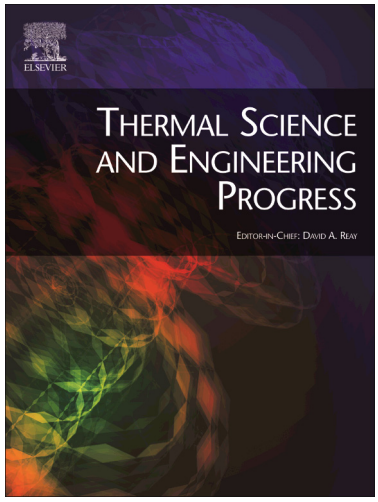

Energetic, exergetic and financial evaluation of a solar driven trigeneration system

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Energetic, exergetic and financial evaluation of a solar driven trigeneration system

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Abstract

The objective of this work is to investigate a solar driven trigeneration system by the energetic, exergetic and financial point of view. Parabolic trough collectors coupled to a storage tank are used in order to feed an Organic Rankine Cycle which rejects heat to an absorption heat pump. The system is optimized using both exergy and energy criteria. The optimization parameters are the heat source temperature in the inlet of the heat recovery system, the pressure in the turbine inlet and the heat rejection temperature of the organic Rankine cycle to the absorption chiller. Toluene, n-octane, MDM and cyclohexane are the examined organic working fluids with toluene to be the most suitable choice according to the conducted multi-objective optimization procedure. The next step is the dynamic simulation of the optimum system design for all the year period. This optimum system is also evaluated financially. According to the final results, the yearly operation of the optimum system leads to heating, cooling and electricity production equal to 995 KWh, 232 kWh and 154 kWh respectively. The payback period was found 5.33 years and the internal rate of return 20.02%, values which indicate a viable system. The analysis is performed with a developed thermodynamic model in Engineering Equation Solver.

Keywords

Solar Energy, Parabolic Trough Collectors, Trigeneration, ORC, Optimization

1. Introduction

Solar energy utilization is one of the most promising ways for facing the recent problems as the climate change, the fossil fuel depletion, the increasing energy demand and the high electricity price [1]. Solar energy can be utilized by many applications as space heating, space cooling, hot water production, industrial processes, desalination and electricity production [2]. Modern systems exploit solar energy in cogeneration, trigeneration or multi-generation systems [3] in order to produce the useful energy quantities with more efficient methods. One of the most interesting ideas is the exploitation of solar energy in trigeneration systems for heating, cooling and electricity production and application in the building sector. This sector is responsible for the 30-40% of the global energy consumption [4] and thus the use of solar energy in the buildings is an important step for reaching to a sustainable society.