Assessing the performance of solar desalination system to approach near-ZLD under hyper arid environment

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ABSTRACT

The aim of this study was to investigate the performance of a solar desalination system using three different types of feedwater to reach near zero liquid discharge (ZLD) under hyper arid environment. Solar still was used to desalinate seawater (SW), groundwater (GW), and agricultural drainage water (DW). The influence of meteorological parameters on the performance of the solar still was investigated. The system productivity (MD), operational recovery ratio (ORR), and thermal efficiency ($\eta_{th}$) were determined during the desalination process. Some physicochemical properties of the feed, brine, and distilled water were measured such as total dissolved solids (TDS), electrical conductivity (EC), pH, density ($\rho$), and color. The performance was in direct proportion to solar radiation and ultraviolet index. The average ranges of the MD, ORR, and $\eta_{th}$ were 0.56 L/m$^2$/h, 36.77, and 52.38%, respectively, for all waters. The final recovery ratios were 68, 93, and 95.6% for SW, GW, and DW, respectively. Statistical empirical models were found to predict the system performance with a range of $R^2$ was 88–96%. One major output of this research is the assessment of the solar still system during the desalination process for near-ZLD, which adds a new perspective to system design, analysis, and modeling of the possible use of solar energy in ZLD desalination process. On the other hand, more studies are required for the continuous pilot production system, modeling for commercial production, in addition to full economic evaluation of the system.

Keywords: Solar desalination; Solar still; Zero liquid discharge; Recovery ratio

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