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Exergy analyses and optimization of a single flash geothermal power plant combined with a trans-critical CO_2 cycle using genetic algorithm and Nelder–Mead simplex method

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Abstract

Compared with conventional fossil fuel sources, geothermal energy has several advantages. The produced geothermal energy is safe for the environment and suitable for meeting heating power needs. Because the hot water used in the geothermal process can be recycled and used to generate more steam, this energy is sustainable. Furthermore, the climate change does not affect geothermal power installations. This study suggests a combined power generation cycle replicating using the EES software that combines a single flash cycle with a trans-critical carbon dioxide cycle. The findings demonstrate that, in comparison to the BASIC single flash cycle, the design characteristics of the proposed system are greatly improved. The proposed strategy is then improved using the Nelder–Mead simplex method and Genetic Algorithm. The target parameter is exergy efficiency, and the three assumed variable parameters are separator pressure, steam turbine outlet pressure, and carbon dioxide turbine inlet pressure. The system's exergy efficiency was 32.46% in the default operating mode, rising to 39.21% with the Genetic Algorithm and 36.16% with the Nelder–Mead simplex method. In the final step, the exergy destruction of different system components is calculated and analyzed.

Highlights

- Designing and simulating a combined single flash geothermal cycle with a trans-critical carbon dioxide cycle in the EES software.
- Genetic algorithms (GA) and the Nelder–Mead simplex (NMS) method are used to optimize the proposed system to increase the system's exergy efficiency.
- Examining the system's various components' energy destruction rates.

Keywords: Optimization, Geothermal, Genetic algorithm, Nelder–Mead simplex method, Exergy efficiency, Exergy destruction