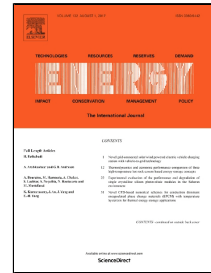


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Thermodynamic analysis and comparison for different direct-heated supercritical CO₂ Brayton cycles integrated into a solar thermal power tower system

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1 **Thermodynamic analysis and comparison for different direct-heated supercritical CO₂ Brayton cycles integrated**
2 **into a solar thermal power tower system**

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8
9 **Abstract:** In this paper, a complete mathematical model is developed to carry out the thermodynamic analysis and
10 comparison for different direct-heated S-CO₂ Brayton cycles (simple, pre-compression, recompression, partial-cooling, and
11 intercooling) integrated into a solar power tower (SPT) system. Based on the model, the effect of turbine inlet temperature
12 (TIT) on the thermodynamic performances of the receiver, the thermal energy storage unit, the S-CO₂ power cycle blocks
13 and the integrated SPT systems is investigated respectively for these cycles. Additionally, a comparison of cycle efficiencies
14 and overall integrated SPT system efficiencies is performed for five S-CO₂ cycles at a series of total recuperator
15 conductance (UA_{total}) values. The results reveal that the TIT exhibits a parabolic effect on the overall efficiencies for each
16 S-CO₂ cycle, and the intercooling S-CO₂ cycle achieves the highest overall efficiencies followed by the recompression, the
17 partial-cooling, the pre-compression, and the simple cycles at different TIT values. Furthermore, the partial-cooling cycle
18 possesses the highest overall specific work at each TIT and offers higher overall efficiencies than the recompression cycle at
19 a constant TIT (650 °C) as the UA_{total} is rather low, having the potential to reduce the costs of integrated SPT systems with
20 limited UA_{total} values.

21 **Keywords:** Direct-heated S-CO₂ Brayton cycles; Solar power tower; Complete mathematical model; Thermodynamic
22 analysis; Performance comparison

23 **1. Introduction**

24 The global environmental crisis resulted from the excessive fossil fuel combustion has become an urgent issue for
25 years [1-3]. Solar energy is a clean and bountiful renewable energy resource which offers a solution to the serious

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