§65. Study on AC Losses and Stabilities of Superconducting Cables

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1. Introduction

It is important to study on ac losses and stabilities of compacted strand cable which is used for large scale superconducting magnets. In 1997, studies on ac losses of the cable and heat conducting properties from the cable to He II have been carried out.

2. AC losses of compacted strand cable

The Nb_3Sn compacted strand cable has very low interstrand resistivities caused by sintering copper surfaces of strands during the heat treatment. Therefore, it shows relatively large ac losses between strands. A new idea to reduce the coupling losses has been developed by putting a thin stainless steel foil (20 μm) between layers at cabling.

The ac loss measurement of this cable has been carried out by changing frequencies of alternating magnetic field which has the amplitudes of 8 and 16 gauss under a bias field of 0.5 T. The frequencies were changed from 0.07 to 318 Hz. We can measure only ac losses caused by eddy current (coupling losses) without hysteresis losses. We have measured also a sample without a stainless steel foil for comparison. The frequency dependences of ac losses for two kinds of samples are shown in Fig. 1 as one of the results. In the figure, indices O and S are without and with a foil, respectively. Index F is ac losses when the ac field is perpendicular to the cable wide face, and E is that in case of parallel. The length of each sample is 4.7 times of the twist pitch one.

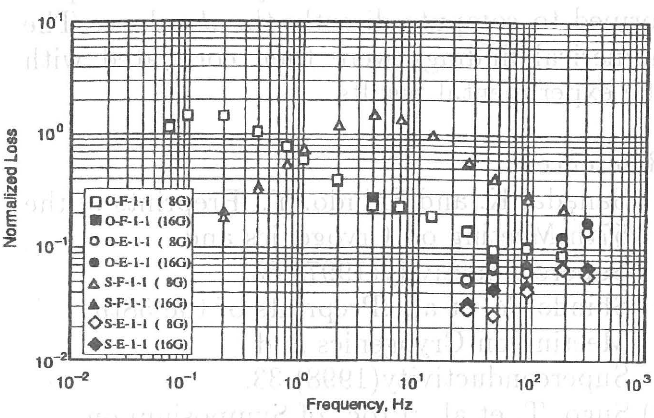

Fig. 1 Coupling losses of Nb_3Sn compacted strand cables with and without a stainless steel foil.

In the figure, the frequencies of the peaks correspond to amount of ac losses, and lower frequency means larger losses. By put a foil into the cable, the peak frequency was shifted from 0.14 Hz to 4.8 Hz, that is the ac losses is reduced around 1/30 of that of the cable without a foil.

This study showed that ac losses can be reduced by this method. However, the reduction is not enough as expected. The reason why the effect is small might be localized small interstrand resistances without covering whole crossover area by a stainless steel foil.

3. Heat conduction properties in He II

We have measured heat conduction properties in He II. We made a compacted strand cable using a CuNi wire as a substitute for superconducting cables for the experiment. The cable was heated up by flowing current and the temperature increase was measured with tiny thermo-sensors put in the cable. The behavior of the temperature increase has been measured for various cable insulation schemes. The cable was covered with a 25 μm-thick polyimid tape with half lap and then another 50 μm-thick polyimid tape with a gap. The measurement has been carried out for changing the gap and epoxy resin thickness on the 50 μm tape. This means that conditions of cooling micro-channels were changed. One of the obtained results is shown in Fig. 2.

The insulation scheme using thicker epoxy resin might reduce the size of micro-channels, and then the temperature increase is higher than others. It is important to make efficient cooling channels for magnet stability.

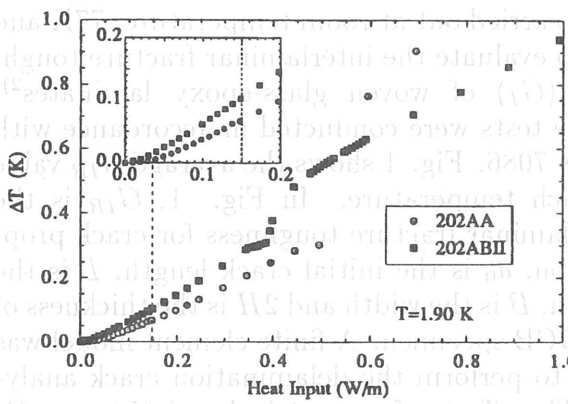

Fig. 2 Heat conduction properties in He II under various cable insulating schemes.

4. Summary

We have studied on ac losses of compacted strand cables and heat conduction properties in He II both of which are important factors for superconducting magnet stability. These studies show us very interesting and important suggestions, however, the further continuous studies should be pushed forward.