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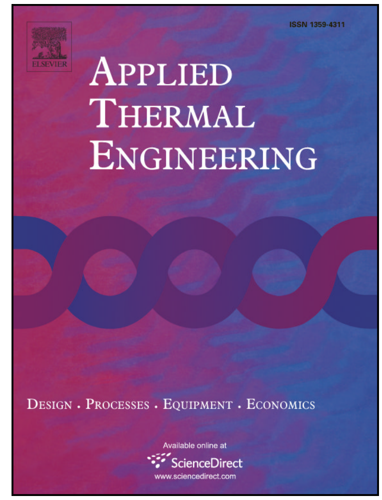

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Parametrized analysis of a Carbon Dioxide transcritical Rankine cycle driven by solar energy

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Highlights:

- A detailed model of the system is presented considering mass, energy, exergy, and heat transfer analysis.
- An exergoeconomic analysis is used as a figure of merit to optimize the system configuration.
- A multiobjective optimization is used to evaluate the trade-off between exergy efficiency and thermoeconomic cost.
- The presence of a regenerator increases considerably the energetic and economic benefit.
- The regenerator allows reducing the optimum solar field's size
- Incorporating a solar source changes the optimum design in transcritical Rankine cycles

Abstract

Several authors have reported in the literature the benefits of transcritical carbon dioxide regenerative Rankine power cycles using low - and medium - temperature sources. However, their technical potential when driven by solar-thermal collectors has not been fully addressed yet. The methodology presented herein is based on two parametric analyses: the first approach attempts to determine the heat transfer area of the regenerator and its respective cost, and the second approach studies the radial heat transfer in each solar collector, at different operation pressures, aiming to determine the heat losses, the pressure drop and the overall performance of the collectors with the use of supercritical Carbon Dioxide. Therefore, through this analysis, the total area required by each component is determined. Then, the solar field configuration is optimized to maximize the exergy efficiency. In that sense, by considering the differences of the specific costs for each area, a multi-objective optimization methodology is applied to the cycle, which determines the best configuration and operation pressure for the cycle based on exergy destruction minimization and the minimum thermoeconomic cost. These results allow determining an optimum size design for the regenerator and solar field configuration, which takes full advantage of the available energy at the lowest possible cost.

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