Experimental study of a stand-alone solar-wind-powered reverse osmosis seawater desalination system

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ABSTRACT

An experimental photovoltaic-wind-powered seawater desalination system with a design capacity of 1 m³/d was developed and tested in Xiamen, China. A 5-kWp photovoltaic array was used as the main driving source, and two 0.5-kW wind generators as the supplementary source. A small-capacity battery bank for 1.5 h of system autonomy was equipped, and an electricity equilibrium/buffer controller was specially developed to manage the produced, demanded, stored, and rejected power of the system. The desalination unit used was a three-stage reverse osmosis (RO) unit without energy recovery device. The system was operated in an automatic mode throughout September and October 2015, showing good suitability to unsteady solar and wind energy, during which the RO unit ran for 6.1 h/d averagely, showing reliable performance in the intermittent off-and-on operation mode. The daily water production ranged from 0 to 1.56 m³/d, and the daily average was 0.92 m³/d. Using real seawater with a salinity of 31,000 ppm as feed, the system obtained a salt retention rate over 99% and a water recovery ratio about 20%. The specific energy consumption of freshwater was 17 kWh/m³, with the ways to lower it discussed.

Keywords: Stand-alone desalination; Photovoltaics; Wind power; Reverse osmosis