

Membrane Separation Processes By Kaushik Nath

This book is a printed edition of the Special Issue "Bioconversion Processes" that was published in Fermentation

Emerging Technologies for Sustainable Desalination Handbook provides professionals and researchers with the latest treatment activities in the advancement of desalination technology. The book enables municipalities and private companies to custom-design sustainable desalination plants that will minimize discharge, energy costs and environmental footprint. Individual case studies are included to illustrate the benefits and drawback of each technique. Sections discuss a multitude of recently developed, advanced processes, along with notable advances made in existing technologies. These processes include adsorption, forward osmosis, humidification and dehumidification, membrane distillation, pervaporation and spray type thermal processes. In addition, theoretical membrane materials, such as nanocomposite and carbon nanotube membranes are also explored. Other chapters cover the desalination of shale gas, produced water, forward osmosis for agriculture, desalination for crop irrigation, and seawater for sustainable agriculture. International in its coverage, the chapters of this handbook are contributed by leading authors and researchers in all relevant fields. Expertly explains recent advances in sustainable desalination technology, including nanocomposite membranes, carbon nanotube membranes, forward reverse osmosis and desalination by pervaporation Provides state-of-the-art techniques for minimizing system discharge, energy cost and environmental footprint Includes individual case studies to illustrate the benefits and drawbacks of each technique Discusses techniques for the custom-design of sustainable

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desalination plants for municipalities, private companies and industrial operations Membrane technology is an important part of the separation technology. This volume broadly addresses the field of membranes and membrane processes. It highlights developments in the field, as well as research opportunities for the future.

Separation of molecules present in organic solvents by membrane (nano)filtration has great potential in industries ranging from refining to fine chemical and pharmaceutical synthesis and is currently an area of intensive studies. This will be the first concise reference book offering a critical analysis on this topic. Nanofiltration, is a pressure driven membrane process used to remove solutes with molecular weight in the range of 200-1,000 g mol⁻¹ typically from aqueous streams. A recent innovation is the extension of nanofiltration processes to organic solvents an emerging technology referred to as Organic Solvent Nanofiltration (OSN). Separation of molecules present in organic solvents by nanofiltration has great potential in various processes such as petroleum refining, fine chemical and pharmaceutical synthesis, catalyst recycle, enrichment of aromatics etc. This book summarizes the developments in the field of OSN. It describes materials and methods used for the preparation of organic solvent stable membranes. Various techniques for manufacturing of OSN membranes, their physico-chemical and performance related characterization and membrane transport mechanisms will be discussed and critically evaluated. A summary of the commercially available OSN membranes, their separation properties and manufacturers will also be presented. Finally a detailed overview of the OSN applications in various industrial and laboratory scale processes as well as their future prospective will be presented. Complete coverage of the field of organic Solvent Nanofiltration: theory and industrial applications Provides all you want to know in this fast

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developing application of membranes in industrial filtration and water purification Applications of membranes - summary of the existing applications and proposed new applications; review and critical analysis of the data on currently available OSN membranes. The benefit of this feature to the users is outlined in the comment of one referee: "I use these types of books as an instant reference, resource and fact checker when I am writing or researching topics in membrane technology. I also read the content carefully to keep myself at the state-of-the-art in the technology. R&D is an expensive and time consuming endeavor so anything learned from the literature is valuable when it helps to guide my efforts". Contains a large number of diagrams /figures (60 approx) which offer graphical explanations of the processes and the mechanisms underlying the processess provides practical and easy to understand examples of practical applications. The user can easily adapt these to his/her specific application Worked examples 15 (approx) Guide the reader through the various parameters, and show the reader the effect of these parameters in the overall design of the process Includes multimedia content, videos and active tables and diagrams Enable the user to add his/her own data and conditions and get results relevant to his/her situation. Tables (25 approx) Provides review and critical analysis of the data on currently available OSN membranes Glossary Summary of the main terms used in OSN

The book Modeling in Membranes and Membrane-Based Processes is based on the idea of developing a reference which will cover most relevant and "state-of-the-art" approaches in membrane modeling. This book explores almost every major aspect of modeling and the techniques applied in membrane separation studies and applications. This includes first principle-based models, thermodynamics models, computational fluid dynamics simulations,

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molecular dynamics simulations, and artificial intelligence-based modeling for membrane separation processes. These models have been discussed in light of various applications ranging from desalination to gas separation. In addition, this breakthrough new volume covers the fundamentals of polymer membrane pore formation mechanisms, covering not only a wide range of modeling techniques, but also has various facets of membrane-based applications. Thus, this book can be an excellent source for a holistic perspective on membranes in general, as well as a comprehensive and valuable reference work. Whether a veteran engineer in the field or lab or a student in chemical or process engineering, this latest volume in the “Advances in Membrane Processes” is a must-have, along with the first book in the series, Membrane Processes, also available from Wiley-Scrivener.

Applications of Advanced Green Materials provides a comprehensive and authoritative review on recent advancement in green materials in various applications. Each chapter is focused on a specific application of advanced green materials from packaging to sensor technology, biomedical to environmental applications, textile to catalysis to electronic shielding applications, supercapacitors, drug delivery, tissue engineering, bioelectronic, gas storage and separation, etc. This book also discusses life cycle assessment and circular economy of green materials and their future prospective. The book is unique with contributions from renowned scientists working on biopolymers and biocomposites, bioactive and biodegradable materials, composites, and metallic natural materials. This book is an essential resource for academicians, researchers, students and professionals interested in exploring potential of advanced green materials. Includes up to date information on applications of advanced green materials Each chapter is specifically discussing a particular application with examples Present

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a unified approach to discuss in detail about origin, synthesis and application of green materials

The brief primarily focuses on the performance analysis of CNT based interconnects in current research scenario. Different CNT structures are modeled on the basis of transmission line theory. Performance comparison for different CNT structures illustrates that CNTs are more promising than Cu or other materials used in global VLSI interconnects. The brief is organized into five chapters which mainly discuss: (1) an overview of current research scenario and basics of interconnects; (2) unique crystal structures and the basics of physical properties of CNTs, and the production, purification and applications of CNTs; (3) a brief technical review, the geometry and equivalent RLC parameters for different single and bundled CNT structures; (4) a comparative analysis of crosstalk and delay for different single and bundled CNT structures; and (5) various unique mixed CNT bundle structures and their equivalent electrical models.

This study concentrates on a general optimization of a particular class of membrane separation processes: those involving batch diafiltration. Existing practices are explained and operational improvements based on optimal control theory are suggested. The first part of the book introduces the theory of membrane processes, optimal control and dynamic optimization. Separation problems are defined and mathematical models of batch membrane processes derived. The control theory focuses on problems of dynamic optimization from a chemical-engineering point of view. Analytical and numerical methods that can be exploited to treat problems of optimal control for membrane processes are described. The second part of the text builds on this theoretical basis to establish solutions for membrane models of increasing

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complexity. Each chapter starts with a derivation of optimal operation and continues with case studies exemplifying various aspects of the control problems under consideration. The authors work their way from the limiting flux model through increasingly generalized models to propose a simple numerical approach to the general case of optimal operation for batch diafiltration processes. Researchers interested in the modelling of batch processes or in the potential industrial applications of optimal control theory will find this monograph a valuable source of inspiration, instruction and ideas.

This book provides useful information about bioremediation, phytoremediation, and mycoremediation of wastewater and some aspects of the chemical wastewater treatment processes, including ion exchange, neutralization, adsorption, and disinfection. Additionally, this book elucidates and illustrates the wastewater treatment plants in terms of plant sizing, plant layout, plant design, and plant location. Cutting-edge topics include wet air oxidation of aqueous wastes, biodegradation of nitroaromatic compounds, biological treatment of sanitary landfill leachate, bacterial strains for the bioremediation of olive mill wastewater, gelation of arabinoxylans from maize wastewater, and modeling wastewater evolution.

Presently, energy and the environment are closely related issues throughout the world. The indiscriminate use of fossil fuels has resulted in adverse effects on the environment (i.e., excessive production of greenhouse gases, pollution of underground and superficial waters, soil contamination). The international reserves of crude oil are declining, and some pessimistic references refer to an important detriment in the annual oil availability for 2050. Because of these facts, the necessity to develop novel sources of energy, especially fuels from sustainable sources, is mandatory. Such alternative sources of energy (i.e. wind, solar, biomass, hydraulic)

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are potential renewable sources capable of changing the paradigm of productive activities around the world. In many cases, the energy production processes include resources commonly available or even the use of materials that are considered waste (i.e., wastewaters, agriculture residues, urban solid wastes). Despite all the desirable characteristics involved, the processes included in the generation of renewable energy may not only positively impact the environment, but may also cause harm on surrounding areas. However, to our knowledge, relatively few works have been published carrying out this type of environmental cost-benefit analysis.

MEMBRANE SEPARATION PROCESSES PHI Learning Pvt. Ltd.

Food materials are processed prior to their consumption using different processing technologies that improve their shelf life and maintain their physicochemical, biological, and sensory qualities. Introduction to Advanced Food Process Engineering provides a general reference on various aspects of processing, packaging, storage, and quality control and assessment systems, describing the basic principles and major applications of emerging food processing technologies. The book is divided into three sections, systematically examining processes from different areas of food process engineering. Section I covers a wide range of advanced food processing technologies including osmo-concentration of fruits and vegetables, membrane technology, nonthermal processing, emerging drying technologies, CA and MA storage of fruits and vegetables, nanotechnology in food processing, and computational fluid dynamics modeling in food processing. Section II describes food safety and various non-destructive quality assessment systems using machine vision systems, vibrational spectroscopy, biosensors, and chemosensors. Section III explores waste management, by-

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product utilization, and energy conservation in food processing industry. With an emphasis on novel food processes, each chapter contains case studies and examples to illustrate state-of-the-art applications of the technologies discussed.

Cold atmospheric plasma (CAP) emerges as a possible new modality for cancer treatment. This book provides a comprehensive introduction into fundamentals of the CAP and plasma devices used in plasma medicine. An analysis of the mechanisms of plasma interaction with cancer and normal cells including description of possible mechanisms of plasma selectivity is included. Recent advances in the field, the primary challenges and future directions are presented.

The first guide to compile current research and frontline developments in the science of process intensification (PI), *Re-Engineering the Chemical Processing Plant* illustrates the design, integration, and application of PI principles and structures for the development and optimization of chemical and industrial plants. This volume updates professionals on emerging PI equipment and methodologies to promote technological advances and operational efficacy in chemical, biochemical, and engineering environments and presents clear examples illustrating the implementation and application of specific process-intensifying equipment and methods in various commercial arenas.

Separation processes are challenging steps in any process industry for isolation of products and recycling of reactants. Membrane technology has shown immense potential in separation of liquid and gaseous mixtures, effluent treatment, drinking water purification and solvent recovery. It has found endless popularity and wide acceptance for its small footprint, higher selectivity, scalability, energy saving capability and inherent ease of integration into other unit

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operations. There are many situations where the target component cannot be separated by distillation, liquid extraction, and evaporation. The different membrane processes such as pervaporation, vapor permeation and membrane distillation could be used for solving such industrial bottlenecks. This book covers the entire array of fundamental aspects, membrane synthesis and applications in the chemical process industries (CPI). It also includes various applications of pervaporation, vapor permeation and membrane distillation in industrially and socially relevant problems including separation of azeotropic mixtures, close-boiling compounds, organic–organic mixtures, effluent treatment along with brackish and seawater desalination, and many others. These processes can also be applied for extraction of small quantities of value-added compounds such as flavors and fragrances and selective removal of hazardous impurities, viz., volatile organic compounds (VOCs) such as vinyl chloride, benzene, ethyl benzene and toluene from industrial effluents. Including case studies, this is a must-have for any process or chemical engineer working in the industry today. Also valuable as a learning tool, students and professors in chemical engineering, chemistry, and process engineering will benefit greatly from the groundbreaking new processes and technologies described in the volume.

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

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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 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).

Climate resilience and growing population are the two main global challenges that encourage the development of an affordable and sustainable source of

vegetable protein to ensure future food security. Advanced scientific programs and agro-food developments should be proprietarily on-demand to face different stresses in order to maintain yield and quality of seed production. In this regard, legume crops are key sustainable alternatives for healthier diets while contributing to appropriate natural resource management. Taken together, the 11 chapters in this book represent a generous addition to the progress in our understanding of climate-resilient legumes, hoping to contribute to the improvement of global food security in the future.

Membrane Contactors: Fundamentals, Applications and Potentialities, Volume 11 covers new operations that could be efficiently used to improve the performance of a variety of industrial production cycles in applications ranging from biotechnology to agrofood. This book focuses on the basic "principles of work": required membrane materials and properties; major operating parameters; the importance of module configuration and design and; the performance of membrane contactors in specific processes. The authors' dynamic approach to this subject makes Membrane Contactors: Fundamentals, Applications and Potentialities, Volume 11 the most comprehensive book currently available on all aspects related to the 'membrane contactor world. * Describes new unit operations in process engineering * Covers a wide variety of industrial

applications, from biotechnology to agrofood * Applicable to process intensification and sustainable growth strategies

Vapour permeation and membrane distillation are two emerging membrane technologies for the production of vapour as permeate, which, in addition to well-established pervaporation technology, are of increasing interest to academia and industry. As efficient separation and concentration processes, they have high potential for use in the energy, water, chemical, food and pharmaceutical sectors. Part One begins by covering the fundamentals, preparation and characterization of pervaporation, before going on to outline the associated systems and applications. State of the art uses, future trends and next generation pervaporation are then discussed. Part Two then explores the preparation, characterization, systems and applications of membranes for vapour permeation, followed by modelling and the new generation of vapour permeation membranes. Finally, Part Three outlines the fundamentals of membrane distillation and its applications in integrated systems, before the book concludes with a view of the next generation. Explores three emerging membrane technologies that produce vapour as a permeate. Looks at the fundamentals, applications, state of the art uses and next generation of each technology. Provides an authoritative guide for chemical engineers and academic researchers interested in membrane

technologies for desalination, process water/steam treatment, water purification, VOCs removal and other aspects of pollution control, industrial process chemistry, renewable energy production or separation and concentration in the food/pharmaceutical industries.

Green Sustainable Process for Chemical and Environmental Engineering and Science: Solid State Synthetic Methods cover recent advances made in the field of solid-state materials synthesis and its various applications. The book provides a brief introduction to the topic and the fundamental principles governing the various methods. Sustainable techniques and green processes development in solid-state chemistry are also highlighted. This book also provides a comprehensive literature on the industrial application using solid-state materials and solid-state devices. Overall, this book is intended to explore green solid-state techniques, eco-friendly materials involved in organic synthesis and real-time applications. Provides a broad overview of solid-state chemistry Outlines an eco-friendly solid-state synthesis of modern nanomaterials, organometallic, coordination compounds and pure organic Gives a detailed account of solid-state chemistry, fundamentals, concepts, techniques and applications Deliberates cutting-edge recent advances in industrial technologies involved in energy, environmental, medicinal and organic chemistry fields

Liquid Membranes: Principles and Applications in Chemical Separations and Wastewater Treatment discusses the principles and applications of the liquid membrane (LM) separation processes in organic and inorganic chemistry, analytical chemistry, biochemistry, biomedical engineering, gas separation, and wastewater treatment. It presents updated, useful, and systematized information on new LM separation technologies, along with new developments in the field. It provides an overview of LMs and LM processes, and it examines the mechanisms and kinetics of carrier-facilitated transport through LMs. It also discusses active transport, driven by oxidation-reduction, catalytic, and bioconversion reactions on the LM interfaces; modifications of supported LMs; bulk aqueous hybrid LM processes with water-soluble carriers; emulsion LMs and their applications; and progress in LM science and engineering. This book will be of value to students and young researchers who are new to separation science and technology, as well as to scientists and engineers involved in the research and development of separation technologies, LM separations, and membrane reactors.

- Provides comprehensive knowledge-based information on the principles and applications of a variety of liquid membrane separation processes.
- Contains a critical analysis of new technologies published in the last 15 years.

Mixed matrix membranes (MMMs) have attracted a large amount of interest in

research laboratories worldwide in recent decades, motivated by the gap between a growing interest in developing novel mixed matrix membranes by various research groups and the lack of large-scale implementation. This Special Issue contains six publications dealing with the current opportunities and challenges of mixed matrix membranes development and applications to solve environmental and health challenges of the society of 21st century.

Water is one of the most precious and basic needs of life for all living beings, and a precious national asset. Without it, the existence of life cannot be imagined. Availability of pure water is decreasing day by day, and water scarcity has become a major problem that is faced by our society for the past few years. Hence, it is essential to find and disseminate the key solutions for water quality and scarcity issues. The inaccessibility and poor water quality continue to pose a major threat to human health worldwide. Around billions of people lacking to access drinkable water. The water contains the pathogenic impurities; which are responsible for water-borne diseases. The concept of water quality mainly depends on the chemical, physical, biological, and radiological measurement standards to evaluate the water quality and determine the concentration of all components, then compare the results of this concentration with the purpose for which this water is used. Therefore, awareness and a firm grounding in water

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science are the primary needs of readers, professionals, and researchers working in this research area. This book explores the basic concepts and applications of water science. It provides an in-depth look at water pollutants' classification, water recycling, qualitative and quantitative analysis, and efficient wastewater treatment methodologies. It also provides occurrence, human health risk assessment, strategies for removal of radionuclides and pharmaceuticals in aquatic systems. The book chapters are written by leading researchers throughout the world. This book is an invaluable guide to students, professors, scientists and R&D industrial specialists working in the field of environmental science, geoscience, water science, physics and chemistry.

Membrane Modification: Technology and Applications is written for engineers, scientists, graduate students, and researchers in the field of membrane science and technology, materials science, applied physics, chemistry, and environmental science. The book presents the complete range of membrane modification techniques used to increase efficiency of membrane processes. The book starts with an examination of the use of membrane modification to optimize the performance of membranes used in industry. It concludes by demonstrating how membrane modification can improve separation processes in industrial sectors that are recognized as global polluters of water sources. Features

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Illustrates the use of Electrochemical Impedance Spectroscopy (EIS) in the characterization of commercial and novel membranes
Overviews various surface modification techniques applied to enhance the bulk and surface properties of nanofiber membranes
Covers the factors affecting membrane fouling and the use of nanoparticles in membrane modification processes
Explores the use of plasma treatment for the modification of polymeric membranes
Written by professors, engineers, and researchers in the field, the book covers recent advances and comprehensively describes novel and most-used membrane characterization techniques. Modification of different materials and geometrics include flat-sheet, hollow-fiber, and nano-fiber membranes as well as different membrane processes such as reverse osmosis, membrane distillation, gas separation, pervaporation, and membrane fuel cells. Chapters contain tables, figures, photographs, and theoretical equations to aid with reader comprehension.

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This systematically organized and well-balanced book compresses within the covers of a single volume the theoretical principles and techniques involved in bio-separations, also called downstream processing. These techniques are derived from a range of subjects, for example, physical chemistry, analytical chemistry, bio-chemistry, biological science and chemical engineering. Organized in its 15 chapters, the text covers in the first few chapters topics related to chemical engineering unit operations such as filtration, centrifugation, adsorption, extraction and membrane separation as applied to bioseparations. The use of chromatography as practiced at laboratory as well as industrial scale operation and related techniques such as gel filtration, affinity and pseudoaffinity chromatography, ion-exchange chromatography, electrophoresis and related methods have been discussed. The important applications of these techniques have also been highlighted.

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A growing proportion of the world's population is dependent on Seawater Desalination as a source of fresh water for both potable and civil use. One of the main drawbacks of conventional desalination technologies is the substantial energy requirement, which is facing cost increases in the global energy market. "Seawater Desalination" presents an overview of conventional and non-conventional technologies, with a particular focus on the coupling of renewable energies with desalination processes. The first section of this book presents, in a technical but reader-friendly way, an overview of currently-used desalination processes, from thermal to membrane processes, highlighting the relevant technical features, advantages and disadvantages, and development potential. It also gives a rapid insight into the economic aspects of fresh water production from seawater. The second section of the book presents novel processes which use Renewable Energies for fresh water production. From the first solar still evaporators, which artificially reproduced the natural cycle of water, technology has progressed to develop complex systems to harness energy from the sun, wind, tides, waves, etc. and then to use this energy to power conventional or novel desalination processes. Most of these processes are still at a preliminary stage of development, but some are already being cited as examples in remote areas, where they are proving to be valuable in solving the problems of water scarcity. A rapid growth in these technologies is foreseen in the coming years. This book provides a unique foundation, within the context of present and future

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sustainability, for professionals, technicians, managers, and private and public institutions operating in the area of fresh water supply.

Annotation Containing 32 peer-reviewed papers, this volume documents the proceedings of the international symposium of the same name (held under the aegis of the Materials Science and Technology Conferences) in December of 2001. Devoted to research into high-temperature polymers, the papers are organized into sections dealing with synthesis, properties, and bulk characterization in the first half and surface modification, interfacial or adhesion aspects, and applications in the second. Annotation (c)2003 Book News, Inc., Portland, OR (booknews.com).

This book on hollow fiber contactors presents an up-to-date compilation of the latest developments and milestones in this membrane technology. Hollow Fiber Membrane Contactors: Module Fabrication, Design and Operation, and Potential Applications provides a comprehensive discussion of hollow fiber membrane applications (including a few case studies) in biotechnology, chemical, food, and nuclear engineering. The chapters in this book have been classified using the following, based on different ways of contacting fluids with each other: Gas-liquid contacting; Liquid-liquid contacting; Supported liquid membrane; Supported gas membrane; Fluid-fluid contacting. Other features include: Discusses using non-dispersive solvent extraction, hollow fiber strip dispersion, hollow fiber supported liquid membranes and role of process intensification in integrated use of these processes Provides technical and economic perspectives with several case studies related to specific scenarios Demonstrates module fabrication, design, operation and maintenance of hollow fiber contactors for different applications and performance Presents discussion on newer concepts like membrane

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emulsification, membrane nanoprecipitation, membrane crystallization and membrane condenser Special focus on emerging areas such as the use of hollow fiber contactor in back end of nuclear fuel cycle, membrane distillation, dehumidification of air and gas absorption and stripping Discusses theoretical analysis including computational modeling of different hollow fiber membrane processes, and presents emphasis on newly developed area of hollow fiber membrane based analytical techniques Presents discussion on upcoming area dealing with hollow fiber contactors-based technology in fermentation and enzymatic transformation and in chiral separations This book is equally suited for newcomers to the field, as well as for engineers and scientists that have basic knowledge in this field but are interested in obtaining more information about specific future applications.

A comprehensive reference book for those with interest in, or need to know, how operations in the world's factories work, and how common products, components, and materials are made. Part II: Casting Metallurgy 1. The Melt 2. Entrainment 3. Flow 4. Molds and Cores (updated and expanded) 5. Solidification Structure 6. Casting Alloys (new chapter) 7. Porosity 8. Cracks and Tears (new consolidated chapter) 9. Properties of Castings Part II: Casting Manufacture 10. The 10 Rules 11. Filling System Design Fundamentals 12. Filling System Components 13. Filling System Design Practice 14. Melting 15. Molding 16. Casting 17. Controlled Solidification Techniques 18. Dimensional Accuracy 19. Post-Casting Processing Index.

This textbook is intended for courses in heat transfer for undergraduates, not only in chemical engineering and related disciplines of biochemical engineering and chemical technology, but also in mechanical engineering and production

engineering. The author provides the reader with a very thorough account of the fundamental principles and their applications to engineering practice, including a survey of the recent developments in heat transfer equipment. The three basic modes of heat transfer - conduction, convection and radiation - have been comprehensively analyzed and elucidated by solving a wide range of practical and design-oriented problems. A whole chapter has been devoted to explain the concept of the heat transfer coefficient to give a feel of its importance in tackling problems of convective heat transfer. The use of the important heat transfer correlations has been illustrated with carefully selected examples.

Despite constant significant advances, cardiovascular as well as more general outcomes of hemodialysis treatment remain unsatisfactory. The introduction of innovative 'high retention onset' membranes has led to the development of a new treatment modality called 'expanded hemodialysis' (HDx), which is the focus of this book. This new therapy is likely to benefit end-stage kidney disease patients, thanks to enhanced removal of molecules retained by current dialysis techniques. HDx is simple to set up and application does not require special hardware or specific nursing skills. This book contains emerging evidence and fascinating new hypotheses on HDx. It is highly recommended for all physicians and healthcare professionals who are caring for dialysis patients and are seeking

innovation and improved care solutions. It will also be of considerable interest to students and fellows.

The indiscriminate use of medications and their inadequate disposal have resulted in them being released into the environment via municipal, hospital and industrial discharges. This volume critically examines the presence of pharmaceuticals in aquatic ecosystems, the hazards they entail, and how to minimize their impact on the environment. The topics covered include: historical findings that have made the development of the discipline ecopharmacovigilance possible; the main exposure routes, fate and life cycle of pharmaceuticals in water; occurrence data and the impact on biodiversity; methods used for the detection, analysis and quantification of pharmaceuticals in water and for their removal; current legislation on the presence of emerging contaminants in water; biosensors for environmental analysis and monitoring; and the measures needed to reduce the existing problems. This book is aimed at students, academics and research workers in the fields of toxicology, ecology, microbiology and chemistry, as well as those in the pharmaceutical industry, health sector professionals, and members of government bodies involved in environmental protection and legislation.

Biological nitrogen fixation has essential role in N cycle in global ecosystem.

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Several types of nitrogen fixing bacteria are recognized: the free-living bacteria in soil or water; symbiotic bacteria making root nodules in legumes or non-legumes; associative nitrogen fixing bacteria that resides outside the plant roots and provides fixed nitrogen to the plants; endophytic nitrogen fixing bacteria living in the roots, stems and leaves of plants. In this book there are 11 chapters related to biological nitrogen fixation, regulation of legume-rhizobium symbiosis, and agriculture and ecology of biological nitrogen fixation, including new models for autoregulation of nodulation in legumes, endophytic nitrogen fixation in sugarcane or forest trees, etc. Hopefully, this book will contribute to biological, ecological, and agricultural sciences.

Modern membrane science and technology aids engineers in developing and designing more efficient and environmentally-friendly processes. The optimal material and membrane selection as well as applications in the many involved industries are provided. This work is the ideal introduction for engineers working in membrane science and applications (wastewater, desalination, adsorption, and catalysis), process engineers in separation science, biologists and biochemists, environmental scientists, and most of all students. Its multidisciplinary approach also stimulates thinking of hybrid technologies for current and future life-saving applications (artificial organs, drug delivery).

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Thermal Induced Membrane Separation Processes describes the fundamental and advanced areas associated with the field of thermal induced membrane separation processes. It includes extensive coverage of material selection, types, and theory of thermal induced membrane fabrication, characterization, and modification. This book focuses on the applications of various thermal induced membrane processes and discusses ancillary topics related to the subject, such as membrane modules, membrane contactors and reactors, preparation and characterization techniques, smart membranes, fouling and its mitigation, and economic analysis of the thermal induced membrane separation processes. Thermal Induced Membrane Separation Processes elaborates on every aspect on the thermal induced membranes in a simple and straightforward manner, helping readers ranging from students to researchers in academia and the industry to understand the processes for successful execution and implementation into their research.

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