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JT-60SA TFC02 COMPLEMENTARY QUENCH TESTS IN CTF: THERMOHYDRAULICAL ANALYSIS AND SMOOTH QUENCH CRITICALITY

Thursday 18 November 2021 10:00 (20 minutes)

In the framework of the commissioning of JT-60SA Tokamak (Japan), all the 20 Toroidal Field Coils (TFC) have been tested at Cold Test Facility (CTF, CEA-Saclay) during acceptance quench (with a quench temperature equal to 7.5 K at nominal current). Some complementary tests have been performed (September 2018), on spare coil TFC02 with different quench conditions, especially reduced current (at 75% and 50% of nominal current) and increased detection parameters (detection and action time Tda). The acceptance quench test of TFC02 shows a hot spot temperature (maximal conductor temperature supposed to be equal to measured maximal helium temperature) at nearly 23 K. Some models have been performed, with SuperMagnet (fortran, CryoSoft) including THEA (Thermohydraulic 1-D of Cable In Conduit Conductor, CICC) and Flower (external cryogenic cooling circuit model).
During complementary quench tests, an increased Tda causes, as expected, a higher hot spot temperature: 32 K and 35 K for detection and action time respectively equal to 0.5 s and 1 s. A reduced current, at 75 % of nominal current, implies a smaller hot spot temperature at nearly 14 K (maximal helium temperature due to less Joule Energy deposited). At 50 % of nominal current, a so called "smooth"quench occurs and the slower propagation and detection difficulty are the cause of a slightly greater hot spot temperature at nearly 16 K (maximal helium temperature). Each quench is characterised by a large increase of helium pressure and helium expulsion mass flow. The measurements are presented and compared to the calculated results with SuperMagnet (observed time delay governed by the modelled exhaust quench valve friction factor). These analyses shows, despite the respected hot spot criteria (temperature non-adiabatically smaller than 150 K), the potential criticality of the so called "smooth"quench and some further analyses would be performed in Tokamak environment.

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