

Gas Separation Membranes: Polymeric and Inorganic

by A.F. Ismail, K.C. Khulbe, and T. Matsuura

Springer International Publishing, Switzerland, 2015, 331 pages,
ISBN: 978-3-319-01094-6 (HB \$79.99 from Springer), 978-3-319-01095-3 (eBook \$59.99 from Springer)

Reviewed by

Jeremy Lewis

University of North Dakota

As topics such as membrane separations become more advanced, their niche topics start to develop into topics of their own and require freestanding monographs to thoroughly inform their expanding audience. This book is one that addresses gas separation membranes as a separate entity from other membranes in application, while including information still pertinent to general membrane separation studies. Chemists, material scientists, chemical engineers, mechanical engineers, energy engineers, and process designers engaged in gas separations will all find value in this book.

The authors preface this book stating its intended audience is researchers in universities and other institutions, engaged in membrane research. They manage to address nearly all aspects of membrane research in seven chapters.

The first chapter introduces membrane separations including a rough timeline of membrane development as well as some strengths and weakness of membrane processes. Chapter two is written almost as a dictionary, defining and describing many of the common phenomena encountered when investigating membranes. Terms defined include Knudsen diffusion and mean free path. Although somewhat unnecessary for seasoned researchers, these two chapters appeal greatly to young researchers who are new to the concept of membrane science.

In chapter three the authors discuss, in detail, polymers and inorganic materials used to construct membranes. Focusing on molecular-level properties, they display chemical structures, map out some synthesis techniques, and state some of the desired and undesired characteristics associated with each material. Some examples include polysulfone and polyamide type polymers, and metal organic frameworks.

The following three chapters focus on membrane fabrication techniques, module design, and their applications. The authors discuss a wide range of proven fabrication methods such as phase inversion and spin coating, some in more detail than others.

They also include many lab-scale and commercial module designs, followed by mature and emerging applications in gas separations. Some designs include flat sheet, plate and frame type, and hollow fiber modules. Some applications discussed were hydrogen recovery, oxygen enrichment, and carbon capture.

The last chapter is, in my opinion, the chapter that stands out most from other books and creates a good reference book. It discusses many of the analytical techniques including various spectroscopic, microscopic, calorimetric, and tensile-strength tests, used for membrane characterization. The authors go into the theory behind the techniques and give examples as to how the results can characterize membranes.

Although quality information is presented, it is my opinion that further editing will result in a much better second edition. Many of the introductory paragraphs make claims that are not supported in the following sections. For example, the introductory paragraph to chapter two makes a general claim that hollow fibers are preferred over flat sheets. This statement may be relevant in some context, however, that idea is not developed in that chapter but is discussed later. The authors also occasionally include sentences that do not add information, but merely distract the reader and interrupt the flow of ideas. An example from chapter two states that Henry's law is "...one of the gas laws formulated by William Henry in 1803." Although true, it is an unnecessary detail that should have been left out.

Many of the sections include much detail with several references to relevant literature, and other sections contain noticeably less information with no references to outside literature. Some sections in this book contain a literature review, describing state-of-the-art studies. However, the reviews do nothing more than summarize key points in the referenced studies and usually do not attempt to synthesize or critically analyze any of them.

The book contains many positive aspects. The studies referenced in this book are mostly fundamental and their ideas will likely be relevant for many years. These fundamental studies give young researchers a place to start when beginning their research. The authors also do a great job in comparing different membrane materials, types, and modules. They describe advantages and disadvantages of each from a separation, permeability, stability, and cost perspective.

With the exception of the mentioned short-comings, this book is a valuable resource for new researchers, and a decent reference for mature researchers in the field of gas phase membrane separations. □