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The Coil Optimization Design of H-SFCL Applied in Ship DC System

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The application scenario of Hybrid type superconducting fault current limiter (H-SFCL) is the ship DC system. Therefore, the superconducting coil works in low frequency environment. The use of iron core can effectively reduce the tapes consumption, help to reduce the end leakage magnetic field, and reduce the AC loss of the superconducting coil in operation. When designing a superconducting coil with an iron core, the design idea is divided into three parts:
1. The system parameter matching optimization algorithm is adopted to obtain the basic operating parameters of the H-SFCL.
2. Use the magnetic-circuit method to determine the basic size of the superconducting coil, use the finite element software to verify the electromagnetic design parameters and determine the final design parameters.
3. Use finite element software to simulate and analyze the operating characteristics of the superconducting coil, and verify the dynamic stability.
The main conclusions are as follows:
1. Through the optimization simulation calculation of the system, the target inductance value *L*set of the superconducting coil, the maximum operating current *I*max, the maximum uniform magnetic flux density upper limit *B*max are obtained.
2. Based on the magnetic-circuit method, the edge leakage flux coefficient is corrected, and the inductance calculation formula is obtained. The basic structural parameters of superconductivity are optimized by the combination of magnetic-circuit method and genetic algorithm. The finite element model verifies that the magnetic-circuit method has high accuracy and fast calculation speed in the optimization process.
3. Multi physics field simulation calculations are carried out through COMSOL, and the results show that the superconducting coil meets the design requirements in terms of electromagnetic, temperature and stress.

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