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Finite Element Analysis of a Modular Brushless Wound Rotor Synchronous Machine

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Abstract : This paper presents a comparative study of different modular brushless wound rotor synchronous machine (MB-WRSM). The goal of the study is to highlight the structure which offers the best fault tolerant capability and the highest output performances. The fundamental winding factor is calculated by using the method based on EMF phasors as a significant criterion to select the preferred number of phases, stator slots, and poles. With the limited number of poles for a small machine (3.67kW/7000rpm), 15 different machines for preferred phase/slot/pole combinations are analyzed using two-dimensional (2-D) finite element method and compared according to three criteria: torque density, torque ripple and efficiency. The 7phase/7slot/6pole machine is chosen with the best compromise of high torque density, small torque ripple (3.89%) and high nominal efficiency (95%). This machine is then compared with a reference design surface permanent magnet synchronous machine (SPMSM). In conclusion, this paper provides an electromagnetic analysis of a new brushless wound-rotor synchronous machine using multiphase non-overlapping fractional slot double layer winding. The simulation results are discussed and demonstrate that the MB-WRSM presents interesting performance features, with overall performance closely matching that of an equivalent SPMSM.

Keywords : finite element method (FEM), machine performance, modular wound rotor synchronous machine, non-overlapping concentrated winding
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