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Speed Control of Three Phase Induction Motor in a Cement Plant Using Variable Frequency Drive Controller

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ABSTRACT: **Induction motor is the workhorse in industrial and residential motor applications due to its durability, robustness and reliability.. This project aims at analysis of a three phase induction motor drive using IGBTs at the inverter power stage with volts hertz control in closed loop using variable frequency drive as a controller. Three phase squirrel cage induction motors are widely used in industry because of its rugged construction and negligible maintenance. To operate this motor star-delta starters are used, but because of its variable speed characteristics, many a time it is driven with the help of variable frequency drives. The simulation study for the same control strategy is discussed and model is simulated in simulink. The result of hardware implementation is compared with simulation results. Variable Frequency Drives (VFD) can also be used to control the motor rotation direction and rotation speed of the three phase induction motor. All the required control and motor performance data will be taken to a personal computer via PLC for further analysis. Speed control from control side and protection from performance side will be priority.**
***Keywords* – IGBT, PID, PLC, VFD.**

I. INTRODUCTION

Variable Frequency Drive (VFD) is a technique that enables speed control of induction motor by applying variable frequency of AC supply voltage. By controlling the output AC frequency, it is possible to drive the motor at different speed based on the requirements. These are adjustable speed drives largely used in industrial applications such as pumps, ventilation systems, elevators, machine tool drives etc. It is essentially an energy saving system. Therefore the first requirement is to generate sine wave with different values of frequency for VFD [1].

II. OBJECTIVE OF THE PROJECT

The objectives of this project are:

- To study the various speed schemes available with main focus on the VFD based schemes.
- To study implementation of speed control of three phase induction motor using v/f method
- To model and simulate volts per hertz speed control based for IM drives using toolboxes available in MATLAB/Simulink.

III. VARIABLE FREQUENCY DRIVE

A VFD is basically an electrical circuit, which is connected between a supplying network and a motor

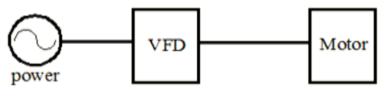

Figure.1 Scheme of control

In general, a state-of-the-art VFD consists of a rectifier section, a DC-link section and an inverter section, the VFD converts motor speed from fixed to variable speed.

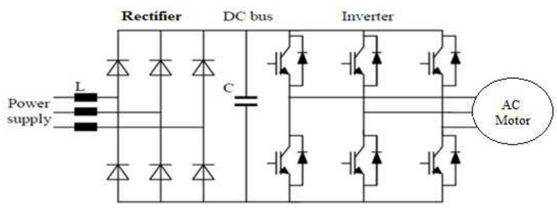

Figure 2. VFD circuit

IV. VARIABLE FREQUENCY DRIVES IN THE CEMENT INDUSTRY.

Starting from quarry to the finished cement product at each stage, variable frequency drives (VFDs) are used to smoothly start large motors and continuously adjust the speed as required by the process.

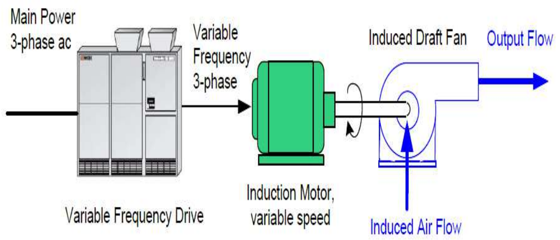

Figure 3. VFD in cement Industry

V.PROPOSED CONTROL METHODOLOGY

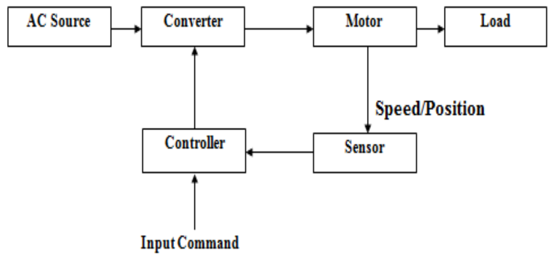

Figure 4.Block diagram of an electric drive system

Figure. Shows a block diagram of an electric motor drive The controller, by comparing the input command for speed and/or position with the actual values measured through sensors, will provide an appropriate control signal to the converter which consists of a power semiconductor device.

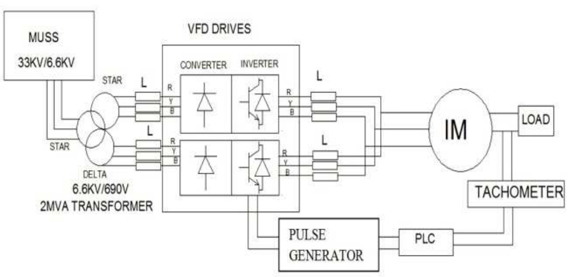

Figure 5. Project Block Diagram.

Figure5 shows block diagram consists of Master Unit Sub-Station (MUSS), 2MVA transformer, Variable frequency Drive (VFD), induction motor, PLC and Pulse generator. The transformer rating is 2MVA. The output of transformer is given to the input filter (L) which gives pure sinusoidal output voltage to the variable frequency drive. VFD consists of rectifier, chopper and inverter circuit. The rectifier converts AC to DC output and output of rectifier is uncontrollable in nature. This can further be controlled by using DC to DC converter and can be fed to the inverter and inverter output is fed to the induction motor which further drives the load (cooling oriented application).The speed of the motor is continuously measured by the tachometer. The motor speed is continuously monitored by the Programmable logic controller (PLC). Programmable logic controller gives the error signal to the pulse generator and pulse generator drives the gate terminal of the IGBT. IGBT is a high frequency switching device which reduces the switching loss and decreases the switching time by this increasing in the efficiency

PLC PROGRAM

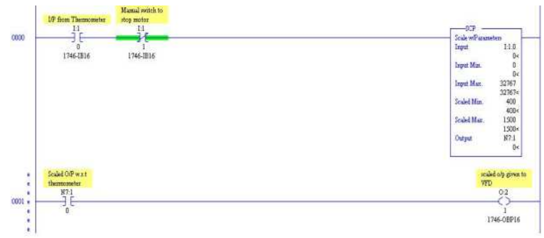

Figure6. PLC Ladder Diagram

The above ladder diagram written as per speed monitoring and gives the signal to VFD of the inverter circuit it consists of IGBT. As a rotor speeds of the motor is minimum 400 RPM and maximum1500 RPM based on this written the PLC program as per load.

VI. SIMULATION OF VOLTS PER HERTZ CONTROL METHOD

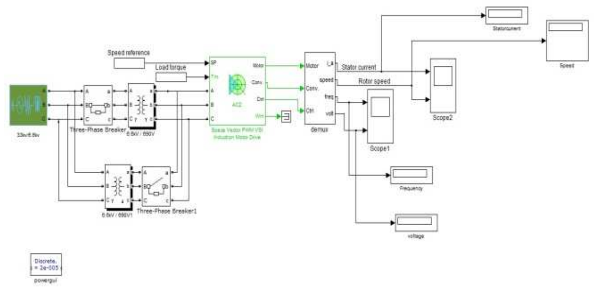

Figure7. Simulink model of volts per hertz control method

VII. RESULT AND ANALYSIS

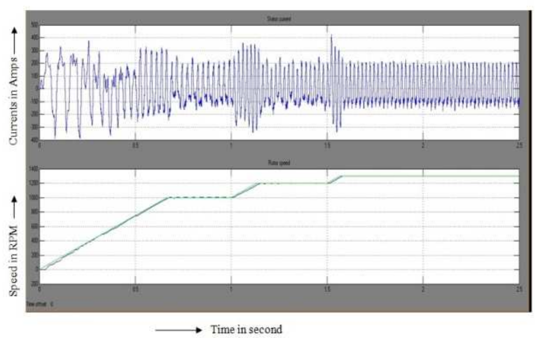

Figure8. Wave forms of stator currents and rotor speed

Fig8. shows the wave form of stator current and rotor speed of induction motor. The speed changes with variation in load with respect to time. With increase in current during starting speed increases rapidly as shown fig. when it attains approximately 80% of rated speed the starter changes the position from star to delta. With changes in starters position current becomes constant and hence the speed. Later with increase in load there will be increase in speed.

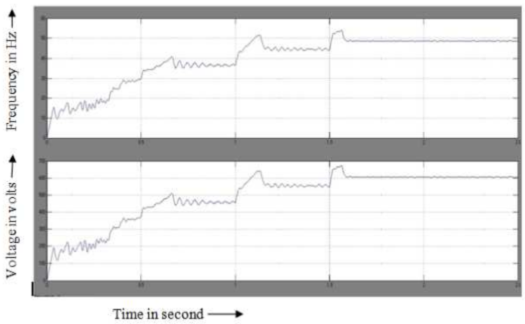

Figure9. Wave forms of Frequency and Voltage

Figure9 frequency and voltage very linearly, ratio of voltage and frequency remains constant.

VIII.CONCLUSION

Speed control of motor is achieved with good accuracy. Hence in this work accuracy of speed control is very efficient. The variation of stator voltage and frequency is done proportionally, such that V/F ratio is constant. The inverter line to line voltage is maintained stable and smoothened with use of the filter and hence the VFD drive so designed is more efficient and economical. The monitoring and control system of VFD driven by PLC based controller proves to be highly efficient in speed regulation at variable loads when compared to conventional controllers. The PLC based controlled proved to be versatile in nature and easy to program. The digital controllers designed using PLC facilities the following features:

- variable speed for any changes in load with respect to time.
- constant torque over wide range of speed.
- high performance parameters in closed loop control.

IX. SCOPE OF FUTURE WORK

This project can be further utilised in

- Multiplexing two are more drives to start and control.
- More advanced VFD that can control multiple motors of different capacity (HP) can be designed and implemented.

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