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Tue-Af-Po2.20-09 [61]: Cogging Torque Reduction in Double-Rotor Hybrid Excited Axial Switched-Flux Permanent Magnet Machine

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The double-rotor hybrid excited axial switched-flux permanent magnet (PM) (DR-HASFPM) machine is a novel hybrid excited machine with single stator and double disk-type rotors. The double rotors have same structure without PMs and windings. The stator contains 6 doubly-H-shaped cores and 6 interlaced magnetized PMs. The PMs are sandwiched between the two doubly-H-shaped cores, where the armature windings are coiled on the sandwich units. The excitation windings are wound around the middle teeth of the doubly-H-shaped cores. The machine exhibits a lot of merits such as short axial length, simple and compact structure, high power/torque density, large torque capability, and wide speed-regulation range, which has good prospect for in-wheel traction motor. However, it has relatively high cogging torque due to the doubly salient structure and high air-gap flux density. Therefore, the cogging torque reduction methods, including notching and chamfering in the stator and rotor teeth, are investigated in this paper.

The expression of the cogging torque is deduced by energy method, and the composition as well as the influence factors are analyzed. Based on 3-D finite-element method, the cogging torque reduction techniques including notching or chamfering in the stator/rotor, both notching and chamfering in the stator and rotor are investigated. Meanwhile, the influence of the dummy slot width, depth, location, shape and number, and chamfering width on the cogging torque, electromagnetic torque, especially the average output torque and torque ripple are compared and evaluated in detail.

The results indicate that the cogging torque reduction effect by notching in the rotor teeth is well, and the technique of adding two dummy slots is better than that of adding one dummy slot. Besides, the chamfering technique in both stator and rotor reduces the cogging torque and hardly affects the average torque. The combination of notching and chamfering in the rotor teeth can significantly reduce the cogging torque with negligible reduction of the average torque in the novel DR-HASFPM machine.

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