MEMBRANE AND ULTRAFILTRATION TECHNOLOGY

Developments Since 1981

Edited by S. Torrey

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Foreword

The detailed, descriptive information in this book is based on U.S. patents, issued between January 1982 and June 1983 that deal with membrane and ultrafiltration technology.

The book contains two parts. Part I covers recent patent technology. Part II, an overview of membrane separation processes, provides a review of current technology and suggests possibilities for future research.

Part I is data-based material, providing information retrieved and made available from the U.S. patent literature. It thus serves a double purpose in that it supplies detailed technical information and can be used as a guide to the patent literature in this field. By selecting the significant information from the patents, the book presents an advanced commercially oriented review of recent developments in the field of membrane and ultrafiltration technology.

The U.S. patent literature is the largest and most comprehensive collection of technical information in the world. There is more practical, commercial, timely process information assembled here than is available from any other source. The technical information obtained from a patent is extremely reliable and comprehensive; sufficient information must be included to avoid rejection for "insufficient disclosure." These patents include practically all of those issued on the subject in the United States during the period under review; there has been no bias in the selection of patents for inclusion.

The patent literature covers a substantial amount of information not available in the journal literature. The patent literature is a prime source of basic commercially useful information. This information is overlooked by those who rely primarily on the periodical journal literature. It is realized that there is a lag between a patent application on a new process development and the granting of a patent, but it is felt that this may roughly parallel or even anticipate the lag in putting that development into commercial practice.

Many of these patents are being utilized commercially. Whether used or not, they offer opportunities for technological transfer. Also, a major purpose of this book is to describe the number of technical possibilities available, which may open up profitable areas of research and development. The information contained in this book will allow you to establish a sound background before launching into research in this field.

The information in Part II is from *Membrane Separation Technology In the 1980s,* prepared by H.K. Lonsdale of Bend Research, Inc. for the U.S. Department of Energy Jet Propulsion Laboratory, March 1982.

The table of contents is organized in such a way as to serve as a subject index. Other indexes by company, inventor and patent number help in providing easy access to the information contained in this book.

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16 Reasons Why the U.S. Patent Office Literature Is Important to You

1. The U.S. patent literature is the largest and most comprehensive collection of technical information in the world. There is more practical commercial process information assembled here than is available from any other source. Most important technological advances are described in the patent literature.
2. The technical information obtained from the patent literature is extremely comprehensive; sufficient information must be included to avoid rejection for "insufficient disclosure."
3. The patent literature is a prime source of basic commercially utilizable information. This information is overlooked by those who rely primarily on the periodical journal literature.
4. An important feature of the patent literature is that it can serve to avoid duplication of research and development.
5. Patents, unlike periodical literature, are bound by definition to contain new information, data and ideas.
6. It can serve as a source of new ideas in a different but related field, and may be outside the patent protection offered the original invention.
7. Since claims are narrowly defined, much valuable information is included that may be outside the legal protection afforded by the claims.
8. Patents discuss the difficulties associated with previous research, development or production techniques, and offer a specific method of overcoming problems. This gives clues to current process information that has not been published in periodicals or books.
9. Can aid in process design by providing a selection of alternate techniques. A powerful research and engineering tool.
10. Obtain licenses–many U.S. chemical patents have not been developed commercially.
11. Patents provide an excellent starting point for the next investigator.
12. Frequently, innovations derived from research are first disclosed in the patent literature, prior to coverage in the periodical literature.
13. Patents offer a most valuable method of keeping abreast of latest technologies, serving an individual's own "current awareness" program.
14. Identifying potential new competitors.
15. It is a creative source of ideas for those with imagination.
16. Scrutiny of the patent literature has important profit-making potential.

Contents and Subject Index

PART II
OVERVIEW

Introduction

This book on membrane technology may be viewed as a study of the latest techniques for the separation and purification of fluids. The book contains two parts. Part I describes recent patent technology in the field, and Part II is an overview of membrane separation processes which provides a review of current technology and suggests some possibilities for future research.

A membrane is defined as a thin sheet of natural or synthetic material which is permeable to substances in solution. A semipermeable membrane, the use of which is delineated in this book, is a natural or synthetic microporous structure which acts as an efficient filter for particles in the range of molecular dimensions.

In 1861 Thomas Graham, a British chemist, first observed the marked difference in the rates of the diffusion of certain substances through a parchment membrane. His studies led to the development of colloid chemistry. The rates of diffusion of various sized molecules vary widely; e.g., the diffusion rate of sodium chloride is 2.3, that for sucrose is 7 and for such macromolecules as proteins the rate is from 50 to 100. These diffusion rate differences establish the separation and purification processes of this book.

There are three types of barrier separation processes–filtration, with which we are not concerned here, ultrafiltration, and osmosis. Filtration applies to particles greater than approximately one micron in diameter. Ultrafiltration is the process in which colloidal particles or large molecules (generally greater than about 20 Angstrom units in diameter) are separated from solution. The process of osmosis is potentially capable of separating low molecular weight salts from their solvent.

Part I is divided into eight chapters. In the first chapter, semipermeable membranes which are useful for more than one kind of procedure are described; e.g., membranes which can be used for dialysis and for desalination.

Chapter two involves the electrolysis of brine to chlorine and sodium hydroxide in cells of the diaphragm or permionic type. This procedure is of great importance industrially.

The third chapter takes a look at other electrolytic processes involving membranes–electrodialysis (a process in which dialysis is accelerated by the use of an electric field), membranes used as battery separators, etc.

Chapter four examines the various kinds of membrane separation processes for fluids which are not specifically covered in other chapters, and apparatus designed for such separations.

The fifth and sixth chapters have to do with medical applications of membrane techniques. The whole of chapter five deals with the blood-washing technique based on dialysis in which the dialyzer and the machine which operates it act as an artificial kidney. Hemodialysis removes the toxic metabolites usually contained in urine from blood of patients who are suffering from chronic kidney disease. Hemodialysis was first used on humans in 1945 and the development of hollow filaments of cellulosic or synthetic polymers made possible the introduction of more compact dialyzers in the late 1960s. New types of membranes and new dialyzer designs to make dialysis faster, less expensive and safer for the patient continue to be invented.

Chapter six looks at other medical applications for semipermeable membranes. These include artificial lungs or blood oxygenators, processes for the fractionation of blood, and drug delivery systems, for example.

The seventh chapter deals with the subject of water purification, and includes various desalination processes and means of wastewater purification. This subject becomes more important each year, as the world's supply of pure water dwindles inexorably.

Chapter eight covers miscellaneous uses of membranes–for roofing, road paving, artificial sports surfaces, etc.

It was, of course, difficult to assign these patents to one particular chapter. Definitions of terms used in membrane technology show how much overlapping there is in the concepts–dialysis and ultrafiltration, for example, seem nearly indistinguishable–and many of the patents could well have been placed in another location in the book. It is felt, however, that a perusal of the headings listed in the Contents and Subject Index will enable persons interested in specific types of processes to find the patents which are applicable.

Part II, as noted above, presents an overview of the state of the art of membrane separations–the technology, applications, and science. Current activities and future directions are also covered.

Part I
Patent Technology

1

Multipurpose Membranes

POLYMERIC MEMBRANES

Mixture of Two Polyethers to Make an Ultrafiltration Membrane

X. Marze and M. Minfray; U.S. Patent 4,319,008; March 9, 1982; assigned to Rhone-Poulenc Industries, France.

It is well known to this art to utilize semi-permeable membranes in various separation processes, such as reverse osmosis and ultrafiltration.

For such applications, it is advantageous to fabricate screen-based or reinforced membranes, namely, membranes which comprise, for at least a portion of their thickness, a flexible support or backing [which is frequently a fabric, non-woven or grid], which support renders the membranes both strong and easy to handle, even when in the form of samples having large dimensions. Screen-based membranes are generally produced by casting a polymer solution, followed by removal of the solvent [notably by evaporation and/or coagulation]. The polymer solution is hereafter referred to as the "collodion", regardless of the polymer envisaged.

Thus, the present invention features novel semi-permeable membranes which can be widely used in industry, in particular for purposes of ultrafiltration, and which are based on a polymeric composition of polysulfone type but which can be fabricated from fairly concentrated collodions.

The membranes according to the invention are characterized in that they comprise a mixture including at least one polymer (polyether) comprising recurring units of the structural formula (I):