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Thermal-Hydraulic Analysis of the DEMO PF Coils Designed by CEA

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The European DEMOnstration Fusion Power Plant (EU-DEMO) is planned as an intermediate step between the ITER experimental reactor and the future prototype fusion power plant. The core of EU-DEMO is a tokamak equipped with a fully superconducting magnet system, which includes six Poloidal Field (PF) coils. Two concepts of the PF winding packs (WP) are being developed by CEA IRFM (France) and EPFL-SPC (Switzerland) teams. Each of PF coils designed by CEA is double-pancake wound using a square NbTi Cable-in-Conduit Conductor with a central cooling channel. Our present work is focused on thermal-hydraulic analysis of the CEA design of the PF coils, based on the DEMO 2018 baseline. We performed simulations, using the THEA code by CryoSoft, of the behavior of each PF coil at normal operating conditions during the whole simplified current scenario, which consists of: Premagnetisation (10 s), Plasma Current Ramp-Up (80 s), plasma burn (7200 s, between the Start of Flat-Top (SOF) and End of Flat-Top (EOF)) and dwell (600 s) phases. The aim of this study was to estimate the minimum temperature margin for each PF coil. We took into account the realistic magnetic field profiles along each conductor and heat loads due to the AC coupling losses and time dependent hysteresis losses following changes of Jc (B,T). The obtained results serve as a verification of the proposed design with regard to the acceptance design criteria and provide information for further improvements and optimization of the PF winding packs design.

Category

Multi-scale and multi physics design methods

Keywords

EU-DEMO, PF coils, thermal-hydraulic analysis, temperature margin

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