

MIDDLE EAST TECHNICAL UNIVERSITY

DEPARTMENT OF

ELECTRICAL AND ELECTRONICS

ENGINEERING

EE568 - Special Topics on Electrical Machines

Project #3

PM Motor Comparison Analysis

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# Introduction

In this assignment, several surface-mount PM machines are designed and compared. All machines have constant parameters as given below.

* Number of phases: 3
* Number of poles: 4
* Motor Axial Length: 100 mm
* Air-gap clearance: 1 mm
* Magnet to Pole Pitch Ratio: 0.8

# Magnetic Loading

In this part, a surface-mount PM machine with NdFeB magnet with following parameters and constant parameters given in introduction section is designed. For one pole-pair equivalent magnetic circuit is drawn. By using machine parameters, reluctances of magnet and air gap are calculated. After that, operating magnetic flux density is calculated and load line of magnet is drawn. On this load line operating point of magnet is given. For this operating point, magnetic loading of this machine is calculated. Finally, air gap flux density is obtained by using FEA. FEA result is compared with the analytical result and some comments on this comparison are given.

* Magnet Type: NdFeB N42 grade (=1.05), radial shaped
* Rotor Diameter: 100 mm
* Magnet Radial Thickness: 4 mm

The equivalent magnetic circuit for one pole-pair is given in Figure 1.

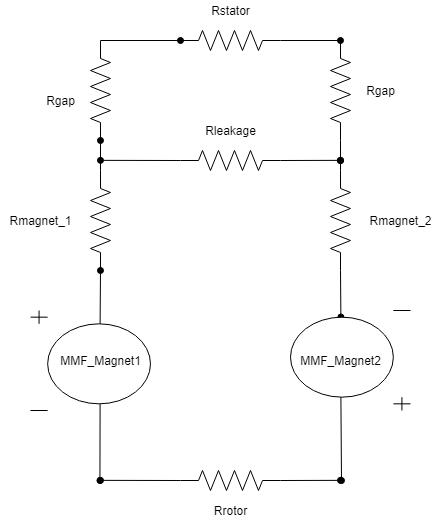


Figure 1. Equivalent magnetic circuit for one pole-pair

Area of magnet, is given as,

(1)

where, Di: rotor diamater

L: axial length of the motor

p: number of poles

Then, reluctances of magnet and airgap are given as,

(2)

(3)

MMF of magnet is calculated as,

(4)

(5)

where,

(6)

if we ignore leakage flux and assume that rotor and stator are infinitely permeable.

+ (7)

By substituting (6) and (7) into equation (5)

is obtained as,

.387 \* (Weber) (8)

Magnetic flux density is calculated as,

(9)

(10)

where, : residual flux density of N42 NdFeB material which is 1.28

In Fig. 2, load line and operating point of N42 NdFeB is given. As can be seen from appendix A, the residual magnetic flux density is 1.28 and intrisintic coercive force is -955 for N42 NdFeB material. At the operating point, is calculated as in equation (9) and is calculated as -201.59in equation (10).

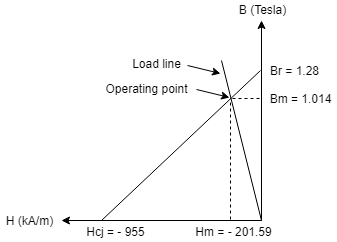


Figure 2. Load line and operating point on B-H curve of N42 NdFeB material

The magnetic loading of the machine is given as,

# Electrical Loading and Machine Sizing

## 20-pole and 24-slot Machine

## 20-pole and 30-slot Machine

## Comment and comparison of machines:

# Comparison and Optimization