Desalination and Water Treatment
www.deswater.com

doi: 10.5004/dwt.2021.26994

217 (2021) 1–21
March

Parametric study and multi-objective optimization of a combined cooling, desalination and power system

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Received 22 May 2020; Accepted 24 December 2020

ABSTRACT

Multi-generation system driven by alternative energies provides a promising solution for meeting the challenges of energy and fresh water with the rapid development of economy. In this paper, an innovative combined cooling, desalination and power (CCDP) cycle is proposed, which integrates multi-effect distillation (MED) and ejector refrigeration cycle with organic Rankine cycle. The surface warm seawater further heated by the solar energy and the deep cold seawater are taken as the heating and cooling sources, respectively. Mathematical model of the combined cycle is developed to evaluate the thermodynamic and economic performances. The effects of generation temperature, condensing temperature and evaporating temperature are investigated, and comparative analysis of five working fluids is conducted as well. The results indicate that the CCDP system with lower condensing temperature and generation temperature is conducive to obtaining higher exergy efficiency η_{ex}, but leads to the increase of total cost rate (TCR). Furthermore, for the trade-off between thermodynamic and economic performances, a multi-objective optimization is conducted in terms of η_{ex} and TCR as objective functions. The Pareto optimal solutions (POS) for the five working fluids are determined based on a fast and elitist non-dominated sorting genetic algorithm (NSGA-II) and decision-making technique. According to the results of POS, R601 has the best performance with 6.51×10^4 \$/y of TCR and 31.62% of exergy efficiency, followed by R245fa, R600a, R236ea and R152a. The percentage of initial investment and the distribution of exergy flow for the POS of R601 are obtained as well.

Keywords: Combined cooling; Desalination and power system; Organic Rankine cycle; Multi-effect distillation; Ejector refrigeration; Ocean thermal energy; Multi-objective optimization

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