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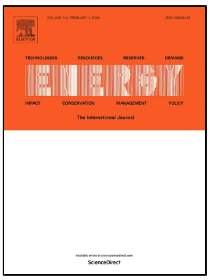

Multi-objective optimization of a solar driven trigeneration system

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Abstract

The objective of this study is to optimize a solar driven trigeneration system under various optimization criteria. More specifically, parabolic trough collectors are selected to feed with heat the generator of a trigeneration system. The produced vapor is expanded in a turbine where electricity is produced. The system also includes an ejector device, a condenser where the heating is produced and an evaporator where the cooling is produced. The cooling load is produced at 10^{o}C and the heating load at 50^{o}C, typical temperature levels for building applications, as hotels. This system is optimized under steady-state conditions with different criteria which are based on the exergetic, energetic and economic performance. The optimization is performed separately with every criterion, as well as with combined goals performing multi-objective optimization procedures. Different criteria lead to different optimum system designs. According to the final results, using all the examined criteria together, the optimum system presents 11.26% exergy efficiency, 87.39% energy efficiency and 7.694 €/h energy savings cash flow. The electricity, cooling and heating productions are 4.6 kW, 7.1 kW and 59.4 kW respectively. These results are obtained for turbine pressure ratio 3.6, turbine inlet temperature 195.5^{o}C and R141b as working fluid.

Keywords

Parabolic trough collector, Multi-objective optimization, Solar thermal, Trigeneration, Solar thermal system

1. Introduction

Solar energy utilization is one of the most promising techniques to face major problems as the growing population [1], the climate change, the fossil fuel depletion and the high electricity price [2]. Especially in the building sector, the use of solar energy is an essential tool for achieving the sustainability [3]. It is noticeable that building sector is responsible for a great part of the total energy consumption which is ranged from 30%-40% among the countries [4], while about the 36% of the total CO_2 emissions [5].

Solar thermal energy exploitation in the building sector is mainly achieved through the low-temperature systems for domestic hot water production and heating [6]. However, the uses of solar thermal energy for solar cooling purposes [7] or electricity production [8] are also interesting and promising ideas. In this direction, a lot of research has been focused on solar driven trigeneration [9] or polygeneration [10]