Three-phase active switch PWM controlled Induction motor drive

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***ABSTRACT*: In this paper presents realization for obtaining high power factor, high efficiency and speed control of three phase squirrel cage induction motor drive. It require less maintenance and rugged in construction. The specialty of this scheme with high frequency controlling the speed of induction motor with high frequency semiconductor switch and no freewheeling switch is used across the stator winding. Its economical cost is less than the use of A.C. switch. In most of the industrial applications 3-phase induction motor is used because of its utility, simplicity to control, the proposed topology of this drive in Industries used for Industrial high power cooling fans, blowers and pumps. Proposed drive is expected to provide higher efficiency, high power factor and required speed range.**

***Keywords*— PWMcontrol; PAC; VVVFDrive; Triangular pulse genrator; Three- phase Induction motor.**

I. Introduction:

Nowadays, in most of the industrial applications, induction motor is used as a drive, because of Induction motors are simple, rugged in construction and require less maintenance. Hence, induction motors are preferred in most of the industrial applications such as in fans, pumps, blower, Lathes, Drilling machines, Lifts, Cranes, Conveyors etc. Induction motors are most widely used in almost all industries.AC voltage controllers as power converters can be used as a soft starter for induction motor. The speed control of induction motor drives can be achieved by controlling the applied voltage on the motor by using power electronic devices.

Variable voltage and variable frequency controlled (VVVF) Induction motor drives are widely adopted in various processing industries for high power fans, blowers and pumps where wide range speed control is not necessary. The main purpose for using VVVF drive is to save input energy whenever reduced load torque with speed control is required. Additional input power factor improvement stage is added at front end in VVVF drives to improve the converter power factor and thereby overall drive power factor, which amounts to decrease in efficiency due to additional power stage [1]-[4]. Phase angle control (PAC) technique was earlier in use for this purpose but it suffers from inherent disadvantages such as lagging power factor at the input side especially at lower speeds due to increase in firing angle.

To overcome above disadvantages, the proposed research work focuses on reducing power consumption and improving power factor of two different induction motor drives. A variable voltage control scheme is proposed for induction motor drives. A high Frequency PWM controlled direct AC to AC voltage controlled converter is proposed for three phase induction motor to improve the drive efficiency and input power factor along with fan speed control. In the proposed work only one main active switch and using additional three extremely low value capacitor across the induction motor stator winding connected in parallel. The smooth starting and speed control of induction motor is possible with high efficiency and high power factor. The advantages of proposed scheme are high frequency PWM switching with high power factor, high efficiency and minimum number of controlled power semiconductor switches. The specialty of the proposed scheme is that three phase alternating current through the motor is not abruptly broken but it is circulated in the same direction during turn off of main switch and in this way high efficiency is achieved as compared to conventional existing PAC and VVVF drive motor.

A] Phase Angle Controlled Drive:

In Phase angle control technique, the motor current tend to be more and more discontinuous at lower speed and lower torque. Therefore chances of discontinuous operation of the motor increases at higher firing angles. This is because of the increased switch off period and decreased conduction period of the power semiconductor switches. The speed of small rating squirrel cage induction motors for applications like fans, pump, and blowers may be changed by reducing the line voltage. This reduces the torque available to the load which reduces the speed. But the variation occurred in the load torque hardly affects the performance of motor. In turn the amount of power saving due to the reduction in the speed is an added advantage as the power consumption is directly proportional to cube of fan speed.

$$P \alpha N^3$$

In the proposed drive the power saving is achieved using small reduction in the torque with the same speed of the motor which is required in such applications. The torque speed characteristic of the induction motor running for fan, pump, and blower type of application using variable voltage is as shown below.

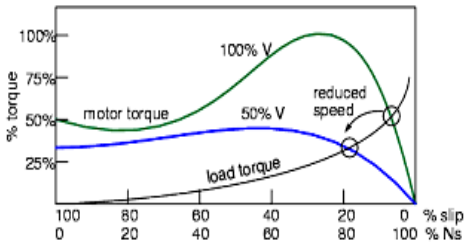

Figure 1: Speed torque characteristics of variable voltage induction motor drive

B] Pulse width Modulated Converters:

The PWM technique improves the performance of the converters. A sinusoidal pattern of PWM control has been used by the authors [6] to improve the power quality. The pulse width modulation technique has been used for switching mode power supplies and for variable speed drives. It is found that with the increase in switching frequency the motor improve. The improved input power quality is the most desirable additional benefit of high frequency switching.

C] VVVF Drive:

Variable Frequency Drive or VVVF drive for AC motors popularly known as AC drive is an electronic mechanism which receives energy from a fixed frequency fixed voltage single phase or three phase AC source and converts it into a variable voltage variable frequency three phase supply for a three phase drive motor. In converting power from one form to another, it gives the ability to motor to run at different variable speeds. Hence the drive is known as variable speed drives.

II Proposed technique:

To gain better performance, efficiency, and precision for induction motor drives, advanced electric motor drives are now replacing older motor drives. Advanced motor drives uses more sophisticated controllers to monitor and regulate motor output. That's why they are capable of better precision. These drives also offer better efficiency by using more efficient converter topologies and more efficient electric motors. The advanced power electronics drives in today competitive environment also offer a performance boost by utilizing superior switching schemes for more output power by the use of lighter motors and more compact power electronics circuits. A new novel technique of using extremely low value of capacitor across the stator winding for freewheeling is invented in the proposed drive for three phase Induction Motor drive. This technique is simple, economical and very easy to implement. In Our proposed drive we have improved the Power Quality and performance of three phase Induction Motor drive.

III SIMULATION RESULTS:

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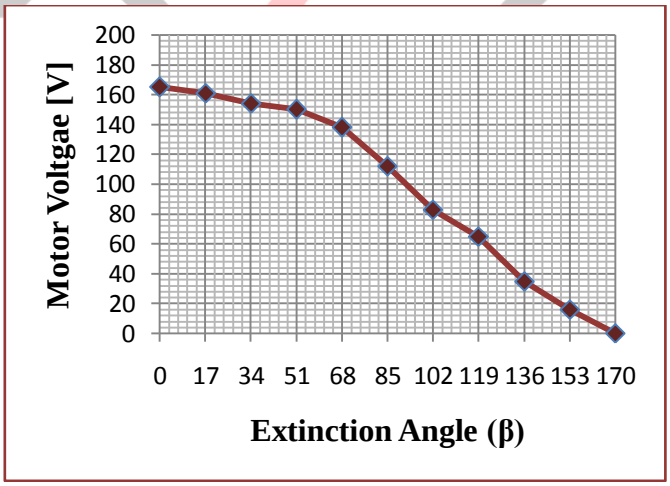

Figure 2: Variation of Motor applied voltage with Extinction angle (β).

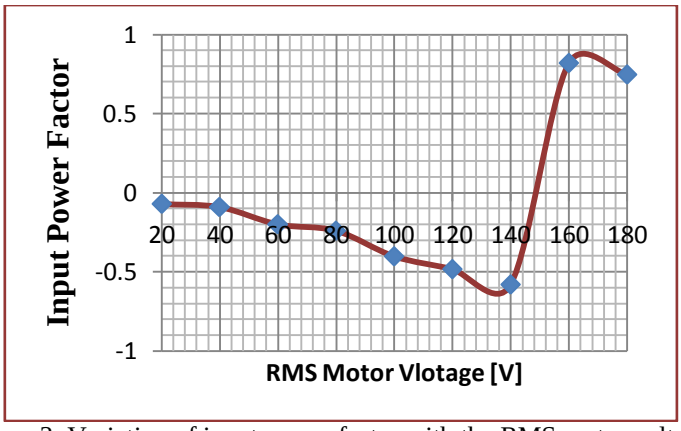

Figure 3: Variation of input power factor with the RMS motor voltage.

Figure 2 demonstrate the computation of measured rms value of the motor applied voltage with the extinction angle. A signification of improvement in the input power factor with the extinction angle control is shown in Figure 3 which gives the variation of the THDF of the input current with the motor applied voltage.

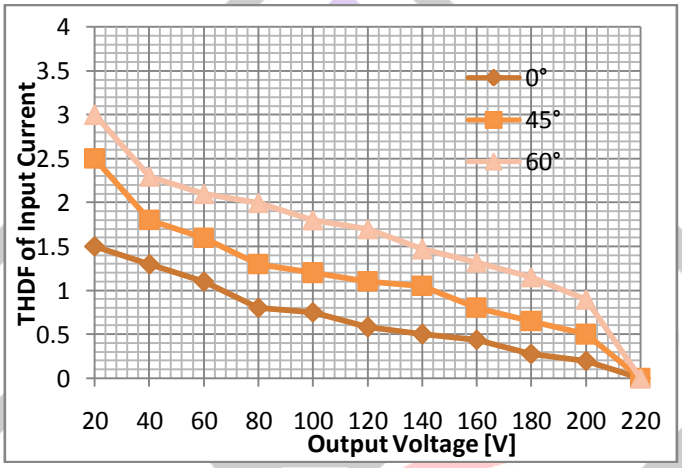

Figure 4: Variation of THDF of input current with the output voltage.

Figure 4 shows the measured variations of the total harmonic distortion factor (THDF) of the input current versus the rms output voltage for different load conditions. In this figure, as the extinction angle increases then output voltage decreases therefore, the THDF in the supply current increases. Also, the THDF increases so, load power factor decreases. That means it is for the same load condition, which is increase in the THDF with the input power factor goes from lag to lead as well as displacement factor. Although the increase in the THDF will reduce the value of the supply power factor, however, it will not affect its leading nature

IV Experimental Setup:

Figure 5: Hardware Model

V Conclusion:

In this paper instead of using four or six A.C. switches we are using here extremely low value capacitor parallel connecting with stator winding of induction motor drive .The variable PWM controlled pulses will be generated by comparing high triangular career wave with variable reference D.C. controlled voltage ranging from 0-10v and motor speed will be varying by the duty ratio of IGBT switch ,the A.C. voltage across three-phase induction motor and thereby r.m.s. A.C. current can be controlled . The frequency of IGBT switch will perform noiseless of induction motor drive. A proposed scheme to implement energy savings of three-phase induction motor drive. Economic energy efficient high power factor, reduced number of semiconductor switches, Reduced initial cost, Simplicity of control, More reliable due to less components and less power semiconductor switches, Lower size, weight and volume of the drive ,Soft start, High power factor and high efficiency

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