

Research on the Electromagnetic Characteristics of No-Insulation Coils Wound with Aluminum-stabilized Stacked Tape Cable

In the high-temperature superconducting (HTS) scheme for the detector of the Circular Electron Positron Collider (CEPC), a solenoid coil wound with aluminum-stabilized HTS stacked cables is proposed. Combining experimental and simulation methods, this paper systematically conducts research on the electromagnetic characteristics of this prototype coil. Firstly, the critical current of the coil was tested in a liquid nitrogen cryogenic environment. The results show that when the applied current is higher than the critical current, the coil can still maintain a stable operating state; at this point, the aluminum stabilizer can effectively carry part of the current, highlighting its supporting role in ensuring the operational stability of the coil. Subsequently, for coils under different axial preload conditions, current-carrying experiments were carried out at current rates of 0.1 A/s, 1 A/s, and 10 A/s respectively, and the variation laws of coil voltage response and magnetic field delay were compared and analyzed. The research indicates that the introduction of the aluminum stabilizer can significantly suppress the magnetic field delay phenomenon—a characteristic that is significantly different from that of insulation-free HTS tape coils—providing key references for the regulation of coil electromagnetic performance. In addition, a three-dimensional model of the coil was established through finite element simulation, and the influence mechanism of the inter-turn contact resistance on the coil time constant was systematically explored, further improving the theoretical analysis system for the electromagnetic properties of this type of coil. This study not only provides experimental data and theoretical support for understanding the electromagnetic behavior of solenoid coils wound with aluminum-stabilized HTS stacked cables but also plays an important foundational role in the design and optimization of the HTS scheme for the CEPC detector magnet system.

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Session Classification: Poster