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# Influence of curved-shape magnets on the cooling performance of an axial flux permanent magnet synchronous machine

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In order to have an efficient design of an axial flux permanent magnet synchronous machine (AFPMSM), one should minimize the losses in such a device e.g., the electromagnetic losses. Generally, these losses manifest themselves as the production of heat. The operating temperature of an electrical machine can be controlled by balancing between heat generated and heat removal rate. Controlling the machine operating temperature is crucial, in order to avoid overheating. This means the maximum attainable temperature in the machine is a design constraint that limits the power density. As a consequence, it is imperative to keep the surface temperatures in the allowable range by means of a proper cooling system. The rotor disk with the magnets on it in an AFPMSM could act as radial air-channels to the circulation of the cooling flow. In order to take full advantage of this effect, the influence of the curved-shape magnets instead of the conventional permanent magnet (PM) with trapezoidal shape on the cooling flow characteristics are studied here.

In this paper, several arbitrary pairs of the rotor disk with their respective curved-shape magnets are considered as the case-study. CFD simulations are performed by means of Frozen Rotor (FR) concept to model the cooling airflow in the air-gap region of the machine. Conjugate heat transfer calculations are carried out to predict the steady state surface temperature of the rotor and the stator in the full load of the machine. The objective is to implement the comparative study to figure out the influence of the curved-shape magnets on the cooling performance of the machine. The results reveal that the use of the rotor disk with the curved-shape PMs could improve the machine performance. Moreover, defining an optimal shape of the curved-shape magnet at the rotor disk represents a trade-off problem that should be solved by finding the compromise between the thermal performance and the windage losses.