

Desalination Performance of a Passive Solar-Driven Membrane Distiller: Effect of Middle Layer Material and Thickness

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Abstract : Water scarcity is a global problem and membrane-based desalination technologies are one of the promising solutions to this problem. In this study, a passive solar-driven membrane distiller was fabricated and tested for its desalination performance. The distiller was composed of a TiNOX plate solar absorber, cellulose-based upper and lower hydrophilic layers, a hydrophobic middle layer, and aluminum heatsinks. The effect of the middle layer material and thickness on the desalination performance was investigated in terms of distillate productivity and salinity. The materials used for the middle layer were a screen mesh (2 mm, 4 mm, 6 mm thickness) to generate an air gap, a PTFE membrane (0.3 mm thickness), and a combination of the screen mesh and the PTFE membrane (2.3 mm total thickness). Salt water (35 g/L NaCl) was desalinated using the distiller at a rooftop setting at the University of San Carlos, Cebu City, Philippines. The highest distillate productivity of 1.08 L/m²-h was achieved using a 2-mm screen mesh (air gap) but it also resulted in a high distillate salinity of 25.20 g/L. Increasing the thickness of the air gap lowered the distillate salinity but also decreased the distillate productivity. The lowest salinity of 1.07 g/L was achieved using a 6-mm air gap but the productivity was reduced to 0.08 L/m²-h. The use of the hydrophobic PTFE membrane increased the productivity (0.44 L/m²-h) compared to a 6-mm air gap but produced a distillate with high salinity (16.68 g/L). When using a combination of the screen mesh and the PTFE membrane, the productivity was 0.13 L/m²-h and a distillate salinity of 1.61 g/L. The distiller with a thick air gap as the middle layer can deliver a distillate with low salinity and is preferred over a thin hydrophobic PTFE membrane. The use of a combination of the air gap and PTFE membrane slightly increased the productivity with comparable distillate salinity. Modifications and optimizations to the distiller can be done to improve further its performance.

Keywords : desalination, membrane distillation, passive solar-driven membrane distiller, solar distillation

Conference Title : ICDMT 2023 : International Conference on Desalination and Membrane Technology

Conference Location : Rome, Italy

Conference Dates : January 16-17, 2023