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# PROCESS CHALLENGES IN MEMBRANE DISTILLATION FOR SEAWATER DESALINATION: MEMBRANE FOULING AND WETTING

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Amongst a variety of novel desalination technologies, membrane distillation (MD) has recently been gaining attention by the research community because of its attractive features for stand-alone systems and low operational requirements. MD is a thermally driven membrane separation process which uses a hydrophobic membrane to create a liquid-vapor interface from which water evaporates. This vapor crosses the membrane and is condensed on the other side as salt-free distillate. However, two key parameters affecting the MD process performance, membrane wetting and fouling, have been under-studied.

Liquid Entry Pressure (LEP) is defined as the minimum trans-membrane pressure required for the salty water feed to overcome the hydrophobic forces and enter and wet the membrane pores. Hence, in MD, LEP is desired to be as high as possible to avoid pore wetting, as that leads to deterioration of the permeate production rate and quality. In our research, polytetrafluroethylene (PTFE) membranes were evaluated for wetting behavior under MD conditions. In the MD temperature range (25-70$^{o}$C), experimental LEP results for PTFE membranes showed deviations from the theoretically estimated values obtained using the well-established Laplace equation, suggesting changing membrane geometry with temperature. Subsequent thermogravimetric analysis and differential scanning calorimetry measurements revealed possible relaxation of internal stresses in the interconnected continuous fibrils of the PTFE membranes. Further evidence of microstructure evolution due to fibril distortions in the membranes was revealed using scanning electron microscopy. Therefore, a temperature dependent geometric correction factor in the Laplace equation was proposed for non-isothermal conditions.

Additionally, hydrophobic MD membranes are often claimed to be chemically stable and fouling-resistant. In our research, we also investigated the effect of salt deposition on the properties of polyvinylidene fluoride (PVDF) and PTFE membranes, commonly used in MD. Parameters related to surface and structural characteristics of the membranes, before and after salt deposition, were evaluated. A variety of tools were also applied to make inferences about the mechanism of salt deposition on the membranes and its impact during MD operations. MD tests using fresh and fouled membranes were finally conducted to verify the proposed mechanism. It was concluded that, unlike what is commonly reported, MD membranes can be susceptible to scaling in a way that could significantly affect several aspects of their performance.