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Comparative thermoeconomic analysis of trigeneration systems based on absorption heat transformers for utilizing low-temperature geothermal energy

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Two novel trigeneration cycles are proposed based on Absorption Heat Transformers (AHTs) to generate power and produce freshwater, and heating effect from low-temperature geothermal energy. Simulation models are developed to examine the thermodynamic and thermoeconomic performances of the systems based on the single-stage, double and double-effect AHTs. The power is generated in an Organic Rankine Cycle (ORC) and a single-stage evaporation desalination system is employed to produce freshwater. The exergy performance parameters are determined, and the levelized cost of energy (LCOE) and water (LCOW) are considered as the criteria for the thermoeconomic assessment. According to the results, a maximum of 191.1 kW of power can be generated by the proposed systems, for a geofluid with a temperature of 95 °C and mass flow rate of 50 kg/s, that belongs to the double-effect AHT based system. This is 18.6 and 60.9 kW more than the single-stage and double AHT based systems power, respectively. Also, the energy and exergy efficiencies, as well as LCOE and LCOW for this system, are calculated to be 40.07%, 57.38%, 0.04636 $/kWh, and 34.85 $/m^3, respectively. Moreover, a parametric study revealed the notable influences of temperatures of AHT components on the performance parameters of the systems.

1. Introduction

Increasing demand for energy and clean water because of the rapid urban and population growth along with the development of the global economy has increased pressure on the limited energy and water resources of the earth. This is an important challenge at the local, national and worldwide levels as one of the most important criteria to achieve sustainable development is energy and water saving which are interdependent [1]. Nowadays, fossil fuels provide about 75% of the world's energy demand which causes global warming and several environmental problems such as air quality deterioration and pollution [2]. According to the World Health Organization's (WHO) latest report, 90% of the world people breathe polluted air [3]. Moreover, reserves of fossil fuels are limited and declining. This condition provides the basis to use renewable energy resources to overcome energy and water scarcity problems. Many countries implement and support programs and policies to use resources of renewable energy to fulfill their energy needs.

One of the reliable methods to upgrade the performance of power and energy systems, and consequently, moderate the environmental effects is employing multigeneration systems. Renewable energy based multigeneration systems have been of interest to researchers in recent years. Rashidi and Khorshidi [4] proposed a multigeneration system based on solar energy and carried out an exergoeconomic analysis as well as a multi-objective optimization for the system in which, electricity is produced by an Organic Rankine Cycle (ORC) and photovoltaic solar collectors. Moreover, a Reverse Osmosis (RO) desalination unit provides freshwater, as well as the heating and cooling effects are generated by a water heater and an absorption chiller, respectively. They presented the optimization results as Pareto optimal fronts and emphasized that the solar radiation intensity, pinch point temperature difference in the ORC evaporator, the mass flow rate of collectors inlet air and collector length have the significant impacts on the performance of the system. Shuja Azhar et al. [5] performed an exergy analysis for an integrated system utilizing geothermal, solar and ocean thermal energies. The proposed system utilizes solar energy in a direct

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