§6. Experimental Study on High Temperature Superconducting Coils Using External Jacket Configurations

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High temperature superconductors such as BSCCO and YBCO, are very promising for high field superconducting magnets. However, the mechanical stresses in these superconductors lower their critical currents. Especially, the windings of helical coils have three-dimensional complex shapes, meaning that it may be difficult to manufacture the helical windings without a decrease in the critical current. Due to this, special considerations are required for the coil manufacturing processes. The objective of this work is to investigate the feasibility of the conduction cooling method using external jacket configurations for high temperature superconducting helical windings.

Fig. 1 shows a schematic illustration of the helical winding technique using the external jacket configurations. After the copper jacket is formed into the shape of the helical winding, the YBCO conductors is wound onto the jacket in order to minimize the applied mechanical stresses during the winding process. In this configuration, the copper jacket is used as a thermal stabilizer for the quench protection, and also is used as a heat exchanger for the conduction cooling of the high temperature superconducting coil.

As a first step of this work, the authors examined the short sample test of the external jacket concept using an experimental model as shown in Fig. 2. The copper jacket model has 10 mm in width, 1 mm in thickness and 400 mm in length. In order to simulate the conduction cooling conditions, the copper jacket model is covered with the thermal insulators, and only both ends is cooling with liquid nitrogen. In this case, the interval of the cooling points is 200 mm. After the liquid nitrogen cooling, the initial temperature at the middle point of the copper jacket model was 94 K.

In order to estimate the required cross section of the copper jacket for the quench protection, the authors investigate the relationship between the cooling temperature at the middle point of the copper jacket model and the current density. From the experimental results in Fig. 3, the increase in the temperature can be controlled less than 200 K when the current density is lower than almost 30 A/mm^2. As a further step of this work, the authors is planning to demonstrate the cooling tests using YBCO tapes, and evaluate the current sharing between the YBCO tapes and the copper jackets.

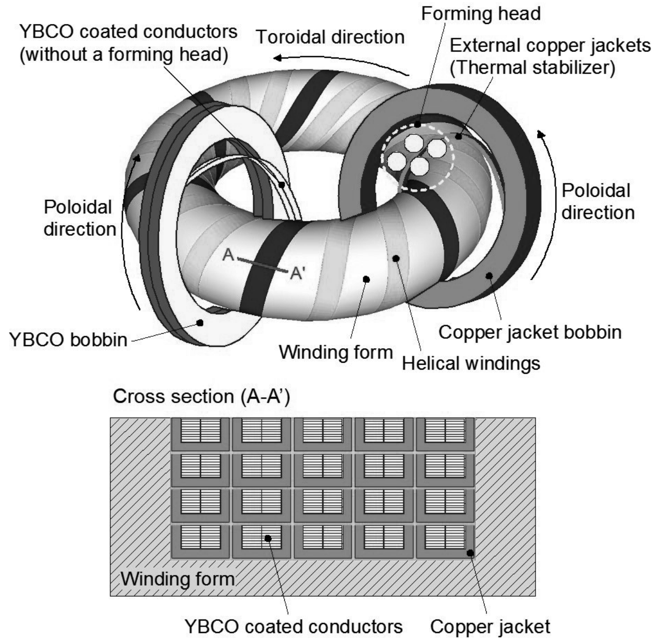

Fig. 1: Schematic illustration of the helical windings using the external jacket configurations.

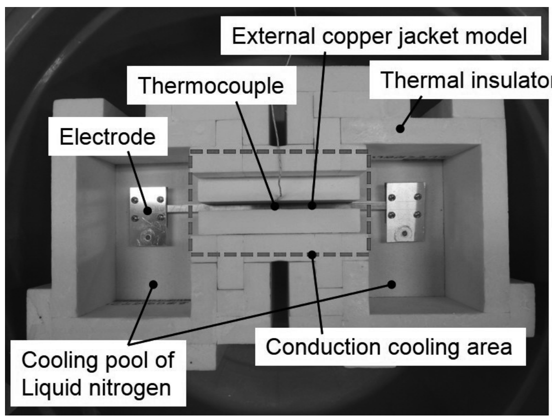

Fig. 2: Experimental setup of an external copper jacket model.

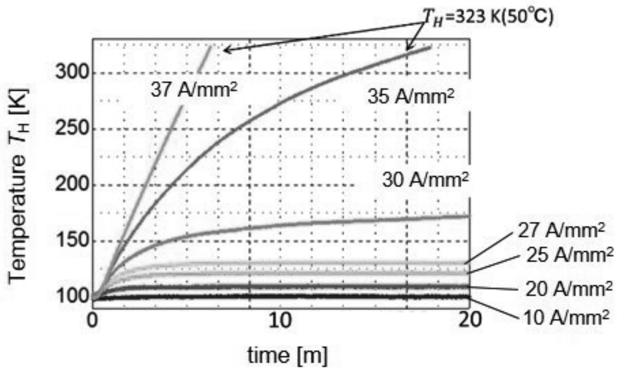

Fig. 3: Cooling temperature at the middle point of the copper jacket dependence on the current density.