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Minimization design of torque ripple for bearingless synchronous reluctance motor

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Bearingless synchronous reluctance motors (BSRMs) have received more and more attention in recent years. Besides some general advantages of non-friction, high critical speed and non-lubrication of bearingless motors (BMs), the BSRM have some additional characteristics of simple structure, low loss and low temperature rising. Therefore, BSRMs have wide application prospect in some special fields including aerospace, high speed drive, precision manufacturing and flywheel energy storage. At present, the conventional BSRM with salient pole rotor is easy to process and manufacture at the cost of low torque output and high torque ripple. In order to decrease the torque ripple and increase the torque output of BSRMs, a novel BSRM with improved rotor structure is proposed in this paper. Firstly, the fundamental structure and operation principle of the proposed BSRM are analyzed, based on which the mathematical models of radial suspension force and electromagnetic torque are established respectively. Secondly, on this basis, the improved rotor structure, the parameters of magnetic bridge and air gap magnetic barrier are designed with the objective of torque ripple minimization. Finally, the relationships between winding current, radial suspension force and torque are simulated and analyzed using finite element method (FEM), and the computed radial suspension force, maximum torque and average torque ripple are further compared with those of the conventional BSRM. The comparison results show that the torque ripple by utilizing this improved rotor structure deceases about 27% and the torque output increases about 23% compared with those of the conventional salient pole rotor structure, and that it further leads to more stable suspension force output.

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