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Configurations of reverse osmosis plants with variable energy consumption for off-grid wind-powered seawater desalination: system modeling and water cost

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ABSTRACT

A technical and economic assessment of wind-powered seawater reverse osmosis (SWRO) systems is presented to identify the best combination of coupling between wind power and demanded power for a 5,000 m^3/d SWRO unit. Three situations have been studied: Reference or Case 0) SWRO plant operating at the nominal point all of the time; Case 1) SWRO plant operating with variable power demand (up to 67% of the nominal point) by reducing the rotation speed of the high pressure pump, and Case 2) use of a modular SWRO plant, able to operate at four different values of power consumption by means of configuring two units of 1,250 m^3/d and a unit of 2,500 m^3/d. Power and fresh water production are calculated through a year based on experimental data of wind availability with time steps of 1 h. A comparative techno-economic analysis is performed to identify the best configurations along with recommendations on nominal values of desalination capacity and battery capacity in relation to the nominal power of the wind turbine installed.

Keywords: Wind-powered desalination; Seawater desalination; Reverse osmosis; Design configurations; Water cost

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