MEMBRANE DISTILLATION AS A THERMAL CONDUCTIVITY MEASUREMENT DEVICE

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A large number of geothermal exploration wells exist in the US that don't produce the quantity and quality of heat required for power generation with an Organic Rankine Cycle (ORC). At temperatures under 150 °C, power generation is currently not cost effective. Membrane distillation (MD) can desalinate water at temperatures as low as 50 °C and thus may enable production of clean water from low grade heat provided by these abandoned wells. Moreover, if the distillate can be used in evaporative cooling of air-cooled geothermal plants, the efficiency and thus revenue of these plants can be substantially augmented. This narrative motivated the geothermal office of US Department of Energy (DOE) to fund a collaborative research between the National Renewable Energy Laboratory (NREL) and the Colorado School of Mines (CSM) to map the potential application of geothermal MD deslination in the US and design, build, and test a pilot-scale MD unit at two major geothermal power plants in California and Nevada. In the first phase of the project we are selecting most suitable MD membranes. The performance of 15 different MD membranes from 6 different manufacturers was analysed over a wide temperature range (40-70 °C). Most of these manufacturers don't make dedicated MD membranes, but make microfiltration membranes for water and air purification with the adequate pore size and hydrophobicity for MD. Due to the different application of these membranes, some manufacturers don't report important membrane characteristics, or use different methods to determine essential parameters (e.g., pore size and porosity) needed for modeling of MD performance. None of them report vapour fluxes or thermal conductivity. Therefore, a model was developed that does not require the knowledge of the pore size, the porosity, or the thermal conductivity of the membrane. We found that thermal efficiency is fairly constant for a wide range of salinities and temperature differences across the membrane. The Schofield method [1] was adapted to incorporate the thermal efficiency instead of the thermal conductivity, pore size, and porosity. Thermal efficiency is often not reported in MD literature, but it can have an important impact on the efficiency and hence the cost effectiveness of the process for geothermal desalination. The membranes tested exhibited thermal efficiencies from 15 to 55 %. In other words, up to 85% of the heat input was lost for thermal conduction through the membrane. Because a relation was derived between the thermal conductivity and thermal efficiency, MD can effectively be used as a thermal conductivity measurement device.

References:
[1] R.W. Schofield, A.G. Fane and C.J.D. Fell, JMS, 33 (1987) 299-313