

Design and Analysis of the Secondary Circuit of the DEMO Fusion Power Plant for the HCPB BB Option without the Energy Storage System and with the Auxiliary Boiler

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The EU-DEMO (European DEMONstration Fusion Power Plant) is being designed to produce fusion electricity at a level of several hundred MW, by about 2060. The Primary Heat Transfer System (PHTS) transfers heat from the fusion reactor heat sources, to the secondary Power Conversion System (PCS), which is responsible for the generation of the electrical energy. Several cooling concepts for the DEMO blanket and the related PHTS are considered. In some variants the Intermediate Heat Transfer System (IHTS) with the Energy Storage System (ESS) have been added between the PHTS and PCS, in order to mitigate transient effects resulting from the pulsed DEMO operation. In the present work a detailed GateCycle model of the steam/water PCS, for the option Helium Cooled Pebble Bed Breeding Blanket (HCPB BB) without the ESS is created and its operation at the nominal conditions (plasma burn) and at the reduced heating power (dwell period) is studied. The proposed circuit utilizes thermal power extracted from the four reactor heat sources, namely: Breeding Blanket with the First Wall cooled in series with the Breeding Zone, Divertor Plasma Facing Components, Divertor Casette and Vacuum Vessel, as well as the auxiliary boiler fueled with natural gas, which plays the role of the main heat source during the dwell phase. The proposed model of the PCS cycle is used to demonstrate possibility of stable operation of a DEMO plant without the IHTS/ESS during both, pulse and dwell phases. The study of the effect of the operating conditions on the cycle power and efficiency is also performed.

Keywords: DEMO, Power Conversion System, Helium Cooled Pebble Bed Breeding Blanket, GateCycle

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