Design of Magnetizer and Rotor of Ferrite Spoke-Type PMSM for Post-Assembly Magnetization

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The post-assembly magnetization has the advantage of simplifying the manufacturing process, but it is difficult to magnetize permanent magnet by 100 percent and demagnetization of permanent magnet may occur. The performance of Spoke type PMSM is determined by ratio of magnetization. In this paper, 3 times magnetizer is introduced for post-assembly magnetization and its design is described to improve ratio of magnetization and reduce demagnetization. Finally, design of spoke-type rotor considering improvement of magnetization is carried out.

***Index Terms*— Magnetization, Spoke-type PMSM, Post-Assembly Magnetization**

I. Introduction

PERMANET Magnet should receive a magnetic field energy from outside in order for magnetization. There are individual magnetization and post-assemble magnetization. The post-assembly magnetization has the advantage of simplifying the manufacturing process, but it is difficult to magnetize permanent magnet by 100 percent and demagnetization may occur [1]-[4]. So, performance of Spoke type PMSM is determined by ratio of magnetization.

In this paper, 3 times magnetizer is introduced for post-assembly magnetization and its design is described to improve ratio of magnetization and reduce demagnetization. Finally, design of rotor considering improvement of magnetization is carried out.

II. Magnetization Yoke considering Post-Assembly Magnetization

A. *3 Times Magnetization Yoke*

To become a permanent magnet magnetized, it must be given high magnetic field intensity. In case of Ferrite permanent magnet, it is applied over 320kA/m.

Fig. 1 shows 3 times magnetizer. Magnetic flux from main pole magnetize permanent magnet and the flux from inter-pole prevents demagnetization of the permanent magnet. It magnetize the four permanent magnets per 1 times. Then it is magnetized after the rotor has rotated 144 degrees. The ten magnets are magnetized through three magnetization processes.

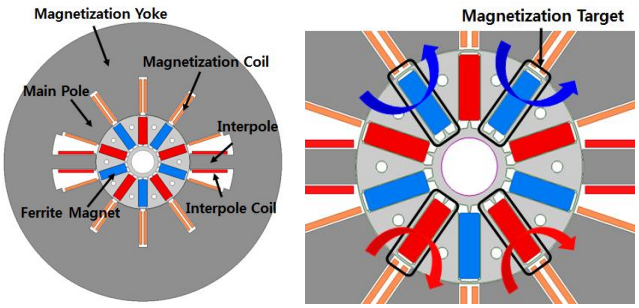


Fig. 1. 3 Times Magnetization Yoke

B. *Design of 3 Times Magnetization Yoke*

Because permanent magnet of spoke-type PMSM is placed deeply to shaft, very large magnetic field intensity is required and it is important that magnetic field intensity passes through the permanent magnet around shaft. However, very large magnetic field intensity causes to demagnetization due to leakage. Therefore, it is necessary to design for improvement of ratio of magnetization and decrease of demagnetization. In Fig. 2, red area is magnetization area (over than 320kA/m), green area is part that is not magnetized (below 320kA/m) and blue area is demagnetization area (below -280kA/m).

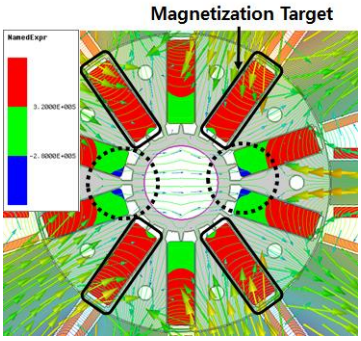
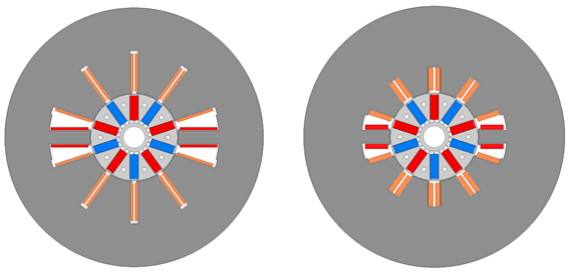


Fig. 2. Magnetization and Demagnetization of Spoke-type PMSM

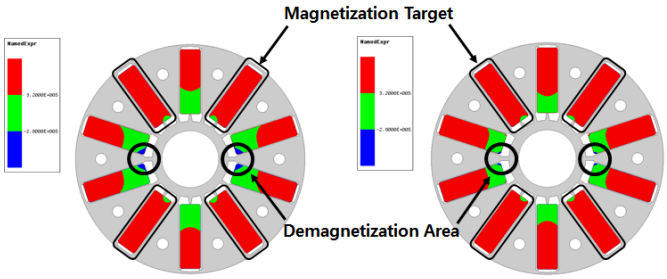
Winding method of 3 times magnetization yoke can be 1 layer or 2 layer. Fig. 3 shows the magnetization yoke according to the winding method and Fig. 4 is the results of magnetization. In Fig. 4, green area and blue area of 2 layer model is smaller than 1 layer model.

Magnetic flux density of 2 layer model (maximum 1.1T) is higher than 1 layer model but it did not become saturated in the main pole and inter-pole. Its magnetic resistance is smaller than 1 layer model because it has the shorter length of main pole and inter-pole. Because of this, although it has the same magneto-motive force, the large magnetic flux is generated. Therefore, 2 layer winding is advantageous than 1 layer winding for magnetization.



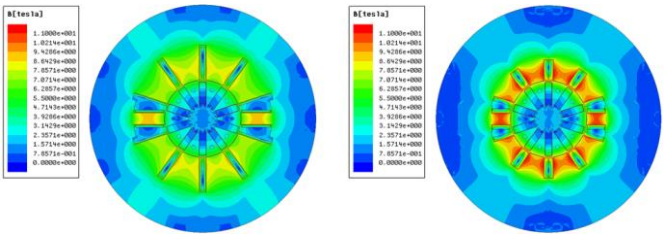
(a) 1 Layer (b) 2 Layer

Fig. 3 Winding of 3 Times Magnetization Yoke



(a) 1 Layer (b) 2 Layer

Fig. 4 Results of Magnetization



(a) 1 Layer (b) 2 Layer

Fig. 5 Magnetic Flux Density

The design of inter-pole is very important because the magnetic flux from the inter-pole serves to cancel demagnetization flux as shown in dotted circle in Fig. 6. It can be controlled by adjusting the inter-pole width. Also, if flux from inter-pole is too large, the flux of main pole can be reduced. Thus, it is designed in an optimal point.

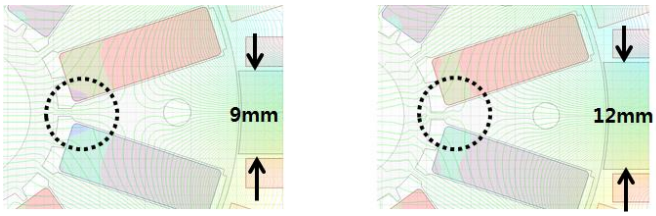
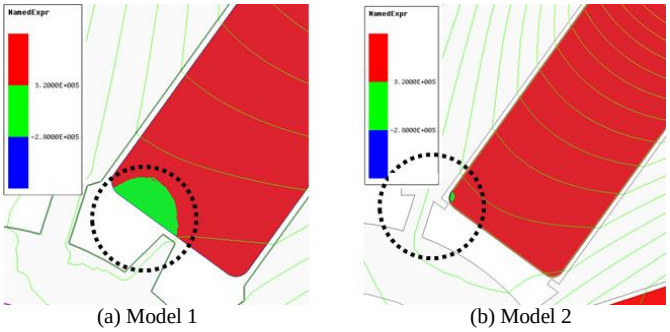


Fig. 6 Effect of interpole width

III. Design of Rotor Considering Post-Assembly Magnetization

There are two ways to support the permanent magnet in design of rotor of spoke-type PMSM as shown in Fig. 7. In Fig. 7(a), there is part that is not magnetized because structure of model 1 causes to leakage flux. Thus, it is appropriate to the design as shown in Fig. 7(b).



(a) Model 1 (b) Model 2

Fig. 7. Results of Magnetization

IV. Experiment

Fig. 8 is a rotor shape of optimized spoke-type PMSM using 3 times magnetization yoke. In the full paper, we will demonstrate the validity of design of magnetizer and rotor through experiments.

Fig. 8. Prototype of Rotor

V. Conclusion

In this paper, design of 3 times magnetizer and rotor of spoke-type PMSM is described. In order to improve the ratio of magnetization and reduce the demagnetization, winding conditions and shape of magnetizer is very important. For this reason, design parameters were selected and optimized. Also, design of rotor considering improvement of magnetization is carried out. Finally, we will demonstrate the validity of design of magnetizer and rotor through experiments.

References

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