단일치 권선을 가지는 분절회전자형 12/8SRM의 설계 및 특성해석

정광일, 이동희, 안진우

경성대학교 메카트로닉스 공학과

Design and Characteristics Analysis of Segmental Rotor Type 12/8 poles SRM with single teeth windings

Guang Il Jeong, Dong Hee Lee, Jin Woo Ahn

Dept. of Mechatronics Engineering, Kyungsung University, Busan, Korea

ABSTRACT

In this paper, a novel 12/8 segmental rotor type switched reluctance motor (SRM) is proposed. Different from conventional structures, the proposed rotor consists of a series of discrete segments, and the stator is constructed from two types of stator poles: exciting and auxiliary poles. Moreover, in this structure short flux paths are taken and no flux reverse exists in the stator. While the auxiliary poles are not wound by the windings, which only provide the flux return path. Compared with conventional 12/8 SRM, the proposed structure increases the electrical utilization of the machine and decreases the core losses, which may lead to high efficiency. To verify the proposed structure, finite element method (FEM) is employed to get static and dynamic characteristics. Finally, a prototype of the proposed motor is tested for characteristics comparisons.

Keywords Switched Reluctance Motor, segmental rotor, short flux path , high efficiency

1 INTRODUCTION

Switched Reluctance Motor (SRM) is a doubly salient and singly excited machine wherein the stator carries the wingding and the rotor is simply made of stacked silicon steel laminations. Compared with the other types of motors, an SRM has several advantages, such as: less maintenance, higher fault tolerance, rugged construction, no permanent magnet, simple structure and very wide range of speed[1 2].

Furthermore, the SRM has several outstanding characteristics, such as good reliability and lower hysteresis loss[3 4]. With these advantages, the SRM has gained more attention recently and has been treated as a good alternative for the electric motor drive application.

In contrast, the SRM possesses several disadvantages, including torque ripples, which are produced in an SRM because of its operation principle and magnetic structure. The torque ripples contribute to mechanical wear and acoustic noise. These torque ripples can be reduced, and the performance of the SRM can be improved by modifying the geometry or by using an appropriate control method[7]. The optimal control method to reduce the torque ripple is not discussed in this paper.

In this paper, a novel 12/8 segmental type SRM with short flux path and no flux reverse in the stator is proposed. Different from conventional structures, the rotor of proposed structure is constructed from a series of discrete segments and the stator is constructed from two types of stator poles: exciting and auxiliary poles, in which the segmental core is embedded in aluminum(conductive metal) rotor block in order to increase the mechanical strength and easy manufacturing as well as to improve the torque performance. Compared with conventional SRM, the proposed structure increases the electrical utilization of the machine, decreases the magneto motive force(MMF) requirements and the core losses. All the characteristics of proposed 12/8 segmental rotor type SRM are analyzed by FEM

2 DESIGN OF 12/8 SEGMENTAL ROTOR TYPE SRM

This section presents the basic principles of the novel 12/8 segmental rotor type SRM with short magnetic flux. Furthermore, the FEA analyses of the proposed motor are also presented. In order to show the advantages of the proposed motor, a comparison of torque of the conventional 12/8 and the proposed SRM is realized. Table I shows the specifications of the proposed SRM.

Table 1 Specifications of the proposed SRM

Parameters	Value	Parameters	Value
Output Power	500[W]	Average Torque	1.802[Nm]
Stator Poles	12	Rotor Poles	8
Outer Radius	52.5[mm]	Outer Radius of Rotor	28[mm]
Length of Stack	35[mm]	Air gap	0.30[mm]
Stator Pole Arc	30/12[°]	Rotor Pole Arc	41[°]

The concept of the proposed motor is based on the conventional 12/8 3 phase SRM. The 12/8 SRM employs a

long magnetic flux path, this magnetic path is related to the core loss of a motor. A short magnetic path is better than long ones to reduce mmfs. To realize a short magnetic path in the 3 phase motor, the stator rotor poles of a 12/8 motor is to be modified. The stator pole should be able to stream the magnetic flux through the shortest path, while the rotor poles should be able to drain the magnetic flux in any rotor position. The modified structure makes the conventional 12/8 SRM into a 12/8 segmental rotor type SRM with short flux path and no flux reverse in the stator. The concept of the proposed 3 phase 12/8 segmental rotor type SRM is proposed in Fig.1.
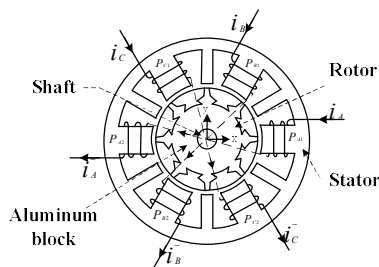

Fig. 1 Concept of proposed SRM

To verify the proposed structure, a prototype of the novel structure is designed (as shown in Table I) to compare with a conventional 12/8 SRM, which is designed for cooling fan application (12V, 500W, and 2800rpm). Fig.2 shows the torque comparison of the conventional 12/8 and proposed SRM. Both of the conventional 12/8 and proposed SRM use the same dimension and input parameters.
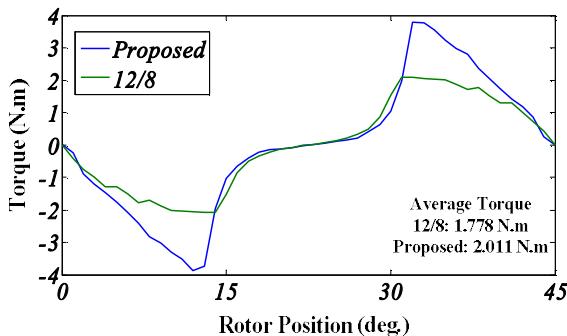

Fig. 2 Torque characteristics

As shown in Fig.2, the average torque of conventional 12/8 SRM is 1.778[Nm], while proposed one is 2.011[Nm]. The average torque of the proposed SRM is 13.1% higher than that the conventional one.

3 EXPERIMENT RESULT

Fig. 3 shows the speed torque and efficiency comparisons of the 12/8 and proposed types. From the comparison results, it can be seen that, the efficiency of the proposed motor is 80.68% that is higher than that of the conventional one at rated condition, which is 79%.The proposed structure

improves the electrical utilization of the machine and reduce the core loss, which the novelty and advantages of proposed structure.
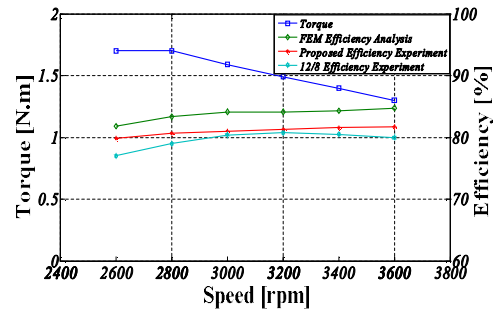

Fig. 3 Efficiency comparisons of 12/8 and proposed SRMs

4. CONCLUSION

In this paper, a novel 12/8 segmental rotor type SRM is proposed. In this structure, short flux paths are taken and no flux reversion exists in the stator. Characteristics, including static and dynamic, are analyzed. A torque comparison is also executed, which demonstrates the proposed SRM offers better performance in term of the maximum and average torque production. Further, in the experiment, the efficiency of the proposed motor is higher than that of the conventional 12/8 motor. The comparison and experimental results verify the validity of the proposed structure. More detailed experimental results and performances will be published in the future paper.

REFERENCE

[1] D. H. Lee, Z. G. Lee, J. N. Liang, J. W. Ahn, "Single phase SRM Drive with Torque Ripple Reduction and Power Factor Correction," IEEE Trans. on Industry Applications, Vol. 43, No. 6, pp. 1578 1587, Nov. Dec. 2007.

2] B.C. Mecrow, "New Winding Configurations for Doubly Salient Reluctance Machines," IEEE Trans. on Industry Applications, Vol. 32, No. 6, pp. 1348 1356, Nov. Dec. 1996.

[3] J. Oyama, T. Higuchi, T. Abe, and K. Tanaka, "The Fundamental Characteristics of Novel Switched Reluctance Motor with Segment Core Embedded in Aluminum Rotor Block," Journal of Electrical Engineering & Technology, Vol. 1, No.1, pp. 58 62, 2006.

[4] B.C. Mecrow, J.W. Finch, E.A. EI Kharashi and A.G. Jack, "Switched Reluctance Motors with Segmental Rotors," IEE Proc. of Electr. Power Appl., Vol. 149, No. 4, pp. 245 254, July 2002.