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Investigation on Optimal Third-order Harmonic Shaping Method for Parallel Magnetized Surface-Mounted PM Machine

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Abstract- On the basis of the high power (MW-level) and high torque density requirements for large ship Integrated Full Electric Propulsion (IFEP) system, the optimal third-order harmonic shaping method for parallel magnetized direct-drive surface-mounted permanent magnet (SPM) machine is developed in this paper. In contrast to conventional surface-mounted magnet pole, the sinusoidal third-order harmonic shaping (Sine+3rd) method exhibits smaller cogging and output ripple torques. Meanwhile, the Sine+3rd method provides significant larger average torque or power density than that of traditional sinusoidal shaping method. However, the analytical determination of optimal third-order harmonic injection value for parallel magnetized SPM machine having “bread-loaf” magnet pole is still unknown. In addition, the finite element analysis (FEA) scanning method is very time consuming. Thus, the determination equation to obtain optimal sine+3rd value is derived and its accuracy is validated by FEA. The further investigation reveals that the average torque and power density can be increased obviously for SPM machine using optimal Sine+3rd method.

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