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Controlling Of Squirrel Cage Induction Motor by Using Three Phase Cycloconverter with IGBTs

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ABSTRACT

Three Phase Induction Motors are the most widely used and acceptable motors in many applications and of these three phase induction motors, Squirrel Cage Induction Motors has more applications because of advantages like high overload capacity etc. These motors are to be controlled in order to get the output as required and desired by the load conditions and in order to get increased efficiency and minimized transient to drive the varying mechanical loads for long time. For controlling the output parameters i.e., Speed and Electromagnetic Torque of Three Phase Induction Motors, frequency has to be varied. The frequency can be varied by using the Three Phase Cycloconverter which is built on IGBTs. The IGBT is preferred due to its improved dynamic performance and efficiency. The controlling of IGBT is easy compared to Thyristors and BJTs in high voltage and high current applications. Also, no external devices are required due to use of PWM technique for output voltage variation with lower order harmonics and filter can reduce the higher order harmonics.

KEYWORDS: *Squirrel Cage Induction Motor, Three Phase Cycloconverter, PWM Technique, IGBT, MATLAB R (2012a).*

INTRODUCTION

Three Phase Induction Motors are mainly of two types, namely Squirrel Cage Induction Motors and Slip Ring Induction Motors. The main difference between the two types of motor is that use of slip rings. Using of slip rings is the main cause for more losses in the Slip Ring Induction Motors. That is the reason why Squirrel Cage Induction Motors are extensively used compared to Split Phase Induction Motors. Controlling method for Single Phase Induction Motor was analyzed and in work by using the frequency drive i.e., Cycloconverter. Three Phase to Three Phase Cycloconverter is involved in this paper for the control of Squirrel Cage Induction Motor which is Three Phase Motor. Three Phase to Three Phase Cycloconverter is shown in fig.1 and Squirrel Cage Induction Motor is shown in fig.3. IGBTs are used in the cycloconverter circuit. IGBT has the advantage of high speed, high power switching for designing PWM controlled Cycloconverter. Section II gives the information about Three Phase Cycloconverter and Section III gives the details about Squirrel Cage Induction Motor. Here, the selected type of Cycloconverter is

Three Phase to Three Phase Cycloconverter which has both the input and output in the Three

Phase form. The reason for choosing the Three Phase to Three Phase Cycloconverter is, the machine which is to be controlled, being the Three Phase Machine and it definitely requires the parameters in Three Phase only.

II. THREE PHASE TO THREE PHASE CYCLOCONVERTER

Renewable energy sources are interfaced with the grid through power converters. Depending upon their operation DPG system, power converters may have the following modes of operation: voltage source, current source and active power filter mode. In voltage source mode, converter can work in off grid system (or) in islanded micro grid as a grid forming unit. In this mode of operation, the AC voltage and frequency are controlled to meet the power quality requirements.

III. ELIMINATION OF POWER QUALITY PROBLEMS

Three Phase to Three Phase Cycloconverter is constructed with 18 IGBTs. The input for this cycloconverter is three phase sinusoidal signals. To each phase of input signal, 6 IGBTs are connected and the output is taken from the three arms. This output is connected to the Three Phase Load (Squirrel Cage Induction Motor) and is shown in fig.3.

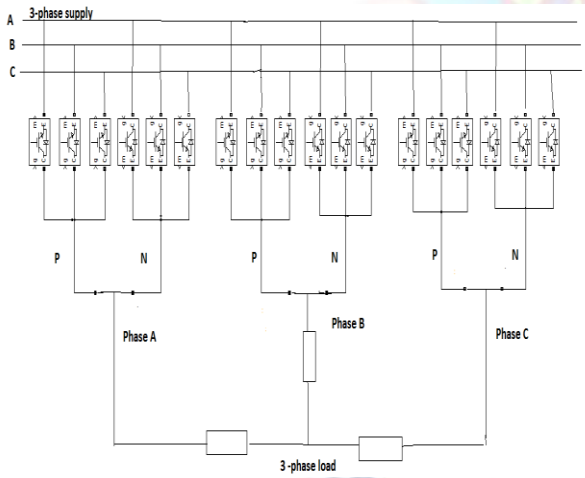


Fig.1 Three Phase Cycloconverter

IGBT:

The Insulated Gate Bipolar Transistor (IGBT) is a voltage-controlled device with MOS input characteristics and bipolar output characteristics. It is a minority carrier device with high input impedance and large bipolar current carrying capability. IGBT has the advantages of both MOSFET and BJT. IGBT is used in many power electronic applications and mostly in Pulse Width Modulation (PWM) techniques. It is used in Uninterruptible Power Supplies (UPS), Switched-Mode Power Supplies (SMPS).

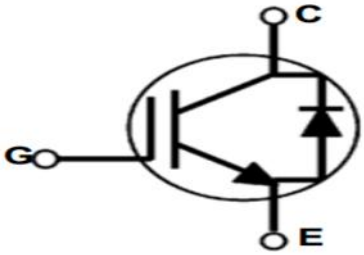


Fig.2 SYMBOL OF IGBT

The main advantages of IGBT over a Power MOSFET and a BJT are:

1. Due to very low on-state voltage drop, size and cost can be reduced.
2. The input MOS gate structure results in low driving power and simple drive circuit.
3. IGBT has high input impedance and switching speed while MOSFET has low input impedance.
4. It offers greater power gain than the BJT.

SQUIRREL CAGE INDUCTION MOTOR

Squirrel Cage Induction Motor is relatively small in size for a given horsepower rating when compared to other types of motors. It has very good speed regulation under varying load conditions.

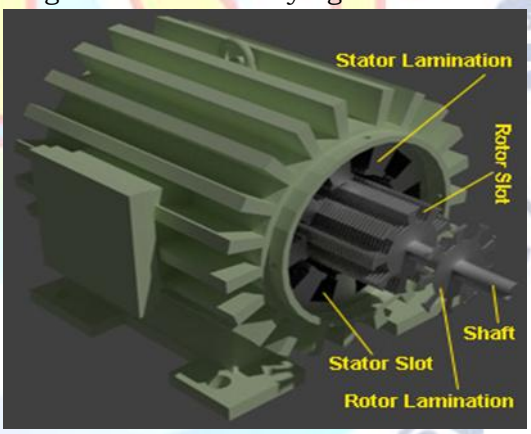


Fig.3 Squirrel Cage Induction Motor

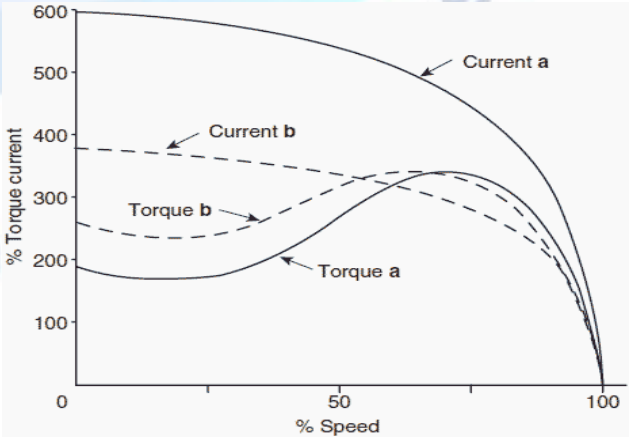


Fig.4 Speed-Torque Characteristics

The output parameters of squirrel cage induction motor, speed and electromagnetic torque, are varied by changing the frequency. If the frequency

increases, speed will increase and electromagnetic torque will decrease i.e., frequency and speed are directly proportional and frequency and electromagnetic torque are inversely proportional. This varied frequency can be applied to the motor as input with the help of cycloconverter. The output voltage of cycloconverter with varied frequency will be given to the motor as input. The frequency variation in cycloconverter can be done with the help of PWM technique which is discussed in the next section.

IV. PWM TECHNIQUE

Pulses are generated using the PWM technique and the generated pulses are given to the IGBTs in the cycloconverter circuit. Sine wave and Triangular waves are compared to produce the pulses. Here, the sine wave is the reference signal and the triangular wave is the carrier signal. The advantages of PWM technique are:

a) External components are required to control the output voltage.

b) PWM minimizes the lower order harmonics.

SPWM (Sinusoidal Pulse Width Modulation) is chosen in this paper. No external control circuitry is needed.

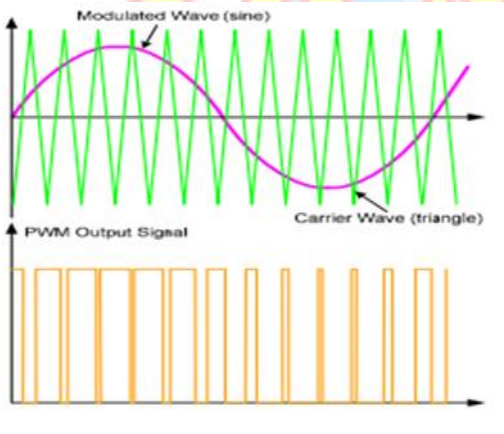
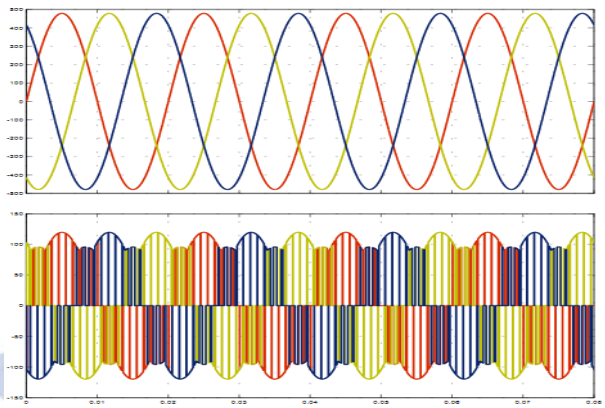


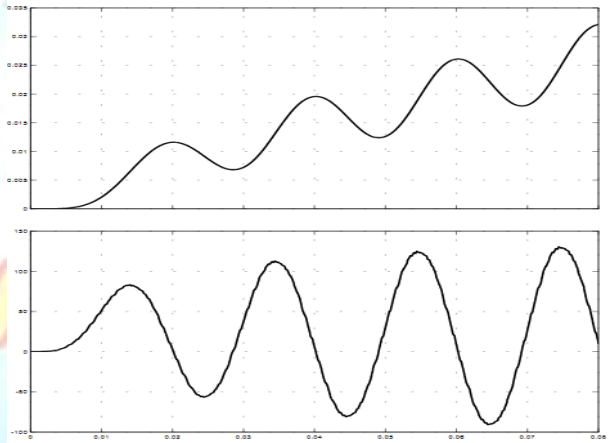
Fig.5 SPWM Wave Form Generation

V. SIMULATION RESULTS

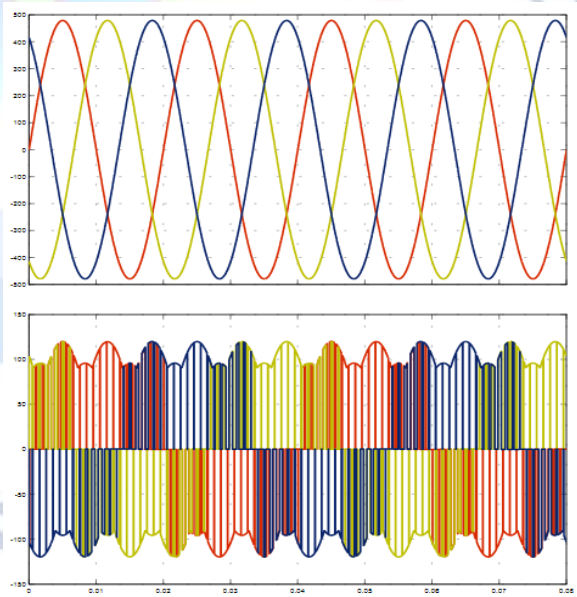
In this section, the input and output voltages of three phase cycloconverter at different frequencies say 50Hz, 25Hz, 12.5Hz etc are shown. Also, the output parameters i.e., speed and electromagnetic torque of squirrel cage induction motor, which are to be varied, are shown.



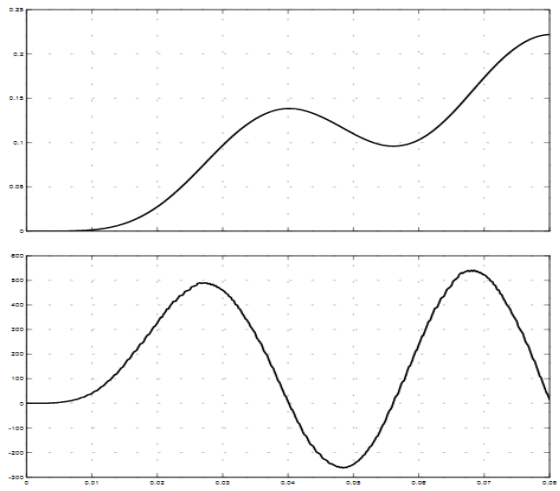
a. Input voltage, b. Output voltage of three phase cycloconverter, when input frequency is equal to output frequency



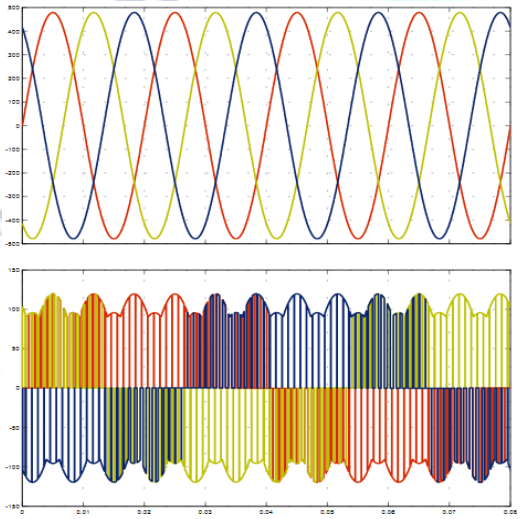
a. Speed, b. Electromagnetic Torque of squirrel cage induction motor, when input frequency is equal to output frequency



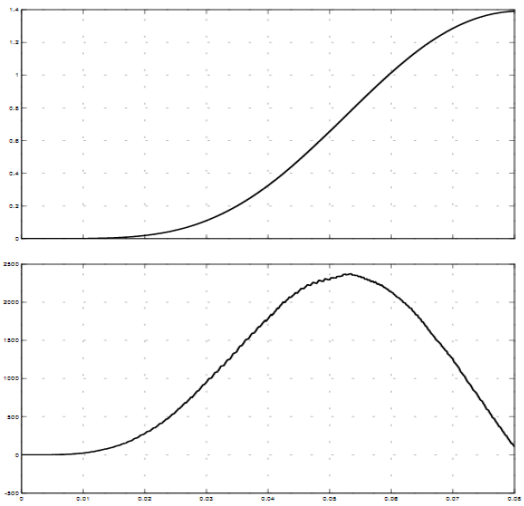
a. Input voltage, b. Output voltage of three phase cycloconverter, when input frequency is equal to two times of output frequency



a. Speed, b. Electromagnetic Torque of squirrel cage induction motor, when input frequency is two times of output frequency



a. Input voltage, b. Output voltage of three phase cycloconverter, when input frequency is four times of output frequency



a. Speed, b. Electromagnetic Torque of squirrel cage induction motor, when input frequency is four times of output frequency

SPEED & TORQUE VALUES FOE DIFFERENT FREQUENCIES

FREQUENCY (Hz)	SPEED (rpm)	TORQUE (N-m)
50	0.03211	9.731
25	0.2219	12.64
12.5	1.391	103.2

VI. CONCLUSION

Speed and Electromagnetic Torque, which are output parameters of the Squirrel Cage Induction Motor, are controlled by using the Three Phase to Three Phase Cycloconverter. From this, the three phase induction motor can be controlled by varying the frequency. If there will be an existence of high rated machines with frequency as high, this method can be used in order to get the desired output to meet the load demand.

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