

## **Evaluation of geothermal energy in desalination by vacuum membrane distillation**

### **Abstract**

This paper presents the energy evaluation of the cross-flow vacuum membrane distillation (VMD) for three types of lab-fabricated polyvinylidene fluoride (PVDF) membranes and the commercial Westran S PVDF membrane. Membranes with the effective area 23.5 cm<sup>2</sup> are tested with distilled water and geothermal water as the feed solutions. Results show that the membrane porosity controlled the flux through the fabricated membranes and the commercial membrane. The commercial membrane with porosity of approximately 76.5%, which was the most porous among the tested membranes, gave the highest flux at 9.28 kg/m<sup>2</sup> h under the optimum conditions of 33.2 L/h feed flow rate and 30 kPa downstream pressure. The corresponding specific energy consumption was 66.03 kW/kg h<sup>-1</sup> when distilled water was examined. Heating energy of 87–89 kW/kg h<sup>-1</sup>, which is approximately 95% of the total energy consumption, could be saved when the warm geothermal water is fed directly into the VMD system. The water produced meets the drinking water quality with the TDS varying between 102 and 119 ppm, thus the geothermal water desalination using the VMD system to produce the drinking water is satisfactory. An economic analysis for a 20,000 m<sup>3</sup>/d VMD desalination plant finds that the water production costs are \$0.50/m<sup>3</sup> and \$1.22/m<sup>3</sup> respectively for the plant operated with and without geothermal energy (GE). Compare to the plant without GE utilisation, the water production costs of the plant operated with GE are less than \$0.50/m<sup>3</sup> that is at least \$0.72/m<sup>3</sup> or approximately 59% in cost saving when the water fluxes are larger than 6.6 kg/m<sup>2</sup> h. The specific membrane cost reduced from \$0.058/m<sup>3</sup> to \$0.035/m<sup>3</sup> when the membrane life extended from 3 to 5 years.