Heat Transfer Enhancement With Nanofluids A Thesis

In today’s modern world, the manufacturing industry is embracing an energy-efficient initiative and adopting green techniques. One aspect that has failed to adopt this scheme is flood grinding. Current flood grinding methods increase the treatment cost of grinding fluid and waste large quantities. In order to remain sustainable and efficient, in-depth research is necessary to study green grinding technologies that can ensure machining precision and surface quality of workpiece and reduce grinding fluid-induced environmental pollution. Enhanced Heat Transfer Mechanism of Nanofluid MQL Cooling Grinding provides emerging research exploring the theoretical and practical aspects of nanofluid lubrication and its application within grinding flow and green manufacturing. Featuring coverage on a broad range of topics such as airflow distribution, morphology analysis, and lubrication performance, this book is ideally designed for mechanical professionals, engineers, manufacturers, researchers, scientists, academicians, and students seeking current research on clean and low-carbon precision machining methods.

Nanofluid in Heat Exchanges for Mechanical Systems: Numerical Simulation shows how the finite volume method is used to simulate various applications of heat exchanges. Heat transfer enhancement methods are introduced in detail, along with a hydrothermal analysis and second law approaches for heat exchanges. The melting process in heat exchanges is also covered, as is the influence of variable magnetic fields on the performance of heat exchange. This is an important reference source for materials scientists and mechanical engineers who are looking to understand the main ways that nanofluid flow is simulated and applied in industry. Provides detailed coverage of major models used in nanofluid analysis, including the finite volume method, governing equations for turbulent flow, and equations of nanofluid in presence of variable magnetic field Offers detailed coverage of swirling flow devices and melting processes Assesses which models should be applied in which situations

Introduction to nanofluids--their properties, synthesis, characterization, and applications Nanofluids are attracting a great deal of interest with their enormous potential to provide enhanced performance properties, particularly with respect to heat transfer. In response, this text takes you on a complete journey into the science and technology of nanofluids. The authors cover both the chemical and physical methods for synthesizing nanofluids, explaining the techniques for creating a stable suspension of nanoparticles. You get an overview of the existing models and experimental techniques used in studying nanofluids, alongside discussions of the challenges and problems associated with some of these models. Next, the authors set forth and explain the heat transfer applications of nanofluids, including microelectronics, fuel cells, and hybrid-powered engines. You also get an introduction to possible future applications in large-scale cooling and biomedicine. This book is the work of leading pioneers in the field, one of whom holds the first U.S. patent for nanofluids. They have combined their own first-hand knowledge with a thorough review of theliterature. Among the key topics are: * Synthesis of nanofluids, including dispersion techniques and characterization methods * Thermal conductivity and thermo-physical properties * Theoretical models and experimental techniques * Heat transfer applications in microelectronics, fuel cells, and vehicle engines This text is written for researchers in any branch of science and technology, without any prerequisite.It therefore includes some basic information describing conduction, convection, and boiling of nanofluids for those readers who may not have adequate background in these areas. Regardless of your background, you'll learn to develop nanofluids not only as coolants, but also for a host ofnew applications on the horizon.

This Brief addresses the phenomena of heat transfer enhancement. A companion edition in the SpringerBrief Subseries on Thermal Engineering and Applied Science to three other monographs including “Critical Heat Flux in Flow Boiling in Microchannels,” this volume is idea for professionals, researchers, and graduate students concerned with electronic cooling.

Application of Control Volume Based Finite Element Method (CVFEM) for Nanofluid Flow and Heat Transfer discusses this powerful numerical method that uses the advantages of both finite volume and finite element methods for the simulation of multi-physics problems in complex geometries, along with its applications in heat transfer and nanofluid flow. The book applies these methods to solve various applications of nanofluid in heat transfer enhancement. Topics covered include magnetohydrodynamic flow, electrohydrodynamic flow and heat transfer, melting heat transfer, and nanofluid flow in porous media, all of which are demonstrated with case studies. This is an important research reference that will help readers understand the principles and applications of this novel method for the analysis of nanofluid behavior in a range of external forces. Explains governing equations for nanofluid as working fluid Includes several CVFEM codes for use in nanofluid flow analysis Shows how external forces such as electric fields and magnetic field effects nanofluid flow

Although the empirical treatment of fluid flow and heat transfer in porous media is over a century old, only in the last three decades has the transport in these heterogeneous systems been addressed in detail. So far, single-phase flows in porous media have been treated or at least formulated satisfactorily, while the subject of two-phase flow and the related heat-transfer in porous media is still in its infancy. This book identifies the principles of transport in porous media and compares the avalaible predictions based on theoretical treatments of various transport mechanisms with the existing experimental results. The theoretical treatment is based on the volume-averaging of the momentum and energy equations with the closure conditions necessary for obtaining solutions. While emphasizing a basic understanding of heat transfer in porous media, this book does not ignore the need for predictive tools; whenever a rigorous theoretical treatment of a phenomena is not avaliable, semi-empirical and empirical treatments are given.

Heat Transfer Enhancement in Microchannel Heat Sink Using Nanofluids.

In the recent decades, efficiency enhancement of refineries and chemical plants has been become a focus of research and development groups. Use of nanofluids in absorption, regeneration, liquid-liquid extraction and membrane processes can lead to mass transfer and heat transfer enhancement in processes which results in an increased efficiency in all these processes. Nanofluids and Mass Transfer introduces the role of nanofluids in improving mass transfer phenomena and expressing their characteristics and properties. The book also covers the theory and modelling procedures in details and finally illustrates various applications of Nanofluids in mass transfer enhancement in various processes such as absorption, regeneration, liquid-liquid extraction and membrane processes and how can nanofluids increase mass transfer in processes. Introduces specifications of nanofluids and mechanisms of mass transfer enhancement by nanofluids in various mass transfer processes Discusses mass transfer enhancement in various mass transfer processes such as: absorption, regeneration, liquid-liquid extraction and membrane processes Offers modelling mass transfer and flow in nanofluids Challenges industrialization and scale up of nanofluids

Nanofluids are gaining the attention of scientists and researchers around the world. This new category of heat transfer medium improves the thermal conductivity of fluid by suspending small solid particles within it and offers the possibility of increased heat transfer in a variety of applications. Bringing together expert contributions from across the globe, Heat Transfer Enhancement with Nanofluids presents a complete understanding of the application of nanofluids in a range of fields and explains the main techniques used in the analysis of nanofuids flow and heat transfer. Providing a rigorous framework to help readers develop devices employing nanofluids, the book addresses basic topics that include the analysis and measurements of thermophysical properties, convection, and heat exchanger performance. It explores the issues of convective instabilities, nanofluids in porous media, and entropy generation in nanofluids. The book also contains the latest advancements, innovations, methodologies, and research on the subject. Presented in 16 chapters, the text: Discusses the possible mechanisms of thermal conduction enhancement Reviews the results of a theoretical analysis determining the anomalous enhancement of heat transfer in nanofluid flow Assesses different approaches modeling the thermal conductivity enhancement of nanofluids Focuses on experimental methodologies used to determine the thermophysical properties of nanofluids Analyzes forced convection heat transfer in nanofluids in both laminar and turbulent convection Highlights the application of nanofluids in heat exchangers and microchannels Discusses the utilization of nanofluids in porous media Introduces the boiling of nanofluids Treats pool and flow boiling by analyzing the effect of nanoparticles on these complex phenomena Indicates future research directions to further develop this area of knowledge, and more Intended as a reference for researchers and engineers working in the field, Heat Transfer Enhancement with Nanofluids presents advanced topics that detail the strengths, weaknesses, and potential future developments in nanofluids heat transfer.

Heat transfer calculations in different aspects of engineering applications are essential to aid engineering design of heat exchanging equipment. Minimizing of computational time is a challenging task faced by researchers and users. Methodology of calculations in some application areas are incorporated in this book, such as differential analysis of heat recoveries with CFD in a tube bank, heating and ventilation of equipment and methods for analytical solution of nonlinear problems. Numerical analysis is the prerequisite of design and for the manufacture of heat exchanging equipment. Some numerical and experimental information are presented with utmost skill. Similarly, the analytical solution of heat transfer is touched in this book. Study of heat transfer phenomena and applications are equally emphasized in this issue.

This book presents select peer reviewed proceedings of the International Conference on Applied Mechanical Engineering Research (ICAMER 2019). The books examines various areas of mechanical engineering namely design, thermal, materials, manufacturing and industrial engineering covering topics like FEA, optimization, vibrations, condition monitoring, tribology, CFD, IC engines, turbo-machines, automobiles, manufacturing processes, machining, CAM, additive manufacturing, modelling and simulation of manufacturing processing, optimization of manufacturing processing, supply chain management, and operations management. In addition, recent studies on composite materials, materials characterization, fracture and fatigue, advanced materials, energy storage, green building, phase change materials and structural change monitoring are also covered. Given the contents, this book will be useful for students, researchers and professionals working in mechanical engineering and allied fields.

Heat Transfer Enhancement Using Nanofluid Flow in Microchannels: Simulation of Heat and Mass Transfer focuses on the numerical simulation of passive techniques, and also covers the applications of external forces on heat transfer enhancement of nanofluids in microchannels. Economic and environmental incentives have increased efforts to reduce energy consumption. Heat transfer enhancement, augmentation, or intensification are the terms that many scientists employ in their efforts in energy consumption reduction. These can be divided into (a) active techniques which require external forces such as magnetic force, and (b) passive techniques which do not require external forces, including geometry refinement and fluid additives. Gives readers the knowledge they need to be able to simulate nanofluids in a wide range of microchannels and optimise their heat transfer characteristics Contains real-life examples, mathematical procedures, numerical algorithms, and codes to allow readers to easily reproduce the methodologies covered, and to understand how they can be applied in practice Presents novel applications for heat exchange systems, such as entropy generation minimization and figures of merit, allowing readers to optimize the techniques they use Focuses on the numerical simulation of passive techniques, and also covers the applications of external forces on heat transfer enhancement of nanofluids in microchannels

ABSTRACT: Nanofluids have been demonstrated to be promising for heat transfer enhancement in forced convection and boiling applications. The addition of carbon, copper, and other high-thermal-conductivity material nanoparticles to water, oil, ethylene glycol, and other fluids has been determined to increase the thermal conductivities of these fluids. The increased effective thermal conductivities of these fluids enhance their abilities to dissipate heat in such applications. The use of nanofluids for spray cooling is an extension of the application of nanofluids for enhancement of heat dissipation. In this investigation, experiments were performed to determine the level of heat transfer enhancement with the addition of alumina nanoparticles to the fluid. Using mass percentages of up to 0.5% alumina nanoparticles suspended in water, heat fluxes and surface temperatures were measured and compared. Compressed nitrogen was used to provide constant spray nozzle pressures to produce full-cone sprays in an open loop spray cooling system. The range of heat fluxes measured were for single-phase and phase-change spray cooling regimes.

Key Message: This book aims to explain physics in a readable and interesting manner that is accessible and clear, and to teach readers by anticipating their needs and difficulties without oversimplifying. Physics is a description of reality, and thus each topic begins with concrete observations and experiences that readers can directly relate to. We then move on to the generalizations and more formal treatment of the topic. Not only does this make the material more interesting and easier to understand, but it is closer to the way physics is actually practiced. Key Topics: INTRODUCTION, MEASUREMENT, ESTIMATING, DESCRIBING MOTION: KINEMATICS IN ONE DIMENSION, KINEMATICS IN TWO OR THREE DIMENSIONS; VECTORS, DYNAMICS: NEWTON'S LAWS OF MOTION , USING NEWTON'S LAWS: FRICTION, CIRCULAR MOTION, DRAG FORCES, GRAVITATION AND NEWTON'S6 SYNTHESIS , WORK AND ENERGY , CONSERVATION OF ENERGY , LINEAR MOMENTUM , ROTATIONAL MOTION , ANGULAR MOMENTUM; GENERAL ROTATION , STATIC EQUILIBRIUM; ELASTICITY AND FRACTURE , FLUIDS , OSCILLATIONS , WAVE MOTION, SOUND , TEMPERATURE, THERMAL EXPANSION, AND THE IDEAL GAS LAW KINETIC THEORY OF GASES, HEAT AND THE FIRST LAW OF THERMODYNAMICS , SECOND LAW OF THERMODYNAMICS , ELECTRIC CHARGE AND ELECTRIC FIELD , GAUSS'S LAW , ELECTRIC POTENTIAL , CAPACITANCE, DIELECTRICS, ELECTRIC ENERGY STORAGE ELECTRIC CURRENTS AND RESISTANCE, DC CIRCUITS, MAGNETISM, SOURCES OF MAGNETIC FIELD, ELECTROMAGNETIC INDUCTION AND FARADAY'S LAW, INDUCTANCE, ELECTROMAGNETIC OSCILLATIONS, AND AC CIRCUITS, MAXWELL'S EQUATIONS AND ELECTROMAGNETIC WAVES, LIGHT: REFLECTION AND REFRACTION, LENSES AND OPTICAL INSTRUMENTS, THE WAVE NATURE OF LIGHT; INTERFERENCE, DIFFRACTION AND POLARIZATION, SPECIAL THEORY OF RELATIVITY, EARLY QUANTUM THEORY AND MODELS OF THE ATOM, QUANTUM MECHANICS, QUANTUM MECHANICS OF ATOMS, MOLECULES AND SOLIDS, NUCLEAR PHYSICS AND RADIOACTIVITY, NUCLEAR ENERGY: EFECTS AND USES OF RADIATION, ELEMENTARY PARTICLES,ASTROPHYSICS AND COSMOLOGY Market Description: This book is written for readers interested in learning the basics of physics.

ABSTRACT: Spray cooling is a technique for achieving large heat fluxes at low surface temperatures by impinging a liquid in droplet form on a heated surface. Heat is removed by droplets spreading across the surface, thus removing heat by evaporation and by an increase in the convective heat transfer coefficient. The addition of nano-sized particles, like aluminum or copper, to water to create a nanofluid could further enhance the spray cooling process. Nanofluids have been shown to have better thermophysical properties when compared to water, like enhanced thermal conductivity. Although droplet size, velocity, impact angle and the roughness of the heated surface are all factors that determine the amount of heat that can be removed, the dominant driving mechanism for heat dissipation by spray cooling is difficult to determine. In the current study, experiments were conducted to compare the enhancement to heat transfer caused by using alumina nanofluids during spray cooling instead of de-ionized water for the same nozzle pressure and distance from the heated surface. The fluids were sprayed on a heated copper surface at a constant distance of 21 mm. Three mass concentrations, 0.1%, 0.5%, and 1.0%, of alumina nanofluids were compared against water at three pressures, 40psi, 45psi, and 50psi. To ensure the suspension of the aluminum oxide nanoparticles during the experiment, the pH level of the nanofluid was altered. The nanofluids showed an enhancement during the single-phase heat transfer and an increase in the critical heat flux (CHF). The spray cooling heat transfer curve shifted to the right for all concentrations investigated, indicating a delay in two-phase heat transfer. The surface roughness of the copper surface was measured before and after spray cooling as a possible cause for the delay.

Hybrid Nanofluids for Convection Heat Transfer discusses how to maximize heat transfer rates with the addition of nanoparticles into conventional heat transfer fluids. The book addresses definitions, preparation techniques, thermophysical properties and heat transfer characteristics with mathematical models, performance-affecting factors, and core applications with implementation challenges of hybrid nanofluids. The work adopts mathematical models and schematic diagrams in review of available experimental methods. It enables readers to create new techniques, resolve existing research problems, and ultimately to implement hybrid nanofluids in convection heat transfer applications. Provides key heat transfer performance and thermophysical characteristics of hybrid nanofluids Reviews parameter selection and property measurement techniques for thermal performance calibration Explores the use of predictive mathematical techniques for experimental properties

Nanofluids are solid-liquid composite material consisting of solid nanoparticles suspended in liquid with enhanced thermal properties. This book introduces basic fluid mechanics, conduction and convection in fluids, along with nanomaterials for nanofluids, property characterization, and outline applications of nanofluids in solar technology, machining and other special applications. Recent experiments on nanofluids have indicated significant increase in thermal conductivity compared with liquids without nanoparticles or larger particles, strong temperature dependence of thermal conductivity, and significant increase in critical heat flux in boiling heat transfer, all of which are covered in the book. Key Features Exclusive title focusing on niche engineering applications of nanofluids Contains high technical content especially in the areas of magnetic nanofluids and dilute oxide based nanofluids Feature examples from research applications such as solar technology and heat pipes Addresses heat transfer and thermodynamic features such as efficiency and work with mathematical rigor Focused in content with precise technical definitions and treatment

Featuring contributions by leading researchers in the field, Nanoparticle Heat Transfer and Fluid Flow explores heat transfer and fluid flow processes in nanomaterials and nanofluids, which are becoming increasingly important across the engineering disciplines. The book covers a wide range, from biomedical and energy conversion applications to materials properties, and addresses aspects that are essential for further progress in the field, including numerical quantification, modeling, simulation, and presentation. Topics include: A broad review of nanofluid applications, including industrial heat transfer, biomedical engineering, electronics, energy conversion, membrane filtration, and automotive An overview of thermofluids and their importance in biomedical applications and heat-transfer enhancement A deeper look at biomedical applications such as nanoparticle hyperthermia treatments for cancers Issues in energy conversion from dispersed forms to more concentrated and utilizable forms Issues in nanofluid properties, which are less predictable and less repeatable than those of other media that participate in fluid flow and heat transfer Advances in computational fluid dynamic (CFD) modeling of membrane filtration at the microscale The role of nanofluids as a coolant in microchannel heat transfer for the thermal management of electronic equipment The potential enhancement of natural convection due to nanoparticles Examining key topics and applications in nanoscale heat transfer and fluid flow, this comprehensive book presents the current state of the art and a view of the future. It offers a valuable resource for experts as well as newcomers interested in developing innovative modeling and numerical simulation in this growing field.

Heat transfer enhancement has seen rapid development and widespread use in both conventional and emerging technologies. Improvement of heat transfer fluids requires a balance between experimental and numerical work in nanofluids and new refrigerants. Recognizing the uncertainties in development of new heat transfer fluids, Advances in New Heat Transfer Fluids: From Numerical to Experimental Techniques contains both theoretical and practical coverage.

This book focuses on the use of nanotechnology in several fields of engineering. Among others, the reader will find valuable information as to how nanotechnology can aid in extending the life of component materials exposed to corrosive atmospheres, in thermal fluid energy conversion processes, anti-reflection coatings on photovoltaic cells to yield enhanced output from solar cells, in connection with friction and wear reduction in automobiles, and buoyancy suppression in free convective heat transfer. Moreover, this unique resource presents the latest research on nanoscale transport phenomena and concludes with a look at likely future trends.

There are only a few discoveries and new technologies in materials science that have the potential to dramatically alter and revolutionize our material world. Discovery of two-dimensional (2D) materials, the thinnest form of materials to ever occur in nature, is one of them. After isolation of graphene from graphite in 2004, a whole other class of atomically thin materials, dominated by surface effects and showing completely unexpected and extraordinary properties, has been created. This book provides a comprehensive view and state-of-the-art knowledge about 2D materials such as graphene, hexagonal boron nitride (h-BN), transition metal dichalcogenides (TMD) and so on. It consists of 11 chapters contributed by a team of experts in this exciting field and provides latest synthesis techniques of 2D materials, characterization and their potential applications in energy conservation, electronics, optoelectronics and biotechnology.

In the present book, various applications of microfluidics and nanofluidics are introduced. Microfluidics and nanofluidics span a broad array of disciplines including mechanical, materials, and electrical engineering, surface science, chemistry, physics and biology. Also, this book deals with transport and interactions of colloidal particles and biomolecules in microchannels, which have great importance to many microfluidic applications, such as drug delivery in life science, microchannel heat exchangers in electronic cooling, and food processing industry. Furthermore, this book focuses on a detailed description of the thermal transport behavior, challenges and implications that involve the development and use of HTFs under the influence of atomistic-scale structures and industrial applications.

While robust progress has been made towards the practical use of nanofluids, uncertainties remain concerning the fundamental effects of nanoparticles on key thermo-physical properties. Nanofluids have higher thermal conductivity and single-phase heat transfer coefficients than their base fluids. The possibility of very large thermal conductivity enhancement in nanofluids and the associated physical mechanisms are a hotly debated topic, in part because the thermal conductivity database is sparse and inconsistent. This thesis reports on the International Nanofluid Property Benchmark Exercise (INPBE) in which the thermal conductivity of identical samples of colloidally stable dispersions of nanoparticles, or 'nanofluids', was measured by over 30 organizations worldwide, using a variety of experimental approaches, including the transient hot wire method, steady-state methods and optical methods. The nanofluids tested were comprised of aqueous and non-aqueous basefluids, metal and metal oxide particles, near-spherical and elongated particles, at low and high particle concentrations. The data analysis reveals that the data from most organizations lie within a relatively narrow band (± 10% or less) about the sample average, with only few outliers. The thermal conductivity of the nanofluids was found to increase with particle concentration and aspect ratio, as expected from classical theory. The effective medium theory developed for dispersed particles by Maxwell in 1881, and recently generalized by Nan et al., was found to be in good agreement with the experimental data. The nanofluid literature contains many claims of anomalous convective heat transfer enhancement in both turbulent and laminar flow. To put such claims to the test, we have performed a critical detailed analysis of the database reported in 12 nanofluid papers (8 on laminar flow and 4 on turbulent flow). The methodology accounted for both modeling and experimental uncertainties in the following way. The heat transfer coefficient for any given data set was calculated according to the established correlations (Dittus-Boelter's for turbulent flow and Shah's for laminar flow). The uncertainty in the correlation input parameters (i.e. nanofluid thermo-physical properties and flow rate) was propagated to get the uncertainty on the predicted heat transfer coefficient. The predicted and measured heat transfer coefficient values were then compared to each other. If they differed by more than their respective uncertainties, we called the deviation anomalous. According to this methodology, it was found that in nanofluid laminar flow in fact there seems to be anomalous heat transfer enhancement in the entrance region, while the data are in agreement (within uncertainties) with the Shah's correlation in the fully developed region. On the other hand, the turbulent flow data could be reconciled (within uncertainties) with the Dittus-Boelter's correlation, once the temperature dependence of viscosity was included in the prediction of the Reynolds number. While this finding is plausible, it could not be directly confirmed, because most papers do not report information about the temperature dependence of the viscosity for their nanofluids.

The automotive cooling system is a significant part of the car that removes the engine generated heat outside across the radiator. The increasing demand of nanofluids for industrial applications has led many researchers to focus on the subject in the last decade. The limited thermophysical properties and heat transfer fo liquids across the car radiator have resulted in much research to find better coolant fluids. Space constraints are another key issue in the evofofotua applications to remove heat from high heat flux generating surfaces of automobile engines. In order to improve thermophysical properties of the coolant fluid to enhance heat transfer in the automotive cooling system, nanofluids have been utilized as a coolant. This study aims to enhance heat transfer with a slight pressure drop in the automotive cooling system by using multi types of nanoparticles dispersed in various types of basefluids. The appropriate type of nanofluids and the influence of different nanofluids on the heat transfer performance for the car cooling system have been identified. The radiator performance efficiency to reduce the radiator size and weight has been studied. The friction factor and heat transfer enhancement using different types of nanofluids are studied. The TiO_2 and SiO_2 nanopowders suspended in four different base fluids (pure water, EG, 10%EG+90%W and 20%EG+80%W) are prepared experimentally. The thermophysical properties of both nanofluids and base fluids have been measured and validated with the standard and the experimental data available. The experimental test rig setup included a car radiator, collecting tank, pump, rotameter, valves and plastic tubes. The evaluation of the friction factor and heat transfer coefficient by taking readings of the temperature and pressure drop under laminar flow condition were conducted. The volume flowrate was found to be in the range of (1-5LPM) for pure water and (3-12LPM) for other base fluids; while, the inlet temperature and nanofluid volume fraction were in the range of (60-80oC) and (1- 4%) respectively. The CFD analysis for the nanofluids flow inside the flat tube of a car radiator under laminar flow was carried out. A simulation study was conducted by using the finite volume oaotfm to solve the continuity, momentum, and energy equations. The geometry meshing of problem with a description of the boundary conditions was performed by using commercial software to determine the friction factor and heat transfer coefficient. The experimental results showed the friction factor decreased with the increase of the volume flowrate and increased with the increase of nanofluid volume fraction but slightly decreased with the increase of the inlet temperature. The simulation results showed good agreement with the experimental data with deviation not exceeding 4%. The experimental results showed the heat transfer coefficient increased with the increase of the volume flowrate, the nanofluid volume fraction and the inlet temperature. The simulation results showed good agreement with the experimental data with deviation not exceeding 6%. In addition, the SiO2 nanofluid showed higher values of the friction factor and heat transfer coefficient than TiO2 nanofluid. The base fluid (20%EG+80%W) gave higher values of the heat transfer coefficient and proper values of friction factor compared to other base fluids. The 4% of SiO2 nanoparticles suspended in (20%EG+80%W) base fluid was significant augmentation of heat transfer in the automobile radiator. The regression equations among input (Reynolds number, Prandtl number, and nanofluid volume fraction) and response (friction factor and Nusselt number) were found to be correlated. The experimental results were compared with the experimental data available and there were good agreements with a maximum deviation of approximately 5%.

Titanium dioxide is mainly used as a pigment and photocatalyst. It is possible to find it in food, cosmetics, building materials, electric devices, and others. This book contains chapters about application of titanium dioxide in different branches of economy such as the agriculture, the food industry, the medicine, the cosmetics, the water treatment technologies, and the semiconductors.

Applications of Nanofluid for Heat Transfer Enhancement explores recent progress in computational fluid dynamic and nonlinear science and its applications to nanofluid flow and heat transfer. The opening chapters explain governing equations and then move on to discussions of free and forced convection heat transfers of nanofluids. Next, the effect of nanofluid in the presence of an electric field, magnetic field, and thermal radiation are investigated, with final sections devoted to nanofluid flow in porous media and application of nanofluid for solidification. The models discussed in the book have applications in various fields, including mathematics, physics, information science, biology, medicine, engineering, nanotechnology, and materials science. Presents the latest information on nanofluid free and force convection heat transfer, of nanofluid in the presence of thermal radiation, and nanofluid in the presence of an electric field Provides an understanding of the fundamentals in new numerical and analytical methods Includes codes for each modeling method discussed, along with advice on how to best apply them

In the present book, nanofluid heat and mass transfer in engineering problems are investigated. The use of additives in the base fluid like water or ethylene glycol is one of the techniques applied to augment heat transfer. Newly, innovative nanometer-sized particles have been dispersed in the base fluid in heat transfer fluids. The fluids containing the solid nanometer-sized particle dispersion are called "nanofluids." At first, nanofluid heat and mass transfer over a stretching sheet are provided with various boundary conditions. Problems faced for simulating nanofluids are reported. Also, thermophysical properties of various nanofluids are presented. Nanofluid flow and heat transfer in the presence of magnetic field are investigated. Furthermore, applications for electrical and biomedical engineering are provided. Besides, applications of nanofluid in internal combustion engine are provided.

Convective Flow and Heat Transfer from Wavy Surfaces: Viscous Fluids, Porous Media, and Nanofluids addresses the wavy irregular surfaces in heat transfer devices. Fluid flow and heat transfer studies from wavy surfaces have received attention, since they add complexity and require special mathematical techniques. This book considers the flow and heat transfer characteristics from wavy surfaces, providing an understanding of convective behavioral changes.

(Cont.) Critical heat flux enhancement in nanofluids of up to 100% was experimentally observed. The cause of this enhancement was determined to be the decreased static contact angle of nanofluid boiled surfaces. The increased wettability modified the growth of bubbles prior to CHF and promoted rewetting of hotspots at CHF. In parallel quenching tests, rewetting temperatures and velocities were simultaneously measured for the first time. Surfaces that had been pre-boiled in nanofluids were found to have significantly higher rewetting temperatures and velocities than clean surfaces. Interpretation of the experimental data was conducted with consideration of the governing surface parameters and existing models. It was found that there is significant room for improvement of most pool boiling models, especially with regard to surface effects. The research performed in this thesis help demonstrate the power of the infrared thermography technique and its potential for future improvement of boiling models.

Control volume finite element methods (CVFEM) bridge the gap between finite difference and finite element methods, using the advantages of both methods for simulation of multi-physics problems in complex geometries. In Hydrothermal Analysis in Engineering Using Control Volume Finite Element Method, CVFEM is covered in detail and applied to key areas of thermal engineering. Examples, exercises, and extensive references are used to show the use of the technique to model key engineering problems such as heat transfer in nanofluids (to enhance performance and compactness of energy systems), hydro-magnetic techniques in materials and bioengineering, and convective flow in fluid-saturated porous media. The topics are of practical interest to engineering, geothermal science, and medical and biomedical sciences. Introduces a detailed explanation of Control Volume Finite Element Method (CVFEM) to provide for a complete understanding of the fundamentals Demonstrates applications of this method in various fields, such as nanofluid flow and heat transfer, MHD, FHD, and porous media Offers complete familiarity with the governing equations in which nanofluid is used as a working fluid Discusses the governing equations of MHD and FHD Provides a number of extensive examples throughout the book Bonus appendix with sample computer code

Heat Transfer Enhancement with NanofluidsCRC Press

In three handy volumes, this ready reference provides a detailed overview of nanotechnology as it is applied to energy sustainability. Clearly structured, following an introduction, the first part of the book is dedicated to energy production, renewable energy, energy storage, energy distribution, and energy conversion and harvesting. The second part then goes on to discuss nano-enabled materials, energy conservation and management, technological and intellectual property-related issues and markets and environmental remediation. The text concludes with a look at and recommendations for future technology advances. An essential handbook for all experts in the field - from academic researchers and engineers to developers in industry.

Microscale and Nanoscale Heat Transfer: Analysis, Design, and Applications features contributions from prominent researchers in the field of micro- and nanoscale heat transfer and associated technologies and offers a complete understanding of thermal transport in nano-materials and devices. Nanofluids can be used as working fluids in thermal systems; the thermal conductivity of heat transfer fluids can be increased by adding nanoparticles in fluids. This book provides details of experimental and theoretical investigations made on nanofluids for use in the biomechanical and aerospace industries. It examines the use of nanofluids in improving heat transfer rates, covers the numerical approaches for computational fluid dynamics (CFD) simulation of nanofluids, and reviews the experimental results of commonly used nanofluids dispersed in both spherical and nonspherical nanoparticles. It also focuses on current and developing applications of microscale and nanoscale convective heat transfer. In addition, the book covers a wide range of analysis that includes: Solid–liquid interface phonon transfer at the molecular level The validity of the continuum hypothesis and Fourier law in nanochannels Conventional methods of using molecular dynamics (MD) for heat transport problems The molecular dynamics approach to calculate interfacial thermal resistance (ITR) A review of experimental results in the field of heat pipes and two-phase flows in thermosyphons Microscale convective heat transfer with gaseous flow in ducts The application of the lattice Boltzmann method for thermal microflows A numerical method for resolving the problem of subcooled convective boiling flows in microchannel heat sinks Two-phase boiling flow and condensation heat transfer in mini/micro channels, and more Microscale and Nanoscale Heat Transfer: Analysis, Design, and Applications addresses the need for thermal packaging and management for use in cooling electronics and serves as a resource for researchers, academicians, engineers, and other professionals working in the area of heat transfer, microscale and nanoscale science and engineering, and related industries.

Studies of fluid flow and heat transfer in a porous medium have been the subject of continuous interest for the past several decades because of the wide range of applications, such as geothermal systems, drying technologies, production of thermal isolators, control of pollutant spread in groundwater, insulation of buildings, solar power collectors, design of nuclear reactors, and compact heat exchangers, etc. There are several models for simulating porous media such as the Darcy model, Non-Darcy model, and non-equilibrium model. In porous media applications, such as the environmental impact of buried nuclear heat-generating waste, chemical reactors, thermal energy transport/storage systems, the cooling of electronic devices, etc., a temperature discrepancy between the solid matrix and the saturating fluid has been observed and recognized.

This book, first published in 2003, provides a concise but sound treatment of ODEs, including IVPs, BVPs, and DDEs.

This book comprises select proceedings of the International Conference on Emerging Trends in Mechanical Engineering (ICETME 2018). The book covers various topics of mechanical engineering like computational fluid dynamics, heat transfer, machine dynamics, tribology, and composite materials. In addition, relevant studies in the allied fields of manufacturing, industrial and production engineering are also covered. The applications of latest tools and techniques in the context of mechanical engineering problems are discussed in this book. The contents of this book will be useful for students, researchers as well as industry professionals.

Turbulent nanofluids flows in Rib-Groove channel are numerically investigated. The continuity, momentum and energy equations were solved by means of a finite volume method (FVM). A commercial CFD package, FLUENT, is used to perform the modeling and simulation. Different Rib-Groove shapes are used (Rectangular Rib, Triangular Rib, Trapezoidal Rib, Rectangular Groove, Triangular Groove, and Trapezoidal Groove). Four different types of Nanoparticles (Al_2O_3, CuO, SiO_2, and ZnO) with different volumes fractions in the range (0-4)% and different nanoparticle diameters in the range (25-80)nm, are dispersed in the base fluid (water, glycerin and engine oil) are used. In this study, several parameters such as different Reynolds numbers in the range of 5000

The purpose of this research is to determine the differences in heat transfer enhancement of poly alpha olefin oil after the addition of two types of carbon coated nanoparticles, specifically carbon coated cobalt and carbon coated copper nanoparticles. The carbon shell allows for the nanoparticles to be homogenously dispersed in the oil and remain stable throughout the experimental procedure. The nanofluids were prepared in concentrations of 0.5, 1.0, and 1.5 wt%. A constant surface heat flux testing rig is used to determine the heat transfer coefficients of the base fluids and the nanofluids. Inlet temperatures to the heat transfer section of the rig and flow rate of the fluid are varied to allow analysis of the impact of fluid temperature and Reynolds number. Testing occurred at temperatures of 50, 65, and 90 oC and fluid flow rates of 10 to 100 mL/s. The carbon coated copper nanoparticles showed the largest heat transfer enhancement at a fluid temperature of 65oC and at a loading concentration of 1.0 wt%. In general heat transfer enhancement decreased as both particle concentration and fluid temperature increased. The carbon coated cobalt nanoparticles exhibited the largest heat transfer enhancement at a fluid temperature of 90 oC and a particle concentration of 1.5 wt%. Heat transfer enhancement generally increased as both temperature and particle concentration increased. Overall heat transfer enhancement by the carbon coated copper nanoparticles was larger than the enhancement provided by the carbon coated cobalt nanoparticles at the same flow rate, temperature, and concentration. This is attributed to the higher thermal conductivity of copper metal.