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Electromagnetic performance comparison between heteropolar and homopolar six-pole hybrid magnetic bearings

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Due to the use of high-performance permanent magnet, hybrid magnetic bearing (HMB) has the advantages of compact structure, high levitation force density and low power consumption. In particular, the six-pole AC HMB can be driven by a three-phase inverter to generate radial two degrees of freedom (2-DOF) suspension force with low cost, symmetrical structure, good linear force current relationship. In addition, compared with the three-pole HMB, the difference of the 2-DOF maximum bearing capacity of the six-pole HMB is small and easy to control. Therefore, the six-pole AC HMB has a broad application prospects. However, there are two main structures of the six-pole AC HMB, one is to install the permanent magnets and the suspension windings together in the radial space, the other is to install the permanent magnets in the axial control, while the suspension windings is installed in the radial space, which leads to the big difference of their electromagnetic characteristics.

Therefore, under the premise of the same main parameters, this paper makes a detailed comparative study on the electromagnetic performance of the heteropolar and homopolar AC six-pole HMBs. Firstly, the structure, magnetic circuit and suspension mechanism of heteropolar and homopolar AC six-pole HMBs are analyzed. Two kinds of equivalent magnetic circuit are given, and the mathematical model of suspension force and the maximum bearing capacity are derived respectively by using equivalent magnetic circuit method. Under the condition that the parameters of the stator, rotor, winding, axial length and area ratio are identical, a three-dimensional analysis model is established to calculate the magnetic circuit, force-current relationships, maximum bearing capacity and electromagnetic loss. Finally, the electromagnetic performances of two kinds of six-pole AC HMBs are evaluated.

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