§6. Single Coil Tests of the IV Poloidal Coil for LHD

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The first cool down test of IV poloidal coil for LHD was successfully conducted from January to March of 1995. The IV coil is one of a few large-scale CICC superconducting coils existing in the world. It is very important to measure cooling characteristics of the IV coil as an example of a forced flow cooled multi-paths superconducting coil. The test results also become essential data to assemble the cooling system and to construct automatic cooling program for LHD.

The configuration of the IV coil is shown in Figure 1 and the parameters are listed in Table 1. The IV coil consists of 8 double-pancake coils wound with a NbTi CICC. The cooling paths of IV coil are 16 parallel with the length of 170 m. Before installing the IV coils to the LHD cryostat, we are conducting single coil tests of the IV coil using test facilities at the cryogenic and superconductivity laboratory of NIFS.

Within 250 hours, we could cool down the coil to the superconducting state. The coil was cooled uniformly keeping the coil inlet and outlet temperature difference less than 50 K by controlling the coil inlet temperature according to the programmed cooling rate of about 1 K/h. The temperature distribution of each pancake coil was monitored with the each pancake coil resistance as shown in Figure 2. The coil was cooled uniformly and there was no temperature difference between each pancake. The flow rates were measured at the inlet of each double-pancakes. The flow rates of the first and second double-pancake coils were less than the other 6 double-pancake coils. However, it is not serious problem because there was no temperature deviation from the coil average temperature as shown in Figure 2. The measured pressure drop of the coil was almost the same as the nominal value. We could confirm the superconducting characteristics of the IV coil in spite of 1/10 of the nominal current. The SHe cryogenic centrifugal pump unit could be successfully operated under the relatively high pump head of 0.2 MPa and the flow rate of 20 g/s.

The blocking of the inlet filter with the contamination resulted the instability of the cooling system. There are future R&D items which are the filter system adequate for CICC coils, the measuring system and the controlling technique of the ppb level contamination.

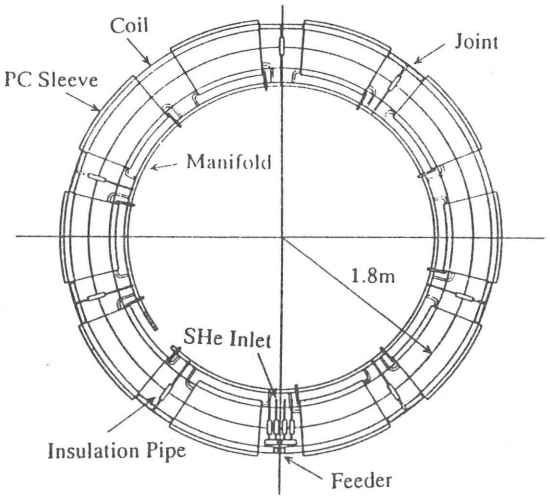

Fig. 1. Configuration of the IV coil.

Table 1. Specifications of the IV coil

Cooling type	SHe forced-flow
Inner/outer radii	1.6 m / 2.1 m
Height	0.46 m
Total weight	16 tons
Number of turns	15 x 16 = 240
Operating current	20.8 kA
Maximum field	6.5 T
Total mass flow rate	80 g/s
Cooling paths	16
Cooling path length	170 m
Inlet temperature	4.5 K
Inlet pressure	1.0 MPa
Pressure drop	0.1 MPa

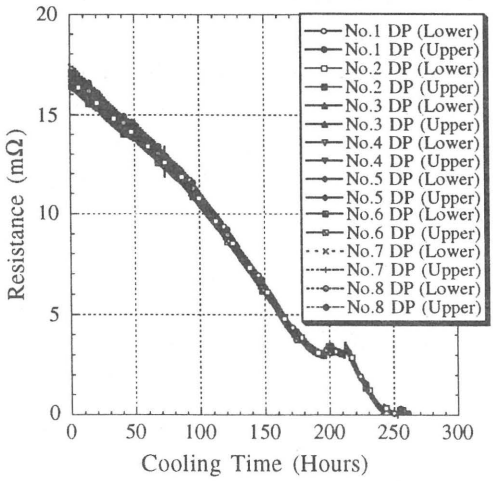

Fig. 2. Resistance of each pancake coil.

References

1) Mito, T., et al., "Single Coil Tests of the IV Poloidal Coil for LHD.", Proceedings of 9th US-Japan WS on HF-SC Mat., Wires and Conductors and ST Proc. for HFSC Wire Testing, March 13-15, 1995, Kyoto.