

A novel supercritical CO₂ recompression Brayton power cycle for power tower concentrating solar plants

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Abstract-

Power tower concentrating solar plants with thermal energy storage will play a key role in the transition to a low carbon scenario, thanks to be a dispatchable renewable energy system. The ternary MgCl₂/KCl/NaCl salt appears as one of the most promising due to its lower melting point, higher heat capacity, lower cost and stability up to 800 °C. A cavity-type receiver has been selected because minimizes radiation heat loss at high working temperatures, compared to an external-type receiver, since all commercial selective coatings degrade in air. Supercritical Brayton power cycle is chosen for the power block because it can surpass 50% efficiency, even when working in dry cooling conditions, and printed circuit heat exchangers are usually recommended due to its ability to support the high pressures. However, plugging/clogging issues arise in their small channels when using molten salts. This paper proposes a novel supercritical CO₂ Brayton power cycle whose heat power is supplied through the low pressure side (over 85 bar) allowing the use of shell and tube heat exchangers, achieving a higher compactness and a lower investment. Thus, different options based on the recompression layout with intercooling and reheating have been investigated in both dry and wet cooling scenarios. Reheating is recommended for wet cooling, reaching 54.6% efficiency and an investment of 8662 \$/kWe; intercooling with reheating is the best option for dry cooling, reaching 52.6% efficiency and an investment of 8742 \$/kWe.

Index Terms- Supercritical CO₂; Recompression Brayton power cycle; Concentrated solar plant; Shell and tube heat exchanger; Ternary chloride molten salt; Cavity receiver

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Citation:

Linares, J.I.; Montes, M.J.; Cantizano, A.; Sánchez, M.C. "A novel supercritical CO2 recompression Brayton power cycle for power tower concentrating solar plants", Applied Energy, vol.263, no.114644, pp.114644-1-114644-21, April, 2020.