

§18. The Change of Coupling Losses in Aluminum-Stabilized Superconductors due to the Hall Effect

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Aluminum-stabilized NbTi superconductors are used for the winding of large-scale dc magnets such as the helical coil of the Large Helical Device (LHD). A lot of pure aluminum in the conductor causes the large inter-strand coupling losses under changing transverse magnetic fields, which are produced by the poloidal coil in the case of LHD.

On the other hand, the longitudinal dc field as well as the changing transverse field is simultaneously applied to the conductor, and so it is in case of the helical coil conductor in LHD. In such a case, there can be the Hall effect due to the coexistence of the longitudinal dc field and the inter-strand coupling current which is induced by the changing transverse field. Such a Hall effect on the coupling loss was pointed out in our previous paper¹⁾. However, it was estimated for not a real conductor but an idealized model conductor only.

The purpose of this paper is to measure this Hall effect on the inter-strand coupling losses in the real aluminum-stabilized superconductors²⁾. For this purpose we take up the R&D conductor for LHD, which is composed of a superconducting strand bundle, an aluminum stabilizer, a clad layer of it and copper housing.

As the sample conductor, the aluminum-

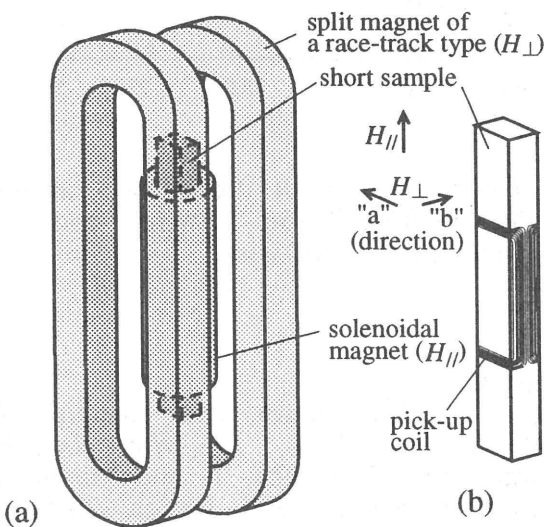


Fig. 1. (a) An arrangement of a split magnet of a race-track type, generating H_{\perp} , and a solenoidal one, generating H_{\parallel} . (b) a pick-up coil wound around the short sample.

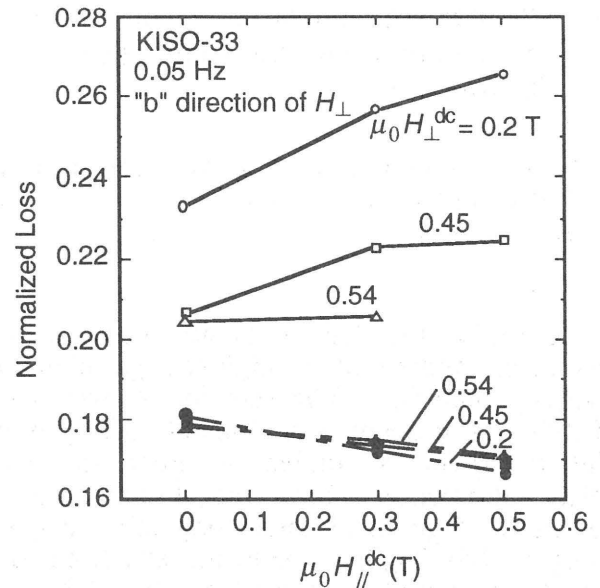


Fig. 2. Longitudinal field dependence of the loss at 0.05 Hz for various values of H_{\perp}^{dc} . The white and the black marks represent the measured loss and the calculated one, respectively.

stabilized NbTi conductor named KISO-33, the R&D conductor for the helical coil of LHD, is used in this experiment. The short sample conductors are put in the split magnet as shown in Fig. 1. The small ac magnetic field H_{\perp}^{ac} superposed on the dc field H_{\perp}^{dc} is generated in the transverse direction to the axis of the short sample in the split magnet. Figure 2 shows the longitudinal field dependence of the loss at 0.05 Hz of H_{\perp}^{ac} for various values of H_{\perp}^{dc} , where the ac and dc transverse fields are applied in the "b" direction. The observed loss induced by the ac transverse field is increased by the existence of the longitudinal dc field. This result cannot simply be explained by the only one variable such as the magneto-resistance.

In this case the dependence of the coupling losses on the longitudinal dc field is also calculated by the two dimensional finite element method (FEM). In Fig. 2, the black marks show the calculated results of the longitudinal dc field dependence of the inter-strand coupling loss in comparison with the experimental results.

Since the experimental results cannot be explained by this calculation, we are requested to further our study in the analysis and the calculation from new points of view.

References

- 1) Kawashima, T. et al., : IEEE Trans. Magn., MAG-30 (1994) 2562.
- 2) Sumiyoshi, F. et al., : IEEE Trans. Appl. Super., 5, (1995) (to be published).