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Research on Permanent Magnet Linear Synchronous Motor Control System Simulation[*]

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Abstract

Based on the analysis of mathematical models of PMLSM and theories of vector control, it puts forward control system modeling method, two control loops which are the inner current-loop and the outer speed-loop are used in Matlab/Simulink, permanent magnet linear synchronous motors mathematical model is also modeled by end effect and three phase asymmetric winding. The simulation results proved the affectivity of the system's model and verified its control calculation way, and it also provided sufficient theoretical basis for designing and adjusting in practical control system.

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1. Introduction

The permanent magnet synchronous linear motor that is a new feed transmission, and it does not use mechanical transmissions. The permanent magnet synchronous linear motor was more and more used in factory automation and numerical control systems because they can be operated without indirect coupling

mechanisms, such as gear boxes, chains and screw coupling, allowing high precision control to be achieved. It is a trance that linear motors are widely used in high performance CNC machine tools [1]. The vector control system of permanent magnet synchronous linear motor doesn't have the advantage of high precision control and high dynamic performance, but also can change speed more conveniently, as a result, the system attract more and more scholars to pay attention home and abroad [2]. The experiment has built the model of vector control system of PMSLM based on the environment of MATLAB software, which can provide the design and work of actual system with a new measure.

2. Mathematical model of PMLSM

The model of linear synchronous motor with permanent magnets is given in the "rotor" coordinates; it is derived from the model of rotary PMSM motor, which is based on the general theory of electrical machines.

The model is valid only under the (simplistic) terms: the windings is three-phase, symmetrical, connected in star and with not connected central node, magnetizing characteristic is linear, loss in the magnetic circuit is zero, resistances and inductances are constant, air gap is constant, magnetic field in the air gap has a sinusoidal distribution and in the longitudinal axis is constant, boundary effects and the influence of the grooves is not considered.
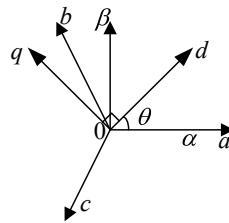

Fig.1. Coordinate system

Because that three phase permanent magnet synchronous linear motor has the characters of Multi variable, nonlinear and strong coupling. Engineers can't control anyone of three phases directly. To control it more conveniently, the model should be described in the d-q coordinate system. According to unified theory of electric motor, the equation from three-phase static coordinates to rotary two-phase coordinates as follow:

$$C_{3s/2s} = \sqrt{\frac{2}{3}} \begin{bmatrix} \cos\theta & \cos(\theta - \frac{2}{3}\pi) & \cos(\theta + \frac{2}{3}\pi) \\ -\sin\theta & -\sin(\theta - \frac{2}{3}\pi) & -\sin(\theta + \frac{2}{3}\pi) \\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{bmatrix} \tag{1}$$

Thus, the following voltages equation of the stator which in the d-q coordinates system is given easily.

$$\begin{bmatrix} u_d \\ u_q \\ u_0 \end{bmatrix} = C_{3s/2s} \begin{bmatrix} u_a \\ u_b \\ u_c \end{bmatrix} \tag{2}$$