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Tue-Mo-Po2.12-12 [110]: Design and Investigation of a Dual-Stator Flux-Modulated Permanent Magnet Motor with High Demagnetization Withstand Capability

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Recently, flux-modulated permanent magnet (FMPM) motors which based on flux-modulation principle have been extensively investigated, due to inherent high torque density at low speed. With the increasingly critical operating environments for traction machines, high-reliability operation of machines has gained much attention. Especially when traction machines operate under extreme conditions, like overload and deep flux-weakening, PMs often suffer from high irreversible demagnetization risk. Under such conditions, motor output torque capability would be reduced to some extent, which impacts the continuous high-reliability operation of motors. Yet, the current studies on FMPM motors are mainly biased on proposing novel motor topologies, and investigating the relationship among airgap harmonics and flux linkage, back-EMF, and output torque, the relationship between motor demagnetization capability is seldom involved. Hence, in order to fill the knowledge gap, the relationship between airgap harmonics and motor anti-demagnetization capability are investigated. Based on this, a dual-stator flux-modulated permanent magnet (DS-FMPM) motor with high demagnetization withstand capability is proposed and investigated.

In the investigated DS-FMPM motor, the spoke-type PMs are inserted in the middle rotor, while the middle rotor is sandwiched between the inner and outer stators. Firstly, the relationship between motor airgap harmonics and PM operation points is investigated in detail. Then, based on this, in order to improve motor anti-demagnetization capability, some key design parameters, like PM topology, are purposely designed and optimized. It is noted that, compared with the initial motor, the average PM operating points is improved from 0.18T to 0.25T, and the PM demagnetized area is about 1/3 of that of the initial motor, while the torque output capability of the investigated motor is almost the same. Hence, it not only proves the high-demagnetization capability of the investigated DS-FMPM motor, but also verifies the relationship between air-gap harmonics and motor demagnetization characteristics, which lays solid foundation for the design of high-reliability flux-modulated permanent magnet motors.

Authors: Prof. QUAN, Li (School of Electrical and Information Engineering, Jiangsu University, Zhenjiang, China); FAN, Deyang (Jiangsu University)

Presenter: FAN, Deyang (Jiangsu University)

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