MT 26
International Conference
on Magnet Technology
Vancouver, Canada | 2019

Contribution ID: **746** Type: **Poster Presentation**

Tue-Mo-Po2.11-06 [92]: Research on a High Torque Density Outer Rotor Flux-Modulated Machine with Sandwiched-Permanent-Magnet Topology

Tuesday, 24 September 2019 08:45 (2 hours)

In recent years, flux-modulated principle is investigated extensively in diverse permanent magnet (PM) motors due to the prominent advantages of low-speed and large torque capability. And then, a new electrical machine family, nominated as flux-modulated PM (FMPM) motor, is formed gradually. Interestingly, the FMPM motors break through the traditional motor design rule that the pole-pairs of the stator winding and rotor are required to be the same, thus they provide new opportunities and challenges for realizing the high-performance drive motors. In current studies, the PM source designs have been regarded as the main research subject for the FMPM motors, which determine the motor performances greatly. It is worth noting that, according to the flux-modulated principle, the variation of the PM sources will result in changes on the airgap harmonics and further influence on motor performances. It means that the airgap field harmonics are actually essential bridges or deliverers in motor energy conversion, which is vital during the design analysis of the FMPM motors. Hence, it can be inferred that the establishment of relationship among the airgap harmonics, PM sources and motor performance objectives are indispensable to achieve high performances of the FMPM motors. In this paper, a sandwiched-permanent-magnet flux-modulated (SPMFM) motor with two magnet topologies are proposed, where the unique PM designs is beneficial to bring about an enhanced flux-modulated effect. So it can be indicated that the SPMFM motor possesses the potential performance features of high torque density and high PMs utilization. For achieving the optimal motor performances, the parameter design is conducted purposely by considering the leading airgap harmonics. And the key motor performances are evaluated, consisting of harmonic characteristics, back-EMF, output torque, and so on. For further verification, a prototype is manufactured and tested. Finally, the simulation analysis and experimental results validates the proposed SPMFM motor.

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Session Classification: Tue-Mo-Po2.11 - Motors V