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Fri-Mo-Po.09-10: Test and Analysis of Feasibility for HTS Magnet in SMES Applications Using High-frequency Switching Power Electronics Circuits

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This research investigates the feasibility of high-temperature superconductor (HTS) magnets as pivotal components for superconducting magnetic energy storage (SMES) applications, with a focus on their integration into power grids. SMES systems store energy in the magnetic field of superconducting coils, and the large current-carrying capability of HTS has shown its potential for SMES applications utilizing HTS magnets. To evaluate the potential of SMES for power grid applications, simple power electronics circuits were employed.

In simple charging/discharging test, the constructed HTS magnet demonstrated its designed inductance value. However, under AC conditions, its inductance decreased to nearly half of its original value. For no-insulation (NI) class magnets, the conventional lumped circuit model could not fully explain the frequency response at high frequencies. Therefore, a new NI lumped circuit model has been proposed to address the observed discrepancies under AC conditions. According to the proposed model, the equivalent inductance of the NI-class HTS magnet is reduced under high-frequency conditions. To address this limitation, an insulated HTS magnet was constructed and tested in subsequent experiments. Challenges encountered during its fabrication, such as wrapping insulation around the superconducting tape and creating reliable joints between tapes and pancake layers, are discussed alongside the experimental results.

Based on the lessons learned from the prototype insulated HTS magnet, a small-scale module coil was designed and constructed for further experimentation, which includes the integration of the insulated HTS magnet and the power electronics circuits. This study details the technical difficulties and experimental findings related to the insulated HTS coil. Based on these results, this research highlights the feasibility of scaling up HTS magnets for SMES applications.

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