

§32. Stability Test of Cable-In-Conduit Type SMES Conductor by Inductive Heating

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For large-scale superconducting magnets e.g. nuclear fusion systems or superconducting energy storages (SMES), the larger magnetic field and transport current through the superconducting cable are necessary. To design the conductor, we should evaluate the quench energy margin, in the other word its stability exactly. The index of the stability is the minimum quench energy (MQE), which is the minimum amount of the heat to trigger normal transition called 'Quench'.

For the large fusion magnet systems, the cable-in-conduit-conductors (CICC) are generally employed. CICC has a stiff conduit, which is made with stainless steel etc. and the superconducting cable is in it. Because of the conduit, it is difficult to introduce pulsive heat into the superconducting cable directly. We employed the inductive heater for the stability test [1]. Selecting the induction coil frequency ~ 300 Hz, the magnetic field penetrates through the resistive conduit and the cable is heated selectively. Before the stability test, we had calibrated the inductive heater and finally evaluated MQE of the CICC in the SMES for power system stabilization [2].

Fig. 1 shows the sample composed of two conductors. The current goes down and up through the splice in the bottom. The inductive heaters are located in the middle of the conductors. The cross-sectional view of the conductor and the specifications are presented in the figure. This sample was installed in the large conductor test facility at NIFS. The actual SMES system is cooled by forced flow supercritical Helium (SHE) at 0.6 MPa in pressure. However, this stability test was performed in the liquid helium at atmospheric pressure.

Fig. 2 presents the measured MQE vs. transport current. The results of numerical simulation code Gandalf™ are shown. The stabilities under different cooling conditions: immersed cooling by liquid helium and forced flow SHE cooling were simulated are compared. The MQE of this conductor is measured around 300mJ at the nominal current (9.6 kA) and is expected to be ~ 1 J in the nominal operation.

Minimum quench energies of the CICC in the SMES for power system stabilization were evaluated and good stability of the conductor was confirmed experimentally. The inductive heating was revealed to be valuable to evaluate the stability of the CICC.

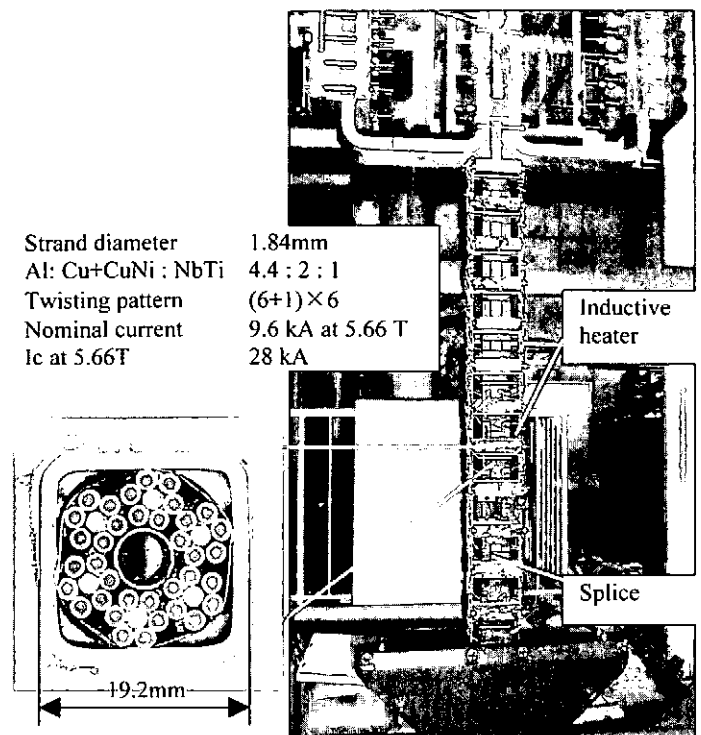


Fig. 1. Photograph of the sample. Aluminum stabilized NbTi strands are twisted into (6+1) × 6.

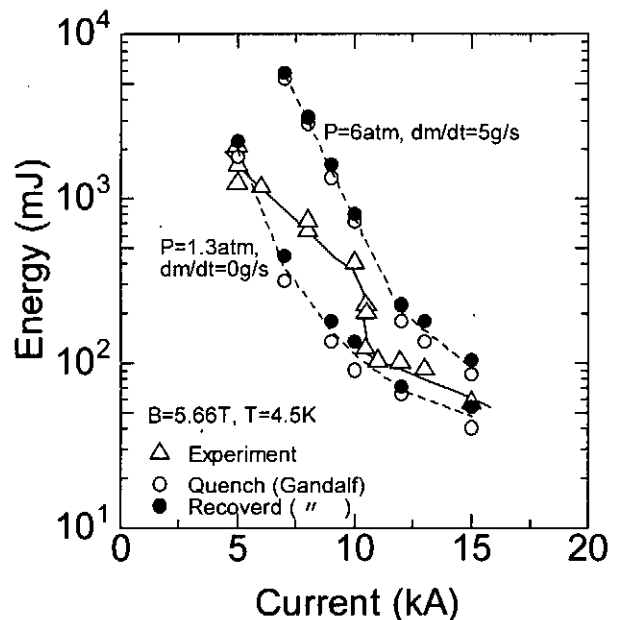


Fig. 2. MQE vs. transport current. Nominal current is 96 kA.

Reference

- 1) Seo, K., Takahata, K., Mito, T., Hayashi, H. et al., 2B-a10, Abstracts of CSJ Conference, 70 (2004) 108
- 2) Terazono, K., Hayashi, H. et al., 2B-a08, Abstracts of CSJ Conference, 70 (2004) 106