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Magnetothermal Coupling Analysis of Claw Pole Machine using Combined Magnetic and Thermal Network Method

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For the traditional electrical machine, both the stator and rotor core are made of silicon steel sheets, and the main magnetic fluxes are worked in the 2D plane thus the 2D electromagnetic analysis is effective for such kind of electrical machines. However, for particular electrical machines such as claw pole machine (CPM), the accuracy rate of the 2D electromagnetic analysis is not effective due to the exists of 3D magnetic flux path. Besides the electromagnetic analysis, multiphysics coupling calculation is quite of essential for the analysis of electrical machine, as the final performance is determined by the temperature rise and etc.. Finite element method(FEM) has been widely used in the electromagnetic field analysis, however FEM is time consuming especially when related to 3D analysis and multiphysics analysis.
In this paper, a magnetothermal coupled model for CPM using 3D magnetic and thermal network is established. The model is proposed mainly for quick prediction of magnetic and thermal performance of CPM and it is suitable for speeding up the CPM optimization process. The accuracy of the proposed model is verified by using 3D FEM. The 3D magnetic network model(MNM) for CPM is first established. The MNM is composed of equivalent reluctance of air gap, PM, rotor and stator core. The winding and PM excitation are equivalent to the magnetic motive forces. The magnetic field distribution and electromagnetic performances are calculated by using established MNM. Then, a thermal network model(TNM) which possess a similar structure to MNM is built. The heat sources in TNM are calculated using magnetic density results calculated by MNM. To improve accuracy, the rotating magnetization core loss in stator is calculated instead of alternating magnetization loss. Finally, the MNM and TNM are coupled. The magnetic performance and thermal distribution in CPM are obtained by the coupling model.

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