## BQ05

# Novel Configuration of the Magnetizing Fixture for Halbach Permanent Magnet used for a Brushless Permanent-Magnet Motor

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Halbach magnetized permanent magnet brushless machines offer a number of attractive features [l]. For example, the airgap field distribution which results from the Halbach magnetization is inherently sinusoidal, which makes for negligible cogging torque and an essentially sinusoidal emf waveform, without recourse to conventional design features such as skewing of the stator/rotor, optimization of the magnet pole-arc, distributed stator windings, etc [2]. Dubois et al. studied about the effects of magnet volume and magnetizing direction on the no-load voltage in machines [3]. According to the paper [3], motor performance is maximized when the magnetizing direction is the same with the direction of a magnetic field on the magnet established only by the armature current. A distribution of the magnetic field is similar to Halbach magnetizing distribution. Therefore, motor performance can be also increased with the Halbach magnetized magnet. A configuration of Halbach magnet could be either one of using pre-magnetized segment magnets or using ring magnet magnetized in a fixture. With the former configuration, it is difficult to assemble because of high magnetic force and it cost too much. However high resultant magnetic field could be obtained. With the latter configuration, it is relatively easy to manufacture but special magnetizing fixture is needed. Figure 1 shows conventional magnetizing fixture. As shown in the picture, non-fully magnetized parts exist on the magnet. Because of the part, motor performance is decreased. In this paper, novel configuration for the magnetizing fixture is suggested to maximize utilization of the magnet. Additional coil is used for that and geometry of the fixture is changed.

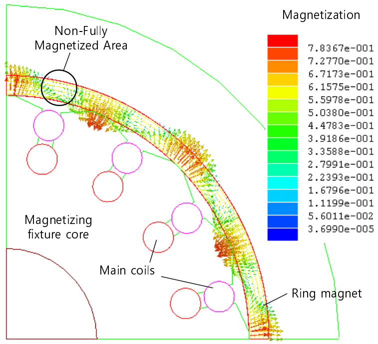


**Fig. 1.** Magnetizing fixture and magnetized manget.

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## BQ06

# A Study on Improving Torque Density and Reducing Cogging Torque of IPMSM for Washing Machines

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Nowadays the electrical machines for electric home appliances require several design points such as compact size, high torque density, high efficiency and noise reduction and so on. In this paper, inner rotor type of IPMSM is designed for washing machine to improve characteristics of the conventional outer rotor type of SPMSM and to reduce its size while the output power is the same. [1],[2] The size could be reduced by changing magnet material from Ferrite to NdFeB and designing barrier to improve flux utilization. It is choosing that the magnet length and position of magnet and barrier as design parameters to increase torque density and to reduce size and cogging torque while other characteristics remains the same. FEA and Taguchi methods are used for optimization. There are two kinds of operation mode for washing machines. One is washing mode: it requires 20 [Nm] at speed of 45 [rpm] and output power is 95[w]. Second is spin mode: it requires 5[Nm] at speed of 1500 [rpm] and output power is 790[w]. It has very wide range of CPSR (Constant Power Speed Range) therefore it is very important to choose the base speed of the motor and it must satisfy both the requirements at the same time. Considering all requirements mentioned above and given condition such as DC link voltage and so on, motor prototype is designed having 8-pole, 12-slot and 400 [rpm] as base speed and 840[w] as output power and its size is reduced 22%. To demonstrate the validity of the proposed method the optimized IPMSM was manufactured and its performance of the power factor, efficiency, back-emf and cogging torque were measured. Fig. 1 shows the torque characteristics of optimal model and convenient model.

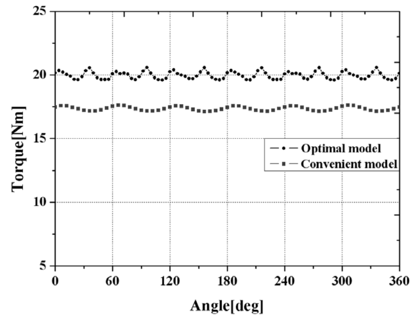


**Fig. 1.** Torque characteristics of optimal model and convenient model.

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