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Mon-Af-Po1.15-04 [37]: Numerical Analysis of a fully HTS Magnetic Bearing Under High-speed Operation

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The superconducting magnetic bearing (SMB) has great application potential in flywheel energy storage system (FESS), because of the merits of wear-free, low-drag torque, self-stable, unlubricated and vacuum-compatible operation. A fully high-Tc superconducting (HTS) FESS with a 300 kW power has been established in Japan, 2015. The next generation MW-class FESS needs a larger weight and higher-speed rotor, therefore, the fully high-Tc SMB composed of the HTS coils and HTS bulks is the best choice. This fully SMB should have a flywheel rotor of over a ton-class weight with thousands-of-round-class per minute. Accordingly, both the mechanical and thermal stabilities of stator of HTS coils and rotor of HTS bulks are critical issues in engineering application. In the present work, a two-dimensional (2-D) finite-element model of the fully SMB based on H-formulation and a nonlinear constitutive relationship was built and calculated by finite-element method. The dynamic, electromagnetic and thermal characteristics in the rotor of HTS bulk and stator of HTS coated conductor coils were calculated and discussed systematically, when the rotor of HTS bulks operates under different speeds from hundreds to thousands of rpm. An overall picture were build to show the mechanical, electromagnetic and thermal stabilities of this SMB, especially the heat loss and speed degradation in superconductors. Based on this prognostic work, several operable rules are provided for the design and operation of SMB.

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Author: Dr YE, Changqing (Hohai University)

Co-authors: MA, Guangtong (Southwest Jiaotong University); GONG, Tianyong (Southwest Jiaotong University); YANG, Wenjiao (Southwest Jiaotong University)

Presenters: Dr YE, Changqing (Hohai University); MA, Guangtong (Southwest Jiaotong University)

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