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Sat-Mo-Po.04-03: Thermal/electrical characteristics of ice-impregnated coils enhanced with ethanol and Zylon filler

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During the operation of rotating motors based on superconducting coils, impregnation is used to enhance the mechanical integrity against rotational vibration and to protect the superconducting coils from mechanical disturbances in strong magnetic fields. Generally, epoxy resin is primarily used for high-temperature superconducting (HTS) coil impregnation because of its low cost, excellent mechanical strength, and superior adhesion. However, its low thermal conductivity can cause thermal gradients, and the significant difference in thermal contraction between the epoxy resin and HTS coils degrades the superconducting properties. Attempting to overcome these problems, we previously proposed an ice impregnation method that exploits the expansion of water during its phase transition to ice; however, this method has limitations because of the low mechanical strength of ice. In this study, we investigated a novel ice impregnation method using ethanol and Zylon filler. This method involves mixing ethanol, a hydrophilic substance that prevents the formation of voids and cracks during the phase transition to ice, with Zylon fiber, a high-strength material with a negative thermal expansion coefficient, as a filler to provide enhanced support for HTS coils. The effect of ice impregnation with ethanol and the Zylon filler on the thermal and electrical properties of HTS coils was examined by performing cool-down tests, repetitive cooling tests, compressive tests, and charge-discharge tests.

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