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(Research article)

Comparative Study Analysis of Double Sided Linear Induction Motor Model by Varying Geometrical bases Parameters

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Abstract

In this paper, An Analysis of Double Sided Linear Induction Motor is done using one of the latest Finite Element Tool that is a Maxwell. The work is emphasized to evaluate the Magnetic and Electric characteristics of Double Sided Linear Induction Motor by varying geometrical based parameters. The 2-Dimensional Finite Element analysis used her to compute Magnetic Flux Density, Magnetic Flux Intensity and Flux Lines with refinement of meshing. These parameters further used to evaluate the end effect and other effect of Double Sided Linear Induction Motor to design best performing Model by varying air-gap between teeth of stator.

Keywords: *Linear Induction Motor, Maxwell, Finite Element Method, Magnetic Field Analysis.*

1. Introduction

The majority of electrical Machine is designed to produce a rotary motion. In which there are various types of AC and DC Machine that converted the Electrical energy into Mechanical energy to be used according to load requirement. According to change in load and meet the system requirement the new topological feature of Electric Machine are modified, therefore low power application single phase AC Machine is used and high power application three phase AC Machine is used in various type of application such that transportation, conveyer, Lathes, Shapers, elevators and Submersible pump system, so that various type of Electric Machine is design to fulfillment the environmental condition of load.
As a result of topological change in magnetic circuit of Machine new phenomena are introduced that cannot be fully explained by conventional theory. Consequently older methods of analysis have to be modified and sometime new theories have to be developed. We attempt to present the method of analysis and certain design approach applicable to Linear Motion.

The principle of the Linear Induction Motor can be easily understood by analogy with the conventional Squirrel Cage Induction Motor. By Linear motion, a force in plane perpendicular to the direction of thrust is called normal force. It is understand that there are certain differences between a Linear Motion Electric Machine and Rotary Machine. The Rotary Electric Machine can be transformed into linear motion Electric Machine if the stator of the Rotary Machine is cut by radial plane and unrolled and rotor is replaced by conducting sheet. In the Linear Motion Electric Machine stator of the Motor is called as a primary part and the rotor as a secondary part.

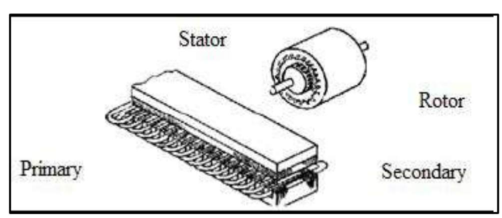

Fig. 1 Closed and rolled model of Induction Motor

Linear Induction motors basically three model is commonly used such as

- Single Sided Linear Induction Motor (SLIM)
- Double Sided Linear Induction Motor(DLIM)
- Tabular Linear Induction Motor

In Linear Induction Motor Primary and Secondary are parallel to each other. In DLIM Secondary is sandwich between two Primaries, but in Tabular Linear Induction Motor placed co-axially to each other. These Motor is design for low and higher speed application. Single Sided Linear Induction Motor has similar application as compare to Double Sided Linear Induction Motor. The main difference is that DLIM is can operated with low

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and high speed application, but this is not possible in SLIM.

$N_S = 2\tau f$ τ = Pole Pitch f = Frequency

In linear Induction Motor Magnetic flux density is importantly consider. In DLIM has maximum value of flux density in air-gap, because the both sided of the (stator) Primary magnetic field is induce. Higher the value of the flux density in air-gap higher force is produce. The force produce by Linear Induction is given as

$$F = \frac{P_r}{N_S}$$

P_r = Power transmitted by mover

N_S = Synchronous speed

The Double Sided Linear Induction Motor is available for low and higher power application such as little horse power to hundred horse power, so that meet the system requirement the DLIM is design for single and three phase power supply. In three phases motor the size of the motor is reduce and energy looses are also to be reduce as compare to single phase Motor.

2. DLIM Model

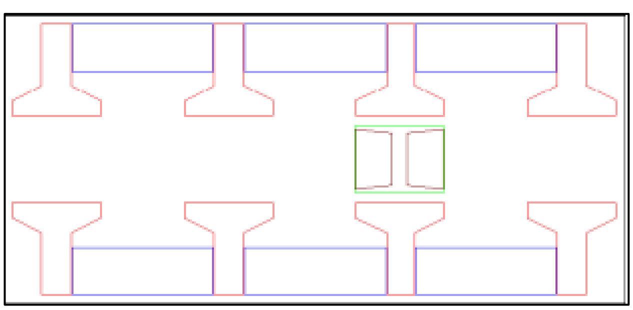

Fig. 1 Double Sided Linear Induction Motor Model

In the figure shown that in which one part is stator and the other one is rotor (mover). The Stator of DLIM is Infinite and the mover of DLIM is finite length. Lim model has been defined with different materials shown below: Primary (stator) teeth –Stainless steel Primary Rectangular Pole – ferrite Secondary core – Stainless steel Secondary Winding - Copper The DLIM model has been designed with following specification:-

The Model of Double Sided Linear Induction Motor used for the High speed application is analyzed using Finite Element Method. The structure Model Specification of Double Sided Linear Induction Motor and the coordinate system are shown in Table 1. The secondary is moving and composed by secondary core laminated by silicon steel sheet and winding coil. The primary with teeth and rectangular pole is installed with given air-gap with secondary. For the study of Double Sided Linear Induction Motor the geometrical based parameter of the Model is changed by the change air-gap between two adjacent poles but remain same between two similar poles. The parameter is changed on primary region, but secondary region is remaining same as the Model A. The Length of the primary region is increase by the increase the air-gap between two adjacent Poles, therefore length of the primary Magnetic field also increases. In the Model of Double Sided Linear Induction Motor one part is Primary and the other one is Secondary (mover). The Primary of Double Sided Linear Induction Motor is Infinite and the mover of Double Sided Linear Induction Motor is finite length. In presents work analysis of a Double Sided Linear Induction Motor model is carried by using 2-Dimensional Finite Element method. The Finite Element Method is the most powerful and precise tool to calculate electromagnetic field distributions and field related parameters. The fundamental concept involves dividing the body under study into a Finite number of pieces called element. Particular assumptions are then made on the variation of the unknown dependent variable across each element using so called interpolation or approximation functions. This approximated variation is quantified in terms of solution values at special element locations called nodes.

Table 1 DLIM model formulation

Length of Primary rectangular pole	30.5mm
Height of Primary Teeth	19.70mm
Length of Primary Teeth	19.05mm
Air-gap Length	4.80mm
Height of Primary rectangular Pole	10.16mm
Length of Secondary(MOVER)	19.05mm
Height of Primary(MOVER)	15.90mm
No. of Primary rectangular pole	4
Distance between rectangular Pole	6.39mm

Through this discretization process, the method sets up an algebraic system of equations for unknown nodal value which approximate the continuous solution. Because element size, shape and approximating scheme can be varied to suit the problem, the method can accurately simulate solution to problem of complex geometry and loading and thus this technique has become a useful and practical tool.

3. Simulation results of model

A Based on the Finite Element method, the 2-Dimensional is built up by Maxwell (Ansoft Inc.). This tool has a strong ability to solve Electromagnetic field equation. The Analysis of a Double Sided Linear Induction Motor is carried out in terms of electromagnetic field equations. To reduce the boundary value problem the actual slotted structure is replaced with smooth surface and the current carrying windings are replaced by fictitious, infinitely thin current elements called current sheets, having linear current densities. The current density distribution of the current sheet is the same as that of the slot embedded conductor configurations, such that the field in the air gap remains unchanged. The Double Sided Linear Induction Motor has basically three main parts, where the secondary is coupled with single phase copper winding with stainless-steel core, the primary with permanent magnet rectangular pole with stainless-steel tooth pole core and air-gap between the primary and secondary.

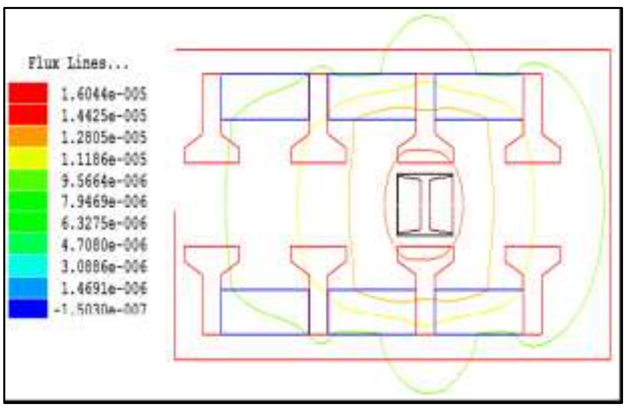

Fig. 2 Flux Lines of Model A

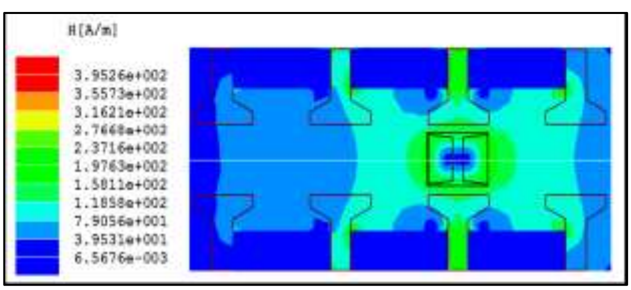

Fig. 3 Magnetic Field Intensity of Model A

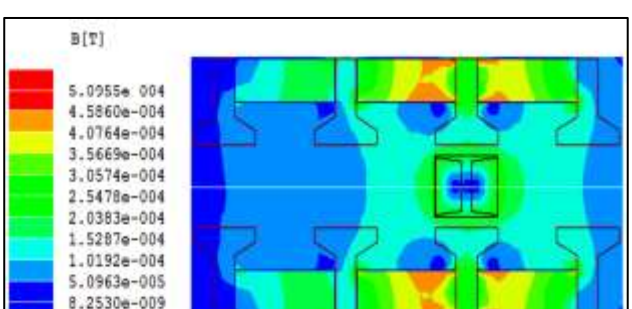

Fig. 4 Magnetic Flux Density of Model A

Simulation result of model B

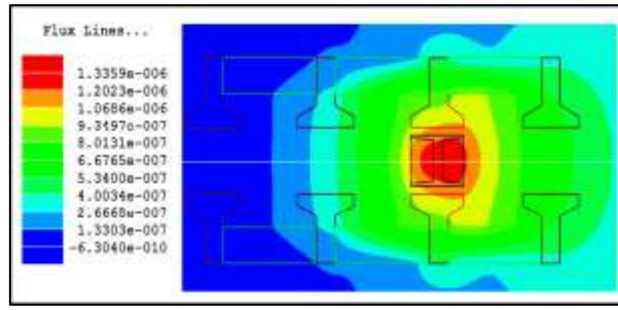

Fig. 5 Flux Lines of Model B

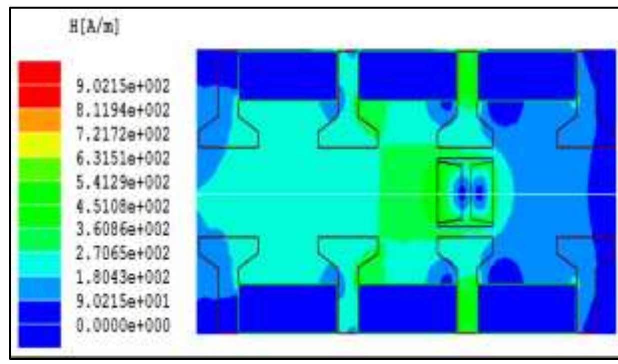

Fig. 6 Magnetic Field Intensity of Model B

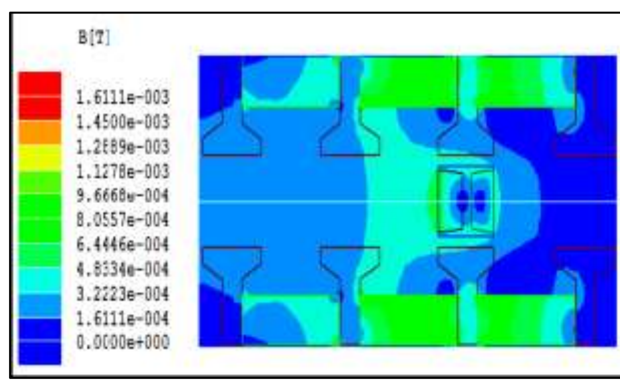

Fig. 7 Magnetic Flux Density of Model

Table 2 Comparison of model a and model B

Model	Max. flux density	Max. Magnetic force	Max. energy produce	Minimum energy error %
Model A	5.0955e-004	3.26745e-005	7.81633e-005	0.8415
Model B	1.6111e-003	2.53663e-006	7.68292e-005	7.8505

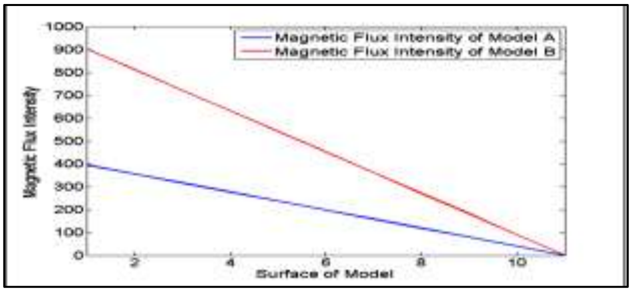

Fig. 8 Comparison of Magnetic Flux Intensity of DLIM Models

The generated mesh-gap of Double Sided linear induction motor is study in fig. 9

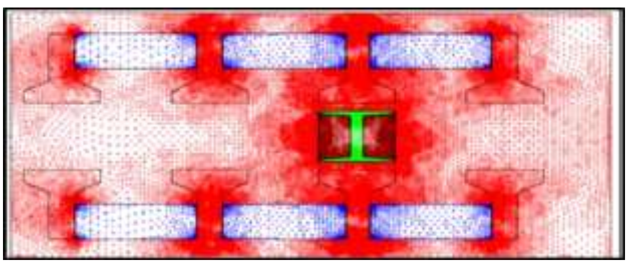

Fig. 9 Mesh around the air-gap

The Model of DLIM is cut- out in Finite piece called the Element. The size of the element is increase or decrease according the stress on the body. In the Model shown that there is a Large stress in the air-gap. In such condition no. of the element is increase to solve the Magnetic field problem. CONCLUSION In the present work the Finite Element Model of Double Sided Linear Induction Motor is simulated in Maxwell Ansoft Inc. to evaluate its performance by varying its one of the Geometrical structure which is the gap between two adjacent tooth of the primary core of the Motor, as the previous literature shows that the performance could be improved by varying the air-gap between two primary and secondary, winding structure and material composition. The significant change has been recorded in different parameters like thrust, Magnetic Field distribution and air-gap Flux when distance between two adjacent teeth varied up to certain length. It has been further concluded that in the present work, the goodness factor is improved significantly when the distance between two teeth become equal to the length of air-gap between two opposite teeth pole. This is because the electromagnetic stresses reduce at the corner of the mover during the operation of Motor.

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