AUTO VOLTAGE COMPENSATION FOR SINGLE PHASE INDUCTION MOTOR FOR VARIABLE LOAD

S. R. Kumbhar

Department of Electronics, Willingdon College, Sangli, 416415, (M.S.), India

Abstract

In olden days DC drives were used and even in online parameter measurement circumstances. The adjustable speed drive was developed by Bose B. K. (1984) and used for long time (Kumbhar S.R. et.al., 1999,2000) measured the online parameters of dc motors and data acquisition system was developed. It was used in very large scale but now a day's electric drives are used in the industrial power drive applications and even in the agriculture. However the development of the semiconductor technology the development in the power drive application also changed has no boundaries to specify. Computer Microcontroller, Microprocessor, PLC and other remote drives strategies are used to reduce the power requirement. Bhim Singh (2000) developed microprocessor based speed control starting method for inverter fed cage motor drive. The reduction of size, power, cost and the modular concept is the main requirement and met by the variety of drives present the market by varies companies with Power and switching of power drives has been increased with development in advanced semiconductor technology. For agriculture operation the induction motors are used for pumping the water from well as well as tube well. With increase in load on the motor due to the level of water the current requirement increases and the motor draws more current than expected. The heating of the wiring takes place and damage of motor or the winding and fuse takes place if the voltage does not remain constant as it decreases due to increase in load. The increase in the current requirement may lead the damage the transformer. This happens many times in the summer season as it puts more loads on the motor so motor draws more current than the expected. This also leads to shut down the power due to over loading and the process hampers for long time as well as the transformer repair cost is very high.

The current topic deals with the design of servo mechanism stabilizer in the input stage of supply for maintaining the constant voltage for the induction motor even though the load increases and the current requirement remains the same. The servo mechanism will maintain the voltage requirement with change in load. This possible using the microcontroller based feed back system which will control the servo mechanism. If load increases, the feedback is taken by the microcontroller and the servo mechanism will allow to increase the voltage using the servo stabilizer. This will maintain the constant output voltage.

Key words: *Induction motor, Servomechanism for voltage compensation. Microcontroller based servo mechanism.*

Introduction

During the 19th century DC motors were used for control applications however it has changed the concept and the induction were now used and AC drives and its modeling concepts dominated the industrial application (Krishnamoorthy K. A. et.al.,1978) worked on the line harmonic reduction of the drive. However the actual power semiconductor devices were used in the drive by Dubey G. K. (1989). The advanced technologies are already started using in motor control with the help of microprocessor, Microcomputer, Microcontroller and PLC based devices. The mathematical modeling was used by Hill R. J. (1990) in the induction drive (Williams F. et.al., 1992) worked on modeling and controlling rotating stall and surge of machinery. Use of these power semiconductor and simulation techniques plays significant role in the controlling techniques of the induction motor. As there is demand of control of induction motor in industrial application is day by day increasing in the industrial applications. To run the system for particular application the voltage or current must be constant and at many applications we find that the one of the above mentioned parameter varies. Generally the voltage drops below the expected value so motor draws more current than expected. So due to excess current the cabling and the internal winding may damage and due to heating wastage of power will takes place. To avoid this constant voltage is provided by using the servo techniques using the feedback from the drive with the help of microcontroller. Input voltage to the motor I kept constant with the help of servo stabilizer mechanism that will keep the current constant throughout the process constant.

System Design Details

Fig.1 shows an overall block diagram of the system. The control system includes the servo mechanism for the maintaining the constant voltage even the load changes during the pumping of the water (changing load). The instantaneous microcontroller based control. System will note the feedback parameters and according to the noted parameters the servo mechanism will provide the voltage to the motor. Snubber circuit will avoid the sharp transient changes in the system. The voltage and the current sensing are done using the respective signal conditioning circuits.

When the system is switched ON There will be sudden change in the current takes place which is avoided or reduced change by using the snubber circuit. The snubber consists of simply inductor, diode and capacitor and the circuit is simple with less cost. The motor will turn ON. The load on the motor, changes with change in the level of water. As the level goes down, the load increases and the current requirement increase. The motor will draw more current causing problem of heating and damaging the components and windings. It draws more current from the transformer of the supply which may damage due to excessive current in the supply winding. In Order to provide constant current the output of the servo stabilizer transformer windings are used which is controlled by a Microcontroller.

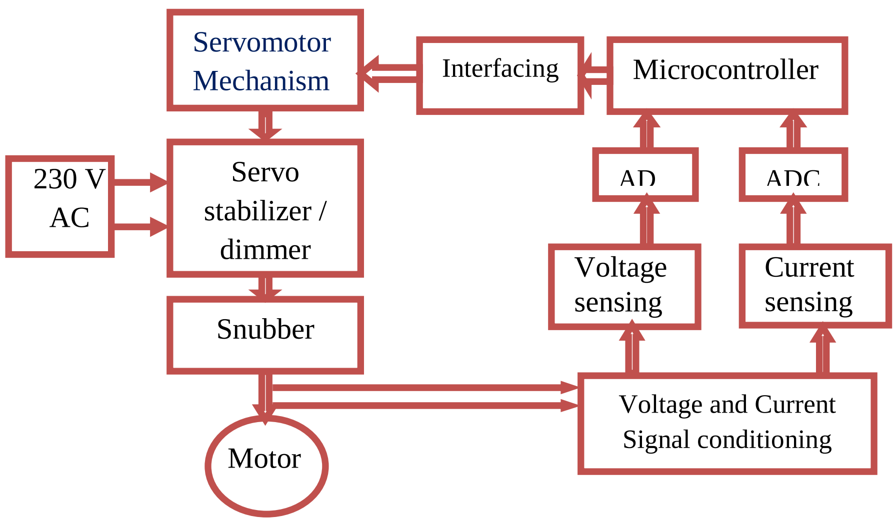

Fig. 1 Block diagram of the system

The feedback of the motor current and voltage through signal conditioning is provided to Microcontroller. It compares the incoming data ad through software the corrective action is taken by rotating servo mechanism. If current requirement increases then servo mechanism will provide more voltage to compensate the current requirement by stepping up and vive versa for other condition. Hence providing servo mechanism it is possible to reduce the rise in current avoiding heating and loss of power.

Snubber design

The snubber circuit is effective during the turn-off and turn-on of the transistor which consists of simply register, capacitor in parallel with power module and parasitic inductance is placed in series with power module. Snubbers are required because transistor have safe operating area limitations during turn-off to avoid catastrophic second breakdown failure. When the transistor current falls opposite diode can begin to conduct load current. The snubber inductance in the inverter phase now generate an overshoot voltage which appears across the transistor during the transistor fall time and collector voltage begins to rise. The snubber capacitor begins to charge. The charging current is from the transistor charging the capacitor to be maximum. At the same time feedback diode begins to conduct and current is transferred from snubber to diode. The choice of snubber capacitance limits the peak overshoot which helps to reduce turn-off losses. Mathematical modeling and line reduction harmonics were used in the large scale in the drive design and its extensive work was carried by Hill R. J. (1990). The redundancy in the system drive was reported by Kumbhar S. R. (2002) in drive design.

Signal Conditioning

Signal conditioning is required in order to provide proper signal and sense the voltage and current as per the conditions.

AC Voltage Sensing

The AC voltage measurement was performed by using peak detector circuit. The variation the voltage of the peak detector according to the line voltage changes applied to one of the ADC channel and further converted to actual voltage by scaling the output voltage of peak detector through software. The calibration is essential for the measurement of sensed voltage. If required the correction factor is also applied. The correction factor is given through the software to get the correct result.

Current Sensing

A simple technique used current measurement, consists of step up transformer whose primary is short-circuited by the shunt wire and the current through the shunt is given to the motor. The voltage drop across the shunt wire is proportional to the current passing through it, which is the current of the motor and secondary voltage is proportional to the motor current. The output voltage varies from 0 to 5 volt for variation of current from 0 to 5 ampere. There is linear relationship between input current and output voltage. The scaling is only essential and through correction factor it’s possible to provide linearity in the input and output.

Flowchart of Developed Software

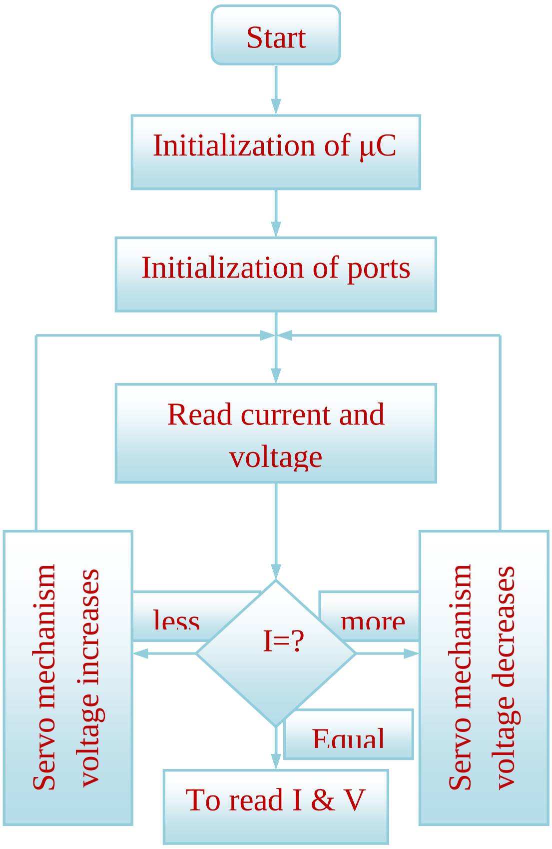

Fig. 4 Flow chart the system software

Calibration of System

Calibration of the system is very essential to maintain the accuracy of the system because, while sensing instrumental, human or environmental error may occur which may lead to deviation from the actual value. Therefore, it is necessary to have a precision meters and a stable noise free DC voltage source. In the present system current and voltage calibration is carried out by standard meters and required correction factor is applied through software.

Voltage Calibration

Fig 5(a) shows the variation of measured voltage versus input voltage. It is observed that output voltage varies linearly with input voltage however; initially the output is slightly deviated with respect to input. This creates the error while reading the input voltage. To read the actual value of the input voltage, some correction factor must be introduced and it is introduced through software by Kumbhar S. R. et.al. (2000). After applying the correction factor the output is measured. The plot of corrected voltage versus measured input voltage is shown in Fig 5 (b) indicating that corrected voltage displayed by the computer varies linearly with the measured voltage with standard voltmeter.

Current Calibration

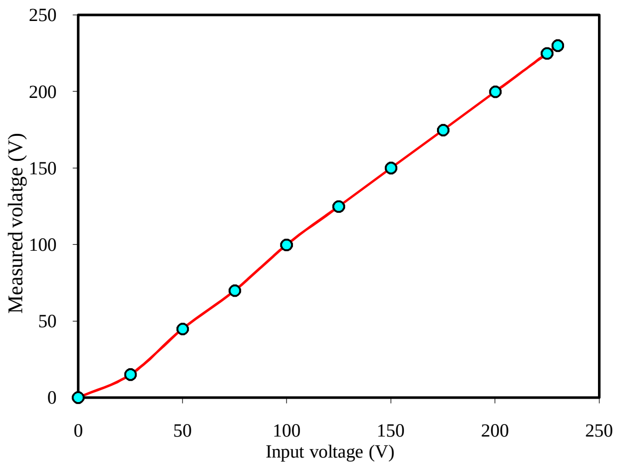

Fig. 5(a) Plot of measured voltage versus input voltage

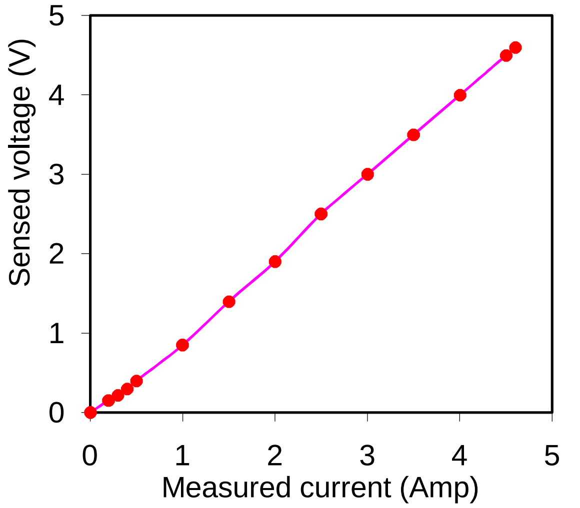

Fig. 6(a) Plot of sensed voltage versusmeasured current

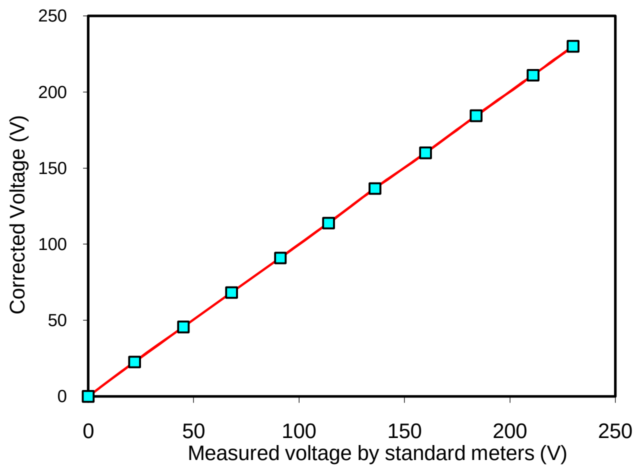

Fig. 5(b) Plot of corrected voltage versus measured voltage by standard meters

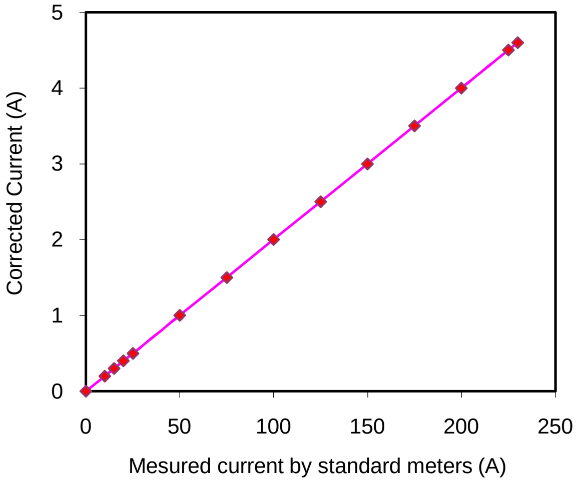

Fig. 6(b) Plot of corrected current versus measured current by standard meters.

Current measurement in case of induction motor under working condition is very important. The output voltage of the amplifier is proportional to the current. The calibration for the current measurement is done at different current ranges, to get the correct result. One such current calibration plot of the variation of sensed voltage (proportional to the current) versus measured current is shown in Fig. 6(a). After applying the calibration for current through software, output readings are recorded. Fig. 6(b) shows the plot of corrected current versus measured current. From the plot it is observed that both actual current and measured current are equal. However, there is little non-linearity in the graph at lower currents. So correction in measurement at lower current level is required.

Conclusion

For agriculture operation the induction motors are used for pumping the water from well as well as tube well. With increase in load on the motor due to the level of water the current requirement increases and the motor draws more current which is compensated or kept constant by implementing servo mechanism stabilizer in the input stage of supply even though the load increases. The servo mechanism maintains the voltage requirement with change in load. The using the microcontroller based feedback system which will controls the servo mechanism.

Acknowledgement

I would like to thank to UGC New Delhi for providing the financial assistance for research work in the form of Major Research Project.

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