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Tue-Af-Po2.21-03 [67]: Equivalent magnetic circuit analysis of doubly salient permanent magnet motor with Π-shaped stator iron core segments

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Due to the advantages of simple rotor structure and ease of PMs temperature regulation, stator permanent magnet (PM) motors have been attracted more and more attention. A doubly salient PM motor with Π-shaped stator iron core segments (Π-core DSPM motor) has been proposed, of which the special operating principle was explained by the principle of magnetic field modulation and the magnetic field density was deduced based on the equivalent magnetic circuit (EMC) method. The results of the EMC method are agreed well with those of the 2-dimensional finite element method. However, in the existing paper, the quantitative calculation of key electromagnetic performances, such as flux density, no-load EMF and torque, have not been presented in detail.
In this paper, an EMC analytical method for the Π-core DSPM motor will be presented. An EMC of the Π-core DSPM motor will be established firstly according to the distribution characteristics of main magnetic flux. On this basis, the expressions of stator and rotor permeance can be determined according to its unique double salient pole structure. Then the detailed deduction and calculation process of magnetic field density will be obtained subsequently. The deduced expressions of no-load EMF and torque will also be presented one after another. A comparative analysis of the calculation results of proposed EMC method and the 2-dimensional finite element method (2D FEM) reveals that those results are in good agreement, so that the reasonability and feasibility of proposed EMC method can be verified. Compared with the finite element method, the analytical method has the advantage of easy and fast calculation, so as to save a lot of time when analyzing many motor designs with different dimensions. So the EMC method can therefore be used as a powerful tool during the motor design processes. Thus, the preliminary design of the motor will be carried out with the proposed EMC method and the experimental results will be tested to verify the proposed analytical method.

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