

Design, Fabrication and Testing of a Superconducting Electrodynamic Suspension Magnet with Coated Conductor Tapes

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Abstract— Coated conductor magnet wound with coated conductor tapes, as the onboard magnet of electrodynamic suspension (EDS) train, is deemed promising due to its relatively high operating temperature, low cooling cost, and good mechanical tolerance, making the liquid-helium-free high-temperature superconducting (HTS) EDS train possible. In order to promote the progress of HTS EDS train, we designed, fabricated and tested an HTS EDS magnet. The HTS magnet is designed with the comprehensive considerations of the electromagnetic calculation, thermal-mechanical coupling analysis, as well as the heat load estimation. A radiation shield was used to reduce the heat leakage, enabling the cryogenic system to provide a better low-temperature environment for the magnet. Through a deliberate design, the magnet was fabricated, including two HTS coils and the tailored cryogenic system. It was proven that the magnet can be cooled to below 15 K; besides, the magnet has been successfully charged to 240 A. Afterwards, the electromagnetic interaction between the magnet and ground coils was investigated with both simulation and experiment. To measure the three-dimensional magnetic forces between the magnet and ground coils, a static test platform was built with an analytical-experiment coupling method. Moreover, an experimental rig was established and utilized to clarify the thermal performance of the magnet when subjected to the travelling magnetic field generated by the ground propulsion coils. The present study will provide useful implications for the design and performance evaluation of onboard HTS magnets in EDS train.

Keywords (Index Terms) — Coated Conductor, Electrodynamic Suspension (EDS), Conduction-Cooled Magnet