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Numerical Modeling and Optimization of an Axial-type Synchronous Motors with Bulk HTS

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More attention is focused on high temperature superconducting (HTS) machines due to lighter weight, smaller size, higher power density and torque than conventional counterparts. An axial-type synchronous motor with Gd-123 bulk as field poles has been manufactured and tested successfully in Tokyo University of Marine Science and Technology. The rated output power of the HTS motor is 30 kW at a rotating speed of 720 min-1. Besides, it has eight HTS field poles and three-phase symmetrical copper armature windings. The performance of the prototype HTS motor is expected to be improved and optimized based on the below study.
Several axial-type synchronous motors are modeled based on the above HTS prototype, which include the bulk HTS motor model with the stator back-iron, the motor model with the permanent magnet (PM) rotor and the bulk HTS motor model with both air-core stator and rotor. The nonlinear constitutive law of the bulk HTS is included in the developed motor model through a treatment of the power law. Based on the motor models, a set of transient studies are completed, which includes the distribution of the magnetic flux, the output torque characteristics of the different type motors with the rotating speeds. In addition, we carried out and discussed the output torque of the bulk HTS motor with both air-core stator and rotor at different rotating speeds, air gap lengths, maximum excitation fields and armature coil currents. Finally, the performance of different type motors is estimated, and the optimal model and operating conditions are determined.

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