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Membrane Technology : An Overview

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Abstract

Membranes have become increasingly significant in chemical technology, and they are being used in a wide range of applications. The capacity of a membrane to control the permeability of a chemical species in contact with it is a key attribute that is used in every application. In most packaging applications, the goal is to entirely prevent penetration. The purpose of controlled drug delivery is to slow the rate at which a drug passes from a reservoir to the body. The purpose of separation applications is to allow one component of a mixture to readily permeate the membrane while preventing other components from doing so. Membrane science has evolved from a laboratory curiosity to a widely used technology in industry and medical since the 1960s. This trend is anticipated to continue, especially in the areas of membrane gas separation and pervaporation separation.

Introduction

Membranes will be crucial in the next generation of biomedical devices, including artificial pancreas and livers. In the 30 years leading up to 1994, the overall membrane market rose from $10 million to $1-2 billion. Spectacular development of this magnitude is unlikely to continue, but the whole industry is anticipated to double in size to $2-4 billion in the decade following. The eighteenth century philosophical scientists were the first to conduct systematic research of membrane phenomena. In 1748, Abbe Nolet developed the term osmosis to describe water penetration through a diaphragm. Membranes had no industrial or commercial applications in the nineteenth and early twentieth centuries, but they were employed in laboratories to test physical and chemical ideas. For example, in 1887, van't Hoff used Traube and Pfeffer's membrane observations of solution osmotic pressure to develop his limit law, which explains the behaviour of perfect dilute solutions. The van't Hoff equation was born out of this research. Maxwell and others developed the kinetic theory of gases about the same time, using the concept of a perfectly selective semipermeable membrane. Collodion (nitrocellulose) membranes were later favoured because they could be manufactured in a consistent manner. Bechhold developed a method for producing nitrocellulose membranes with graded pore sizes, which he determined using a bubble test, in 1907. Other researchers improved on Bechhold's approach, and microporous collodion membranes became commercially available in the early 1930s.

Early researchers experimented with any form of diaphragm they could find, including pig, cattle, and fish bladders, as well as animal intestine sausage casings. This early microfiltration membrane technique was developed to additional polymers, most notably cellulose acetate, over the next 20 years. At the end of World War II, membranes were used for the first time in the filtration of drinking water samples. The time and work it took to design these filters was well worth it. The Millipore Corporation, the first and still largest microfiltration membrane manufacturer, took advantage of a project supported by the United States Army.

The elements of current membrane research had been developed by 1960, but membranes were only used in a few laboratory and small, specialised industrial applications at the time.