7th National Conference on
"Role of Engineers in Nation Building" organized by VIVA Institute of Technology, Mumbai
(1st and 2nd March 2019)
International Journal of Engineering Research & Science (IJOER)
ISBN: [978-93-5321-411-1] ISSN: [2395-6992] [Vol-5, Issue-3, March- 2019]

Designing of Brushless DC Motor with controllers

Piyali Mondal[1], Somraj Sengupta[2]

[1]Department of Electrical Engineering, VIVAIT, Mumbai University, Virar-401303
[2]Hysol Renewable Consultants LLP, Virar-401303

***Abstract*—*The electronically commuted DC Motor which operates without brushes are gaining advantage and are very much in application now a days. The combination of permanent magnet in the rotor, electromagnets in the stator and high power transistors, all perform together to turn the shaft. The controller ensures the smooth power distribution by using solid state circuit. This paper presents the electrical and mathematical design of BLDC Motor along with the control circuit. The step by step approach of the designing procedure and the analysis on MATLAB is self-explanatory and accelerates the understanding process. The mathematical calculations and designs are performed in a 8 pole BLDC Motor.*

Keywords*—*BLDC Motor, Brushes, Electrical Design, Mathematical Modelling, Permanent Magnet.

I. INTRODUCTION

There is a major increase in the application of BLDC Motor in recent years due its easy and efficient applications. In this paper we will see the control circuit of BLDC Motor and observe its performance. The design and all the calculation are done for a 8 pole BLDC Motor. To reduce skewing in concentrated rotor Permanent Magnet BLDC Motor is used. The air gap is such considered so that the flux distribution in the air gap remains sinusoidal. Basic design considerations are discussed so as to obtain a machine with optimal operation and improved performance. Design methodology is discussed step by step and explained with the help of MATLAB software.

II. CONSTRUCTION

The construction of BLDC Motor is as that of Permanent Magnet Synchronous Motor where rotor is comprises of one or more permanent magnets.

2.1 Dimensions

The major dimensions that are to be paid attention in designing of BLDC Motor are as follows.

2.1.1 Stator Diameter

The maximum distance between the center of the motor and the stator outer circumference is called the stator outer radius. Twice the stator outer radius is the stator outer diameter. The maximum distance between the center of the motor and the stator inner circumference is called the stator inner radius.

2.1.2 Rotor Diameter

The maximum distance between the center of the motor and the rotor outer circumference is called the rotor outer radius. The maximum distance between the center of the motor and the rotor inner circumference is called the rotor inner radius.

2.1.3 Slot Dimension

The distance between start point and end point of the slot opening at the top is Slot width top. The distance between start point and end point of the slot opening at the bottom is Slot width bottom. The total width of the stator teeth is Tooth width. The linear distance between the stator outer circumference and the stator inner circumference is Back iron length. The maximum distance between the mid-point of the start point and the mid-point end point of the slot teeth is Slot depth.

ISBN: [978-93-5321-411-1] ISSN: [2395-6992] [Vol-5, Issue-3, March- 2019]

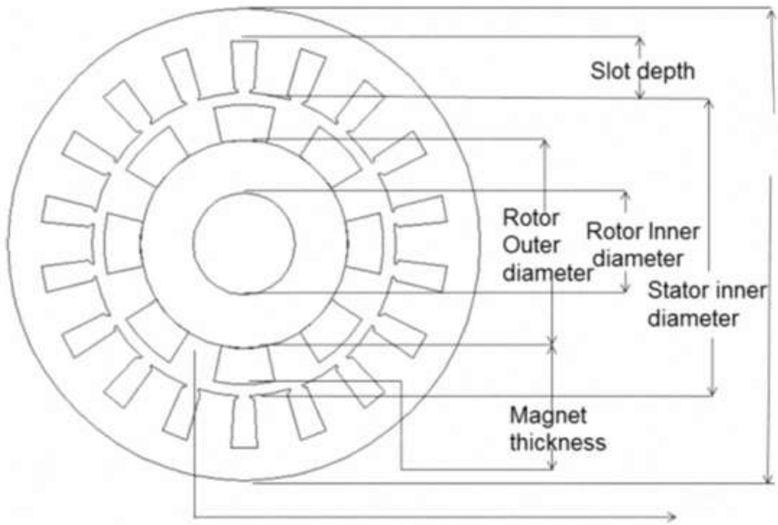


FIG.1 Dimensions of BLDC Motor

III. DESIGN OF BLDC MOTOR

In this section, a generalized procedure for designing a PMBLDCM, either having the dependent variables or arriving the independent variables or vice versa is proposed. Before a BLDC motor design can begin, several important decisions must be made regarding the features of different types of brushless motors and the availability of different magnetic materials.

A. Torque Expression of BLDC motor

Force on a current carrying conductor

magnetic field is given by,

F=lLxB

where,L is length of the conductor, B is magnetic

flux density, and I is current through the conductor.

The magnitude of the force is

F=BILsinB

The BLOC motor works on same principle as a DC motor i.e. armature current and magnetic field are kept orthogonal to each other in space(B=900). Thus the force on one conductor in the BLDC motor is given by,

F=BIL

Torque on a conductor is given by,

r: $B/_c$ LR,;

=

A tum consists of 2 conductors, one above north pole and other above south. Therefore torque on one tum is

ISBN: [978-93-5321-411-1] ISSN: [2395-6992] [Vol-5, Issue-3, March- 2019]

T=2BILR

Torque on a coil with turns n_s is given by,

$$T_{coil} = 2B_g I_c n_s L R_{si}$$

Each pole pair has to have all 3 phase coils. Therefore total number of coils per phase is equal to no. of pole pairs. A full pitch winding (SPP=I) is used to get square mmf wave.

Torque per phase is given by,

$$T_{phase} = 2pB_g I_c n_s L R_{si}$$

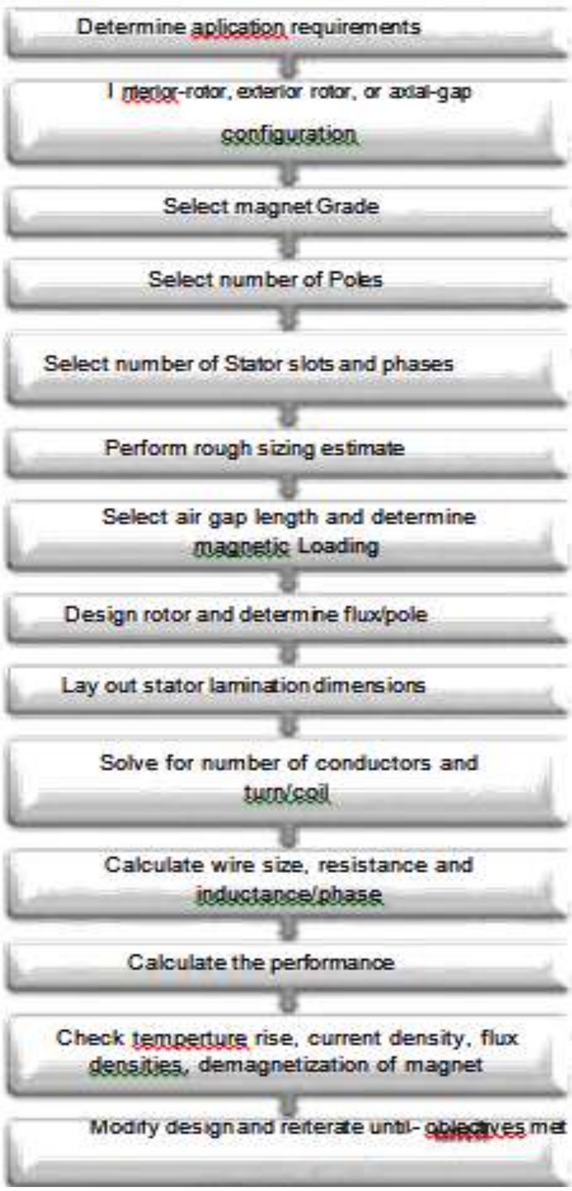
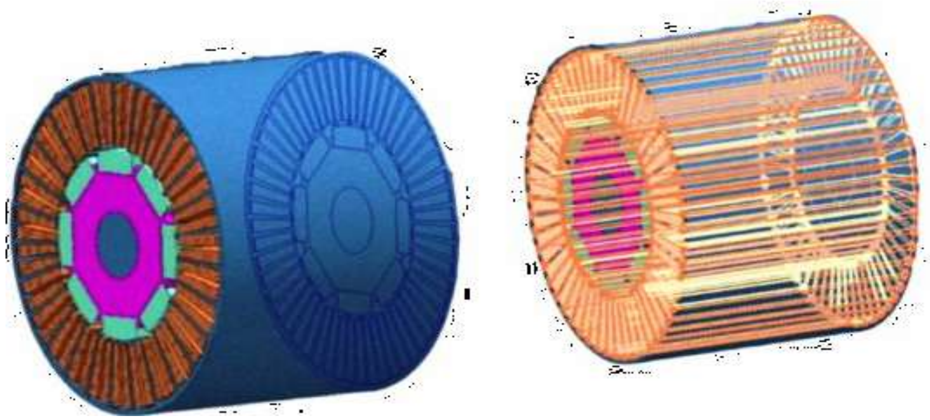


FIG.2 Design procedure

ISBN: [978-93-5321-411-1] ISSN: [2395-6992] [Vol-5, Issue-3, March- 2019]

The flux flow pattern of the designed PMBLDCM is shown



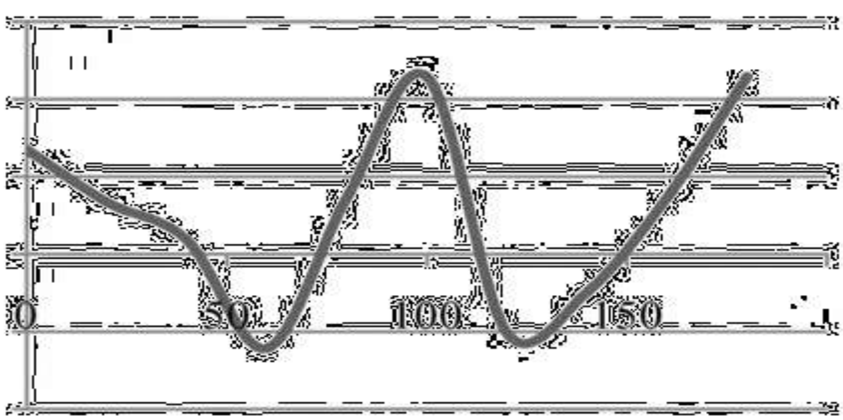


FIG.3: Side view, flux pattern and waveform

The rotor is rotated from 0 to 360 degrees and cogging torque is measured at each position. Cogging torque of electrical motors is the torque due to the interaction between the permanent magnets of the rotor and the stator slots of a Permanent Magnet (PM) machine. It is especially prominent at lower speeds, with the symptom of jerkiness.

IV. CONCLUSION

A generalized procedure for designing a Permanent Magnet Brushless DC (PMBLDC) motor is proposed in this paper. The dependent variable and the arrival of independent variables or vice versa are possible in the proposed procedure. This paper gives the combination of both the techniques. A step by step procedure of designing and analyzing a PMBLDC motor using the is shown. The result has been discussed in such a way that it is possible to improve the teaching-learning methods in this field with interactive screens. The models of basic PMBLDC motor are developed and performance waveforms are obtained. It is evident that the developed tool will help a UG level of understanding and performance predictions of PMBLDC motors.

REFERENCES

[1] D. Hanselman, Brushless Permanent-Magnet Motor Design. 1994. McGraw-Hill,
[2] Bin Zhang, Xiuhe Wang, Ran Zhang, Xiaolei Mou*

ISBN: [978-93-5321-411-1] ISSN: [2395-6992] [Vol-5, Issue-3, March- 2019]

[3] M. Ehsan 'Cogging Torque Reduction by Combining Teeth Notching and Rotor Magnets Skewing in PM BLDC with Concentrated Windings" IEEE Transaction on Electrical machines and systems,(IC EMS),03 VoU pp. 3189 - 3192 .Feb.2009.

[4] I.S.Jacobs and C.P.Bean, "Fine particles, thin films and exchange an isotropy," in Magnetism, vol.III, G.T. Rado and H.Suhl, Eds. NewYork: Academic,1963,pp.271–350.