Three Phase Induction Motor Speed Control By Using Variable Frequency Drive

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Abstract: The main aim of the project deal with the concept of speed control of a three-phase induction motor with energy saving. To do so, a VFD (Variable Frequency Drive) is used for controlling the speed of a three-phase induction motor. It certainly leads to the best performance and high efficiency of the induction motor. In recent years, a major issue that is threatening Tamil Nadu for the past two years is the shortage of electricity. In such case, the unwanted energy should be saved. As mentioned in above constrain, we need to energy conservation in each and every field. Hence modern technology is used for that purpose. In recent trends of technology some drives designed by SIVANANDA ELECTRONICS which is especially for speed control of Induction Motor, in various industrial application. The implementation of VFD (Drives) helps in saving a large amount of energy by reducing the sudden jerks happening at the starting of the Induction motor.

Speed is not vary proportion to application so it consume the rated power and it becomes economically disadvantages. To overcome above problem a new concept of Variable Frequency Drive (VFD) is introduced. Adding a Variable Frequency Drive (VFD) to a motor driven system can offer potential energy saving in a system in which the load vary with time. The primary function of VFD in application is to provide energy saving, speed reduction of 20% can save energy up to 50%.

Keywords: Variable frequency drive, three-phase induction motor, pulse width modulation, frequency control.

I. INTRODUCTION

A new trend to adjust the speed of a three phase induction motor is by using variable frequency drives. Generally, an induction motor can run only at its rated speed when it is connected directly to the main supply. However, many applicationsneed variable speed operations. In most of the applications the input power is directly proportional to the cube of motor speed. In certain applications like induction motor-based centrifugal pump, a speed reduction of 20% results in an energy saving of approximately 50%.The loads on induction motor always vary as per its application but speed of induction motor is constant & cannot match with the load demand. If load on induction motor decrease, the speed of induction motor cannot be decreases as per the load. Hence it takes rated power from supply so the energy consume by the motor is same.Hence there is energy consumption is same during load varying condition also. To overcome this problem a VFD is used. VFD is a power conversion device. The VFD converts a basic fixed-frequency, fixed voltage sine-wave power (line power) to a variable-frequency, variable-voltage output used to control speed of induction motor.

AC Motor Speed - The speed of an AC induction motor depends upon two factors:

1) The number of motor poles
2) The frequency of the applied power.

AC Motor Speed Formula:-

RPM =<u>120 x Frequency</u>

Number of Poles

II. METHODS

The speed controlling techniques are given below:

1. Stator Frequency Control:

We know that Actual Speed N is given by,

N = Ns (1 - s)
i.e.N = Actual speed
Ns = Synchronous speed
S = Slip

So, we can change the actual speed N by changing the synchronous speed. But synchronous. But synchronous speed Ns can be changed by changing the stator supply frequency. So, theoretically we can control the speed by changing only Frequency.

2.Controlling the Number of Poles:

We know that the synchronous speed is given by,

Ns = 120F / P

i.e. Ns = Synchronous Speed of Induction Motor

F = Stator Supply Frequency

P = Number of Poles of the Motor

So, it is possible to change the synchronous speed by changing Number of Poles. The Number of Poles can be changed by changing the connections of stator winding with the help of simple switching. So, we get different speed.

3. Changing in Stator Resistance:

In this method we can control the speed by changing the stator resistance. This control is basically the stator voltage control because when we change the rheostat connected in the stator circuit, a part of supply voltage will drop across the rheostat. Hence the actual voltage applied to the stator is reduced. The speed changes due to variable stator voltage. In that start position a minimum stator voltage is applied and the speed of the induction motor is minimum. As the rheostat is reduced, the stator voltage is increased ad the speed also increases.

III. SYSTEM DESCRIPTION

The three phase induction motor is the most widely used electrical motor. Almost 80% of the mechanical power used by industries is provided by three phase induction motors because of its simple and rugged construction, low cost, good operating characteristics, absence of commutator and good speed regulation. In three phase induction motor the power is transferred from stator to rotor winding through induction. The induction motor is also called a synchronous motor as it runs at a speed other than the synchronous speed.

VFD operation requires following basic sections:-

i. Rectifier and Filter
ii. Inverter circuit(IGBT)

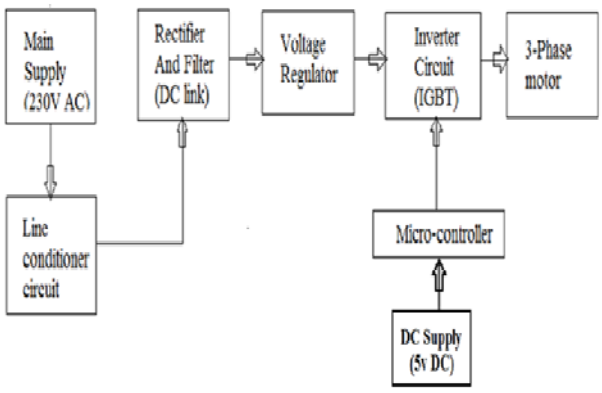

Fig.3.4 Block diagram of VFD Drive.

iii. Microcontroller for controlling frequency

The line filtering is done to reduce noise from the AC power supply.The rectifier converts the AC input signal to pulsating DC signal and filter is used for smoothing the signal, the filters are basically consist of capacitor and resistor circuitry.The final section of VFD is an inverter. The inverter requires a stable dc voltage at its input. For this voltage regulator circuit is used to provide stable voltage.A voltage regulator converts the unregulated dc voltage obtained from the bridge rectifier into regulated dc voltage. It provides a constant dc output voltage and contains a circuitry that continuously holds the output voltage at the desired value.The inverter contains power transistors that deliver power to the motor. The inverter requires a stable dc voltage at its input. Hence, the rectified output of the bridge rectifier which is filtered using DC link is made constant using a voltage regulator circuit. Microcontroller is one of the most important component of VFD.It control the frequency by using pulse width modulation technique by adjusting the firing angle of IGBT.Thus the speed of 3 phase induction motor is vary as the frequency of the supply is change by using,

SPEED = $\frac{120 * \text{FREQUENCY}}{\text{POLES}}$

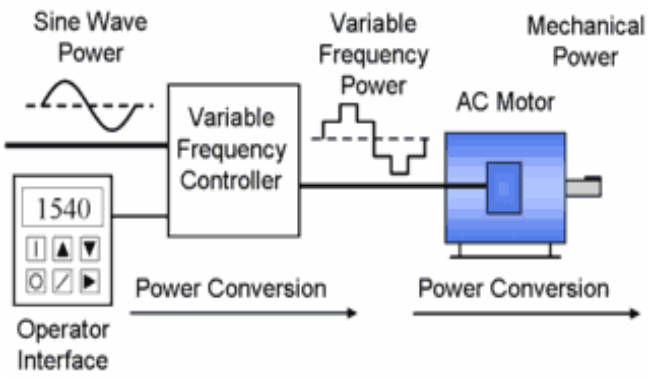

Fig.3.5 controlling method of VFD

Pulse Width Modulated (PWM) drives In a PWM drive, a rectifier provides a fixed DC voltage to the inverter stage. The inverter controls both the voltage and the frequency of the output waveform. The output voltage is controlled by dividing the basic 6-step waveform into a series of narrow voltage pulses and modulating the width of the pulses.

The PWM output waveform is more complicated to generated than the 6-step waveform, but the cost of that complexity is “only a few lines of code ’’ in the microprocessor. The use of fast switching IGBT transistors has resulted in PWM drives that are much efficient and compact than the older topologies

IV. ADVANTAGES

1. Large energy saving at lower speed.
2. Increased Life of rotating components due to lower operating speed.
3. Reduces Noise and Vibration level.
4. Reduction of thermal and mechanical stresses.
5. High protection levels available.
6. Readily available replacements world-wide.

7. Minimal moving parts therefore low maintenance cost.
8. High starting torque, suitable for wide variations of applications.

V. APPLICATIONS

Industry segments are important, because many applications are industry specific. Some VFD applications for various industries are provided below:

- Fans and pumps.
- Food Processing: agitators, mixers, conveyors for food transport, packaging and bottling, preparation machines (slicers, dicers, choppers), extruders.
- Petrochemicals: deep well pumps, oil field recovery, local distribution pumps, fans and pumps.
- Mining and Metals: reheat furnaces, cooling beds, run in/out tables, fans and pumps.
- Pulp and Paper/Forest Producers: washers, kilns, slitters, chippers, saws, sanders, peelers, de-barkers, fans and pumps, vacuum removal systems.
- Machine Tool: replace spindle drives, grinders, saws, and lathes, tool positioning drives, balancing machines, fans and pumps.
- Transportation: material handling conveyors, cranes and hoists, small vehicle drives, fans and pumps.
- Any machine or process that can be improved by varying speed or flow is a candidate for a VFD.

VI. CONCLUSION

Hence the modern world which seeks a renewable energy source for the electricity requires the concept of power which can be achieved using the concept of Modern VFD drive for the speed control of 3-phase induction motors. A V/F solution can be implemented using Variable Frequency Drive with PWM technique is suitable for crisp control of motors. In industries where motors and pumps used to satisfy all basic necessities can used the VFD controlled motors lead to higher energy saving. Also the additional resources used along with VFD like timers and run lamps provide greater safety and security measures against sudden jerk in current and voltage.

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