Experimental investigation of the performance of a reverse osmosis desalination unit under full- and part-load operation

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ABSTRACT

Sea water reverse osmosis (SWRO) desalination constitutes a successful technology for covering the potable water needs of islands and coastal regions. SWRO units can be combined with renewable energy technologies such as photovoltaic and wind generators. Conventional small scale SWRO units are not often combined with energy recovery devices; however, these devices can decrease drastically the energy consumption of the SWRO units. Furthermore, in the literature there are references which prove that the operation of a desalination unit in part-load conditions can result in lower specific energy consumption compared to full-load operation. This paper presents the simulation and the experimental investigation under full- and part-load conditions of an existing SWRO desalination unit (50 mS/cm feed water) in order for the desalination unit to be optimally utilized in a polygeneration microgrid topology which uses advanced energy management algorithms. The experimental operation of the SWRO Unit in part-load conditions is achieved by varying the speed of the motor—pump assembly, the pressure and the flow rate of the feed water. During the evaluation of the measurements result, an optimum operating window in the range of 40–57 bar was drawn regarding the operation of the SWRO desalination unit in part- and full-load conditions. More specifically, in this pressure range the average value of fresh water production was 60 L/h with an acceptable fresh water electrical conductivity of 550 μS/cm, and with a specific energy consumption range from 6.1 to 7.7 kWh/m³. With these results the operational parameters of the polygeneration microgrid energy management system can be optimized.

Keywords: Sea water reverse osmosis desalination; Variable operating conditions; Polygeneration; Microgrid

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