Novel Thermal Efficiency-Based Model for Geothermal Membrane Distillation

Johan Vanneste[1], John Bush[1], Christopher Marks[1], Tzahi Y. Cath[1,] *

[1]*Department of Civil and Environmental Engineering, Colorado School of Mines,*

1500 Illinois St., Golden, CO, USA

* tcath@mines.edu

A large amount 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 can desalinate water at temperatures as low as 50 °C and thus constitutes a possibility to generate revenue from these abandoned wells. Moreover, if the distillate can be applied for evaporative cooling of air-cooled geothermal plants, the efficiency and thus revenue of these plants can be augmented substantially. This narrative motivated the geothermal office of DOE to award a project between the National Renewable Energy Laboratory (NREL) and the Colorado School of Mines (CSM) to map the potential application in the US and build and install a pilot-scale membrane distillation unit at a test site of ORMAT.

First phase of this project is to select an appropriate membrane. The performance of 15 different membranes was analysed from 6 different manufacturers over a wide temperature range (40-70 °C). Most of these manufacturers don`t make dedicated membrane distillation membranes, but make microfiltration membranes for water and air purification with the appropriate pore size and contact angle. One manufacturer makes oleophobic membranes for humidity equilibration and oil rejection in automotive applications. Due to the different application of these membranes, some manufacturers don`t report characteristics or use different methods to determine essential parameters to model membrane distillation performance, like pore size and porosity for instance. Non 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. It was found that thermal efficiency is fairly constant for a wide range of salinities and temperature differences over the membrane. The Schofield method 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 through conduction.