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Estimation of the Cool-Down Speed under the SHe inlet condition in JT-60SA CS module

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The JT-60 Super Advanced (JT-60SA) magnet system consists of toroidal field (TF) coils, central solenoid (CS), and equilibrium field (EF) coils, and all coils are thermally protected by a thermal shield. The CS consists of four stacked modules with 52 layers, and the conductor is designed with a cable-in-conduit conductor (CICC). The CS is cooled to an operating temperature of 4.5 K by supercritical helium (SHe). The CS is cooled over a month-long process, one of the temperature control conditions during the cool-down is to keep the maximum temperature difference in the coil below 40 K to limit the mechanical stress of the coil. The second condition is that the maximum temperature difference between the thermal shield and the coils is within 50 K. The 26 inlets and outlets are installed on the outer radius of the CS module, respectively, and the highest temperature in the conductor is likely to be near the center in the longitudinal direction due to heat exchange between supply and return. However, since the temperature measurements are only possible at the inlet and outlet, the maximum temperature difference in the coil cannot be measured. Hence, the estimating the temperature distribution in the coil is important for ensuring the safe cooling operation of the JT-60SA. In the previous work, a temperature distribution analysis model of the two layers in the CS module was created based on the measurement results of the CS module cool-down test, and the temperature difference between the inlet and outlet was calculated to keep the maximum temperature difference at 40 K during cool-down. In this works, based on the results of the previous work, the effect of the temperature conditions on the cool-down speed of the CS module was investigated.

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