

Experimental and numerical simulation of solar membrane distillation and humidification – dehumidification water desalination system

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<https://doi.org/10.1016/j.renene.2023.118915> Get rights and content

Abstract

In this study, a novel solar hybrid air-gap membrane distillation and humidifier-dehumidifier desalination (AGMD-HDD) unit was designed and investigated. In this proposed system, photovoltaic panels were used as the source of electricity in the AGMD-HDD hybrid system. The present work was conducted to explore experimentally the hybrid system's performance within 12 months and simulated numerically using TRNSYS software. The simulated results

were in good agreement with the measured values. The flowrate of produced purified water from the solar AGMD-HDD hybrid system were 21.29 kg/h and 11.76 kg/h in the summer and winter seasons respectively. The specific thermal energy consumption (STEC) varied from 60 kWh/m₃ to 310 kWh/m₃ in summer and 87.12 kWh/m₃ - 605.2 kWh/m₃ in winter. Freshwater cost estimation using the solar AGMD/HDH system showed a remarkable decrease in freshwater production up to USD 14.32/m₃. The gained output ratio (GOR) and the system competence reached 5.33 and 91.03% in summer using a seawater flow rate of 600 kg/h. The total reduction in CO₂ emissions was 32 tons in winter and 43 tons in summer seasons.