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Short Communication

An Overview of Membrane Distillation and its Classification

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DESCRIPTION

Membrane Distillation (MD) is a thermally driven separation process in which separation is driven by phase change. A hydrophobic membrane presents a barrier for the liquid phase, allowing the vapour phase (example water vapour) to passing through the membrane's pores. The driving force of the process is a partial vapour pressure difference commonly triggered by a temperature difference. The membrane distillation process is an important and relatively new application for porous membranes. The volatility of the separating component, as well as the structure of the porous membrane, has a strong influence on separation efficiency [1,2].

PRINCIPLE OF MEMBRANE DISTILLATION

Most membrane separation methods depend on a static pressure difference between the two bounding surfaces (example Reverse Osmosis-RO), a difference in concentration (dialysis), or an Electric Field (ED). The selectivity of a membrane can be attributed to the pore size-to-substance size interaction, its diffusion co-efficient, or its electrical polarization. Membranes used in membrane distillation to prevent water on the surface passing through while allowing free water molecules and therefore water vapour to pass around [3,4].

These membranes are composed of hydrophobic synthetic material (such as PTFE, PVDF, or PP) and have pores with standard diameters ranging from 0.1 to 0.5 m. Because water has strong dipole characteristics, and the membrane fabric is non-polar, the liquid doesn't hydrate the membrane material. Despite the reality that the pores are much larger than the molecules, the high surface energy of the water prevents the water molecules from entering the pores [5].

MEMBRANE DISTILLATION TECHNIQUES

There are various membrane distillation techniques are available. The basic four techniques are characterized mainly by the configuration of their distillate channels or the method in which this channel is performed. The following technologies are the most widely used: Vacuum Multi-Effect Membrane Distillation (V-MEMD), Sweeping Gas MD (SWGMD), Permeate Gap MD (PGMD), Vacuum MD (VMD), Direct Contact MD (DCMD), Air Gap MD (AGMD).

Vacuum multi-effect membrane distillation

A conventional vacuum multi-effect membrane distillation interface includes a steam raiser, evaporation-condensation stages, and a heat exchanger. Each stage restores condensed water heat, resulting in a multi-effect design. Each evaporation-condensation stage, as well as the capacitor, produces distillate.

Sweeping-gas MD

Sweeping-gas MD is also known as air stripping, implements a channel configuration with a permeate side empty difference. This is the same configuration as in AGMD. The vapor is condensed outside of the MD module in an external evaporator. This process, including Air Gap MD, can distil volatile substances with low surface tension. Sweeping gas MD has an advantage over AGMD in that it significantly reduces the barrier to mass transport through forced streams.

Permeate-gap MD

The subsequent sections will explain the basic channel configuration and operation of a standard DCMD module as well as a DCMD module with a separate permeate gap. It can also be interpreted as a construct for flat-hollow-fiber or spiral-wound components. A heat exchanger channel with an inlet and outlet and an evaporator channel with inlet and outlet represent the entire channel configuration. The hydrophobic, micro porous membrane separates these two channels.

Vacuum MD

Vacuum MD has an air gap channel configuration. Such as sweeping gas MD, after passing through the membrane, the vapor is absorbed out of the permeate channel and accumulates outside the module. VCMD and SWGMD can be used to separate volatile substances from a solvent such as water or to generate pure water from concentrated salt water. Another advantage of this method is that un-dissolved vapors that are

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preventing the membrane pores are absorbed by the vacuum, resulting in a more effective surface of the membrane productive.

Direct-contact MD

In DCMD, both sides of the membrane are charged with liquid-phase warm feed water on the evaporator side and cooled permeate on the permeate side. Vapour passing through the membrane combines directly inside the liquid phase at the membrane boundary surface. Because the membrane is the only barrier to mass transport, DCMD can achieve relatively high surface related permeate streams. The high sensible heat loss is a disadvantage because the dielectric properties of the single cell membrane are poor.

Air-gap MD

The evaporator channel in air-gap MD is similar to that in DCMD, but the permeate gap is filled with air and it is located between the membrane and a cooled walling. Before condensing on the cooler surface, the vapor passing through the membrane must overcome this air gap. The high thermal material towards the evaporator channel of this method minimizes heat conduction losses. However, the air gap acts as an additional barrier for mass transport, and reducing surface-related permeate performance when compared to DCMD.

Applications of membrane desalination

Desalination of seawater, desalination of brackish water, treatment of brine from desalination, treatment of untreated wastewater, purification of water, ammonium removal and concentration of resources all are applications of membrane desalination.

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