# SPEED CONTROL OF THREE PHASE INDUCTION MACHINE USING MATLAB

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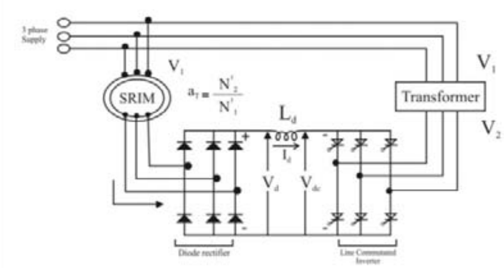
**Abstract**
**In this thesis a new slip power recovery scheme is presented of the three phase induction motor which is fed from a rectifier inverter system. Here rotor voltage is rectified, converted in to ac using inverter system and then Step up by step up Transformer. The simulation is carried out 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**
**Steady-state performance analysis of the drive is done with the help of dc and ac mathematical models. MATLAB simulation of this drive is done using equivalent circuit model of the wound rotor induction motor. This drive is developed in the laboratory for a wound-rotor induction motor. Theoretical and experimental performances and simulation results are found as expected.**

**INTRODUCTION**

As we know in case of three phase induction motor the portion of air gap power which is not converted into mechanical power is called as slip power. As in the most of the industrial application in induction motor has been Used in the past mainly in application requiring a constant speed because conventional method of their speed control have been expensive or highly inefficient but due to availability of thyrister,IGBT have allowed the development of variable speed induction motor drive

In this scheme shown in figure1. The rotor terminals are connected to the ac input Supply though to fully control bridges.Bridge1 operates as a rectifier and bridge2 operates as a inverter to feed the power output of the rotor back into the A.C. mains this is known as slip power recovery scheme.



Static Kramer Drive

### 1.1 Steady State Induction Machine Analysis

This section of the course considers the induction machine in steady state. The term steady state refers to the fact that the RMS currents and voltages, mechanical torque and speed, etc. are constant during the period being analysed.

Considering balance steady state operation, the machine can be analysed using a per-phase equivalent circuit. Later, when transient conditions are considered, the per phase circuit can no longer be applied.

To begin with, machines are analysed as though a variable voltage and frequency sinusoidal supply is available. Once the principles behind operation with sinusoidal supply have been considered, the power electronic circuits capable of producing variable voltage and frequency outputs are briefly described and analysed. The effects of applying the non-sinusoidal outputs of power electronic circuits to machines are analysed, together with the impact on the power system.

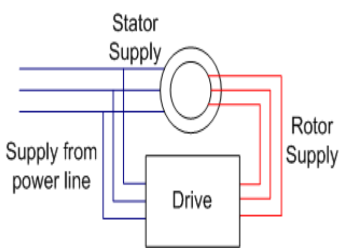
In addition to considering the impacts of changing the stator supply conditions, the option of applying control to the rotor circuit, "slip control" will also be considered.

**Limits on steady state operation**

It is important to remember that during steady state operation, there are two fundamental limits on operation

- The stator supply voltage should not exceed the rated, (or base), value: $V_s < V_{s\,b}$
- The stator current should not exceed the rated, (or base), value: $I_s < I_{s\,b}$

Exceeding rated voltage can cause premature insulation breakdown, resulting in motor failure. Exceeding rated currents causes excessive heating, again resulting in insulation breakdown and motor failure.




Whether the supply being controlled is to the stator or to the rotor, the drive must perform one basic function. It must convert a fixed-voltage, fixed-frequency supply to variable-voltage, variable-frequency (VVVF). This in turn may be done one of two ways:

- Direct AC-AC Conversion
- AC-DC Conversion plus DC-AC Conversion

**1.2 Slip Control**

Slip control is only possible with wound rotor induction motors. The principle of slip control is to control the speed of the motor by adjusting the rotor circuit, ***while the stator supply voltage and frequency remain constant.***

Consider the equivalent circuit of a wound rotor induction machine with the rotor circuit not referred to the stator.

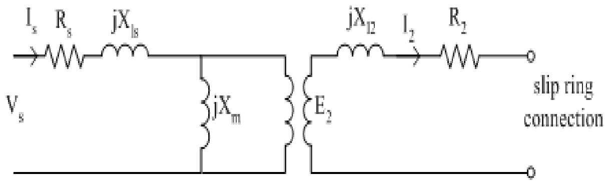



Fig-3

Note that to maintain the drives notation of subscript "r" to denote rotor variables referred to the stator, subscript "2" is used for actual rotor circuit parameters. This is the reverse of the standard machines notation used in the machine course.

Applying slip control, air gap power is diverted from the mechanical system to an external rotor circuit. This can be achieved with an external resistance:

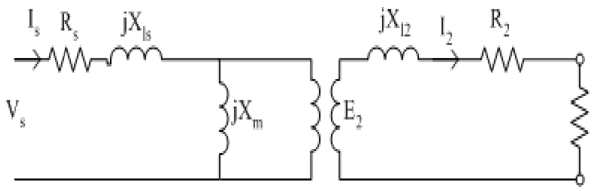


Fig-4

or by applying a voltage to the rotor slip rings

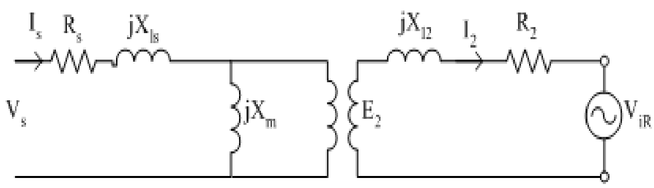


Fig-5

**2.1 WORKING PRINCIPLE OF SLIP POWER RECOVERY SCHEME**

The three phase controlled induction motor drive has a low efficiency, its approximate efficiency equals the PU speed .As speed decreases, the rotor copper losses increase , thus reducing the output and efficiency. The rotor copper loss are given by

$$Pc=3\ l'_2{}^2R'_2$$

Where Pa is the air gap power. The increase in this slip power, result in a large rotor current. This slip power can be recovered by introducing a variable EMF sources in the rotor of the induction motor and absorbing the slip power into it. By linking the EMF source to A.C. supply lines through a suitable power converter. The slip power energy is sent back to the A.C. supply. This is by varying the magnitude of the E.M.F source in rotor, the rotor current, torque and slip are controlled. The rotor current is controlled and hence rotor copper losses, and a significant portion of the power that would have been dissipated in the rotor is absorbed by the E.M.F source, thereby improving the efficiency of the motor drive

In slip power recovery scheme we control the speed below and above of the base speed .For sub synchronous speed control, bridge one has firing angle less than 90 degree whereas bridge two has firing angle more than 90 degree. In other words, bridge one works as rectifier and bridge two as line co mediated inverter.

While for super synchronous motor control, bridge one is made to work as line commutated inverter with firing angle more than 90degree and bridge two as a rectifier with firing angle less than 90 degree. The power flows is now from load to supply.

**RESULTS**

The simulation of slip power recovery scheme has been done by the use of MATLAB-SIMULINK for the purpose of simulation first of all the model file of different firing angle speed shown in figure.

1. Now let us take a look on change in speed with firing angle.

(i) At firing angle of α=50 deg. Speed become 1100 rpm

(ii) At firing angle of α=40 deg. Speed become 1300 rpm

(iii)At firing angle of α=35 deg. Speed become 1500 rpm

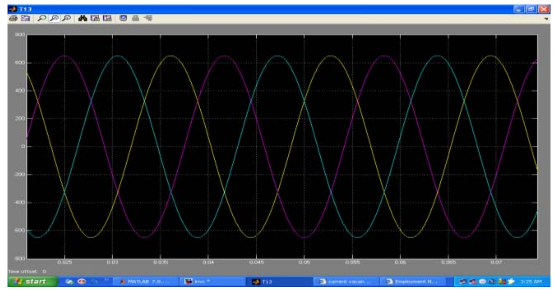
(iv) At firing angle of α=30 deg. Speed become 1700rpm

(v) At firing angle of α=25 deg. Speed become 2000 rpm

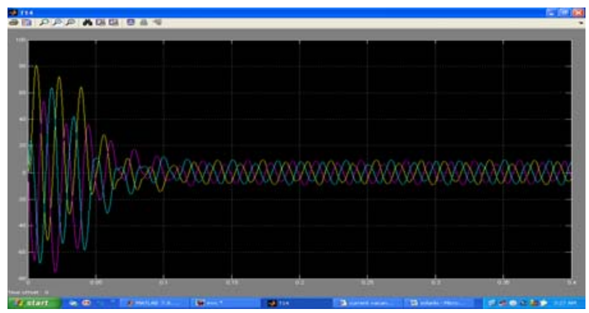
In the slip power recovery scheme highest firing angle at the lowest motor speed giving highest power factor and lowest reactive power at the lowest speed this improves the drive power factor and reduces reactive power at all speeds in the speed range of the drive.

In means that as an increasing the firing angle the speed decrease and vice-versa this also can be shown by a graph of speed.

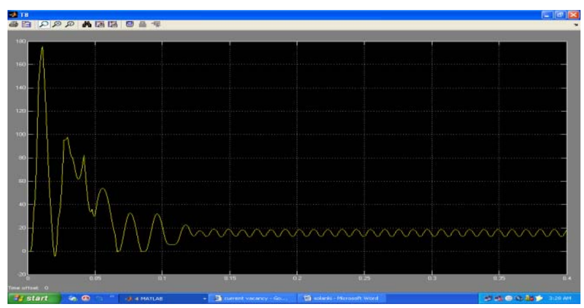
We observe various waveform at different firing angle shown in figure.



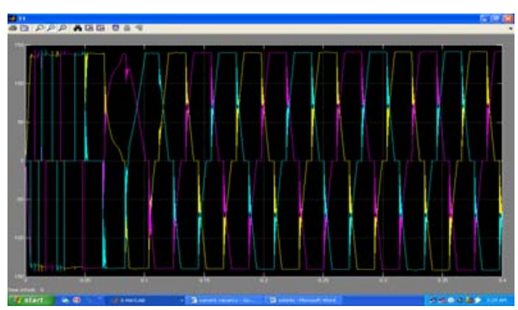
Wave form of three phase source in volt



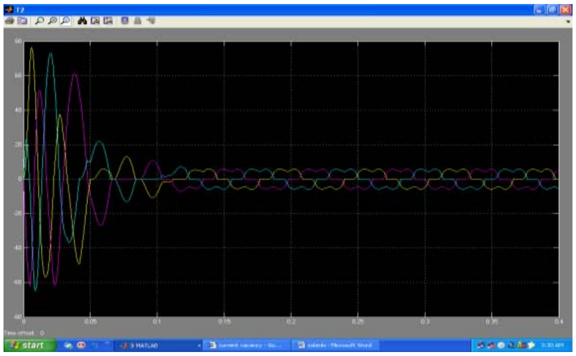
Wave form of three phase current source



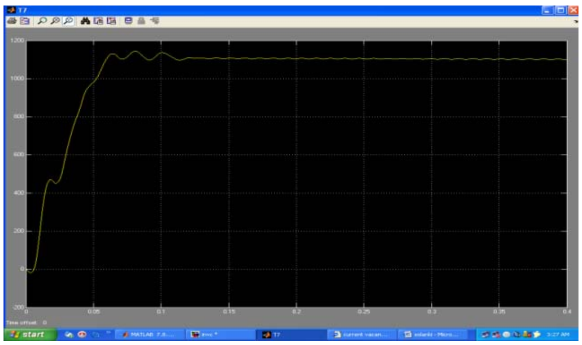
Wave form of Torqe NM



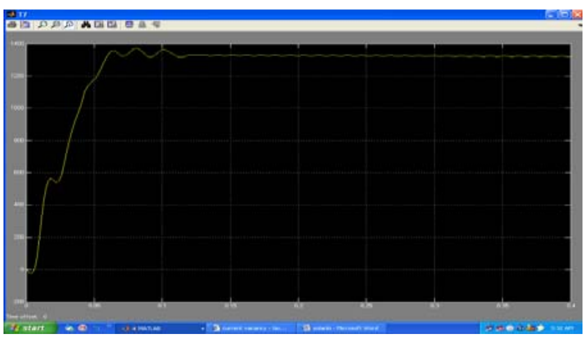
Wave form of three phase inverter out put in volt



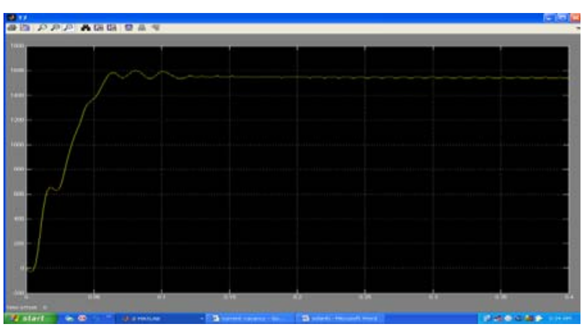
Wave form of three phase rotor current in am



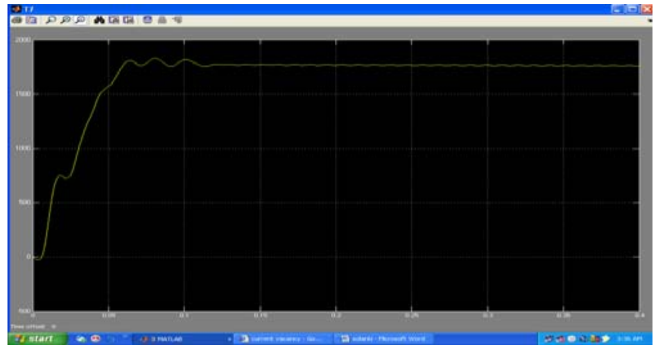
Speed wave form at firing angle =50de



Speed wave form at firing angle =40deg



Speed wave form at firing angle =35deg



Speed wave form at firing angle =30deg

**CONCLUSION**-The new slip power recovery scheme for speed control of three phase induction motor not only improve the power factor but also provide the flexible and simple starting of machine as explained earlier the interface transformer is replaced by step up chopper. The slip power frequency scheme is operates on 3-phase induction motor using Kramer drive .Kramer Drive simulated with 3-phase induction motor by using MATLAB application on Kramer drive we obtain the slip power recovery .

## 5.2 SCOPE FOR FUTURE WORK

As in the time of starting the three phase supply is connected momentarily to the stator with load duty ratio of chopper. As soon as the machine a trend some speed to produce sufficient back emf in the stator binding to commuted the inverter switches and then motor is disconnected from supply and is fed by DC link this problem can be eliminated by using IGBT and MOSFET to make a starting more simple harmonics can be further reduced by using PWM technique the speed control range should be increased.

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