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Improved efficiency in an integrated geothermal power system including fresh water unit: Exergoeconomic analysis and dual-objective optimization

Tao Hai [a b c], Amit Kumar [d], Saman Aminian [e], Basim Al-Qargholi [f], Naglaa F. Soliman [g], Walid El-Shafai [h i]

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Abstract

The single-flash geothermal cycle (SFGC) is not without its limitations, featuring drawbacks like diminished efficiency, restricted power generation capacity, and the incapability to yield multiple outputs concurrently. Furthermore, the SFGC requires a substantial water supply, potentially leading to adverse environmental consequences. In a concerted effort to enhance overall performance and facilitate the concurrent production of multiple valuable products, this study introduces a multigeneration system (MGS). By integrating additional subsystems into the SFGC framework, including a branched GAX cycle enabled by a thermoelectric generator (TEG), a domestic water heater (DWH), and a reverse osmosis unit, the objective is to surmount these limitations effectively. A thermodynamic and exergoeconomic analysis of the system is conducted and a bi-objective optimization is employed to minimize system cost and maximize exergy efficiency. The parametric study reveals that when degassing ranges are in the range of 0.2–0.37, the system product cost varies from $27.07/MWh to $28.44/MWh. In the optimized scenario there is a decrease of 67.7% in cooling provided by the system. This leads to an increase of 3.5% in generated electricity and a 3% increase in water purification compared to the base scenario. Through optimization the exergy efficiency of the system improves from 61.84% to 62.90% while the multigeneration gain output ratio (MGOR) decreases from 1.40 to 1.38.