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Performance analysis of power, desalination and cooling poly-generation system using parabolic trough solar collectors

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ABSTRACT

This work presents a thermodynamic analysis of a poly-generation system powered by solar energy using parabolic trough solar collectors. The system is composed of an organic Rankine cycle (ORC), a multiple effect distillation and an absorption cooling unit. The analysis is based on the solution of mass, energy and exergy balances of the set of equations of all the components of the system. It is also based on the technical specifications of sub-systems and working fluid properties. The validation of the computer program is achieved systematically. The performance of the poly-generation plant is investigated under Riyadh weather conditions and for several conditions of the operating parameters. The variation of the energy rates required for desalination, cooling and electricity generation has been obtained for two representative days in summer and winter of 2013 in Riyadh. Results expressing the plant performance using the energy and exergy efficiencies are presented and discussed. Specifically, energy utilization factor, artificial thermal efficiency, fuel energy saving factor and exergy efficiency were introduced and used as plant performance indicators. The fresh water production rate and the power to water ratio were also evaluated for two representative days in June and January of 2013. The main results of the study show that although there is a clear dispersion of the obtained values for the performance of the solar poly-generation plant, the exergy efficiency and the fuel energy saving factor give close values.

Keywords: Solar energy; Multi-generation; MED; Organic Rankine cycle; Absorption cooling; Exergy analysis

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