Abstract: Now a days, Permanent Magnet Synchronous Motor (PMSM) is designed not only to be more powerful but also with lower mass and lower moment of inertia. Due to its high power density and smaller size, PMSM has in recent years evolved as the preferred solution for speed and position control drives on machine tools and robots. One of the efficient control strategies of PMSM is Vector Control. The rotor position is necessary to achieve the vector control drive system of Permanent Magnet Synchronous Motor. The proposed scheme has to be verified by simulation. PMSM is widely used in national defense, agriculture and daily life. PMSM is a multivariable, nonlinear and high coupling system. The output torque and stator current present a complicated function relation. Magnetic field can be decoupled to get a good control performance. It was no slip frequency current, less affected by the rotor parameters, easier to implement vector control.

Keywords: Permanent Magnet, Synchronous Motor, Control, Simulink Drive, PI Controller, Torque Angle, Electrical Drive.

I. INTRODUCTION

The electrical machine that converts electrical energy into mechanical energy and vice versa. Drive system are widely used in applications such as pumps, fans, paper, robotics, textile mills elevators and electric vehicles etc. More than 85% of drive systems use Induction motors at present but Permanent Magnet Synchronous Motors (PMSM) can replace them as they are more efficient which in turn reduces there placement cost. Hence they have more market now a days and it can be used for low and mid power applications such as computer peripherals and adjustable speed drives effectively. In this work, the simulation of a field oriented controlled PM motor drive system is developed using simulink.

II. OVERVIEW OF ELECTRICAL DRIVES

Motion control is required in large number of industrial and domestic applications like transportation systems, rolling mills, paper machines, textile mills, fans, pumps, robots, washing machines etc. System employed for motion control are called drives and may employ any of the prime movers such as, diesel or petrol engines, gas or steam turbines, steam engines, hydraulic motors and electric motors for supplying mechanical energy for motion control. Drives employing electric motors are known as Electrical Drives.

III. VECTOR CONTROL

Vector control is also known as decoupling or field orientated control. Vector control decouples three phase stator current into two phase d-q axis current, one producing flux and other producing torque. This allows direct control of flux and torque. So by using vector control, the PMSM is equivalent into a separately excited dc machine. The model of PMSM is nonlinear. So by using vector control, the model of PMSM is linear. The scheme of vector control is based on coordinate transformation and motor torque equation by means of controlling stator current to improve the performances of motor, and is widely used in the field of PMSM servo system. In the control of a three-phase PMSM system, modulated current is supplied to the A-B-C stator windings to build rotated magnetic field and drive the rotor. The vector control strategy is formulated in the synchronously rotating reference frame. By Clarke-Park transformations and inverse transformations the equivalent relations of currents are built among a,b,c stator coordinates, stationary α, β axis coordinates and rotating d, q axis coordinates. Fig.2, shows a vector diagram of the PMSM. Phase a is assumed to be the reference. The instantaneous position of the rotor (and hence rotor flux) is at 0° from phase a. The application of vector control, so as to make it similar to a DC machine, demands that the quadrature axis current iq be in quadrature to the rotor flux. Consequently id has to be along the rotor flux since in the reference used id lags iq by 90°. If id is in the same direction as the rotor flux, the d axis stator flux adds to the rotor flux that leads to increase in the net air gap flux. On the other hand if id is negative then the stator d-axis flux is in opposite to that of the rotor flux resulting in a decrease in air gap flux.

IV. PMSM VECTOR CONTROL THEORY

Vector control is actually control of phase and amplitude for a motor stator voltage or current vector at the same time. The motor torque will depend on the stator current space vector is = id + iq. When the permanent magnet flux and the direct excitation, cross-axis inductance is confirmed. In other words, control id and iq that can control the motor torque. Current id as excitation current, on the id of the control, in practical application there are three kinds of general circumstances, this paper use id = 0 of the control strategy. Permanent magnet rotor according to the location of the different permanent magnet synchronous motor can be divided into: the surface and inside buried. The tile-shaped magnet was generally and in the outer surface of the rotor iron core in the surface permanent magnet synchronous motor (SPM SM). This important feature of the motor is that straight axis and cross axis for the main inductance is equal (L d = L q). And within the interior permanent magnet synchronous motor (IPMSM) of the permanent magnets in the rotor inside the stator magnet in vitro surface and inner circle core made of ferromagnetic material between the pole shoe can protect the permanent magnets. This important feature of permanent magnet motor is direct, cross-axis of the main inductance is not equal to (L d f L q). For surface-
type PMSM, as \( L_d = L_q \), this style incorporated into the electromagnetic torque equation. Torque equation can be obtained equation (2.10) that only related to the electromagnetic torque and the q axis current \( i_q \). So let \( i_d = 0 \), through control the \( i_q \), you can achieve maximum torque control in the surface type PM SM vector control. Figure 2 shows a vector control strategy block diagram with the use of \( i_d = 0 \).

V. SIMULINK BASED SIMULATION MODEL OF PMSM

Used directly in the Simulink side Simpower systems own model of parts library. Speed and Figure 3 is a model for sensorless vector control, which is called this simulation platform. Permanent magnet motor and inverter models position information from the measurement module Machines Measurement Demux direct feedback. Use \( i_d = 0 \) control method to control the speed and dq-axis current with PI control.

VI. SIMULATION RESULTS

According to the proposed vector control of PMSM simulation model, run in Matlab, using the motor parameters in bellow are as follows: electrical power \( P = 2kW \), DC voltage \( U_{dc} = 310V \), stator windings resistance \( R_s = 1.4 \Omega \), d- phase winding inductance \( L_d = 0.0036e-3H \), the pole number \( p = 6 \), magnetic flux density \( B = 0 \). Set the total simulation time \( t = 0.2s \), for the sudden increase in torque test. No load start, \( t = 0.1s \) when the additional load \( T_m = 5N.m \), speed is 700 r / min. Waveforms as follows:
VII. CONCLUSION

In this paper, Simulink based simulation of PMSM vector control system modeling. Simulation results show that the system can run smoothly, has good static and dynamic characteristics. Experiment and validate \( \text{id} = 0 \) is a good control algorithm. It provides an effective means and tools for analysis and design of PMSM control system. It also show its controlling is too easy.

REFERENCES


