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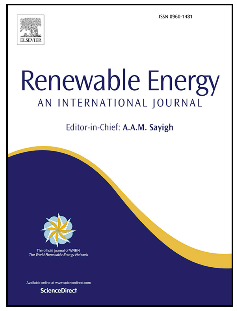

Exergoeconomic evaluation of a CSP plant in combination with a desalination unit

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Exergoeconomic evaluation of a CSP plant in combination with a desalination unit

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Abstract

Due to increasing energy prices and the anticipated increase of freshwater demand in the Middle East and North Africa (MENA) region, it is essential that water is desalinated at a low cost. The estimation of the product costs of a co-generating system (electricity and water) can be calculated using a methodology of exergoeconomics. A co-generation concentrating solar power tower with an integrated low temperature desalination model plant is analysed using methods of exergy and exergoeconomics. The plant is located on the Red Sea coast in Egypt and has been simulated using meteorological data measured by a local weather station. The economic and exergy analysis gives the input for the exergoeconomic evaluation. There are two operational cases examined: In Case 1, the water output and in Case 2, the electricity output is maximized, respectively. The electricity generation costs are calculated to 0.2051 USD/kWh and 0.2079 USD/kWh. The water generation costs are calculated from 0.8464 USD/m^3 to 0.3991 USD/m^3 for the two cases. The interpretation of the results are performed using the sensitivity analysis which shows that the number of full load hours during the year have the biggest influence on product costs. The comparison of the calculated results with a lost-kilowatts cost accounting method shows the shortcomings of the exergetic analysis considering the economic value of fresh water. From the exergoeconomic analysis can be concluded that the use of condensation heat has a positive effect on the overall plant balance. Considering the economic viability, is essential to reduce the investment costs for solar energy related components.

Keywords:
Concentrating solar power, cogeneration, exergoeconomics, low temperature desalination

1. Introduction

The Middle East and North Africa (MENA) [1] is known as one of the most water-scarce places in the world and has an annual problem in producing enough freshwater [2]. Other regions under stress are parts of North America, Australia, China, and India. The orange areas in Figure 1 mark physical water scarcity.

Taking into account the anticipated population growth and increasing living standards, a significant water gap is predicted for the future [4]. According to data from the World Bank,