Simulation based Speed Control of Induction Motor

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Abstract— Induction motor has wide use in present world. Whether in an industry or at home we can find large number of applications of an induction motor. This paper gives technique of speed control of induction motor using cycloconverter. This speed control technique has been adopted in order to make it possible to use same motor for different applications according to the requirement of user. In this project simulation has been done to find out the behaviour of speed characteristics by controlling the frequency through cycloconverter. Also by doing this speed control we can globalize our motor as it could operate at different frequencies.

Key words: Induction Motor, Cycloconverter, Simulink, Frequency

I. INTRODUCTION

The characteristics in case of a single phase induction motor are identical as compared to that of a three phase induction motor except that single phase induction motor has no starting torque present so certain methods have to be used to make itself starting. Apart from having the disadvantage of not being self-starting, single phase induction motor is being used as three phase supply is not available everywhere.

In this project, we are doing single phase induction motor speed control by using cycloconverter. The complete control circuitry depends on only one parameter i.e., Voltage. We know that torque developed is proportional to square of the voltage. Thus, the applied voltage to induction motor stator terminals is controlled by thyristor and its gate pulses. Since it is known that if the triggering pulses to gate are provided with delay then the stator terminals of induction motor gets reduced voltage and thus as the voltage and torques are proportional to one another, torque decrease and simultaneously speed of the motor gets reduced. The control circuitry consists of the following:

1) Triggering circuit
2) Cycloconverter circuit and
3) Power supply circuit.

The power supply circuit will provide AC supply 100V, 50 Hz to the electronic devices which require the biasing voltage. The pulses generated by the triggering circuit are provided to the thyristor as gate pulses for the triggering purpose. Finally, cycloconverter circuit acts as intermediate part between supply and induction motor. Therefore, applied voltage from the supply to induction motor and thereby speeds are controlled.

II. CYCLOCONVERTER

A cycloconverter is a type of power electronics where the alternating voltage at one frequency is directly converted to the alternating voltage at another frequency without requirement of any intermediate deck stage. It can either be a step-up or step-down cycloconverter. Controlling of cycloconverter is done by controlling the timing of firing pulses.

The frequency and amplitude of the output voltage is controlled by controlling frequency as well as depth of phase modulation of firing angles provided to the cycloconverter. Thus, a cycloconverter controls both output frequency as well as voltage continuously and independently. This frequency is normally less than 1/3 of the input frequency. The frequency is restricted by quality of output voltage wave and its harmonic distortion. At low output frequency this distortion is very low.

Cycloconverter has another advantage of putting down the use of flywheel. When a flywheel is present an increase in the torsional vibration along with fatigue in the power system component is observed. Therefore, it is eliminated from the design of any machine. Hence variable voltage variable frequency (VVF) method is chosen to design three phase cycloconverter to drive three phase induction motor to get required frequency varying with different time interval that generates supply torque characteristics monitoring with demand torque.

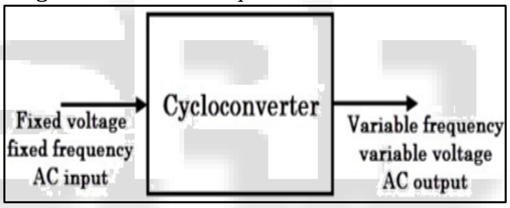


Fig. 1: Principle Diagram of Cycloconverter

A. *Types of Cycloconverter*

1) *Step Down Cycloconverter*

It acts like a step-down transformer that provides the output frequency less than that of input,

fo < fi

2) *Step Up Cycloconverter*

It provides the output frequency more than that of input,

fo > fi.

Where,

fo =frequency output

fi= frequency input

In case of the step-down cycloconverter, the value of the output frequency is somewhat limited to a fraction of input frequency, typically it is found to be below 20Hz in case of a 50Hz supply frequency. In this case, SCRs are line commutated so no separate commutation circuits are required.

Whereas in case of a step-up cycloconverter, in order to TURN OFF SCRs at the desired frequency we need forced commutation circuit which are relatively complex.

Therefore, majority of these power controlled devices are of step-down type that lowers the value of output frequency than input frequency.

III. INDUCTION MOTOR

Construction ally, this motor is more or less similar to a poly phase induction motor accept.

1) Stator is provided with a single phase winding
2) A centrifugal switch is used in some types of motors, in order to cut out a winding, used only for starting purpose.

When fed from a single phase supply, its stator winding produces a flux which is alternating but not revolving (rotating) flux. This alternating or pulsating flux acting on squirrel cage rotor can't produce rotation. That is why single phase motor is not self-starting.

For starting purpose temporarily, it is converted into a two phase induction motor by providing an auxiliary winding. The main winding and auxiliary winding are 90° apart and connected in parallel across the single phase supply. Based on this following are the types of induction motors,

1) Resistance split phase motor
2) Capacitor Start induction motor
3) Capacitor Start-Run induction motor
4) Shaded Pole induction motor

In our Simulink model we have designed capacitor start as well as capacitor start-run motors respectively.

IV. BLOCK DIAGRAM

The block diagram of our project is shown below,

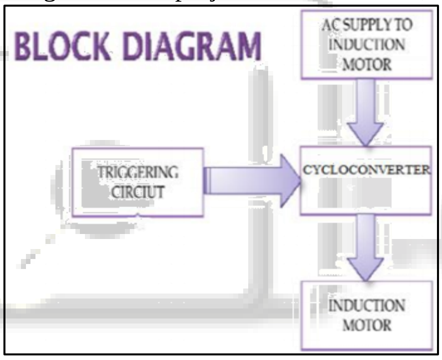
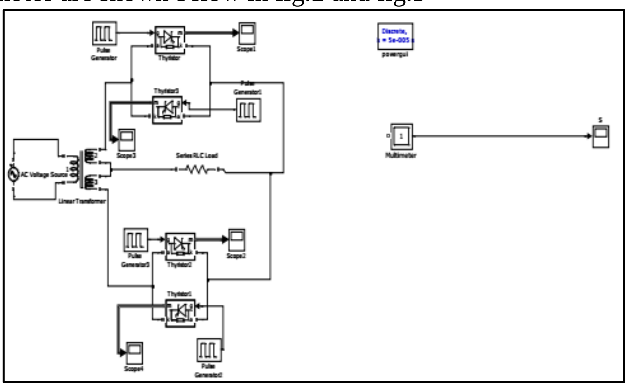


Fig. 1:

Cycloconverter is connected between the input supply and the induction motor for the required controlling. Triggering circuit connected to the cycloconverter, it is used to provide the firing angles to thyristors present in the cycloconverter to carry out the required mechanism.

V. MATLAB SIMULINK MODEL

Simulink model for the cycloconverter and the induction motor are shown below in fig.2 and fig.3



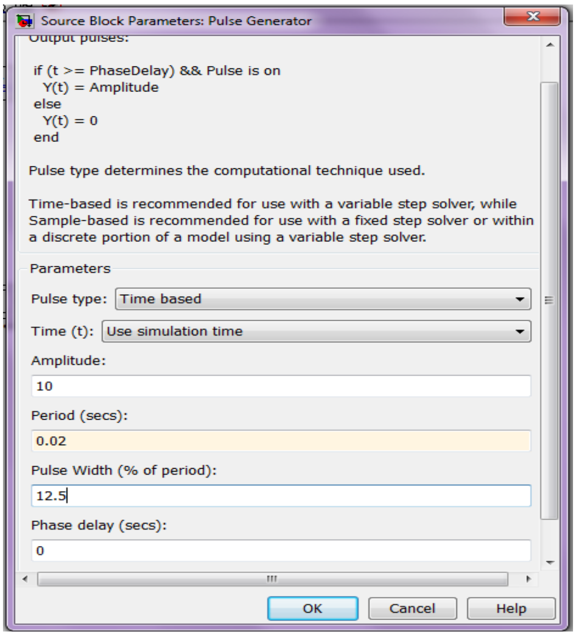


Fig. 12: Simulink Model & Parameters of Cycloconverter

In the above fig.2 the simulink model along with the parameter of the first thyristor is shown. In accordance to our requirement necessary phase delay can be provided to different thyristor for their operation at different time and the required output for the given load can be obtained.

Now the simulink model for the induction motor alongwith its input parameter is shown,

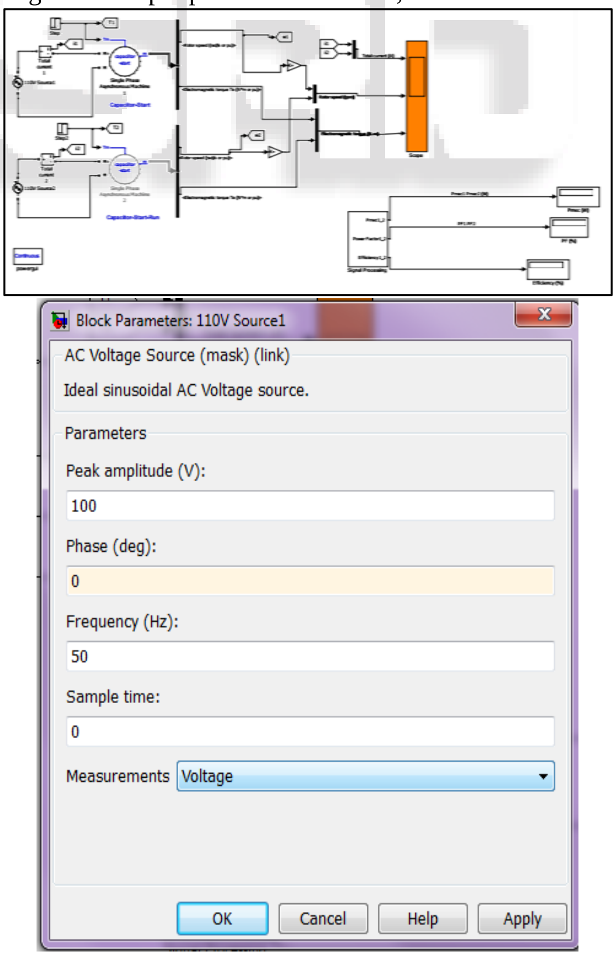


Fig. 3: Simulink Model & Parameters of Induction Motor

So the above models are designed on Simulink to get the required characteristics and compare it with the literature to ensure that our results are correct.

VI. RESULT & DISCUSSION

After applying the control strategy, the proposed simulation results obtained are shown in fig.4, 5, 6, 7 and 8 respectively, Following are the output waveform of cycloconverter for different firing angles,

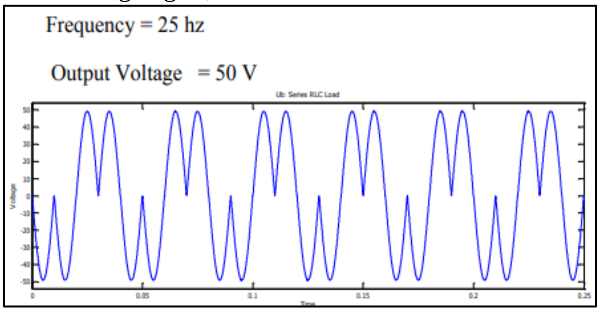


Fig. 4: Voltage VS Time at Output Frequency 25Hz

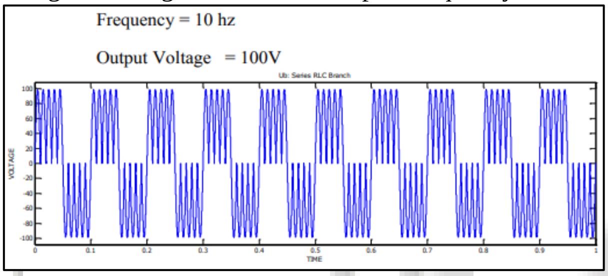


Fig. 5: Voltage VS Time at Output Frequency 10Hz

Now the obtained speed graphs at different frequencies are

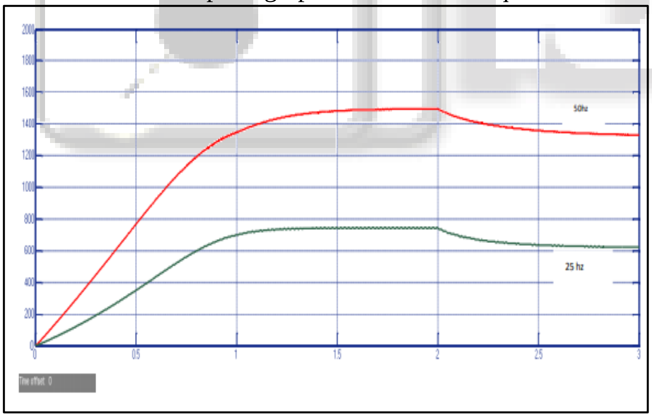


Fig. 6: Graph between Speeds for Frequency 25 Hz

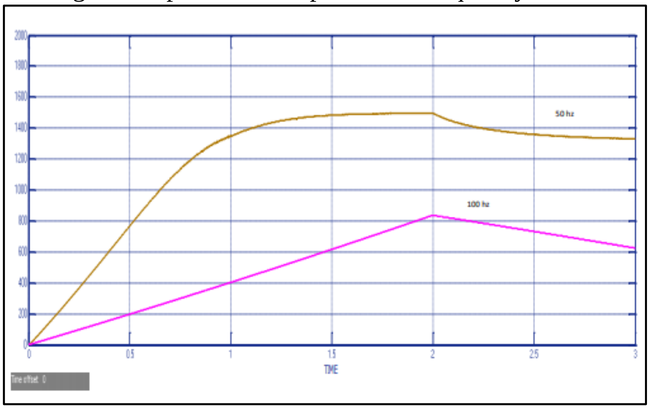


Fig. 7: Graph between Speeds for Frequency 100 Hz

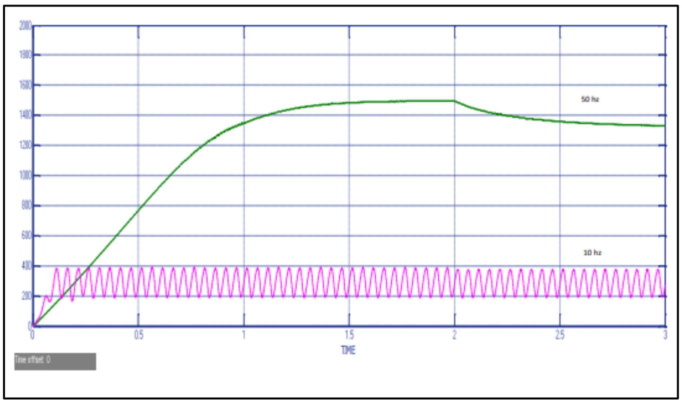


Fig. 8: Graph between Speeds for Frequency 10 Hz

The above graphs are obtained from the following analysis,

S. No.	Frequency	Max Speed (RPM)
1.	25	750
2.	10	200-300
3.	100	830

Table 1:

VII. CONCLUSION

Thus the cycloconverter circuit has been simulated and the desired result are obtained for the various values of frequencies, thus by changing the value of the supply frequency speed variation for an induction motor can be done and this change in frequency is made by using power electronic device such as a cycloconverter.

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