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Wed-Mo-Po3.12-01 [96]: Design of a Novel Axial Flux Rotor Consequent-Ploe Permanet Magnet Machine

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In this paper, a novel 3-phase 12/10-pole rotor-permanent magnet (PM) hybrid excited axial switched-flux (RPM-HEASF) machine is proposed and investigated, which exhibits high power/torque density, wide speed-regulation range, and good overload capability, and is interesting for electrical vehicle (EV) or hybrid EV applications.
The RPM-HEASF machine contains double-outer-stator and single-inner-rotor, and the two outer stators have same structure. The armature and excitation windings are remained in stators, while the PMs with interlaced magnetized direction are embedded in the rotor. The stator consists of 6 E-shaped modular core units, and the excitation windings are wound around the middle teeth of the stator units which provide physical and magnetic isolation between the armature windings. There are 10 sandwich units in the rotor and the sandwich unit is composed of two rotor teeth and one PM. By injecting the positive or negative DC exciting current in the excitation windings, the air-gap field can be regulated in a wide range. Hence, the hybrid excitation operation is implemented and the operation principles are investigated in detail.
Based on the flux-regulation range and output torque, the optimization design is carried out and the key dimension parameters are obtained. The main electromagnetic performance of the novel RPM-HEASF machine is investigated and analyzed by 3-D finite element method, including the magnetic field distribution, air-gap flux density, open-circuit PM flux-linkage, back-EMF, torque characteristic, as well as flux-regulation principles and capability.
The results indicate that the RPM-HEASF machine has essentially sinusoidal and symmetrical PM flux-linkage and back-EMF under PM and hybrid excitation mode, and is very suitable for brushless AC operation. Moreover, by injecting a small DC excitation current, the air-gap field can be flexibly controlled and the machine can attain a low-speed large-torque and wide-speed constant-power operation range. By placing the PMs in the rotor, the torque output capability is better while the torque ripple is smaller. Hence, the proposed RPM-HEASF machine is very attractive for EVs/HEVs application.

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