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Tue-Af-Po2.20-05 [57]: A New Hybrid Excitation Synchronous Machine with Radial Combination of PM and ALA

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A permanent magnet synchronous machine (PMSM) has the advantages of simple structure, high power density and high efficiency, without the excitation winding and its loss. However, the magnetic field in PMSM is difficult to be regulated, due to its excitation by permanent magnet (PM), which leads to limited constant power speed range (CPSR) as a motor and/or confined voltage regulation capacity (VRC) as a generator. In the recent decades, the hybrid excitation synchronous machine (HESM), which combines PM with axially-laminated anisotropic (ALA) in the axial direction in the rotor, has attracted a lot of interests. It tries to take advantages of both PMSM and ALA reluctance synchronous machine (RSM), which can easily achieve wide CPSR and/or excellent VRC based on the electric excitation (EE). However, since the magnetic fields of the PM part and the ALA part are almost self-governed in the rotor with the essential magnetic barriers between the two parts for this kind of HESM, the existing axial combination of PM and ALA cannot sufficiently develop the performances of the HESM.

In this paper, a new combination structure of PM and ALA is proposed, in which PM and ALA are composed in the radial direction in the rotor. In this way, the magnetic fields of the PM part and the ALA part work both in serial and in parallel. The inductances of the direct axis and the quadrature axis of PM part are deeply influenced by the ALA part. The direct axis inductance could be much bigger than the quadrature axis inductance, which is different from the traditional PMSM. And EE can increase or decrease the magnetic field of PM according to different load conditions of applications. Moreover, some more details of the new HESM introduced in this paper, such as the design principle of the radial combination of PM and ALA and its effects on the parameters and performances of HESM, will be discussed in the full paper.

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