

§12. AC Loss Measurements of the Experiments on a Single Inner Vertical Coil (EXSIV) for the Large Helical Device

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The AC losses of the Inner Vertical (IV) coil have been measured during the Experiments on a Single Inner Vertical coil (EXSIV). The IV coils are the smallest poloidal coils of the Large Helical Device (LHD) and their inner and outer diameters are 3.2 m and 4.2 m, respectively. The coil consists of 16 pancake coils wound with the cable-in-conduit conductors (CICC) whose strands are NbTi/Cu without any surface coating. The AC losses were measured with a calorimetric method during excitation tests and current shut-off tests.

We assumed the coupling time constant as a parameter to investigate and compare the measured coupling losses. Assumed coupling time constants are shown in Fig.1 as a function of the maximum coil current.

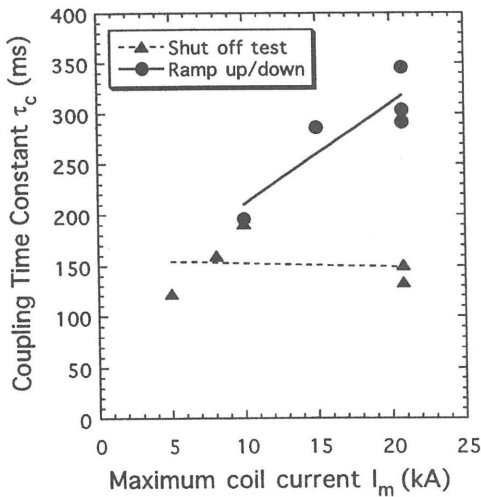


Fig.1. Assumed coupling time constants as a function of the maximum coil current.

Estimated coupling time constant for the ramp up and down tests seems to have a current

dependence and becomes more than 300 ms at 20.8 kA, while the coupling time constant during the current shut off test is approximately constant about 150 ms which is independent of the coil current.

The precise treatment considering frequency dependence of the coupling loss is necessary for the CICC coils which has a multi coupling time constants corresponding to multi-peaks of the coupling loss as a function of the frequency of an external field. Fig. 2 shows the normalized loss Q^* plotted as a function of the inverse of the ramp time period t_1 or the decay time constant t_e .

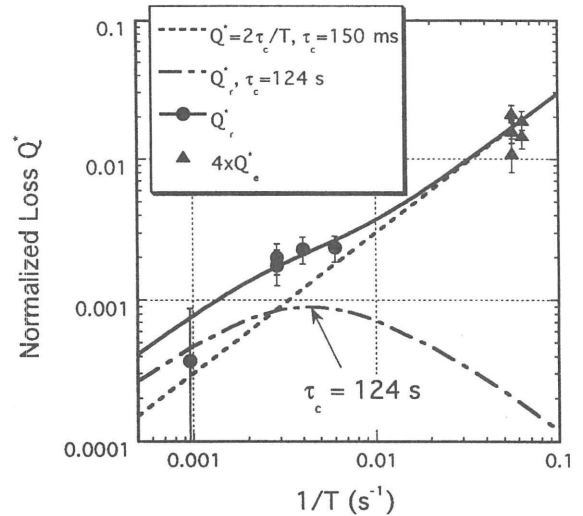


Fig. 2. Normalized losses plotted as a function of the inverse of the ramp time period or the decay time constant

According to the frequency dependence data, the coupling losses for the ramp up/down tests are thought to be enhanced due to the coupling current with a very long time constant of 124 s. The coupling current with a long time constant is assumed to be caused by the non-uniform current distribution in CICC.

AC loss measurements for the IV coil were conducted under various excitation tests as well as current shut off tests. In addition to the usual inter-strand coupling losses with short time constants, unexpected coupling losses were observed due to the coupling current of a long time constant.

References

- 1) Mito, T. et al., "AC Loss Measurements of the Experiments on a Single Inner Vertical Coil (EXSIV) for Large Helical Device.", to be published in the IEEE Trans. on Applied Superconductivity, 1997.