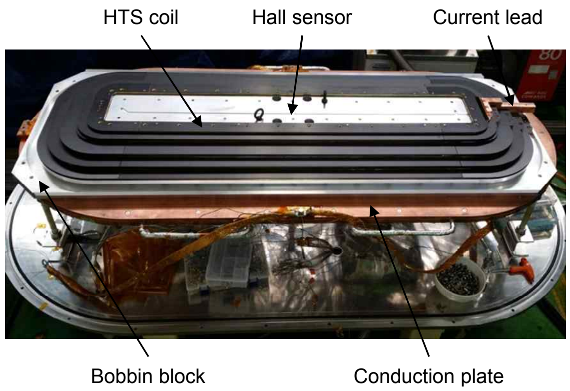
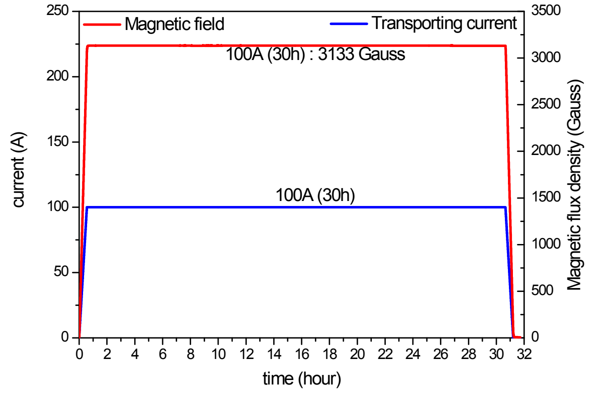
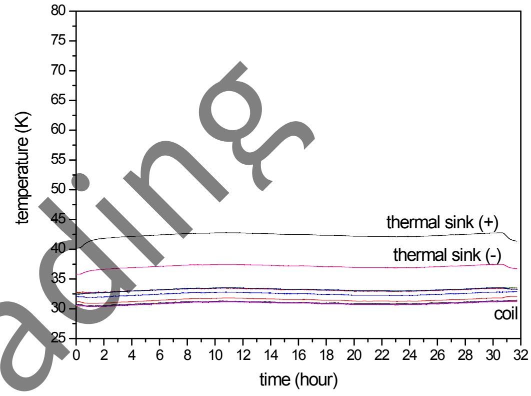


Fig. 10. Conduction cooling test rig for the assembled coil with the bobbin block



(a) Trend plot of the transporting current and magnetic field



(b) Temperature variation of the HTS coil

Fig. 12. Test results for 30 hours of current transporting

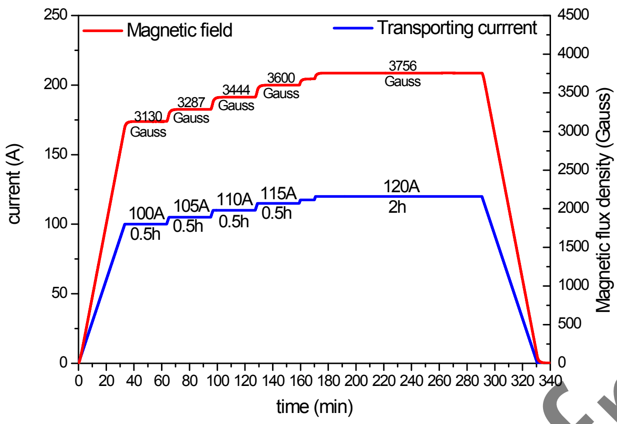


Fig. 11. Trend plot of the transporting current and magnetic field (at 30 K)

3.3 Prototype coil test

Fig. 10 shows that the eight fabricated coils are equipped with a conduction cooling test rig. The eight coils were fabricated by applying a process, which was confirmed through the fabrication and testing of large test coils; the Ic characteristics and coil integrity were confirmed individually through LN2 cooling tests. For the setup in the conduction cooling test system, an aluminum bobbin block was installed, and each coil was installed in the shape of a bobbin block embossed to match the internal shape. As shown in Fig. 10, a hall sensor was installed in the middle of the bobbin block to measure the generated magnetic field, and the magnetic field analysis value and the measured value were found to have an error of about 3.2% based on the operation current. In addition, a 120% energization and 2-hour maintenance test of the operating current was carried out, and the linear relationship with the generated magnetic field is shown in Fig. 11.

Fig. 12 shows the results of the operating current at 100% of the design value for 30 hours after energization. The test results show that the current and flux remain stable and that the temperature rises about 2.5 K higher than the initial temperature at the thermal sink of the current lead — though it stabilizes over time. As a result, it can be seen that the minute changes in the temperature are due to the change of the radiation heat invasion, which is caused by the external temperature change around the test apparatus. In other words, the temperature of the coil was judged to be completely stabilized.

4. Conclusions and Discussions

The degradation of the coils was confirmed through the small coil test. In order to solve this problem, an epoxy with an appropriate thermal expansion rate and a viscosity suitable for the process was selected and applied; it was mixed with alumina and silica as a filler. The degradation of the small and large test coils was clearly improved. The results can be summarized as follows:

It was confirmed that the proper mixing of the epoxy and mixed filler has similar properties to the thermal expansion rate of 2G HTS wire. It is expected that degradation will decrease as the difference in thermal expansion rates becomes smaller.

As the ratio of the mixed filler increases, the difference in the thermal expansion coefficient becomes smaller, but since the viscosity becomes high and it becomes unsuitable in view of workability, a proper balance between the thermal expansion coefficient and workability is needed.

The small and large test coils were fabricated by using the mixed material filler in the proper ratio, and cooling and energizing tests were performed under LN2 and 30 K conditions — through which stable results have been confirmed.

As in the case of the actual rotating machine, eight coils were stacked and subjected to the cooling energization test at 30 K. As a result, stable flux generation of up to 120% of the designed operating current was confirmed.

The laminated coil assembly was confirmed to be in a stable state by energizing and maintaining 100% current for 30 hours, and it was confirmed that the generated magnetic field was in good agreement with the results of the analysis.

From the above results, the possibility of decreasing the degradation of 2G HTS coils by applying an appropriate ratio of the mixed filler was demonstrated.

Future studies will ensure the stability of large 2G HTS coils for MW-class rotating machines.

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