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A Noval Method of Single Phase to Three Phase Cyclo Converter for Three Phase Induction Motor Drive

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Abstract: *This paper present the study on analysis of speed of induction motor when the motor is made to run on different loads torque. fed by single phase to three phase cyclo converter.. Normally, constant voltage constant frequency single phase AC or three phase AC is used. However in some rural areas, only a single phase utility is available, so it became necessary to convert single phase supply to three phase supply to run three phase induction motors. For this purpose, cyclo converter model is patterned by MATLAB/SIMULINK SOFTWARE to convert single phase supply to three phase supply. Converter model employs only six IGBT so the resulting Cyclo converter-motor drive system is cheap and compact, As we know that the rating of the machine increases with the increase in number of phase .eg. output of three phase motor is 1.5 times the output of a single phase motor of same size. therefore it is beneficial to use three phase induction motor instead of single phase induction motor for low industrial applications.*

Keywords: Cycloconverter, Single-Phase to Three-Phase conversion, Induction motor, IGBT.

I. INTRODUCTION

Three phase induction motors are refered as the workhorse of the power industry due to its low cost and rotor rugged constructions. in the past years , several improvement have been proposed to achieve the goal of supplying the three phase induction motor by a single phase supply. normally, it is quite common to have single phase supply in residential , industrial. agricultural and mainly in rural areas. while the adjustable speed drives such as induction motor requires a three phase supply.

: The induction motor is a simple small in size and robust in constructione, but its controlling is considered as complex task when managed directly from the line voltage, the motor operates at nearly a constant speed [17]. To have speed and torque variations, it is required to modify both the voltage and the frequency. It is realized from the study that the ratio of the voltage and frequency should be constant approximately [8] & [18]. The trends of desgning optimal controllers developed due tothe increased demand in power consumption, which indicatesthe most important issues in the world due to the decreased power resources in the last few decades [5] & [15]. The studies proved that there is a chance of possibility to reduce the power consumption and increasing the efficiency of the inducton machines.. The quality of output voltage wave and its harmonic distortion also impose the restriction on this frequency. The distortion is very low at low output frequency. Here, a cyclo-inverter is suggested where the IGBT switch is self commutated and hence eliminates the need for a commutation circuit. The control system , capable of achieving all of these conditions are known as the drive system optimization [1], [10] & [20].

It is a almost known that the speed of an induction machines initially depends on the number of poles of the motor and the frequency of the supplied voltage.. The amplitude of the voltage supplied and the load on the motor shaft also affect the motor speed, however not with the same degree. As a result , changing the frequency of the supply voltage is an ideal method of speed control of induction motor. Hence to ensure a correct motor magnetization, it is necessary to change the amplitude of the voltage regarding the following equations:

The value of electromagnetic force is represented by the following equation

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$$E = 4.44\, f\, N \quad (1)$$

Where:

E : Electromagnetic Motive Power.

f : Supply Frequency.

: Flux.

N : Stator windings turn number.

Assuming, that the voltage drop of stator circuit is negligible, the relationship between the voltage and the frequency is written as

$$V\ K\ f \quad (2)$$

Where:

V : Stator Voltage [V].

K : Constant.

Liter Therefore, in order to keep the motor flux, the V/F ratio is maintained to be kept constant. Thus , this method is known as the constant Volt/Hertz principle

In this reasearch, a cycloconverter model is desgnied to convert single phase input supply into three phase ouput supply to ron three phase induction motor, The performance of induction motor is analysed by varying the load torque to know the load bearing capabalitity of induction motor.

II. LITERATURE REVIEW

Sahraneshin, et.al[1] This paper shows a novel switching pattern for single to three-phase cycloconverter used as a part of the optional of Inductive Power Transfer (IPT) system. The principle objective of this switching strategy is to reduce the switching loss of cycloconverter to lower than 33% in compression with the conventional PWM technique. A few preferences of this proposed switching misfortune reduction technique are: the effortlessness of execution and enhancing the effectiveness of the cycloconverter thus the aggregate system. It is confirmed by recreation examination that the proposed switching pattern has lower switching misfortune, when contrasted with the routine balances pattern like PWM system.

Sahraneshin, et.al [2] This paper introduces a basic and cost direct single to three-phase frequency converter based oncycloconverter for use in Inductive Power Transfer (IPT) systems. The proposed topology has the favorable circumstances to traditional topologies normally used as a part of IPTs' secondary output for three-phase applications, for example, switch reduction and capacitor end due to no dc-join. Space Vector Modulation (SVM) has been employed as switching procedure because of its capacity of decreasing so as to enhance the nature of output voltage Total Harmonic Distortion (THD). To checking the ability of those topology and technique to changing over the frequency and adequacy of the supply to variable frequency and sufficiency of any sought quality, two reproductions for an IPT system with three-phase output are given. To begin with reproduction utilizes a three-phase adjusted R-L load and in second reenactment an induction motor is used.

Azam, M.A.[3] In this paper, we used a new approach to pattern a decent power quality three to single phase Cycloconverter managed and controlled by Buck-Boost converters differentially associated over the load has been proposed. The proposed Cycloconverter enhances Power Quality by lessening Total Harmonic Distortion (THD) of input line current, input Power Factor (Pf) and general Efficiency (η) of the power conversion. **silicon controlled rectifier** (SCR) cycloconverter has high THD (19% or more) and has just two quadrant operation on V~f patterne. The proposed Cycloconverter has a lower THD (15% and underneath), requires just eight switches and it has the upside of four quadrant control of voltage and frequency. Simulation has been performed in PSIM and Simulink for resistive and inductive load with Back-emf. Open loop sliding Technique is connected to ensure great power quality at wanted execution. Points of interest of Operation and circuit execution is introduced in this paper.

Santhosh Kumar R[4] the most generally used motors as a part of late days are prompting motors because of its straightforward development and less costly contrasted with DC motors. In any case, the primary downside of induction engine compared with independently energized DC engine is that it is a consistent speed engine. Henceforth previously, impelling motors have been used fundamentally as a part of steady speed applications. Variable frequency is vital in the majority of the modern applications and the late headway in the power gadgets field makes this errand simple by

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utilizing the power semiconductor devices. There are numerous systems used to differ the supply frequency, out of which cycloconverter is one of the usually used method. Among every one of the strategies this is basic, solid and prudent. The objective of the paper is to pattern a control circuit to give an appropriate sequence of pulses for the semiconductor switches of the cycloconverter power circuit. The control circuit is patterned utilizing the Op amps and logic gates. The patterned control circuit is simulated utilizing the Or CAD Pspice software.

Z.M.S. El-Barbary[5] this paper presented a solitary to three-phase induction engine drive system to give variable output voltage and frequency. The proposed drive system utilizes just six IGBT switches, which form the front-end rectifier and the output inverter for the one phase transformation from singlephase supply to output three-phase supply. The front-end rectifier grants bidirectional power stream and gives fabulous regulation against variances in source voltage. Also, it joins dynamic information current forming highlight. The control procedure of the proposed drive arrangement of threephase affectation engine depends on speed sensorless vector control method. A minimal effort of engine drive and significantly more points of interest can be accomplished utilizing the proposed drive system. Simulation and experimental results are carried out to analysis and explore the characteristics of the proposed drive system.

III. SIMULATION MODEL

A cyclonverter model is desgined using IGBT to convert single phase input supply into three phase output. This three phase output voltage and current is first measured in three phase VI measurement block. A three phase induction motor has been connected as a load unit at the output terminals of the cycloconverter. The MATLAB SIMULINK model for the complete system has been constructed to test the variations in motor speed by varying the load mechanical input (torque) at constant frequency 25hz. and to estimate the efficiency of motor upto which we can increase to have better performance of motor. With the use of cycloconverter and with its power electronic circuit it is possible to pattern power supply to induction motor to generate supply torque matching with demand torque.

Pulse Width modulation is used and these pulses are used to fire connected IGBT. Firing pulses are generated at 25hz frequency. In this work, simulation is carried out with a 400V, 50hz single phase supply. The three phase induction motor used for analysis is of 1430 rpm speed, 400V 50hz, squirrel cage rotor type. The stator resistance rs= 1.405Ω and stator inductance is Ls= 0.005839 henry. The rotor resistance rs=1.395Ω and inductance Ls= 0.005839 henry. The mutual inductance Lm= 0.1722H. These are the precondition for satisfactory performance of the three-phase asynchronous motor.

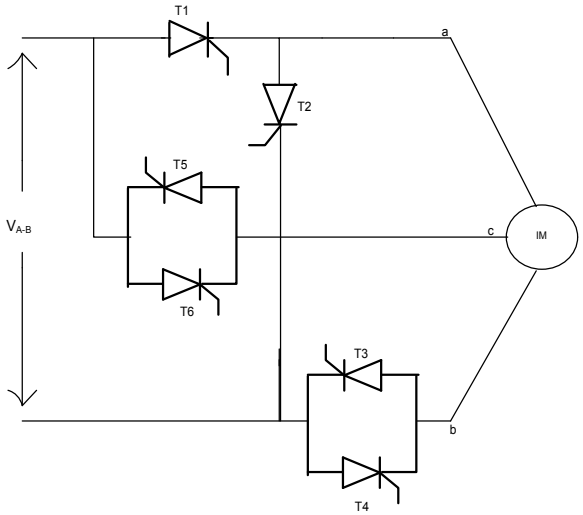

Fig.1. block configuration of proposed single phase to three phse cyclonverter

Step 1:

Control Scheme: we have used six pulses using PWM. The pulse type which used is time based and its amplitude is 1, with 25% pulse width controlling IGBT. The phase delay is different for each pair of pulse generator. For Pulse 1 &

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Pulse 2 the phase delay set to 0 sec. while for Pulse 3 & Pulse 4 the phase delay set to 120 degree. and for pulse 5 & Pulse 6 the set phase delay is 240 degree of refrence signal.

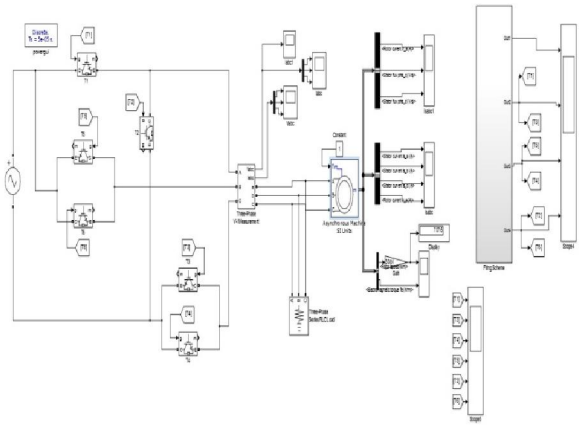

Fig. 2: cyclo-converter main circuitry

Step 2:

After control scheme the goto blocks connected with IGBT. Detailed model of Thyristor in parallel with a series RC snubber circuit is used. T1 tag block connected with T1 IGBT and T2 block with T2 IGBT and so on. In on-state the Thyristor model has an internal resistance (Ron) and inductance (Lon). In off-state the Detailed Thyristor as an impedance. Best accuracy is achieved when Tq is larger than the simulation step size. Latching current and turn-off time are not modeled when Lon is set to zero.

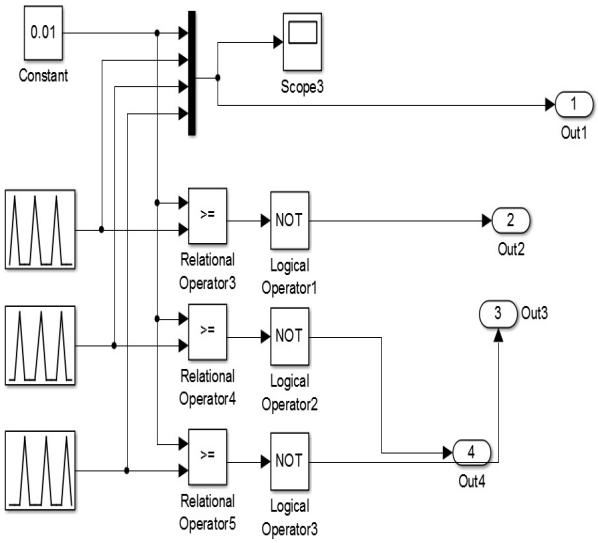

Fig.3. PWM Technique

The switching scheme for frequency 25Hz,during first cycle of input supply frequency let the IGBT T1 and T3 be fired at instant t1= 0 sec, then current Iab is obtained, as a result Iab produces mmf vector Fab,Now at instant t2=0.01sec IGBT T4 and T5 is fired, current Ibc produces mmf vector Fbc,Similarly at time t3 = 0.02sec IGBT T2 and T6 is fired, then current Ica is obtained, as a result Ica produces mmf vector Fca Pulse time for thyristor is shown in Table..pulse width calculation is as follows:-

Required Output Frequency = 25Hz

Time period = 1/25sec =0.04Sec

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Ttotal = 0.04sec
Pulsewidth = (ton/total)*100= (0.01/0.04)*100
Pulse Width = 25%

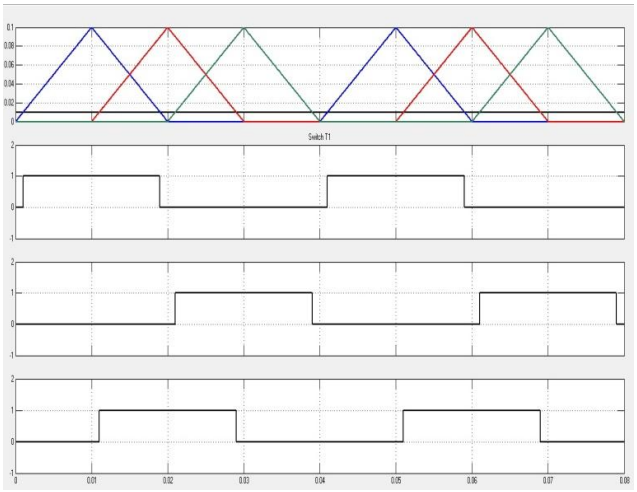

Fig.4. Firing Scheme for Power Switches

Table. No.1 Switching States

IGBT\time(sec)	0.0	0.01	0.02	0.03	IGBT\time(sec)
T1	ON	OFF	OFF	OFF	T1
T2	OFF	OFF	ON	OFF	T2
T3	ON	OFF	OFF	OFF	T3
T4	OFF	ON	OFF	OFF	T4
T5	OFF	ON	OFF	OFF	T5
T6	OFF	OFF	ON	OFF	T6

Step 3:

The output A, B and C through cycloconverters connected with three phase V-I measurement. The block can output the voltages and currents in per unit values or in volts and amperes. The voltage measurement set to phase to phase. Vabc and Iabc, two scopes connected with this.

A three-phase asynchronous machine (squirrel cage) modeled in a selectable dq reference frame (rotor, stator, or synchronous) implemented. Stator and rotor windings are connected in wye to an internal neutral point.

It operates in either generator or engine mode. The method of operation is dictacted by the indication of the mechanical torque:

• If Tm is positive, the machine goes about as an engine.
• If Tm is negative, the machine goes about as a generator.

The electrical part of the machine is introduced by a fourth-request (or 6th request for the double squirrel-confine machine) state-space model, and the mechanical part by a second-arrange system. Every single electrical variable and parameters are alluded to the stator, showed by the prime signs in the accompanying machine mathematical statements. All stator and rotor amounts are in the self-assertive two-axis reference frame (dq frame).

IV. RESULT ANALYSIS

The simulation work is accomplished on Matlab Platform/Tool Box. Three phase power supply obtained by providing 50 Hz single phase input power supply to six cycloconverter. By varying the mechnical load torque ™, the variation in speed and electromagnetic torque is ontained in following figures,

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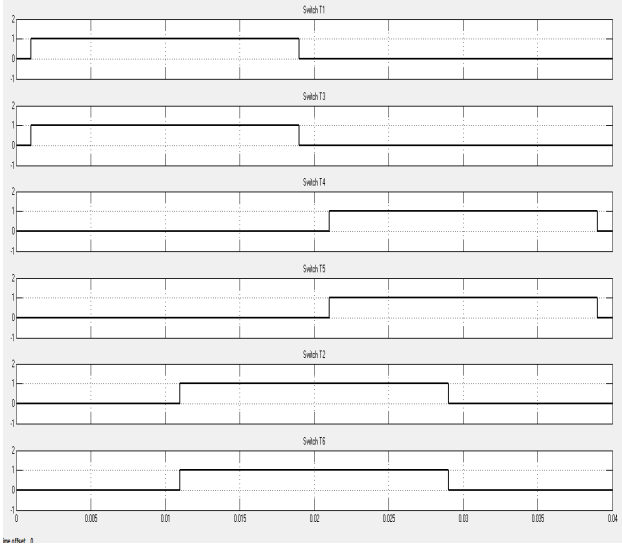

Figure 5: Firing Waveform of Six IGBT

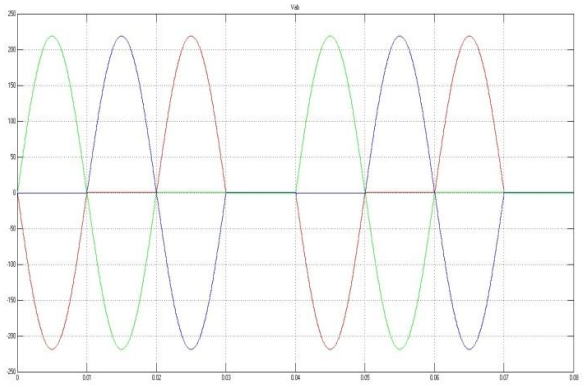

Figure 6:Three phase output with R load

Table No.2.Circuite Parmeters

S. No.	Elements	COnfig.
1	Motor	5.4 HP
2	RL Load	1 Ohm & 1mh
3	Supply Voltage	440
4	Suplly Frequency	50Hz
5	Motor Oprating Frequency	25 Hz

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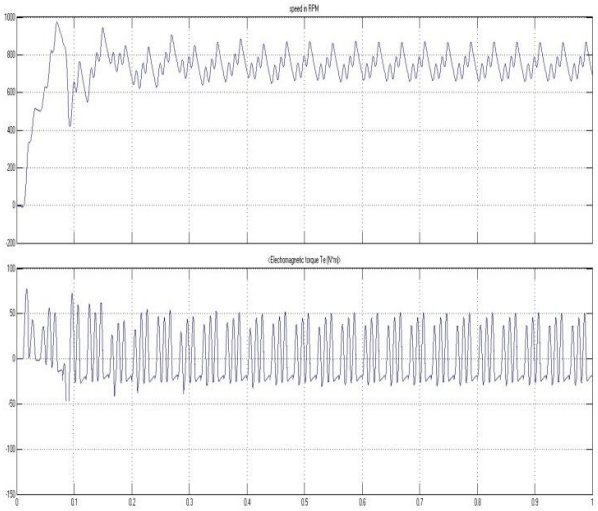

Figure 7:Three phase output with Induction motor load

V. CONCLUSION

In this paper , we conclude about three things:

• Conversion of single phase to three phase

• Speed frequency analysis i.e. variation of speed with 50hz frequency and 25hz frequency can be seen

• Load frequency analysis and on 25hz frequency

From the result obtained from the simulation, it is clear that for three phase induction motor running at 50 hz frequency, the speed is 1450rpm however same induction motor with single phase to three phase converter gives speed of 750 rpm (avg) which gives variation between 900- 700 rpm with specific load . in case of no load , the motor gives more variation. so it is observed that constant load value is 12.5 is more specific value on which motor speed variation is less. From The Above Waveform Obtained It Is Clearly Aobserved That When The Load Torque Is Incresed Behond 13.5 N-M , The Speed Of Induction Motor Becomes Negativei.E Motor Becomes Out Of ContrOl

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