Velocity Control of 3 Phase Induction Motor V/F Technique by using Space Vector Modulation

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Abstract— This thesis presents the need of Speed Control in the Induction Motors. Out of the so many methods of controlling Induction motors, V/f Control has proven to be the most versatile. The overall system of implementing V/f control has been offered. One of the basic requirements of this scheme is the PWM Inverter. In this, PWM Inverters have been modeled and their outputs fed to the Induction Motor drives. The uncontrolled of transient and steady state response of the Induction Motor has been obtained and the analyzed. A MATLAB code was developed to successfully implement Open Loop V/f Control on a PWM-Inverter fed 3-phase Induction Motor, and the Torque was found to be constant for the various rotor speeds. This was followed by the MATLAB model for Closed-Loop V/f Control on the PWM-Inverter fed 3-phase Induction Motor. It was the observed that using a Closed-Loop system with a Proportional Controller gave a very better way of controlling the speed of an Induction motor as maintaining a constant maximum torque.

Key words: Matlab Simulink, V/F Control, Voltage Source Inverter (VSI), Pulse Width Modulation (PWM), Three Phase Induction Motor

I. INTRODUCTION

The torque developed by the induction motor is directly proportional to the v/f ratio. If we vary the voltage and frequency, keeping their ratio constant, then the torque produced by induction motor will remain constant for all the speed range.

A three phase induction motor is basically a constant speed motor. It is widely used in industry due to low cost and rugged constructions. The speed control of induction motor is done at the cost of decrease in efficiency and low electrical power factor.

Speed control means change the drive speed as desired by the process of maintain different process parameter at different load, energy saving, speed control is a different concept from speed regulation where there is natural change in speed due change in load on the shaft. Speed control is either done manually by the operator or by means of some automatic control device, low speed starting requirement.

II. V/F SPEED CONTROL FOR THREE PHASE INDUCTION MOTOR

This is the most popular method for controlling the speed of an induction motor. If the supply frequency is reduced keeping the rated supply voltage, the air gap flux will tend to saturate. This will cause excessive stator current and distortion of the stator flux wave. There for the stator voltage should also be reduced in proportional to the ratio of the stator voltage and the frequency. Hence, if the ratio of voltage to frequency is kept constant, the flux remains constant.

Also, by keeping v/f constant, the developed torque remains approximately constant. In sinusoidal pulse width modulation there are multiple pulses per half-cycle and the width of the each pulse is varied with respect to the sine wave magnitude corresponding to that duration.

In v/f control we have to maintain the constant ratio of voltage and frequency.

In order to achieve the constant ratio, we have to fire the (IGBT) in such way that the amplitude of output voltage waveform in a cycle will maintain the v/f ratio according the frequency change.

the voltage applied to the stator is directly proportional to product of the stator flux and angular velocity.

And hence

$$V \alpha (\Phi * f)$$

$$\Phi \alpha v/f$$

This makes the flux produced by stator proportional to the ratio of the applied voltage and frequency of supply.

$$V/F=C$$

V is voltage and f is called frequency, c=constant.

Therefore by the varying of voltage and frequency by the same ratio, the torque can be kept constant throughout the speed range. This makes constant V/f is the most common speed control of the induction motor.

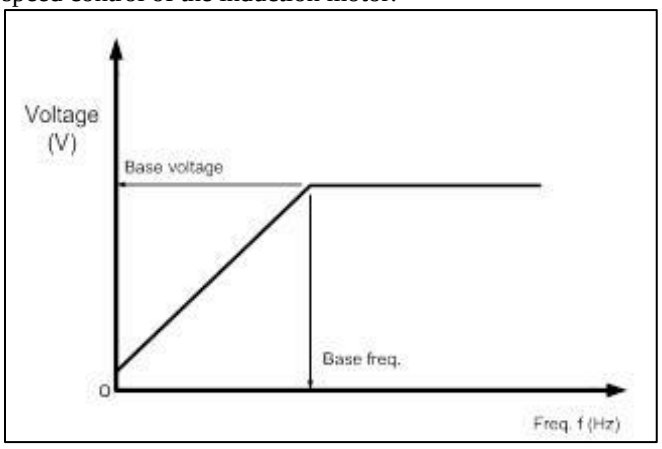

Fig. 1: Voltage-Frequency under constant V/f principle

A. Construction

The Induction Motor has the stator and a rotor. The rotor is a large magnet with poles constructed of steel lamination projecting out of the rotor core. The field winding is wound on the rotor which produces the magnetic field and the armature winding is on the stator where voltage is induced.

The rotor is usually the primary winding and receives its voltage from an external voltage source. The stator receives its voltage from the rotor by magnetic coupling. Rotor construction there are two common type of

synchronous rotor in use the salient-pole rotor and the drum or wound rotor.

The stator is the built up of high grade alloy steel laminations to be reduce eddy current losses. It has 3 main parts namely outer frame, the stator core and the stator winding.

As the stator name indicates stator is a stationary part of induction motor. As stator winding is placed in the stator of induction motor and the three phase supply is given to it. Rotor: the rotor is a rotating part of induction motor. The rotor is connected to the mechanical load through the shaft.

B. Torque-Speed Analysis

The equivalent circuit of the Induction Motor can be the depicted as shown below:

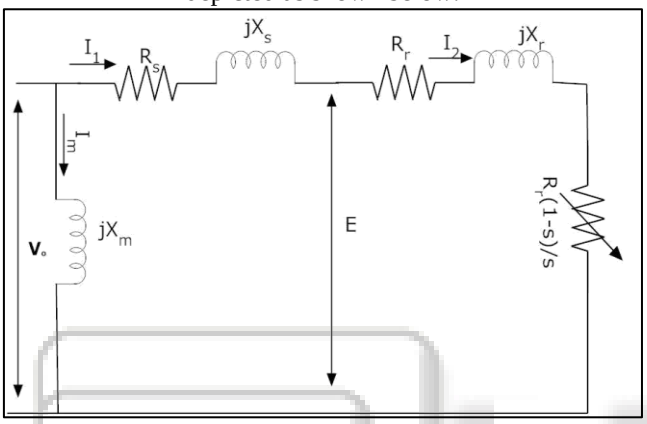

Fig. 2: Circuit Diagram of Torque-Speed Analysis

Where
Xm= Magnetizing Reactance
Xs= Stator Reactance
Xr= Rotor Reactance
Rs= Stator Resistance
Rr= Rotor Resistance
S = slip

In an Induction Motor the slip is given as

$$S = Ns\text{-}Nr/Ns \quad (1)$$

Where Ns = Synchronous speed
Nr = Rotor speed
The following expressions can be derived from the above circuit,

1) Rotor Current

$$I_2 = Vo/(Rs+Rr/S)+j(Xs+Xr) \quad (2)$$

2) Torque

$$T=+(3Vo^2Rr/s)/Ws[(Rs+Rr/s)^2+(Xs+Xr)^2] \quad (3)$$

As the speed increases, the current reduces slightly and then drops significantly when the speed reaches close to 80% of the rated speed. At the base speed, the rated current flows in the motor and rated torque is delivered.

As the speed increases, the current reduces slightly and then drops significantly when the speed reaches close to 80% of the rated speed. At the base speed, the rated current is flows in the motor and the rated torque is the delivered.

At base speed, if the load is increased to beyond the value for the rated torque, the speed drops and slip increases. At a speed of 80% of the Synchronous speed, the load increases up to 2.5 times the rated torque, this is known as the breakdown torque. Increasing the load further causes the torque to fall rapidly and the motor stalls.

III. SPACE VECTOR MODULATION

Consider the 3-phase inverter shown below. The 3- phase inverter are use in six pulse generator it is reduce the system harmonic by the rectification mode by six switches combination of inverter. The system are connected in the induction motor in control of speed by v/f method.

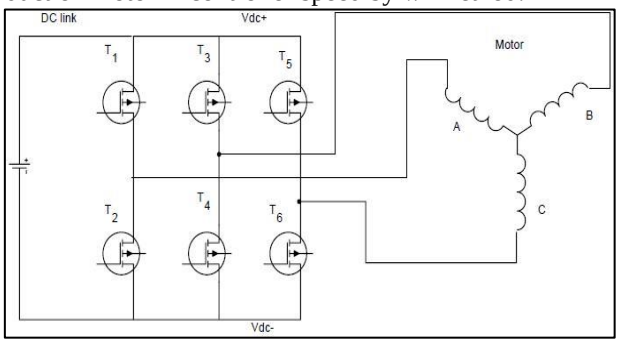

Fig. 3: Typical Inverter Bridge Configuration

The six-switch combination in the inverter has eight permissible switching states. summaries these states along with the corresponding line to neutral voltage applied to the motor.

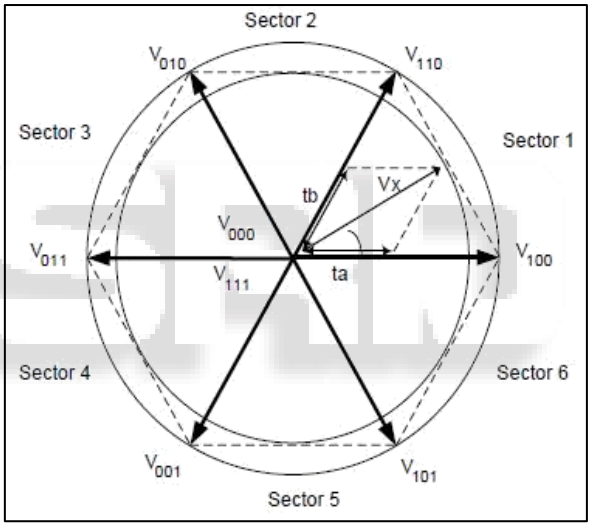

Fig. 4: Space Vector Diagram – Line to Neutral Voltages

IV. RESULTS & SIMULATION

A. Simulation

The simulation are done by metlab simulink it is speed control of induction motor by use in the v/f method in six switches mode work on the svm inverter.

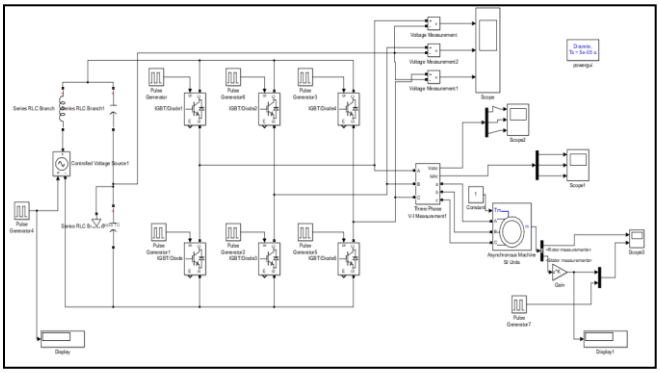

Fig. 5: SIMULINK Model

B. Results

The simulation model is done in matlab simulation. The proposed model are speed control of induction motor by V/F method in the rating are increased by comparison of reference paper. In this paper are conclude by the speed rating increased and control of motor are very easily. The result is not too suitable in this paper in that region are mainly follows. The parameter of element are not apply proper value then our simulation model are not give suitable graph then we can apply the all parameter value are correct of element then the graph will correct, in simulation model.

V. CONCLUSION

This model conclude by the speed control induction motor by V/F method by use space vector PWM method the model are popular for speed control in present time it is use to domestic and industrial purpose the method are control 5.4 HP, 400V 50Hz of induction motor to control in varies by V/F in use to comparison of other model the performance is high and harmonic is low.

VI. FUTURE SCOPE

There are several method to control the speed of induction motor but still V/F method is a challenging task in order to obtain better accuracy to improve the efficiency of entire system. V/F control of three-phase induction motor. The torque developed by the motor is directly proportional to the magnetic field produced by the stator. If we vary the voltage and frequency, keeping their ratio constant, then the torque produced by induction motor will remain constant for all the speed range. In the future work we can use always, this method easily.

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