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PERFORMANCE OF THREE PHASE INDUCTION MOTOR USING MATLAB SIMULATION

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Abstract— The three phase induction motor has been the motor of choice in industrial settings for about the past half century because power electronics can be used to control its output behavior. In past years, the dc motor was widely used because of its easy speed and torque controllability. The two main reasons are its ruggedness and low cost. The induction motor is a rugged machine because it is brushless and has fewer internal parts that need maintenance or replacement. In this paper a new performances is presented of the three phase induction motor which is fed from a rectifier inverter system. Here rotor voltage is rectified, converted in to ac using inverter system and then Step up by step up Transformer. The simulation is carried out with three phase induction machine. In this method not only the starting of machine is simple but this scheme also provides flexibility in speed control and calculates the performance parameters

The performance analysis and MATLAB simulation of inverter-fed slip-power recovery drive is presented. This drive is different than other slip-power recovery drives in the sense that the slip-power from rotor terminals is recovered to the dc-link of feeding inverter to the motor while in other schemes slip-power is recovered to the ac source. Recovery of slip-power from rotor terminals to ac supply is blocked by diode bridge rectifier, which is used to feed the motor inverter.

Keywords— Matlab simulation, Three phase induction machine, IGBT Inverter.

I. INTRODUCTION

One of the most common electrical machines used in most applications which is known as induction motor**.** This motor is also called as asynchronous machines because it runs at a speed less than synchronous speed. We define what synchronous speed is. Synchronous speed is the speed of rotation of the magnetic field in a rotary machine and it is depends upon the frequency and number poles of the machine. An induction machine always runs at a speed less than synchronous speed because the rotating magnetic field which is produced in the stator will generate flux in the rotor which will make the rotor to rotate, but due to the lagging of flux current in the rotor with flux current in the stator, the rotor will never reach to its rotating magnetic field speed i.e. the synchronous speed. Induction machine we given only one supply, so it is really interesting to know that how it works. When we are giving the supply to the stator winding, flux will generate in the coil due to flow of current in the coil. Now the rotor winding is arranged in such a way that it becomes short circuited in the rotor itself. The flux from the stator will cut the coil in the rotor and rotor coils are short circuited, according to Faraday's law of electromagnetic induction, current will start flowing in the coil of the rotor. When the current will flow, another flux will get generated in the rotor. One is stator flux and another is rotor flux and the rotor flux will be lagging to the stator flux. Due to this, the rotor will feel a torque which will make the rotor to rotate in the direction of rotating magnetic flux. So the speed of the rotor will be depending upon the ac supply and the speed can be controlled by varying the input supply.

As we all know the input to the three phase induction motor is three phase supply. So, the three phase supply is given to the stator of three phase induction motor.

Let, P_{in} = electrical power supplied to the stator of three phase induction motor,

V_L = line voltage supplied to the stator of three phase induction motor,

I_L = line current,

Cosφ = power factor of the three phase induction motor.
Electrical power input to the stator, $P_{in} = \sqrt{3}V_L I_L \cos\varphi$

A part of this power input is used to supply stator losses which are stator iron loss and stator copper loss. The remaining power i.e (input electrical power – stator losses) is supplied to rotor as rotor input.
So, rotor input $P_2 = P_{in}$ – stator losses (stator copper loss and stator iron loss).
Now, the rotor has to convert this rotor input into mechanical energy but this complete input cannot be converted into mechanical output as it has to supply rotor losses. Since the iron loss depends upon the rotor frequency, which is very small when the rotor rotates, so it is usually neglected. So, the rotor has only rotor copper loss. Therefore the rotor input has to supply these rotor copper losses. After supplying the rotor copper losses, the remaining part of Rotor input, P_2 is converted into mechanical power, P_m.

Let P_c = rotor copper loss,
I_2 = rotor current under running condition,
R_2 = rotor resistance,
P_m is the gross mechanical power developed.
$P_c = 3I_2^2R_2$
$P_m = P_2 - P_c$

Now this mechanical power developed is given to the load by the shaft but there occur some mechanical losses like friction and windage losses. So, the gross mechanical power developed has to supply these losses. Therefore the net output power developed at the shaft, which is finally given to the load, is P_{out}.
$P_{out} = P_m$ – Mechanical losses (friction and windage losses).

II. Efficiency of Three Phase Induction Motor

Efficiency is defined as the ratio of the output to that of input,

$$Efficiency,\ \eta = \frac{output}{input}$$

Rotor efficiency of the three phase induction motor ,

$$= \frac{rotor\ output}{rotor\ input}$$

= gross mechanical power developed / rotor input

$$= \frac{P_m}{P_2}$$

Three phase induction motor efficiency,

$$= \frac{power\ developed\ at\ shaft}{electrical\ input\ to\ the\ motor}$$

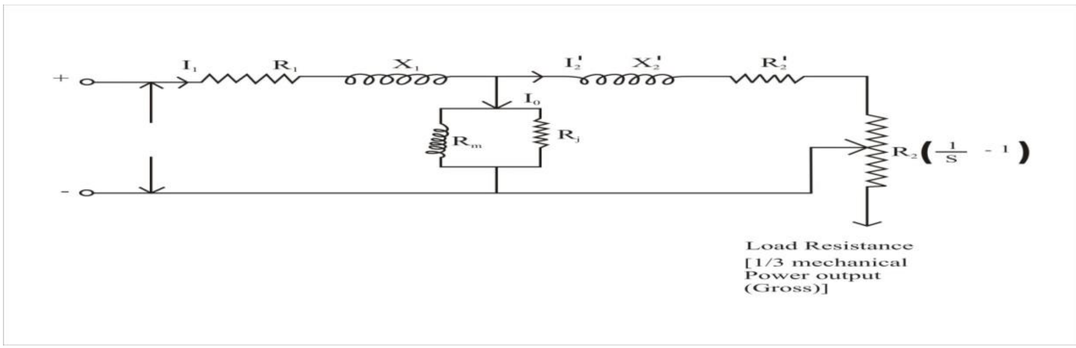
Three phase induction motor efficiency

$$\eta = \frac{P_{out}}{P_{in}}$$

III. EQUIVALENT CIRCUIT OF AN INDUCTION MACHINE

Considering the equivalent circuit, if the injected voltage is increased, the rotor current will be reduced, resulting in a reduction in the available torque generated by the motor. If there is a load applied to the motor, the rotor will slow down, resulting in an increase in slip. As slip increases, the effective voltage seen by the stator will be reduced (the actual voltage physically induced in the rotor, due to the stator, will increase). As a result, rotor current will increase. This process allows the machine to find a new steady state where the induced rotor current produces enough torque to equal the load torque.

3.1 Analysis of operation



Equivalent circuit diagram of a three phase induction machine

WE know the gross Mechanical power is given by

$P_m = P_G - 3l'^2_2 R'_2$ ……………… …..(1)

$= 3l'^2_2 R'_2(1/s-1) = (1-s)P_G$ .... …………….(2)

This means that the gross mechanical power output is three times (three-phase) the Electrical power absorbed in resistance $R'_2(1/s-1)$. Figure can therefore be drawn as in Figure where R'_2/s is represented as.

$R'_2/2 = R'_2 + R'_2(1/s-1)$………………………..(3)

It is notice from Eq. 1that the mechanical power output is a fraction (1-s) of the Total power delivered to the rotor. While a fraction s of it is dissipated as the rotor Copper-loss. It is then evident that high-slip operation of the induction motor would be highly Inefficient. Induction motor are therefore, designed to operate at low slip (2-8%) at full-load.

Rotor speed is

$w = (1-s)w_s$, rad(mech.)/s……………….(4)

The electromagnetic torque developed is then given by

$(1-s)w_s T = P_m = (1-s)P_G$

or $T = P_G/w_s = 3l'^2_2 (R'_2/2)/w_s$ Nm. …….. (5)

IV. SIMULATION & RESULTS

The simulation results of open-loop ac drive system, classical optimal control system and matlab simulation based optimal control system are presented. All these results are supported by figures that compare the three above-mentioned systems. The performance of poly phase induction motor is checked first without any controller and then with the help of IGBT inverter Control controller. The simulink model is developed with the help of Matlab Simulation .The simulation is carried out for 3HP, 460 V squirrel cage induction motor drive using six step gate turn over thyrstier is shown in figure. In this work simulink model of induction machine drives has been implemented. Unlike most other induction machine model implements, with this model the user has access to all the internal variables for getting an insight into the machine operation.

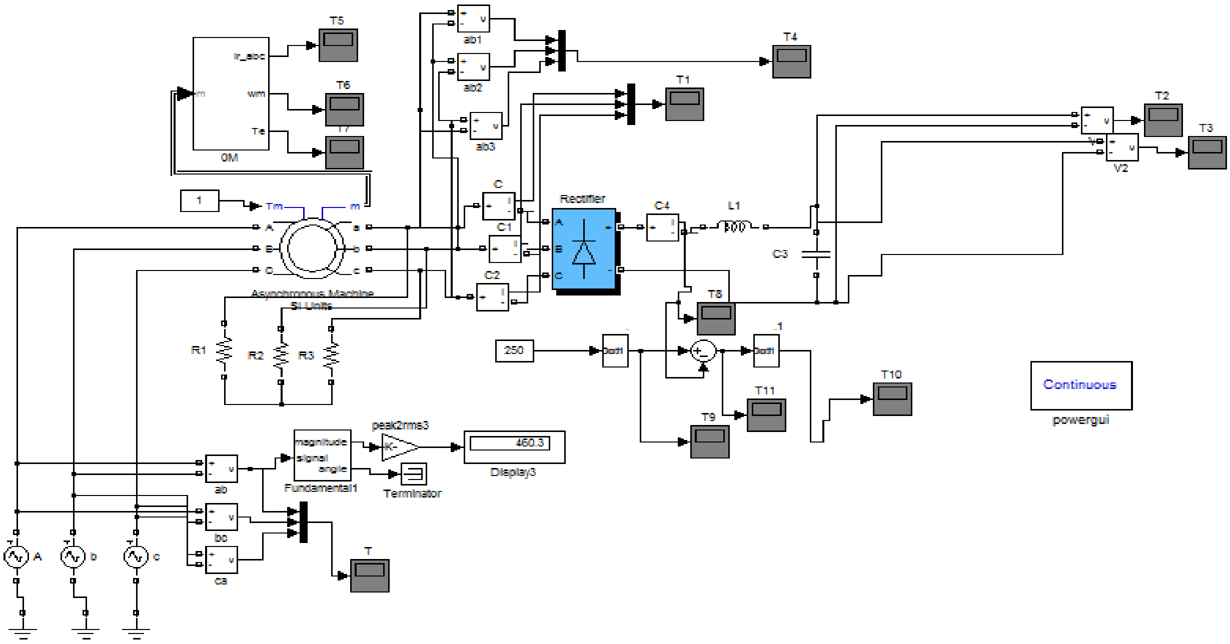


Figure. Matlab simulation of three phase induction machine

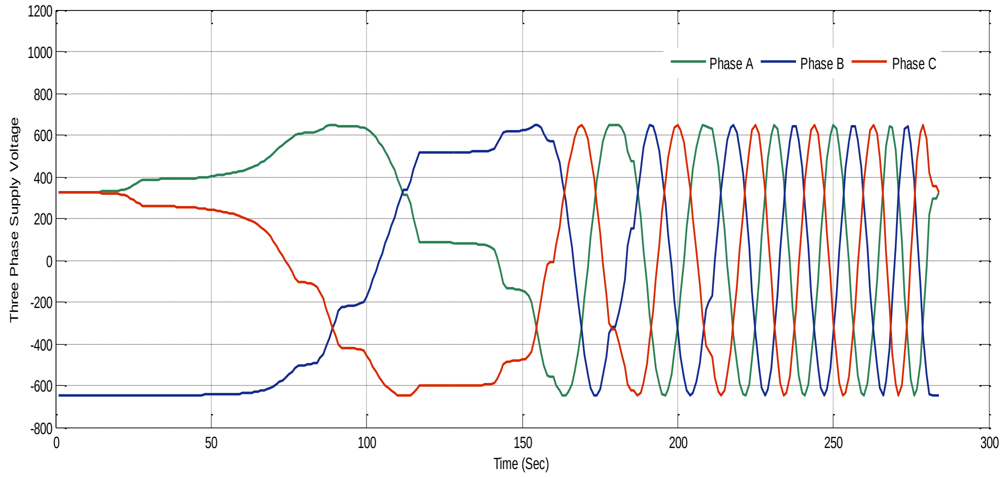


Figure Waveform of supply voltage

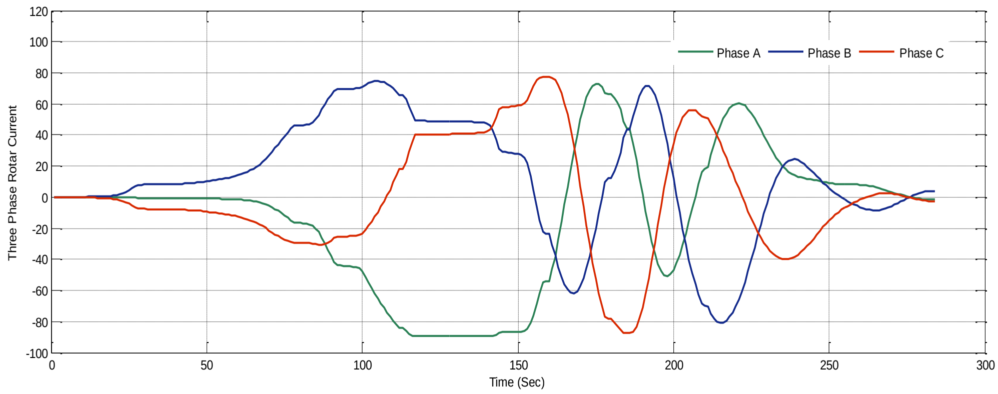


Figure Waveform of supply current

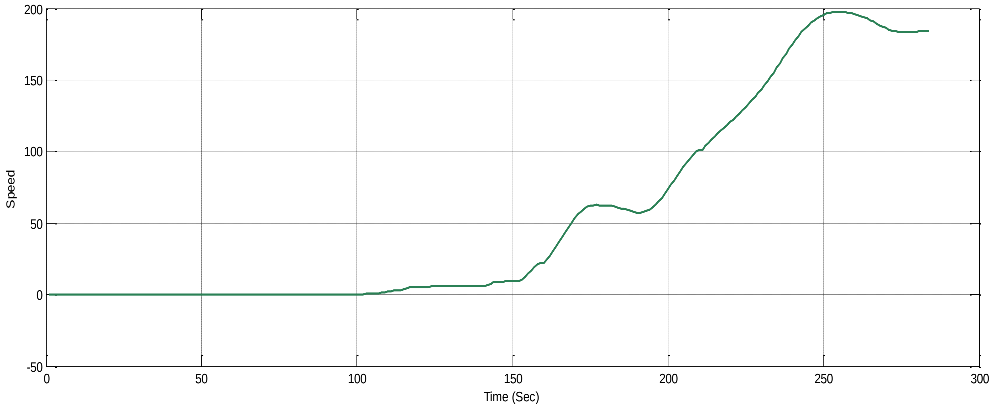


Figure Waveform of Speed

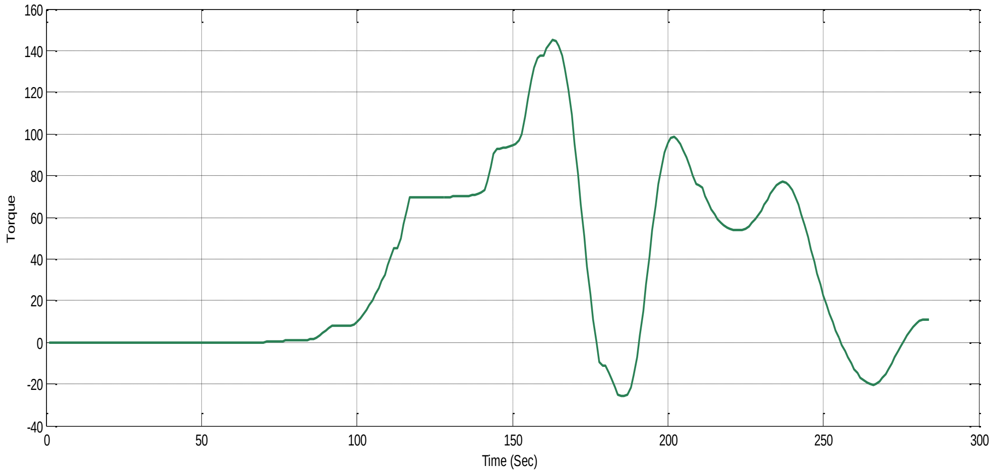


Figure Waveform of Torque

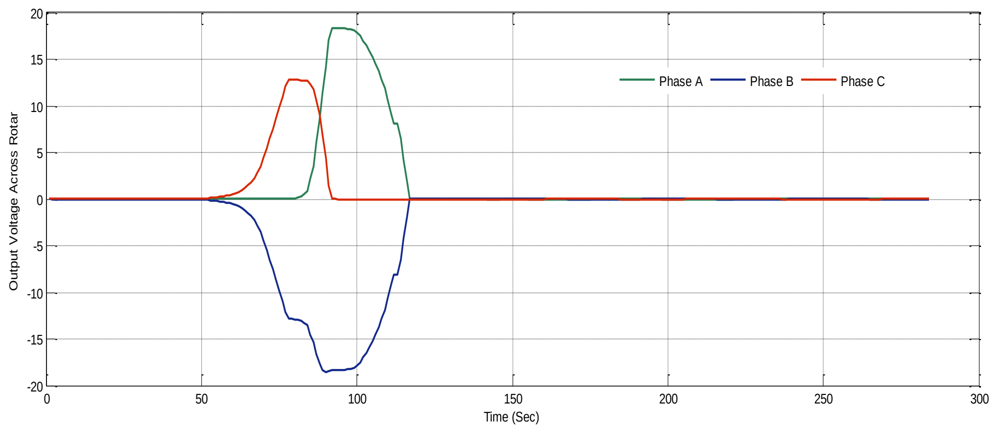


Figure Waveform of rotor output

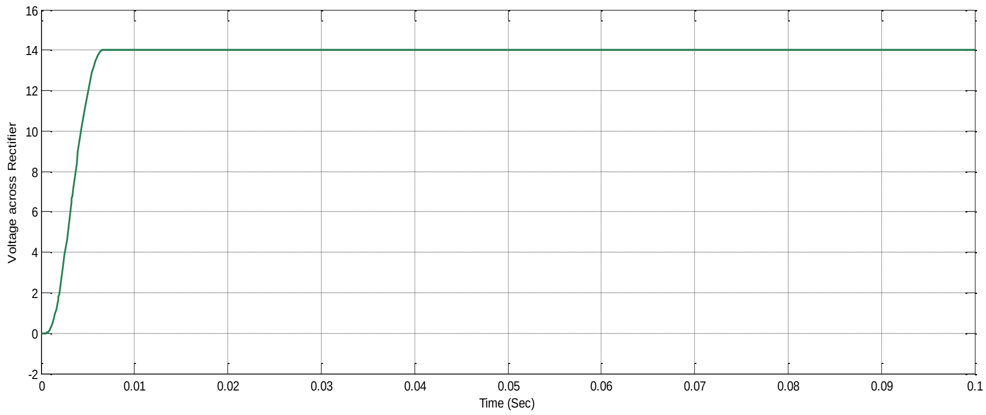


Figure Waveform rectifier

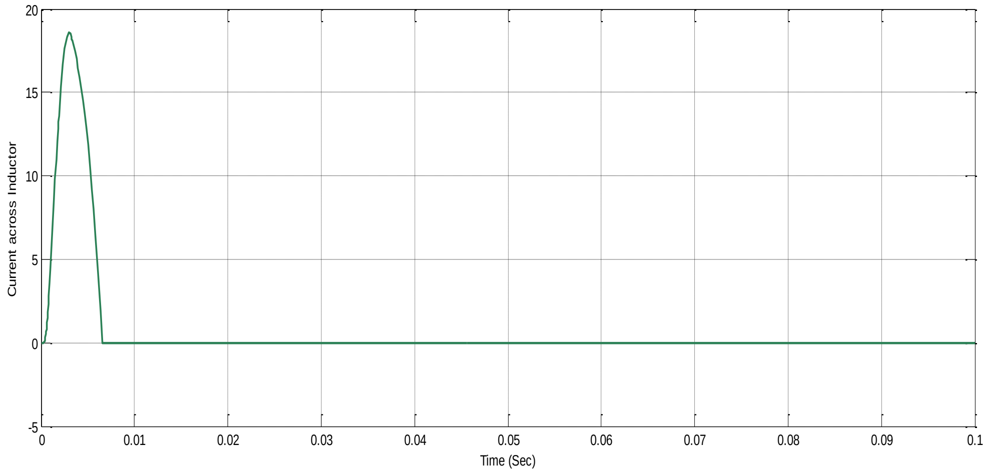


Figure Waveform of inductor

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