§8. Transient Stability of Evaluation for the Helical Coils of LHD

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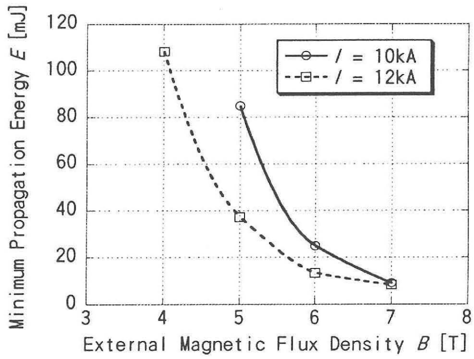
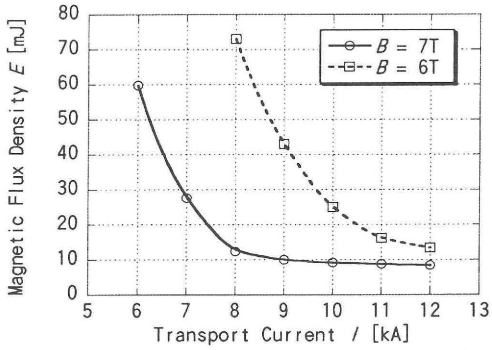
In the case of the transient stability analysis of large superconductors stabilized aluminum whose electrical resistivity is much lower than that of copper, it is pointed out that the effect of current diffusion in the cross-sectional direction of the conductor can't be ignored. To investigate the transient stability, we have been developing a 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-zone propagation. Furthermore, we investigated the transient stability affected by the coolant (lq.He), Hall current generation, the cross-sectional area ratio of Al to NbTi/Cu region, and so on.

We have been investigating the maximum recovery current and the minimum propagation current. Before, we assumed the length and the duration of the initial heat were 10 mm and 1 ms, respectively. However, these factors affect the transient stability of LHD conductor. Therefore, the minimum propagation energy, which represents the minimum energy of the initial heat to propagate the normal state into the longitudinal direction of conductor, is calculated with respect to the external magnetic flux density *B*, the transport current *I*, and the length *L* and the duration t of the initial heat. These results are shown in Fig. 1. In Fig. 1 a) and b), the minimum propagation energy decreases abruptly as the external magnetic flux density or the value of transport current increases. In Fig. 1 c) and d), the minimum propagation energy is affected by the length and the duration of the initial heat. And we confirmed that the permissible length, which is the minimum length of the normal state to propagate the normal state into the longitudinal direction of conductor, exists. If the length of normal state is shorter than this permissible length, the normal state doesn't propagate into the longitudinal direction. And the permissible length doesn't change under the condition of the same transport current and the same external magnetic flux density.

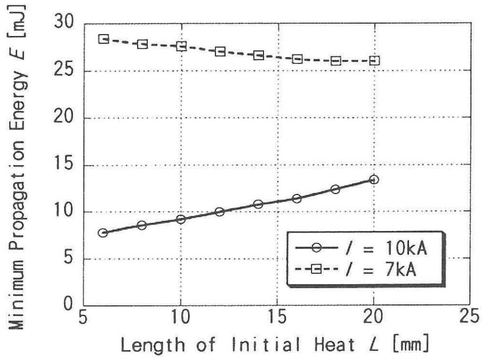
In this analysis, the heat transfer of coolant is set to the experimental data of He-I by the short sample of LHD. To increase the transport current with high transient stability, we will have to investigate the effect of the coolant condition, i.e. He-II, affects to the Minimum Propagation Energy.



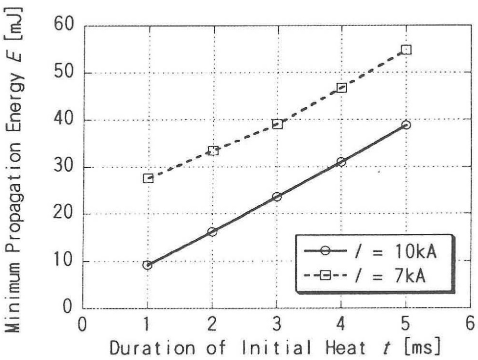
a) Minimum Propagation Energy vs. External Magnetic Flux Density.



b) Minimum Propagation Energy vs. Transport Current.



c) Minimum Propagation Energy vs. Length of Initial Heat.



d) Minimum Propagation Energy vs. Duration of Initial Heat.

Fig.1 Minimum Propagation Energy under some Conditions