§14. Excitation Test Results of a Single Inner Vertical Coil (EXSIV) for LHD

Satow, T.

The Large Helical Device (LHD) has two helical coils and three pairs of poloidal coils. The superconductors used for poloidal coils are also cable-in-conduit conductors (CICCs) consisting of 486 NbTi strands with a copper matrix.

We conducted supercritical helium (SHe) forced flow cooling and excitation tests to confirm the cooling and superconducting characteristics of the IV-L coil before assembling it into the cryostat. A superconductivity test facility for the IV-L coil was set up in the Cryogenics and Superconductivity Laboratories at the Toki site of NIFS.

Its first test had been carried out from the end of January to the beginning of March 1995. The coil had been cooled down to 4.5 K, but limited to an excitation of 2.2 kA because of insufficient liquid helium storage and repeated chokings of the mesh filter in the cooling pipe into the coil.

The second test was successfully conducted from November to early December 1995 by means of repairs of the test facility in part; the addition of middle-pressure helium gas holders for increasing LHe storage and the use of an appropriate filter system. Process and major events on excitation tests are described as follows:

A current interruption occurred when the coil was excited to 8.1 kA at a current sweep rate of 20 A/s on the 6th of December. It was recognized to be a gas-flow-type quench detector operation due to SHe flow rate reduction by half. The reduction was forced by mistaken movement of a pneumatic adjustment valve of the SHe pump in a leakage magnetic field of 20 gauss or more. The coil was again energized after mechanically fixing the moving part of the valve, and another valve operated mistakenly resulted in a current interruption at 9.5 kA. As the means of solving this problem all pneumatic adjustment valves were transferred far from the cryostat. The coil achieved the rated current of 20.8 kA on the 8th of December. However, a current interruption happened again because of mistaken movement by leakage magnetic field of a water level indicator for cooling the power supply.

After canceling the interlock of water level the coil was excited without a quench at a sweep rate of 20 A/s, and a flat-top current of 20.8 kA was held for 10 minutes. The measured characteristic of the IV-L coil and the nominal one of the IV coils are shown in Fig. 1. The measured coil current and voltage performances for the IV-L coil are shown in Fig. 2. The coil terminal voltage was measured to be 6.2 V. This voltage agreed well with the value calculated from the coil inductance of 0.31 H. The coil current was lowered at a rate of 60 A/s. Thereafter, several excitations were carried out on the conditions of a discharge time constant of 20 s, various sweep rates, or various holding times.

Total resistance of seven joints between double-pancakes was calculated to be less than 0.14 nΩ from the observed resistive voltages. Acoustic emission (AE) signals were not almost observed at the current region excited once more, but they appeared more frequently at a virgin region. Since this means that good seating at strand motion in the CICC was made, the IV-L coil is evaluated to have good stability. The IV-L coil was taken out from the cryostat, and assembled into the lower supporting structure for LHD in May 1996.

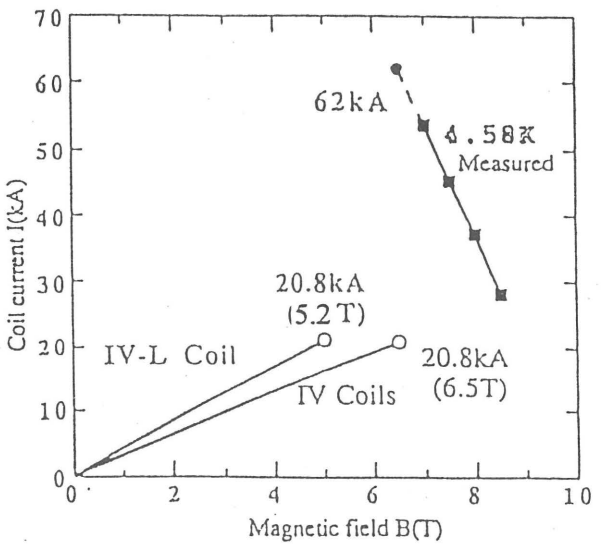

Fig. 1. Measured characteristic of the IV-L coil

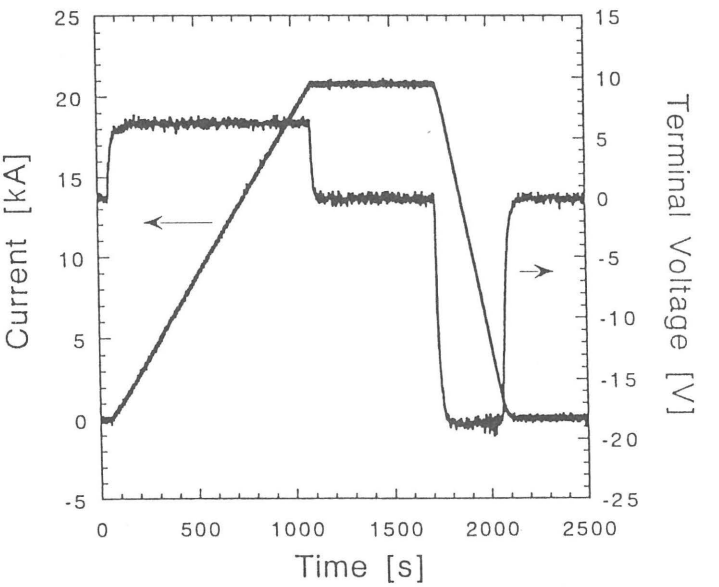

Fig. 2. Excitation test results of the IV-L coil