

Entropy Generation Minimization The Method Of Thermodynamic Optimization Of Finite Size Systems And Finite Time Processes Mechanical And Aerospace Engineering Series

This book describes the Exergy-based Input – Output (ExIO) framework, a comprehensive methodology for assessing the primary fossil fuels requirements for the production of goods and services within a given economy from a lifecycle perspective. In the ExIO approach, exergy is assumed to be the best suited thermodynamic metric for characterizing fossil fuels. The mathematical formulation of ExIO is based on Input-Output analysis, which defines boundaries in time and space for any system or product analyzed, encompassing its entire lifecycle. The Hybrid-ExIO approach has been developed to increase the accuracy of results and to analyze energy systems in detail, leading to the definition of criteria and indicators for identifying and optimizing the primary fossil fuels requirements of system products. Lastly, the Bioeconomic ExIO model has been proposed to account for the side effects that the working hours required for producing goods and services have on the total primary fossil fuels consumption. As such, the book will be of considerable interest to both researchers and engineers in industry, offering them essential guidelines on the utilization of exergy and thermoeconomic analysis.

Good, No Highlights, No Markup, all pages are intact, Slight Shelfwear, may have the corners slightly dented, may have slight color changes/slightly damaged spine.

This book presents the diverse and rapidly expanding field of Entropy Generation Minimization (EGM), the method of thermodynamic optimization of real devices. The underlying principles of the EGM method - also referred to as "thermodynamic optimization," "thermodynamic design," and "finite time thermodynamics" - are thoroughly discussed, and the method's applications to real devices are clearly illustrated. The EGM field has experienced tremendous growth during the 1980s and 1990s. This book places EGM's growth in perspective by reviewing both sides of the field - engineering and physics. Special emphasis is given to chronology and to the relationship between the more recent work and the pioneering work that outlined the method and the field. Entropy Generation Minimization combines the fundamental principles of thermodynamics, heat transfer, and fluid mechanics. EGM applies these principles to the modeling and optimization of real systems and processes that are characterized by finite size and finite time constraints, and are limited by heat and mass transfer and fluid flow irreversibilities. Entropy Generation Minimization provides a straightforward presentation of the principles of the EGM method, and features examples that elucidate concepts and identify recent EGM advances in engineering and physics. Modern advances include the optimization of storage by melting and solidification; heat exchanger design; power from hot-dry-rock deposits; the on & off operation of defrosting refrigerators and power plants with fouled heat exchangers; the production of ice and other solids; the maximization of power output in simple power plant models with heat transfer irreversibilities; the minimization of refrigerator power input in simple models; and the optimal collection and use of solar energy.

Kjelstrup, Bedeaux, Johannessen, and Gross describe what non-equilibrium thermodynamics is in a simple and practical way and how it can add to engineering design. They explain how to describe proper equations of transport that are more precise than those used so far, and how to use them to understand the waste of energy resources in central process units in the industry. The authors introduce the entropy balance as an additional equation to use in engineering; to create consistent thermodynamic models, and to systematically minimize energy losses that are connected with the transport of heat, mass, charge and momentum. Non-equilibrium Thermodynamics for Engineers teaches the essence of non-equilibrium thermodynamics and its applications at a level comprehensible to engineering students, practitioner engineers, and scientists working on industrial problems. The book may be used as a textbook in basic engineering curricula or graduate courses.

Is the heat and mass transfer intensification defined as a new paradigm of process engineering, or is it just a common and old idea, renamed and given the current taste? Where might intensification occur? How to achieve intensification? How the shape optimization of thermal and fluidic devices leads to intensified heat and mass transfers? To answer these questions, Heat & Mass Transfer Intensification and Shape Optimization: A Multi-scale Approach clarifies the definition of the intensification by highlighting the potential role of the multi-scale structures, the specific interfacial area, the distribution of driving force, the modes of energy supply and the temporal aspects of processes. A reflection on the methods of process intensification or heat and mass transfer enhancement in multi-scale structures is provided, including porous media, heat exchangers, fluid distributors, mixers and reactors. A multi-scale approach to achieve intensification and shape optimization is developed and clearly explained. Providing readers with a tool box of reflections, techniques, methods, supported by literature reviews, Heat & Mass Transfer Intensification and Shape Optimization: A Multi-scale Approach will be a key guide for students, a teaching aid for lecturers and a source of inspiration for future research subjects.

Selecting and bringing together matter provided by specialists, this project offers comprehensive information on particular cases of heat exchangers. The selection was guided by actual and future demands of applied research and industry, mainly focusing on the efficient use and conversion energy in changing environment. Beside the questions of thermodynamic basics, the book addresses several important issues, such as conceptions, design, operations, fouling and cleaning of heat exchangers. It includes also storage of thermal energy and geothermal energy use, directly or by application of heat pumps. The contributions are thematically grouped in sections and the content of each section is introduced by summarising the main objectives of the encompassed chapters. The book is not necessarily intended to be an elementary source of the knowledge in the area it covers, but rather a mentor while pursuing detailed solutions of specific technical problems which face engineers and technicians engaged in research and development in the fields of heat transfer and heat exchangers.

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The engineer's ready reference for mechanical power and heat Mechanical Engineer's Handbook provides the most comprehensive coverage of the entire discipline, with a focus on explanation and analysis. Packaged as a modular approach, these books are designed to be used either individually or as a set, providing engineers with a thorough, detailed, ready reference on topics that may fall outside their scope of expertise. Each book provides discussion and examples as opposed to straight data and calculations, giving readers the immediate background they need while

pointing them toward more in-depth information as necessary. Volume 4: Energy and Power covers the essentials of fluids, thermodynamics, entropy, and heat, with chapters dedicated to individual applications such as air heating, cryogenic engineering, indoor environmental control, and more. Readers will find detailed guidance toward fuel sources and their technologies, as well as a general overview of the mechanics of combustion. No single engineer can be a specialist in all areas that they are called on to work in the diverse industries and job functions they occupy. This book gives them a resource for finding the information they need, with a focus on topics related to the productions, transmission, and use of mechanical power and heat. Understand the nature of energy and its proper measurement and analysis Learn how the mechanics of energy apply to furnaces, refrigeration, thermal systems, and more Examine the and pros and cons of petroleum, coal, biofuel, solar, wind, and geothermal power Review the mechanical parts that generate, transmit, and store different types of power, and the applicable guidelines Engineers must frequently refer to data tables, standards, and other list-type references, but this book is different; instead of just providing the answer, it explains why the answer is what it is. Engineers will appreciate this approach, and come to find Volume 4: Energy and Power an invaluable reference.

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Applications of Heat, Mass and Fluid Boundary Layers brings together the latest research on boundary layers where there has been remarkable advancements in recent years. This book highlights relevant concepts and solutions to energy issues and environmental sustainability by combining fundamental theory on boundary layers with real-world industrial applications from, among others, the thermal, nuclear and chemical industries. The book's editors and their team of expert contributors discuss many core themes, including advanced heat transfer fluids and boundary layer analysis, physics of fluid motion and viscous flow, thermodynamics and transport phenomena, alongside key methods of analysis such as the Merk-Chao-Fagbenle method. This book's multidisciplinary coverage will give engineers, scientists, researchers and graduate students in the areas of heat, mass, fluid flow and transfer a thorough understanding of the technicalities, methods and applications of boundary layers, with a unified approach to energy, climate change and a sustainable future. Presents up-to-date research on boundary layers with very practical applications across a diverse mix of industries Includes mathematical analysis to provide detailed explanation and clarity Provides solutions to global energy issues and environmental sustainability

This book offers a collection of original peer-reviewed contributions presented at the 8th International Congress on Design and Modeling of Mechanical Systems (CMSM'2019), held in Hammamet, Tunisia, from the 18th to the 20th of March 2019. It reports on research, innovative industrial applications and case studies concerning mechanical systems and related to modeling and analysis of materials and structures, multiphysics methods, nonlinear dynamics, fluid structure interaction and vibroacoustics, design and manufacturing engineering. Continuing on the tradition of the previous editions, these proceedings offers a broad overview of the state-of-the art in the field and a useful resource for academic and industry specialists active in the field of design and modeling of mechanical systems. CMSM'2019 was jointly organized by two leading Tunisian research laboratories: the Mechanical Engineering Laboratory of the National Engineering School of Monastir, University of Monastir and the Mechanical, Modeling and Manufacturing Laboratory of the National Engineering School of Sfax, University of Sfax.

This book results from a Special Issue related to the latest progress in the thermodynamics of machines systems and processes since the premonitory work of Carnot. Carnot invented his famous cycle and generalized the efficiency concept for thermo-mechanical engines. Since that time, research progressed from the equilibrium approach to the irreversible situation that represents the general case. This book illustrates the present state-of-the-art advances after one or two centuries of consideration regarding applications and fundamental aspects. The research is moving fast in the direction of economic and environmental aspects. This will probably continue during the coming years. This book mainly highlights the recent focus on the maximum power of engines, as well as the corresponding first law efficiency upper bounds.

Constructal theory has been extensively used to analyze and optimize many different shapes and structures in both living and non-living systems. It is generally considered to be a law that could govern the evolutions of shapes and structures in biology, physics, technology, and social organization. Accordingly, it seems that the constructal method is suitable for designing and analyzing all kinds of shapes and structures in the world. However, in most cases, the details for its applications were not carefully checked, meaning that it was often incorrectly applied, and that many unreasonable or inaccurate results were provided. This book systematically reviews and checks the applications of constructal theory in street design, economics, heat transfer optimization, flow systems, and explanations of natural structures and social phenomena. Every detail of the models, methods, optimizations, applications, results and conclusions is analysed, with careful consideration of theoretical derivations and typical examples. Accordingly, the problems and mistakes in the applications of the theory are directly pointed out and discussed in detail. The abuse and limitation of the constructal approach are also discussed. In many cases, it is shown that the theory has significant flaws and is even not applicable in certain circumstances. As constructal theory is widely used in the analysis and design of shapes and structures, this book will be essential for scientists, researchers, engineers, teachers, postgraduates and undergraduates in the fields of structure analysis, design and optimization in physics, biology, flow dynamics, heat transfer and thermodynamics.

The goal of this project is to demonstrate by using a heat exchanger as an example, that the minimization of life cycle entropy generation is a useful concept for the optimization of thermal systems. For this purpose the entropy production over the life of the heat exchanger is calculated and in addition the entropy generated during the manufacturing process is accounted for too. In this exploratory phase of the project, the entropy generation during the manufacturing process is calculated based only on the entropy production during the various energy conversion processes that contribute to the

manufacturing process. This includes the metal processing beginning with theory and accounting for a fraction of recycled metal that is usually included it also accounts for the contribution of human labor, although this term is found to be usually negligible. A simulation code was written for the heat exchanger to calculate and minimize its life cycle entropy generation. The results clearly show that minima are found when design parameters such as material selection, tube length, number of tubes, operating conditions and others are varied. The results also indicate that this method will continue to be useful when applied to more complex systems such as entire subsystems and complete, integrated systems such as aircraft.

From engineering fluid mechanics to power systems, information coding theory and other fields, entropy is key to maximizing performance in engineering systems. It serves a vital role in achieving the upper limits of efficiency of industrial processes and quality of manufactured products. Entropy based design (EBD) can shed new light on various flow processes, ranging from optimized flow configurations in an aircraft engine to highly ordered crystal structures in a turbine blade. Entropy Based Design of Fluid Engineering Systems provides an overview of EBD as an emerging technology with applications to aerospace, microfluidics, heat transfer, and other disciplines. The text extends past analytical methods of Entropy Generation Minimization to numerical simulations involving more complex configurations and experimental measurement techniques. The book begins with an extensive development of basic concepts, including the mathematical properties of entropy and exergy, as well as statistical and numerical formulations of the second law. It then goes on to describe topics related to incompressible flows and the Second Law in microfluidic systems. The authors develop computational and experimental methods for identifying problem regions within a system through the local rates of entropy production. With these techniques, designers can use EBD to focus on particular regions where design modifications can be made to improve system performance. Numerous case studies illustrate the concepts in each chapter, and cover an array of applications including supersonic flows, condensation and turbulence. A one-of-a-kind reference, Entropy Based Design of Fluid Engineering Systems outlines new advances showing how local irreversibilities can be detected in complex configurations so that engineering devices can be re-designed locally to improve overall performance.

Since its publication almost a decade ago, Adrian Bejan's Advanced Engineering Thermodynamics has established itself as the definitive modern treatment of this challenging subject. Now the Second Edition brings this important work fully up to date with current analyses and practices, and explores uncharted territory along the promising frontier of contemporary research. Grounded in the axiomatic formulation and Gibbsian analytical structure of classical thermodynamics, this revised volume offers an incisive examination of the history, concepts, and language of thermodynamics. Readers will find a clear review of the first and second laws of thermodynamics, along with enhanced material on exergy analysis methods, entropy generation minimization, and related design applications. The Second Edition takes an in-depth look at the latest developments in the field in areas such as power generation, solar energy, low-temperature refrigeration, air conditioning, and thermal design. Bridging the gap between physics and biology, this book, for the first time, provides a fascinating introduction to the constructal theory of macroscopic organization in nature, extending thermodynamics into the realm of naturally organized systems. Geometric shape and structure are deduced from a single principle of thermodynamic optimization. Complete with original problems, worked-out examples, exceptional graphics, and hundreds of references throughout, Advanced Engineering Thermodynamics, Second Edition is the ideal cutting-edge reference for today's professional engineers and researchers as well as a superb resource for advanced engineering students. Praise for the First Edition: "Demonstrates that engineering thermodynamics is still an active research field . . . will be valuable to all those seeking a deeper understanding of thermodynamic systems." —ASLIB Book List "Strikes a balance between the latest developments in the field and the 'classical' approach to the study of thermodynamics." —Engineering Societies Library Incomparable coverage of engineering thermodynamics—in a brand-new, up-to-date edition . . . The first edition of Advanced Engineering Thermodynamics broke fresh ground with its engaging treatment of key topics in thermal engineering. Now, building on the success of its predecessor, this Second Edition balances a detailed examination of the history, concepts, and language of classical thermodynamics with state-of-the-art coverage of the latest developments in analysis and practice. In addition to cutting-edge material on contemporary research areas such as entropy generation minimization and the constructal theory of organization in nature, readers of the Second Edition will find: A solid review of the first and second laws of thermodynamics, with an emphasis on problem-solving Separate chapters devoted to single-phase systems, multiphase systems, chemically reactive systems, exergy analysis, thermodynamic optimization, and irreversible thermodynamics Thermodynamics applied to specific areas, including power generation, solar energy, refrigeration, air conditioning, and thermal design More problems and worked-out examples throughout the text High-quality original graphics, plus hundreds of classical and contemporary references Moving effortlessly between analysis and essay, this revised edition of Adrian Bejan's trailblazing work will inspire a new generation of researchers and students in all areas of engineering.

This book presents selected extended papers from The First International Conference on Mechanical Engineering (INCOM2018), realized at the Jadavpur University, Kolkata, India. The papers focus on diverse areas of mechanical engineering and some innovative trends in mechanical engineering design, industrial practices and mechanical engineering education. Original, significant and visionary papers were selected for this edition, specially on interdisciplinary and emerging areas. All papers were peer-reviewed.

This book is the first major work covering applications in thermal engineering and offering a comprehensive introduction to optimal control theory, which has applications in mechanical engineering, particularly aircraft and missile trajectory optimization. The book is organized in three parts: The first part includes a brief presentation of function optimization and variational calculus, while the second part presents a summary of the optimal control theory. Lastly, the third part describes several applications of optimal control theory in solving various thermal engineering problems. These applications are grouped in four sections: heat transfer and thermal energy storage, solar thermal engineering, heat engines and lubrication. Clearly presented and easy-to-use, it is a valuable resource for thermal engineers and thermal-system designers as well as postgraduate students.

A comprehensive and rigorous introduction to thermal system design from a contemporary perspective Thermal Design and Optimization offers readers a lucid introduction to the latest methodologies for the design of thermal systems and emphasizes engineering economics, system simulation, and optimization methods. The methods of exergy analysis, entropy generation minimization, and thermoeconomics are incorporated in an evolutionary manner. This book is one of the few sources available that addresses the recommendations of the Accreditation Board for Engineering and Technology for new courses in design engineering. Intended for classroom use as well as self-study, the text provides a review of fundamental concepts, extensive reference lists, end-of-chapter problem sets, helpful appendices, and a comprehensive case study that is followed throughout the text. Contents include: * Introduction to Thermal System Design * Thermodynamics, Modeling, and Design Analysis * Exergy Analysis * Heat Transfer, Modeling, and Design Analysis * Applications with Heat and Fluid Flow * Applications with Thermodynamics and Heat and Fluid Flow * Economic Analysis * Thermoeconomic Analysis and Evaluation * Thermoeconomic Optimization Thermal Design and Optimization offers engineering students, practicing engineers, and technical managers a comprehensive and rigorous introduction to thermal system design and optimization from a distinctly contemporary perspective. Unlike traditional books that are largely oriented toward design analysis and components, this forward-thinking book aligns itself with an increasing number of active designers who believe that more effective, system-oriented design methods are needed. Thermal Design and Optimization offers a lucid presentation of thermodynamics, heat transfer, and fluid mechanics as they are applied to the design of thermal systems. This

book broadens the scope of engineering design by placing a strong emphasis on engineering economics, system simulation, and optimization techniques. Opening with a concise review of fundamentals, it develops design methods within a framework of industrial applications that gradually increase in complexity. These applications include, among others, power generation by large and small systems, and cryogenic systems for the manufacturing, chemical, and food processing industries. This unique book draws on the best contemporary thinking about design and design methodology, including discussions of concurrent design and quality function deployment. Recent developments based on the second law of thermodynamics are also included, especially the use of exergy analysis, entropy generation minimization, and thermoeconomics. To demonstrate the application of important design principles introduced, a single case study involving the design of a cogeneration system is followed throughout the book. In addition, Thermal Design and Optimization is one of the best newsources available for meeting the recommendations of the Accreditation Board for Engineering and Technology for more design emphasis in engineering curricula. Supported by extensive reference lists, end-of-chapter problem sets, and helpful appendices, this is a superb text for both the classroom and self-study, and for use in industrial design, development, and research. A detailed solutions manual is available from the publisher.

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In this book, the fundamentals of chemical engineering are presented with respect to applications in micro system technology, microfluidics, and transport processes within microstructures. Special features of the book include the state-of-the-art in micro process engineering, a detailed treatment of transport phenomena for engineers, and a design methodology from transport effects to economic considerations. Despite the vast research on energy optimization and process integration, there has to date been no synthesis linking these together. This book fills the gap, presenting optimization and integration in energy and process engineering. The content is based on the current literature and includes novel approaches developed by the authors. Various thermal and chemical systems (heat and mass exchangers, thermal and water networks, energy converters, recovery units, solar collectors, and separators) are considered. Thermodynamics, kinetics and economics are used to formulate and solve problems with constraints on process rates, equipment size, environmental parameters, and costs. Comprehensive coverage of dynamic optimization of energy conversion systems and separation units is provided along with suitable computational algorithms for deterministic and stochastic optimization approaches based on: nonlinear programming, dynamic programming, variational calculus, Hamilton-Jacobi-Bellman theory, Pontryagin's maximum principles, and special methods of process integration. Integration of heat energy and process water within a total site is shown to be a significant factor reducing production costs, in particular costs of utilities for the chemical industry. This integration involves systematic design and optimization of heat exchangers and water networks (HEN and WN). After presenting basic, insight-based Pinch Technology, systematic, optimization-based sequential and simultaneous approaches to design HEN and WN are described. Special consideration is given to the HEN design problem targeting stage, in view of its importance at various levels of system design. Selected, advanced methods for HEN synthesis and retrofit are presented. For WN design a novel approach based on stochastic optimization is described that accounts for both grassroot and revamp design scenarios. Presents a unique synthesis of energy optimization and process integration that applies scientific information from thermodynamics, kinetics, and systems theory Discusses engineering applications including power generation, resource upgrading, radiation conversion and chemical transformation, in static and dynamic systems Clarifies how to identify thermal and chemical constraints and incorporate them into optimization models and solutions

Thermal analyses and optimizations are very ubiquitous and important in academic research and engineering applications. In this field, the entropy generation minimization has been widely used and found to be effective in many cases. Sometimes, it was even used without checking the applicability, and seemed to be a unified theory that could solve all thermal problems. Is this really the case? This book answers this question through detailed theoretical derivations and different numerical examples in heat transfer and heat-work conversion. It shows clearly that the theory has limitations and a definite application scope, beyond which it may provide unreasonable or incorrect results. Therefore, the entropy generation minimization is far from perfect. This book will be of interest to students, researchers and engineers in thermal science and engineering, as it will help the reader to apply the entropy generation minimization correctly.

This Brief offers a comprehensive study covering the different aspects of gas allocation optimization in petroleum engineering. It contains different methods of defining the fitness function, dealing with constraints and selecting the optimizer; in each chapter a detailed literature review is included which covers older and important studies as well as recent publications. This book will be of use for production engineers and students interested in gas lift optimization.

A comprehensive assessment of the methodologies of thermodynamic optimization, exergy analysis and thermoeconomics, and their application to the design of efficient and environmentally sound energy systems. The chapters are organized in a sequence that begins with pure thermodynamics and progresses towards the blending of thermodynamics with other disciplines, such as heat transfer and cost accounting. Three methods of analysis stand out: entropy generation minimization, exergy (or availability) analysis, and thermoeconomics. The book reviews current directions in a field that is both extremely important and intellectually alive. Additionally, new directions for research on thermodynamics and optimization are revealed.

"This extensive update of a well-known and respected title is revised for greater accessibility and to include new cutting-edge topics."--Publisher's description.

This book describes the state of the art at the interface between energy and environmental research. The contributing authors are some of the world leaders in research and education on energy and environmental topics. The coverage is worth noting for its breadth and depth. The book begins with the latest trends in applied thermodynamics: the methods of exergy analysis, entropy generation minimization and thermoeconomics. It continues with the most modern developments in energy processing and conservation techniques: heat transfer augmentation devices, inverse thermal design, combustion and heat exchangers for environmental systems. The environmental impact of energy systems is documented in a diversity of applications such as the flow of hazardous waste through cracks and porous media, thermally induced flows through coastal waters near power plants, and lake ecology in the vicinity of pumped storage systems. The book outlines new research directions such as the manufacturing of novel materials from solid waste, advances in radiative transport, the measurement of convective heat transfer in gas turbines and environmentally acceptable refrigerants. The book is rich in engineering design data that make a concrete statement on topics of world wide interest, e.g., toxic emissions, the depletion of energy resources, global environmental change (global warming), and future trends in the power generation industries. Written by leaders in research and education, this book is an excellent text or supplement for undergraduate and graduate courses on energy engineering and environmental science.

Heat Transfer XIII: Simulation and Experiments in Heat and Mass Transfer contains the proceedings of the thirteenth conference in the well established series on Simulation and Experiments in Heat Transfer and its applications. Advances in computational methods for solving and understanding heat transfer problems continue to be important because heat transfer topics and related phenomena are commonly of a complex nature and different mechanisms like heat conduction, convection, turbulence, thermal radiation and phase change as well as chemical reactions may occur simultaneously. Typically, applications are found in heat exchangers, gas turbine cooling, turbulent combustion and fires, fuel cells, batteries, micro- and mini- channels, electronics cooling, melting and solidification, chemical processing etc. Heat Transfer might be regarded as an established and mature scientific discipline, but it has played a major role in new emerging areas such as sustainable development and reduction of greenhouse gases as well as for micro- and nano- scale structures and bioengineering. Non-linear

phenomena other than momentum transfer may occur due to temperature-dependent thermophysical properties. In engineering design and development, reliable and accurate computational methods are requested to replace or complement expensive and time consuming experimental trial and error work. Tremendous advancements have been achieved during recent years due to improved numerical solution methods for non-linear partial differential equations, turbulence modelling advancements and developments of computers and computing algorithms to achieve efficient and rapid simulations. Nevertheless, to further progress in computational methods requires developments in theoretical and predictive procedures – both basic and innovative – and in applied research. Accurate experimental investigations are needed to validate the numerical calculations. Topics covered include: Heat transfer in energy producing devices; Heat transfer enhancements; Heat exchangers; Natural and forced convection and radiation; Multiphase flow heat transfer; Modelling and experiments; Heat recovery; Heat and mass transfer problems; Environmental heat transfer; Experimental and measuring technologies; Thermal convert studies.

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Porous and Complex Flow Structures in Modern Technologies represents a new approach to the field, considering the fundamentals of porous media in terms of the key roles played by these materials in modern technology. Intended as a text for advanced undergraduates and as a reference for practicing engineers, the book uses the physics of flows in porous materials to tie together a wide variety of important issues from such fields as biomedical engineering, energy conversion, civil engineering, electronics, chemical engineering, and environmental engineering. Thus, for example, flows of water and oil through porous ground play a central role in energy exploration and recovery (oil wells, geothermal fluids), energy conversion (effluents from refineries and power plants), and environmental engineering (leachates from waste repositories). Similarly, the demands of miniaturization in electronics and in biomedical applications are driving research into the flow of heat and fluids through small-scale porous media (heat exchangers, filters, gas exchangers). Filters, catalytic converters, the drying of stored grains, and a myriad of other applications involve flows through porous media. By providing a unified theoretical framework that includes not only the traditional homogeneous and isotropic media but also models in which the assumptions of representative elemental volumes or global thermal equilibrium fail, the book provides practicing engineers the tools they need to analyze complex situations that arise in practice. This volume includes examples, solved problems and an extensive glossary of symbols.

The generation of globally optimal designs which can minimize capital and/or operating cost expenditures is a highly sought after objective within the chemical industry. A methodology which can systematically generate such globally optimal solutions to objective functions commonly encountered in the chemical industry is the IDEAS framework. The IDEAS framework decomposes a process network into an operator, OP network, where the unit operations (reactors, distillation columns, heat exchangers, etc.) occur, and a distribution, DN network, where the flow operations (mixing, splitting, recycling, and bypass) occur. The optimal process network structure is identified through solution of an infinite linear program (ILP) that is formulated within the IDEAS framework. The ILP's solution is approximated by finite dimensional linear programs of ever increasing size. The global optimization of complex, multi-pressure distillation networks for the separation of azeotropic mixtures using the IDEAS framework, is presented in chapter 1. The objective function in this case aims at minimizing total network flow in an effort to directly (indirectly) reduce capital (operating) costs. The global optimization of chemical reactor networks is presented in chapter 2-4. There, interesting properties relating to energy consumption and entropy generation for isothermal/isobaric reactor networks are described in the context of the attainable region (AR). Given certain assumptions, namely that all reactors are either of the endothermic or exothermic kind, a proof is presented that energy consumption and entropy generation can be rigorously identified in the infinite space of chemical reactors, independently of the network's internals (chapter 2). For the case of isothermal/isobaric chemical reactor networks where both endothermic and exothermic reactors participate in delivering the desired outlet product composition, entropy generation minimization is synonymous with an objective function of minimum hot/cold utility cost, with the cost coefficient of hot (cold) streams being the inverse of the temperature of the cold (hot) reservoir to which it adds (removes) energy. For this scenario, the network's internal structure plays a key role in determining the optimal reactor network, which is determined using the IDEAS framework (chapter 3). A novel method to identify the sequence of isothermal mixed flow reactors (CSTR's) which globally minimizes a reactor residence time dependent objective function (able to represent such objectives as capital cost, volume, or total annualized cost), subject to a constraint dependent on the reactor sequence's exit concentrations, is presented in chapter 4. Finally, chapter 5 discusses a novel, heat-integrated, pressure-temperature-swing-adsorption (PTSA) process for the capture of CO₂ from the flue gas of fossil-fueled power plants using MgO sorbents.

In this monograph Prof. Pramanick explicates the law of motive force, a fundamental law of nature that can be observed and appreciated as an addition to the existing laws of thermodynamics. This unmistakable and remarkable tendency of nature is equally applicable to all other branches of studies. He first conceptualized the law of motive force in 1989, when he was an undergraduate student. Here he reports various applications of the law in the area of thermodynamics, heat transfer, fluid mechanics and solid mechanics, and shows how it is possible to solve analytically century-old unsolved problems through its application. This book offers a comprehensive account of the law and its relation to other laws and principles, such as the generalized conservation principle, variational formulation, Fermat's principle, Bejan's constructal law, entropy generation minimization, Bejan's method of intersecting asymptotes and equipartition principle. Furthermore, the author addresses some interrelated fundamental problems of contemporary interest, especially to thermodynamicists, by combining analytical methods, physical reasoning and the proposed law of motive force. This foundational work is a valuable reading for both students and researchers in exact as well as non-exact sciences and, at the same time, a pleasant learning experience for the novice. Extensively revised and thoroughly updated, this popular text de-emphasizes high level mathematics in favor of effective, accurate modeling. Real-world examples amplify the theory and show how to use derived equations to model physical problems. Exercises that parallel the examples build readers' confidence and prepare them to confront the more complex situations they encounter as professionals.

This new volume of the annual review "Advances in Transport Phenomena" series contains three in-depth review articles on the microfluidic fabrication of vesicles, the dielectrophoresis field-flow fractionation for continuous-flow separation of particles and cells in microfluidic devices, and the thermodynamic analysis and optimization of heat exchangers, respectively.

This book presents a wide-ranging review of the latest research and development directions in thermal systems optimization using population-based metaheuristic methods. It helps readers to identify the best methods for their own systems, providing details of mathematical models and algorithms suitable for implementation. To reduce mathematical complexity, the authors focus on optimization of individual components rather than taking on systems as a whole. They employ numerous case studies: heat

exchangers; cooling towers; power generators; refrigeration systems; and others. The importance of these subsystems to real-world situations from internal combustion to air-conditioning is made clear. The thermal systems under discussion are analysed using various metaheuristic techniques, with comparative results for different systems. The inclusion of detailed MATLAB® codes in the text will assist readers—researchers, practitioners or students—to assess these techniques for different real-world systems. Thermal System Optimization is a useful tool for thermal design researchers and engineers in academia and industry, wishing to perform thermal system identification with properly optimized parameters. It will be of interest for researchers, practitioners and graduate students with backgrounds in mechanical, chemical and power engineering.

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