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# Tue-Mo-Po2.12-04 [102]: Analysis and Design of a New Type of Less-rare-earth Hybrid-magnet Motor with Different Rotor Topologies

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Permanent magnet (PM) machines have been a research hotspot for EV propulsion due to their merits of high power density and high reliability [1]. Recently, considering the high price and unstable supply of rare-earth PM material, the non-rare-earth PM (NRE-PM) motor has drawn increasing attention. However, the relatively low magnetic energy product of non-rare-earth PM makes it difficult to ensure the high torque output. And the large volume of PM material is generally required in the NRE-PM motor, which reduces the mechanical strength of the rotor. To realize high torque density, in this paper, a new type of less-rare-earth hybrid-magnet (LRE-HM) motor is proposed, where two types of excitation sources of non-rare-earth ferrite-PM and rare-earth NdFeB-PM are integrated into the rotor.

In the proposed LRE-HM motor, the placement of two types of PM materials is very flexible, so it can be formed in series or parallel magnetic circuit, or even mixed one. According to the further desired objectives of improved flux-weakening ability and enhanced capability of anti-demagnetization, the LRE-HM motor with different rotor topologies are designed artfully. In this LRE-HM motor, through the interaction of two kinds of PM materials, the higher operating points of hybrid PMs can be also obtained.

Compared with the NRE-PM motor, the motor performance of the proposed machine such as torque density, speed range and demagnetization withstand capability have been significantly improved. In addition, the LRE-HM motor with parallel magnetic circuit has the smaller magnetic leakage and the higher utilization rate of PM torque than those with series magnetic circuit. With the properly designed barrier, a larger d-axis inductance can be obtained and the total torque output can be further improved combining with the reluctance torque.

In order to verify the feasibility of the LRE-HM motor topology and the desirable electromagnetic performance, the experimental prototype are fabricated, and more theoretical analysis and experimental verification will be provided in the full text.

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