Membrane-based Hybrid Processes for Wastewater Treatment

Separation of Functional Molecules in Food by Membrane Technology deals with an issue that is becoming a new research trend in the fields of food and bioproducts processing. The book fills in the gap of transmits practical knowledge between academia and industry by highlighting membrane techniques and applications for the separation of food components in bioresources, discussing separation mechanisms, balancing advantages and disadvantages, and providing relevant applications. Edited by Charis Galanakis, the book is divided in 13 chapters written by experts from the meat science, food technology and engineering industries. Covers the 13 modern relevant topics of functional macro and micro molecules separation using membrane technology in the food industry. Brings the most recent advances in the field of membrane processing. Presents the sustainability principles of the food industry and the modern bioeconomy frame of our times.

MEMBRANE SEPARATION PROCESSES

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. The membranes 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.

Membrane Distillation

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: 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. Modifying of different materials and geometries 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,
Industrial Membrane Separation Technology

Membrane technologies are currently the most effective and sustainable methods utilized in diversified water filtration, wastewater treatment, as well as industrial and sustainable energy applications. This book covers essential subsections of membrane separation and bioseparation processes from the perspectives of technical innovation, novelty, and sustainability. The book offers a comprehensive overview of the latest improvements and concerns with respect to membrane fouling remediation techniques, issues of bioincompatibility for biomedical applications, and various subsections of membrane separation processes, which will be an efficient resource for engineers.

Basic Principles of Membrane Technology

Membranes processing techniques are used to help separate chemical components based on molecular size under specific pressure. A great advantage of membrane processing techniques is that it is a non-thermal processing technique, which can retain enormous bioactive constituents to a greater extent. Being a less energy intensive process, this technique is widely used in several food processing industries such as in the clarification of fruit juices and wine; the concentration of milk; the preparation of whey protein concentrate; and water and waste treatment, among others. Applications of Membrane Technology for Food Processing Industries introduces membrane processing techniques, presenting principles, theory and operational conditions for achieving efficient quality product. It discusses different types of membrane processing techniques viz. reverse osmosis, nanofiltration, ultrafiltration, electro dialysis, microfiltration, pervaporation, including its applications, advantages and disadvantages. Key features: Deals with the retention of antioxidants by using novel membrane processing techniques Includes the application of membrane processing techniques in whey processing Explains the method for degumming, dewatering and decolorization of edible crude oils Narrates application of membrane processing techniques in waste water treatment for efficient use Readers, such as professors, scientist, research scholars, students and industrial personnel, will come to know about the current trends in use of membrane processing techniques for its application in several food processing industries. This book can be a ready reference for the food industry for manufacturing of deacidified clarified fruit juices and wine by using integrated membrane technique approach. In a nutshell, this book will benefit food scientist, academicians, students and food industry personnel by providing in-depth knowledge about membrane processing of foods for quality retention and also for efficient consumer acceptability.

Membrane Technology and Applications

Advanced membranes—from fundamentals and membrane chemistry to manufacturing and applications A hands-on reference for practicing professionals, Advanced Membrane Technology and Applications covers the fundamental principles and theories of separation and purification by membranes, the important membrane processes and systems, and major industrial applications. It goes far beyond the basics to address the formulation and industrial manufacture of membranes and applications. This practical guide: Includes coverage of all the major types of membranes: ultrafiltration; microfiltration; nanofiltration; reverse osmosis (including the recent high-flux and low-pressure membranes and anti-fouling membranes); membranes for gas separations; and membranes for fuel cell uses Addresses six major topics: membranes and applications in water and wastewater; membranes for biotechnology and chemical/biomedical applications; gas separations; membrane contractors and reactors; environmental and energy applications; and membrane materials and characterization Includes discussions of important strategic issues and the future of membrane technology With chapters contributed by leading experts in their specific areas and a practical focus, this is the definitive reference for professionals in industrial manufacturing and separations and research and development; practitioners in the manufacture and applications of membranes; scientists in water treatment, pharmaceutical, food, and fuel cell processing industries; process engineers; and others. It is also an excellent resource for researchers in industry and academia and graduate students taking courses in separations and membranes and related fields.

Principles of Membrane Bioreactors for Wastewater Treatment

Engineering Aspects of Membrane Separation and Application in Food Processing presents an overview and introduction to a wide range of membrane processes, their unique characteristics and challenges. In the food industry, as in many industries, membranes have an environmental advantage over conventional processes that they displace, because they are less energy intensive. The processing at near-ambient conditions also retains flavors and nutritional value. These advantages, together with significant reductions in the cost of membrane modules, augur well for their future not only in the dairy industry but in other parts of the food industry, such as alcohol processing, animal product processing, and fruit and vegetable processing. Chapters address a wide range of membrane separations in the food and beverage industries, and applications are provided that will be of value not only to food engineers but also to process engineers working in other areas. The processing of food is now a highly interdisciplinary science, and anyone concerned with food processing will benefit from reading this book and understanding what membrane processes of the twenty-first century have to offer.

Membrane Modification

Table of Contents Preface Acknowledgments for the first edition Acknowledgments for the second edition 1 Overview of Membrane Science and Technology 1 2 Membrane Transport Theory 15 3 Membranes and Modules 89 4 Concentration Polarization 161 5 Reverse Osmosis 191 6 Ultrafiltration 237 7 Microfiltration 275 8 Gas Separation 301 9 Pervaporation 355 10 Ion Exchange Membrane Processes – Electrodialysis 393 11 Carrier Facilitated Transport 423 12 Medical Applications of Membranes 465 13 Other Membrane Processes 491 Appendix 523 Index 533.

Membrane Processes in Biotechnology and Pharmaceutics
Membrane Separation Principles and Applications: From Material Selection to Mechanisms and Industrial Uses, the latest volume in the Handbooks in Separation Science series, is the first single resource to explore all aspects of this rapidly growing area of study. Membrane technology is now accepted as one of the most effective tools for separation and purification, primarily due to its simple operation. The result has been a proliferation of studies on this topic; however, the relationships between fundamental knowledge and applications are rarely discussed. This book acts as a guideline for those who are interested in exploring membranes at a more progressive level. Covering methods of pressure driving force, partial pressure driving force, concentration driving force, electrical potential driving force, hybrid processes, and more, this volume is more complete than any other known resource on membrane separations. Covers membrane material selection, membrane fabrication, membrane characterization, separation mechanisms and applications in each chapter. Authored by contributors who are internationally recognized as experts in their respective fields. Organized by the driving force behind each type of membrane separation—a unique approach that more clearly links fundamental principles with their dominant applications.

Separation of Functional Molecules in Food by Membrane Technology

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 textbook 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 more.

Membrane-Based Separation in Metallurgy: Principles and Applications begins with basic coverage of the basic principles of the topic and then explains how membrane technology helps in the development of new environmentally friendly and sustainable metallurgical processes. The book features the principles of metallurgical process and how widely the membrane-based technology has been applied in metallurgical industry, including the basic principles of membrane-based separation in terms of material science, membrane structure engineering, transport mechanisms, and module design. Detailed metallurgical process flowcharts with emphasis on membrane separations, current process designs, and membranes problems and provides possible solutions. In addition, the book includes specific membrane applications, molecular design of materials, fine tuning of membrane’s multi-scale structure, module selection and process design, along with a final analysis of the environmental and economic benefits achieved by using these new processes. Outlines membrane separation processes and their use in the field of metallurgy. Includes case studies and examples of various processes and individual sectors of extractive metallurgy as well as the design of flowsheets. Provides a quick reference to wastewater treatment using membrane technology in the metallurgical industry. Outlines the design of flowsheets, a topic that is not covered in academic studies, but is necessary for the design of working process. Provides examples and analysis of the economic implications and environmental and social impacts.

Desalination

Membrane technology is a rapidly developing area, with key growth across the process sector, including biotech separation and biomedical applications (e.g. haemodialysis, artificial lungs), through to large scale industrial applications in the water and waste-water processing and the food and drink industries. As processes mature, and the cost of membranes continues to dramatically reduce, so their applications and use are set to expand. Process engineers need access to the latest information in this area to assist with their daily work and to help to develop and apply new and even more efficient liquid processing solutions. This book covers the latest technologies and applications, with contributions from leading figures in the field. Throughout, the emphasis is on delivering solutions to practitioners. Real world case studies and data from leading organizations -- including Cargill, Lilly, Microbach, ITT -- mean this book delivers the latest solutions as well as a critical working reference to filtration and separation professionals. Covers the latest technologies and applications in this fast moving bioprocessing sector. Presents a wide range of case studies that ensure readers benefit from the hard won experience of others, saving time, money and effort.

World class author team headed up by the Chair of Chemical Engineering at Oxford University, UK and the VP of Plant Operations and Process Technology at Cargill Corp, the food services company and largest privately owned company in the US.

Advances in Membrane Technologies

Osmosis Engineering

The Handbook of Membrane Separations: Chemical, Pharmaceutical, Food, and Biotechnological Applications, Second Edition provides detailed information on membrane separation technologies from an international team of experts. The handbook fills an important gap in the current literature by providing a comprehensive discussion of membrane application.

Membrane Biophysics: As Viewed from Experimental Bilayer Lipid Membranes

“Blue is the new green.” This is an all-new revised edition of a modern classic on one of the most important
subjects in engineering: Water. Featuring a total revision of the initial volume, this is the most comprehensive and up-to-date coverage of the process of desalination in industrial and municipal applications. "Water, for engineers, technicians, scientists working in research and development, and operators. It is also useful as a textbook for graduate classes studying industrial water applications."

**Membrane-Based Separations in Metallurgy**

III . 2 Preparation of synthetic membranes 72 III . 3 Phase inversion membranes 75 III . 3. 1 Preparation by evaporation 76 III . 3. 2 Precipitation. from the vapour phase 76 III . 3. 3 Precipitation by controlled evaporation 76 Thermal precipitation 76 III . 3. 4 III . 3.5 Immersion precipitation 77 Preparation techniques for immersion precipitation 77 III . 4 Flat membranes 77 III . 4. 1 78 III . 4. 2 Tubular membranes 81 III . 5 Preparation techniques for composite membranes 82 III . 5. 1 Interfacial polymerisation Dip-coating 83 III . 5. 2 III . 5. 3 Plasma polymerisation 86 III . 5. 4 Modification of homogeneous dense membranes 87 III . 6 Phase separation in polymer systems 89 III . 6. 1 Introduction 89 III . 6. 2 Thermodynamics 89 III . 6. 2. 1 Binary mixtures 99 III . 6. 2. 2 Ternary systems 102 III . 6. 3 Crystallisation 104 III . 6. 4 Gelation 106 III . 6. 5 Vitrification 108 III . 6. 6 Thermal precipitation 109 III . 6. 7 Immersion precipitation 110 III . 6. 8 Diffusional aspects 114 III . 6. 9 Mechanism of membrane formation 117 III . 7 Influence of various parameters on membrane morphology 123 III . 7. 1 Choice of solvent-nonsolvent system 123 III . 7. 2 Choice of the polymer 129 III . 7. 3 Polymer concentration 130 III . 7. 4 Composition of the coagulation bath 132 III . 7. 5 Composition of the casting solution 133 III . 7.

**Sustainable Membrane Technology for Energy, Water, and Environment**

Water is accepted as the most important source of life. It is assumed that life began in water and spread from there to the whole world. But water has been polluted anthropogenically since the beginning of the industrial revolution in the late 19th century. At the end of the 20th century, most water sources cannot be used for aquaculture, irrigation, and human use. Therefore, for sustainable development, we have to protect our water sources on Earth, because it's the only planet we have!

**Inorganic Polymeric and Composite Membranes**

Principles of Membrane Bioreactors for Wastewater Treatment covers the basic principles of membrane bioreactor (MBR) technology, including biological treatment, membrane filtration, and MBR applications. The book discusses concrete principles, appropriate design, and operational aspects. It covers a wide variety of MBR topics, including filtration theory, membrane materials and geometry, fouling phenomena and properties, and strategies for minimizing fouling. Also covered are the practical aspects such as operation and maintenance. Case studies and examples in the book help readers understand the basic concepts and principles clearly, while problems presented help advance relevant theories more deeply. Readers will find this book a helpful resource to understand the state of the art in MBR technology.

**Engineering Aspects of Membrane Separation and Application in Food Processing**

Inorganic membrane science and technology is a new field of membrane separation technology which until recently was dominated by the earlier field of polymer membranes. Currently the subject is undergoing rapid development and innovation. The present book describes the fundamental principles of both synthesis of inorganic membranes and membrane supports and also the associated phenomena of transport and separation in a semi-quantitative form. Features of this book: - Examples are given which illustrate the state-of-the-art in the synthesis of membranes with controlled properties - Future possibilities and limitations are discussed - The reader is provided with references to more extended treatments in the literature - Potential areas for future innovation are indicated. By combining aspects of both the science and technology of inorganic membranes this book serves as a useful source of information for scientists and engineers working in this field. It also provides some observations of important investigators who have contributed to the development of this subject.

**Basic Principles of Membrane Technology**

Advanced Membrane Technology and Applications

Grasp the Essential Principles of Membrane Bioreactor Processes Evolved from the conventional activated sludge (CAS) process, membrane bioreactor (MBR) processes have become the next-generation solution for municipal and industrial wastewater treatment and recycle. Membrane Bioreactor Processes: Principles and Applications explores nearly all the theoretical and practical aspects of membrane bioreactor technologies. Using the author's expertise obtained from academia and industry, this book provides the crucial details on MBR technology that you need to know. The book details the theoretical and practical backgrounds of current practices involved with membrane module design, biological and membrane system design, system optimization, and system operation. Outlines the State of the Art of the Membrane Bioreactor Technology The text discusses the fundamentals of membrane filtration, emphasizing the principles of submerged membrane
However, there are still some challenges related to fabrication of asymmetric carbon membranes, the performance can potentially offset the relatively high production cost compared to polymeric membranes. As high separation performance to reach the industrial attractive region. Further improvement on membrane development, pre-treatment and energy usage.

Wastewater and Water Quality

Osmosis Engineering provides a comprehensive overview of the state-of-the-art surrounding osmosis-based research and industrial applications. The book covers the underpinning theories, technology developments and commercial applications. Sections discuss innovative and advanced membranes and modules for osmosis separation processes (e.g., reverse osmosis, forward osmosis, pressure retarded osmosis, osmotic membrane distillation), different application of these osmosis separation processes for energy and water separation, such as the treatment of radioactive waste, oily wastewater and heavy metal removal, draw solutions, pretreatment technologies, fouling effects, the use of renewable energy driven osmotic processes, computational, environmental and economic studies, and more. Covers state-of-the-art osmotic engineering technologies and applications. Presents multidisciplinary topics in engineered osmosis, including both fundamental and applied EO concepts. Includes major challenges such as fouling mitigation, membrane development, pre-treatment and energy usage.

Reverse Osmosis

Membrane-Based Hybrid Processes for Wastewater Treatment analyzes and discusses the potential of membrane-based hybrid processes for the treatment of complex industrial wastewater, the recovery of valuable compounds, and water reutilization. In addition, recent and future trends in membrane technology are highlighted. Industrial wastewater contains a large variety of compounds, such as heavy metals, salts and nutrients, which makes its treatment challenging. Thus, the use of conventional water treatment methods is not always effective. Membrane-based hybrid processes have emerged as a promising technology to treat complex industrial wastewater. Discusses the properties, mechanisms, advantages, limitations and promising solutions of different types of membrane technologies. Addresses the optimization of process parameters. Describes the performance of different membranes. Presents the potential of Nanotechnology to improve the treatment efficiency of wastewater treatment plants (WWTPs). Covers the application of membrane and membrane-based hybrid treatment technologies for wastewater treatment. Includes forward osmosis, electrodialysis, and diffusion dialysis Considers hybrid membrane systems expanded to cover zero liquid discharge, salt recovery, and removal of trace contaminants.

Fundamentals of Inorganic Membrane Science and Technology

Membranes play a central role in our daily life, or as indicated by one of my foreign colleagues, Richard Bowen, ‘If you are tired of membranes, you are tired of life’. Biological membranes are hardly used in industrial applications, but separations with synthetic membranes have become increasingly important. Today, membrane processes are used in a wide range of applications and their numbers will certainly increase. Therefore, there is a need for well educated and qualified engineers, chemists, scientists and technicians who have been taught the basic principles of membrane technology. However, despite the growing importance of membrane processes, there are only a few universities that include membrane technology in their regular curricula. One of the reasons for this may be the lack of a comprehensive textbook. For me, this was one of the driving forces for writing a textbook on the basic principles of membrane technology which provides a broad view on the various aspects of membrane technology. I realize that membrane technology covers a broad field but nevertheless I have tried to describe the basic principles of the various disciplines. Although the book was written with the student in mind it can also serve as a first introduction for engineers, chemists, and technicians in all kinds of industries who wish to learn the basics of membrane technology.

Palladium Membrane Technology for Hydrogen Production, Carbon Capture and Other Applications

Today, membranes and membrane processes are used as efficient tools for the separation of liquid mixtures or gases in the chemical and biomedical industry, in water desalination and wastewater purification. Despite the fact that various membrane processes, like reverse osmosis, are described in great detail in a number of books, processes involving ion-exchange membranes are only described in a fragmented way in scientific journals and patents; even though large industrial applications, like electrodialysis, have been around for over half a century. Therefore, this book is emphasizing on the most relevant aspects of ion-exchange membranes. This book provides a comprehensive overview of ion-exchange membrane separation processes covering the fundamentals as well as recent developments of the different products and processes and their applications to the audience for whom the book is intended. It also includes plant managers and process engineers as well as research scientists and graduate students. The separate chapters are based on different topics. The first chapter describes the relevant Electromembrane processes in a general overview. The second chapter explains thermodynamic and physicochemical fundamentals. The third chapter gives information about ion-exchange membrane preparation techniques, while the fourth and fifth chapter discusses the processes as unit operations giving examples for the design of specific plants. First work on the principles and applications of electrodialysis and related separation processes. Presently no other comprehensive work that can serve as both reference work and textbook is available. Book is suited for teaching students and as source for detailed information.

Membrane Separations Technology

Carbon membranes have great advantages of strong mechanical strength and high chemical stabilities, as well as high separation performance to reach the industrial attractive region. Further improvement on membrane performance can potentially offset the relatively high production cost compared to polymeric membranes. However, there are still some challenges related to fabrication of asymmetric carbon membranes, the
controlling of structure and pore-size and module up-scaling for commercial application. The aim of this book is to provide the fundamentals on carbon membrane materials for the young researchers and engineers to develop for their membrane processes. This book describes the status and perspectives of both self-supported and supported carbon membranes from fundamentals to applications. The key steps on the development of high performance carbon membranes including precursor selection, tuning carbon membrane structure and regeneration are discussed. In the end, different potential applications both in gas and liquids separation are well described, and the future directions for carbon membrane development were pointed out. To this end, membrane science and engineering are set to play crucial roles as enabling technologies to provide energy efficient and cost-effective future solutions for energy and environment related processes. Based on this approach the research projects which are trying to find attractive carbon materials in our days are many. The published papers, per year, in the topic of carbon membranes, especially for biogas upgrading, natural gas sweetening and hydrogen purification, are numerous with very high impact. However, only few are the books which include relevant to the topic of carbon membrane technology. This book offers the condensed and interdisciplinary knowledge on carbon membranes, and provides the opportunity to the scientists who are working in the field of carbon membrane technology for gas and liquid separations to present, share, and discuss their contributions within the membrane community.

Membrane and Desalination Technologies

The field of membrane separation technology is presently in a state of rapid growth and innovation. Many different membrane separation processes have been developed during the past half century and new processes are constantly emerging from academic, industrial, and governmental laboratories. While new membrane separation processes are being conceived with remarkable frequency, existing processes are also being constantly improved in order to enhance their economic competitiveness. Significant improvements are currently being made in many aspects of membrane separation technology: in the development of new membrane materials with higher selectivity and/or permeability, in the fabrication methods for high-flux asymmetric or composite membranes, in membrane module construction and in process design. Membrane separation technology is presently being used in an impressive variety of applications and has generated businesses totalling over one billion U.S. dollars annually. The main objective of this book is to present the principles and applications of a variety of membrane separation processes from the unique perspectives of investigators who have made important contributions to their fields. Another objective is to provide the reader with an authoritative resource on various aspects of this rapidly growing technology. The text can be used by someone who wishes to learn about a general area of application as well as by the knowledgeable person seeking more detailed information.

Basic Principles Of Membrane Technology

Thanks to their outstanding hydrogen selectivity, palladium membranes have attracted extensive R&D interest. They are a potential breakthrough technology for hydrogen production and also have promising applications in the areas of thermochemical bio-refining. This book summarises key research in palladium membrane technologies, with particular focus on the scale-up challenges. After an introductory chapter, Part one reviews the fabrication of palladium membranes. Part two then focuses on palladium membrane module and reactor design. The final part of the book reviews the operation of palladium membranes for synthesis gas/hydrogen production, carbon capture and other applications. Review of manufacture and design issues for palladium membranes Discussion of the applications of palladium membrane technology, including solar steam reforming, IGCC plants, NGCC plants, CHF plants and hydrogen production Examples of the technology in operation.

Inorganic Membranes: Synthesis, Characterization and Applications

This book aims to elaborate the basics and recent advances of membrane distillation (MD) as the same shows promise for seawater desalination and wastewater treatment. Starting with MD fundamentals, including the heat and mass transfer analysis, energy evaluation and mathematical modelling, text includes engineering and molecular design of MD membranes. Various types of hybrid systems, including freeze desalination (FD)-MD, MD-crystallization (MDC), pressure retarded osmosis (PRO)-MD and forward osmosis (FO)-MD, will be discussed in this book. Further, it summarizes the future of MD from both industrial and academic perspectives along with energy sources and economic analysis.

Membrane Technology

Carbon Membrane Technology

This new edition of the bestselling Reverse Osmosis is the most comprehensive and up-to-date coverage of the process of reverse osmosis in industrial applications, a technology that is becoming increasingly more important as more and more companies choose to “go green.” This book covers all of the processes and equipment necessary to design, operate, and troubleshoot reverse osmosis systems, from the fundamental principles of reverse osmosis technology and membranes to the more advanced engineering principles necessary for designing a reverse osmosis system. The second edition is an enhanced version of the original bestseller. Each chapter has been reviewed and updated. Revised features include more detail on various pretreatment techniques such as greensand and pyrolusite pretreatment media. The design projection chapter has been edited to include up-to-date information on current projectsprograms. A new section on microbial fouling control featuring chlorine and alternative techniques is included to address the needs of most RO systems. Also, a discussion on forward osmosis is added as an alternative and/or companion technology to reverse osmosis for water treatment. The second edition includes all updated, basic, in-depth information for design, operation, and optimization of reverse osmosis systems. Earlier chapters cover the basic principles, the history of reverse osmosis, basic terms and definitions, and essential equipment. The book then goes into pretreatment processes and system design, then, finally, operations and troubleshooting. The author includes a section on the impact of other membrane technologies and even includes a “Frequently Asked Questions” chapter.
Handbook of Membrane Separations

A detailed look at the most recent developments in sustainable membrane technology for use in energy, water, and the environment. A collection of twenty-seven groundbreaking papers on important ideas about the developments of membrane science and technology. Sustainable Membrane Technology for Energy, Water, and Environment brings together contributions from leading international experts in one comprehensive volume. Covering the latest developments and most innovative ideas in the field, this book is a unique resource for understanding the growing interest in using membranes across several industries. Divided into six chapters that cover new membrane materials and membrane development, membrane applications for gas and vapor separation, membrane applications in water treatment; environmental applications of membranes; energy applications of membranes; and other industrial membrane applications, the book looks at the current and emerging applications for membrane science and technology. In detail, as the Association of Southeast Asian Nations (ASEAN) and the Middle East emerge as the next generation of membrane research and development centers, in part due to the demand for water and natural gas production technology, this book provides invaluable insights into the cutting-edge work taking place in these regions. Additional topics covered also include new membrane materials, membrane applications for food processing, and much more. Designed for engineers, scientists, professors, and graduate students, as well as anyone interested in sustainable development, Sustainable Membrane Technology for Energy, Water, and Environment is a cutting-edge look at membrane applications.

Membrane Bioreactor Processes


Basic Principles of Membrane Technology

Membrane science and technology is an expanding field and has become a prominent part of many activities within the process industries. It is relatively easy to identify the success stories of membranes such as desalination and microfiltration and to refer to others as developing areas. This, however, does not do justice to the wide field of separations in which membranes are used. No other 'single' process offers the same potential and versatility as that of membranes. The word separation classically conjures up a model of removing one component or species from a second component, for example in a mass transfer process such as distillation. In the field of synthetic membranes, the terminology 'separation' is used in a wider context. A range of separations of the chemical/mass transfer type have developed around the use of membranes including distillation, extraction, absorption, adsorption and stripping, as well as separations of the physical type such as membranes. Synthetic membranes are an integral part of devices for analysis, energy generation and reactors (cells) in the electrochemical industry.

Membrane Technology

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' distinct 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

Basic Principles of Membrane Technology

Membrane materials allow for the selective separation of gas and vapour and for ion transport. Materials research and development continues to drive improvements in the design, manufacture and integration of membrane technologies as critical components in both sustainable energy and clean industry applications. Membrane technology offers process simplification and intensification in industry, providing low-cost, and efficient and reliable operation, and contributing towards emissions reductions and energy security. Advanced membrane science and technology for sustainable energy and environmental applications presents a comprehensive review of membrane utilisation and integration within energy and environmental industries. Part one introduces the topic of membrane science and engineering, from the fundamentals of membrane processes and separation to membrane characterization and economic analysis. Part two focuses on membrane utilisation for carbon dioxide (CO2) capture in coal and gas power plants, including pre- and post-combustion and oxygen transport technologies. Part three reviews membranes for the petrochemical industry, with chapters covering hydrocarbon fuel, natural gas and synthesis gas processing, as well as advanced biofuels production. Part four covers membranes for alternative energy applications and energy storage. Part five discusses membranes for redox and lithium batteries, fuel cells and hydrogen production. Finally, part five discusses membranes utilisation in industrial and environmental applications, including microfiltration, ultrafiltration, and forward osmosis, as well as water, wastewater and nuclear power applications. With its distinguished editors and team of expert contributors, Advanced membrane science and technology for sustainable energy and environmental applications is an essential reference for membrane and materials engineers and manufacturers, as well as researchers and academics interested in this field. Presents a comprehensive review of membrane science and technology, focusing on developments and applications in sustainable energy and clean-industry Discusses the fundamentals of membrane processes and separation and membrane characterization and economic analysis.
Membrane Separation Principles and Applications

III . 2 Preparation of synthetic membranes 72 III . 3 Phase inversion membranes 75 III . 3. 1 Preparation by evaporation 76 III . 3. 2 Precipitation. from the vapour phase 76 III . 3. 3 Precipitation by controlled evaporation 76 Thermal precipitation 76 III . 3. 4 Immersion precipitation 77 Preparations techniques for immersion precipitation 77 III . 4 Flat membranes 77 III . 4. 1 Flat membranes 77 III . 5 Interfacial polymerisation Dip-coating 83 III . 5. 2 III . 5. 3 Plasma polymerisation 86 III . 5. 4 Modification of homogeneous dense membranes 87 III . 6 Phase separation in polymer systems 89 III . 6. 1 Introduction 89 III . 6. 1. 1 Thermodynamics 89 III . 6. 2 Demixing processes 99 III . 6. 2. 1 Binary mixtures 99 III . 6. 2. 2 Ternary systems 102 III . 6. 3 Crystallisation 104 III . 6. 4 Gelation 106 III . 6. 5 Vitrification 108 III . 6. 6 Thermal precipitation 109 III . 6. 7 Immersion precipitation 110 III . 6. 8 Diffusional aspects 114 III . 6. 9 Mechanism of membrane formation 117 III . 7 Influence of various parameters on membrane morphology 123 III . 7. 1 Choice of solvent-nonsolvent system 123 III . 7. 2 Choice of the polymer 129 III . 7. 3 Polymer concentration 130 III . 7. 4 Composition of the coagulation bath 132 III . 7. 5 Composition of the casting solution 133 III . 7.

Advanced Membrane Science and Technology for Sustainable Energy and Environmental Applications

This book summarizes the current status of research on bilayer lipid membranes (planar lipid bilayers and spherical liposomes). In addition to describing the properties of lipid bilayers and examining biomembrane phenomena, the book has two other objectives. The first is to present practical methods for the formation and study of lipid bilayers with either aqueous or metal-lipid bilayer interfaces. The second aim is to treat planar lipid bilayers as a new type of interfacial adsorption phenomena. The first nine chapters cover properties of biomembranes, basic principles of membrane biophysics, transport, electrochemistry, physiology, bioenergetics, and photobiology. Chapter 10 presents the following topics: lipid bilayers in medicine, supported lipid bilayers as sensors, a short discussion of liposomes, and solar energy transduction via semiconductor septum photovoltaic cells based on natural photosynthesis.

Membrane Contactors: Fundamentals, Applications and Potentialities

The withstanding properties of inorganic membranes provide a set of tools for solving many of the problems that the society is facing, from environmental to energy problems and from water quality to more competitive industries. Such a wide variety of issues requires a fundamental approach, together with the precise description of applications provided by those researchers that have been close to the industrial applications. The contents of this book expand the lectures given in a Summer School of the European Membrane Society. They combine an easily accessible description of the technology, suitable for the graduate level, with the most advanced developments and the prospective of future applications. The large variety of membrane types makes almost compulsory to select a specialist for each of them, and this has been the approach selected in this book. In the case of porous membranes, the advances are related to the synthesis of microporous materials such as silica, carbon and zeolite membranes and hollow fibre membranes. A chapter covers the increasingly relevant hybrid membranes. Attention is also devoted to dense inorganic membranes, experiencing constantly improved properties. The applications of all these membranes are considered throughout the book. Covers all the inorganic membranes field, by different experts It comes from a European Summer School It includes future directions in the field

Applications of Membrane Technology for Food Processing Industries

Inorganic, Polymeric and Composite Membranes: Structure-Function and Other Correlations covers the latest technical advances in topics such as structure-function relationships for polymeric, inorganic, and composite membranes. Leading scientists provide in depth reviews and disseminate cutting-edge research results on correlations but also discuss new materials, characterization, modelling, computational simulation, process concepts, and spectroscopy. Unified by fundamental general correlations theme Many graphical examples Covers all major membrane types

Copyright code : 4010325bea7428969350f2b336dcde218