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Performance Improvement for double-stator permanent magnet synchronous machine using analytical subdomain model

Abstract

An analytical subdomain model is employed in this paper for predicting the magnetic field distributions in a three-phase double-stator permanent magnet synchronous machine (DS-PMSM) during open-circuit and onload conditions. Due to the stator cores are located in the outer and inner parts of the motor, the DS-PMSM construction is quite complex. The rotor magnets are positioned between these two stators. The stator inner radius, stator outer radius, slot opening, magnet arc, magnet thickness, inner and outer air-gap thickness and number of windings turns will directly influence the motor performance in DS-PMSM. The analytical subdomain model employed in this paper has a significant advantage as a rapid design tool since it is capable of precisely predicting the performance of DS-PMSM while requiring less computational effort. The analytical model was initially created using the separation of variables technique in four subdomains based on the Poisson's and Laplace's equations: inner air-gap, inner magnet, outer magnet and outer air-gap. Applying the appropriate boundary and interface conditions yields the field solutions in each subdomain. Besides, the fractional DS-PMSM with different number of slots between outer and inner stators to rotor poles can result in low cogging torque and non-overlapping winding configuration. The analytical results are validated by Finite Element Analysis (FEA). The slotted air-gap flux density, back-emf, and output torque have all been evaluated as electromagnetic performances. The results demonstrate that the suggested analytical model is capable of accurately predicting the DS-PMSM performance.

Keywords

Analytical Subdomain Model; Double-Stator; Permanent Magnet; Synchronous Machine