ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 7, July 2017

Magnetic Field Analysis of Two Pole DC Motor using Adaptive Finite Element Method in Mat Lab

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ABSTRACT: In magnetic field analysis Finite Elements Method is a contemporary numerical method for determination of distribution ofelectromagnetic fields inside different objects. In this paper dc motor is analyzed.In all analyzed motors distribution of electromagnetic field and magnetic flux density are calculated using magneto-static approach at zero herz frequency. Further on, calculation of different motor parameters such as magnetic flux density distribution in motor air gap at different operating regimes is performed and adequate conclusion are derived.

KEYWORD: Finite Element Method, dc motor, air gap, magnetic field.

I. INTRODUCTION

Electromagnetic Field: Electromagnetic field is a physical field produced by electrically charged object. It affects the behavior of charged object in the vicinity of the field. The electromagnetic field extends indefinitely throughout the space and describes the electromagnetic interaction. Electromagnetic phenomena are defined in terms of the electromagnetic force, sometimes called the Lorentz force which includes both electricity and magnetism as different presentation of the same phenomenon.

Electromagnetic field is combination of electrical field and magnetic field. According to our need total electromagnetic field is calculated. It is often sufficient to solve either an electric field problem or magnetic field problem

Magneto statics: Magneto statics is the study of magnetic fields in systems where the currents are steady (not changing with time). It is the magnetic analogue of electrostatics where the charges are stationary. Laws of magnetic force

First law like poles repel each other while unlike poles attracts each other.

Second Law The force between two magnetic poles is directly proportional to the product of their magnitude and inversely proportional to the square of distance between them.

Mathematically

$$F \propto \frac{Q1Q2}{d^2}$$

Or

$$F = k\frac{Q1\,Q2}{d^2}$$

Where

$$k = \frac{1}{4\pi\varepsilon_0 \quad \varepsilon_r}$$

ε_0 Absolute permittivity of vacuum or air. Its value is 8.854×10^{-12}

ε_r Relative permittivity of the medium in which the charges are placed for vaccum or air its value is 1.

Simple two pole dc motor: In simple DC electric motor when the coil is powered, a magnetic field is generated around the armature. The left side of the armature is pushed away from the left magnet and drawn toward the right, causing

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rotation. The armature continues to rotate. When the armature becomes horizontally aligned, the torque becomes zero. At this point, the commutator reverses the direction of current through the coil, reversing the magnetic field. The process then repeats. A simple DC motor has a stationary set of magnets in the stator and an armature with one or more windings of insulated wire wrapped around a soft iron core that concentrates the magnetic field. The windings usually have multiple turns around the core, and in large motors there can be several parallel current paths. The ends of the wire winding are connected to a commutator. The commutator allows each armature coil to be energized in turn and connects the rotating coils with the external power supply through brushes

II. EXISTING METHOD

Finite element analysis: Finite element analysis is the modeling and simulation of electromagnetic applications has become increasingly important over the years and is now a mature and well-established research area

The main difficulty with computational analysis is that a very large number of free modeling parameters are frequently necessary for computing accurate and reliable simulations of realistic systems: sufficient mathematical degrees of freedom (DOF) are required to both resolve the geometric and material features of practical devices, and to represent the fields of the electromagnetic system. As a result, the computational effort required for the electromagnetic simulation can frequently be prohibitive. Currently one promising approach to overcome this type of computational difficulty is to employ adaptive solver technologies

III.PROPOSED APPROACH

Adaptive Finite Element Method: Adaptive methods begin with relatively in expensive initial discretizations for systems, then establish operational solution error distributions over them and subsequently add DOF to the models to improve them.

Advanced AFEMs for electromagnetic analysis and simulation, which can compute sufficiently accurate solutions to problems using many fewer DOF than non-adaptive methods

In addition recent research and development progress with advanced strategy feedback control systems which are employed to guide the adaptive process now hold great promise for overcoming the computational blockage.

In order to accurately and efficiently model the highly non-uniform electromagnetic fields developed within sophisticated systems, AFEMs that can reliably identify and selectively refine the regions of high solution error need to be established. Presently, four basic types of adaption models are applied to refine finite element approximations: h-type; p-type; combined h- and p-type (called hp-type); and r-type.

This model only differ in the techniques used to update the finite element discretization within the adaptive feedback loop

The adaption model and feedback control system framework for the study of AFEMs, within the context of the general finite element solution scheme.

The general finite element solution process, usually involves:

- Pre-processing unit for building a computational model of the problem.
- A finite element solver for computing solutions to the discretized problems.
- Post-processing unit for analyzing the computed solutions. An adaption model is a set of well-defined procedures used within AFEMs to update the finite element discretization.

Partial Differential Equation Toolbox: The Partial Differential Equation (PDE) Toolbox provides a powerful and flexible environment for the study and solution of partial differential equations in two space dimensions and time. The equations are discretized by the Finite Element Method (FEM). The objectives of the PDE Toolbox are to provide you with tools that:

- Define a PDE problem, i.e., define 2-D regions, boundary conditions, and PDE coefficients.
- Numerically solve the PDE problem, i.e., generate unstructured meshes discretize the equations, and produce an approximation to the solution.
- Visualize the results.

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Methodology:

In this paper Adaptive finite element method is use for electromagnetic field analysis in electrical machine. Adaptive finite element method consist of following steps

- Generate initial finite element discretization
- Assemble and solve finite element problem.
- Evaluate solution accuracy; if adequate then stop.
- Identify regions of inadequate discretization.
- Determine require discretization refinements.
- Update finite element discretization
- Until stop.

IV. RESULT AND DISCUSSION

We analysis the number of nodes and mesh in different air gap such that 0.4mm, 0.6mm, 0.8mm. By analyzing these value we find out out the optimum air gap where we get maximum flux density. The analysis table is given below. These value of nodes and triangle are for normal mesh.

Normal Mesh Table

Air Gap	0.4mm	0.6mm	0.8mm
No. of Nodes	207	235	259
No. of Triangle	371	421	462
Solution Time Period	4.25	4.57	4.12

Table .1

Normal Mesh

- When air gap between rotor and stator is 0.4 mm (Figure 1).
- When air gap between rotor and stator is 0.6mm (Figure 2).
- When air gap between rotor and stator is 0.8mm (Figure 3).

- For Normal Mesh air gap is 0.4mm.

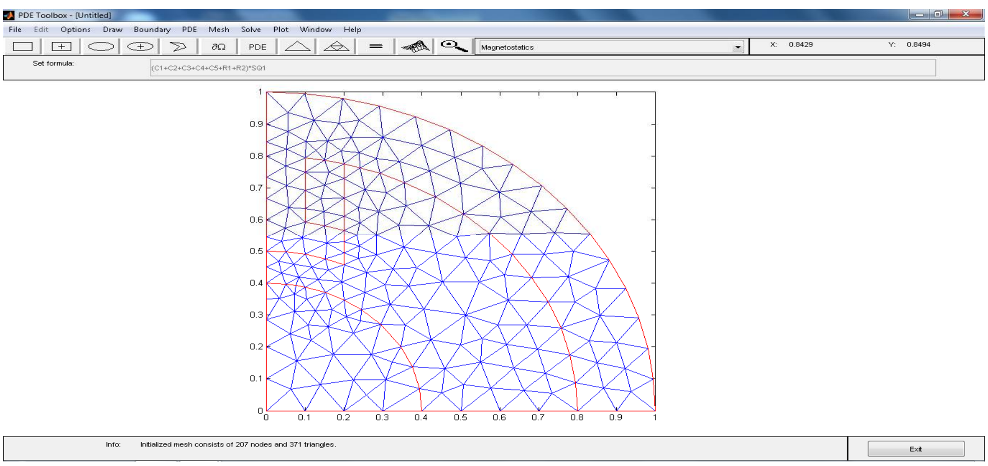

Fig . 1 model of two pole DC motor

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- For Normal mesh when air gap is 0.6mm.

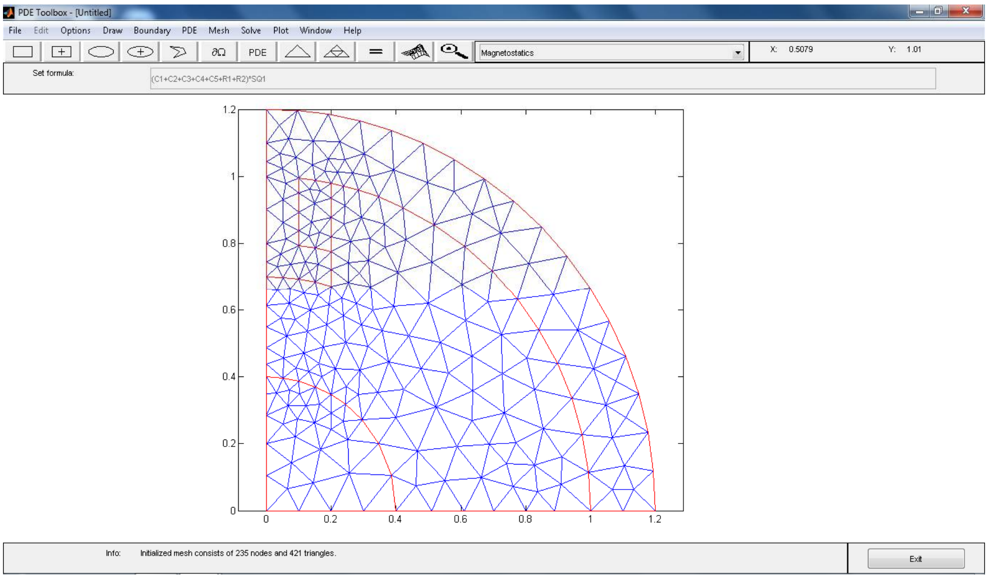

Fig. 2 model of two pole DC motor

- For Normal Mesh when air gap is 0.8mm.

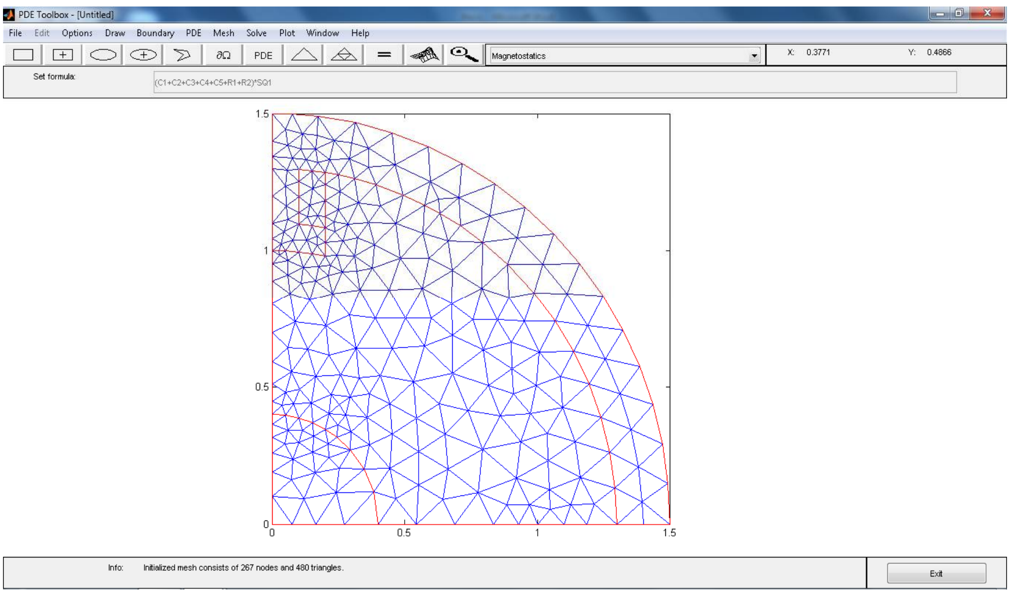

Figure 3 model of two pole DC motor

V. CONCLUSION

Adaptive Finite Elements Method is applied in dc motor in order to be obtained magnetic flux distribution inside the motor models. Magneto static approaches is implemented in magnetic field calculation at f=0 Hz Magneto

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static approach involves consequent calculation of current densities in each motor winding as a result of the flux from the excitation winding. On that way calculation of electromagnetic process inside the machines is much closer to the real ones.

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