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Tue-Mo-Po2.12-11 [109]: Analysis and Optimization of Less-rare-earth Hybrid Excitation Flux-switching Machine

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Flux-switching permanent magnet (FSPM) machine is extensively investigated own to its advantages of robust motor structure, low torque ripple and high efficiency. Recently, considering the high price and unstable supply of rare-earth PM, less-rare-earth or none-rare-earth PM motors have drawn increasing attention. Due to the relatively low magnetic energy product of non-rare-earth PM, the larger volume of PM material is generally required to ensure the high torque output. However, the stator space is limited in the conventional FSPM machine, which restricts the amount of PMs and armature windings, and consequently limits the improvements of the electromagnetic performance and heat dissipation capacity.

In this paper, by integrating the special partitioned double-stator structure in the multi-excitation flux switching motor, a less-rare-earth hybrid excitation flux-switching machine (LREHE-FSM) is proposed for EV propulsion. The proposed DSHE-FSM inherits the advantage of high space utilization. The hybrid-PMs of rare-earth NdFeB and none-rare-earth ferrite are applied to reduce the consumption of rare-earth PM material while keep high torque density. The field windings around ferrite-PMs can be as supplementary electric excitation windings. Moreover, with AC and DC field windings equipped in the outer and inner stator separately, more flexible flux adjustment can be achieved and more wide effective speed range can be obtained. The demagnetizing withstand capability of ferrite-PMs can also be improved. According to the requirements at different EV driving cycles, the proposed LREHE-FSM needs to offer multiple driving modes. The electromagnetic performances including output torque, torque ripple, efficiency and flux regulation ratio are then selected as optimization targets for different driving modes. Then the proposed LREHE-FSM is optimized and compared with a conventional dual stator flux switching machine.

In order to verify the feasibility of the LREHE-FSM topology and the effectiveness of the proposed optimization, the experimental prototype is fabricated, and more theoretical analysis and experimental verification will be provided in the full text.

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