

Performance and cost evaluation of an autonomous solar vacuum membrane distillation desalination plant

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ABSTRACT

The aim of this work is to investigate the overall performance of an autonomous solar vacuum membrane distillation (VMD) plant for seawater desalination. The system performance was evaluated in terms of several indicators, such as membrane flux rate (MFR), gained output ratio (GOR), performance ratio (PR), recovery ratio (RR) and specific thermal energy consumption (STEC). The obtained results were compared with the reported values from published operational parameters of various solar-powered membrane distillation systems previously tested in literature. The maximum values of MFR, GOR, PR and RR were found to be 14 L/h·m², 3.3, 0.95 kg/MJ and 4.66%, respectively. In addition, the minimum value achieved for STEC was 290 kWh/m³ by a recovery of the latent heat of condensation. Besides, a sensitivity analysis was carried out to study the effect of some operating parameters on GOR performance. The results showed that the GOR can be maximized at low feed flow rate and high feed temperature. A higher GOR value can also be attained with an increase in vacuum level and solar collector area. Finally, an economic study was performed to estimate the expected cost of distilled water produced by the solar VMD plant.

Keywords: Seawater desalination; Vacuum membrane distillation; Solar energy; Performance evaluation; Sensitivity analysis; Economic study

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