

Stator Modelling Part 2

by Nathan Davies

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Stator Modelling Part 2

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Module: Electrical Machines

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Abstract

The premise of this report was to create varies different model related to the previous model that was created in the last report and try to make them more efficient then the original model. This task was completed with two models having less flux leakage that the original model. Other models where created as test to see how high the flux leakage could go and to generally get use to creating models and collecting data from them.

Introduction

The aim of this assignment is to create varies redesigned models of the previous model used in the last report to determine how to improve the efficiency of the model. The way that this will be done is by changing specific areas of the design then observing and recording the data that these model produce. This data will then be compared to the data from the original model to see how the efficiency of the overall model has changed.

Method

There were a lot of changes that could have been made to the model to test the efficiency of it. Some of them including changing the stator inner radius, armature dimensions, winding positions and adding fish tails on to the armatures. During the testing the design of the models was somewhat random meaning that some models might just have slight differences between them.

The first thing that was done at the start of this experiment was to first acquire the model from the previous model this can be seen in figure 1. After this the variety of changes listed above where introduced to the model this being changing the armature dimensions, radius etc.

As each of these new models where created data was collected from them, this was done in the same way as the previous report by first creating a mesh for the model then using the in program calculations to calculate the flux density. The countour tool was again using on the gap of the armature to get the total flux within the model and then used across the middle to simulate the rotor so that data could be acquired. A few of the new models created can be found in figures 2 – 3 bellow.



Figure 1 Original model design

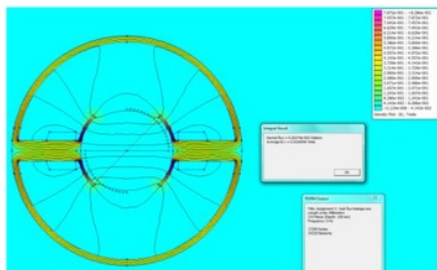


Figure 2 One of the newly created models

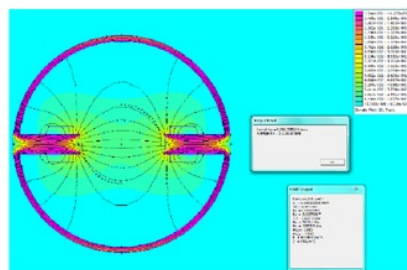


Figure 3 Another newly created model

Results

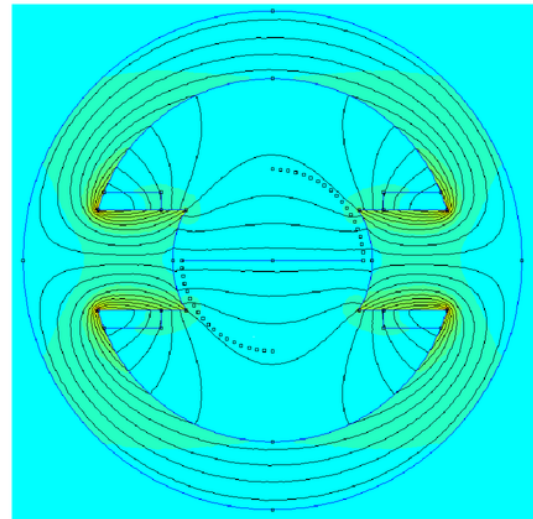
In this section will be a variety of tables and screenshots with the results of testing each of the newly created models a discussion of the results and comparison of them will be given in the following section.

Original Model

Total flux	
Flux being created in the stator circuit	
flux across gap	average B.n
0.000255409	0.116095

Useful flux	
Flux cutting the rotor coil	
Normal Flux	Average B.n
8.65771E-05	0.0216443
8.66787E-05	0.0216696
8.69308E-05	0.0217329
8.73573E-05	0.0218391
8.79309E-05	0.0219827
8.85461E-05	0.0221368
8.91642E-05	0.0222906
8.96325E-05	0.0224082
8.97591E-05	0.0224347
8.90727E-05	0.0222684
8.70025E-05	0.0217504
8.21566E-05	0.0205389
7.18051E-05	0.0179509
5.72388E-05	0.0143099
4.35416E-05	0.0108854
3.14804E-05	0.00786996
2.04825E-05	0.00512065
1.00879E-05	0.00252197
-1.52959E-08	-3.82E-06

Flux leakage
2.950E+00
2.947E+00
2.938E+00
2.924E+00
2.905E+00
2.884E+00
2.864E+00
2.850E+00
2.845E+00
2.867E+00
2.936E+00
3.109E+00
3.557E+00
4.462E+00
5.866E+00
8.113E+00
1.247E+01
2.532E+01
-1.670E+04



Model 1

Total flux	
Flux being created in the stator circuit	
flux across gap	average B.n
0.000136861	0.136861

Useful flux	
Flux cutting the rotor coil	
Normal Flux	Average B.n
6.22E-05	0.0155394
6.22E-05	0.015559
6.24E-05	0.0155909
6.26E-05	0.01564
6.28E-05	0.0156914
6.31E-05	0.0157769
6.34E-05	0.0158406
6.37E-05	0.0159144
6.39E-05	0.015975
6.41E-05	0.0160281
6.39E-05	0.0159831
6.35E-05	0.0158711
6.22E-05	0.0155416
5.97E-05	0.0149218
5.48E-05	0.0137121
4.55E-05	0.0113812
3.07E-05	0.00767687
1.49E-05	0.00373532
9.36E-08	2.34E-05

Flux leakage
4.54E-01
4.55E-01
4.56E-01
4.57E-01
4.59E-01
4.61E-01
4.63E-01
4.65E-01
4.67E-01
4.68E-01
4.67E-01
4.64E-01
4.54E-01
4.36E-01
4.01E-01
3.33E-01
2.24E-01
1.09E-01
6.84E-04

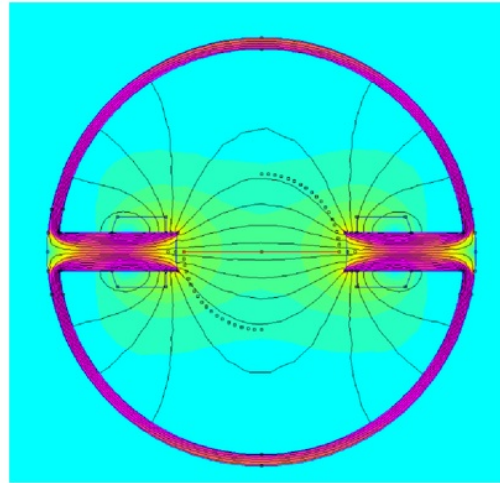


Figure 4 Model 1 – thinner armatures, larger inner radius

Model 2

Total flux	
Flux being created in the stator circuit	
flux across gap	average B.n
0.000251794	0.114452

Useful flux	
Flux cutting the rotor coil	
Normal Flux	Average B.n
8.40E-05	0.0209883
8.40E-05	0.021005
8.43E-05	0.0210699
8.47E-05	0.0211715
8.52E-05	0.0213008
8.58E-05	0.0214498
8.63E-05	0.021577
8.67E-05	0.0216758
8.67E-05	0.0216689
8.59E-05	0.0214656
8.35E-05	0.0208861
7.83E-05	0.0195775
6.76E-05	0.0168939
5.30E-05	0.0132532
3.99E-05	0.00997838
2.87E-05	0.00717039
1.86E-05	0.00464633
9.16E-06	0.0022892
1.05E-08	2.63E-06

Flux leakage
3.33E-01
3.34E-01
3.35E-01
3.36E-01
3.38E-01
3.41E-01
3.43E-01
3.44E-01
3.44E-01
3.41E-01
3.32E-01
3.11E-01
2.68E-01
2.11E-01
1.59E-01
1.14E-01
7.38E-02
3.64E-02
4.17E-05

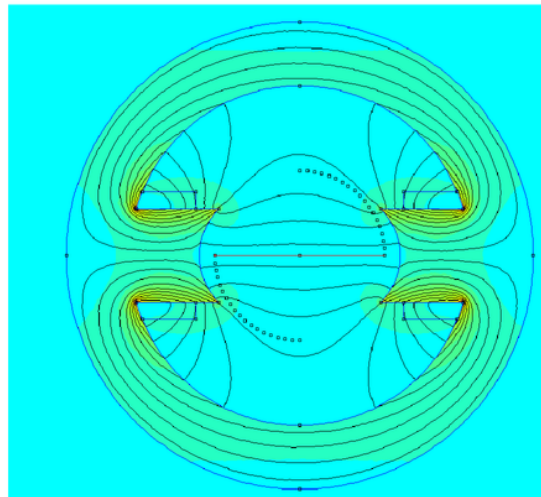


Figure 5 Model 2 – poles closer together

Model 3

Total flux	
Flux being created in the stator circuit	
flux across gap	average B.n
0.000199186	0.199186

Useful flux	
Flux cutting the rotor coil	
Normal Flux	Average B.n
8.90E-05	0.0222606
8.91E-05	0.022282
8.92E-05	0.0223113
8.94E-05	0.0223584
8.96E-05	0.0224015
8.99E-05	0.0224708
9.00E-05	0.0225079
9.00E-05	0.0224877
8.96E-05	0.022388
8.84E-05	0.0221063
8.59E-05	0.0214868
8.07E-05	0.0201671
6.99E-05	0.0174823
6.28E-05	0.0157164
4.91E-05	0.0122844
3.07E-05	0.00768428
2.00E-05	0.00500321
9.85E-06	0.00246284
-5.06E-08	-1.27E-05

Flux leakage
4.47E-01
4.47E-01
4.48E-01
4.49E-01
4.50E-01
4.51E-01
4.52E-01
4.52E-01
4.50E-01
4.44E-01
4.31E-01
4.05E-01
3.51E-01
3.15E-01
2.46E-01
1.54E-01
1.00E-01
4.95E-02
-2.54E-04

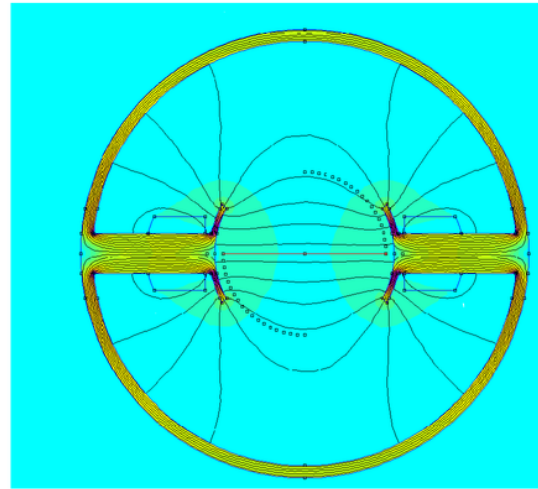


Figure 6 Model 3 armature thinner, inner radius bigger, small fish tail

Model 4

Total flux	
Flux being created in the stator circuit	
flux across gap	average B.n
0.000273218	0.273218

Useful flux	
Flux cutting the rotor coil	
Normal Flux	Average B.n
0.000118466	0.0296165
0.000118512	0.0296279
0.000118423	0.0296058
0.000118293	0.0295728
0.000117769	0.0294422
0.000117003	0.0292512
0.000115482	0.0288698
0.000112167	0.00011217
9.85E-05	0.0246479
8.47E-05	0.0211904
7.73E-05	0.0193278
6.44E-05	0.0160917
5.31E-05	0.0132784
4.30E-05	0.0107385
3.36E-05	0.00839515
2.48E-05	0.00619133
1.63E-05	1.63E-05
8.09E-06	0.00202172
6.07E-09	1.52E-06

Flux leakage
0.433595151
0.433763515
0.433437768
0.432961957
0.431044075
0.428240453
0.42267347
0.410540301
0.360584222
0.30993895
0.282968911
0.235590993
0.194404468
0.157212556
0.122907715
0.090644833
0.059642483
0.029598745
2.22267E-05

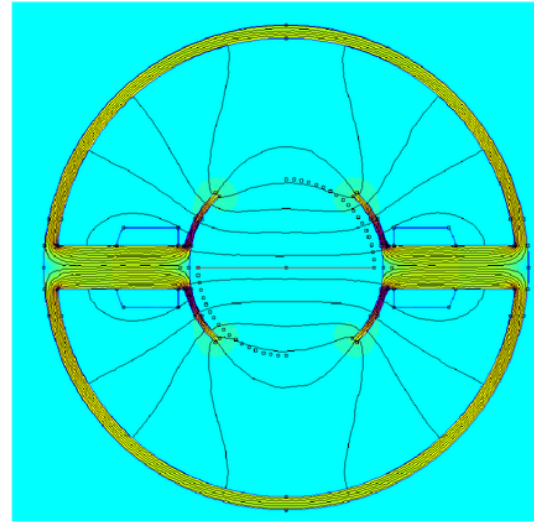


Figure 7 Model 4 - thinner armatures, inner radius bigger, big fishtail

Model 5

Total flux	
Flux being created in the stator circuit	
flux across gap	average B.n
0.000225238	0.102381

Useful flux	
Flux cutting the rotor coil	
Normal Flux	Average B.n
8.05E-05	0.0201275
8.07E-05	0.0201658
8.11E-05	0.0202845
8.19E-05	8.19E-05
8.29E-05	0.0207339
8.42E-05	0.0210544
8.57E-05	0.0214134
8.71E-05	0.0217827
8.85E-05	0.0221132
8.92E-05	0.0222925
8.85E-05	0.0221224
8.47E-05	0.0211836
7.47E-05	0.0186697
5.95E-05	0.0148673
4.51E-05	0.0112759
3.25E-05	0.00813635
2.12E-05	0.00528815
1.04E-05	0.00260742
-1.21E-08	-3.02E-06

Flux leakage
3.57E-01
3.58E-01
3.60E-01
3.64E-01
3.68E-01
3.74E-01
3.80E-01
3.87E-01
3.93E-01
3.96E-01
3.93E-01
3.76E-01
3.32E-01
2.64E-01
2.00E-01
1.44E-01
9.39E-02
4.63E-02
-5.37E-05

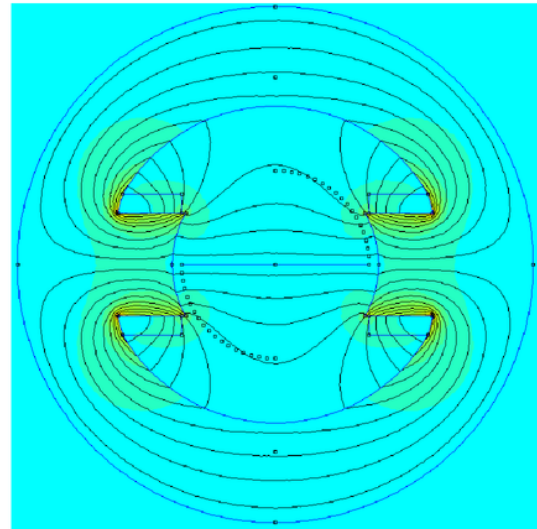


Figure 8 Model 5 – smaller inner radius

Discussion

During this section the results have been made into graph to be read easily and to show trends within the data that has been recorded. This section will first discuss the results from all the models and then show a comparison of them with the original models' data, this will then show which model had less flux leakage meaning that that model would be the most efficient.

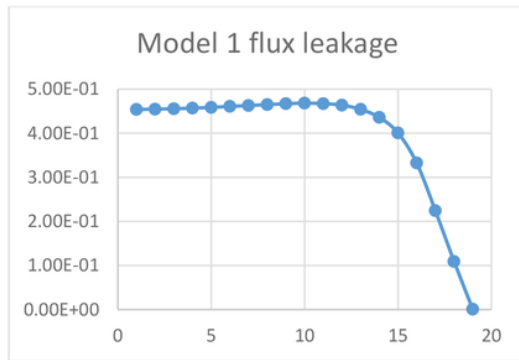


Figure 9 Model 1 flux leakage graph

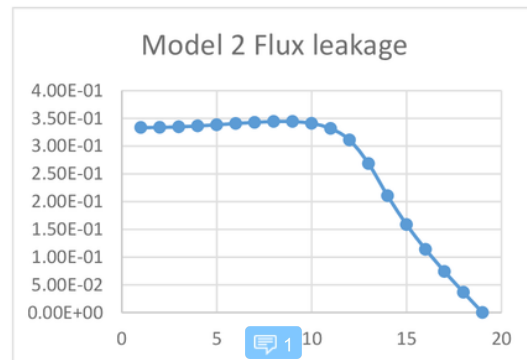


Figure 10 Model 2 flux leakage graph

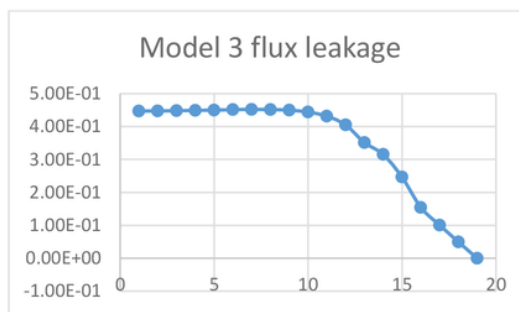


Figure 11 Model 3 flux leakage graph

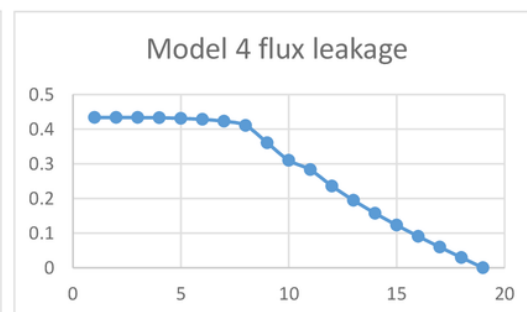


Figure 12 Model 4 flux leakage graph

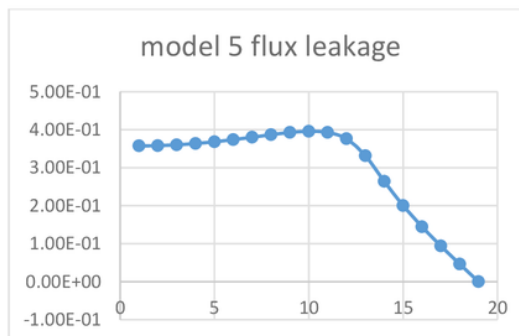


Figure 13 Model 5 flux leakage graph

Found above in figures 9-13 are the graphs produced from the results of each model. As can be seen most of the graphs have a similar trend in curve except Model 4 which is more of a gradual decline. Model 4 also has the most flux leakage out of all the models with a maximum value of 0.433595151 Weber. The two models with the lowest flux leakage and similar results are Models 2 and 5, model 2 had the poles moved closer and model 5 had the inner radius of the stator was shrunk.

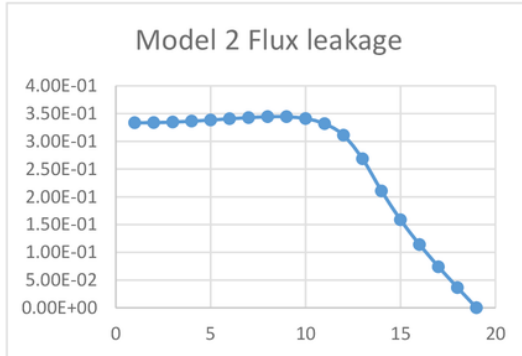


Figure 10 Model 2 Flux leakage graph

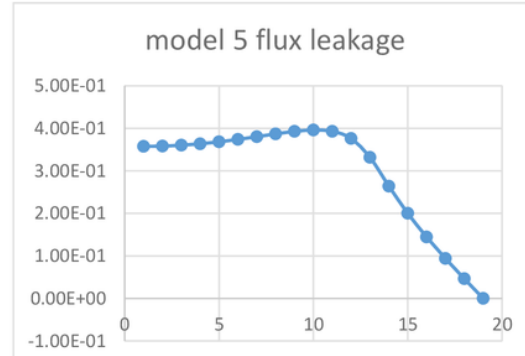


Figure 13 Model 5 flux leakage graph

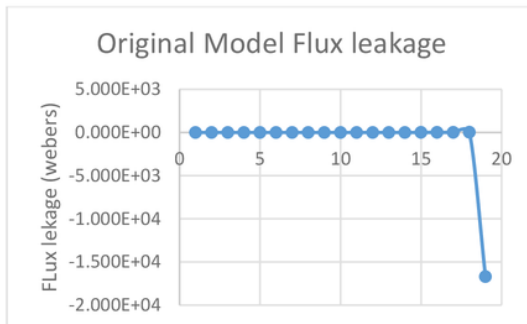


Figure 4 Original models flux leakage graph

The graphs above show the two models that had the least amount of flux leakage alongside the Original Models flux leakage graph. As can be seen by this comparison the two models created in this experiment models 2 and 5 have a more curved look rather than the immediate drop seen in the original model. Models 2 and 5 also have a much lower value of flux leakage compared to the original showing that the models are being more efficient in moving flux around the motor.

Conclusion

Overall the experiment went as planned, the whole premise of this report was to create varies magnetostatics models that when compared to the original model created in the previous report would have a lower flux leakage meaning that, that model would be more efficient. As can be seen in the results section and the discussion section this has been done with two of the created models these being Models 2 and 5 being more efficient than the original model. Some improvements that could be made if this experiment was to be done again could be to create even more models so that a wider variety of data could be collected and compared, another improvement could be to change even more variables about the stator such as the material type, winding number and winding material.

Stator Modelling Part 2

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

40/100

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Comment 1

Axis labels & units missing.

Horizontal axis should be in units of degrees, not just the measurement number.

The flux leakage should be a single value for each design, not a graph with a range of values.

PAGE 10

GRADING FORM: SMU GENERIC_SMOSEY

ENGAGEMENT WITH LITERATURE

including reading, referencing, academic conventions and academic honesty



You have not cited any reference sources at all.

KNOWLEDGE & UNDERSTANDING

Knowledge of the basic underlying concepts and principles of a subject.



Evidence of basic knowledge and understanding of the relevant concepts and underlying principles.

12.3

COGNITIVE & INTELLECTUAL

Evaluate underlying concepts and principles of a subject and interpret qualitative and quantitative data in order to develop lines of argument and make sound judgements.



Evidence of some logical, analytical thinking and some attempts to synthesise, albeit with some weaknesses. Some evidence to support findings/ views, but evidence not consistently interpreted. Some relevant conclusions

13.5

PRACTICAL APPLICATION SKILLS

Different approaches to solving problems in particular contexts.



An adequate awareness and mostly appropriate application of well-established methods and techniques. Basic appreciation of the context of the application.

8.4

TRANSFERABLE SKILLS

Communicate the results of their study/work accurately and reliably, and with structured and coherent arguments; the qualities needed for employment requiring the exercise of some personal responsibility within a structured and managed environment.



Can communicate well, confidently and consistently in a suitable format. Work is coherent and fluent and is well structured and organised.

6