LINEAR INDUCTION MOTOR DRIVEN ELEVATOR

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Abstract

Conventionally lifts or Elevators are driven by DC series motor, now days this changing technology is focusing on high efficiency and should be economical .With DC series motors rectifier circuits are needed they are very costly .Therefore Elevators are driven by linear induction motors which reduces cost of rectifiers and their speed is high comparatively. In conventional system due to rectifier circuits it produces Harmonics in the system which affects self as well as neighboring system this problem can be avoided by using linear induction motors

Keyword: - *Linear induction motor*

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1. INTRODUCTION

Nowadays, the vast majority of applications, that a linear motion is necessary. It uses a rotary electrical motor as source of motion in order to convert the rotary motion into a linear motion. Often, it is necessary to use a complex mechanical system of gears, axles and Screws jacks. When used directly, these transmission systems for movement have great losses. Among the reasons is the increased abrasive wear due to the friction of the mechanical parts, even when using low viscosity fluids for the lubrication. This results into higher operational and maintenance costs. Therefore, for transport applications, the use of an electrical machine that produces directly the linear motion would result in lower operational and maintenance Costs as well as higher reliability and efficiency.

2. LINEAR INDUCTION MOTOR

2.1 Linear Induction Motor Theory And Equations

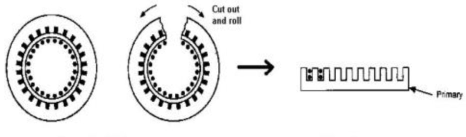

Fig-1:- Imaginary process of LIM

The working principle of a linear induction motor is same as that of a induction motor. By opening the rotating squirrel cage induction motor and laying it flat then we obtain linear Induction motor. Instead of producing rotary torque from a cylindrical machine this flat structure produces a linear force. LIMs can be designed to produce thrust up to the several thousands of Newton's. The supply frequency and winding design determine the speed of a LIM.

There should be relative motion between the magnetic lines of flux and the conductor for a voltage to be induced in the conductor. Therefore induction motors, normally operate at a speed V_r that is slightly less than the synchronous velocity V_s. Slip is the difference between the rotor speed and stator magnetic field speed .Relative motion required in the induction motor to induce a voltage in the rotor, and it is given by -

$$S = \frac{Vs - Vr}{Vs}$$

The synchronous velocity V_s is given by:-

$$Vs = 2\acute{\omega}R/p$$

2.2 Forces In LIM

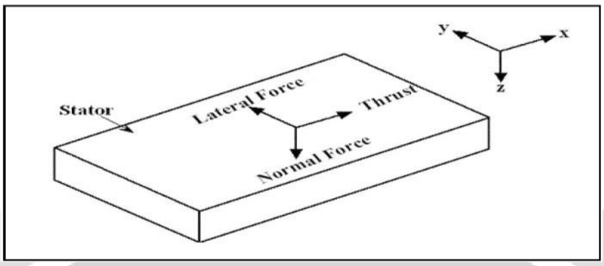

Fig-2:-. Forces in LIM

As shown in fig. normal force, thrust force and lateral force are the main forces involved with LIM.This project is interested in thrust and its relation to other variable parameters. The normal force is perpendicular to the stator of LIM in the z-direction. Lateral forces are undesirable forces which are developed in a LIM because of the orientation of the stator of LIM.

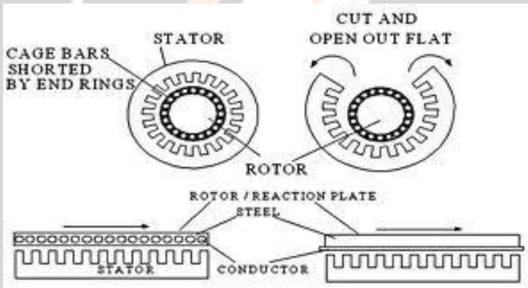

Fig-3:- Front View of Stator & Rotor of LIM.

A linear induction motor (LIM) is an AC asynchronous linear motor that works by the same principles as other induction motors but it is designed to produce motion in a straight line.Linear induction motors have a finite length primary, which generates end-effects, whereas with a conventional induction motor the primary is of infinite length.3 phase supply is required to run linear induction motors.It includes linear propulsion, magnetic levitation and linear actuators.

2.3 LIM Stator Unit Design

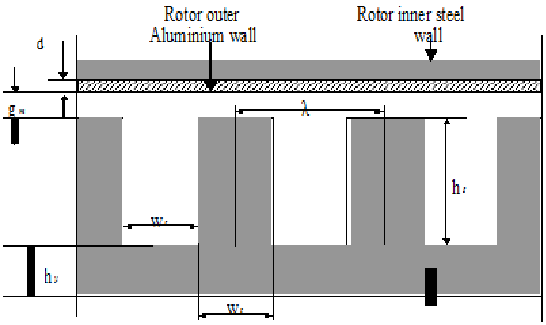

Fig-4:- Slotted stator

Rating of motor=1 HP =0.746 KW.
Number of pole (p) =4.
Supply voltage (v)=415v.
Synchronous speed Ns=120*f/p=1500 rpm
Speed in rps=25 rps
Rotor speed N=Ns(1-s)=1416 rpm
E=4.44*f*φm*Kw*Tph.
Q=C0*ns*D2L.
C0=11Kw*Bav*ac*10-3.
C0=11*0.955*0.44*21000
C0=97066.066.
Q=C0*ns*D2L.
Q=Pout/(cos*eff)=1130 VA
Input power=Q*cos=932.50 w
D^2L=0.0005
L/D=1.1780
D=0.0734
L=0.086
Width of slot=0.006 m
Height of yoke=0.002 m
Length of core=3.14*D=0.2483 m
Mean length of stator core=0.4 m/s
Stator field velocityVs=D*ns=6.2075 m/s
Linear speed=stator field velocity *(18/5)=22.34 km/h
τ=L/1.2=0.0621 m
Max flux = Bavg *τ *L=0.02 wb
Stator turns per phase=Vph/ (4.44*f*Øm*kw)=962.11
Total no of turns=3*Nph=2886.35
Total no conductors Z=2*Nph=5772.70
Conductor per phase=Z/3=1924.23
Stator conductor per slot=Z/Ss=240.52
Stator current per phase= Pin / (3)0.5*Vl*Il*cos=0.09079 A
Line current =1.57 A
Area of stator conductor=Iph/δ=0.186mm2
Area of each slot = Zss*asz/space factor=109.8185 mm2
Diameter of stator conductor=(4*asz/3.14=0.4809)0.5 mm
Radius of conductor=0.24 mm
Diameter of conductor with insulation=d+covering=0.5530mm
Area of stator conductor with insulationAsz=0.2401 mm2
Mean length of stator conductor=2*L+2.3*τ+0.24=0.53 m
Length of stator winding per phase=Lmtps*Nph=1534 m
Stator winding resistance per phase = τ*lmtps/asz*ts=59.16`Ω
Area of stator core =Ls *Ws=0.029 m2
Air gap length=(0.2+2DL)0.5=0.35 mm
Volume of stator core=Asc*Hs+Hy=0.001 m3
Volume of copper material =Asz*Lw=0.0004 m3
Weight of copper =V*ϱ=2.89 kg
Weight of stator core=V*ϱ=10.19 kg

Image-1:-. No of conductors per phase

2.4 Rotor Unit Design

Aluminum short circuit strip is used as rotor bar.
Length=135cm=1350mm.
Width=8.6cm=86mm
Thickness=5mm
Therefore the losses in the rotor are assumed 100 w.
Total losses=261 w
Estimated output power=Pin-Ploss
Pout=670.88w
%ή=(Pout/Pout-Ploss)*100
%ή=71.91

2.5 Elevator Structure Design

Height of structure=121.90 cm
Aluminium plate height=135 cm
Air gap=2 mm
Counter weight=1/3 of empty cage
Weight of empty cage=2.5kg
Weight to be lifted by elevator,
Velocity of rotor(V_s)=(2*(2*3.14*R*F))/P
V_s=(2*2*3.14*50*0.0477)/4 =7.50 m/s
Power = Force *Velocity
746=F*7.49
F=100 N
F=Mg(According to the law of Gravitation)
100 N=M*9.81
M=10.19 kg

Image-2:-Elevator structure.

3. DESIGN DATA SHEET

5.2.1 Input Data

PARAMETER	NOTATION	VALUE	SI UNIT
Output power	Pout	746	W
Frequency	F	50	Hz
No of phases	M	3	
Poles	P	4	
Power factor	Cos	0.825	
Efficiency	΄Η	0.8	
Specific magnetic loading	Bavg	0.44	wb/m^2
Maximum flux density	Bm	0.698412698	wb/m^2
Core Length/Pole pitch	L/τ	1.5	
Specific electric loading	Ac	21000	AC
Slip	S	0.056	
Input voltage	V	415	V
Phase voltage	$V_{ph}=V_l$	415	V
Winding factor	Kw	0.955	
Slot per pole per phase	Q	2	
Current density	Δ	5	A/mm^2
Resistivity	P	0.021	ohm/m/mm^2
Copper Density		7.85E+03	m^3
Iron Density		8.96E+03	
Specific core loss per kg		1.3	w/kg
Space Factor		0.4	
Rotor Slot	S_r	22	

Table-1:- Input data

4. EFFICIENCY ANALYSIS

Load in %	Efficiency (%)
Full Load	71.90
75% Load	53.93
Half Load	35.95
25% Load	17.97

Table-2:- Efficiency Analysis

Image-3:-. Performance Analysis

5. Conclusion

The project is very informative, no doubt, but a better conclusion will give a good finishing hand to this project. Conclusion can also be said to the salient features of this project. Firstly, we learnt about the working mechanism of Linear Induction Motor and how the generation of linear magnetic field occurs. Secondly, the most vital part of any project is the designing process. We had done two types of designs viz. theoretical and practical. Theoretical design is done by various calculations succeeded by programming analysis and then it is done in workshop. In this journey of designing we saw huge difference between the theoretical and practical approach of designing but we also saw many similarities in calculations and practical process.

6. Acknowledgment

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