Book review

Handbook of Membrane Separations: Chemical, Pharmaceutical, Food, and Biotechnological Applications

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CRC Press, Taylor & Francis Group, Boca Raton, FL, USA, 2009

The aim of the book (1164 pages) entitled Handbook of Membrane Separations: Chemical, Pharmaceutical, Food, and Biotechnological Applications is to endeavour to highlight the exact mechanisms involved in membrane separation and its commercial applications in Chemical, Pharmaceutical, Food, and Biotechnological disciplines. The title task of the book is clearly evident and is distributed in three sections. Each section is disseminated into chapters for different applications. Chapters are contributed by different groups of specialist authors, edited with a sound knowledge and generally thrive in being enthralling and beneficial.

This book describes the key developments in the area of membrane separation. The first section contains 16 chapters related to applications in Chemical and Pharmaceutical industries as well as conservation of natural resources. The first chapter provides an overview of this section. The second chapter explains the detailed sketch of membrane contractors, principle of operation, benefits and commercial applications as well as mass transfer process. Chapter 3 provides thorough information on membrane chromatography, which includes preparation of membranes as stationary phases and their activation, mechanism of adsorption, advantages and applications. Chapter 4 deals with membrane application in gas separation, which takes account of transport mechanisms for gases, membrane materials used for gas separation, module design along with latest applications and novel developments in this area. Chapter 5 discusses pervaporation using membranes; it includes theory and practice. Detailed applications of pervaporation using membranes in chemical and allied industries (e.g. dehydration of organics, removal of organics from aqueous phase and organic-organic separations) are also presented. Chapter 6 explains in detail ceramic membrane technology (viz., description, mass transfer information and separation properties), current developments, applications and future prospects. Chapter 7 presents recent developments and significant applications (e.g. caffeine separation, essential oil separation) in membrane technology using supercritical fluids without any obstacles, which can safeguard the environment. Chapter 8 describes the various strategies and techniques (viz., Pulsed flow, Taylor flow, Dean vortices, Flow channel spacers, High shear devices, Two-phase flows, electrofiltration and ultrasound filtration) to augment performance of different membranes to achieve their natural potential by minimising concentration polarisation and fouling. Chapter 9 presents physicochemical regularities of hydrocarbon permeation in membranes based on glass and rubbery polymers, and also provides significant applications in the separation and removal of hydrocarbons using these membranes. Chapter 10 describes the synthesis and main characteristics of zeolite membranes and reviews the basic mechanisms of gas separation and pervaporation using zeolite membranes and their industrial applications. It also describes zeolite-membrane reactors, their applications and recent advances such as micro sensors and micro separators. Chapter 11 presents fouling phenomena of several types of membranes, analytical methods for its quantification and strategies for its reduction, which includes recommendations to users. Chapter 12 focuses on theory and principles of membrane extraction and its application in pre-concentration, sampling and trace analysis of chemical, biological and food samples. Chapter 13 describes theory, module design and applications of organic hybrid liquid membranes in separation of biotechnological and pharmaceutical products as well as organic and metal species. Chapter 14 presents advancements in membrane technologies and its applications in pharmaceutical industry, current status and future potential. Chapter 15 provides details of membrane applications in various types of drug delivery systems. It includes mechanism, mass transport and future trends. Chapter 16 presents introduction to responsive hydrogel membranes, their preparation and theoretical description and applications in drug delivery.

The second section contains 11 chapters related to applications in biotechnology, food processing, life sciences and energy conversion. Chapter 17 provides an outline of this section. Chapter 18 describes ultrafiltration as an exciting panorama in the area of bioseparations engineering. It provides an insight into the theory involved and its role in concentration, desalting, clarification and fractionation steps of protein bioseparation. Chapter 19 focuses on different types of Membrane distillations (viz. Direct contact, Air gap, vacuum, Sweeping gas and osmotic) and provides the details of heat and mass transfer as well process parameters in each of these methods along with required membranes and their modules. Applications of membrane

doi:10.1111/j.1365-2621.2009.01974.x

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distillations in food processing are also reviewed. Chapter 20 discusses uses of membrane separations in brewing industry in different steps (e.g. beer clarification, cold sterilisation, tank bottom recovery, alcohol removal and water as well as effluent treatments). Chapter 21 reviews the principles of operation of homopolar and bipolar membrane and detailed applications of electro dialysis with bipolar membranes in food industry (viz., production, separation and fractionation of proteins such as soy and whey). Applications in other industries such as chemical (speciality and fine chemicals), biotechnology, Nutraceautical, cosmeceutical and biopharmaceutical are also included. Chapter 22 presents applications of membranes in dairy industry for various functions such as cheese manufacturing, removal of microorganisms, fractionation of whey proteins and milk fat, sanitation and cleaning. It also includes emerging applications (viz., separation of microporous membrane blood oxygenator for critical medical applications, which ensures oxygen-rich blood to the cells in the body during cardiopulmonary operations. Chapter 24 focuses on the design and synthesis of nanotube membranes (e.g. silica nanotubes) and their applications in bio extraction, biocatalysis, drug detoxification and bioseparations (e.g. selective enantiomeric separations, enantioseparations of amino acids and DNA transporter). Chapter 25 focuses on the physicochemical properties, modeling and process of Emulsion Liquid Membrane systems and their application in chemical and biotechnological separations (e.g. treatment of low-concentration waste streams). Chapter 26 presents the theory and physicochemical aspects of cell membrane, the current understanding of the dynamics involved in electroporation as well as its devices. It also includes numerous promising applications of electroporation in human health. Chapter 27 describes the developments in proton conducting membranes for fuel cells and covers the basic principles, types (e.g. polymer electrolyte membranes, perfluorinated sulfonic acid membranes), mechanistic aspects of proton conductivity, physicochemical properties of materials required, and their applications.

The third section contains 16 chapters related to membrane applications in Industrial waste management (including nuclear), environmental engineering, and future trends in membrane science. Chapter 28 presents an introduction to all the chapters of this section. Chapter 29 explains fundamentals of sources and characteristics of radioactive wastes and scope of different membrane processes for treatment of these wastes. Chapter 30 deals with membrane processes for radioactive waste processing (e.g. membrane selection, system design, process and membrane control, radiological protection requirements) including liquid radioactive waste and current global scenario of membrane processes for the treatment of nuclear waste using pressure driven processes. This chapter also presents the future role of membrane processes in nuclear technology and the advantages and limitations of applied membrane processes. Chapter 31 describes the advances in the field of liquid membranes and their classifications and their applications in the separation of actinides (which are a long term environmental hazard), separation of radionuclides from waste streams. Chapter 32 presents sources of radioactive wastes and their treatment by reverse-osmosis processes. Chapter 33 provides membrane based processes for treatment of radioactive nuclear plant waste as well as nondispersive solvent extraction for the separation, removal and concentration of actinides. Chapter 34 describes theory and mechanism of Donnan membrane processes DMP. It also presents selective coagulant recovery using the DMP. A non-pressure driven DMP, also referred to as dialysis, is analysed as a technique for alum recovery for water treatment residuals. Authors claim the DMP is free from surface fouling by natural organic matter. Chapter 35 describes the applications of membrane processes (e.g. microfiltration, ultrafiltration, nanofiltration and reverse osmosis) for treatment of the effluents generated in the pulp and paper industry. Chapter 36 explains operation as well as mechanism of membrane bioreactors and its application in municipal and industrial waste water treatment for removal of various pollutants. Chapter 37 presents process modelling and optimisation of membrane-assisted solvent extraction for the recovery of metallic pollutants. Chapter 38 provides basic principles (viz., Mass-transfer resistances, membrane requirements) and potentialities of membrane contactors in treatment of gaseous waste streams along with module design. Chapter 39 presents working function of the pseudo-emulsion based hollow fiber strip dispersion technique and its application separation/removal/concentration of metals (e.g. actinides). Chapter 40 describes electrically enhanced membrane processes (such as electrochemical modification and electrostatic driven) for water purification. It also covers the case studies on electrosorption membranes for waste water treatment and electrocatalytic membranes for decomposition of organic pollutants. Chapter 41 provides case studies on the treatment of industrial tannery effluents using membrane bioreactors and reverse osmosis pilot plants. Chapter 42 presents developments in theory and membranes (viz., materials, modules, synthesis, modification and applications) of nanofiltration technology. It also provides a case study on recovery of impurity free sodium thiocyanate for acrylic fiber industry using nanofiltration plant. Chapter 43 provides the future scenario of membrane processes covering chemical, biotechnological, pharmaceutical applications, etc and also focussing future progresses in

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International Journal of Food Science and Technology 2009
membrane engineering such as catalytic membrane reactors, membrane based artificial organs, membrane contactors, nanostructured materials and membranes in electronic devices.

I really enjoyed reading this book owing to the clarity maintained throughout its presentation. The work reviewed in this publication is of superior quality and is sound enough. Regarding the figures, although the figures are very tidy and obvious to the reader, colour will positively add to the easy perception. The book is extremely useful to the researchers in the fields of chemistry, pharmacy, medicine, food and biotechnology. As a food researcher, I could recommend it for its scope, readability, value and importance.

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