Case Studies in Thermal Engineering, vol.61, pp.105021-1-105021-19, September, 2024.

Direct coupling of pressurized gas receiver to a brayton supercritical CO2 power cycle in solar thermal power plants

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

Abstract-

Three layouts of Brayton supercritical CO2 power cycles directly coupled to the receiver are proposed for Generation 3 solar power plants: conventional recompression, recompression with partial cooling, and recompression with intercooling. To achieve direct coupling, the solar heat is introduced downstream of the turbine, where CO2 pressure is lower. A higher temperature rise diminishes the receiver's dimensions, thus increasing its energy efficiency. It also lowers the average working temperature since the maximum temperature is fixed at 700 °C, thereby reducing losses. However, optical efficiency decreases as the receiver size diminishes. Both intercooling and partial cooling layouts further increase the cycle's net efficiency, which reduces the receiver's size, following similar trends observed with an increase in temperature rise. Considering all these effects, various factors push in opposite directions, affecting overall efficiency and costs. This competitive interplay results in overall efficiencies ranging from 30.26 % to 31.58 % and Levelized Costs of Electricity (LCOEs) between 162.47 €/MWh and 166.81 €/MWh. In conclusion, similar outcomes in terms of energy and economics are achieved with the three layouts, suggesting the simplest layout (recompression) as the most advisable. If thermal storage is incorporated, partial cooling becomes preferable due to its significant increase in the receiver's temperature rise.

Index Terms- CSP; Supercritical CO2 power cycle; Pressurized gas receiver; Microchannel receiver

Citation:
Arenas, E.M.; Cantizano, A.; Linares, J.I.; Montes, M.J.; Pérez-Domínguez, J.R.;

Porras, J. "Direct coupling of pressurized gas receiver to a brayton supercritical CO2 power cycle in solar thermal power plants", Case Studies in Thermal Engineering, vol.61, pp.105021-1-105021-19, September, 2024.