Thermo-economic analysis of solar humidification-dehumidification desalination system with subsurface condenser

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ABSTRACT

The solar humidification-dehumidification (HDH) desalination system with a subsurface condenser is a promising renewable energy-based desalination system to provide a sustainable water supply. In this study, the computational model of the solar HDH desalination system with the subsurface condenser is formulated based on thermodynamic analysis and the conservation of mass and energy. The developed model is used to evaluate the thermo-economic performance of the solar HDH desalination system with the subsurface condenser. For this purpose, the long-term performance of open-loop and closed-loop configurations of the system is evaluated. Moreover, to use the desalination system in remote areas facing a lack of electricity, photovoltaic cells are designed to supply the necessary electricity and are also included in the economic analysis. It is demonstrated that the average daily water yield and Gained Output Ratio (GOR) of the closed-loop system are 70% higher than the open-loop system. In addition, the cost of fresh water production in the closed-loop system is about 0.037 US $/lit which is 41% less than the cost of water production in the open-loop system. With the addition of photovoltaic cells, the cost of fresh water production in the closed-loop system increases by 44% and reaches 0.054 US $/lit which is 41% less than the cost of water production in the open-loop system with photovoltaic cells. Therefore, according to the thermo-economic analysis, it is recommended that the solar HDH desalination system with the subsurface condenser be designed as a closed cycle.

Keywords-humidification-dehumidification; desalination; solar humidifier; subsurface condenser