§57. Transient Stability of Large Current Aluminum Stabilized Superconductors

Ishiyama, A., Kim, S.B., (Dept. of EEC Eng., Waseda Univ.)
Satow, T.

In the case of the transient stability analysis of large superconductors stabilized aluminum 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 ignored. To investigate the phenomenon called "traveling normal zone", we have been developing computer code based on finite element method analysis of the transient thermal and electromagnetic behaviors of large aluminum stabilized superconductors. We adopted two-dimensional analysis in longitudinal direction of the conductor for thermal and current diffusion. And Cu-2%Ni clad with high electrical resistivity and low thermal conductivity, which is placed around the aluminum stabilizer to restrain the Hall current generation, affects the characteristic of normal transition and normal-zone propagation. Figure 1 shows the relation of the current and the ratio of area of aluminum for NbTi/Cu. The background magnetic field is 7T. In the figure, the recovery current is the current value which recovers superconducting state because the cooling effect by helium is lager 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 recovery current increases to restrain joule heat generation effectively 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 aluminum caused by delay of current diffusion. It can be considered that "traveling normal zone" phenomenon may occur due to the current between the recovery current and non-propagation current. And Cu2%Ni clad reduces the non-propagation current value. It is caused that the current diffusion is delayed and the heat is not conducted to the aluminum by high electrical resistivity and low thermal conductivity of Cu2%Ni clad. Figure 2 shows the example of occurrence of "traveling normal zone". The figure is temperature variations of the cases that the current which is slightly larger than non-propagation current 9000A are transported. And the velocity of normal front with Cu2%Ni is slower than that without Cu2%Ni[1].

From these investigations, we can conclude as follows,

1. The Cu2%Ni clad prevents the current and the heat form conducting to the aluminum.
2. It reduces the non-propagation current.
3. It makes the velocity of normal-zone propagation slow.

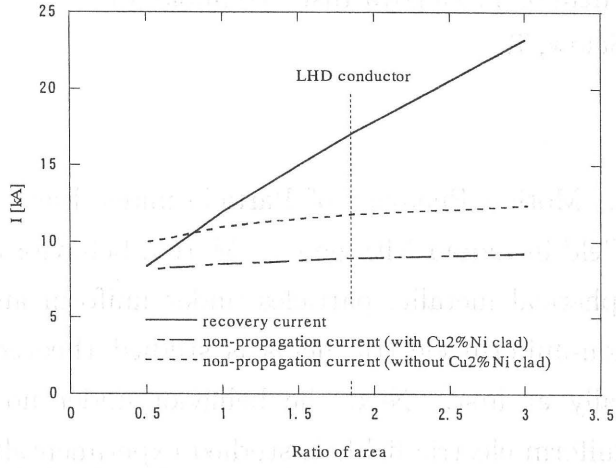

Fig.1. The influence of current diffusion.

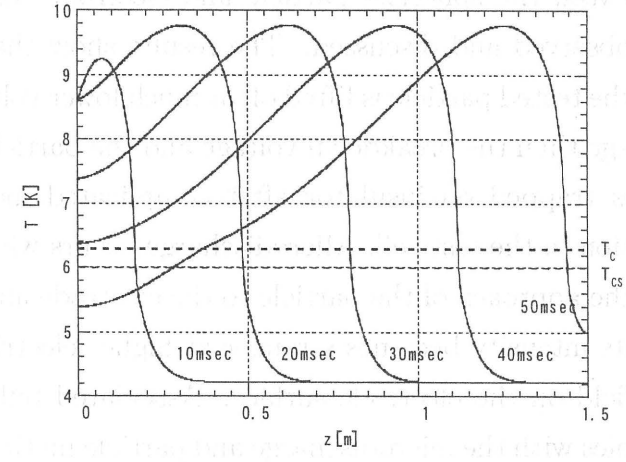

Fig.2. Calculated temperature distribution in longitudinal direction of the conductor

Reference

[1] A.Ishiyama; "Transient Stability Analysis of Large Current Aluminum Stabilized Superconductors", ANNUAL REORT OF NATIONAL INSTITUTE FOR FUSION SCIENCE 1995 pp.32.