications. They also report on and assess the feasibility of uniform characterization protocols and main performance indicators, compared to previous attempts to be found in the literature. The book will help to increase awareness of thermal energy storage technologies in both the academic and industrial sectors, while also providing experts new tools to achieve a uniform approach to thermal energy storage characterization methods. It will also be of interest to all students and researchers seeking an introduction to recent innovations in TES technologies. Alloy 718 is a structure material widely used in elevated-temperature applications. In particular, it was extensively used in the design of the upper internal system and control rod drive line of the proposed Clinch River Breeder Reactor. Its popularity is due to several excellent behavioral features, including high creep and creep-rupture strength, good oxidation resistance, and exceptional high-cycle fatigue strength. However, alloy 718 is extremely complex, and its microstructure can be significantly modified by thermal treatment. The stability of the alloy in long-term elevated-temperature service is therefore a substantial concern in any such application. This report

presents tensile and creep data obtained on three heats of alloy 718 after thermal aging for up to 27,000 h from 593 to 76°C. Implications of these results in terms of long-term stability of the alloy are discussed. 5 refs., 13 figs., 6 tabs. In support of traveling-wave tube amplifier tube encapsulant evaluations, a cured sample of Solithane 113 (a polyurethane potting compound supplied by Watkins-Johnson) was exposed to a vacuum-thermal (120 C) environment for 300+ hours to determine if channel degradation occurs on such exposure. Degradation was determined qualitatively by sampling into a quadrupole mass spectrometer the gases and vapors produced from the sample and analyzing the spectra of the gases. The resultant spectra indicated significant thermochemical degradation of the polymer under the conditions of the exposure. These results should be factored into deliberations on the choice of encapsulants for TWTA components. Degradation of this kind may markedly affect physical-chemical properties of the material over the long term and should be treated as a potential source of tube failure due to corona discharge. (Author). Glass fiber core Vacuum Insulation Panels (VIPs) have thermal performance per unit thickness of about 5-10 times higher than the traditionally used building insulation materials such as mineral wool, XPS, EPS, foam, etc. This advantage of VIP has made it very attractive new option for innovative building designs. Especially in Canada, where some of the areas have long and very cold winters. Confidence in the service life of a

building material is necessary before putting a product to market. Extensive research has been conducted on the product development, quality improvement, and field application of VIPs around the world. However, there is lack of consistent and simple prediction method for the long-term thermal performance of VIPs. This paper discussed the process and performance of a field project using glass fiber VIPs to retrofit a commercial building in Yukon, Canada. The thermal performance of the VIPs used in this project was continuously monitored and critically analyzed since the start in 2011. The results have shown satisfactory thermal performance of VIPs for the past 8 years. The findings were also used to validate glass fiber core VIP accelerated aging tests conducted by the National Research Council Canada (Ottawa), and the aging rate of VIPs in a cold and dry climate was determined. The second part of this study investigated the monitored performance results from two sets of simplified accelerated laboratory aging tests, the results were analyzed with the aim to separate the impact of air diffusion from water vapour on the long-term thermal performance of glass fiber VIPs. In addition, this study also investigated the potential application of VIPs in balcony constructions to reduce heat transfer through thermal bridges. Computer modeling exercises, using a benchmarked (EN ISO 10211) three-dimensional transient and steady-state heat transfer simulation tool HEAT3, were carried out on the most optimal (thermal performance) balcony

assemblies of wood framed buildings using VIP as insulation. This niche application of VIPs can significantly increase the energy efficiency of building envelopes/skins in extreme climates of Canada and elsewhere in the world. Thermal, Mechanical, and Hybrid Chemical Energy Storage Systems provides unique and comprehensive guidelines on all non-battery energy storage technologies, including their technical and design details, applications, and how to make decisions and purchase them for commercial use. The book covers all short and long-term electric grid storage technologies that utilize heat or mechanical potential energy to store electricity, including their cycles, application, advantages and disadvantages, such as round-trip-efficiency, duration, cost and siting. Also discussed are hybrid technologies that utilize hydrogen as a storage medium aside from battery technology. Readers will gain substantial knowledge on all major mechanical, thermal and hybrid energy storage technologies, their market, operational challenges, benefits, design and application criteria. Provide a state-of-the-art, ongoing R&D review Covers comprehensive energy storage hybridization tactics Features standalone chapters containing technology advances, design and applications Renewable energies have a major role in today's energy systems development, energy security and climate change fight. Thermal Concentrating Solar Power (CSP) has the potential to get up to 11.3% of world's electricity production with the adequate support. This type of renewable

energy has proved to be price competitive and to have the advantage of integrating Thermal Energy Storage (TES). This adds the generation flexibility that other renewable energies, like wind or photovoltaics, does not have integrated.In order to continue developing this technology, solid particle CSP has been proposed. This design uses granular solid materials as Heat Transfer Fluid (HTF) and TES material in solar towers in order to be able to achieve higher operation temperatures, than current commercial CSP. Higher temperature means more efficiency in heat-to-electricity conversion, due to the use of better power generation cycles.The main objective of this thesis is to enhance relevance and provide theoretical and experimental background for solid particles to be used as TES material and HTF for CSP tower power plants, from the materials perspective, by using existent or new methodologies.During this dissertation, current scientific output and relevance were studied in two separate contributions, one for CSP and the other for TES, both by using bibliometric methods. For the CSP study, additional analyses were carried out according to the harvesting technologies (parabolic trough, solar tower, Stirling dish and linear Fresnel). For the TES study, the additional analyses were performed according to the different ways to store thermal energy (sensible, latent and thermochemical). For both analyses, most productive countries, regions, authors, journals and research communities were identified. Moreover, funding impact and

cooperation between countries and authors were analyzed. For developing these bibliometric analyses, a specific methodology was implemented following Bibliometrics principles. For these purposes, two existing software programs were used for a part of the analysis, while for performing the rest of the analysis a special software was developed ad-hoc for this study.For providing background, two state-of-the-art analyses were performed in order to get current development status of solid particle CSP. The first one was oriented to the plant design itself. Several solar receivers were analyzed, as well as TES, Heat Exchanger (HEX) and conveyance systems. During the second state-of-the-art, a material driven study was carried out in order to understand the behavior expected by the particle media and to identify some of the materials proposed by the most relevant researchers in this field.Next step of this dissertation was focused on establishing the design criteria for solid particle CSP technology, from the materials science perspective. This was achieved by finding the most relevant objectives that a power plant of this kind must comply, as well as the influence of the particle media properties and parameters.Last part of this dissertation is related with two studies regarding the durability of some of the most promising solid particle materials from high temperature exposure effect perspective. The first study was focused on analyzing the effect of long term high temperature (900 °C) in the optical, mechanical, thermal and chemical properties and parameters of the solid

particle material. The second study was focused in the effect of long term thermal cycling, in which is considered that the materials should resist several thousand charge-discharge cycles remaining with acceptable operational conditions. For achieving an accelerated thermal cycling test with realistic thermal conditions, a novel device was developed to perform the thousands of thermal cycles required. Electronic, software and hardware design was developed and implemented. Current device has performed more than 20 thousand cycles for different kind of materials, analyzing the same properties and parameters as the first study. This book focuses on latent heat storage, which is one of the most efficient ways of storing thermal energy. Unlike the sensible heat storage method, the latent heat storage method provides much higher storage density with a smaller difference between storing and releasing temperatures. Thermal Energy Storage with Phase Change Materials is structured into four chapters that cover many aspects of thermal energy storage and their practical applications. Chapter 1 reviews selection, performance, and applications of phase change materials. Chapter 2 investigates mathematical analyses of phase change processes. Chapters 3 and 4 present passive and active applications for energy saving, peak load shifting, and price-based control heating using phase change materials. These chapters explore the hot topic of energy saving in an overarching way, and so they are relevant to all courses. This book is an ideal research reference for

students at the postgraduate level. It also serves as a useful reference for electrical, mechanical, and chemical engineers and students throughout their work. FEATURES Explains the technical principles of thermal energy storage, including materials and applications in different classifications Provides fundamental calculations of heat transfer with phase change Discusses the benefits and limitations of different types of phase change materials (PCM) in both micro- and macroencapsulations Reviews the mechanisms and applications of available thermal energy storage systems Introduces innovative solutions in hot and cold storage applications Abstract: The Pt/Si/Ta/Ti multilayer metal contacts on 4H–SiC are annealed in Ar atmosphere at 600 °C–1100 °C by a rapid thermal processor (RTP). The long-term thermal stability is evaluated by aging the annealed contact at 600 °C in air. The contact's properties are determined by current–voltage measurement, and the specific contact resistance is calculated based on the transmission line model (TLM). Transmission electron microscope (TEM) and energy-dispersive x-ray spectrometry (EDX) are used to characterize the interface morphology, thickness, and composition. The results reveal that a higher annealing temperature is favorable for the formation of an Ohmic contact with a lower specific contact resistance, and causes the rapid degradation of the Ohmic contact in the aging process. A number of metrics for assessing human thermal response to climatic conditions have been proposed in scientific

literature over the last decades. They aim at describing human thermal perception of the thermal environment to which an individual or a group of people is exposed. More recently, a new type of “discomfort index” has been proposed for describing, in a synthetic way, long-term phenomena. Starting from a systematic review of a number of long-term global discomfort indices, they are then contrasted and compared on a reference case study in order to identify their similarities and differences and strengths and weaknesses. Based on this analysis, a new short-term local discomfort index is proposed for the American Adaptive comfort model. Finally, a new and reliable long-term general discomfort index is presented. It is delivered in three versions and each of them is suitable to be respectively coupled with the Fanger, the European Adaptive and the American Adaptive comfort models. The Effect of Long Term Thermal Exposure on Plastics and Elastomers, Second Edition brings together a wide range of essential data on the effect of long-term thermal exposure on plastics and elastomers, enabling engineers to make optimal material choices and design decisions. This second edition has been thoroughly revised to include the latest data and materials. This highly valuable handbook will support engineers, product designers, R&D professionals, and scientists who are working on plastics products or parts for high temperature environments across a range of industries. This readily available data will make it easy for practitioners to learn about plastic

materials and their long- term thermal exposure without having to search the general literature or depend on suppliers. This book will also be of interest to researchers and advanced students in plastics engineering, polymer processing, coatings, and materials science and engineering. Provides essential data and practical guidance for engineers and scientists working with plastics in high temperature environments Includes introductory chapters on the effect of heat aging and testing methods, providing the underpinning knowledge required to utilize the data Covers a wide range of commercial polymer classes that are updated to include the latest developments in plastics materials Room temperature tensile testing of Chemically Pure (CP) Titanium Grade 2 was conducted for as-received commercially produced sheet and following thermal exposure at 550 and 650 K for times up to 5,000 h. No significant changes in microstructure or failure mechanism were observed. A statistical analysis of the data was performed. Small statistical differences were found, but all properties were well above minimum values for CP Ti Grade 2 as defined by ASTM standards and likely would fall within normal variation of the material. Ellis, David L. Glenn Research Center WBS 463069.04.03 Vacuum plasma spray coatings (Zr0[sub]2 + 18% Ti0[sub]2 + 10% Y[sub]20[sub]3, ZrC, Fe[sub]2Ti0[sub]5, ZrTi0[sub]4, Zr0[sub]2 + 8% Y[sub]0[sub]3 + 2% Hf0[sub]2, and Al[sub]20[sub]3 + Ti0[sub]2) have been developed to improve the emissivity of material surfaces under consideration for TPV

radiator applications. These coated surfaces have been shown to be thermally stable at temperatures up to 1200 degree C for as much as 8000 hours and have produced a desired increase in the surface emissivity of molybdenum and niobium radiators. The spectralemissivity of these surfaces is measured before and after long-term vacuum anneals to determine the power density that would be provided to a TPV cell. The thermal stability of the coatings is further evaluated by characterization after long-term vacuum annealing. A kinetic model of the volatility of oxide phases is used to describe the excellent thermal stability of the coatings that possess the highest post-annealemittance values (Zr0[sub]2 + 18% Ti0[sub]2 + 10% Y[sub]20[sub]3, ZrC, and Al[sub]20[sub]3 + Ti0[sub]2). Abstract: Different urban microscale models exist to model street-level mean radiation temperature (Tmrt). However, these models are computationally expensive, albeit to varying degrees. We present a computational shortcut using a convolutional encoder-decoder network (U-Net) to predict pedestrian level (1.1 m a.g.l.) Tmrt at a building-resolved scale (1 × 1 m). SOLWEIG is used to create spatial training data for 68 days at hourly resolution in the city of Freiburg, Germany. Validation of the model was carried out in two steps: First, SOLWEIG (and U-Net) were validated against Tmrt point measurements. Second, U-Net was validated against SOLWEIG on 6 areas and 12 days resulting in a MAE of 2.4 K. The U-Net is 22 times faster than SOLWEIG, and thus able to emulate a

micrometeorological physical model with computational superiority. As a demon- stration case, U-Net is applied to model Tmrt for the urbanized area of Freiburg for two complete 30-year periods (1961-1990, 1991-2020) driven by hourly ERA5-Land reanalysis data. Sum- mertime daily maximum Tmrt increased on average by 2.5 K, whereas summertime daily maximum air temperature increased by only 1.5 K. Maximum Tmrt increase is stronger on non- tree covered paved areas (2.8 K) than on tree covered grassy areas (1.8 K)

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