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Tue-Af-Po2.20-07 [59]: Comparative Study on A Novel Modular Multistage Axial Flux Permanent Magnet Machine with Different Core Materials

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Comparative study of a 5kW novel modular multistage axial flux permanent magnet machine (MMAFPMM) is carried out. The mentioned MMAFPMM has three rotors and two stators. The rotors and stators are arranged in axial direction alternately and the two sets of windings are independent. So there are different forms to adopt the different operating conditions. They can work in respective, series-wound, or shunt-wound form. As a key part of the machine, stator core have significant contribution to behaviors of machine such as magnetic field distribution, back electromotive force (EMF), electromagnetic torque, and core loss. In order to analyze the influence of different materials used in stator core, comparative study is carried between silicon steel, amorphous alloy, and soft magnetic composite. A 3-D finite element method (FEM) model is built and different materials are applied to analyze the mentioned MMAFPMM. No-load, full-load, magnetic field distribution, core loss, etc. are calculated. FEM result indicates that SMC and amorphous alloy have almost equal influence with silicon steel on magnetic field distribution, back EMF, and electromagnetic torque. But in aspect of core loss, difference appears between SMC, amorphous alloy, and silicon steel. Due to the high resistivity, the eddy loss of SMC is rather lower than amorphous alloy and silicon steel, but the hysteresis loss is higher due to the higher coercivity. Amorphous alloy has better electromagnetic performance than SMC, but the mechanical property limits the application to the MMAFPMM. Finally, SMC material is selected to fabricate a prototype. No-load and full-Load experiment are carried out to test the performance. An improved method using lever principle is applied to measure the cogging torque. The experimental results is consistent with the FEM results and confirms the validity of machine design.

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