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

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Abstract : Water scarcity is a global problem. One of the promising solutions to this challenge is the use of membrane-based desalination technologies. In this study, a passive solar-driven membrane (PSDM) distillation was employed to test its desalination performance. The PSDM was fabricated using a TiNOX sheet solar absorber, cellulose-based hydrophilic top and bottom layers, and a middle layer. The effects of the middle layer material and thickness on the desalination performance in terms of distillate flow rate, productivity, and salinity were investigated. An air-gap screen mesh (2 mm, 4 mm, 6 mm thickness) and a hydrophobic PTFE membrane (0.3 mm thickness) were used as middle-layer materials. Saltwater input (35 g/L NaCl) was used for the PSDM distiller on a rooftop setting at the University of San Carlos, Cebu City, Philippines. The highest distillate flow rate and productivity of 1.08 L/m^2-h and 1.47 L/kWh, respectively, were achieved using a 2 mm air-gap middle layer, but it also resulted in a high salinity of 25.20 g/L. Increasing the air gap lowered the salinity but also decreased the flow rate and productivity. The lowest salinity of 1.07 g/L was achieved using 6 mm air gap, but the flow rate and productivity were reduced to 0.08 L/m^2-h and 0.17 L/kWh, respectively. The use of a hydrophobic PTFE membrane, on the other hand, did not offer a significant improvement in its performance. A PDSM 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. Various modifications and optimizations to the distiller can be done to improve its performance further.

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