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Innovative integrated solar combined cycle: enhancing dispatchability with a partial recuperative gas turbine and supercritical CO2 bottoming cycle, coupled with an ORC

J.I. Linares Hurtado; E.M. Arenas Pinilla; A. Cantizano González; M.J. Montes Pita; A.J. Rovira de Antonio; J. Porras Galán; J.R. Pérez Domínguez

Abstract-

Concentrating solar power is crucial in the future energy mix due to its ability to integrate thermal energy storage, thus providing dispatchability. One way to address the current high costs of this technology is by using higher temperatures, which can, however, lead to issues with heat transfer fluids and storage. A promising integrated solar combined cycle is here proposed to solve that current major issue. A partially recuperated gas turbine is coupled to a solar tower system using a Brayton supercritical CO2 power cycle, which recovers heat at two temperature levels. An Organic Rankine Cycle is also used to exploit the low-temperature flue gases. The performance at the design point is assessed under different solar contributions. The modulation of the thermal duty in the gas turbine recuperator allows reaching a nearly constant power production in the plant (180 MWe): 56 % coming from the gas turbine, 39 % from the CO2 power cycle, and 5 % from the ORC. The global efficiency achieved is 57.2 %. Carbon dioxide emissions range from 236 g CO2/kWhe (86 g CH4/kWhe are consumed) with the maximum solar contribution to 346 g CO2/kWhe (126 g CH4/kWh are consumed) with no solar contribution.

Index Terms- Recuperative gas turbine; CSP; Combined cycle; supercritical CO2 power cycle

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