§23. Excitation Test of the High Temperature Superconducting Coil for the Mini-RT Device

Yanagi, N., Mito, T., Hishinuma, Y.,
Ogawa, Y., Morikawa, J. (Univ. of Tokyo),
Iwakuma, M. (Kyushu Univ.)

A magnetically levitated superconducting coil system, Mini-RT, is being developed at the High Temperature Plasma Center of the University of Tokyo for examining a magnetic confinement scheme of high-beta plasmas with new relaxation processes [1]. High temperature superconductors (HTS) made of Bi-2223 Ag-sheathed tapes are used for the floating coil (diameter: 300 mm, weight: 20 kg, total current: 50 kA). The major specifications of the coil are given in TABLE 1.

Along with basic design and construction of the coil, research and development have also been carried out regarding the engineering issues on this coil [2]. The winding process of the coil was successfully completed using 420 m of the HTS tapes. The coil and the persistent current switch (PCS) were assembled with a 2 mm gap in between. It has been decided that the performance of this coil should be examined before it would be actually installed in the Mini-RT device. Thus, excitation tests of the coil were carried out at the Cryogenics Laboratory of NIFS using a helium cryostat. The experimental setup of the coil is shown in Fig. 1. Helium gas was supplied through heat exchangers situated in liquid helium, and electrical heaters were used to control the inlet temperature. The excitation tests were conducted two times by changing the thermal insulation of the coil.

The second experiment was carried out by installing the coil and PCS in a tentative vacuum chamber. With this setup, sufficient temperature difference was realized between the coil and PCS with good thermal insulation. The effective PCS function was confirmed by increasing the PCS temperature up to the critical value (approx. 110 K). By turning off the PCS heater, the coil current was successfully induced up to the nominal current of 117 A. Here, the coil current was precisely evaluated by measuring the magnetic field at the coil center using Hall probes.

In this experiment, the time constant of the magnetic field decay was also examined by keeping the coil temperature at 20 K and 40 K. Figure 2 shows an example of this measurement when the coil temperature was kept at 40 K. According to the decay curves, the time constant was determined to be about 38 hours at 20 K and 6.5 hours at 40 K. These values are in fairly good agreement with the predicted values by calculating the critical current.

TABLE I Major Specifications of the Mini-RT Floating Coil

Major Radius / Minor Radius	150 / 28 mm
Number of Turns	428 (solenoid)
Superconductor	Ag-sheathed Bi-2223
Critical Current (77K, sf)	108 A
Silver Ratio	1.57
Cable Length	420 m
Max. Field (Perp. / Para.)	0.51 T / 0.76 T
Stored Energy	598 J
Inner Diameter of PCS	337.3 mm
Number of Turns of PCS	20 (bifilar)
Cable Length of PCS	21.24 m
Superconductor of PCS	(Ag-0.3wt%Mn sheathed) Bi-2223
Critical Current of PCS (77K, sf)	53 A
Turn-off Resistance of PCS	0.27 Ω
Type of PCS Heater	ϕ0.5 mm Manganin

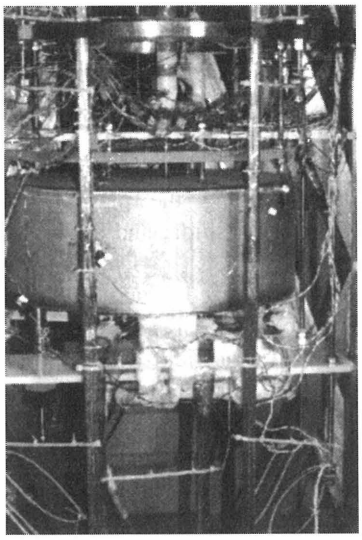

Fig. 1. Experimental setup of the HTS floating coil.

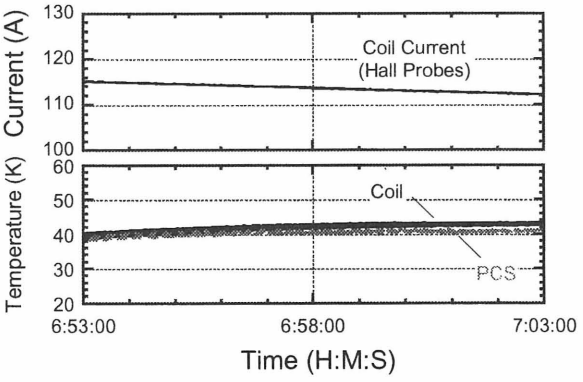

Fig. 2 Temporal decay of the magnetic field measured at the coil center. The coil temperature is kept at 40 K.

References

1) Y. Ogawa, et al., AIP Conf. Proc. (1999) pp. 417-422.
2) Yanagi, N. et al.: to be published in IEEE Trans. Appl. Supercond.