EE568 - Selected Topics on Electrical Machines

Project - 3

PM Motor Comparison Analysis

Özgür Yazıcı

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# Introduction

fhgjgj

# Magnetic Loading

## Magnet operating point

Magnetic equivalent circuit for single pole pair is shown in figure 1.



Figure 1 Magnetic equivalent circuit for single pole pair

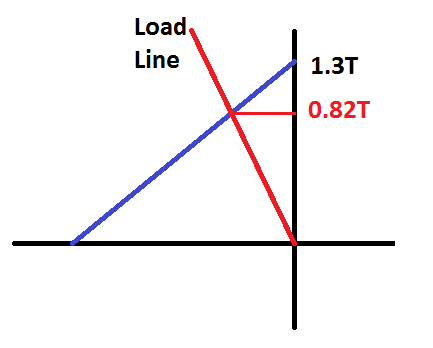


Figure 2 Load line and operating point of magnet

## Magnetic Loading

Magnetic loading means average air gap flux density. It was found in the first part as **0.82T**. This is high for a standard machine. Normally magnetic loading is around 0.6T. This is caused because of assuming the stator solid and taking the gap only 1mm. In reality effective value of air gap length is larger than this value. So magnetic loading should be smaller with a slotted stator.

## Air Gap flux Density Distribution

In this part magnetic circuit is modelled with FEA tool. Model is shown in figure 3. After that, air gap flux density distribution is calculated and plotted in figure 4.

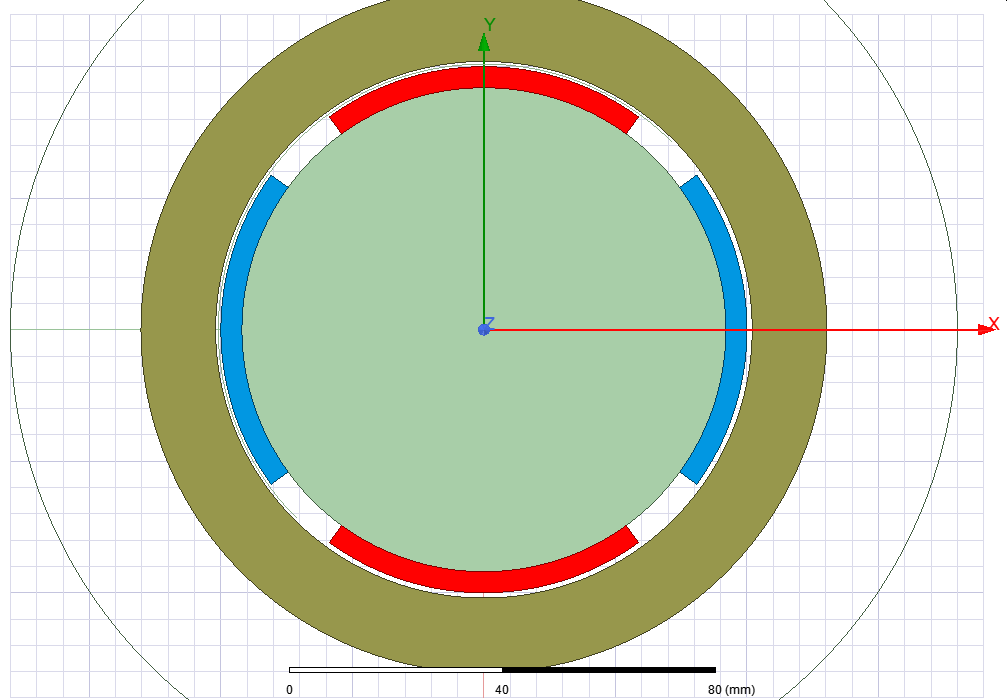


Figure 3 FEA Model

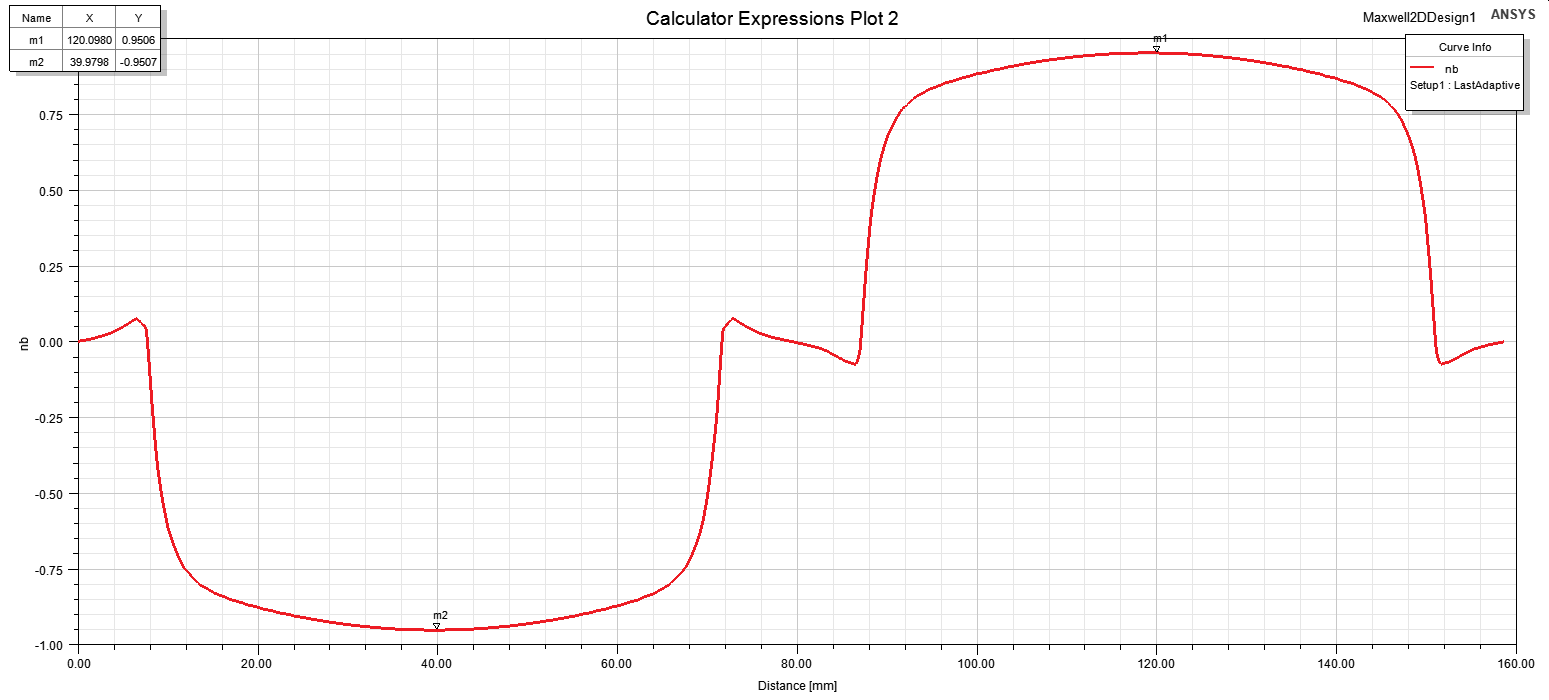


Figure 4 Air gap flux densith distribution

|  |  |  |
| --- | --- | --- |
|  | Avg Flux Density | Peak Flux Density |
| Analytical Result | 0.82 T | 1.29 T |
| FEA Result | 0.68 T | 0.95 T |

# Electrical Loading and Machine Sizing

## Number of slots

When choosing number of slots, both electrical and mechanical disadvantages should be considered. Winding factor should be as high as possible and teeth size should not be too small or large. Because of that 12 slot stator is used for design.

When **12 slots full pitch** is used, winding factor is maximized and slot pitch is 26mm which is usable.

## Suitable Wire

Current is 2.5A and current density is 5A/ so wire cross section needs to be 0.5 . Checking from awg wire catalog**, 20 awg wire can be used with 0.52** area.

## Slot Height, Number of Coils, Back Core Thickness

According to lecture notes, for a 4 pole machine

In our case inner diameter is 100mm so **outer diameter can be 188mm.**

Now back-core thickness should be found. Half of flux per pole goes through back-core and flux density should be around 1.4T.

From the first part;

Back-core flux =

Back-core flux /1.4T/0.1m = **23mm back-core**

Stator starts from 102mm and goes to 188mm

43mm thickness and 23mm back-core

So **teeth length is 20mm**

Lastly, number of turns per slot will be calculated.

# Conclusion

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