Energy and exergy analysis of a solar/hybrid humidification–dehumidification desalination system

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Received 12 May 2020; Accepted 22 August 2020

Abstract

Conventional energy and exergy analyses were performed for solar/hybrid humidification–dehumidification and heating (HDH) desalination systems. An experimental investigation of HDH productivity under various operating conditions was also performed. The three major objectives of this work were to investigate the maximum productivity of solar and hybrid HDH systems, identify the locations where the largest exergetic destructions occur, and compare the results of conventional energy and exergy analyses. The prototype was constructed and designed in the Solar Energy Laboratory at the Faculty of Engineering, Chemical Engineering Department, Minia University, Egypt. It was composed of a flat-plate solar collector (product of Inter Solar Egypt Company, Egypt), a packed-bed humidifier, dehumidifier, and an additional gas heater. Different experiments were carried out to identify the factors that influence HDH system performance and exergy destruction, such as the temperatures and flow rates of air and saline water. The experimental results showed that the productivity of the system increased with increasing flow rates of air and saline water. The highest productivity was 3 and 8.8 kg/h for the solar and hybrid HDH systems, respectively. The exergy analysis showed that, for the solar heating system, the highest exergetic destruction occurred in the flat-plate solar collectors. In the hybrid HDH system, the largest exergetic destruction occurred in the dehumidifier, which can be decreased by increasing the inlet saline water temperature. The exergetic efficiency of the humidifier was found to be improved by decreasing the inlet saline water flow rate. In addition, exergetic destruction in the humidifier was reduced by decreasing the inlet air temperature.

Keywords: Conventional energy analysis; Exergy analysis; HDH; Exergy destruction

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