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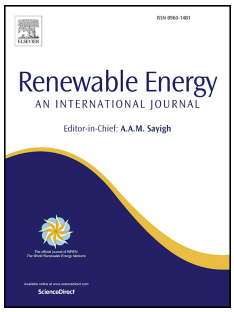

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Thermodynamic and economic assessments of a novel CCHP cycle utilizing low-temperature heat sources for domestic applications

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Abstract

This paper presents thermo-economic analysis of a novel combined cooling, heating, and power (CCHP) cycle based on the first and second laws of thermodynamics and economic point of view. The proposed CCHP cycle includes an organic Rankine cycle, an ejector refrigeration cycle and a domestic water heater to produce the desired electrical power, cooling and heating, simultaneously. The basic CCHP (BCCHP) system is modified by regenerative method (RCCHP). Four different dry working fluids R123, R236fa, R245fa and R600a are employed. Both systems are analyzed thermo-economically and their performance, total cost rate and unit cost of products are compared. Moreover, parametric study is conducted to investigate the effect of key parameters. Under given condition, thermodynamics analysis of proposed systems is conducted in which the maximum energy and exergy efficiencies corresponded to the BCCHP system using R123 as working fluid. The exergy analysis results show that, vapor generator has a major contribution in the overall exergy destruction, which is followed by the domestic water heater. Also, minimum total cost rate belongs to the proposed RCCHP system utilizing R123. Furthermore, a multi-objective optimization is performed for both systems. The optimization results show that RCCHP system has the smaller total cost rate compare to the BCCHP while their thermodynamic performances are approximately the same.

Keywords: Organic Rankine cycle; Ejector refrigeration cycle; Domestic water heater; Low-temperature heat source; Thermo-economic analysis; Multi-objective Optimization.

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