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Sizing of a recuperative supercritical CO2 Brayton cycle as power conversion system for DEMO fusion reactor based on dual coolant lithium lead blanket

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Abstract— A modified recuperative supercritical CO2 cycle for DEMO fusion reactor is analysed. A layout with just one recuperator is used, because of the relatively low temperature of the breeding blanket coolants. The proposed cycle is able to integrate several thermal sources with different temperature ranges and includes two kinds of thermal energy storage to overcome the pulse operation: a two-tank molten salt storage and a concrete storage. The design point is obtained using the Engineering Equation Solver (EES) environment, which allows to use pure substance models for CO2, helium and water. Once the design point is calculated, the sizing of pipes, heat exchangers, turbomachines and energy storage systems has been performed in order to obtain a preliminary estimation of the layout and its complexity. So, the power conversion system has been split into four equal parts in order to use commercial pipe diameters. Even though Printed Circuit Heat Exchangers (PCHE) have been used, extremely large sizes have been obtained, especially for the HTR recuperator. These sizes contrast with the small values obtained for the turbomachines, whose preliminary design has been carried out, using the AXIAL™ meanline design software. In addition, the two largest heat exchangers are divided into serial and parallel configurations when assessing the allocation of the components of the power conversion system to reduce the footprint. An average electric efficiency (including pulse and dwell period) of 28.25% has been reached. The required mass of molten salt per each power conversion subsystem is 2568?t, while the mass of concrete is 833?t. Regarding the footprint, 85?×?170 m2 are required for each power conversion subsystem, including the storage systems.

Index Terms— Balance of plant; Fusion power; Supercritical CO2 Brayton cycle; DCLL; DEMO

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