ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 1, January 2016

Compare the Direct Torque Control of Permanent Magnet Synchronous Motor with Asynchronous Motor by Increasing Levels of Inverter

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ABSTRACT: Industrial automation have been developed mostly the around of motion control systems in which the controlled electric motor have vital role as heart of system. So, motor control systems with a very good performance to a large extent result in optimum performance of the automation of production that this work is associated with increased production and quality of products. In fact, the performance of modern automation systems, which in terms of speed, accuracy, flexibility and performance are defined, mainly related to control strategies. Recent developments in the power electronics industry has led to a significant increase of power that can exchanged by semiconductor equipment. Despite this, most voltage supported by this equipment is a major obstacle in the applications of medium & high Voltage. Multilevel converters have been introduced for such applications. These inverters have less harmonic distortion compared with standard two-level inverters when they are working a switching frequency. Permanent magnet synchronous motors (PMSM) newly developed with high energy permanent magnet materials if properly controlled can provide fast dynamic and performance with high efficiency and compatibility are very good in various applications. In spite of all these, motor control including PMSM control is a challenge due to dynamic of very fast motor and very linear models of machines. So, much of motor control development includes extraction of appropriate mathematical models. Modelling & simulation is performed on MATLAB\SIMULINK software.

KEYWORDS: Permanent magnet synchronous motors, Three-level inverter, Direct torque control, MATLAB\SIMULINK Software.

I.INTRODUCTION

1.1. SYNCHRONOUS MOTOR

A synchronous electric motor is an AC motor in which, at steady state, the rotation of the shaft is synchronized with the frequency of the supply current; the rotation period is exactly equal to an integral number of AC cycles. It is not used for speed control because rotated at a constant speed. Many losses caused in the machine because these motors have brush and sliding ring. Three phase synchronous motor used for reactive power control (condenser) in power systems, i.e. it can received reactive power from network and injected reactive power to network. So, it used to adjust voltage of transmission lines. But the most important use of synchronous electric motor is the power factor correction. i.e., by changing the excitation current can convert motor current from lag to lead phase state and vice versa [1].

1.2. PERMANENT MAGNET SYNCHRONOUS MOTOR

A permanent magnet synchronous motor (PMSM) uses permanent magnets embedded in the steel rotor to create a constant magnetic field. The stator carries windings connected to an AC supply to produce a rotating magnetic field. At synchronous speed the rotor poles lock to the rotating magnetic field. These motors are not self-starting. Because of the constant magnetic field in the rotor these cannot use induction windings for starting.

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PMSM used more in case that requires rapid torque response and performance quality. PMSM is very similar to synchronous motor with winding rotor except that motor does not have the coil dampers and excitation instead of a field coil is provided by a permanent magnet [2].

Remove the field coil, DC source and sliding rings reduce losses and complexity of the motor. For the same frame size, permanent magnet motors have more torque failure. Mathematically proven to increase the electromagnetic torque in a permanent magnet motor is proportional to the increase in scattering angle between the stator and rotor fluxes. So, fast response torque can be achieved by adjusting as soon as possible the velocity of circulation of the stator flux distribution. This is possible by direct torque control (DTC) technique. DTC is used more in industry and PMSM with three-phase two-level voltage source inverter with hysteresis controller because it has some advantages. Such as: simplicity, low dependence on motor parameters and good response of dynamic torque. This type of system drive called classic direct torque control of permanent magnet synchronous motor [2].

1.3. PERMANENT MAGNETS MATERIALS

A permanent magnet synchronous motor (PMSM) is a motor that uses permanent magnets to produce the air gap magnetic field rather than using electromagnets. These motors have significant advantages, attracting the interest of researchers and industry for use in many applications.

The properties of the permanent magnet material will affect directly the performance of the motor and proper knowledge is required for the selection of the materials and for understanding PM motors.

The earliest manufactured magnet materials were hardened steel. Magnets made from steel were easily magnetized. However, they could hold very low energy and it was easy to demagnetize. In recent years other magnet materials such as Aluminum Nickel and Cobalt alloys (ALNICO), Strontium Ferrite or Barium Ferrite (Ferrite), Samarium Cobalt (First generation rare earth magnet) (SmCo) and Neodymium Iron-Boron (Second generation rare earth magnet) (NdFeB) have been developed and used for making permanent magnets.

The rare earth magnets are categorized into two classes: Samarium Cobalt (SmCo) magnets and Neodymium Iron Boride (NdFeB) magnets. SmCo magnets have higher flux density levels but they are very expensive. NdFeB magnets are the most common rare earth magnets used in motors these days. A flux density versus magnetizing field for these magnets is illustrated in figure 1 [2].

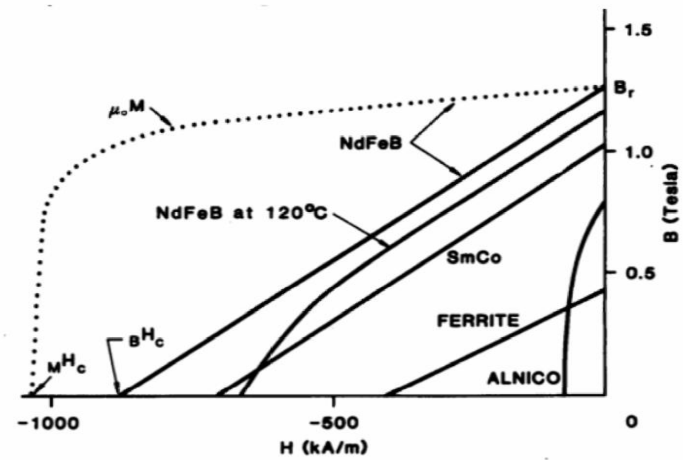

Fig. 1 Flux Density versus Magnetizing Field of Permanent Magnetic Materials [2]

II.MATHEMATICAL MODELING OF PMSM

2.1. SPACE VECTORS

Synchronous machines with permanent magnet in rotor compared to asynchronous machines have less inertia, greater efficiency and more torque to volume ratio. These benefits lead to increased use them in hybrid cars, windmills, compressors, pumps and fans. In addition, the better performance of drives with high dynamic related to PMSM has many applications in the manufacturing processes and transportation systems where it is need to fast and accurate torque response. Advanced control techniques have been developed since the reliability and cost of modern PMSM drives is very important. Basically, a permanent magnet synchronous machine is a conventional AC machine with

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windings distributed in stator slots, so the flux created by the stator current is nearly sinusoidal and use permanent magnets instead of electromagnets to generate a magnetic field of air gap. These motors have significant advantages and have attracted attention researchers and industry to own for use in all types of applications. However, the high initial cost, operating temperature constraints, and the risk of losing permanent magnets can be restrictive in some applications. Permanent magnet installed inside or outside of rotor in PMSM. Unlike DC motors with brushless, PMSM require a drive to provide the commutation current. This event is made through pulse width modulation DC and using a DC to AC inverter in the motor windings [3].

A rotating magnetic field is created by energizing some special windings of the stator based rotor position. Currents of stator windings switch in a predetermined sequence, and therefore permanent magnets can be created a constant magnetic field on the rotor that magnetic field of circular stator follow at constant velocity. This velocity depends on the applied frequency and number of poles of the motor. Since the switching frequency is extracted from the rotor, motor is not capable of losing its synchronization. The current switches always before reaching to permanent magnets; so the motor speed is directly proportional to the rate of flow switching.

In a permanent magnet synchronous motor (PMSM) where the inductances vary as a function of the rotor angle, the two-phase (d-q) equivalent circuit model is a perfect solution to analyze the multiphase machines because of its simplicity and intuition. Conventionally, a two-phase equivalent circuit model instead of complex three-phase model has been used to analyze reluctance synchronous machines [3]. This theory is now applied in the analysis of other types of motors including PM synchronous motors, induction motors etc.

Comparing a primitive version of a PMSM with wound-rotor synchronous motor, the stator of a PMSM has windings similar to those of the conventional wound-rotor synchronous motor which is generally three-phase, Y-connected, and sinusoidally distributed. However, on the rotor side instead of the electrical-circuit seen in the wound-rotor synchronous motor, constant rotor flux (λ_r) provided by the permanent magnet in/on the rotor should be considered in the d-q model of a PMSM.

The space vector form of the stator voltage equation in the stationary reference frame is given as:

$$V_s = r_s i_s + d\lambda_s/dt \tag{1}$$

Where, r_s, V_s, i_s and λ_s are the resistance of the stator winding, complex space vectors of the three phase stator voltages, currents, and flux linkages, all expressed in the stationary reference frame fixed to the stator, respectively. They are defined as:

$$\begin{aligned} V_s &= \frac{2}{3}\left[V_{sa}(t) + aV_{sb}(t) + a^2 V_{sc}(t)\right] \\ i_s &= \frac{2}{3}\left[i_{sa}(t) + ai_{sb}(t) + a^2 i_{sc}(t)\right] \\ \lambda_s &= \frac{2}{3}\left[\lambda_{sa}(t) + a\lambda_{sb}(t) + a^2 \lambda_{sc}(t)\right] \end{aligned} \tag{2}$$

The resultant voltage, current, and flux linkage space vectors shown in fig. 2 for the stator are calculated by multiplying instantaneous phase values by the stator winding orientations in which the stator reference axis for the a-phase is chosen to the direction of maximum MMF. Reference axes for the b- and c- stator frames are chosen 120 and 240 (electrical degree) ahead of the a-axis, respectively. Fig. 2 illustrates a conceptual cross-sectional view of a three-phase, two-pole surface PM synchronous motor along with the two-phase d-q rotating reference frame [4].

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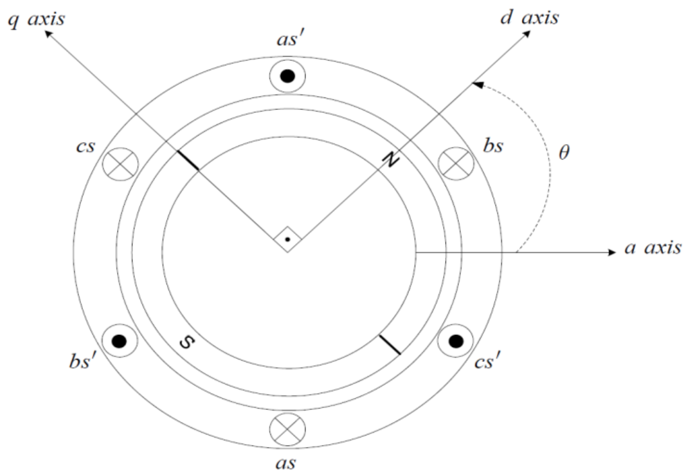

Fig. 2 Two-pole three phase surface mounted PMSM [4]

Voltage equations are given by:

$$V_d = R_s i_d - \omega_r \lambda_q + \frac{d\lambda_d}{dt}$$ (3)

$$V_q = R_s i_q - \omega_r \lambda_d + \frac{d\lambda_q}{dt}$$

Flux Linkages are given by

$$\lambda_d = L_d i_d + \lambda_f$$ (4)

$$\lambda_q = L_q i_q$$

Substituting equations (3) and (4) into (1) and (2)

$$V_d = R_s i_d - \omega_r L_q i_q + \frac{d}{dt}\left(L_d i_d + \lambda_f\right)$$ (5)

$$V_q = R_s i_q - \omega_r\left(L_d i_d + \lambda_f\right) + \frac{d\lambda}{dt}\left(L_q i_q\right)$$

Arranging equations (5) and (6) in matrix form

$$\begin{pmatrix} V_d \\ V_q \end{pmatrix} = \begin{pmatrix} R_s + sL_d & -\omega_r L_q \\ \omega_r L_d & R_s + sL_q \end{pmatrix}\begin{pmatrix} i_d \\ i_q \end{pmatrix} + \begin{pmatrix} 0 \\ \omega_r \lambda_f \end{pmatrix}$$ (6)

The developed torque motor is being given by

$$T_e = \frac{3}{2}\left(\frac{P}{2}\right)\left(\lambda_d i_q - \lambda_q i_d\right)$$ (7)

The mechanical Torque equation is

$$T_e = T_L + B\omega_m + J\frac{d\omega_m}{dt}$$ (8)

Solving for the rotor mechanical speed form equation (9)

$$\omega_m = \int\left(\frac{T_e - T_L - B\omega_m}{J}\right)dt$$ (9)

And

$$\omega_m = \omega_r\left(\frac{2}{p}\right)$$ (10)

In the above equations ωr is the rotor electrical speed whereas ωm is the rotor mechanical speed.

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2.2. CONVENTIONAL DIRECT TORQUE CONTROL (DTC) OPERATION OF PMSM DRIVE

Today there are basically two types of instantaneous electromagnetic torque-controlled AC drives used for high-performance applications: vector and direct torque control (DTC) drives. The most popular method, vector control was introduced more than 25 years ago in Germany by Hasse [5], Blaske [6], and Leonhard. The vector control method, also called Field Oriented Control (FOC) transforms the motor equations into a coordinate system that rotates in synchronism with the rotor flux vector.

Under a constant rotor flux amplitude there is a linear relationship between the control variables and the torque. Transforming the AC motor equations into field coordinates makes the FOC method resemble the decoupled torque production in a separately excited DC motor.

The basic concept behind the DTC of AC drive, as its name implies, is to control the electromagnetic torque and flux linkage directly and independently by the use of six or eight voltage space vectors found in lookup tables. The possible eight voltage space vectors used in DTC are shown in Fig. 3 [4].

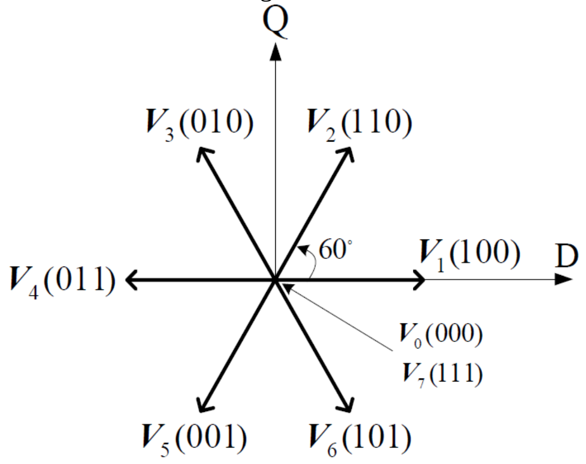

Fig. 3 Eight possible voltage space vectors obtained from VSI.

The typical DTC includes two hysteresis controllers, one for torque error correction and one for flux linkage error correction. The hysteresis flux controller makes the stator flux rotate in a circular fashion along the reference trajectory as shown in Fig. 4. The hysteresis torque controller tries to keep the motor torque within a pre-defined hysteresis band.

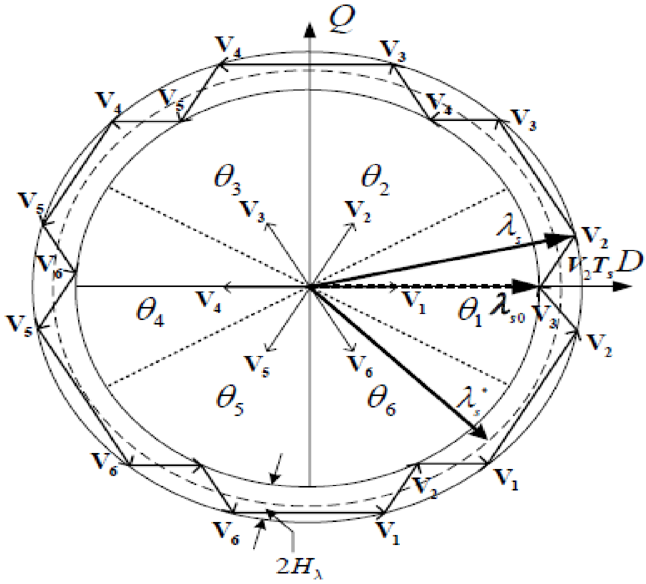

Fig. 4 Incremental stator flux linkage space vector representation in the DQ-plane.

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ISSN (Online): 2278 – 8875

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For a short interval of time, namely the sampling time, $T_s = \Delta t$ the stator flux linkage, λ_s, position and amplitude can be changed incrementally by applying the stator voltage vector, V_s. As discussed above, the position change of the stator flux linkage vector, λ_s, will affect the torque. The stator flux linkage of a PMSM that is depicted in the stationary reference frame is written as:

$$\lambda_s = \int \left(V_S - R_S i_S \right) dt \tag{11}$$

During the sampling interval time or switching interval, one out of the six voltage vectors is applied, and each voltage vector applied during the pre-defined sampling interval is constant, equation (11) can be rewritten as:

$$\lambda_s = V_S t - R_S \int i_S dt + \lambda_{s|t=0} \tag{12}$$

Where $\lambda_{s|t=0}$ is the initial stator flux linkage at the instant of switching, V_s is the measured stator voltage, i_s, is the measured stator current, and R_s is the estimated stator resistance. When the stator term in stator flux estimation is removed implying that the end of the stator flux vector, λ_s , will move in the direction of the applied voltage vector, as shown in Fig. 5, we obtain:

$$\Delta\lambda_s = V_S \ \Delta t \tag{13}$$

The goal of controlling the flux in DTC is to keep its amplitude within a pre-defined hysteresis band. By applying a required voltage vector stator flux linkage amplitude can be controlled. To select the voltage vectors for controlling the amplitude of the stator flux linkage the voltage plane is divided into six regions, as shown in Fig. 3.
In each region two adjacent voltage vectors, which give the minimum switching frequency, are selected to increase or decrease the amplitude of stator flux linkage, respectively. For example, when the voltage vector V_2 is applied in Sector 1, then the amplitude of the stator flux increases when the flux vector rotates counter-clockwise. If V_3 is selected then stator flux linkage amplitude decreases. The stator flux incremental vectors corresponding to each of the six inverter voltage vectors are shown in Fig. 5.

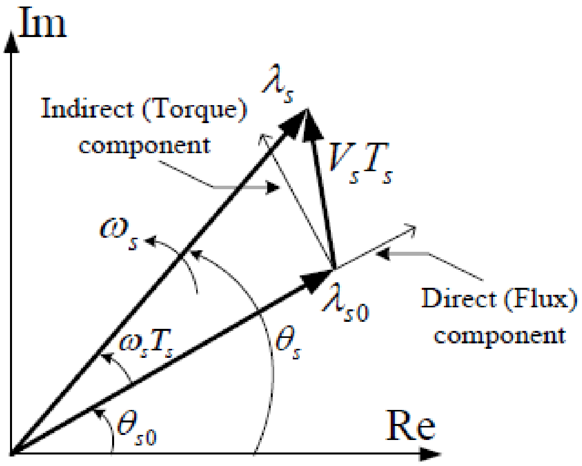

Fig. 5 Representation of direct and indirect components of the stator flux linkage vector [7].

Fig. 5 is a basic graph that shows how flux and torque can be changed as a function of the applied voltage vector. According to the figure, the direct component of applied voltage vector changes the amplitude of the stator flux linkage and the indirect component changes the flux rotation speed which changes the torque. If the torque needs to be changed abruptly then the flux does as well, so the closest voltage vector to the indirect component vector is applied. If torque change is not required, but flux amplitude is increased or decreased then the voltage vector closest to the direct component vector is chosen. Consequently, if both torque and flux are required to change then the appropriate resultant mid-way voltage vector between the indirect and direct components is applied [7]. It seems obvious from (3) that the stator flux linkage vector will stay at its original position when zero $S_a(000)$ and $S_b(111)$ voltage vectors and are applied. This is true for an induction motor since the stator flux linkage is uniquely determined by the stator voltage. On the other hand, in the DTC of a PMSM, the situation of applying the zero voltage vectors is not the same as in induction motors. This is because the stator flux linkage vector will change even when the zero voltage vectors are selected since the magnets rotate with the rotor. As a result, the zero voltage vectors are not used for controlling the

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ISSN (Online): 2278 – 8875

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stator flux linkage vector in a PMSM. In other words, the stator flux linkage should always be in motion with respect to the rotor flux linkage vector [8].

It considers a network with N mobile unlicensed nodes that move in an environment according to some stochastic mobility models. It also assumes that entire spectrum is divided into number of M non-overlapping orthogonal channels having different bandwidth. The access to each licensed channel is regulated by fixed duration time slots. Slot timing is assumed to be broadcast by the primary system. Before transmitting its message, each transmitter node, which is a node with the message, first selects a path node and a frequency channel to copy the message. After the path and channel selection, the transmitter node negotiates and handshakes with its path node and declares the selected channel frequency to the path. The communication needed for this coordination is assumed to be accomplished by a fixed length frequency hopping sequence (FHS) that is composed of K distinct licensed channels. In each time slot, each node consecutively hops on FHS within a given order to transmit and receive a coordination packet. The aim of coordination packet that is generated by a node with message is to inform its path about the frequency channel decided for the message copying.

Furthermore, the coordination packet is assumed to be small enough to be transmitted within slot duration. Instead of a common control channel, FHS provides a diversity to be able to find a vacant channel that can be used to transmit and receive the coordination packet. If a hop of FHS, i.e., a channel, is used by the primary system, the other hops of FHS can be tried to be used to coordinate. This can allow the nodes to use K channels to coordinate with each other rather than a single control channel. Whenever any two nodes are within their communication radius, they are assumed to meet with each other and they are called as contacted. In order to announce its existence, each node periodically broadcasts a beacon message to its contacts using FHS. Whenever a hop of FHS, i.e., a channel, is vacant, each node is assumed to receive the beacon messages from their contacts that are transiently in its communication radius.

III.SIMULATION RESULTS

3.1. DIRECT TORQUE CONTROL TECHNIQUE WITH TWO-LEVEL INVERTER

Control technique simulated in the MATLAB environment and shown in figure 6. Simulink model is as follows

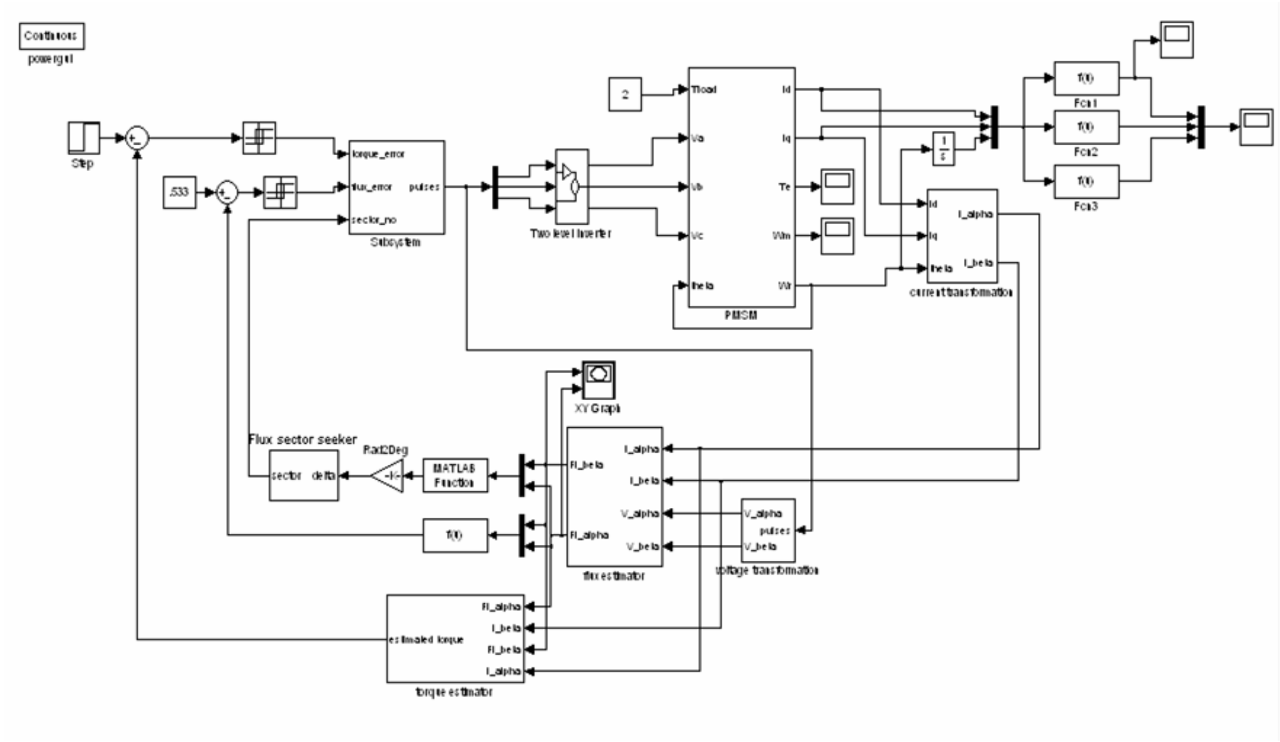

Fig. 6 Direct torque control with two-level inverter

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3.2. DIRECT TORQUE CONTROL TECHNIQUE WITH THREE-LEVEL INVERTER

Direct Torque Control Technique with three-level inverter is implemented in MATLAB\Simulink software and the results are showed. Drive parameters have been used for DTC with two-level inverter and comparison purposes in three-level inverter.

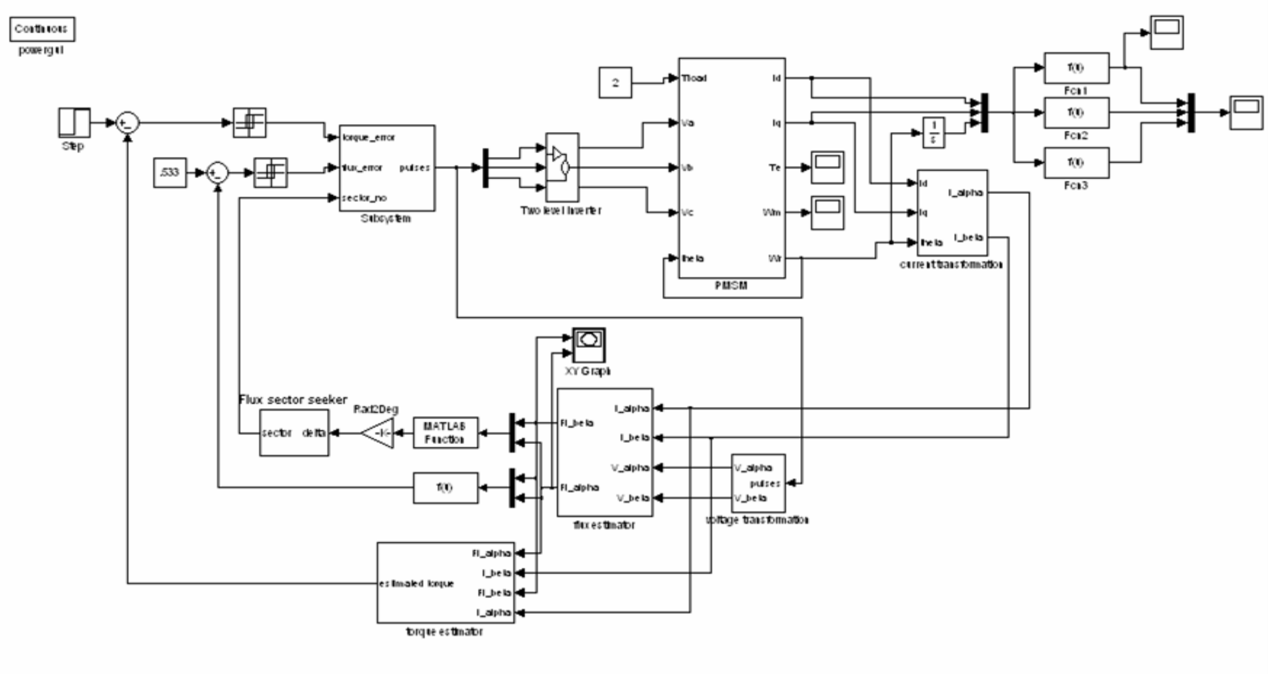

Fig. 7 Direct torque control with three-level inverter

3.3. COMPARISON OF DTC PMSM WITH TWO-LEVEL & THREE-LEVEL INVERTERS

In DTC, by selecting the appropriate switching status, torque and flux of stator adjust to their reference values. By increasing the number of inverter levels from two-level to three-level, so the following factors are changing:

a) reduce ripple of flux and torque

b) reduce the harmonic content of voltage and current

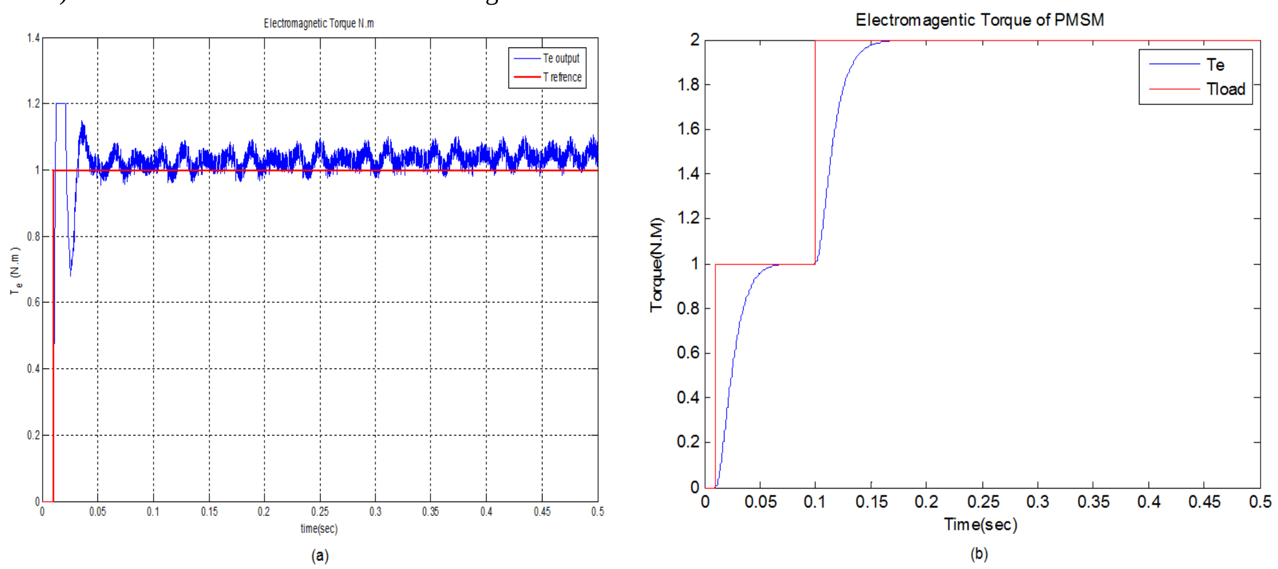

Fig. 8 Comparison of electromagnetic torque with a) two-level & b) three-level inverters

ISSN (Print) : 2320 – 3765
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International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

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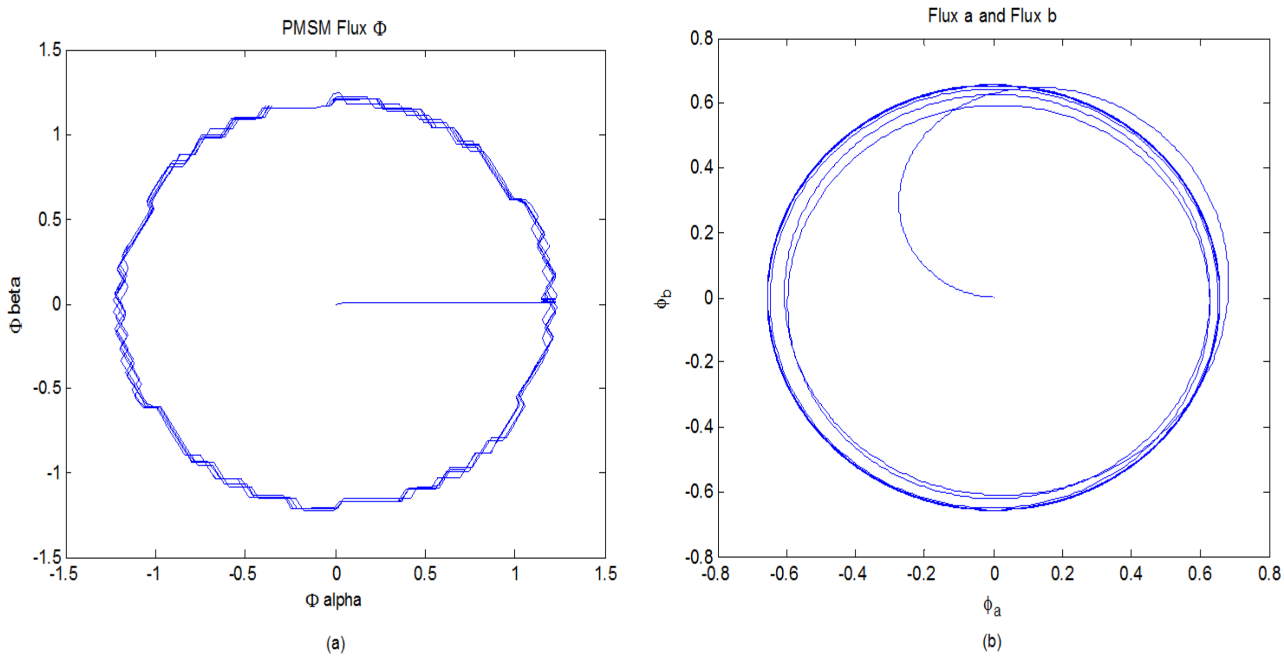

Fig. 9 Comparison of flux movement with a) two-level & b) three-level inverters

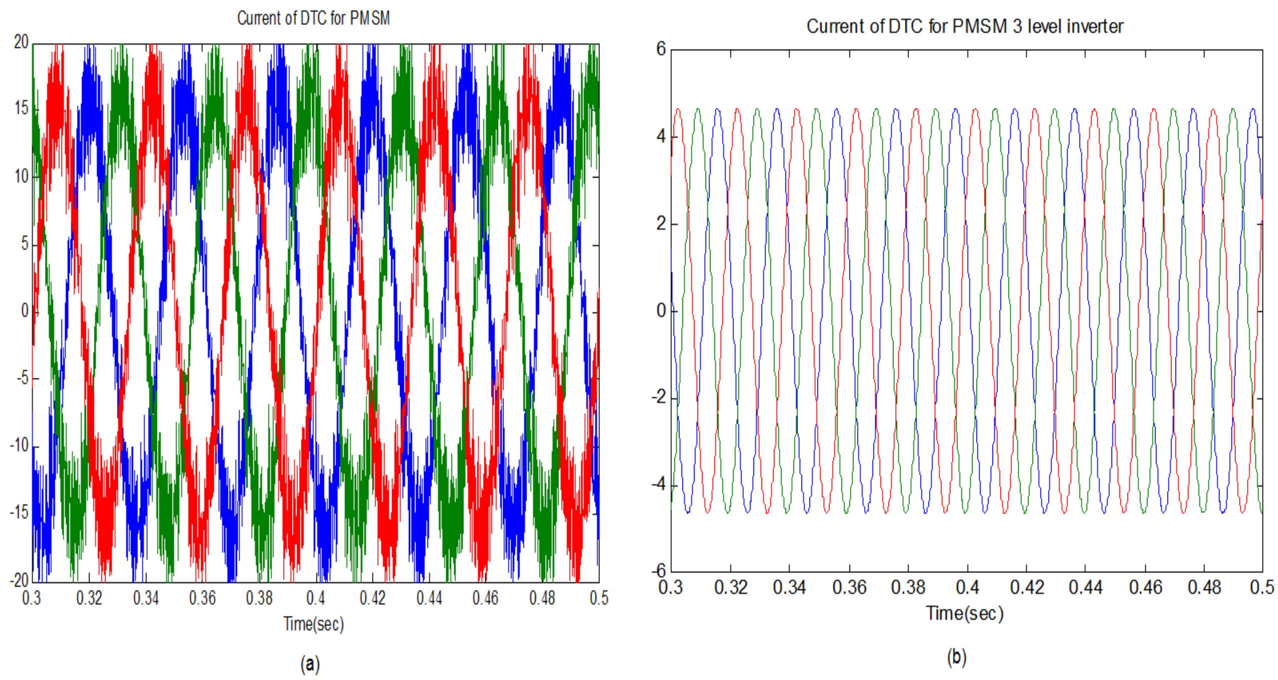

Fig. 10 Comparison of stator currents with a) two-level & b) three-level inverters

IV.CONCLUSION

Motor criteria such as durability, high performance, and high power factor, easy and inexpensive control, requires little maintenance led to a new type of motors with permanent magnets. Direct torque control (DTC) causes the effective control of torque and flux without can be changed motor and load parameters. As well as, Flux and torque can be controlled by inverter voltage vector directly in DTC. Two independent controllers of hysteresis used to be satisfied

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International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

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about flux and torque. In the simulation, some references flux of stator and torque compared with estimated values of motor parameters and errors send to comparators of hysteresis. The outputs of comparators of flux and torque used to determine the appropriate voltage vector and the stator flux space vector.

REFERENCES

[1] WEG Electric Machinery (WEM), "Synchronous Motors," pp. 1-16, 2013.
[2] Enrique L. Carrilo Arroyo, "Modeling and Simulation of Permanent Magnet Synchronous Motor Drive system", Ph.D thesis, University of Puerto Rico Mayaguez campus, 2006.
[3] Cui Bowen, Zhou Jihua, Ren Zhang, "Modeling and simulation of Permanent Magnet Synchronous Motor Drive", Fifth IEEE International Conference on Electrical Machines and Systems, Volume 2, Aug. 2001.
[4] Salih Baris Ozturk, "Modeling, Simulation and Analysis of Low-cost Direct Torque control Of PMSM using HALL-EFFECT sensors", Ph. D thesis, Texas A&M University, December 2005.
[5] K. Hasse, "Drehzahlgelverfahren für schnelle umkehrantriebe mit stromrichtergespeisten asynchron-kurzschlusslaufer-motoren," Reglungstechnik, vol. 20, pp. 60–66, 1972.
[6] S.P.Waikar, "A low-cost low-loss brushless permanent magnet motor drive." Ph.D. dissertation, Texas A&M University, College Station, TX, 2001.
[7] M. R. Zolghadri and D. Roye, "A fully digital sensor less direct torque control system for synchronous machine," Elect. Mach. Power Syst., vol. 26, pp. 709–721, 1998.
[8] L. Zhong, M. F. Rahman, W. Y. Hu, and K. W. Lim, "Analysis of direct torque control in permanent magnet synchronous motor drives," IEEE Trans. Power Electron., vol. 12, pp. 528–536, May 1997.

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