Influence of Self-magnetic Field on Critical Current Density in YBCO Tapes

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1. Introduction

Superconducting cable consists of many superconducting tapes. Clarifying how the self-magnetic field a superconducting tape produced influence the other one near it is important to make the cable a stable state [1]. In this research, the experiments and simulations have been carried out to investigate how the self-magnetic field and critical current density change in different conditions.

2. Simulation

2.1 Simulation of Single Tape

Basing on the basic superconductivity definition and Bean's critical state model, which is delivered to introduce hysteresis of hard Type-II superconductors, the finite element model which can assess the superconducting state of superconducting tape is created. The simulation on single superconducting tape about how the self-magnetic field influence the critical current density in the critical superconducting state have been conducted.

2.2 Simulation of Two Tapes

The simulation which is based on the finite model of two tapes to investigate how the placing method influences the critical current density and self-magnetic field has been conducted. There are two main methods to set the tapes, parallel and stacking, which are showed in Fig.1 and Fig.2. It can be learned that how the self-magnetic field change with color changing in the picture. Then the way of analytic geometry [2] was used to calculate the critical current density. The critical current density of the parallel way is about 143.20 A and in the method of stacking way is about 140.20A. It proves that the parallel way will contain higher current density. At the same time, the simulation to assess the self-magnetic field in two different ways also have been conducted. After that, the simulation of changing the parameter of distance and degrees of the two tapes was conducted to investigate how the critical current density and the magnetic field changed. After that, a research investigation based on the two parameters combination was performed, for example, in the distance parameter of 0.10 mm, the simulation was carried out during the degree period of 0-90 in different current densities from 0A to 120A to obtain the critical current density.

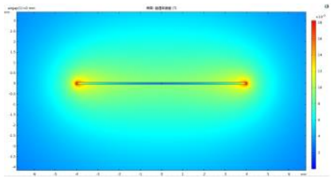

Fig.1 Parallel placing way of two superconducting tapes

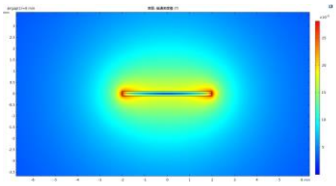

Fig.2 Stacking placing way of two superconducting tapes

3. Discussion

When the experimental curve is relatively flat, the difference of critical current density of the two methods will be less. But when the slope of the curve is large or small, especially these situations are not rare, the influence of self-magnetic field on critical current density between two tapes is very big. On the other hand, experimental B-Jc curve is influenced by many conditions, like the material of tapes, experimental error, the weak connection between superconductors and so on. These conditions may make the curve and self-magnetic field different, then the critical current density between two tapes will be different, even the conclusion of better method will also be changed.

4. Conclusions

In the simulation of comparison between parallel method and stacking method, it proves that parallel method contains higher critical current density. And in the simulation of a single parameter of degree or distance, a bigger degree made self-magnetic field higher, and a longer distance will make it lower in parallel method. In stacking methods, a bigger degree and longer distance made the self-magnetic field lower. By comparing the simulation in the combination of degree and distance, there are four best locations to get the highest critical current density in four different situations.

Reference

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