Evaluation of a solar powered distillation unit as a mitigation to water scarcity and climate change in Cyprus

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ABSTRACT

Cyprus, an island facing water scarcity periods throughout its history, has to cope with even more intense periods due to climate change as it is predicted by several climate models. The aim of the present study is to evaluate the performance of a single-effect distillation unit and the potential of its integration with a concentrated solar power system as a mitigation technique to the water scarcity. Specifically, a single-effect distillation unit for seawater desalination was developed and its performance in terms of performance ratio (PR) (ratio of distillate product and steam fed to the unit) was experimentally investigated. The main parameters examined were the thermal input power, and the temperature and flow rate of the inlet seawater. For several seawater flow rates, three different initial heat loads were used ($T_{st,1}$, $T_{st,2}$, $T_{st,3}$). Experiments were repeated for two seawater inlet temperatures, $T_{sw,1}$, $T_{sw,2}$. A one-dimensional model based on conservation of mass and energy was developed to predict the performance of the device. The results showed that lower heat input load results to a higher value of the PR of the unit and also under constant heat load, a higher temperature of the seawater lead to higher distillate product. The developed model adequately captured the behavior of the device. Thus, it is concluded that such a unit should be expanded into a multiple-effect unit and also implemented with a concentrated solar power system as a mitigation technique to the water scarcity of the island.

Keywords: Multiple-effect distillation; Desalination; Solar thermal energy; Performance ratio; CSP

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