AP3-3

Heat leak of cryogenic pipe for superconducting dc power transmission line

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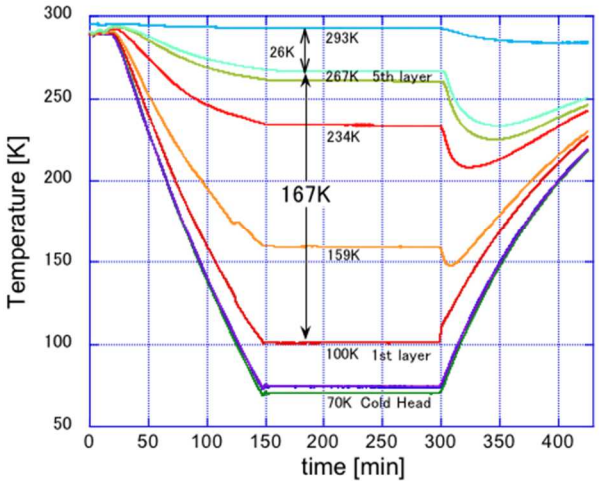
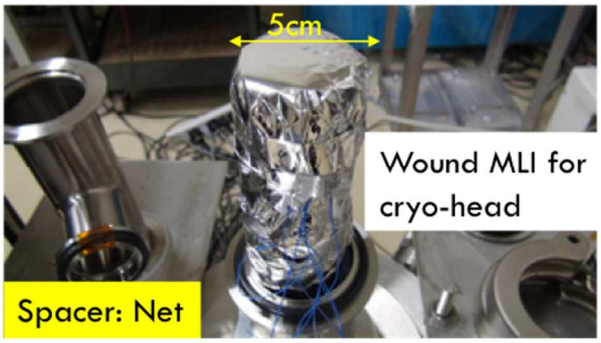
Main loss of the superconducting DC power transmission line (SCDC) comes from the heat leak of the cryogenic pipe because of no internal heat generation in the dc cable. It should be minimized to realize the high performance of SCDC. The major process of the heat leak is the heat transfer through the multi-layer insulation (MLI) and the second process is the thermal conduction of the support leg of the inner pipe. The MLI is made from the multi-layers of the aluminum-coated thin film with the spacer, and the support leg is made of the glass-fiber-reinforced plastic (G-FRP). The aluminum layer reflects the infrared light highly to reduce the heat transfer by radiation, and the spacer prevents the direct contact with the aluminum-coated thin films, and therefore it can reduce the heat transfer by the thermal conduction. Therefore, the weight of the MLI should be light to realize the thermal transfer of the spacer. We tested various types of MLI to find the optimum MLI structure. Unfortunately, computer simulation would not be effective for the MLI to estimate the heat leak. Usually, the measurement of the heat leak is not easy in an actual cryogenic pipe and we need a long time and a relatively large instrument to evaluate the heat leak. But there are several candidates of the structure of MLI. In these meanings, we could not find the optimum structure of the MLI for SCDC. To find the optimum MLI, we started to test three small samples of the MLI supplied from Kaneka Corp., and did not measure the heat leak directly, and measured the temperature of the MLI. Since the weight of the MLI is very light (several grams to ~15 gram per square meters), and therefore its heat capacity is quite low. To measure the temperature of the MLI, we used the 50-micron meters thermocouple (TC) and attached it carefully. To analyze the experimental data, we also adopt an analytical model of heat transfer [1]. This model can estimate the emissivity of the aluminum surface thermally, and its value accorded with the measurement value by the optical method. We summarize the results of the experiments and analysis, and finally, we will able to reduce the heat leaks of the cryogenic pipe to half of the Ishikari project [2].





[1] R. Byron Bird et al, Transport Phenomena, p. 447, 1960, John Willey & Sons, Inc.
[2] H. Watanabe et al, *IEEE Trans. Applied Supercond.* Vol. 27, No. 4, 5400205.

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