
Runze Zhu, Wei Xu, Caiyong Ye, and Xiang Li
State Key Laboratory of Advanced Electromagnetic Engineering and Technology, School of Electrical and Electronic Engineering, Huazhong University of Science and Technology, Wuhan, 430074, China

Background

Traditional heteropolar radial hybrid magnetic bearing (HRHMB) with eight poles has been widely applied in high-speed applications, such as flywheel energy storage system (FESS), because of its simple structure, low power loss, and high critical speed. However, this topology suffers large displacement stiffness, magnetic coupling, and non-negligible rotor iron loss. To overcome these drawbacks, one novel HRHMB with double-layer stator is proposed in this paper.

Objectives

- The control of X and Y dimension in the new structure are independent of each other due to the effect of permanent magnet ring.
- Performance analysis of proposed HRHMB and the comparison with the conventional one from several key indexes, including displacement stiffness, current stiffness, magnetic coupling, and power losses, etc.

Results

- Only four poles with active control coils, which means less fluctuation of magnetic field in the proposed novel HRHMB.
- The control of X and Y dimension are independent of each other in the new structure.

Conclusions

- One novel HRHMB is proposed and fully analyzed by 3-D FEM.
- The mathematical expressions are derived based on equivalent magnetic circuit model, including displacement stiffness, current stiffness and load capacity.
- Under the constraints of same outer diameter and load capacity, some key performance indices of new HRHMB are compared with those of conventional HRHMB in details.
- According to the results of comparison, it can be obtained that the displacement stiffness for novel HRHMB can be reduced to 64% from that (k = 136.36 N/μm) of the conventional HRHMB. In addition, its current stiffness can be increased to 121.9% from that (k = 179.2 N/A) of the conventional HRHMB.
- Moreover, the rotor core loss of the novel HRHMB can be decreased to 26.8% without load and 40.6% with maximum suspension force from those of the conventional HRHMB at rated speed 20,000 rpm.

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