§16. Hydraulic Characteristics and Stability for the Experiments on a Single Inner Vertical Coil (EXSIV) for the Large Helical Device

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Conductors of all poloidal coils are Nb-Ti cable-in-conduit types. Because the conductors do not have any subchannels, special attention should be paid to the pressure drop of the coolant. To investigate such hydraulic characteristics, we performed cooldown and excitation tests of an IV coil using test facilities at the cryogenics and superconductivity laboratories of NIFS before installing the coils in the LHD cryostat. The first experiment were performed from February 1 to March 1 of 1995. However, blocks of the inlet filter resulted in instability of the cooling system, and the excitation up to the specified current of 20.8 kA was suspended. A new filter system was then developed and the second experiment was performed from November 13 to December 8 of 1995, and the coil was successfully energized up to 20.8 kA. Here the hydraulic characteristics, especially the pressure drop, are discussed on the second cooldown and excitation tests.

The friction factors during the cooldown and steady cooling are shown in Fig. 1 as a function of Reynolds number. The open and closed circles indicate the data for the first and the second cooldowns, respectively. The open triangles indicate the data for the previous R&D coil named "IVS" [1], of which path length is 35 m. Both conductors have almost the same configuration. The pressure drop characteristics of both coils agree well in spite of the difference of the path length. Moreover, the Katheder's formula [2], which is a general correlation of many different conductors, agrees with the experimental data.

During the excitations, the mass flow rate increase of the double-pancakes was observed with increasing the current. Figure 2 shows the variations of the friction factor with current on #5 double-pancakes. N_{ex} in the figure indicates the excitation number over 10 kA. The friction factor decreased with increasing the current. The curves also show hysteresis, and the curves after the second excitation are almost the same. Similar behavior has already been observed for the previous R&D coil named "TOKI-PF" [3]. It was considered that a narrow gap was made by the deformation of strands bundle due to the electromagnetic force.

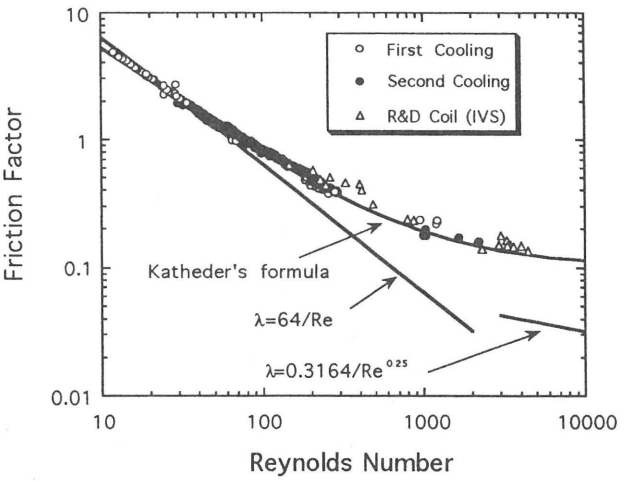

Fig. 1. Friction factor versus Reynolds number

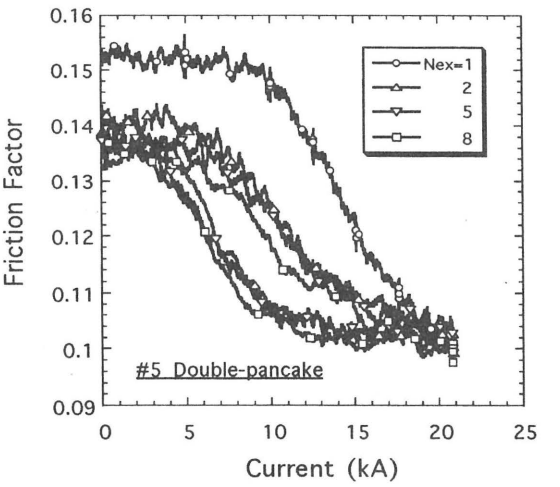

Fig. 2. Variations of the friction factor with current on #5 double-pancake.

References

1) Takahata, K. et al., IEEE Transactions on Magnetics 30 (1994)1705.
2) Katheder, H., Cryogenics 34 (1994) 595.
3) Takahata, K. et al., Fusion Engineering and Design 20 (1993) 161.