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Supercritical CO2 Brayton power cycles for DEMO (demonstration power plant) fusion reactor based on dual coolant lithium lead blanket

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Abstract— This paper presents an exploratory analysis of the suitability of supercritical CO2 Brayton power cycles as alternative energy conversion systems for a future fusion reactor based on a DCLL (dual coolant lithium-lead) blanket, as prescribed by EUROfusion. The main issue dealt is the optimization of the integration of the different thermal sources with the power cycle in order to achieve the highest electricity production. The analysis includes the assessment of the pumping consumption in the heating and cooling loops, taking into account additional considerations as control issues and integration of thermal energy storage systems. An exergy analysis has been performed in order to understand the behavior of each layout.

Up to ten scenarios have been analyzed assessing different locations for thermal sources heat exchangers. Neglecting the worst four scenarios, it is observed less than 2% of variation among the other six ones. One of the best six scenarios clearly stands out over the others due to the location of the thermal sources in a unique island, being this scenario compatible with the control criteria. In this proposal 34.6% of electric efficiency (before the self-consumptions of the reactor but including pumping consumptions and generator efficiency) is achieved.

Index Terms— Balance of plant; Fusion power; Supercritical CO2 Brayton cycle; DCLL lead (dual coolant lithium-lead); DEMO (demonstration power plant)

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