

§18. Measurements of Coupling Losses in Superconducting Cable-in-Conduit Conductors Affected by Internal Transverse Electro-magnetic-Forces

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The inter-strand coupling losses of stranded conductors can become larger according to circumstances of their applications. The treatment of a strand surface to reduce the loss, such as coating or oxidization, usually causes the instability of the conductors. According to them, the losses much depend upon the surface conditions and the structures of the stranded-cables. Under the circumstances of their real applications, the conductors usually have transport current, and consequently the strands in the conductors are subjected to the electromagnetic-forces. The losses can be changed by the forces.

The purpose of this paper is to develop the system which can measure the inter-strand coupling losses itself in the stranded conductors above all CIC conductors with transport current under the transverse magnetic field, and to elucidate the dependence of these losses on the electromagnetic-force to the strands.

We previously developed a compact system which allowed us to measure the coupling loss in straight and short sample of large scale conductors under changing transverse magnetic fields¹⁾. We develop our new system by improving this system, that is, our new system is made a little larger and can supply a current of about 20kA to sample conductors²⁾. By using our system, the preliminary measurement of the coupling loss in IS-conductor of the poloidal field coil for LHD is tried. The experiment is mainly carried out to approximately estimate the losses from the magnetization curves under the conditions the ac magnetic coupling current induced by the magnetic coupling between sample conductors and magnets is not canceled (Method-1). In order to examine the reliability of the approximation of the losses got by Method-1,

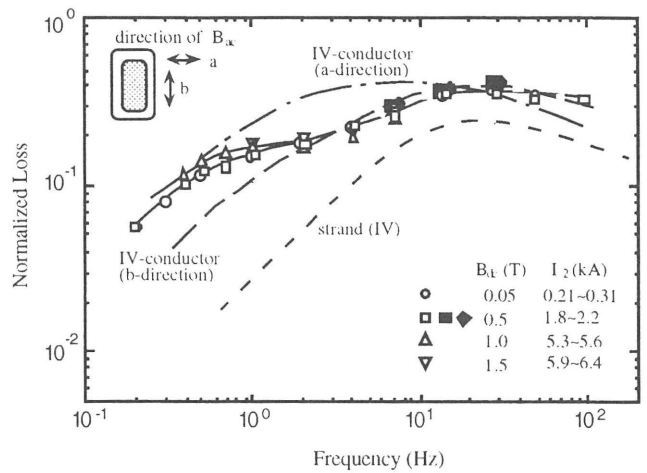


Fig. 1. Frequency characteristics of the coupling loss where white marks are given by Method-1, ■ by Method-2, and ◆ by Method-3.

two measuring methods to be supposed to be more accurate are adopted here. One is the method estimating the losses by measuring the magnetization curve after canceling the ac magnetic coupling current (Method-2). The other is the Poynting vector method which does not cancel the ac magnetic coupling (Method-3).

Figure 1 shows the data of the frequency characteristics of the losses in IS-conductor. In this figure the data of this conductor are compared with those of IV-conductor. The characteristic curve of CIC conductor is relatively broad in shape. This means that the structure of the conductor makes the mechanism of the shielding more complex and the coupling time constant plural. Therefore, if the data nearby 0.1Hz, that is, the operating condition of LHD, only are picked up, the equivalent coupling loss has about 10 times the value of that of the strand itself. When $B_{dc}=1.5T$ and $I_2=6.4kA$, the averaged internal electromagnetic-force is 0.44 MPa. Below such an order of the forces, it is seen that the change of the characteristic is small. The improvement of this system is expected to make it possible to measure the coupling losses under much larger electromagnetic-forces.

References

- 1) Sumiyoshi, F. et al. : IEEE Trans. Magn. MAG-28, (1992) 210.
- 2) Sumiyoshi, F. et al. : IEEE Trans. Magn. MAG-32 (to be published)