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Project 3

EE568

1)Introduction

2)

2.1)

In this part, magnetic loading of the machine with the parameters given in Table 1 will be examined.

|  |  |
| --- | --- |
| **Parameters** | **Value** |
| Number of phases | 3 |
| Number of poles | 4 |
| Motor axial length (mm) | 100 |
| Air-gap clearance (mm) | 1 |
| Magnet to pole pitch ratio | 0.8 |
| Magnet type | NdFeB (N42) |
| Rotor diameter (mm) | 100 |
| Magnet thickness (mm) | 4 |
| Remanent flux of the magnet (Br) | 1.28 |
| Relevant coercivity of the magnet (µr) | 1.05 |

Table 1: Machine parameters

By using the equivalent magnetic circuit given in Figure 1 is used to find magnetic field in the air gap,

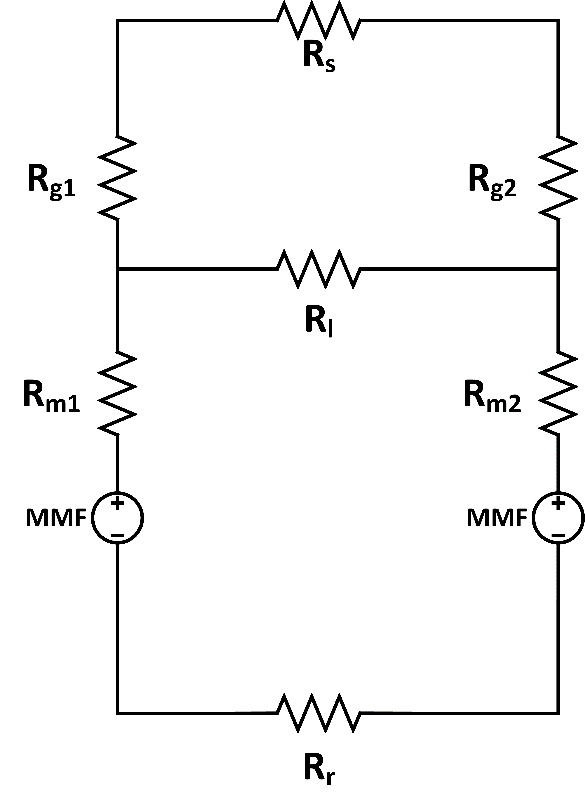


Figure 1: Equivalent magnetic circuit of the machine

Where Rs, Rr, Rl, Rg and Rm are reluctances of stator, rotor, leakage, air-gap and magnets, respectively. In this case, Rs, Rr and Rl are ignored. As a further step, MMF and reluctances of air-gap and magnets are calculated. For this purpose, area of magnet and airgap should be calculated initially.

=0.0063 m2 (1)

Then, by using general reluctance equation, reluctances can be found easily as follows.

(2)

(3)

Finally, MMF is calculated as follows:

(4)

Then, by using equivalent magnetic circuit of the machine and variables that are calculated above, magnetic flux density of the machine can be calculated as follows:

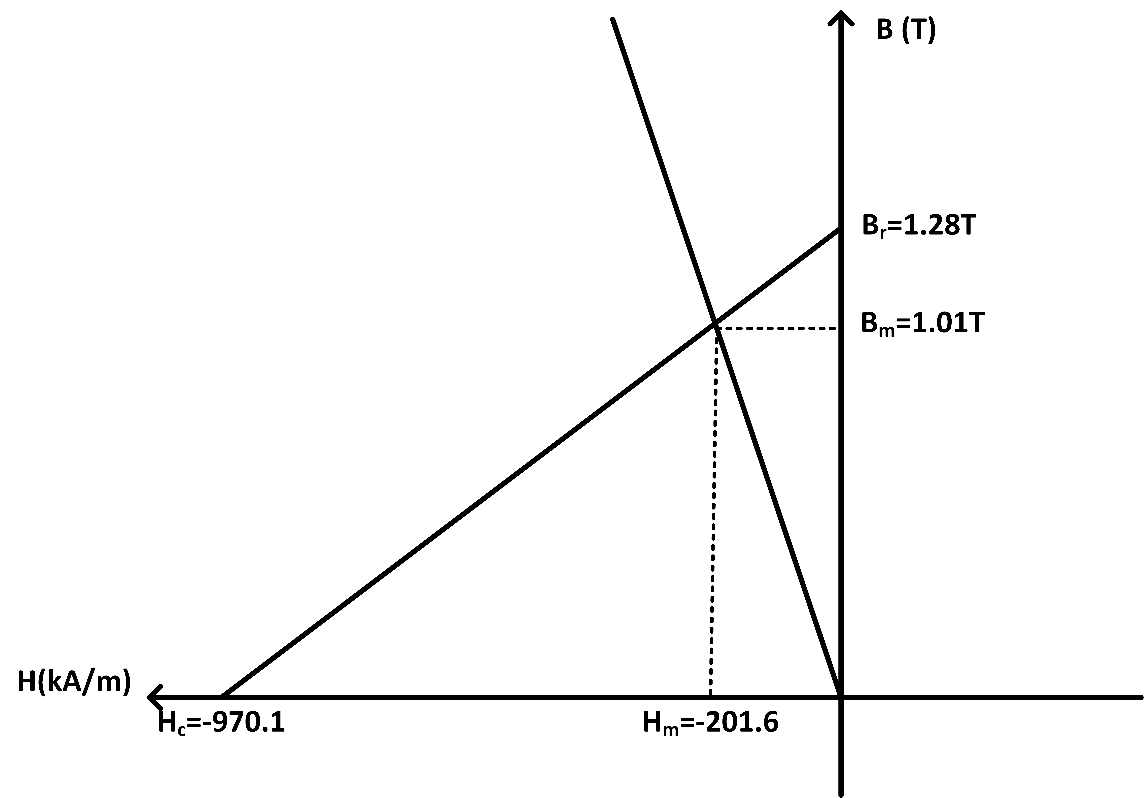


Figure 2: Load line and operating point on the B-H curve

2.2)

Magnetic loading of the machine can be calculated as follows:

(5)

2.3)

In this part, FEA validation of above parts is performed. FEA draw of the machine is given in Figure 2 and results are given in Figure 3.

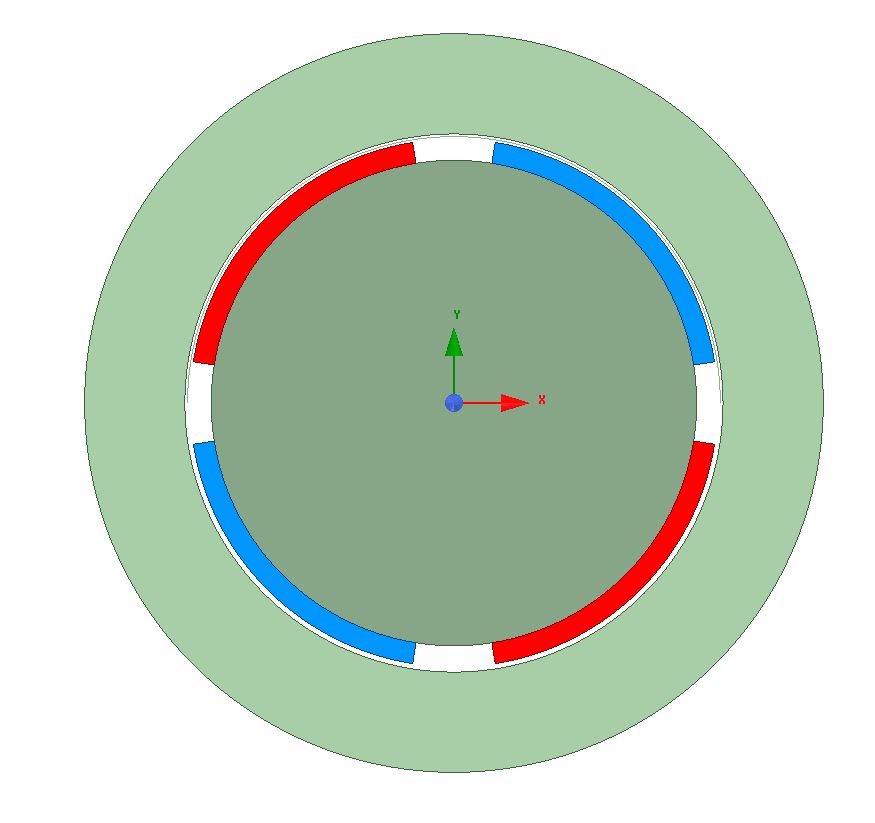


Figure 2: 2D FEA draw of the machine

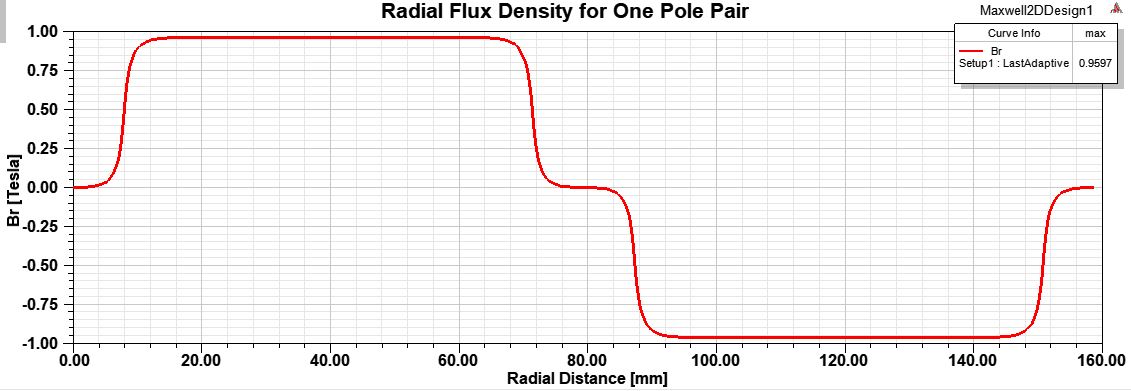


Figure 3: 2D FEA results of air gap flux density at r=(Ri+air-gap/2)

Analytical results and numerical results are close to each other but they are not equal to each other. While analytical calculations are performed, leakage flux can not be modelled and taken into consideration. However, numerical results includes leakage flux and this result is slightly smaller than analytical result.

3)

3.1)

In this part, slot number of the machine is chosen. In this case, q is taken one due to higher winding factor and the corresponding slot number is 12.

3.2)

In this part, wire diameter should be chosen. For this, the restriction is maximum current density (J) in the coil and it is 5 A/mm2. Also, coil current (I) for this machine is 2.5 Ampere. Then, minimum coil area can be calculated as follows:

=0.5 mm2 (6)

So, the wire diameter is chosen larger than that value in order to make sure that maximum current density in the coil is smaller than 5 A/mm2. Furthermore, minimum value for coil area is chosen in order to avoid Eddy currents in the coils (in this step, the frequency of the machine is not known, thus minimum coil area is acceptable. If frequency is known and larger areas are acceptable, it can be discussed later). Then, AWG20 cable is chosen with 0.518 mm2  coil area.