

# Download File Chapter 16 Wordwise Thermal Energy And Heat Free Download Pdf

**Thermal Energy** [Thermal Energy at the Nanoscale](#) [Ultra-High Temperature Thermal Energy Storage, Transfer and Conversion](#) [Advances in Thermal Energy Storage Systems](#) [Thermal Energy Systems](#) [Thermal Energy Systems](#) [Thermal Energy Storage](#) [Thermal Energy Storage](#) [Thermal Energy Storage](#) [Thermal Energy Storage Analyses and Designs](#) [Survey of High Temperature Thermal Energy Storage](#) [Recent Advancements in Materials and Systems for Thermal Energy Storage](#) [Intelligent Thermal Energy Systems](#) [Thermal Energy Storage Technologies for Sustainability](#) [Underground Thermal Energy Storage](#) [Thermal Energy Storage for Sustainable Energy Consumption](#) [Thermal, Mechanical, and Hybrid Chemical Energy Storage Systems](#) [Thermal Energy Harvesting for Application at MEMS Scale](#) [Extreme Physics Heat and Mass Transfer in Building Energy Performance Assessment](#) [Convection and Conduction Heat Transfer](#) [Heat and Mass Transfer in Energy Systems](#) [Thermal Energy Storage Using Phase Change Materials](#) [Proceedings](#) [What Is Heat Energy?](#) [Draft Environmental Assessment](#) [Community Energy Technology Projects in the Sector of Solar](#) [Thermal Energy](#) [Systems Integration of Containerized Molten Salt Thermal Energy Storage in Novel Cascade Layout](#) [Modelling, Simulation and Control of Thermal Energy Systems](#) [Thermal Energy Storage for Solar Energy Applications Based on Regular and Composite Nano-Phase Change Materials](#) [Thermal Energy Storage](#) [Solar and Geothermal Energy](#) [Thermal Energy Systems](#) [An Evaluation of Thermal Energy Networks](#) [Solar Thermal Energy Utilization](#) [Ocean thermal energy conversion \(OTEC\) test facilities study program ...](#) [Teaching Heat Transfer and Heat Exchange](#) [General Questions of Thermodynamics](#) [Standardized Performance Tests of Collectors of Solar Thermal Energy: A Steel Flat-plate Collector with Two Transparent Covers and a Proprietary Coating](#) [Thermal Effects of High Power Laser Energy on Materials](#)

The energy crisis in 1973 and 1979 initiated a great number of activities and programs for low and high temperature application of solar energy. Synthetic fuels and chemicals produced by solar energy is one of them, where temperatures in the range of 600-1000 °C or even higher are needed. In principle such high temperatures can be produced in solar towers. For electricity production, the feasibility and operation of solar tower plants has been examined during the SSPS - project (Small Solar Power System) in Almeria, Spain. The objective of Solar Thermal Energy Utilization is to extend the experience from the former SSPS - program in to the field of solar produced synthetic fuels. New materials and technologies have to be developed in order to research this goal. Metallic components now in use for solar receivers need to be improved with respect to transient operation or possibly replaced by ceramics. High temperature processes, like steam-methane reforming, coal conversion and hydrogen production need to be developed or at least adapted for the unconventional solar operation. Therefore Solar Thermal Energy Utilization is a long term program, which needs time for its development much more time than the intervals expected in between further energy crisis. The "Studies on Technology and Application on Solar Energy Utilization" is a necessary step in the right direction in order to prepare for the energy problems in the future. "This book covers an overview and applications of the thermal storage systems used in batteries for the electric automotive industry such as in electric vehicles, thermal storage system in smart grid systems, thermal harvesting for battery-less use for wireless sensor networks, thermo-electric generators and biomedical sensing. The thermal storage system can be used to harvest energy for implementation of battery-less, zero-maintenance and place-and-forget electronic systems. This book has been prepared for the needs of those who seek an application on developing the thermal system. The choice of material is guided by the basic objective of making an engineer or student capable of dealing with thermal system design. The book can be used as reference book for undergraduate and postgraduate students in the area of thermal system overview, design and applications. Lithium iron phosphate (LiFePO<sub>4</sub>) batteries have gained significant traction in the electric automotive industry in the recent years mainly due to their high safety performance, flat voltage profile and low cost. Although LiFePO<sub>4</sub> batteries have excellent thermal stability, they still suffer from thermal runaway like other lithium-ion type cells. Thermal volatility is a major drawback in the lithium-ion and sufficient knowledge of the thermal distribution and heat generation of the LiFePO<sub>4</sub> battery is necessary to avoid catastrophic thermal failure. The first chapter details the thermal analysis of a LiFePO<sub>4</sub> battery cell with a latent heat thermal cooling wrap. The model has been developed as a tool to study the cooling effects of the wrap on the battery cell during discharging. The proposed latent heat storage based battery cooling wrap is used to passively manage the heat produced by the cell and absorbing and maintaining the battery temperature within operational temperatures and below thermal runaway temperature. Thermal energy storage (TES) is another important concept of the smart grid systems. For non-renewable, the benefit of TES systems is the improvement of the generation performance by supporting the energy demand during peak hours. Also, TES is often able to improve the system efficiency in a way that is more energy and cost effective. The best-known method for thermal energy storage is by utilizing the latent heat of fusion of energy storage material known as phase change materials (PCM). TES systems are classified into two main categories such as sensible and latent heat storage. An overview of the research on performance improvement are also delineated. Hence, the thermal energy harvesting has indeed gained attention in the last decade due to its promising possibilities in area such as wireless sensor networks (WSN) for wide range of IoT (Internet of Things) applications. Thermal energy scavenging from waste heat can enable implementation of battery-less, zero-maintenance and place-and-forget electronic systems. Scavenging energy from the temperature difference between human body heat and ambient is an attractive solution for powering wearables for continuous health monitoring, biomedical sensing and body area sensor networks (BASN). The low energy efficiency and low voltage output of the thermo-electric generators (TEG) pose challenges to the deployment of industry ready powering systems"-- Thermal Energy Storage Technologies for Sustainability is a broad-based overview describing the state-of-the-art in latent, sensible, and thermo-chemical energy storage systems and their applications across industries. Beginning with a discussion of the efficiency and conservation advantages of balancing energy demand with production, the book goes on to describe current state-of-the-art technologies. Not stopping with description, the authors also discuss design, modeling, and simulation of representative systems, and end with several case studies of systems in use. Describes how thermal energy storage helps bridge the gap between energy demand and supply, particularly for intermittent power sources like solar, wind, and tidal systems Provides tables, illustrations, and comparative case studies that show applications of TES systems across industries Includes a chapter on the rapidly developing field of viable nanotechnology-based thermal energy storage systems Thermodynamics is the branch of physics that deals with the relationships between heat and other forms of energy. In particular, it describes how thermal energy is converted to and from other forms of energy and how it affects matter. Emphasising computational modeling, this introduction to the physics on matter at extreme conditions is invaluable for researchers and graduate students. Thermal Energy Systems: Design and Analysis, Second Edition presents basic concepts for simulation and optimization, and introduces simulation and optimization techniques for system modeling. This text addresses engineering economy, optimization, hydraulic systems, energy systems, and system simulation. Computer modeling is presented, and a companion website provides specific coverage of EES and Excel in thermal-fluid design. Assuming prior coursework in basic thermodynamics and fluid mechanics, this fully updated and improved text will guide students in Mechanical and Chemical Engineering as they apply their knowledge to systems analysis and design, and to capstone design project work. These lecture notes provide a detailed treatment of the thermal energy storage and transport by conduction in natural and fabricated structures. Thermal energy in two carriers, i.e. phonons and electrons — are explored from first principles. For solid-state transport, a common Landauer framework is used for heat flow. Issues including the quantum of thermal conductance, ballistic interface resistance, and carrier scattering are elucidated. Bulk material properties, such as thermal and electrical conductivity, are derived from particle transport theories, and the effects of spatial confinement on these properties are established. This book presents a comprehensive introduction to the use of solid-liquid phase change materials to store significant amounts of energy in the latent heat of fusion. The proper selection of materials for different applications is covered in detail, as is the use of high conductivity additives to enhance thermal diffusivity. Dr. Fleischer explores how applications of PCMS have expanded over the past 10 years to include the development of high efficiency building materials to reduce heating and cooling needs, smart material design for clothing, portable electronic systems thermal management, solar thermal power plant design and many others. Additional future research directions and challenges are also discussed. Faced with an ever-growing resource scarcity and environmental regulations, the last 30 years have witnessed the rapid development of various renewable power sources, such as wind, tidal, and solar power generation. The variable and uncertain nature of these resources is well-known, while the utilization of power electronic converters presents new challenges for the stability of the power grid. Consequently, various control and operational strategies have been proposed and implemented by the industry and research community, with a growing requirement for flexibility and load regulation placed on conventional thermal power generation. Against this background, the modelling and control of conventional thermal engines, such as those based on diesel and gasoline, are experiencing serious obstacles when facing increasing environmental concerns. Efficient control that can fulfill the requirements of high efficiency, low pollution, and long durability is an emerging requirement. The modelling, simulation, and control of thermal energy systems are key to providing innovative and effective solutions. Through applying detailed dynamic modelling, a thorough understanding of the thermal conversion mechanism(s) can be achieved, based on which advanced control strategies can be designed to improve the performance of the thermal energy system, both in economic and environmental terms. Simulation studies and test beds are also of great significance for these research activities prior to proceeding to field tests. This Special Issue will contribute a practical and comprehensive forum for exchanging novel research ideas or empirical practices that bridge the modelling, simulation, and control of thermal energy systems. Papers that analyze particular aspects of thermal energy systems, involving, for example, conventional power plants, innovative thermal power generation, various thermal engines, thermal energy storage, and fundamental heat transfer management, on the basis of one or more of the following topics, are invited in this Special Issue: • Power plant modelling, simulation, and control; • Thermal engines; • Thermal energy control in building energy systems; • Combined heat and power (CHP) generation; • Thermal energy storage systems; • Improving thermal comfort technologies; • Optimization of complex thermal systems; • Modelling and control of thermal networks; • Thermal management of fuel cell systems; • Thermal control of solar utilization; • Heat pump control; • Heat exchanger control. Thermal Energy Systems: Design and Analysis, Second Edition presents basic concepts for simulation and optimization, and introduces simulation and optimization techniques for system modeling. This text addresses engineering economy, optimization, hydraulic systems, energy systems, and system simulation. Computer modeling is presented, and a companion website provides specific coverage of EES and Excel in thermal-fluid design. Assuming prior coursework in basic thermodynamics and fluid mechanics, this fully updated and improved text will guide students in Mechanical and Chemical Engineering as they apply their knowledge to systems analysis and design, and to capstone design project work. 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 Underground thermal energy storage (UTES) provide us with a flexible tool to combat global warming through conserving energy while utilizing natural renewable energy resources. Primarily, they act as a buffer to balance fluctuations in supply and demand of low temperature thermal energy. Underground Thermal Energy Storage provides an comprehensive introduction to the extensively-used energy storage method. Underground Thermal Energy Storage gives a general overview of UTES from basic concepts and classifications to operation regimes. As well as discussing general procedures for design and construction, thermo-hydro geological modeling of UTES systems is explained. Finally, current real life data and statistics are included to summarize major global developments in UTES over the past decades. The concise style and thorough coverage makes Underground Thermal Energy Storage a solid introduction for students, engineers and geologists alike. The building industry is influenced by many factors and trends reflecting the current situation and developments in social, economic, technical, and scientific fields. One of the most important trends seeks to minimize the energy demand. This can be achieved by promoting the construction of buildings with better thermal insulating capabilities of their envelopes and better efficiency in heating, ventilation, and air conditioning systems. Any credible assessment of building energy performance includes the identification and simulation of heat and mass transfer phenomena in both the building envelope and the interior of the building. As the interaction between design elements, climate change, user behavior, heating effectiveness, ventilation, air conditioning systems, and lighting is not straightforward, the assessment procedure can present a complex and challenging task. The simulations should then involve all factors affecting the energy performance of the building in questions. However, the appropriate choice of physical model of heat and mass transfer for different building elements is not the only factor affecting the output of building energy simulations. The accuracy of the material parameters applied in the models as input data is another potential source of uncertainty. For instance, neglecting the dependence of hygric and thermal parameters on moisture content may affect the energy assessment in a significant way. Boundary conditions in the form of weather data sets represent yet another crucial factor determining the uncertainty of the outputs. In light of recent trends in climate change, this topic is vitally important. This Special Issue aims at providing recent developments in laboratory analyses, computational modeling, and in situ measurements related to the assessment of building energy performance based on the proper identification of heat and mass transfer processes in building structures. Potential topics include but are not limited to the following: -Development, calibration, and validation of advanced mathematical models for the description of heat and mass transfer in building materials and structures -Computational modeling of heat and mass transfer in building materials and structures aimed at energy performance assessment Boundary conditions for building energy performance simulations in light of climate change trends -Advanced experimental techniques for the determination of heat and mass transport and the storage properties of building materials -On site monitoring and verification of building energy performance -Research and development of new materials with high potential to improve the energy performance of buildings The book details sources of thermal energy, methods of capture, and applications. It describes the basics of thermal energy, including measuring thermal energy, laws of thermodynamics that govern its use and transformation, modes of thermal energy, conventional processes, devices and materials, and the methods by which it is transferred. It covers 8 sources of thermal energy: combustion, fusion (solar) fission (nuclear), geothermal, microwave, plasma, waste heat, and thermal energy storage. In each case, the methods of production and capture and its uses are described in detail. It also discusses novel processes and devices used to improve transfer and transformation processes. In recent years, the interest of the scientific community towards efficient energy systems has significantly increased. One of the reasons is certainly related to the change in the temperature of the planet, which has increased by 0.76 °C with respect to preindustrial levels, according to the Intergovernmental Panel on Climate Change (IPCC), and is still increasing. The European Union considers it vital to prevent global warming from exceeding 2 °C with respect to pre-industrial levels, as it has been proven that this will result in irreversible and potentially catastrophic changes. These changes in climate are mainly caused by greenhouse gas emissions related to human activities, and can be drastically reduced by employing energy systems for the heating and cooling of buildings, as well as for power production, characterized by high efficiency levels and/or based on renewable energy sources. This Special Issue, published in the Energies journal, includes 13 contributions from across the world, including a wide range of applications such as hybrid residential renewable energy systems, desiccant-based air handling units, heat exchangers for engine WHR, solar chimney systems, and other interesting topics. Ultra-High Temperature Thermal Energy Storage, Transfer and Conversion presents a comprehensive analysis of thermal energy storage systems operating at beyond 800°C. Editor Dr. Alejandro Datas and his team of expert contributors from a variety of regions summarize the main technological options and the most relevant materials and characterization considerations to enable the reader to make the most effective and efficient decisions. This book helps the reader to solve the very specific challenges associated with working within an ultra-high temperature energy storage setting. It condenses and summarizes the latest knowledge, covering fundamentals, device design, materials selection and applications, as well as thermodynamic cycles and solid-state devices for ultra-high temperature energy conversion. This book provides a comprehensive and multidisciplinary guide to engineers and researchers in a variety of fields including energy conversion, storage, cogeneration, thermodynamics, numerical methods, CSP, and materials engineering. It firstly provides a review of fundamental concepts before exploring numerical methods for fluid-dynamics and phase change materials, before presenting more complex elements such as heat transfer fluids, thermal insulation, thermodynamic cycles, and a variety of energy conversion methods including thermophotovoltaic, thermionic, and combined heat and power. Reviews the main technologies enabling ultra-high temperature energy storage and conversion, including both thermodynamic cycles and solid-state devices Includes the applications for ultra-high temperature energy storage systems, both in terrestrial and space environments Analyzes the thermophysical properties and relevant experimental and theoretical methods for the analysis of high-temperature materials Model a Thermal System without Lengthy Hand Calculations Before components are purchased and a thermal energy system is built, the effective engineer must first solve the equations representing the mathematical model of the system. Having a working mathematical model based on physics and equipment performance information is crucial to finding 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. Çukurova University, Turkey in collaboration with Ljubljana University, Slovenia and the International Energy Agency Implementing Agreement on Energy Conservation Through Energy Storage (IEA ECES IA) organized a NATO Advanced Study Institute on Thermal Energy Storage for Sustainable Energy Consumption – Fundamentals, Case Studies and Design (NATO ASI TESSEC), in Cesme, Izmir, Turkey in June, 2005. This book contains manuscripts based on the lectures included in

the scientific programme of the NATO ASI TESSEC. The ability of thermal energy storage (TES) systems to facilitate energy savings, renewable energy use and reduce environmental impact has led to a recent resurgence in their interest. The second edition of this book offers up-to-date coverage of recent energy efficient and sustainable technological methods and solutions, covering analysis, design and performance improvement as well as life-cycle costing and assessment. As well as having significantly revised the book for use as a graduate text, the authors address real-life technical and operational problems, enabling the reader to gain an understanding of the fundamental principles and practical applications of thermal energy storage technology. Beginning with a general summary of thermodynamics, fluid mechanics and heat transfer, this book goes on to discuss practical applications with chapters that include TES systems, environmental impact, energy savings, energy and exergy analyses, numerical modeling and simulation, case studies and new techniques and performance assessment methods. Thermal energy storage (TES) technologies store thermal energy (both heat and cold) for later use as required, rather than at the time of production. They are therefore important counterparts to various intermittent renewable energy generation methods and also provide a way of valorising waste process heat and reducing the energy demand of buildings. This book provides an authoritative overview of this key area. Part one reviews sensible heat storage technologies. Part two covers latent and thermochemical heat storage respectively. The final section addresses applications in heating and energy systems. Reviews sensible heat storage technologies, including the use of water, molten salts, concrete and boreholes. Describes latent heat storage systems and thermochemical heat storage. Includes information on the monitoring and control of thermal energy storage systems, and considers their applications in residential buildings, power plants and industry. This book discusses the history of thermal heat generators and focuses on the potential for these processes using micro-electrical mechanical systems (MEMS) technology for this application. The main focus is on the capture of waste thermal energy for example from industrial processes, transport systems or the human body to generate useable electrical power. A wide range of technologies is discussed, including external combustion heat cycles at MEMS (Brayton, Stirling and Rankine), Thermoacoustic, Shape Memory Alloys (SMAs), Multiferroics, Thermionics, Pyroelectric, Seebeck, Alkali Metal Thermal, Hydride Heat Engine, Johnson Thermo Electrochemical Converters, and the Johnson Electric Heat Pipe. Describes the nature of solar and geothermal energy and the processes by which these sources of energy can be harnessed to supply electricity power markets. This book offers a tutorial on the response of materials to lasers, with an emphasis on simple, intuitive models with analytical and mathematical solutions, using techniques such as Laplace Transformation to solve most complex heat conduction equations. It examines the relationship between existing thermal parameters of simple metals and looks at the characteristics of materials and their properties in order to investigate and perform theoretical analysis from a heat conduction perspective mathematically. Topics discussed include optical reflectivity of metals at infrared (IR) wavelengths, laser-induced heat flow in materials, the effects of melting and vaporization, the impulse generated in materials by pulsed radiation, and the influence of the absorption in the blow-off region in irradiated material. Written for engineers, scientists, and graduate-level engineering and physics students, Thermal Effects of High Power Laser Energy on Materials provides an in-depth look at high energy laser technology and its potential industrial and commercial applications in such areas as precision cutting, LIDAR and LADAR, and communications. The knowledge gained from this allows you to apply spaced-based relay mirror in order to compensate laser beam divergence back to its original coherency by preventing further thermal blooming that takes place during laser beam propagation through the atmosphere. Examines the state-of-the-art in currently available high energy laser technologies; Includes computer codes that deal with the response of materials to laser radiation; Provides detailed mathematical solutions of thermal response to laser radiation. Thermal Energy Storage Analyses and Designs considers the significance of thermal energy storage systems over other systems designed to handle large quantities of energy, comparing storage technologies and emphasizing the importance, advantages, practicalities, and operation of thermal energy storage for large quantities of energy production. Including chapters on thermal storage system configuration, operation, and delivery processes, in particular the flow distribution, flow arrangement, and control for the thermal charge and discharge processes for single or multiple thermal storage containers, the book is a useful reference for engineers who design, install, or maintain storage systems. Includes computer code for thermal storage analysis, including code flow charts. Contains a database of material properties relevant to storage. Provides example cases of input and output data for the code. All matter is made up of molecules and atoms. These atoms are always in different types of motion (translation, rotational, vibrational). The motion of atoms and molecules creates heat or thermal energy. All matter has this thermal energy. The more motion the atoms or molecules have the more heat or thermal energy they will have. Heat transfer is the exchange of thermal energy between physical systems. The rate of heat transfer is dependent on the temperatures of the systems and the properties of the intervening medium through which the heat is transferred. The three fundamental modes of heat transfer are conduction, convection and radiation. Heat transfer, the flow of energy in the form of heat, is a process by which a system changes its internal energy, hence is of vital use in applications of the First Law of Thermodynamics. Conduction is also known as diffusion, not to be confused with diffusion related to the mixing of constituents of a fluid. Heat energy transferred between a surface and a moving fluid at different temperatures is known as convection. In reality this is a combination of diffusion and bulk motion of molecules. Near the surface the fluid velocity is low, and diffusion dominates. Away from the surface, bulk motion increases the influence and dominates. Natural convection is caused by buoyancy forces due to density differences caused by temperature variations in the fluid. At heating the density change in the boundary layer will cause the fluid to rise and be replaced by cooler fluid that also will heat and rise. This continues phenomena is called free or natural convection. Conduction as heat transfer takes place if there is a temperature gradient in a solid or stationary fluid medium. With conduction energy transfers from more energetic to less energetic molecules when neighboring molecules collide. Heat flows in direction of decreasing temperatures since higher temperatures are associated with higher molecular energy. This book emphasizes on the principles of convection and conduction heat transfer. "Explore the exciting science of heat energy. Everyone has felt the encompassing embrace of warmth from the sun as we lift our faces upward. This authoritative source explains the world of heat energy: what heat energy is, how it is formed and measured, and its impact in our world daily. Vivid illustrations and vocabulary boxes help to make learning exciting and content clear to elementary readers. Interactive Compare and Contrast and Think About It activities engage students and encourage the development of many key skills stressed in today's common core curriculums." The fluctuating behavior of thermal solar energy creates an enormous need to store thermal solar energy during available periods and use it when unavailable. Among different thermal energy storage techniques, latent thermal energy storage using phase change materials or PCMs has many attractive characteristics, e.g. a low ratio of volume to energy, and isothermal charging and discharging processes. However, the thermal behavior of most phase change materials is alleviated by their low thermal conductivity. To study the potential enhancement of the performance of latent thermal energy storage, dispersing metallic nanoparticles and using metal foams were investigated in the present work. Rectangular and square thermal storage units were studied both experimentally and numerically. Furthermore, a scale analysis of the melting process was performed. In addition, energy streamlines and heatline calculations were performed. Finally, exergy analyses were performed for closed latent heat storage. The numerical model used in the porous case was the Brinkman model. The experimental and numerical results showed that the metal foam significantly enhanced the thermal behavior of the thermal storage unit when compared with the nanoparticles. In order to improve the nano-PCM thermal behavior, more nanoparticles should be used. Nevertheless, using high volume fractions of nanoparticles caused sedimentation. This book covers thermal energy storage materials, devices, systems and applications.

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