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Commentary

Gas Separation Membrane: An Overview

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DESCRIPTION

Gas separation through a membrane is a pressure-driven process where the driving force can be called as the pressure difference between the raw material inlet and the product outlet. The membrane technique is generally used in non-porous sheet such that there is no gas leakage through the membrane. Membrane performance depends on the permeability and selectivity. Permeability is affected by the size of the penetrant and large gas molecules have a low diffusion co-efficient. The flexibility of the polymer chain and the free volume in the polymer of the membrane material affect the diffusion co-efficient, as the space inside the permeable membrane must be large enough for gas molecules to diffuse. The solubility is expressed as the ratio between the concentration of the gas in the polymer and the pressure of the gas in contact with it.

Gas separation membranes can be used in the various steps during the processing of natural gas. This paper considers the current and future potential of polymer membranes in acid gas removal, heavy hydrocarbon recovery, water dewatering, and nitrogen and helium separation. A gas separation membrane can be used in a membrane reactor for steam reforming ethanol or methanol in the production of hydrogen. Gas separation membrane work on the principle of selective permeation through the membrane surface. The permeation rate of each gas depends on its solubility in the membrane material and the rate of gas diffusion. The gases with high solubility and small molecules move through the membrane relatively fast.

The process of membrane separation is a technique that uses a membrane to separate the components of a solution by rejecting unwanted substances and allowing others to pass through the membrane. There are many possible separation mechanisms for both porous and nonporous membranes, but only six are considered as important for gas separation which includes Knudsen diffusion, molecular sieving, surface diffusion, facilitated transport, capillary condensation, gas separation, and distribution of solutions. The membrane gas separation equipment generally pumps the gas into the membrane module, and the target gases are separated based on the difference in diffusivity and solubility. For example, oxygen is separated from ambient air and collected on the upstream side and nitrogen on the downstream side.

Membrane separation technique can remove small substances such as viruses and dissolved ions from water. Nano Filtration Membrane (NFM): Enrichment of organic components by eliminating part of monovalent ions such as sodium and chlorine (partial desalination). Ultra Filtration Membrane (UFM): Although polymeric membranes are economically and technologically useful, they are limited by their performance, is known as the Robeson limit (permeability must be sacrificed for selectivity and vice versa). This limit value has an effect on the use of polymer membranes for CO_2 separation from flue gas streams, since mass transfer is limiting and CO_2 separation becomes very expensive due to low permeability.

Membrane materials have expanded into the realm of silica, and metal-organic frameworks due to their strong thermal and chemical resistance, as well as high tunability (ability to be modified and functionalized), resulting in higher permeability and selectivity. Membranes can be used to separate gas mixtures, where they act as a permeable barrier through which different compounds move at different speeds, or doesn't move at all. The membranes can be nano-porous, polymeric, etc. and gas molecules penetrate according to their size, diffusivity, or solubility.

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