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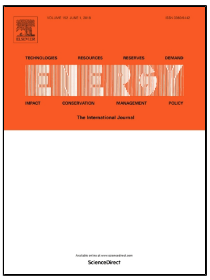

Thermodynamic analysis and optimization of single and combined power cycles for concentrated solar power applications

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Highlights

- Analyzing thermodynamic performance of single and combined power cycles.
- Evaluating the thermodynamic performance over a range of operating conditions.
- Combined Brayton/ORC cycle has the highest thermal efficiency.
- ORC is the best power cycle for low temperature applications.
- Working fluids were selected based on a systematic multi-step method.

Keywords

Combined Brayton/ORC cycle- Organic Rankine cycle- Steam Rankine cycle- Brayton- Combined Rankine/ORC cycle- CSP

Abstract

Thermodynamic analysis and optimization of the power block of concentrated solar power (CSP) plants were performed in this study. Single and combined power cycles such as regenerative steam Rankine cycle with reheat (RSRC), organic Rankine cycle (ORC), combined Rankine/ORC cycle, regenerative Brayton cycle (RBC), regenerative Brayton cycle with recompression (RBCR), and combined Brayton/ORC cycle were compared. Thermodynamic performance of the power cycles was evaluated by performing parametric calculations over a range of operating conditions (maximum temperature, minimum temperature, maximum pressure). Selection of the best power cycle(s) is the main focus of this study. Performance maps which present performance information on the best power cycles in a graphical and straightforward manner were constructed. Results show that for the maximum cycle temperatures lower than 300°C, the ORC has the highest thermal efficiency. For the medium maximum cycle temperatures (between 300 °C to 650°C), the combined Rankine/ORC and RBCR are the best choices. For the maximum cycle temperature higher than 650°C, depending on the maximum pressure, the combined Brayton/ORC cycle and RBCR give the highest thermal efficiency. Also, for low and medium maximum temperatures, RSRC produces the highest specific net work output, followed by the combined Helium Brayton/ORC cycle.