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Optimization of the Levitation Performance for the Fully-Superconducting Magnetic Bearing

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Superconducting flywheel energy storage system (SFESS) has the advantages of fast response, high power density, long life, unlimited charge and discharge and pollution-free. With the improvement of the mechanical properties of superconducting magnetic bearings（SMBs）, it will be a better choice for SFESS to adopt fully-superconducting bearing composed of HTS coil stator and HTS bulk rotor. Due to the high current density of the HTS tape, the magnetic field strength generated by the HTS coil could achieve several tesla, the HTS bulk rotor is subjected in strong magnetic field, which differs from the ordinary SFESS composed of electromagnetic magnet stator and HTS bulk rotor. As a result, the emphasis of this paper lies in the optimization of the levitation performance of the fully-superconducting magnetic bearing in strong magnetic field. A two-dimensional axisymmetric model of fully-superconducting magnetic bearing was established using H-formulation in the finite element software COMSOL. Both the magnetic field dependence and temperature dependence of the critical current density were adopted to better reproduce the the nonlinear electromagnetic behavior of the HTS bulk. In addition, the "fishtail effect"of the HTS bulk critical current density was also taken into consideration to study the levitation performance of the bulk rotor in strong magnetic field. Based on the aforementioned modle, the effects of the bulk rotor shape, size and working temperature were studied aiming to optimize its levitation performance. The results of this paper could serve as the design guideline of the fully-superconducting magnetic bearing.

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