Study on Irreversible Demagnetization Characteristics according to rotor-teeth of SPMSM by means of MEC

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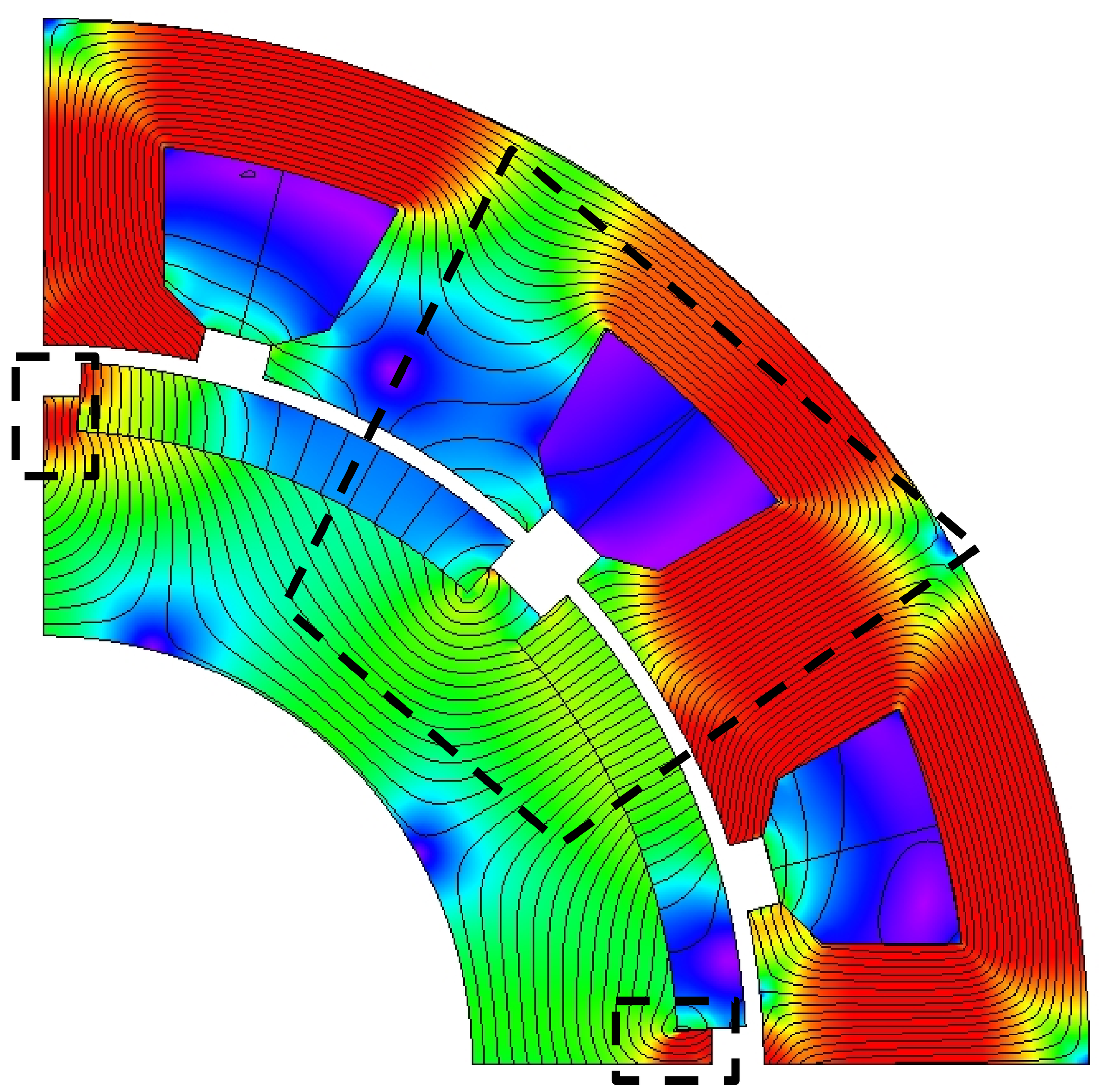
Introduction

- In case of Surface-mounted Permanent Magnet Synchronous Motor(SPMSM), PMs are attached to the surface. However, in order to withstand rotation of the motor, thousands of revolutions per minute, rotor-teeth between PMs are essential to hold them strongly in position.
- The rotor-teeth are also ferromagnetic material, they would be additional paths of magnetic flux. It can reduces a risk of irreversible demagnetization on edge of PMs. It could be shown as trade-off relation, according to performance.
- In this paper, relations between variables and effects are determined by means of analytical method. Then the finding data by proposed method are compared with them of numerical method and verify that the technique is reasonable.

Analysis

- When high level current applied to coil, relatively large MMF is induced and the permanent magnets are in danger about irreversible demagnetization. It cause a performance deterioration of motor, so it is essential to examine whether it is or not.
- Motor core has nonlinear characteristic which ferromagnetic materials have. It belong to saturation level in terms of magnetic density. Therefore, it should be considered in magnetic equivalent circuit for increasing accuracy.
- In each part possible to be saturated is composed of variable permeability based on B-μ curve. And, it is the same for the rotor teeth.

Motor Specification



Parameter		Unit	Value
Number of Pole / Slot		-	8 / 12
Stator Inner / Outer Diameter		*mm*	84.0 / 122.0
Rotor Inner / Outer Diameter		*mm*	50.0 / 82.0
Stack Length		*mm*	88.0
Air-gap Length		*mm*	1.0
Speed	Operating point	*rpm*	3,000 (85℃)
Magnet Br / Hc @ 85℃		T / A/m	1.22 / -920*k*

Equations

$$Kc = \left\{1 - \frac{1}{\frac{\tau}{w}\left(5 \cdot \frac{g}{w} + 1\right)}\right\}^{-1}$$

$$R_R = \left\{\frac{\pi}{u \cdot L} \cdot \ln\left(1 + \frac{\pi}{w} r\right)\right\}^{-1}$$

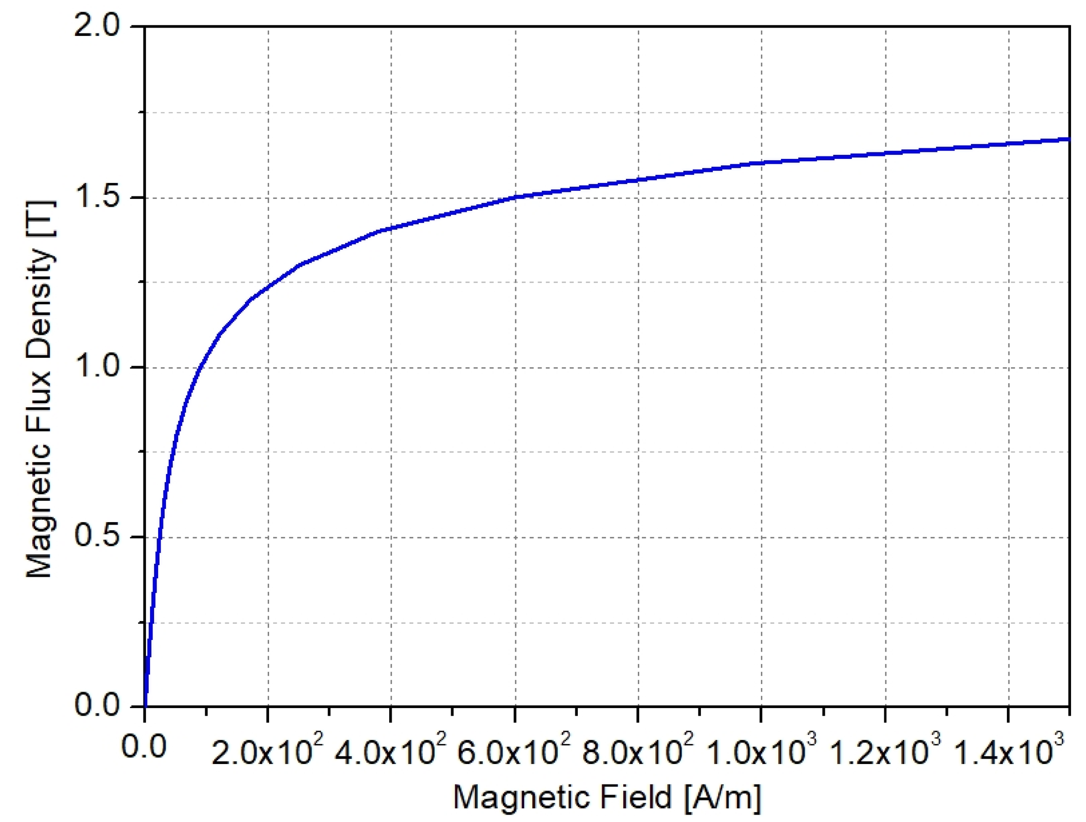
$$R_{MT} = \left\{u_0 \cdot \frac{L}{\pi} \cdot \ln\left(1 + \frac{\pi \cdot g_e}{gap}\right)\right\}^{-1}$$

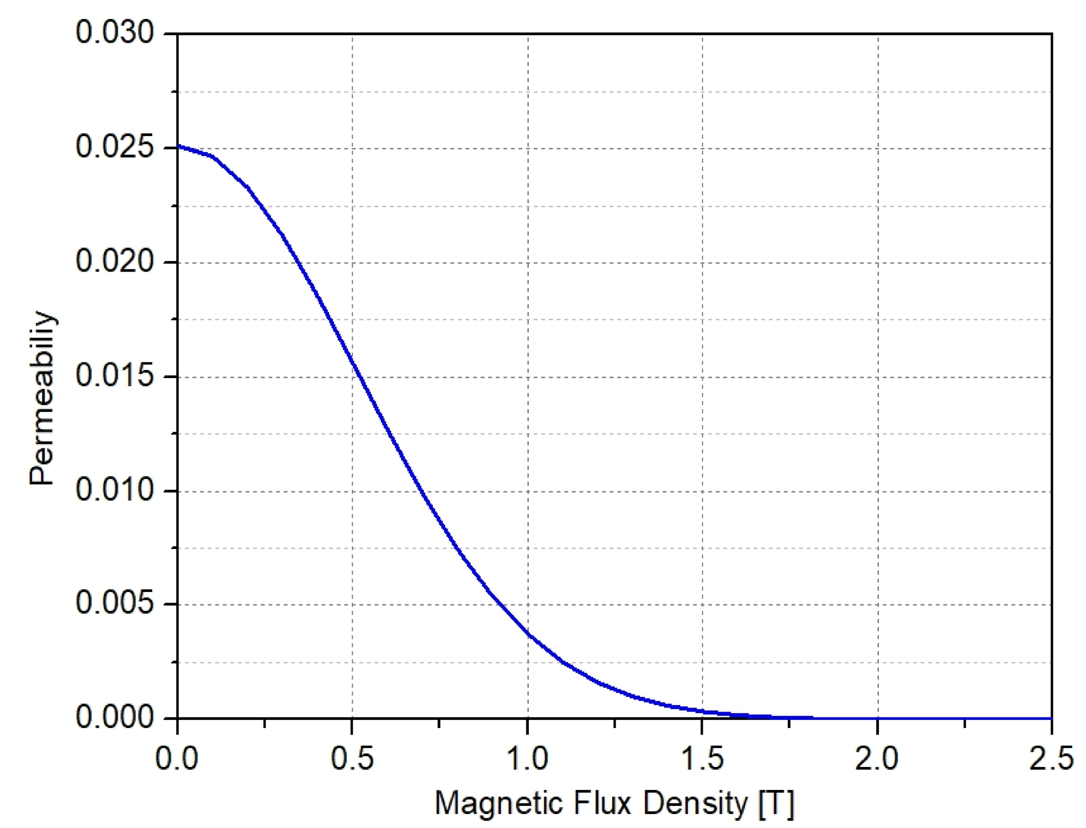
$$u(B) = b \cdot e^{a \cdot B^2}$$

$$H(B) = \int \frac{1}{u(B)}\, dB = \frac{\sqrt{\pi}\ \mathrm{erf}\left(\sqrt{a} \cdot B\right)}{2b\sqrt{a}}$$

- From reference

H-B and B-μ curve





Magnetic Equivalent Circuit