Inductance matrix calculus of a non-uniform air gap motor

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Abstract

The analysis and the models of conventional polyphase induction machines are based on the uniform resulting magnetic field distribution along the air gap. That characteristic leads to a symmetric inductance matrix which cannot be extended to non-uniform air gap machines. Therefore, a variant and dynamic inductance matrix model is proposed in order to provide a more realistic model to be applied in cases which the rotor eccentricity is significant such as bearingless machine or machine vibration and noise analysis. This work is focused on the inductance calculus which means the stator and rotor self inductances, stator mutual inductances, rotor mutual inductances and the mutual inductances between windings of stator and rotor. The winding function has been used to model the air gap function because it takes into consideration the winding distribution along the air gap. In consequence of this approach, the graphics of mutual inductance between windings of stator and rotor vary vertically in function of the air gap variance. This occurs due to the average value of the winding function is zero only if the air gap is uniform. The results showed that the interactions between the stator and rotor windings provide a mutual inductance variation up to 90% by comparing the centralized rotor to a 40% variation of air gap and the self inductances of the stator windings can result in a variation up to 32% at the same conditions. The model has been used and validated in a bearingless machine problem and it has presented satisfactory outcomes, torque and speed measurements have been compared to the calculated amounts by using the proposed model.

Keywords—*Electric machine, inductance matrix, rotor eccentricity, winding function.*

Professional Biography

Jossana Ferreira holds a PhD degree in electrical machines from Federal University of Rio Grande do Norte (UFRN) and postdoctoral studies from University of Virginia. Her current research interests include electrical machine, bearingless machine, magnetic bearings and power electronics. She is a member of UFRN staff as an associate professor.



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