Desalination and Water Treatment
www.deswater.com
doi: 10.5004/dwt.2020.25834

194 (2020) 37–51
August

Performance evaluation of a solar thermal and photovoltaic hybrid system powering a direct contact membrane distillation: TRNSYS simulation

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Received 29 September 2019; Accepted 10 March 2020

ABSTRACT

This paper investigates the integration of solar thermal and photovoltaic (PV) energy powering direct contact membrane desalination (DCMD) to produce clean water. The designed system includes a 2 m^2 flat plate collector (FPC) for thermal energy production, a stratified fluid storage tank with optional internal heater and heat exchangers with 0.3 m^3 of volume, DCMD modules for clean water production, and a PV panel with a maximum power of 55 W. The predicted performance of this system was analyzed and dynamically simulated using the TRNSYS (Transient System Simulation program) code. The DCMD unit was simulated and added to the software library. The DCMD unit and the thermal system were validated based on literature results. The dynamic simulation of this system was carried out in the region of Ain Témouchent (west of Algeria) throughout the year and focusing on 3 type days (24/01), (24/06), and (05/11). The obtained results show that the daily freshwater production by the system is around 59.34 L^{-1} m^2 d^{-1}, and that the temperature of the feed saltwater and the permeate flow through the DCMD system varies, respectively, from 60°C to 21°C and between 20°C and 34°C. In addition, the solar fraction (SF) reaches 0.41, 0.52, and 0.42 and the collector efficiency of FPC values reaches 52%, 64%, and 55% during the 3 selected days, respectively.

Keywords: Solar desalination; Direct contact membrane distillation; Flat plate collector; Photovoltaic panel; TRNSYS

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