

# Ion Exchange Membranes For Electro Membrane Processes

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## **Electrodialysis and Electrodialysis Reversal**

**(M38)** AWWA Staff 1996-06 This manual provides information on electrodialysis and electrodialysis reversal technologies in water treatment. This clearly written manual explains principles of operation, applications for water treatment, equipment, system design, costs, pretreatment and posttreatment, installation, operation, maintenance, and disposal of concentrate.

**Rare Metal Technology 2020** Gisele Azimi 2020-01-20 This collection presents papers from a symposium on extraction of rare metals as well as rare extraction processing techniques used in metal production. Rare metals include strategic metals that are in increasing demand and subject to supply risks. Metals represented include neodymium, dysprosium, scandium and others; platinum group metals including platinum, palladium, iridium, and others; battery related metals including lithium, cobalt, nickel, and aluminum; electronics-related materials including copper and gold; and refractory metals including titanium, niobium, zirconium, and hafnium. Other critical materials such as gallium, germanium, indium and silicon are also included. Papers cover various processing techniques, including but not limited to

hydrometallurgy (solvent extraction, ion exchange, precipitation, and crystallization), electrometallurgy (electrorefining and electrowinning), pyrometallurgy, and aeriommetallurgy (supercritical fluid extraction). Contributions are focused on primary production as well as secondary production through urban mining and recycling to enable a circular economy. A useful resource for all involved in commodity metal production, irrespective of the major metal Provides knowledge of cross-application among industries Extraction and processing of rare metals that are the main building block of many emerging critical technologies have been receiving significant attention in recent years. The technologies that rely on critical metals are prominent worldwide, and finding a way to extract and supply them effectively is highly desirable and beneficial. [Boron Separation Processes](#) Nalan Kabay 2015-01-19 The impending crisis posed by water stress and poor sanitation represents one of greatest human challenges for the 21st century, and membrane technology has emerged as a serious contender to confront the crisis. Yet, whilst there are countless texts on wastewater treatment and on membrane technologies, none address the boron problem and separation processes for boron elimination. Boron

Separation Processes fills this gap and provides a unique and single source that highlights the growing and competitive importance of these processes. For the first time, the reader is able to see in one reference work the state-of-the-art research in this rapidly growing field. The book focuses on four main areas: Effect of boron on humans and plants Separation of boron by ion exchange and adsorption processes Separation of boron by membrane processes Simulation and optimization studies for boron separation Provides in one source a state-of-the-art overview of this compelling area Reviews the environmental impact of boron before introducing emerging boron separation processes Includes simulation and optimization studies for boron separation processes Describes boron separation processes applicable to specific sources, such as seawater, geothermal water and wastewater

Emerging Membrane Technology for Sustainable Water Treatment Rajindar Singh 2016-03-10 Emerging Membrane Technology for Sustainable Water Treatment provides the latest information on the impending crisis posed by water stress and poor sanitation, a timely issue that is one of the greatest human challenges of the 21st century. The book also discusses the use of membrane technology, a serious contender that can be used to confront the crisis on a global scale, along with its specific uses as a solution to this escalating problem. Provides a unique source on membrane technology and its application for water treatment Focuses on technologies designed for the treatment of seawater and brackish water Highlights the most economically and environmentally friendly membrane technologies Lists various technologies and emphasizes their link to renewable energy, energy efficiency, nanotechnology, reuse, and recycle

**Introduction to Membrane Science and Technology** Heinrich Strathmann 2011-10-17 Written by a dedicated lecturer and leading membrane scientist, who has worked both in academia and industry, this advanced textbook provides an impressive overview of all aspects of membranes and their applications. Together with numerous industrial case studies, practical examples and questions, the book provides an excellent and comprehensive introduction to the

topic. Advanced students as well as process and chemical engineers working in industry will profit from this resource. A significant feature of the book is the treatment of more recently developed membranes and their applications in energy conversion, biomedical components, controlled release devices and environmental engineering with an indication of the present and future commercial impact. The solutions to the questions in the book can be found under <http://www.wiley-vch.de/publish/en/books/ISBN3-537-32451-8/> From the Contents: \* Introduction \* Fundamentals \* Membrane Preparation and Characterization \* Principles of Membrane Separation Processes \* Membrane Modules and Concentration Polarization \* Membrane Process Design and Operation

**Ion Exchange Membranes** Toshikatsu Sata 2004 Various separation membranes have been developed since their discovery over half a century ago, providing numerous benefits and fulfilling many applications in our everyday lives. They lend themselves to techniques ranging from microfiltration and gas separation, to what can be considered as the most advanced technique - ion exchange. This book, aimed at academic researchers, engineers and industrialists, contains a brief history of ion exchange and goes on to explain the preparation, characterization, modification and applications of these important membranes. Discussions include the use of ion exchange in analytical and medical techniques, as well as the development of future applications.

Frontiers in Water-Energy-Nexus—Nature-Based Solutions, Advanced Technologies and Best Practices for Environmental Sustainability Vincenzo Naddeo 2019-09-18 This volume includes selected contributions presented during the 2nd edition of the international conference on WaterEnergyNEXUS which was held in Salerno, Italy in November 2018. This conference was organized by the Sanitary Environmental Engineering Division (SEED) of the University of Salerno (Italy) in cooperation with Advanced Institute of Water Industry at Kyungpook National University (Korea) and with The Energy and Resources Institute, TERI (India). The initiative received the patronage of UNESCO - World Water Association Programme (WWAP) and of the International Water

Association (IWA) and was organized with the support of Springer (MENA Publishing Program), Arab Water Council (AWC), Korean Society of Environmental Engineering (KSEE) and Italian Society of Sanitary Environmental Engineering Professors (GITISA). With the support of international experts invited as plenary and keynote speakers, the conference aimed to give a platform for Euro-Mediterranean countries to share and discuss key topics on such water-energy issues through the presentation of nature-based solutions, advanced technologies and best practices for a more sustainable environment. This volume gives a general and brief overview on current research focusing on emerging Water-Energy-Nexus issues and challenges and its potential applications to a variety of environmental problems that are impacting the Euro-Mediterranean zone and surrounding regions. A selection of novel and alternative solutions applied worldwide are included. The volume contains over about one hundred carefully refereed contributions from 44 countries worldwide selected for the conference. Topics covered include (1) Nexus framework and governance, (2) Environmental solutions for the sustainable development of the water sector, (3) future clean energy technologies and systems under water constraints, (4) environmental engineering and management, (5) Implementation and best practices Intended for researchers in environmental engineering, environmental science, chemistry, and civil engineering. This volume is also an invaluable guide for industry professionals working in both water and energy sectors.

Applications of Ion Exchange Materials in the Environment Inamuddin 2019-02-01 This book presents the applications of ion-exchange materials in the area of environmental analysis and treatment. It includes chapters on applications of organic, inorganic and composite ion exchange materials and hexacyanoferrates in various fields such as chemical and biochemical separations, water purification, removal of harmful impurities, dyes and cationic and anionic complexes. This title is a highly valuable source of knowledge on ion-exchange materials and their applications suitable for postgraduate students and researchers but also to industrial

R&D specialists in chemistry, chemical, and biochemical technology. Additionally, this book will provide an in-depth knowledge of ion-exchange column and operations suitable for engineers and industrialists.

### **In-Depth on the Fouling and Antifouling of Ion-Exchange Membranes** Las^aad Dammak

2021-12-31 The use of ion-exchange membranes (IEMs) has accelerated over the past two decades in a wide variety of industrial processes (electrodialysis, electro-electrodialysis, electrolysis, dialysis, etc.) for applications related to chemical, pharmaceutical and food industries, energy production, water treatments, etc. Organic and mineral fouling (or scaling) phenomena are two major factors limiting the efficiencies of IEMs processes and performances (reduction of the IEMs selectivity and stability, increase of their electrical resistance, deduction of the energy efficiency of the process, etc.) leading to significant economic losses. The current washing, cleaning and sterilization processes (anti-fouling treatments) make it possible to recover some of the IEMs performances, but frequently induce degradation on the membrane material. Another essential point in the fouling studies is the choice of the best and appropriate analysis and diagnostic technique to evaluate this or that magnitude, or observe this or that object on the surface or in the mass of the membrane. This book is focused on recent advancements in techniques for diagnosing and characterizing the fouling effects on membranes, in mechanisms governing this complex phenomenon, and in the various innovative and economically viable solutions for reducing fouling.

*Membrane Technology* Sundergopal Sridhar 2018-09-03 Contributed by multiple experts, the book covers the scientific and engineering aspects of membrane processes and systems. It aims to cover basic concepts of novel membrane processes including membrane bioreactors, microbial fuel cell, forward osmosis, electro-dialysis and membrane contactors. Maintains a pragmatic approach involving design, operation and cost analysis of pilot plants as well as scaled-up counterparts

### **Nanotechnology in Membrane Processes**

Kailash Chandra Khulbe 2021-01-09 Nanotechnology has been established in

membrane technology for decades. In this book, comprehensive coverage is given to nanotechnology applications in synthetic membrane processes, which are used in different fields such as water treatment, separation of gases, the food industry, military use, drug delivery, air filtration, and green chemistry. Nanomaterials such as carbon nanotubes, nanoparticles, and dendrimers are contributing to the development of more efficient and cost-effective water filtration processes. Gas separation and carbon capture can be significantly improved in flue gas applications. Nanoporous membrane systems engineered to mimic natural filtration systems are being actively developed for use in smart implantable drug delivery systems, bio artificial organs, and other novel nano-enabled medical devices. The microscopic structure of nanoporous ceramic membranes, mainly focusing on zeolite materials, as well as the energy-saving effect of membrane separation, contribute to various chemical synthesis processes. In the food industry, nanotechnology has the potential to create new tools for pathogen detection and packaging. For each application, nanotechnology is mostly used to make composite membranes, and the book provides a detailed look at the mechanisms by which the composite membrane works in each application area.

**Electrochemical Membrane Technology for Water and Wastewater Treatment** Zhiwei Wang 2022-04-04 Electrochemical Membrane Technology for Water and Wastewater Treatment consolidates state-of-the-art research developments in electrochemical membrane technology in water reclamation and sustainability in terms of fundamental theories, membrane and electrode materials, reactor designs, and fouling control mechanisms and applications. Fundamental theories and applications of electrochemical membrane technology are detailed, with emerging applications of electrochemical membrane technology introduced. The knowledge gaps and future research perspectives in electrochemical membrane technology are also addressed. This book is an excellent resource for understanding fundamental theories, the latest developments, and future prospects in electrochemical

membrane technology. The concepts presented in this book can benefit a broad audience of researchers and engineers working in water purification, membrane technology and electrochemical process. Consolidates scattered knowledge of electrochemical membrane technology into a more assessible resource Provides a comprehensive review of fundamental theories, membrane materials and module design as well as the latest developments in electrochemical membrane technology Provides a state-of-the-art review on the applications of electrochemical membrane technology Includes detailed discussions on the challenges and prospects of electrochemical membrane technology in different applications Presents an excellent reference for the education and understanding of water treatment, wastewater treatment, membrane technology, electrochemical technology, environmental science and technology, and the latest research and developments

Electromembrane Processes Luigi Gurreri 2021-09-08 Electromembrane processes offer a multitude of applications, allowing for the recovery of water, other products, and energy. This book is a collection of contributions on recent advancements in electromembrane processes attained via experiments and/or models. The first paper is a comprehensive review article on the applications of electrodialysis for wastewater treatment, highlighting current status, technical challenges, and key points for future perspectives. The second paper focuses on ZSM-5 zeolite/PVA mixed matrix CEMs with high monovalent permselectivity for recovering either acid or Li+. The third paper regards direct numerical simulations of electroconvection in an electrodialysis dilute channel with forced flow under potentiodynamic and galvanodynamic regimes. The fourth paper investigates the reasons for the formation and properties of soliton-like charge waves in overlimiting conditions. The fifth paper focuses on the characterization of AEMs functionalized by surface modification via poly(acrylic) acid yielding monovalent permselectivity for reverse electrodialysis. In the sixth paper, CFD simulations of reverse electrodialysis systems are performed. The seventh paper proposes an

integrated membrane process, including electrochemical intercalation-deintercalation, for the preparation of  $\text{Li}_2\text{CO}_3$  from brine with a high  $\text{Mg}^{2+}/\text{Li}^+$  mass ratio. Finally, the eighth paper is a perspective article devoted to the acid-base flow battery with monopolar and bipolar membranes.

*Bibliography of Membrane Technology Pertaining to Saline Water Desalination* James M. Shackelford 1965

*Membrane Technology Enhancement for Environmental Protection and Sustainable Industrial Growth* Zhien Zhang 2020-12-14 This book presents a detailed discussion of the fundamentals and practical applications of membrane technology enhancement in a range of industrial processes, energy recovery, and resource recycling. To date, most books on the applications of membrane technology have mainly focused on gas pollution removal or industrial wastewater treatment. In contrast, the enhancement of various membrane processes in the areas of energy and the environment has remained largely overlooked. This book highlights recent works and industrial products using membrane technology, while also discussing experiments and modeling studies on the membrane enhancement process.

**Principles of Desalination** K Spiegler 2012-12-02 Principles of Desalination focuses on the principles of the developing technology of large-scale desalting. This book presents the principal desalting methods and explores the process of hyperfiltration or reverse osmosis. Comprised of 11 chapters, this book starts with an overview of the water use and the problem of a potential water shortage. This text then discusses the fundamentals of the major desalting methods in use and explores the basic scientific and design principles that underlie the methods. Other chapters consider the method of vapor reheat distillation, which incorporates the liquid-liquid heat exchange principle. This book discusses as well the various aspects of ion exchange and explores the mechanisms in dual-purpose plants producing both distilled water and steam-turbine raised power. The final chapter considers the cost of conventional water supplies. This book is a valuable resource for technologists and scientists. Students in the graduate courses of engineering will also find

this book useful.

*Desalination and Water Treatment* Murat Eyvaz 2018-09-19 The need for fresh water is increasing with the rapid growth of the world's population. In countries and regions with available water resources, it is necessary to ensure the health and safety of the water supply. However, in countries and regions with limited freshwater resources, priority is given to water supply plans and projects, among which the desalination strategy stands out. In the desalination process, membrane and thermal processes are used to obtain fresh water from salty water that is in abundant amounts in the sea. This book will outline valuable scientific contributions to the new desalination and water treatment technologies to obtain high quality water with low negative environmental impacts and cost. The editors would like to record their sincere thanks to the authors for their contributions.

Electrodialysis and Water Reuse Andréa Moura Bernardes 2013-08-30 This book presents novel techniques to evaluate electrodialysis processes, to synthesize ionic membranes and to characterize their properties. It shows the potential use of membrane process to the treatment of effluents generated in many industrial sectors such as refineries, leather industries, mining and electroplating processes. The book is based on the results obtained by the author's research group during the past decade. It is useful for students, researchers and engineers interested in membrane technologies for water reuse.

**Electrospun and Nanofibrous Membranes** Ali Kargari 2022-09-30 Electrospun and Nanofibrous Membranes: Principles and Applications covers the fundamental basic science and many engineering aspects of electrospun membrane technology and nanofibers, membrane design and membrane processes. The book comprehensively reviews a wide range of applications including pressure-driven processes, MD process, batteries, oil-water separation, air filtration, drug delivery, fuel-cells, and ion-exchange membranes, as well as antimicrobial membranes. Electrospun and Nanofibrous Membranes will be useful for a range of audiences: chemical, polymer, and materials engineers; professors and graduate

students working on membrane-based separation technology and electrospun nanofibers; as well as R&D engineers in industry working with applications including water and wastewater treatment, desalination, drug delivery and tissue engineering, new generation of batteries, fuel cells, and air filtration. Introduces comprehensively the principles of electrospinning and electrospun membranes Reviews and evaluates the different configurations of electrospinning Discusses scale-up strategies for nanofiber production [Ion Exchange Membranes in Aqueous, Methanolic and Ethanolic Electrolyte Solutions](#) Frank Sarfert 2005 Ion exchange membranes serve as the selective barrier in (electro-)dialytic separation processes. To date they are applied almost exclusively to aqueous electrolyte systems. In principal, however, ion exchange membranes also should be applicable to non aqueous solutions. In order to clarify how and why the membrane behavior in non aqueous electrolyte systems deviates from aqueous systems, equilibrium and transport properties of commercial monopolar and bipolar membranes are determined experimentally for aqueous, methanolic and ethanolic sodium perchlorate solutions in this study. Based on these results the dependence of the membrane performance on solution characteristics such as the relative permittivity, the solute concentration and the ionic mobility and on membrane specifics such as the type of functional groups and the membrane morphology is discussed. Thus, evidence is found for the importance of ion pair formation in the solution as well as in the membrane phase. Both effects lead to a more or less pronounced degradation of the membrane performance. Further insights into the stationary and dynamic behavior of ion exchange membranes is obtained from a detailed, physically meaningful and dynamic bipolar membrane model. It is characterized by the consideration of four ionic species as well as solvent and electric potential, the existence of a space charge region at the cation/anion exchange layer interface, the description of non-idealities by means of solution and membrane phase activity coefficients and the solvent dissociation according to the chemical reaction model. Thus, a model is developed which is able

to reproduce all observed experimental trends for both aqueous and non aqueous solutions. *New Trends in Ion Exchange Studies* Selcan Karakus 2018-11-07 This book covers new systems in technology that have developed our knowledge of ion exchange. This book discusses ion exchange resins to enhance cell growth; anion exchange membrane; nanosystems in ion exchange and ion exchange in environmental applications. The ion exchange system is used in bionanotechnology, cosmetic industry and water treatment.

*Ion and Molecule Transport in Membrane Systems* Victor Nikonenko 2021-08-10 Membranes play an enormous role in our life. Biological cell membranes control the fluxes of substances in and out of cells. Artificial membranes are widely used in numerous applications including "green" separation processes in chemistry, agroindustry, biology, medicine; they are used as well in energy generation from renewable sources. They largely mimic the structure and functions of biological membranes. The similarity in the structure leads to the similarity in the properties and the approaches to study the laws governing the behavior of both biological and artificial membranes. In this book, some physico-chemical and chemico-physical aspects of the structure and behavior of biological and artificial membranes are investigated.

**Ion Exchange Membrane Electrodialysis** Yoshinobu Tanaka 2010 Industrial application of ion exchange membranes started from saline water desalination. However, now it extends widely in many fields such as drinking water or wastewater treatment, demineralisation of amino acid, whey, sugar liquor, recovery of useful components, treatment of organic substances and contributes to the improvement of our standard of living. The application of ion exchange membranes must expand further if we pay attention to unique functions of the membranes for separating ionic species from non-ionic substances or other kinds of ionic species. This book discusses the performance of an electrodialyser from the stand point of fundamental and practical views.

*Membrane Technology and Applications* Richard Baker 2004-05-31 Table of Contents Preface Acknowledgments for the first edition

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**ICREEC 2019** Ahmed Belasri 2020-06-10 This book highlights peer reviewed articles from the 1st International Conference on Renewable Energy and Energy Conversion, ICREEC 2019, held at Oran in Algeria. It presents recent advances, brings together researchers and professionals in the area and presents a platform to exchange ideas and establish opportunities for a sustainable future. Topics covered in this proceedings, but not limited to, are photovoltaic systems, bioenergy, laser and plasma technology, fluid and flow for energy, software for energy and impact of energy on the environment.

**Ion-Exchange Membrane Separation Processes**  
H Strathmann 2004-01-29 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. The audience for this book is heterogeneous, as it 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 text book is available Book is suited for teaching students and as source for detailed information

**Water Resources Quality** Hillel Rubin 2012-10-12 This monograph results from the 4th International Austrian-Israeli Technion Symposium cum Industrial Forum under the banner of the Austrian Technion Society initiative Technology for Peace - Science for Mankind, which was held in Vienna, 23 - 25 April 200 I, devoted to Preservation of the Quality of our Water Resources. The Symposium was a cooperative effort with the Austrian Federal Ministry of Education and Science and Culture, and the Austrian Federal Ministry of Economy and Labor. The program was structured and managed by a joint Program Committee incorporating the editors of this monograph, who are faculty members from the Stephan and Nancy Grand Water Research Institute at the Technion - Israel Institute of Technology, and the University of Agricultural Sciences (Bodenkultur) of Vienna. The Symposium attracted participation from universities, research institutes, industries, and national authorities from Austria, Germany, Greece, Hungary, Israel, Jordan, Palestinian Autonomy, Poland, Russia, Spain, Turkey, USA, and Uzbekistan. The Symposium topics were of major international interest, and talks were at a high professional level. Therefore, I have gladly accepted the initiative of the Symposium Program Committee to extend and expand manuscripts of special merit to chapters of this monograph, whose title is identical to that of the Symposium. Out of the 39 papers presented at the Symposium, 24 papers were selected for inclusion in this monograph, according to their

scientific merit and quality of contribution to the overall subject. Those selected were expanded and subjected to peer review for inclusion in this Volume.

#### Fundamentals of Renewable Energy Processes

Aldo V. da Rosa 2009-05-07 We are hearing a LOT about renewable energy these days! But unlike most available resources on alternative energy that focus on politics and economic impacts, da Rosa's practical guide, *Fundamentals of Renewable Energy Processes*, is dedicated to explaining the scientific and technological principles and processes that enable energy production from safe, renewable, clean sources. Advances in the renewable energy sphere are proceeding with an unprecedented speed, and in order for the world's alarming energy challenges to be solved, solid, up-to-date resources addressing the technical aspects of renewables are essential. This new, updated 2e of da Rosa's successful book continues to give readers all the background they need to gain a thorough understanding of the most popular types of renewable energy—hydrogen, solar power, biomass, wind power, and hydropower—from the ground up. The latest advances in all these technologies are given particular attention, and are carefully contextualized to help professionals and students grasp the "whys and hows" behind these breakthroughs. Discusses how and why the most popular renewable energy sources work, including wind, solar, bio and hydrogen Provides a thorough technical grounding for all professionals and students investigating renewable energy The new 2e of a highly regarded guide written by an internationally renowned pioneer

**Ionic Transport Processes** Kyösti Kontturi 2008-07-10 Modelling of heterogeneous processes, such as electrochemical reactions, extraction or ion-exchange, usually requires solving the transport problem associated to the process. Since the processes at the phase boundary are described by scalar quantities and transport quantities are vectors or tensors, coupling of them can take place only via conservation of mass, charge or momentum. In this book, transport of ionic species is addressed in a versatile manner, emphasizing the mutual coupling of fluxes in particular. Treatment is

based on the formalism of irreversible thermodynamics, i.e. on linear (ionic) phenomenological equations, from which the most frequently used Nernst-Planck equation is derived. Limitations and assumptions made are thoroughly discussed. The Nernst-Planck equation is applied to selected problems at the electrodes and in membranes. Mathematical derivations are presented in detail so that the reader can learn the methodology of solving transport problems. Each chapter contains a large number of exercises, some of them more demanding than others.

*Comprehensive Membrane Science and Engineering* Enrico Drioli 2010-07-09 This multivolume work covers all aspects of membrane science and technology - from basic phenomena to the most advanced applications and future perspectives. Modern membrane engineering is critical to the development of process-intensification strategies and to the stimulation of industrial growth. The work presents researchers and industrial managers with an indispensable tool toward achieving these aims. Covers membrane science theory and economics, as well as applications ranging from chemical purification and natural gas enrichment to potable water Includes contributions and case studies from internationally recognized experts and from up-and-coming researchers working in this multi-billion dollar field Takes a unique, multidisciplinary approach that stimulates research in hybrid technologies for current (and future) life-saving applications (artificial organs, drug delivery)

*Fundamental Modeling of Membrane Systems* Patricia Luis 2018-06-29 Fundamental Modelling of Membrane Systems: Membrane and Process Performance summarizes the state-of-the-art modeling approaches for all significant membrane processes, from molecular transport, to process level, helping researchers and students who carry out experimental research save time and accurately interpret experimental data. The book provides an overview of the different membrane technologies, handling micro-, ultra-, and nanofiltration, reverse and forward osmosis, pervaporation, gas permeation, supported liquid membranes, membrane contactors, membrane bioreactors and ion-

exchange membrane systems. Examples of hybrid membrane systems are also included. Presents an accessible reference on how to model membranes and membrane processes Provides a clear, mathematical description of mass transfer in membrane systems Written by well-known, prominent authors in the field of membrane science

**Electromembrane Processes** Luboš Novák  
2021-12-20 The book is a comprehensive view of all electromembrane processes, including electromembrane processes for energy conversion - a currently very significant problem. The necessary theory and basic information needed for understanding the technology are explained in Part I. Materials used for ion-selective membranes and separation processes are described in Part II, and the applications for synthesis and energy conversion in Part III.

Electromembrane Desalination Processes for Production of Low Conductivity Water Andrej Grabowski 2010 Water of very low mineral content, i.e. low ionic conductivity, is required in many industrial processes and laboratory applications. The demand for total output volume and purity of such water has been significantly increasing during the last decades. Electromembrane processes provide a more sustainable and cost effective water purification compared to alternative processes like distillation and ion-exchange deionization. In the first part of the publication a review of processes used for deionization of water is presented and main physicochemical phenomena occurring in electromembrane processes will be discussed. The subsequent parts are devoted to the experimental verification of novel improvements for two electromembrane processes: electrodialysis and continuous electrodeionization. Considering electrodialysis, an investigation on ion-exchange membranes with profiled surfaces will be presented. It includes a section of appropriate membrane manufacturing procedures and desalination tests with profiled membranes. It turns out that electrodialysis with profiled ion-exchange membranes is superior to conventional electrodialysis with flat membranes and spacers, in particular with respect to desalination degree and reduced energy consumption. Considering

continuous electrodeionization, experimental studies concerning improvements of continuous electrodeionization with bipolar membranes will be presented and discussed. Influence of ion-exchange membrane permselectivity on the product water quality is demonstrated and proposed improvements are aimed to reduce this influence. Concepts with a so-called protection compartment will be discussed and compared experimentally with a concept where the concentrate compartments are filled with ion exchange resin beads. It will be shown that improved continuous electrodeionization with bipolar membranes is able to produce ultrapure water in a quality comparable to conventional mixed-bed ion-exchangers but in a more cost effective and sustainable way.

*Ion Exchange Membranes* Yoshinobu Tanaka  
2015-01-19 Fundamental study and industrial application of ion exchange membranes started over half a century ago. Through ongoing research and development, ion exchange membrane technology is now applied to many fields and contributes to the improvement of our standard of living. *Ion Exchange Membranes*, 2nd edition states the ion exchange membrane technology from the standpoint of fundamentals and applications. It discusses not only various phenomena exhibited by membranes but also their applications in many fields with economical evaluations. This second edition is updated and revised, featuring ten expanded chapters. New to this edition is a computer simulation program of ion-exchange membrane electro dialysis for water desalination that provides a guideline for designing, manufacturing and operating a practical-scale electro dialyzer. Meant to replace experiments, this program will be an important asset to those with time and monetary budgets. New edition features ten revised and expanded chapters, providing the latest developments in ion exchange membrane technology Computer simulation program, accessible through a companion website, provides a guideline for designing, manufacturing and operating practical-scale electro dialyzers Attractive visual presentation, including many figures and diagrams

**Ion Exchange Technology I** Inamuddin Dr.  
2012-06-02 Ion-exchange Technology I: Theory and Materials describes the theoretical

principles of ion-exchange processes. More specifically, this volume focuses on the synthesis, characterization, and modelling of ion-exchange materials and their associated kinetics and equilibria. This title is a highly valuable source not only to postgraduate students and researchers but also to industrial R&D specialists in chemistry, chemical, and biochemical technology as well as to engineers and industrialists.

**Ion Exchange** Friedrich G. Helfferich  
1995-01-01 Comprehensive text provides sound understanding of the relevant factors in ion exchange and the theoretical tools needed to solve specific problems. Detailed coverage of ion exchangers, equilibria, kinetics, electrochemical properties, ion-exchanger membranes, much more. Each chapter contains helpful summary and references. Accessible to nonmathematical students. Introduction. 1962 edition.

**Ion Exchange: Science and Technology** A.E. Rodrigues 2012-12-06 Proceedings of the NATO Advanced Study Institute on Ion Exchange: Science and Technology, Troia, Portugal, July 14-26, 1985

**Ion-Exchange Membrane Separation Processes** H Strathmann 2004-02-12 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. The audience for this book is heterogeneous, as it 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 text book is available Book is suited for teaching students and as source for detailed information

**Sustainable Energy from Salinity Gradients** Andrea Cipollina 2016-03-01 Salinity gradient energy, also known as blue energy and osmotic energy, is the energy obtainable from the difference in salt concentration between two feed solutions, typically sea water and river water. It is a large-scale renewable resource that can be harvested and converted to electricity. Efficient extraction of this energy is not straightforward, however. Sustainable Energy from Salinity Gradients provides a comprehensive review of resources, technologies and applications in this area of fast-growing interest. Key technologies covered include pressure retarded osmosis, reverse electrodialysis and accumulator mixing. Environmental and economic aspects are also considered, together with the possible synergies between desalination and salinity gradient energy technologies. Sustainable Energy from Salinity Gradients is an essential text for R&D professionals in the energy & water industry interested in salinity gradient power and researchers in academia from post-graduate level upwards. For more than ten years the Editors have been sharing substantial research activities in the fields of renewable energy and desalination, successfully participating to a number of European Union research projects and contributing to the relevant scientific literature with more than 100 papers and 2 books on Desalination technologies and their coupling with Renewable Energy. They are intensely working in the field of Salinity Gradient Power, carrying out research with

specific focus on open-loop and closed-loop reverse electrodialysis and pressure retarded osmosis. Covers applications of pressure retarded osmosis, reverse electrodialysis, and capacitive mixing for salinity gradient power in one convenient volume Presents the environmental aspects and economics of salinity gradient energy Explores possible synergies between desalination and salinity gradient energy

### **Mass Transfer and Kinetics of Ion Exchange**

L. Liberti 2012-12-06 While ion-exchange processes were originally used for the treatment of very dilute solutions, many applications for the treatment of concentrated solutions have been developed in recent years. In these situations, the mass transfer bottlenecks are located in the membrane, rather than the liquid phase. Therefore, the development of quantitative models for ion-exchange kinetics requires knowledge about the conductance

characteristics of ions and solvent in the solid phase. A useful approach towards this aim is the study of transport characteristics of these species, and of their interactions in solid ion exchange membranes. Many different transport processes and related phenomena can be observed in membrane-solution systems, e.g., ion migration, electroosmosis, diffusion and self-diffusion, osmosis, hydraulic flow, hyperfiltration (reverse osmosis) or ultrafiltration, streaming potential and streaming current, and membrane potentials (also called "membrane concentration potentials"). It is important to correlate all these phenomena so as to avoid a very large number of unnecessary measurements. Such correlation is often possible [Meares, 1976] since all these phenomena are determined by the ease of migration of the different species across the membrane. Important correlations have been made and summarized even before high-capacity ion-exchange membranes became commercially available [Sollner, 1950, 1971].