BQ01

Design and Parametric Analysis of Axial Flux PM Motors with Minimized Cogging Torque

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This paper deals with design, parametric analysis and experiments of an axial flux PM (AFPM) brushless dc motor with minimized cogging torque as shown in Fig. 1. An AFPM motor can be suitable to the direct drive applications such as electric motor of hybrid electric vehicle or hydrogen fuel cell vehicle, in-wheel electric motor, and wind generator [1-2]. Recently, many optimal designs for the AFPM motor have been done by finite element (FE) analysis, but the FE analysis is time-consuming work [3]. In this study, the equation of magnetic flux lines existing between PMs and core is assumed mathematically and the minimum cogging torque is calculated theoretically and geometrically without FE analysis. The form of equation is assumed to be the 2nd order polynomial in this paper and the virtual core is used to express the cogging torque in analytical model. The skew angle that makes the cogging torque minimized is calculated theoretically and the value of minimum cogging torque is compared with the results obtained by FE analysis and experiments. The maximum cogging torque of a proposed AFPM motor has the smallest value approximately at the skew angle of 4^o in both the theoretical and FE analysis as shown in Fig. 2. Compared with the unskewed motor, the cogging torque of the skewed motor can be decreased to over 90%. In this study, two types of stator cores, with the skew angle of 0^o and 4^o, are analyzed, manufactured, and tested experimentally.

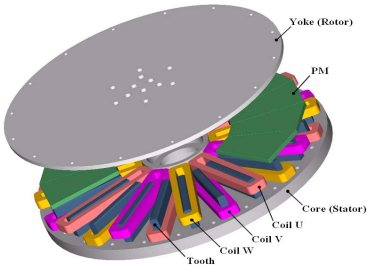

Fig. 1. Schematic design of a proposed AFPM motor.

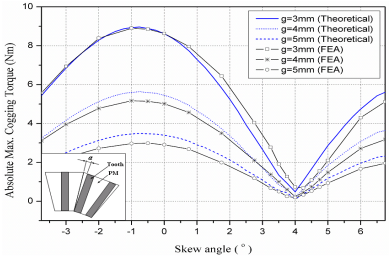

Fig. 2. Absolute maximum cogging torque according to skew angle.

REFERENCES

[1] K. Rahman, N. Patel, T. Ward, J. Nagashima, F. Caricchi, and F. Crescimbini, IEEE IAS Annual Meeting, pp. 1420−1426 (2004).
[2] B S. C. Oh, and A. Emadi, IEEE Transactions on Vehicular Technology, vol. 53, no. 3, pp. 912−919, (2004).
[3] N. Bianchi, S. Bolognani, A.D.F. Cappello, IEE Proceedings Electric Power Applications, vol. 152, no. 3, pp. 703-709, (2005).

BQ02

Minimization of Detent Force in 2 DOF PM Synchronous Motor with Screw Motion

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This paper deals with theoretical analysis, design and experiments of 2 DOF permanent magnet synchronous motor (PMSM) with rotational and linear motion on one axis. Recently, a lot of researches on PMSM with minimized detent force or cogging torque have been done by finite element (FE) analysis [1, 2]. In the study, the equation of magnetic flux lines existing between PMs and iron core is assumed mathematically and the detent force is calculated theoretically and geometrically. The detent force of linear motion is to be minimized by adjusting the distance between the rotational core and the linear core using theoretical analysis as shown in Fig. 1, and its results are to be validated by FE analysis and experiments. The proposed 2 DOF motor, as shown in Fig. 2, is designed, manufactured and then, controlled with space vector PWM method (SVPWM) in this study. The fact that rotational and linear motions are driven independently is confirmed through Fast Fourier Transform (FFT) and transient response.

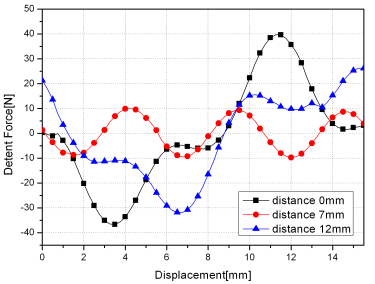

Fig. 1. Detent force according to various distances between two cores.

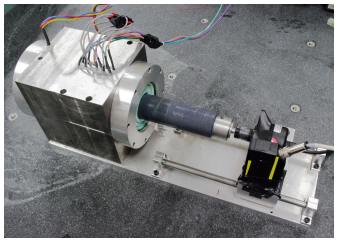

Fig. 2. Proposed 2 DOF PM synchronous motor.

REFERENCES

[1] Carl G. Jeans, Rupert J. Cruise, Charles F. Landy, IEEE International Electric Machines and Drives Conference 1999, pp. 437-439, (1999).
[2] N. Bianchi, S. Bolognani, A.D.F. Cappello, IEE Proceedings Electric Power Applications, vol. 152, no. 3, pp. 703-709, (2005).