§ 19. A Study on Current Equalization by Interphase Reactors

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A practical application of a superconducting cable is expected since it may be possible to send the electric power of a large capacity with a compact size. A superconducting cable is composed of an assembled conductor where a current does not flow uniformly in each strand primarily due to the unbalance of the magnetic coupling between each strand. This unequal current distribution in the conductor causes the increases of ac losses of the superconductor, and also the problem of superconducting stability.

In view of this, an establishment of the unequal current prevention is being required. A method, which makes the current flow equal in each strand, is devised by means of interphase reactors, and its effectiveness is confirmed experimentally. For the purpose of intentional unequal currents generation, ac magnetic fields are coupled with a closed loop circuit consisted of two parallel HTS tapes.

The two tapes are attached at the two faces of FRP plate of the thickness 4 mm and both edges are soldered with copper plate as shown in Fig. 1. Fig. 2 shows the experimental set-up, where the copper wire is for the generation of magnetic fields. A current is induced in the direction in the closed loop in such a way that .the linked fields are cancelled. Accordingly, the induced current i_1 at the tape 1 flows in the same direction as the main current but i_2 the opposite direction at the tape 2 thus enabling i_1 larger than i_2. The distance from the copper wire to the tape 1 is 1 cm. The series resistor R_1 and R_2 are adjusted so that the wire current i_0 and the current i_3 through the series resistance R_2 may be 10 A and 2 A respectively. The tape currents of i_1 and i_2 are measured with an ac current sensor. The HTS tapes are cooled with liquid nitrogen of 77K.

When the interphase reactor is put in use, the tape current of i_1 and i_2 becomes the same value of 1.0 A, and the current equalization of each tape is achieved. However, in the case of not employing the interphase reactor they become i_1 =1.05 A and i_2 =0.95 A respectively, as a natural consequence exhibiting unequal current distribution. These test results are shown in Fig. 3 and Fig. 4.

The application of the interphase reactor was proved to be fundamentally effective for the current equalization of the assembled conductors.

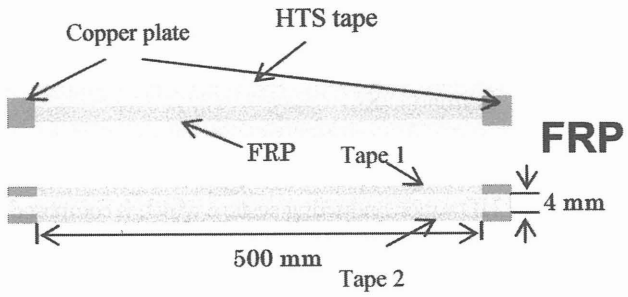

Fig. 1 Connection of HTS tapes.

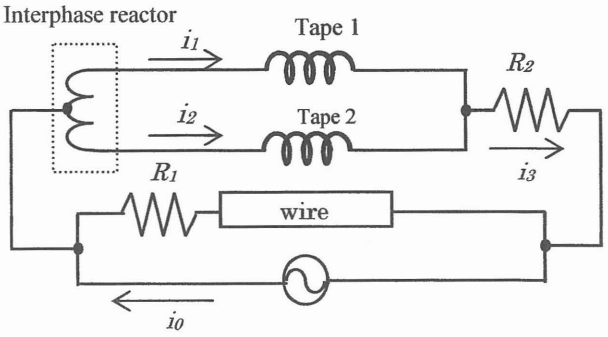

Fig. 2 Test circuit of current equalization.

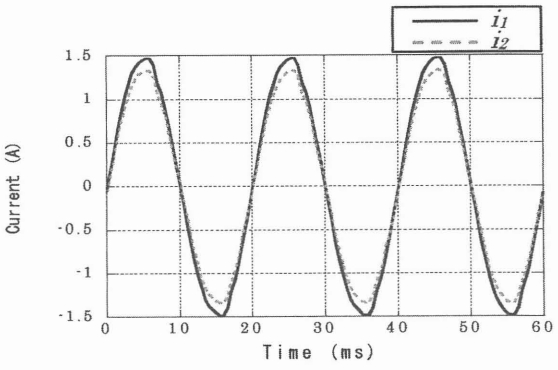

Fig. 3 Current distribution without interphase reactor.

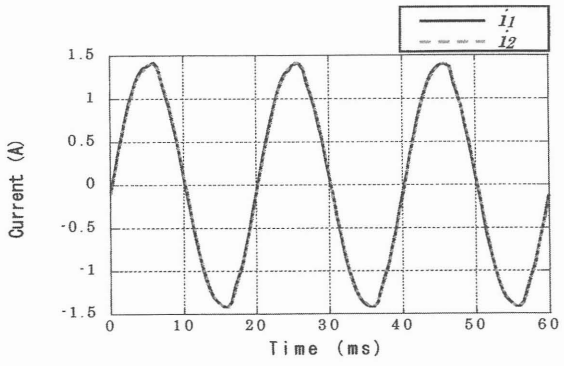

Fig. 4 Current distribution with interphase reactor.