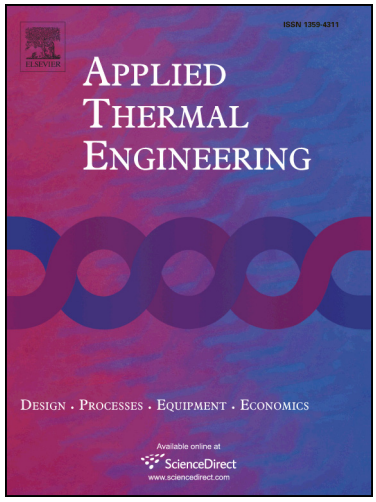

Performance Analysis of an Integrated Solar Based Thermo-electric and Desalination System

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PII: S1359-4311(16)31558-7
DOI: http://dx.doi.org/10.1016/j.applthermaleng.2016.08.199
Reference: ATE 8998

To appear in: *Applied Thermal Engineering*

Received Date: 30 March 2016
Revised Date: 20 August 2016
Accepted Date: 28 August 2016

Please cite this article as: M.J. Aberuee, E. Baniasadi, M. Ziaei-Rad, Performance Analysis of an Integrated Solar Based Thermo-electric and Desalination System, *Applied Thermal Engineering* (2016), doi: http://dx.doi.org/10.1016/j.applthermaleng.2016.08.199

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Abstract

In this paper, the performance of a novel multi-generation solar system is evaluated at different working conditions. The proposed system is able to produce electric power, distilled water and hot water, concurrently. The performance of the main components including thermoelectric generator, thermal energy storage, desalination unit and hot water tank is modeled mathematically, and then evaluated at different working conditions using the second law of thermodynamics. The effects of working temperature and solar irradiation are also investigated as the key operational parameters. Moreover, the Genetic algorithm is employed to determine the optimum working conditions for the minimum thermodynamic irreversibility. The results indicate that using 960 MJ/d of incident solar energy, the system produces 896 kJ/d electrical energy, 177 kg/d distilled water and 29,000 kg/d hot water. The maximum energy and exergy efficiency of the integrated system is about 46 and 1.5 percent, respectively. The outcomes of this research confirm the suitability of such a system for residential application.

Keyword: Solar energy; Thermoelectric; Desalination; Thermal storage; Exergy

1. Introduction

Design and development of novel systems for concurrent production of electrical energy and fresh water is of great priority due to increasing human demands. Natural resources including fossil fuels and fresh water are limited, and the world population is growing rapidly. A sever fresh water shortage is predicated for about 1.7 billion people in 39 countries By 2050 [1]. Moreover, hydrocarbons are currently the main resource for producing electrical energy, and it leads to the global energy crisis. A solution to this problem is to utilize renewable energies for producing electrical power and fresh water.

Thermoelectric generator (TEG) is relatively a new method for generating electrical energy. A TEG directly converts a temperature gradient into an electric voltage based on the Seebeck effect. At microscopic scale, the charge carriers are diffused from the hot side of a