Contribution ID: **1129** Type: **Poster Presentation of 1h45m**

Design and analysis of an interior permanent magnet synchronous machine with multi flux barriers based on electromagnetic-mechanical coupling method

Wednesday, 30 August 2017 13:15 (1h 45m)

Interior permanent magnet synchronous machine (IPMSM) have been widely used in many areas compared with the conventional motors for their advantages, such as high torque, high power, widely variable speed range and so on. Theoretically, IPMSM can be designed with an infinite speed range for constant power operation by utilizing flux weakening control method. But practically, in order to achieve a better flux weakening capability, it usually design the rotor with multi flux barriers to extend the magnetic resistance torque and reduce permanent magnetic field, it thus may cause serious mechanical problems to the rotors because the centrifugal force is easily concentrated in thin areas of iron core at high speed operation. Therefore, the rotor design and checking of mechanical strength has become a challenging task due to the conflicting characteristics of improved electromagnetic performance and rotor mechanical strength. Currently, the electromagnetic and mechanical characteristics are often estimated individually and few researches have dealt with the coupling analysis of the two aspects. In this paper, to meet the requirements of high-speed industrial application, a new electromagnetic-mechanical coupling analysis method is proposed to comprehensively evaluate the drive performances of an interior permanent magnet synchronous machine with multi flux barriers, in which sensitivity analysis and multi-objective optimization method are adopted to confirm the optimal parameters of the machine by considering both the electromagnetic and mechanical limits. Results verify the validity of the proposed method and more detailed analysis will be shown in full paper.

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Session Classification: Wed-Af-Po3.05

Track Classification: E1 - Motors