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sections: fluid mechanics, heat transfer, and mass transfer. Part 2 focuses on key separation processes, including absorption, stripping, humidification, filtration, membrane separation, gaseous membranes, distillation, liquid-liquid extraction, adsorption, ion exchange, crystallization and particle-size reduction, settling, sedimentation, centrifugation, leaching, evaporation, and drying. The authors conclude with convenient appendices on the properties of water, compounds, foods, biological materials, pipes, tubes, and screens. The companion website (trine.edu/transport5ed/) contains additional homework problems that incorporate today's leading software, including Aspen/CHEMCAD, MATLAB, COMSOL, and Microsoft Excel.

Appropriate for one-year transport phenomena (also called transport processes) and separation processes course. First semester covers fluid mechanics, heat and mass transfer; second semester covers separation process principles (includes unit operations). The title of this Fourth Edition has been changed from Transport Processes and Unit Operations to Transport Processes and Separation Process Principles (Includes Unit Operations). This was done because the term Unit Operations has been largely superseded by the term Separation Processes which better reflects the present modern nomenclature being used. The main objectives and the format of the Fourth Edition remain the same. The sections on momentum transfer have been greatly expanded, especially in the sections on fluidized beds, flow meters, mixing, and non-Newtonian fluids. Material has been added to the chapter on mass transfer. The chapters on absorption, distillation, and liquid-liquid extraction have also been enlarged. More new material has been added to the sections on ion exchange and crystallization. The chapter on membrane separation processes has been greatly expanded especially for gas-membrane theory.

This concise and systematically organized text, now in its second edition, gives a clear insight into various membrane separation processes. It covers the fundamentals as well as the recent developments of different processes along with their industrial applications and the products. It includes the basic principles, operating parameters, membrane hardware, flux equation, transport mechanism, and applications of membrane-based technologies. Membrane separation processes are largely rate-controlled separations which require rate analysis for complete understanding. Moreover, a higher level of mathematical analysis, along with the understanding of mass transfer, is also required. These are amply treated in different chapters of the book to make the students comprehend the membrane separation principles with ease. This textbook is primarily designed for undergraduate students of chemical engineering, biochemical engineering and biotechnology for the course in membrane separation processes. Besides, the book will also be useful to process engineers and researchers.

KEY FEATURES

- Provides sufficient number of examples of industrial applications related to chemical, metallurgical, biochemical and food processing industries.
- Focuses on important biomedical applications of membrane-based technologies

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such as blood oxygenator, controlled drug delivery, plasmapheresis, and bioartificial organs. • Includes chapter-end short questions and problems to test students' comprehension of the subject. NEW TO THIS EDITION • A new section on membrane cleaning is included. Membrane fabrication methods are supplemented with additional information (Chapter 2). • Additional information on silt density index, forward osmosis and sea water desalination (Chapter 3). • Physicochemical parameters affecting nanofiltration, determination of various resistances using resistance in series model and few more industrial applications with additional short questions (Chapter 4). • Membrane cross-linking methods used in pervaporation, factors affecting pervaporation and few more applications (Chapter 9). • Membrane distillation, membrane reactor with different modules, types of membranes and reactions for membrane reactor (Chapter 13). Providing chemical engineering undergraduate and graduate students with a basic understanding of how separation of a mixture of molecules, macromolecules or particles is achieved, this textbook is a comprehensive introduction to the engineering science of separation. • Students learn how to apply their knowledge to determine the separation achieved in a given device or process • Real-world examples are taken from biotechnology, chemical, food, petrochemical, pharmaceutical and pollution control industries • Worked examples, elementary separator designs and chapter-end problems are provided, giving students a practical understanding of separation. The textbook systematically develops different separation processes by considering the forces causing the separation and how this separation is influenced by the patterns of bulk flow in the separation device. Readers will be able to take this knowledge and apply it to their own future studies and research in separation and purification. Online resources include solutions to the exercises and guidance for computer simulations.

In the 21st Century, processing food is no longer a simple or straightforward matter. Ongoing advances in manufacturing have placed new demands on the design and methodology of food processes. A highly interdisciplinary science, food process design draws upon the principles of chemical and mechanical engineering, microbiology, chemistry, nutrition and economics, and is of central importance to the food industry. Process design is the core of food engineering, and is concerned at its root with taking new concepts in food design and developing them through production and eventual consumption. Handbook of Food Process Design is a major new 2-volume work aimed at food engineers and the wider food industry. Comprising 46 original chapters written by a host of leading international food scientists, engineers, academics and systems specialists, the book has been developed to be the most comprehensive guide to food process design ever published. Starting from first principles, the book provides a complete account of food process designs, including heating and cooling, pasteurization, sterilization, refrigeration, drying, crystallization, extrusion, and separation. Mechanical operations including mixing, agitation, size

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reduction, extraction and leaching processes are fully documented. Novel process designs such as irradiation, high-pressure processing, ultrasound, ohmic heating and pulsed UV-light are also presented. Food packaging processes are considered, and chapters on food quality, safety and commercial imperatives portray the role process design in the broader context of food production and consumption.

This welcome new edition covers bioprocess engineering principles for the reader with a limited engineering background. It explains process analysis from an engineering point of view, using worked examples and problems that relate to biological systems. Application of engineering concepts is illustrated in areas of modern biotechnology such as recombinant protein production, bioremediation, biofuels, drug development, and tissue engineering, as well as microbial fermentation. The main sub-disciplines within the engineering curriculum are all covered; Material and Energy Balances, Transport Processes, Reactions and Reactor Engineering. With new and expanded material, Doran's textbook remains the book of choice for students seeking to move into bioprocess engineering. NEW TO THIS EDITION: All chapters thoroughly revised for current developments, with over 200 pgs of new material, including significant new content in: Metabolic Engineering Sustainable Bioprocessing Membrane Filtration Turbulence and Impeller Design Downstream Processing Oxygen Transfer Systems Over 150 new problems and worked examples More than 100 new illustrations New to this edition: All chapters thoroughly revised for current developments, with over 200 pgs of new material, including significant new content in: Metabolic Engineering Sustainable Bioprocessing Membrane Filtration Turbulence and Impeller Design Downstream Processing Oxygen Transfer Systems Over 150 new problems and worked examples More than 100 new illustrations

This new third edition provides a modern, unified treatment of the basic transport processes of momentum, heat, and mass transfer, as well as a broad treatment of the unit operations of chemical engineering. Coverage includes the latest membrane separation processes; discussion of bioprocesses; comprehensive treatment of the transport processes of momentum, heat, and mass transfer; adsorption processes; and more. A useful, up-to-date reference for practicing chemical engineers, agricultural engineers, food scientists, environmental engineers, biochemical engineers, and others who work in the process industries.

Bioseparations engineering deals with the scientific and engineering principles involved in large-scale separation and purification of biological products. It is a key component of most chemical engineering/biotechnology/bioprocess engineering programmes. This book discusses the underlying principles of bioprocess engineering written from the perspective of an undergraduate course. It covers membrane based bioprocesses in much more detail than some of the other books on bioprocesses engineering. Based largely on the lecture notes the author developed to teach the course, this book is especially suitable for use as an undergraduate level textbook, as most other textbooks are targeted at graduate students. Separation and purification processes play a critical role in biorefineries and their optimal selection, design and operation to maximise product yields and improve overall process efficiency. Separations and purifications are necessary for upstream processes as well as in maximising and improving product recovery in downstream processes. These processes account for a significant fraction of the total capital and operating costs and also are highly energy intensive. Consequently, a better understanding of separation and purification processes, current and possible alternative and novel advanced methods is essential for achieving the overall techno-economic feasibility and commercial success of sustainable biorefineries. This book presents a comprehensive overview focused specifically on the

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present state, future challenges and opportunities for separation and purification methods and technologies in biorefineries. Topics covered include: Equilibrium Separations: Distillation, liquid-liquid extraction and supercritical fluid extraction. Affinity-Based Separations: Adsorption, ion exchange, and simulated moving bed technologies. Membrane Based Separations: Microfiltration, ultrafiltration and diafiltration, nanofiltration, membrane pervaporation, and membrane distillation. Solid-liquid Separations: Conventional filtration and solid-liquid extraction. Hybrid/Integrated Reaction-Separation Systems: Membrane bioreactors, extractive fermentation, reactive distillation and reactive absorption. For each of these processes, the fundamental principles and design aspects are presented, followed by a detailed discussion and specific examples of applications in biorefineries. Each chapter also considers the market needs, industrial challenges, future opportunities, and economic importance of the separation and purification methods. The book concludes with a series of detailed case studies including cellulosic bioethanol production, extraction of algae oil from microalgae, and production of biopolymers. Separation and Purification Technologies in Biorefineries is an essential resource for scientists and engineers, as well as researchers and academics working in the broader conventional and emerging bio-based products industry, including biomaterials, biochemicals, biofuels and bioenergy.

The Concrete Solutions series of International Conferences on Concrete Repair began in 2003 with a conference held in St. Malo, France in association with INSA Rennes. Subsequent conferences have seen us partnering with the University of Padua in 2009 and with TU Dresden in 2011. This conference is being held for the first time in the UK, in association with Queen's University Belfast and brings together delegates from 36 countries to discuss the latest advances and technologies in concrete repair. Earlier conferences were dominated by electrochemical repair, but there has been an interesting shift to more unusual methods, such as bacterial repair of concrete plus an increased focus on service life design aspects and modelling, with debate and discussion on the best techniques and the validity of existing methods. Repair of heritage structures is also growing in importance and a number of the papers have focused on the importance of getting this right, so that we may preserve our rich cultural heritage of historic structures. This book is an essential reference work for those working in the concrete repair field, from Engineers to Architects and from Students to Clients. Natural phenomena consist of simultaneously occurring transport processes and chemical reactions. These processes may interact with each other and may lead to self-organized structures, fluctuations, instabilities, and evolutionary systems. Nonequilibrium Thermodynamics, Third Edition emphasizes the unifying role of thermodynamics in analyzing the natural phenomena. This third edition updates and expands on the first and second editions by focusing on the general balance equations for coupled processes of physical, chemical, and biological systems. The new edition contains a new chapter on stochastic approaches to include the statistical thermodynamics, mesoscopic nonequilibrium thermodynamics, fluctuation theory, information theory, and modeling the coupled biochemical systems in thermodynamic analysis. This new addition also comes with more examples and practice problems. Informs and updates on all the latest developments in the field Contributions from leading authorities and industry experts A useful text for seniors and graduate students from diverse engineering and science programs to analyze some nonequilibrium, coupled, evolutionary, stochastic, and dissipative processes Highlights fundamentals of equilibrium thermodynamics, transport processes and chemical reactions Expands the theory of nonequilibrium thermodynamics and its use in coupled transport processes and chemical reactions in physical, chemical, and biological systems Presents a unified analysis for transport and rate processes in various time and space scales Discusses stochastic approaches in thermodynamic analysis including fluctuation and information theories Has 198 fully solved examples and 287 practice problems An Instructor Resource

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containing the Solution Manual can be obtained from the author: ydemirel2@unl.edu

This edition of 'Micro Process Engineering' was originally published in the successful series 'Advanced Micro & Nanosystems'. Authors from leading industrial players and research institutions present a concise and didactical introduction to Micro Process Engineering, the combination of microtechnology and process engineering into a most promising and powerful tool for revolutionizing chemical processes and industrial mass production of bulk materials, fine chemicals, pharmaceuticals and many other products. The book takes the readers from the fundamentals of engineering methods, transport processes, and fluid dynamics to device conception, simulation and modelling, control interfaces and issues of modularity and compatibility. Fabrication strategies and techniques are examined next, focused on the fabrication of suitable microcomponents from various materials such as metals, polymers, silicon, ceramics and glass. The book concludes with actual applications and operational aspects of micro process systems, giving broad coverage to industrial efforts in America, Europe and Asia as well as laboratory equipment and education.

The rise and rationalization of the industrial phosphates industry have gone hand in hand with the development and maturation of technologies to purify phosphoric acid. In the 1960s and 70s, driven by the exponential sales growth of the detergent-builder sodium tripolyphosphate, chemical producers raced to develop processes that would provide a sufficiently pure phosphoric acid feedstock for manufacture to undercut thermal phosphoric acid made from phosphorus. As environmental and political pressure led to a collapse in demand for sodium tripolyphosphate in the 1990s, the commercial pressures to rationalize at plant and corporate levels rose such that only the fittest survived. Phosphoric Acid: Purification, Uses, Technology, and Economics, the first and only book of its kind to be written on this topic, covers the development of purification technologies for phosphoric acid, especially solvent extraction, describing the more successful processes and setting this period in the historical context of the last 350 years. Individual chapters are devoted to the key derivative products which are still undergoing active development, as well as to sustainability and how to approach the commissioning of these plants. The text is aimed at students of chemistry, chemical engineering, business, and industrial history, and to new entrants to the industry.

Carbon atoms have the amazing ability to bond in remarkable different manners that can assume distinct astonishing dimensional arrangements from which absolutely diverse and interesting nanostructured carbon materials are obtained. This book aims to cover the most recent advances in (i) Graphene and derivatives, including graphene-based magnetic composites, membranes, wafer devices, and nanofibers for several applications, as well as some particular properties, such as light emission from graphene; (ii) Carbon nanotubes heaters and fibers for reinforcement of cement and diamond-based thin films; and (iii) Nanofluids consisting of both graphene and carbon nanotubes, apart from reporting some important case studies dealing with carbon nanostructures and their use in sensors, coatings, or electromagnetic wave absorbers.

Food research (and funding) is becoming more and more focused on health. While researchers and product developers have made great strides in food engineering, there needs to be increased focus on what happens when the food is actually digested. How is the food absorbed? Do the benefits remain? Digestion is a complex topic, and this will be the first book aimed at food researchers. Authored by a physiologist and a food engineer, the book will be a welcome addition to the literature.

With a detailed analysis of the mass transport through membrane layers and its effect

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on different separation processes, this book provides a comprehensive look at the theoretical and practical aspects of membrane transport properties and functions. Basic equations for every membrane are provided to predict the mass transfer rate, the concentration distribution, the convective velocity, the separation efficiency, and the effect of chemical or biochemical reaction taking into account the heterogeneity of the membrane layer to help better understand the mechanisms of the separation processes. The reader will be able to describe membrane separation processes and the membrane reactors as well as choose the most suitable membrane structure for separation and for membrane reactor. Containing detailed discussion of the latest results in transport processes and separation processes, this book is essential for chemistry students and practitioners of chemical engineering and process engineering. Detailed survey of the theoretical and practical aspects of every membrane process with specific equations Practical examples discussed in detail with clear steps Will assist in planning and preparation of more efficient membrane structure separation Reduced time to market, lower production costs, and improved flexibility are critical success factors for batch processes. Their ability to handle variations in feedstock and product specifications has made them key to the operation of multipurpose facilities, and therefore quite popular in the specialty chemical, pharmaceutical, agricultural, and This book covers a wide variety of topics related to advancements in different stages of mass transfer modelling processes. Its purpose is to create a platform for the exchange of recent observations, experiences, and achievements. It is recommended for those in the chemical, biotechnological, pharmaceutical, and nanotechnology industries as well as for students of natural sciences, technical, environmental and employees in companies which manufacture machines for the above-mentioned industries. This work can also be a useful source for researchers and engineers dealing with mass transfer and related issues.

Transport Processes and Separation Process Principles(includes Unit Operations)Prentice Hall

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.

The knowledge of quantitative turbulence mechanics relies heavily upon the definition of the concept of a vortex in mathematical terms. This reference work introduces the reader to Liutex, which is an accepted, accurate and mathematical definition of a vortex. The core of this book is a compilation of several papers on the subject. presented in the 13th World Congress of Computational Mechanics (WCCM2018), Symposium 704, Mathematics and Computations for Multiscale Structures of Turbulent and Other Complex Flows, New York, United States on July 27, 2018. This compilation also includes other research papers which explain the work done on the vortex definition, vortex identification and turbulence structure from different insight angles including mathematics, computational physics and experiments. The thirteen chapters in this volume will

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be informative to scientists and engineers who are interested in advanced theories about fluid dynamics, vortex science and turbulence research.

This volume presents 10 reviews contributed by eminent researchers around the world on chitosan based materials. The introductory chapters present information on general characteristics of chitosan and various types of materials which are based on it such as nanofibers, nanoparticles, nanocapsules and other chemically modified chitosans. This is followed by an explanation of chitosan characterization and extraction techniques. Concluding chapters describe the applications of chitosan products in water treatment, drug delivery, edible films and pervaporation membranes. Readers will therefore gain an understanding about chitosan and materials derived from this polymer and their practical applications. The volume serves as a simple reference for chemical engineering students and professionals interested in the basic and applied chemistry of chitosan and chitosan-derived products.

A number of food engineering operations, in which heat is not used as a preserving factor, have been employed and are applied for preparation (cleaning, sorting, etc.), conversion (milling, agglomeration, etc.) or preservation (irradiation, high pressure processing, pulsed electric fields, etc.) purposes in the food industry. This book presents a comprehensive treatise of all normally used food engineering operations that are carried out at room (or ambient) conditions, whether they are aimed at producing microbiologically safe foods with minimum alteration to sensory and nutritive properties, or they constitute routine preparative or transformation operations. The book is written for both undergraduate and graduate students, as well as for educators and practicing food process engineers. It reviews theoretical concepts, analyzes their use in operating variables of equipment, and discusses in detail different applications in diverse food processes.

In this essential new volume, Volume 13: Membrane and Desalination Technologies, a panel of expert researchers provide a wealth of information on membrane and desalination technologies. An advanced chemical and environmental engineering textbook as well as a comprehensive reference book, this volume is of high value to advanced graduate and undergraduate students, researchers, scientists, and designers of water and wastewater treatment systems. This is an essential part of the Handbook of Environmental Engineering series, an incredible collection of methodologies that study the effects of pollution and waste in their three basic forms: gas, solid, and liquid. Chapters adopt the series format, employing methods of practical design and calculation illustrated by numerical examples, including pertinent cost data whenever possible, and exploring in great detail the fundamental principles of the field. Volume 13: Membrane and Desalination Technologies is an essential guide for researchers, highlighting the latest developments in principles of membrane technology, membrane systems planning and design, industrial and municipal waste treatments, desalination requirements, wastewater reclamation, biofiltration, and

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more.

Computational fluid dynamics (CFD), which uses numerical analysis to predict and model complex flow behaviors and transport processes, has become a mainstream tool in engineering process research and development. Complex chemical processes often involve coupling between dynamics at vastly different length and time scales, as well as coupling of different physical models. The multiscale and multiphysics nature of those problems calls for delicate modeling approaches. This book showcases recent contributions in this field, from the development of modeling methodology to its application in supporting the design, development, and optimization of engineering processes.

Natural products are used by food, pharmaceutical and cosmetics industries, so that extraction technologies and potential applications for plant extracts are of interest for many research areas and industrial areas. This book is intended to give a holistic, in-depth view of the techniques available for the extraction of natural products. Besides of conventional techniques, the use of ultrasounds, microwaves, pressurized liquids and supercritical fluids will be discussed in detail. Their fundamentals, process parameters and applications will be explored. Examples and case studies will be used to give a balanced outline of recent applications and potential uses of each technique. Furthermore, the most recent trends for the extraction of natural products will also be discussed, including the use of combinatory and hyphenated techniques.

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In aseptic processing, food is stored at ambient temperatures in sterilized containers free of spoilage organisms and pathogens. The results of this food technology come in all shapes and sizes, from the consumer packages of milk on the shelves of the supermarket to the huge containers full of orange juice transported around the world by cargo ships. Over the last couple of decades, aseptic bulk storage and distribution has revolutionized the global food trade. For example, more than 90 percent of the approximately 24 million tons of fresh tomatoes harvested globally each year are aseptically processed and packaged for year-round remanufacture into various food products. The technology has also been applied to bring potable water and emergency food aid to survivors of the 2004 tsunami in Southeast Asia and the victims of Hurricane Katrina in 2005, as well as to other crisis situations worldwide. The construction of new aseptic facilities continues around the world, and an up-to-date understanding of the technology is essential for a new generation of food scientists and engineers alike. The contributors to this important textbook discuss all aspects of aseptic processing and packaging, focusing on the areas that most influence the success or failure of the process. Fully updated, this new edition covers all areas of chemistry, microbiology, engineering, packaging, and regulations as they relate to aseptic processing.

Transport and Surface Phenomena provides an overview of the key transfers taking place in reactions and explores how calculations of momentum, energy and mass transfers can help researchers develop the most appropriate, cost effective solutions to chemical problems. Beginning with a thorough overview of the nature of transport phenomena, the book goes on to explore balances in transport phenomena, including key equations for assessing balances, before concluding by outlining mathematical methods for solving the transfer equations. Drawing on the experience of its expert authors, it is an accessible introduction to the field for students, researchers and professionals working in chemical engineering. The book and is also

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ideal for those in related fields such as physical chemistry, energy engineering, and materials science, for whom a deeper understanding of these interactions could enhance their work. This textbook offers an introduction to multiple, interdependent transport phenomena as they occur in various fields of physics and technology like transport of momentum, heat, and matter. These phenomena are found in a number of combined processes in the fields of chemical, food, biomedical, and environmental sciences. The book puts a special emphasis on numerical modeling of both purely diffusive mechanisms and macroscopic transport such as fluid dynamics, heat and mass convection. To favor the applicability of the various concepts, they are presented with a simplicity of exposure, and synthesis has been preferred with respect to completeness. The book includes more than 130 graphs and figures, to facilitate the understanding of the various topics. It also presents many modeling examples throughout the text, to control that the learned material is properly understood.

This timely book provides authoritative, comprehensive, and easy-to-follow coverage of the fundamental concepts and practical techniques on the use of process integration to maximize the efficiency and sustainability of industrial processes. Over the past three decades, significant advances have been made in treating, designing, and operating chemical processes as integrated systems. Whether you are a process engineer, an industrial decision maker, or a researcher, this book will be an indispensable resource tool for systematically enhancing process performance and developing novel and sustainable process designs. The book is also ideal for use as a text in an upper level undergraduate or an introductory graduate course on process design and sustainability. This ground breaking reference enhances and reconciles various process and sustainability objectives, such as cost effectiveness, yield improvement, energy efficiency, and pollution prevention. The detailed tools and applications within are written by one of the world's foremost process integration and design experts and will save you time and money. Key features:

- Allows the reader to methodically develop rigorous targets that benchmark the performance of industrial processes then develop cost-effective implementations.
- Contains state-of-the-art process integration approaches and applications including graphical, algebraic, and mathematical techniques
- Covers applications that include process economics, targeting for conservation of mass and energy, synthesis of innovative processes, retrofitting of existing systems, design and assessment of renewable energy systems, and in-process pollution prevention.
- Presents fundamentals and step-by-step procedures that can be applied to the design and optimization of new processes as well the retrofitting and operation of existing processes
- Explains how pivotal sustainability issues can holistically and methodically be addressed and reconciled

Includes numerous examples and case studies on a broad array of industrial processes and sustainable designs

About the author Dr Mahmoud El-Halwagi is a professor and holder of the McFerrin Professorship at the Artie McFerrin Department of Chemical Engineering, Texas A&M University. He is internationally recognized for pioneering contributions in the principles and applications of process integration and sustainable design. Dr El-Halwagi has served as a consultant to a wide variety of processing industries. He is the recipient of prestigious research and educational awards including the American Institute of Chemical Engineers Sustainable Engineering forum (AIChE SEF) Research Excellence Award, the Lockheed Martin Excellence in Engineering Teaching Award, The Fluor Distinguished Teaching Award, and the US National Science Foundation's National Young Investigator Award.

- Contains state-of-the-art process integration approaches and applications including graphical, algebraic, and mathematical techniques
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- Presents fundamentals and step-by-step procedures that can be applied to the design and optimization of new processes as well the retrofitting and operation of existing processes, as well as

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including numerous examples and case studies for a broad array of industrial systems and processes

The past thirty years have witnessed a growing worldwide desire that positive actions be taken to restore and protect the environment from the degrading effects of all forms of pollution—air, water, soil, and noise. Because pollution is a direct or indirect consequence of waste, the seemingly idealistic demand for “zero discharge” can be construed as an unrealistic demand for zero waste. However, as long as waste continues to exist, we can only attempt to abate the subsequent pollution by converting it to a less noxious form. Three major questions usually arise when a particular type of pollution has been identified: (1) How serious is the pollution? (2) Is the technology to abate it available? and (3) Do the costs of abatement justify the degree of abatement achieved? This book is one of the volumes of the Handbook of Environmental Engineering series. The principal intention of this series is to help readers formulate answers to the last two questions above. The traditional approach of applying tried-and-true solutions to specific pollution problems has been a major contributing factor to the success of environmental engineering, and has accounted in large measure for the establishment of a “methodology of pollution control.” However, the realization of the ever-increasing complexity and interrelated nature of current environmental problems renders it imperative that intelligent planning of pollution abatement systems be undertaken.

"A pedagogical gem.... Professor Readey replaces 'black-box' explanations with detailed, insightful derivations. A wealth of practical application examples and exercise problems complement the exhaustive coverage of kinetics for all material classes." —Prof. Rainer Hebert, University of Connecticut "Prof. Readey gives a grand tour of the kinetics of materials suitable for experimentalists and modellers.... In an easy-to-read and entertaining style, this book leads the reader to fundamental, model-based understanding of kinetic processes critical to development, fabrication and application of commercially-important soft (polymers, biomaterials), hard (ceramics, metals) and composite materials. It is a must-have for anyone who really wants to understand how to make materials and how they will behave in service." --Prof. Bill Lee, Imperial College London, Fellow of the Royal Academy of Engineering "A much needed text filling the gap between an introductory course in materials science and advanced materials-specific kinetics courses. Ideal for the undergraduate interested in an in-depth study of kinetics in materials." —Prof. Mark E. Eberhart, Colorado School of Mines This book provides an in-depth introduction to the most important kinetic concepts in materials science, engineering, and processing. All types of materials are addressed, including metals, ceramics, polymers, electronic materials, biomaterials, and composites. The expert author with decades of teaching and practical experience gives a lively and accessible overview, explaining the principles that determine how long it takes to change material properties and make new and better materials. The chapters cover a broad range of topics extending from the heat treatment of steels, the processing of silicon integrated microchips, and the production of cement, to the movement of drugs through the human body. The author explicitly avoids "black box" equations, providing derivations with clear explanations.

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