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Dynamical Cryodistribution Model of the JT-60SA Toroidal Field Coil in Cold Test Facility

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This paper deals with the simulation of the JT-60SA tokamak toroidal field coils test facility in CEA Saclay. To have a better understanding of the thermohydraulic behavior of the coils, a model of the cold test facility cryodistribution coupled to a model of the coils has been developed. Each of the 12 Pancakes is modelled by a 1-D thermohydraulic tube of Simcryogenics code representing the Cable-In-Conduit Conductor (CICC) of the coil, with each its own parameters, in particular heat loads from coil casing. This paper presents more in details, the external cryogenic distribution circuit which is modelled with the Simcryogenics library comprising the pump, a heat exchanger, control valves, quench relief valves and a quench tank. This paper focuses on the cryodistribution model made with Simcryogenics and the associated simulation results obtained during the coil test. The experimental test until quench initiation is performed and has been simulated, representing the increase of inlet helium temperature up to 7.46 K leading to the quench, followed by the safety current discharge. The simulation results are compared with the test measurement signals and other simulations performed with THEA and SimCryogenics coupled model, in particular the helium temperature, pressure and mass flow at the extremities of the conductors and coil. This work shows that this Simcryogenics simulation can predict the behavior of a coil coupled to a cryodistribution system until quench initiation, leading to possible future analysis and recommendation for operation of future (JT-60SA) tokamak cryogenic systems (determination of temperature margin with other operating conditions: helium mass flow and casing heat loads).

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