§27. Transient Stability Analysis of Large Current Aluminium Stabilized Superconductors

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In the case of the transient stability analysis of large superconductors stabilized alumimium which electrical resistivity is much lower than that of copper, it is pointed out that the effect of current diffusion in the cross-sectional direction of the conductor can't be ignored. To investigate the phenomenon called "traveling normal zone", we have been developing a computer code based on finite element method analysis of the transient thermal and eletromagnetic behaviors of large aluminium stabilized superconductors. It is desirable to carry out 3-D analysis for the both heat and current diffusion when cross-sectional shape of conductor is considered. We simplified the analysis model as following because of the restriction of computer capacity and the reduction of calculated times. We adopted one-dimensional analysis in longitudinal direction of the conductor for thermal diffusion and two-dimensional analysis in cross-sectional direction for current diffusion. Figure1 shows the relation of the current and the ratio of area of aluminium for NbTi/Cu. In the figure, the recovery current is the current value which recovers superconducting state because the cooling effect by helium is larger than the magnitude of joule heat generation at the end of the current diffusion, and non-propagation current is the maximum current value without normal propagation. The reovery current increases to restrain joule heat generation effeftively according to enlargement of cross-sectional area. However, the non-propagation current does not increase even though the cross-sectional area increases. This reason is that the current flows into only a part of the aluminium caused by delay of current diffusion. It can be considered that "traveling normal zone" phenomenon may occur due to the current between recovery current and non-propagation current. Figures2 and 3 show the example of occurrence of "traveling normal zone". The figures are the temperature variations of the cases that the current which is slightly larger than non-propagation current 7700A and 9000A are transported. Because the normal propagation velocity on the side of large transport current is more fast, "traveling normal zone" is long. Figure4 shows the relation of the non-propagation current and cross-sectional ratio of aluminium and copper respectively. Non-propagation current of aluminium is larger than that of copper because of it's high thermal conductivity and low resistivity. From these investigations, we can conclude as follows,

1. The simplification of the analysis model is accomplished.
2. The possibility of generation of "traveling normal zone" are shown.
3. The availability of aluminium could be confirmed.

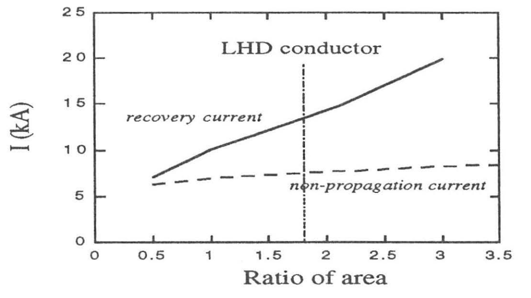

Fig.1 The influence of current diffusion

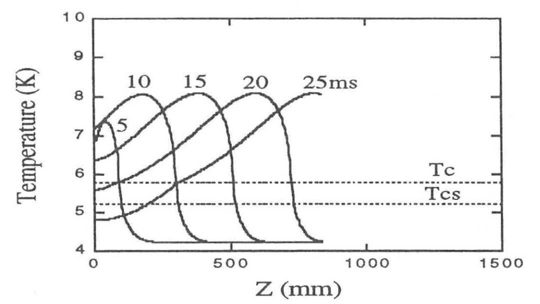

Fig.2 Calculated temperature distribution in longitudinal direction of the conductor(It=7700A)

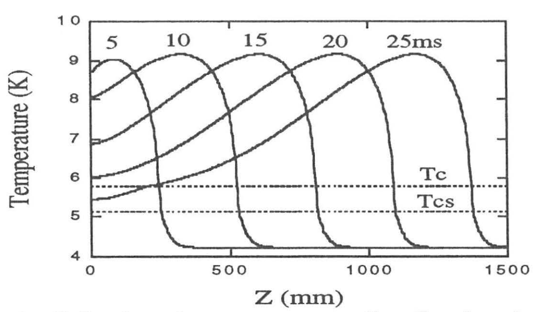

Fig.3 Calculated temperature distribution in longitudinal direction of the conductor(It=9000A)

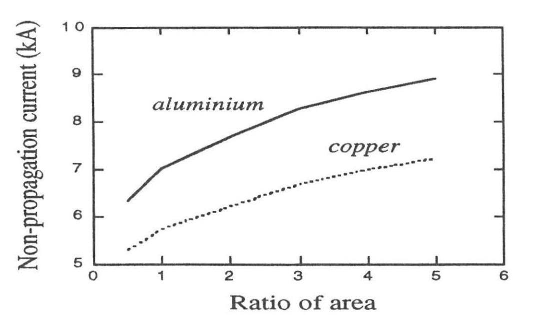

Fig.4 Comparison of the aluminium with copper by the analysis