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Mass Spectrometry & Purification Techniques

Perspective

The Evolution of Membrane Distillation Module Configurations

Keerthana Samuel*

Department of Analytical Chemistry, Jahangirnagar University, Savar Union, Bangladesh

ABOUT THE STUDY

Due to climate change, fast urbanization, and enormous population expansion, water shortage has become one of the largest global environmental issues of the twenty-first century. Two billion people, or 26% of the world's population, will be without access to adequately regulated drinking water in 2020 alone. In addition to an increase in the amount of water needed for human use, metropolitan areas also have substantially degraded water quality due to the discharge of home and industrial waste.

As a result, during the past few decades there has been a rise in interest in finding efficient ways to supply freshwater and alleviate water stress. We can receive freshwater through desalination and wastewater treatment from salty and/or contaminated water sources with a range of salinities, which enables us to treat and reuse wastewater as well as access abundant and renewable resources like seawater. Today, 183 nations throughout the world have active desalination capacity of more than 78 million m^3 per day. Thermal or membrane desalination technologies are the two main subcategories.

Although pressure-driven membrane technologies, most notably Reverse Osmosis (RO) desalination, have overtaken thermal distillation systems such as Multi-Stage Flash (MSF) and Multi-Effect Distillation (MED), which have long been used to extract freshwater through desalination. Membrane-based systems have the benefit of smaller footprints and modular system architecture. Because RO doesn't need water phase shift, it can desalinate at a lower specific energy cost than thermal desalination. Though they are less prone to fouling and less sensitive to feed salinity with excellent separation efficiencies even for hypersaline feed solutions, conventional thermal separation techniques still have some advantages. When low-grade waste heat or solar heat is easily accessible, as is the case in many nations in/around the Arabian Gulf, low-temperature distillation technologies appear promising. The treatment of hypersaline feed solutions, such as desalination reject brine and produced water from oil and gas production, which may have Total Dissolved Solids (TDS) of up to 200,000 ppm, is not energy feasible using RO, which is restricted to the treatment of low to moderately saline solutions. Such hypersaline solutions are better suited to thermal processes, which also allow for zero liquid discharge and the recovery of important chemicals from aqueous streams.

Membrane Distillation (MD) is a newly developed separation technique that blends distillation powered by low-temperature heating with the adaptability and compactness of membrane devices. As a thermally driven process, MD can be used to desalinate saltwater, brackish water, and brine. It is useful for treating a variety of feed types. Additionally, it is used in industrial operations to get rid of volatile organic compounds as well as in the food business to concentrate dairy streams.

A temperature gradient across the membrane induces separation in the thermally driven membrane separation process known as MD. A heated feed solution is in direct contact with a hydrophobic porous membrane, and the vapour pressure differential brought on by the temperature gradient causes vaporisation at the liquid-vapor interface on the feed side, where it then passes through the pores of the membrane and condenses on the permeate side. The driving force and resulting mass flux increase in proportion to the temperature differential between the membrane's two sides. For boosting the effectiveness of permeate production, numerous research utilizing various spacers and multi-staging the various MD systems were conducted. Low temperatures (80°C) and atmospheric pressure are required for the operation of MD systems. The graphic representation of the typical MD process demonstrates how a hydrophobic membrane prevents liquid feed from passing through the pores of the membrane and into the permeate, allowing only volatile vapour to pass through.

Correspondence to: Keerthana Samuel, Department of Analytical Chemistry, Jahangirnagar University, Savar Union, Bangladesh, E-mail: keerthana123samuel@yahoo.co.in

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