MODELLING AND CHARACTERIZATION OF HIGH PERFORMANCE LINEAR OSCILLATING PARAMETRIC MOTOR

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Abstract: : *The paper describes the investigation and development of a structure and performance characteristics of a novel oscillating linear parametric motor. The oscillating thrust is improved by introducing a magnetic circuit to canalise the field lines. The model is verified with experimental results which show that the proposed motor is an ideal launcher.*
In this article authors Show that the model is well adapted to compute Cores losses. A lot of comparisons between measured And simulated results are shown.

Key words: *Linear motor; linear parametric motor, oscillating parametric motor, single phase system.*

1. Introduction

A linear parametric motor plays an important role in factory automation, industry applications and robotics [1]. It has a number of advantages. That is, the linear motor can be excited by single phase power source and has overload protection characteristics. Various linear motors have emerged to serve numerous applications in the home equipment and transport as well [2], [3]. The linear parametric motor with plan or tubular induction is based on the periodical variation of inductance in an electric circuit with a load [4].
The main objective of the project is to design a novel oscillating linear parametric motor. A Mathematical model of the oscillating linear parametric motor has to be developed in which force control can be employed. Measurements are conducted for the oscillating linear parametric motor. The model characteristics are verified.

2. Oscillating linear parametric motor principle

Figure.1 shows the parametric oscillating motor used for the fist time in the project. It consists of a coil and a core
which can slide inside this one. By connecting this coil to an alternating single phase source through a capacitor and variable resistor, under conditions of electromechanical resonance, after an initial displacement of the core, it is possible to obtain a direct-reverse movement of the core [5].

3. A MATHEMATICAL MODEL OF THE MOTOR

The motor operates under ac supply equilibrium and the equations for the whole electromagnetic system, which **is** relevant to the diagram shown in Figure. 1, are as follows.
The electrical equation that describes the system is the same as for the dc motor except that for the ac supply the inductor behaviour is function of the displacement coil given by equation 1

$$R\,i + L\frac{d\,i}{d\,t} + i\,v\frac{dL}{d\,x} + \frac{1}{c}\int i\,dt = U_m \cos\omega_s\,t \quad (1)$$

Where V: is the velocity of oscillating core.
The mechanical equation that describes our system is the same as the mass between two strings and is given by equation 2.

$$m\cdot\frac{d^2x}{dt^2} + f\cdot\frac{dx}{dt} + k\cdot x = -F_{em}(t) \quad (2)$$

The magnetic force is expressed by the following formula

$$F_{em}(t) = \frac{d\,W}{d\,x} = -\frac{1}{2}i^2.\frac{d\,L(x)}{d\,x} \quad (3)$$

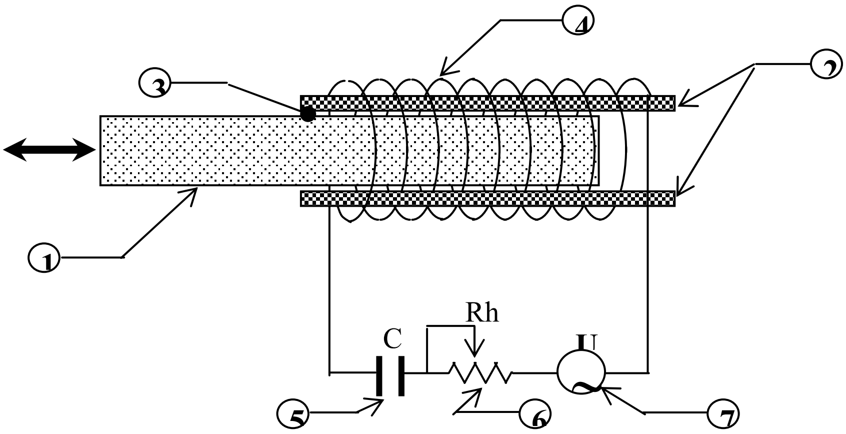

Figure.1. Linear oscillating tubular motor

Where:
W: Electromagnetically energy
f : Friction coefficient
m: is the mass of the core
fm: is the magnetic force acting on the bar,
L: is the coil inductance changing its value with the position of the core
R: is the coil resistance,
C: is the capacitance,
i : is the coil current,
V: is the supply voltage,

However when the motor is supplied from an ac source, the core oscillate between two symmetrical resonant points with respect to the core.

$$x_{r1} \langle x \quad \langle x_{r2}$$

where x_{r1} and x_{r2} are the resonant points.

4. Simulation results of the motor

The differential equations 1 and 2**,** together with other auxiliary equations, can be solved numerically, using MATLAB CODE.

The performances of the motor under steady and dynamical state for the following parameters were carried out.
coil resistance R_b = 11 ohms,
length of the core l= 0.15m
the coil l=0.24m**,**
mass of the bar m **= 0.67** kg,
The capacitance: C =36µf
These data refer to a real motor that was manufactured and tested in our laboratory

The simulation results at ac supply are presented in figures 2 to 6 and refer the variation in magnitude of the following quantities with respect to displacement .x

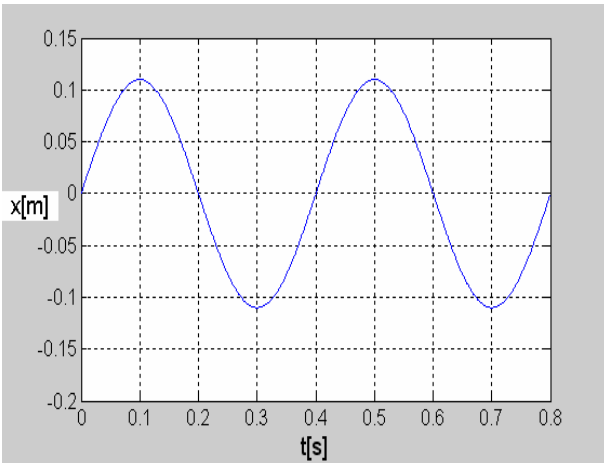

Fig.02. Characteristic of displacement versus time

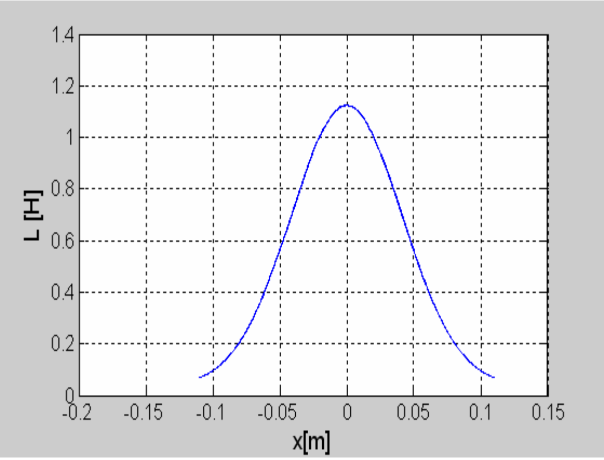

Fig.03. Inductor versus displacement

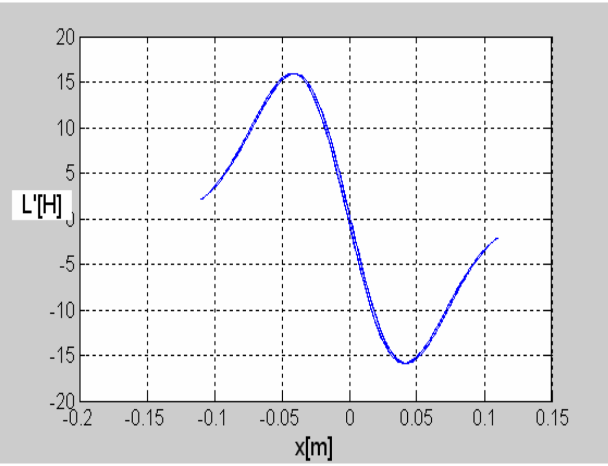

Fig.04. Characteristic of dl/dx versus displacement

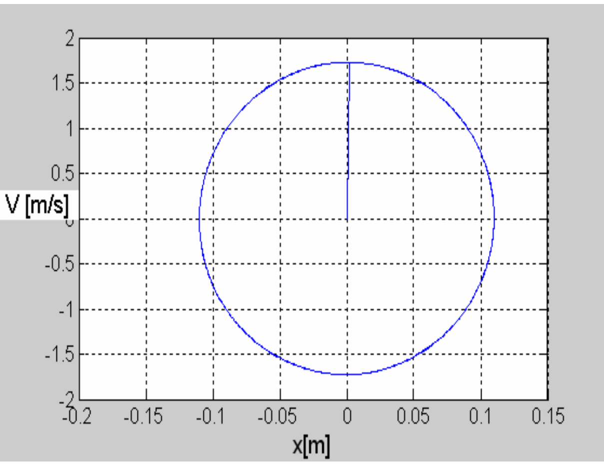

Fig.05.Characteristic of velocity versus displacement

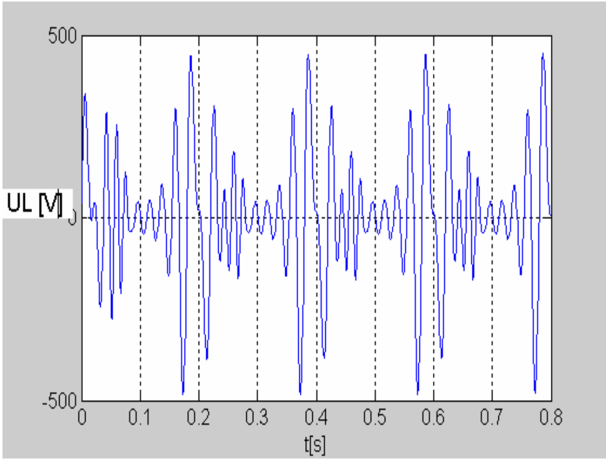

Fig.6.coil voltage Characteristic versus time

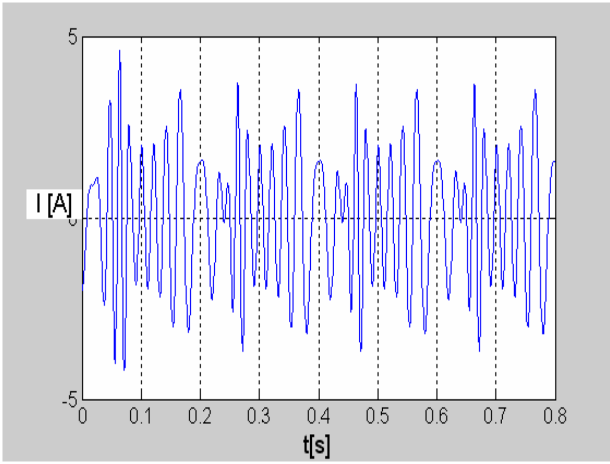

Fig.7. current characteristic versus time

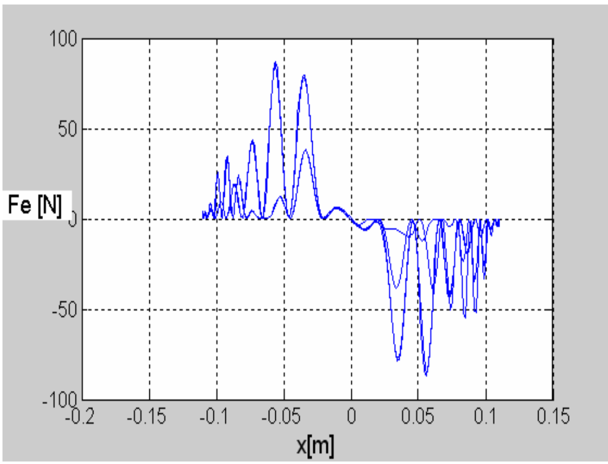

Fig.8. Force characteristic versus displacement

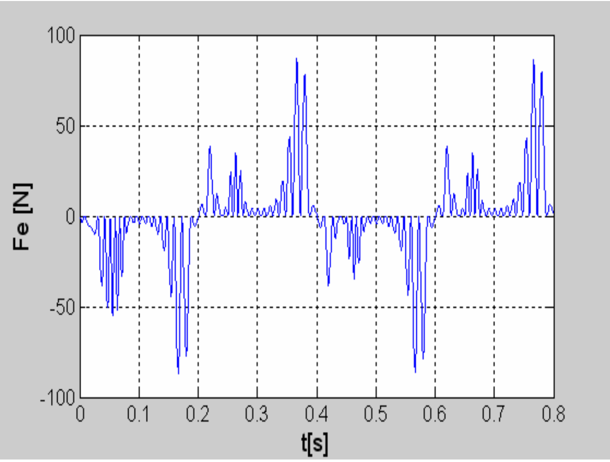

Fig.9.Firce characteristic Force versus time

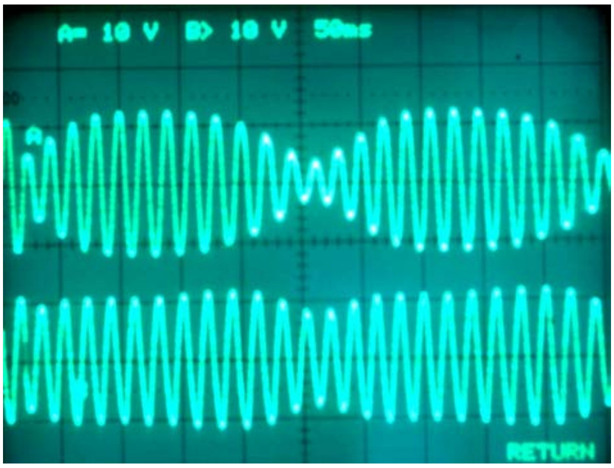

Fig.11 Characteristic of inductor and capacitor versus time

5. Experimental results

The parametric motor operation experimental results on no load were carried out for a fixed capacitor and the supply frequency.

The results of the experience, presented in this paper, illustrate the performance of parametric oscillating motor operating at **ac** supply. For a comparative study the same quantities as in simulation were plotted as indicated by figure 10 through 15.

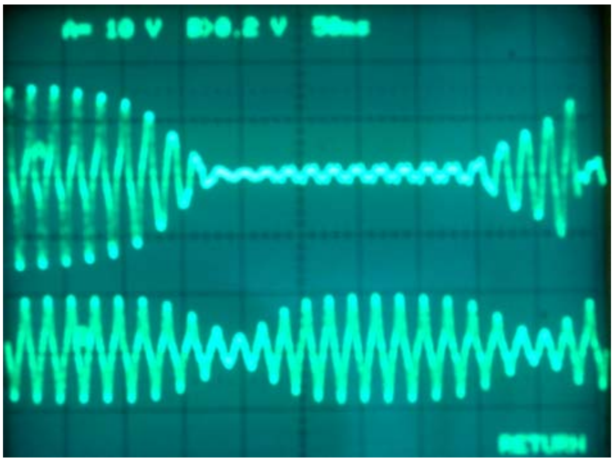

Fig.12 Characteristic velocity and current versus time

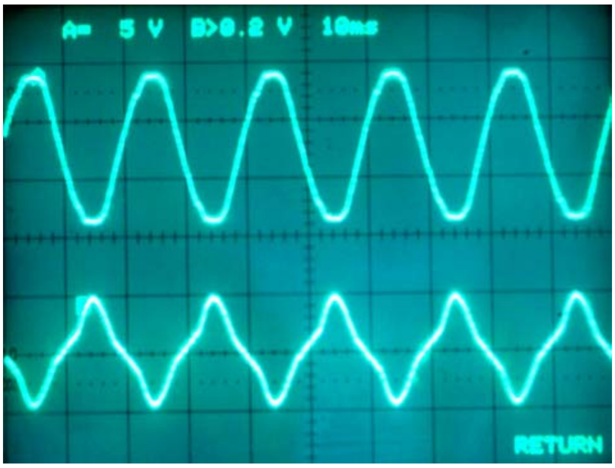

Fig.10 Characteristic of inductor voltage and current versus time

6. Conclusion

The performance of the linear oscillating motor operating under ac supply is presented. The motor under ac supply must be equipped with a capacitor connected to the stator coil. It operates on the basis of the resonance in stator circuit and is known as a self-oscillating motor. The results of the simulation, presented in the paper, illustrate the performance of linear oscillating motor.

The experimental results at ac supply were presented and compared with the ones obtained from simulation

The coil should be always switched on when the bar is at the center. ***At*** a certain distance the driving force drops practically to zero. Thus to avoid unnecessary power loss the coil should be switched off before this point.

7. References

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