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CFD-Parametric Study in Stator Heat Transfer of an Axial Flux Permanent Magnet Machine

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Abstract : This paper copes with the numerical simulation for convective heat transfer in the stator disk of an axial flux permanent magnet (AFPM) electrical machine. Overheating is one of the main issues in the design of AFMPs, which mainly occurs in the stator disk, so that it needs to be prevented. A rotor-stator configuration with 16 magnets at the periphery of the rotor is considered. Air is allowed to flow through openings in the rotor disk and channels being formed between the magnets and in the gap region between the magnets and the stator surface. The rotating channels between the magnets act as a driving force for the air flow. The significant non-dimensional parameters are the rotational Reynolds number, the gap size ratio, the magnet thickness ratio, and the magnet angle ratio. The goal is to find correlations for the Nusselt number on the stator disk according to these non-dimensional numbers. Therefore, CFD simulations have been performed with the multiple reference frame (MRF) technique to model the rotary motion of the rotor and the flow around and inside the machine. A minimization method is introduced by a pattern-search algorithm to find the appropriate values of the reference temperature. It is found that the correlations are fast, robust and is capable of predicting the stator heat transfer with a good accuracy. The results reveal that the magnet angle ratio diminishes the stator heat transfer, whereas the rotational Reynolds number and the magnet thickness ratio improve the convective heat transfer. On the other hand, there a certain gap size ratio at which the stator heat transfer reaches a maximum.

Keywords : AFPM, CFD, magnet parameters, stator heat transfer
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