Heat Pipe Design And Technology A Practical Approach

This work deal with heat pipes experiments depending on the gravity, because gravity is one of the phenomenon which affects the heat transport ability of the heat pipe. In heat pipe technology is gravity on the one side positive when ensure the circulation of the working fluid in gravity heat pipe (GHP) (thermosiphon) and on the other side negative when act opposite the capillary action in the wick heat pipe (WHP). The work describes principle, design and construction of gravity heat pipe (GHP) and wick heat pipe (WHP). Experimental determination influences gravity on the heat transport ability of gravity heat pipes by changing working position. Experimental and mathematical determination influences gravity on the heat transport ability of wick heat pipes by changing working position.

Develop a fundamental understanding of heat transfer analysis techniques as applied to earth based spacecraft with this practical guide. Written in a tutorial style, this essential text provides a how-to manual tailored for those who wish to understand and develop spacecraft thermal analyses. Providing an overview of basic heat transfer analysis fundamentals such as thermal circuits, limiting resistance, MLI, environmental thermal sources and sinks, as well as contemporary space based thermal technologies, and the distinctions between design considerations inherent to room temperature and cryogenic temperature applications, this is the perfect tool for graduate students,

professionals and academic researchers.
This book provides a practical study of modern heat pipe engineering, discussing how it can be optimized for use on a wider scale. An introduction to operational and design principles, this book offers a review of heat and mass transfer theory relevant to performance, leading into and exploration of the use of heat pipes, particularly in high-heat flux applications and in situations in which there is any combination of non-uniform heat loading, limited airflow over the heat generating components, and space or weight constraints. Key implementation challenges are tackled, including load-balancing, materials characteristics, operating temperature ranges, thermal resistance, and operating orientation. With its presentation of mathematical models to calculate heat transfer limitations and temperature gradient of both high- and low-temperature heat pipes, the book compares calculated results with the available experimental data. It also includes a series of computer programs developed by the author to support presented data, aid design, and predict performance.
With its unique ability to transfer heat over large distances with minimal loss, the heat pipe has emerged as a proven environmentally friendly, energy-saving solution for passive thermal control. However, until recently, the high cost and complex construction use of these marvelous mechanisms has generally limited their use to space technology. Written by a former senior chief scientist at Lockheed who has also worked for Westinghouse and the U.S Air Force, Heat Pipe Design and Technology: A Practical

Approach provides a practical study of modern heat pipe engineering in nuclear and solar energy applications, discussing how it can be optimized and made more cost-effective for use on a wider scale. An introduction to operational and design principles, this book explores the use of heat pipes, particularly in high-heat flux applications and in situations in which there is any combination of non-uniform heat loading, limited airflow over the heat generating components, and space or weight constraints. It also discusses design and application of self-controlled, variable-conductance heat pipes for thermal control in spacecraft. Offering a review of heat and mass transfer theory relevant to performance, the book covers issues that can affect successful heat pipe operation, including: Balancing of heat pipe loads Compatibility of materials Operating temperature range Power limitations Thermal resistance Operating orientation With its presentation of mathematical models to calculate heat transfer limitations and temperature gradient of both high- and low-temperature heat pipes, the book compares calculated results with the available experimental data from various sources to increase confidence in existing models. It also explains where and how readers can access helpful interactive computer codes and a series of computer programs developed by the author to support presented data, aid design, and predict performance.
Heat Pipes: Theory, Design and Applications, Seventh Edition, takes a highly practical approach to the design and selection of heat pipes, making it an essential guide for practicing engineers and an ideal text for postgraduate students.The expanded author

team consolidate and update the theoretical background included in previous editions, and include new sections on recent developments in manufacturing methods, wick design and additional applications. The book serves as an introduction to the theory, design and application of the range of passive, two-phase, heat-transfer devices known as heat pipes, serving as an essential reference for those seeking a sound understanding of the principles of heat pipe technology. It provides an introduction to the basic principles of operation and design data which would permit the reader to design and fabricate a basic heat pipe. It also provides details of the various more complex configurations and designs currently available to assist in selecting such devices. This new edition has been fully updated to reflect the latest research and technologies and includes four brand new chapters on various types of heat pipe, theoretical principles of heat transfer and fluid mechanics, additive manufacturing and heat pipe heat exchangers. Fully revised with brand new chapters on Additive Manufacturing and Heat Exchangers Guides the reader through the design and fabrication of a heat pipe Includes detail on more complex configurations and designs available to assist in the election of devices

We describe the development of a new technology for cooling microelectronics. This report documents the design, fabrication, and prototype testing of micro scale heat pipes embedded in a flat plate substrate or heat spreader. A thermal model tuned to the test results enables us to describe heat transfer in the prototype, as well as evaluate the use of this technology in other applications. The substrate walls are Kovar alloy, which has a coefficient of thermal expansion close to that of microelectronic die. The prototype designs integrating micro heat pipes with Kovar enhance thermal conductivity by more than a factor of two over that of Kovar alone, thus improving the cooling of micro-electronic die.

Presents basic and advanced techniques in the analytical and numerical modeling of various heat pipe systems under a variety of operating conditions and limitations. It describes the variety of complex and coupled processes of heat and mass transfer in heat pipes. The book consists of fourteen chapters, two appendices, and over 400 illustrations, along with numerous references and a wide variety of technical data on heat pipes.

This book describes the characteristics of heat pipes under steady-state and transient operating conditions. It emphasizes the physical aspects of heat pipe behavior and develops design formulas on the basis of mathematical models and empirical observation. The author take a tutorial approach, presenting information on the application of heat pipe technology, design methods, and data to heat pipe cooling and heat exchange requirements. He provides the nonspecialist with sufficient understanding of heat pipe technology to appreciate and assess its application potential, while also meeting the needs of the experienced heat pipe designer and researcher.

Critical high temperature, high power applications in space nuclear power designs are near the current state of the art of heat pipe technology in terms of power density, operating temperature, and lifetime. Recent heat pipe development work at Los Alamos National

Laboratory has involved performance testing of typical space reactor heat pipe designs to power levels in excess of 19 kW/cm2 axially and 300 W/cm2 radially at temperatures in the 1400 to 1500 K range. Operation at conditions in the 10 kW/cm2 range has been sustained for periods of up to 1000 hours without evidence of performance degradation. The effective length for heat transport in these heat pipes was from 1.0 to 1.5 M. Materials used were molybdenum alloys with lithium employed as the heat pipe operating fluid. Shorter, somewhat lower power, molybdenum heat pipes have been life tested at Los Alamos for periods of greater than 25,000 hours at 1700 K with lithium and 20,000 hours at 1500°K with sodium. These life test demonstrations and the attendant performance limit investigations provide an experimental basis for heat pipe application in space reactor design and represent the current state-of-the-art of high temperature heat pipe technology.

This book provides general guidelines for solving thermal problems in the fields of engineering and natural sciences. Written for a wide audience, from beginner to senior engineers and physicists, it provides a comprehensive framework covering theory and practice and including numerous fundamental and real-world examples. Based on the thermodynamics of various material laws, it focuses on the mathematical structure of the continuum models and their experimental validation. In addition to several examples in renewable energy, it also presents thermal processes in space, and summarizes size-dependent, non-Fourier, and non-Fickian problems, which have increasing practical relevance in, e.g., the semiconductor industry. Lastly, the book discusses the key aspects of numerical methods, particularly highlighting the role of boundary conditions in the modeling process. The book provides readers with a comprehensive toolbox, addressing a wide variety of topics in thermal modeling, from

constructing material laws to designing advanced power plants and engineering systems.
Heat Pipe Design and TechnologyModern Applications for Practical Thermal ManagementSpringer

An analysis of food cooling applications which reflects new techniques, models, correlations and applications and provides tools and charts. It includes a range of worked-out examples extracted from practical applications.

Covers the fundamentals of combined-cycle plants to provide background for understanding the progressive design approaches at the heart of the text Discusses the types of compact heat exchanger surfaces, suggesting novel designs that can be considered for optimal cost effectiveness and maximum energy production Undertakes the thermal analysis of these compact heat exchangers throughout the life cycle, from the design perspective through operational and safety assurance stages This book describes the quest to create novel designs for compact heat exchangers in support of emergent combined cycle nuclear plants. The text opens with a concise explanation of the fundamentals of combined cycles, describing their efficiency impacts on electrical power generation systems. It then covers the implementation of these principles in nuclear reactor power systems, focusing on the role of compact heat exchangers in the combined cycle loop and applying them to the challenges facing actual nuclear power systems. The various types of compact heat exchanger surfaces and designs are given thorough consideration before the author turns his attention to discussing current and projected reactor systems, and how the novel design of these compact heat e xchangers can be applied to innovative designs, operation and safety analyses to optimize thermal efficiency. The book is written at an undergraduate level, but will be useful to practicing engineers and scientists as well.

This report covers the design, fabrication, and test of several dual slot heat pipe engineering development units. The following dual-slot heat pipes were fabricated and tested: two 6-ft. aluminum heat pipes; a 20-ft. aluminum heat pipe; and a 20-ft. aluminum heat pipe with a four-leg evaporator section. The test results of all four test articles are presented and compared to the performance predicted by the design software. Test results from the four-leg article are incomplete. The methodology for fabricating stainless steel dual slot heat pipes was also studied by performing a tool life test with different single point cutters, and these results are also presented. Although the dual-slot heat pipe has demonstrated the potential to meet the requirements for a high capacity radiator system, uncertainties with the design still exist. The startup difficulties with the aluminum test articles must be solved, and a stainless steel/methanol heat pipe should be built and tested. League, Mark and Alario, Joe Unspecified Center NAS3-24665; RTOP 482-56-87

This text covers the fundamentals of thermodynamics required to understand electrical power generation systems and the application of these principles to nuclear reactor power plant systems. It is not a traditional general thermodynamics text, per se, but a practical thermodynamics volume intended to explain the fundamentals and apply them

to the challenges facing actual nuclear power plants systems, where thermal hydraulics comes to play. Written in a lucid, straight-forward style while retaining scientific rigor, the content is accessible to upper division undergraduate students and aimed at practicing engineers in nuclear power facilities and engineering scientists and technicians in industry, academic research groups, and national laboratories. The book is also a valuable resource for students and faculty in various engineering programs concerned with nuclear reactors. This book also: Provides extensive coverage of thermal hydraulics with thermodynamics in nuclear reactors, beginning with fundamental definitions of units and dimensions, thermodynamic variables, and the Laws of Thermodynamics progressing to sections on specific applications of the Brayton and Rankine cycles for power generation and projected reactor systems design issues Reinforces fundamentals of fluid dynamics and heat transfer; thermal and hydraulic analysis of nuclear reactors, two-phase flow and boiling, compressible flow, stress analysis, and energy conversion methods Includes detailed appendices that cover metric and English system units and conversions, detailed steam and gas tables, heat transfer properties, and nuclear reactor system descriptions
The proceedings document the most recent publications in a number of key areas of space technology, space nuclear power and propulsion systems and technology, solar system exploration technology, and advanced an innovative propulsion concepts. The technical areas covered are the latest on the thermophysics in microgravity, space

nuclear reactor power and propulsion systems for manned exploration of Mars and other distant planets in the solar system, static energy conversion technology on segmented thermoelectric, thermionic, alkali metals as well as thermal to electric conversion. Additional areas include radioisotope power systems, and the recent advances in the technology of Stirling and Brayton engines for space nuclear power and propulsion, and next generation commerical/civil space transportation systems technology.

This book is about theories and applications of thermosyphons and heat pipes. It discusses the physical phenomena that drive the working principles of thermosyphons, heat pipes and related technologies. Many applications are discussed in this book, including: rationalizing energy use in industry, solar heating of houses, decrease of water consumption in cooling towers, improvement of the thermal performance of industrial and domestic ovens and driers and new devices for heating stored oil and gas in petrochemical plants. Besides, the book also presents heat pipe and thermosyphon technologies for the thermal management of electronic devices, from portable equipment to airplanes and satellites. The first part of the book explores the physical working principles of thermosyphons and heat pipes, by explaining current heat transfer and thermal resistance models. The author discusses the new heat pipe and thermosyphon technologies that have been developed in the last decade for solving a myriad of electronic, environment and industrial heat and thermal problems. The focus then shifts to the thermosyphon technology applications, and the models and simulations necessary for each application – including vehicles, domestic appliances, water conservation technologies and the thermal control of houses and other structures. Finally, the book looks at the new technologies for heat pipes (mini/micro) and similar devices (loop heat pipes), including new models for prediction of the thermal performance of porous media. This book inspires engineers to adopt innovative approaches to heat transfer problems in equipment and components by applying thermosyphon and heat pipe technologies. It is also of interest to researchers and academics working in the heat transfer field, and to students who wish to learn more about heat transfer devices.

This book deals with different aspects of gravity that has proved its effectiveness throughout the world, hence their solicitation in recent years. Fundamental theories, applications, and tools have been presented, emphasizing the implementation of the gravity technique. Different research themes for diverse areas in the world are detailed here, highlighting new methods of studies that could be helpful for sophisticated and modern development over the next few years. Four main sections are presented: Gravity Interpretation Tools in Geoscience, Gravity in Geoscience Applications, Gravity in Industrial Technology, and Quantum Gravity. Theoretical and acquisition tools and adapted processing methods have been designed to take into account the initial data, and modeling results thus converge toward a better solution. This book, which makes a worthwhile contribution to the topic gravity, is specifically addressed to specialists, researchers, and industry professionals who shall find its content extremely useful for a better comprehension of the geological, spatial, and industrial aspects of gravity.

This book discusses multiways in the porous materials. It involves materials with a large number of holes, and it highlights the synthesis, structure, and surface properties of porous materials closely related to more applications, such as support, catalyst, energy storage, chemical reactions, and optical applications. It studies the effect of the filling materials, the thermal treatments, and the porous density in the improvement of physical properties, electrical and energy efficiency, and the generation of new materials. Some synthetic process will be discussed with the effect of some parameters on the final characteristics of the prepared porous structures.

A survey of heat pipe theory, applications and developments has been carried out with particular reference to long heat pipes. Applications in Naval operations where the heat pipe technology could be profitably employed are pointed out. Recommendations are made to design and test a long heat pipe in the laboratory with a view to applying the technology in improving equipment operation and reliability, reducing maintenance or component replacement, reducing cost of operation, or permitting designs which otherwise might not be feasible. (Author).

Advances in Heat Pipe Technology covers the proceedings of the Fourth International Heat Pipe Conference, held at the Royal Aeronautical Society in London, United Kingdom on September 7-10, 1981. This conference focuses on the advances in heat pipe and thermosyphon technology. This book is organized into seven parts encompassing 69 chapters.

The first part describes the design and features of heat pipes, as well as their terrestrial and spacecraft applications. The subsequent parts deal with the performance, heat transfer and hydrodynamic properties, and entrainment of thermosyphon and heat pipes, with an emphasis on their application to energy conservation. The last parts discuss the heat pipe theory, and the experimental techniques and life tests of heat pipes.

This book presents a new and innovative approach for the use of heat pipes and their application in a number of industrial scenarios, including space and nuclear power plants. The book opens by describing the heat pipe and its concept, including sizing, composition and binding energies. It contains mathematical models of high and low temperature pipes along with extensive design and manufacturing models, characteristics and testing programs. A detailed design and safety analysis concludes the book, emphasizing the importance of heat pipe implementation within the main cooling system and within the core of the reactor, making this book a useful resource for students, engineers, and researchers.

Two-phase nano- and micro-thermal control device research is now proving relevant to a growing range of modern applications, including those in cryogenics, thermal engineering, MEMS, and aerospace engineering. Until now, researchers have lacked a definitive resource that provides a complete review of micro- and nano-scale evaporative heat and mass transfer in capillaries-porous structures. Transport Phenomena in Capillary-Porous Structures and Heat Pipes covers the latest experiemental research efforts in two-phase thermal control technology research and development. The book covers vaporization heat transfer and hydrodynamic processes occurring in capillary channels and porous structures—paying particular attention to the physical mechanisms of these phenomena. Extensive experimental research activities on

unique film and photo materials of boiling inside slits, capillaries, and capillary-porous structures are reviewed. By providing a complete record of research in the field, this volume gives researchers, engineers, and practitioners working on vaporization heat transfer and hydrodynamic processes the findings needed to avoid unnecessary experimental efforts, and will help further the development of this dynamic area of research.
"Heat pipes are efficient passive devices that can transfer large amounts of heat over long distances with small temperature differences between the heat sources and sinks by evaporation and condensation of the working fluid. Heat can be transferred without the use of any mechanically moving parts such as pumps and active controls in heat pipes. The vapor and liquid circulate in the conventional heat pipes, including thermosiphons, via evaporation/condensation and capillary or gravitational forces. For pulsating heat pipes, liquid slug and vapor plugs in the capillary tube oscillate due to evaporation and condensation. The effective thermal conductivity of a heat pipe can be three orders of magnitude higher than that of a copper rod with the same size. A heat pipe can find its applications in many sectors of industries, including electronics cooling, energy systems, spacecraft thermal control, permafrost cooling, and manufacturing. This book presents current research and development related to the design, applications and technology of various heat pipes, including conventional heat pipes and thermosyphon, pulsating heat pipes, loop heat pipes, and variable conductance heat pipes. Design tools based on computational fluid dynamics simulation and HSHPTM"--
The standard work on the subject, providing the background required by those wishing to use or to design heat pipes. The development of the heat pipe is

discussed and a wide range of applications described. This revised and updated edition takes into account the introduction of new working fluids, and extended life test data; new types of heat pipes; and some of the latest uses. Annotation copyright by Book News, Inc., Portland, OR
Due to the danger of frostbite at very low ambient temperatures, there is a need to develop new handwear technology to protect the fingers at temperatures down to about -80 deg F (-62 deg C). The shortcomings of the existing technology, a glove with a heating element, are need for maintenance, size and limited capacity of the current batteries. An innovative method was investigated to transfer some of the body core thermal energy to the hands. This method involves the use of heat pipe technology, which has the advantages of very high effective heat conductivity, fast response time, flexibility low mass, compact size, and ease of maintenance. The design uses the person's elbow area as the heat source. The heat pipe extends along the arm and terminates at the surface of the back of the hand. From a simple model of the insulated arm and hand, the required heat transfer to the hand by the heat pipe to maintain a hand temperature of -81 deg F (27 deg C) with ambient temperature of -80 deg F 62 deg C) was shown to vary from 5.8 to 21 W for an insulation 'R' value from 0.741 to 0.185m 0 C/W. A very efficient and flexible heat pipe was developed and tested to show the feasibility of

the use of heat pipe technology in the above application. Heat capacities between 1 and 5 W were measured, depending upon orientation with respect to gravity. Due to the necessity of transferring 1 to 5 times this amount of heat and to provide for more uniform heat distribution, these results indicate that multiple heat pipes may be required in the design of a handwear system.

This book covers the entire spectrum of the science and technology of nuclear reactor systems, from underlying physics, to next generation system applications and beyond. Beginning with neutron physics background and modeling of transport and diffusion, this self-contained learning tool progresses step-by-step to discussions of reactor kinetics, dynamics, and stability that will be invaluable to anyone with a college-level mathematics background wishing to develop an understanding of nuclear power. From fuels and reactions to full systems and plants, the author provides a clear picture of how nuclear energy works, how it can be optimized for safety and efficiency, and why it is important to the future.