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Thermal analysis and optimization of mechanical vapour compression desalination process driven by renewable energy using genetic algorithm

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ABSTRACT

In this work, a seawater desalination unit using mechanical vapour compression process driven by a hybrid Wind-Photovoltaic energy system is studied and optimized using genetic algorithm optimization method. The developed model is based on mass and energy balance equations, heat transfer correlations and thermodynamic properties of each stream. The study takes into account the effect of design parameters and the impact of operating conditions. The developed model is validated based on the experimental data of similar process published in literature. The obtained results show that when using one effect, the optimal cost of produced distilled water is approximately equal to 4.2 US$/m^3 for a production capacity equal to 5 m^3/d and achieves an optimal value equals to 2.5 US$/m^3 when the production capacity ranges between 100 and 120 m^3/d. Also, results show that the optimal cost of produced distilled water could be less than 0.77 US$/m^3 for a production capacity equal to 1000 m^3/day and when the number of effects is equal to 8 which is close to the average cost of water production in Morocco. At the end of this study, further possible improvements of the optimized design are proposed based on energy efficiency analysis.

Keywords: Seawater desalination; Mechanical vapour compression; Multi effect evaporation; Hybrid wind-solar energy; Optimization and design; Exergy analysis

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