Enhancement And Heat Exchangers

The Fluidfire shallow fluidized bed heat transfer facility was modified during this program to give increased air flow capacity and to allow testing with different distributor plates and with two-stage heat exchangers. Tests were conducted using this heat transfer facility to investigate the effect of reduced distributor plate pressure loss and amount and type of bed material on the heat transfer performance of a single-stage fluidized bed heat exchanger. Elutriation from the bed was measured for different bed materials and distributor plates; alternate heat exchanger surfaces having different fin spacings were also tested. Two types of two-stage fluidized bed heat exchangers were tested: one having a baffle (having almost no pressure loss) located between the stages and which allowed bed material to recirculate between upper and lower beds; the second having two distributor plates in series with no recirculation of the bed material. The results obtained in the experimental program were used in conceptual design studies of multi-stage fluidized bed heat exchangers for waste heat recovery from diesel engine exhaust gases. Information was obtained from the literature and from diesel engine manufacturers to determine allowable diesel engine operating back pressures. The costs were estimated for two- and three-stage designs and were compared with costs obtained previously for single-stage fluidized bed and conventional heat exchanger designs.
Presented in ten edited chapters this book encompasses important emerging topics in heat transfer equipment, particularly heat exchangers. The chapters have all been selected by invitation only.
A combined experimental and numerical investigation is under way to investigate heat transfer enhancement techniques that may be applicable to large-scale air-cooled condensers such as those used in geothermal power applications. The research is focused on whether air-side heat transfer can be improved through the use of finsurface vortex generators (winglets,) while maintaining low heat exchanger pressure drop. A transient heat transfer visualization and measurement technique has been employed in order to obtain detailed distributions of local heat transfer coefficients on model fin surfaces. Pressure drop measurements have also been acquired in a separate multiple-tube row apparatus. In addition, numerical modeling techniques have been developed to allow prediction of local and average heat transfer for these low-Reynolds-number flows with and without winglets. Representative experimental and numerical results presented in this paper reveal quantitative details of local fin-surface heat transfer in the vicinity of a circular tube with a single delta winglet pair downstream of the cylinder. The winglets were triangular [delta] with a 1:2 height/length aspect ratio and a height equal to 90% of the channel height. Overall mean fin-surface Nusselt-number results indicate a significant level of heat transfer enhancement (average enhancement ratio 35%) associated with the deployment of the winglets with oval tubes. Pressure drop measurements have also been obtained for a variety of tube and winglet configurations using a single-channel flow apparatus that includes four tube rows in a staggered array. Comparisons of heat transfer and pressure drop results for the elliptical tube versus a circular tube with and without winglets are provided. Heat transfer and pressure-drop results have been obtained for flow Reynolds numbers based on channel height and mean flow velocity ranging from 700 to 6500.
Presented in ten edited chapters this book encompasses important emerging topics in heat transfer equipment, particularly heat exchangers. The chapters have all been selected by invitation only. Advances in high temperature equipment and small scale devices continue to be important as the involved heat transfer and related phenomena are often complex in nature and different mechanisms like heat conduction, convection, turbulence, thermal radiation and phase change as well as chemical reactions may occur simultaneously. The book treats various operating problems, like fouling, and highlights applications in heat exchangers and gas turbine cooling. In engineering design and development, reliable and accurate computational methods are required to replace or complement expensive and time consuming experimental trial and error work. Tremendous advancements in knowledge and competence have been achieved during recent years due to improved computational solution methods for non-linear partial differential equations, turbulence modelling advancement and developments of computers and computing algorithms to achieve efficient and rapid simulations. The chapters of the book thoroughly present such advancement in a variety of applications.
This Brief deals with Performance Evaluation Criteria (PEC) for heat exchangers, single phase flow, objective function and constraints, algebraic formulation, constant flow rate, fixed flow area, thermal resistance, heat exchanger effectiveness, relations for St and f, finned tube banks, variations of PEC, reduced exchanger flow rate, exergy based PEC, PEC for two-phase heat exchangers, work consuming, work producing and heat actuated systems. The authors explain Performance Criteria of Enhanced Heat Transfer Surfaces—the ratio of enhanced performance to the basic performance—and its importance for Heat Transfer Enhancement and efficient thermal management in devices.
Heat transfer enhancement in single-phase and two-phase flow heat exchangers in important in such industrial applications as power generating plant, process and chemical industry, heating, ventilation, air conditioning and refrigeration systems, and the cooling of electronic equipment. Energy savings are of primary importance in the design of such systems, leading to more efficient, environmentally friendly devices. This book provides invaluable information for such purposes.

Final Report
Heat Exchangers
Selection, Rating, and Thermal Design, Third Edition
Assessment of Heat Transfer Enhancement and Fouling in Industrial Heat Exchangers
Electrohydrodynamic Enhancement of Heat Transfer in a Shell and Tube Heat Exchanger
Process Intensification
Heat Transfer Enhancement of Heat Exchangers
Heat Transfer Enhancement with Nanofluids
Numerical Simulation
Electrostatic Enhancement of Heat Transfer in Gas-to-gas Heat Exchangers
Enhancement of Heat Transfer in Waste-heat Heat Exchangers

This Brief concerns heat transfer and pressure drop in heat transfer enhancement for boiling and condensation. The authors divide their topic into six areas: abrasive treatment and coatings, combined structured and porous surfaces, basic principles of boiling mechanism, vapor space condensation, convective vaporization, and forced condensation inside tubes. Within this framework, the book examines range of specific phenomena including abrasive treatment, open grooves, 3D cavities, etched surfaces, electroplating, pierced 3D cover sheets, attached wire and screen promoters, non-wetting coatings, oxide and ceramic coatings, porous surfaces, structured surfaces (integral roughness), combined structured and porous surfaces, composite surfaces, single-tube pool boiling tests, theoretical fundamentals like liquid superheat, effect of cavity shape and contact angle on superheat, entrapment of vapor in cavities, nucleation at a surface cavity, effect of dissolved gases, bubble departure diameter, bubble dynamics, boiling hysteresis and orientation effects, basic principles of boiling mechanism, visualization and mechanism of boiling in subsurface tunnels, and Chien and Webb parametric boiling studies.
This book presents the ideas and industrial concepts in compact heat exchanger technology that have been developed in the last 10 years or so. Historically, the development and application of compact heat exchangers and their surfaces has taken place in a piecemeal fashion in a number of rather unrelated areas, principally those of the automotive and prime mover, aerospace, cryogenic and refrigeration sectors. Much detailed technology, familiar in one sector, progressed only slowly over the boundary into another sector. This compartmentalisation was a feature both of the user industries themselves, and also of the supplier, or manufacturing industries. These barriers are now breaking down, with valuable cross-fertilisation taking place. One of the industrial sectors that is waking up to the challenges of compact heat exchangers is that broadly defined as the process sector. If there is a bias in the book, it is towards this sector. Here, in many cases, the technical challenges are severe, since high pressures and temperatures are often involved, and working fluids can be corrosive, reactive or toxic. The opportunities, however, are correspondingly high, since compacts can offer a combination of lower capital or installed cost, lower temperature differences (and hence running costs), and lower inventory. In some cases they give the opportunity for a radical re-think of the process design, by the introduction of process intensification (PI) concepts such as combining process elements in one unit. An example of this is reaction and heat exchange, which offers, among other advantages, significantly lower by-product production. To stimulate future research, the author includes coverage of hitherto neglected approaches, such as that of the Second Law (of Thermodynamics), pioneered by Bejan and co- workers. The justification for this is that there is increasing interest in life-cycle and sustainable approaches to industrial activity as a whole, often involving exergy (Second Law) analysis. Heat exchangers, being fundamental components of energy and process systems, are both savers and spenders of exergy, according to interpretation.
Intensified processes have found widespread application in the chemical and petrochemical industries. The use of intensified systems allows for a reduction of operating costs and supports the “greening” of chemical processes. However, the design of intensified equipment requires special methodologies. This book describes the fundamentals and applications of these design methods, making it a valuable resource for use in both industry and academia.
The method for creation of effective heat transfer surfaces for one-phase flows, boiling, condensation, and radiation are considered. The results of experimental and analytical studies of the laws governing enhancement of heat transfer processes and influence of a macro- and microstructure of surfaces on the mechanism and characteristics of heat transfer are systematized. The concept of a real phase interface - a transition surface region - is introduced. The methods of enhancement of heat transfer in different channels of heat exchanging apparatus are considered. Practical recommendations for the choice of heat transfer enhancement, calculations of heat transfer, and hydraulic losses are given.
Heat exchanger network retrofit plays an important role in energy saving in process industry. Many design methods for the retrofit of heat exchanger networks have been proposed during the last three decades. Conventional retrofit methods rely heavily on topology modifications which often results in a long retrofit duration and high initial costs. Moreover, the addition of extra surface area to the heat exchanger can prove difficult due to topology, safety and downtime constraints. These problems can be avoided through the use of heat transfer enhancement in heat exchanger network retrofit. This thesis develops a heuristic methodology and an optimization methodology to consider heat transfer enhancement in heat exchanger network retrofit. The heuristic methodology is to identify the most appropriate heat exchangers requiring heat transfer enhancements in the heat exchanger network. From analysis in the heuristic roles, some great physical insights are presented. The optimisation method is based on simulated annealing. It has been developed to find the appropriate heat exchangers to be enhanced and to calculate the level of enhancement required. The new methodology allows several possible retrofit strategies using different retrofit methods be determined. Comparison of these retrofit strategies demonstrates that retrofit modification duration and pay-back time are reduced significantly when only heat transfer enhancement is utilised. Heat transfer enhancement may increase pressure drop in a heat exchanger. The fouling performance in a heat exchanger will also be affected when heat transfer enhancement is used. Therefore, the implications of pressure drop and fouling are assessed in the proposed methodology predicated on heat transfer enhancement. Methods to reduce pressure drop and mitigate fouling are developed to promote the application of heat transfer enhancement in heat exchanger network retrofit. In optimization methodology considering fouling, the dynamic nature of fouling is simulated by using temperature intervals. It can predict fouling performance when heat transfer enhancement is considered in the network. Some models for both heat exchanger and heat transfer enhancement are used to predict the pressure drop performance in heat exchanger network retrofit. Reducing pressure by modifying heat exchanger structure is proposed in this thesis. From case study, the pressure drop increased by heat transfer enhancement can be eliminated by modifying heat exchanger structure.
Heat transfer enhancement techniques are widely used in many applications in the heating process to make possible reduction in weight and size or enhance the performance of heat exchangers. These techniques are classified as active and passive techniques. The active technique requires external power while the passive technique does not need any external power. The passive techniques are valuable compared with the active techniques because the swirl inserts manufacturing process is simple and can be easily employed in an existing heat exchange. This book shows how the finite volume method is used to simulate various applications of heat exchanges. First, the heat transfer enhancement methods are introduced in detail. Following this, hydrothermal analysis and second law approaches are presented for heat exchanges. The melting process in heat exchanges is also covered. Finally, the influence of variable magnetic field on performance of heat exchange is discussed. 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 what the major application are.

Performance Evaluation Criteria in Heat Transfer Enhancement
Selection, Design and Operation
Efficient Surfaces for Heat Exchangers
Applications to High Temperature Heat Exchangers
Two-Phase Heat Transfer Enhancement
Heat Transfer Enhancement in Heat Exchangers Network Retrofit
Proceedings of the International Conference on Compact Heat Exchangers and Enhancement Technology for the Process Industries Held at the Banff Centre for Conferences, Banff, Canada, July 18-23, 1999
Enhancement and Heat Exchangers
Literature Review of Heat Transfer Enhancement Technology for Heat Exchangers in Gas-fired Applications
Heat Exchanger Network Retrofit Through Heat Transfer Enhancement
Heat Transfer Enhancement Techniques. With Special Attention to Passive Methods of Heat Transfer Enhancement

The drive to minimize capital investment and improve the energy efficiency of process industry plants has led to a reassessment of the desirability and practicality of incorporating compact heat exchangers (CHEs) and heat transfer enhancement technology into process plants. This volume collects papers presented at the International Conference on Compact Heat Exchangers for the Process Industries, whose objectives were to exploit the existing forms of the CHEs and enhancement technology with their potential use and benefits, to identify new forms of the CHEs and enhancement technology, and to identify and discuss barriers and critical issues preventing the broader use of CHEs and enhancement technology.
Heat exchangers are widely used in the industrial sector, e.g. in the refrigeration, air conditioning, petrochemical, and agricultural food industry. The high cost of energy and material has resulted in an increased effort aimed at producing high performance heat exchanger equipment. Passive methods of heat transfer enhancement do not need external power for enhancement. One of these kinds of passive technique is twisted tape inserts that enhance the performance of heat exchangers. Using multiple twisted tape inserts gives better enhancement than a single twisted tape insert. Using nanofluid gives also better thermal performance than water. Therefore, nanofluid along with twisted tape inserts was used in this study. For this study, different combinations of multiple twisted tape inserts were designed and fabricated. These different combinations contain dual, triple, and quadruple twisted tapes. Directions of twists are also varied which enables to study the effect of different swirl flow generators. Nanofluid is used with various volume concentrations of 0.07%, 0.14% and 0.21% in order to investigate the effect of nanoparticle concentration on heat transfer enhancement. Experimental investigation was carried out by having a constant heat flux condition and by varying the volume flow rate of flow from 2 to 10 lpm.
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
Compact Heat Exchangers: Selection, Design, and Operation, Second Edition, is fully revised to present the most recent and fundamental ideas and industrial concepts in compact heat exchanger technology. This complete reference compiles all aspects of theory, design rules, operational issues, and the most recent developments and technological advancements in compact heat exchangers. New to this edition is the inclusion of micro, sintered, and porous passage description and data, electronic cooling, and an introduction to convective heat transfer fundamentals. New revised content provides up-to-date coverage of industrially available exchangers, recent fouling theories, and reactor types, with summaries of off-design performance and system effects and installations issues in, for example, automobiles and aircraft. Hesselgreaves covers previously neglected approaches, such as the Second Law (of Thermodynamics), pioneered by Bejan and co-workers. The justification for this is that there is increasing interest in life-cycle and sustainable approaches to industrial activity as a whole, often involving exergy (Second Law) analysis. Heat exchangers, being fundamental components of energy and process systems, are both savers and spenders of energy, according to interpretation. Contains revised content, covering industrially available exchangers, recent fouling theories, and reactor types Includes useful comparisons throughout with conventional heat exchangers to emphasize the benefits of CPHE applications Provides a thorough system view from commissioning, operation, maintenance, and design approaches to reduce fouling and fouling factors Compiles all aspects of theory, design rules, operational issues, and the most recent developments and technological advancements in compact heat exchangers
Heat exchangers are essential in a wide range of engineering applications, including power plants, automobiles, airplanes, process and chemical industries, and heating, air-conditioning, and refrigeration systems. Revised and fully updated with new problem sets, Heat Exchangers: Selection, Rating, and Thermal Design, Fourth Edition presents a systematic treatment of heat exchangers, focusing on selection, thermal-hydraulic design, and rating. Topics discussed include Classification of heat exchangers Basic design methods of heat exchangers for sizing and rating problems Single-phase forced convection correlations for heat exchangers Pressure drop and pumping power for heat exchangers and piping circuits Design methods of heat exchangers subject to fouling Thermal design methods and processes for double-pipe, shell-and-tube, gasketed-plate, compact, and polymer heat exchangers Two-phase convection correlations for heat exchangers Thermal design of condensers and evaporators Micro/nanoheat transfer The Fourth Edition contains updated information about microscale heat exchangers and the enhancement heat transfer for applications to heat exchanger design and experiment with nanofluids. The Fourth Edition is designed for courses/modules in process heat transfer, thermal systems design, and heat exchanger technology. This text includes full coverage of all widely used heat exchanger types. A complete solutions manual and figure slides of the text's illustrations are available for qualified adopting instructors.
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.

Investigation of Wire Structures for Heat Transfer Enhancement in Compact Heat Exchangers
Advances in Heat Transfer Enhancement
Energy Conservation Through Heat Transfer Enhancement of Heat Exchangers
Final Report (June 1987 - March 1991)
Fundamentals and Design
Compact Heat Exchangers and Enhancement Technology for the Process Industries
Heat Transfer Enhancement in a Rectangular Channel Using Vortex Generator in a Laminar Flow
Heat Transfer Enhancement of Vapor Condensation Heat Exchanger
Models, Methods and Applications
Heat Transfer - Soviet Review - Enhancement Of Heat Transfer
Nanofluid in Heat Exchangers for Mechanical Systems

Enhancement of heat transfer through various means has been an intense area of research for many years. There are numerous applications where high performance heat exchange is desired. The cooling of electronics, such as microprocessors, is one example. The recent rise in the studies of heat exchange enhancement techniques has also lead to efficient and compact heat exchangers. This research involves the numerical analysis of heat exchange enhancement in a rectangular channel using different types of longitudinal vortex generators (LVG) for a laminar flow. A computational fluid dynamics software package was used to compute the 3-D steady viscous flows with heat transfer. The effects of Reynolds number ranging from 500 to 1000 (laminar flow) are shown from different attack angles of the vortex generators (30° and 45°). Three different types of vortex generators are studied: a delta wing with finite thickness, a trapezoidal delta wing, and a delta winglet pair (also called half delta wing) for a common flow down configuration. The Nusselt number is computed and compared with the Nusselt number without the LVG's. The results show that the LVG's effectively enhances the heat transfer in the rectangular channel. In addition, the impact of the LVG's drag and the resulting pressure drop across the channel was quantified. The Darcy's friction factor (f) was computed and compared with the friction factor without LVG's (f0). For each case the performance evaluation parameter was computed to gauge the overall efficiency of the configuration. Results are discussed and recommendations for future investigations are given.
The efficient and effective utilization of fuel and energy resources is a problem of major importance. The ever increasing heat exchanger ratings and flowrate volumes utilize increasingly large heat exchangers. Making these more efficient and compact will ensure a significant saving of fuel, construction materials and labour.
This Brief deals with heat transfer and friction in plate and fin extended heat transfer enhancement surfaces. It examines Offset-Strip Fin (OSF), Enhancement Principle, Analytically Based Models for j and f vs. Re, Transition from Laminar to Turbulent Region, Correlations for j and f vs. Re, Use of OSF with Liquids, Effect of Percent Fin Offset, Effect of Burred Edges, Louver fin, heat transfer and friction correlations, flow structure in the louver fin array, analytical model for heat transfer and friction, convex louver fin, wavy fin, 3D corrugated fin, perforated fin, pin fins and wire mesh, types of vortex generators, metal foam fin, plain fin, packings, numerical simulation of various types of fins.
This book presents contributions from renowned experts addressing research and development related to the two important areas of heat exchangers, which are advanced features and applications. This book is intended to be a useful source of information for researchers, postgraduate students, academics, and engineers working in the field of heat exchangers research and development.
The book focuses on new analytical, experimental, and computational developments in the field of research of heat and mass transfer phenomena. The generation, conversion, use, and exchange of thermal energy between physical systems are considered. Various mechanisms of heat transfer such as thermal conduction, thermal convection, thermal radiation, and transfer of energy by phase changes are presented. Theory and fundamental research in heat and mass transfer, numerical simulations and algorithms, experimental techniques, and measurements as they applied to all kinds of applied and emerging problems are covered.
Indeed, today "second generation" enhancement concepts are routing in the automotive and refrigeration industries to obtain lower cost, smaller heat exchanger size, and higher energy efficiency in system operation. And the aerospace, process, and power generation industries are not far behind.

Selection, Rating, and Thermal Design, Fourth Edition
Compact Heat Exchangers
May 25 - June 5, 1998, Altin Yunus (Golden Dolphin), Cesme İzmir, Turkey
Heat Transfer Enhancement in Plate and Fin Extended Surfaces
Nanofluid in Heat Exchanges for Mechanical Systems
Topical Technical Report (1 April 1990-28 February 1991)
Heat Transfer
Enhancement of Heat Transfer
Principles of Enhanced Heat Transfer
Advanced Features and Applications
Advances in Heat Exchangers

This Brief deals with electrode design and placement, enhancement of both liquid and gas flow, vapor space condensation, in-tube condensation, falling film evaporation, correlations. It further provides a fundamental understanding of boiling and condensation, pool boiling, critical heat flux, convective vaporization, additives for single-phase liquids like solid particles, gas bubbles, suspensions in dilute polymer and surfactant solutions, solid additives and liquid additives for gases, additives for boiling, condensation and absorption, mass transfer resistance in gas phase (condensation with noncondensible gases, evaporation into air, dehumidifying finned tube heat exchangers, water film enhancement of finned tube exchanger), controlling resistance in liquid phase, and significant resistance in both phases. The volume is ideal for professionals and researchers dealing with thermal management in devices.
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.
Heat exchangers are important devices for engineering, research, and industry. Because of this, any improvement helps to optimize the whole process. Opportunity areas may be found in design, materials, or working fluids. In this sense, the present book compiles some advances in the matter of design (three chapters) and working fluids (one chapter). An introductory chapter also is presented.
Heat exchangers are essential in a wide range of engineering applications, including power plants, automobiles, airplanes, process and chemical industries, and heating, air conditioning and refrigeration systems. Revised and updated with new problem sets and examples, Heat Exchangers: Selection, Rating, and Thermal Design, Third Edition presents a systematic treatment of the various types of heat exchangers, focusing on selection, thermal-hydraulic design, and rating. Topics discussed include: Classification of heat exchangers according to different criteria Basic design methods for sizing and rating of heat exchangers Single-phase forced convection correlations in channels Pressure drop and pumping power for heat exchangers and their piping circuit Design solutions for heat exchangers subject to fouling Double-pipe heat exchanger design methods Correlations for the design of two-phase flow heat exchangers Thermal design methods and processes for shell-and-tube, compact, and gasketed-plate heat exchangers Thermal design of condensers and evaporators This third edition contains two new chapters. Micro/Nano Heat Transfer explores the thermal design fundamentals for microscale heat exchangers and the enhancement heat transfer for applications to heat exchanger design with nanofluids. It also examines single-phase forced convection correlations as well as flow friction factors for microchannel flows for heat transfer and pumping power calculations. Polymer Heat Exchangers introduces an alternative design option for applications hindered by the operating limitations of metallic heat exchangers. The appendices provide the thermophysical properties of various fluids. Each chapter contains examples illustrating thermal design methods and procedures and relevant nomenclature. End-of-chapter problems enable students to test their assimilation of the material.

Heat Transfer Enhancement and Pressure Drop Penalty in Porous Solar Heat Exchangers: A Sensitivity Analysis
Experimental and Numerical Results
Heat Transfer Enhancement
Electric Fields, Additives and Simultaneous Heat and Mass Transfer in Heat Transfer Enhancement
Design Methodologies
Heat Transfer Enhancement for Finned-Tube Heat Exchangers with Vortex Generators
Emerging Topics in Heat Transfer