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A Review of: "HANDBOOK OF INDUSTRIAL MEMBRANE TECHNOLOGY Mark C. Porter, ed. Noyes Publications, Park Ridge, NJ, 1990 hardbound, 604 pages, \$96.00"

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BOOK REVIEW

HANDBOOK OF INDUSTRIAL MEMBRANE TECHNOLOGY

Mark C. Porter, ed.
Noyes Publications, Park Ridge, NJ, 1990
hardbound, 604 pages, \$96.00

The recent surge in interest in the membrane field has lead to the publication of several new texts in membrane technology. The "Handbook of Industrial Membrane Technology" presents the relevant process engineering aspects of membrane unit operations. The content is focused more towards design and applications than theory. It is profusely illustrated with 407 figures and 56 tables. There are extensive references at the end of each chapter (658 total) for those seeking more information.

The first chapter, "Synthetic Membranes and Their Preparation," by Heiner Strathmann discusses fundamental membrane material science and membrane formation techniques. The presentation is mainly on polymeric membranes and includes a brief review of module configuration and fabrication. Although first in sequence it would not satisfy a novice to the membrane field. Some basic membrane nomenclature and unit process review has been presented in the Preface, but a separate introduction chapter would have been more appropriate.

Chapter 2, "Microfiltration," by Mark C. Porter provides a description of microporous membrane characteristics and applications. Tests to determine pore size are reviewed and ways to represent retention characteristics are described. Membrane configuration and operating concerns are discussed. Applications to several industries are presented including the pharmaceutical/biotechnology, electronics and beverage industries.

Chapter 3, "Ultrafiltration," is also written by Mark C. Porter. Its content is organized in a similar manner to the previous chapter. Membrane structure and fabrication, pore size determination and retention characteristics are

described for ultrafiltration membranes. The operating concerns of concentration polarization and fouling are examined. Design and applications are a major part of the chapter and numerous examples are presented. Some of these include the production of ultrapure water, electrocoat painting, oil separation, food and beverage processing and biological/biochemical processing.

Chapter 4, "Reverse Osmosis," is authored by Richard G. Sudak. His introduction is followed by a discussion of basic process considerations and mass transfer relationships. He presents the characteristics of reverse osmosis membranes and reinforces the presentation on module design that was discussed in Chapter 1. This chapter includes case studies on the use of reverse osmosis in wastewater treatment, in refinery operation, and in seawater desalination. The applications are sufficiently described and illustrated. A follow-up chapter by Robert J. Petersen and John E. Cadotte focuses on "Thin Film Composite Reverse Osmosis Membranes." This chapter presents information on the structure, manufacture and performance of some commercially available polymer composites.

Chapter 6, "Process Design and Optimization," by Robert Rautenbach ties together membrane mass transport theory and design for membrane processes. Selected applications in reverse osmosis, ultrafiltration, gas permeation, and pervaporation are included with appropriate design information.

"Enzyme Membrane Reactors and Membrane Fermentors" is the title of Chapter 7 written by Enrico Drioli, Gabriele Iorio and Gerardo Catapano. The authors of this chapter break the content down into enzyme membrane reactors, dynamic enzyme gel reactors, membrane segmented enzyme reactors, membrane bound enzymes in continuous flow systems, and membrane fermentors. This chapter presents information for application of this technology to the growing biotechnology industry.

Chapter 8, "Electrodialysis," by Thomas A. Davis is a concise presentation of theory, design and applications. The ion-exchange membranes that are used in electrodialysis are examined. The design presentation focuses on the proper use of the electrical driving force and system configuration. Concentration polarization and membrane fouling in electrodialysis operation are presented.

"Coupled Transport Membranes" are discussed by Richard Baker and Ingo Blume in Chapter 9. Their presentation examines the fundamentals of counter transport and co-transport. The effect of concentration, complexing agents, interfacial reaction rate, and concentration polarization on coupled transport

systems are described. The design and applications section thoroughly reviews process utilization for separation and concentration of metals from hydrometallurgical feeds and industrial effluents.

The final chapter, "The Separation of Gases by Membranes," is authored by A. Keith Fritzsche and James E. Kurz. They present theory on both porous and non-porous gas separation membranes. The preparation of gas permeation membranes is discussed by reviewing several of the commercially available polymers. Applications to hydrogen recovery, carbon dioxide separation, oxygen/nitrogen separation and dehydration are detailed.

A strong feature of the handbook is the presentation of numerous examples of industrial applications of membrane processes. Many of these are thoroughly described with process design information and economics. The variety of application types are well referenced. The chapters review the history of each membrane unit operation and give a short summary of future directions. More information, or perhaps a separate chapter, should have been provided on pervaporation. Only eight pages devoted to this membrane process appear in Chapter 6. There is some variability in quality between the chapters and the overall organization of the handbook could have been improved. The quality of some figures and equations is poor. This handbook does not serve as a complete source of all information on membrane technology. There are several new texts available that provide a more equally balanced presentation of theory, design and applications. Nonetheless, this handbook would be a good addition to any engineering library.

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