Automatic Soft Starting Control of Single Phase Induction Motor

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Abstract

The electrical machine that converts electrical energy into mechanical energy is the workhorse of motion industry, and when the output speed of the motor is controlled by changing its input frequency, and then the drive is called variable speed drive or variable frequency drive. Presently, it is just the combination of a motor and a controller. Drives can be classified as...

1) DC Drives

2) AC Drives

The control of dc motors requires providing a variable dc voltage which can be obtained from dc choppers or controlled rectifiers. These voltage controllers are simple and less expensive. DC motors are relatively expensive and require more maintenance due to brushes and commutates. While the control of AC drives require complex control algorithms by microprocessors or by microcomputers commonly known as controllers. The AC motors have number of advantages e.g.

1) They are 20% to 40% lighter than equivalent dc motors.

2) Applications of variable speed ac motors with inverter control include crane hoists, blowers, pumps and textile plants etc.

Induction motor control is complex due to its nonlinear characteristics. The speed and torque of induction motors can be controlled by following methods,

a) Stator voltage control

b) Voltage control Rotor

c) Frequency control

d) Stator Voltage and frequency control

e) Stator current control

f) Voltage, Current and Frequency control

In this project we have controlled the speed of induction motor by stator voltage and frequency control method using AVR micro microcontroller. The complete circuit consists of two parts; stator voltage control circuit and frequency control circuit. The stator voltage control circuit consists of PWM Program, Gate Drivers and Opto-couplers and frequency control circuit consist of proximity sensor.

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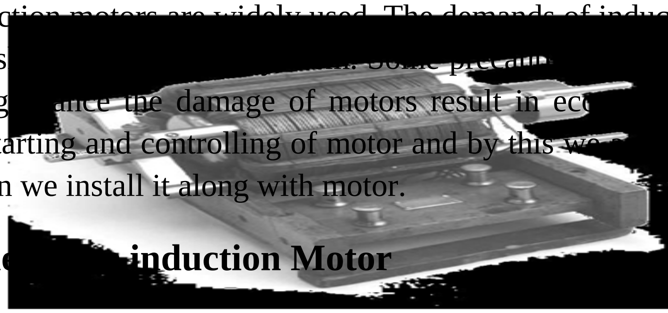
Chapter 1: Introduction

1.1 Introduction

In our society induction motors are widely used. The demands of induction motors are increasing rapidly as many tas[illegible]. Some precau[illegible] made during installation of them but due to ignorance the damage of motors result in economically loss. So we make a technique in soft starting and controlling of motor and by this we [illegible]e that some of its failures will be solved when we install it along with motor.



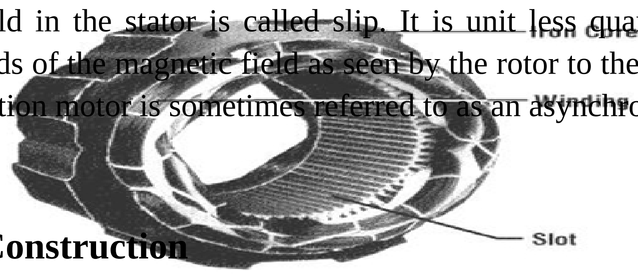
1.2 About Single [illegible] induction Motor

(a) Introduction:

An induction motor (IM) is a type of asynchronous AC motor where power is supplied to the rotating device by means of electromagnetic induction. An electric motor converts electrical power to mechanical power in its rotor (rotating part). There are several ways to supply power to the rotor. In a DC motor this power is supplied to the armature directly from a DC source, while in an AC motor this power is induced in the rotating device. An induction motor is sometimes called a rotating transformer because the stator (stationary part) is essentially the primary side of the transformer and the rotor (rotating part) is the secondary side. Induction motors are widely used, especially poly phase induction motors, which are frequently used in industrial drives.

(b)Principle of Operation:

The basic difference between an induction motor and a synchronous AC motor is that in the latter a current is supplied onto the rotor. This current then creates a magnetic field which, through magnetic interaction, links to the rotating magnetic field in the stator which in turn causes the rotor to turn. It is called synchronous because at steady state the speed of the rotor is the same as the speed of the rotating magnetic field in the stator. By way of contrast, the induction motor does not have any direct supply onto the rotor; instead, a secondary current is induced in the rotor. To achieve this, stator windings are arranged around the rotor so that when energized with a poly phase supply they create a rotating magnetic field pattern which sweeps past the rotor. This changing magnetic field pattern can induce currents in the rotor conductors. These currents interact with the rotating magnetic field created by the stator and the rotor will turn. However, for these currents to be induced, the speed of the physical rotor and the speed of the rotating magnetic field in the stator must be different, or else the magnetic field will not be moving relative to the rotor conductors and no currents will be induced. If by some chance this happens, the rotor typically slows slightly until a current is re-induced and then the rotor continues as before. This difference between the speed of the rotor and speed of the rotating magnetic field in the stator is called slip. It is unit less quantity and is the ratio between the relative speeds of the magnetic field as seen by the rotor to the speed of the rotating field. Due to this an induction motor is sometimes referred to as an asynchronous machine.

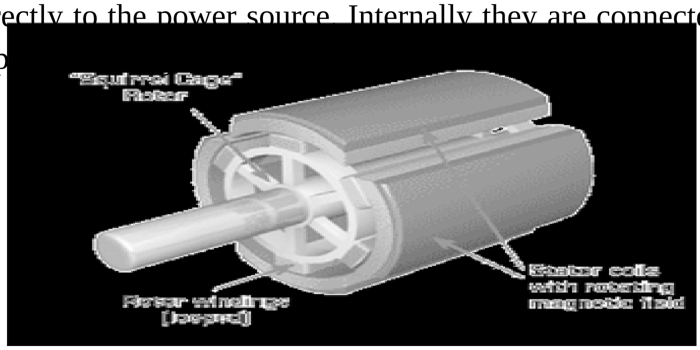


(c) Basic Construction

Like most motors, an AC induction motor has a fixed outer portion, called the stator and a rotor that spins inside with a carefully engineered air gap between the two.

Stator

The stator is made up of several thin laminations of aluminum or cast iron. They are punched and clamped together to form a hollow cylinder (stator core) with slots. Coils of insulated wires are inserted into these slots. Each grouping of coils, together with the core it surrounds, forms an electromagnet (a pair of poles) on the application of AC supply. The number of poles of an AC induction motor depends on the internal connection of the stator windings. The stator windings are connected directly to the power source. Internally they are connected in such a way, that on applying AC supp



Rotor

The rotor is made up of several thin steel laminations with evenly spaced bars, which are made up of aluminum or copper, along the periphery. In the most popular type of rotor (squirrel cage rotor), these bars are connected at ends mechanically and electrically by the use of rings. Almost 90% of induction motors have squirrel cage rotors. This is because the squirrel cage rotor has a simple and rugged construction. The rotor consists of a cylindrical laminated core with axially placed parallel slots for carrying the conductors.

Rotor

Each slot carries a copper, aluminium, or alloy bar. These rotor bars are permanently short-circuited at both ends by means of the end rings. The rotor slots are not exactly parallel to the shaft. Instead, they are given a skew for two main reasons.

The first reason is to make the motor run quietly by reducing magnetic hum and to decrease slot harmonics. The second reason is to help reduce the locking tendency of the rotor. The rotor teeth tend to remain locked under the stator teeth due to direct magnetic attraction between the two. This happens when the numbers of stator teeth are equal to the number of rotor teeth. The rotor is mounted on the shaft using bearings on each end; one end of the shaft is normally kept longer than the other for driving the load.

(d) Single Phase Induction Motor

This type of motor has only one stator winding (main winding) and operates with a single-phase power supply. In all single-phase induction motors, the rotor is the squirrel cage type. The single-phase induction motor is not self-starting. When the motor is connected to a single phase power supply, the main winding carries an alternating current. This current produces a pulsating magnetic field.

Single phase induction motor

Due to induction, the rotor is energized. As the main magnetic field is pulsating, the torque necessary for the motor rotation is not generated. This will cause the rotor to vibrate, but not to rotate. Hence, the single phase induction motor is required to have a starting mechanism that can provide the starting kick for the motor to rotate. The starting mechanism of the single-phase induction motor is mainly an additional stator winding (start/auxiliary winding). The start winding can have a series capacitor and or a centrifugal switch. When the supply voltage is applied, current in the main winding lags the supply voltage due to the main winding impedance. At the same time, current in the start winding leads/lags the supply voltage depending on the starting mechanism impedance. Interaction between magnetic fields generated by the main winding and the starting mechanism generates a resultant magnetic field rotating in one direction. The motor starts rotating in the direction of the resultant magnetic field.

1.3 Aim of the project

The objectives of this project are:

1) To make a well design that has efficient working for motors.

2) Due this reason we designed efficient, cheap and power saving.

3) Our project is light weight, economical, easily to install and easy to operate.

The proposed approach for designing this system is to implement a microcontroller based control module that receives its instructions from motor and run it according to rating of motor and prevent it from any loss.