IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Vol. 09, Issue 5 (May. 2019), ||S (V) || PP 10-14

Control and Synchronisation of Motors in Paper Mills Using PLC

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Abstract-*Paper mill industry has seen a lot of revolution since automation took place. Automation has led to reduced human efforts and also reduced costing of human labor, the advantage of automation is that controlled error techniques can be employed to remove any manufacturing error. Paper mill industry involves making paper from pulp then this processed sheet is passed through rollers in order to heat it and make it process-able for making paper , the sheet of papers are then cut according to the usage and application in which the paper shall be used. The proposed work presents an implementable technique for paper mill which will automate the process of paper mills and reduce human efforts. If the speed of motor is not controlled it may lead to damage of the papers and eventually tearing down of whole manufactured batch hence there is a need to control the speed of motor and maintain it at accurate speed. Each stage in paper mill requires different speeds and ratings hence synchronization for the whole unit has to be done. Induction motors are the most efficient motors in terms of usage in manufacturing plants and mills. The paper mill uses induction motor and drives at various stages. The main motor runs at a constant speed and variation in its speed affects the quality of paper severely. The speed of motors cannot be monitored and maintained manually. Automation at this stage and synchronization of the whole unit is thus done using PLC. PLC is a automation technology used in electrical industry and it' is widely used due to its reliability and good control techniques.*

Keywords: *Programmable Logic Controller, Induction motor, Paper mills*

I. Introduction

Induction motors are widely used motors in manufacturing industries and plants as they can operate in any environmental condition as well as are cheaper in cost as they do not have brushes, commutators, slip rings which are present in other motors They do not require a lot of maintenance. Induction motors can be operated in a wide variety of environments. A motor driver and a system to control it is used with different methods. The speed of Induction motor gets affected by change in supply frequency, change in the number of motor stators, and the input power variations. The speed of motor can be changed manually or in an automated manner. For automated speed control, computer with programmed logics are used and the logics for each application is different. PLC is used to implement this project. A variable frequency drive mechanism is used to control the speed of IM. It is very important to monitor the speed of IM in different conditions and take up actions accordingly In this project PLC is used to keep machine interface simple, where in different parameters can be monitored in a paper mill. There are certain situations when the places at which motors are installed is inaccessible due to environmental conditions or any other constraints, here the process of automation is used to control and monitor the parameters remotely.PLC has now become the first choice for automation projects owing to the ease of use and efficient as well as reliable performance. The failure rate of PLC is very less hence it is very much preferred at industrial level. The Ideal choice for Speed control of Induction motor in this project is therefore PLC.Guy A. Dumont[1] has described in his research about the problems that arise in paper mills owing to the variation in speed of motor. The pulp and process involved in making paper also affects the quality of paper being manufactured. The quality control team keeps the track of errors arising due to motor speed variations and defects in raw material being used. There arises a need to manufacture different types and qualities of papers which will eventually lead to vary speed of entire series of rolls but relative speed of rolls should be constant or it will lead to tearing of paper. There should be an arrangement to control the speed of any rolls in order to draw the paper out from the set of rollers. The biggest problem that arises in any paper mill is the amount of wastage of papers which lead to losses in production cost and also degrades the quality of manufactured paper.

II. Methodology

The process of paper mill has to be analyzed in order to design an efficient system that monitors the speed and synchronizes the whole unit so as to manufacture good quality of paper. Figure 1 shows a paper mill unit which requires rollers. The paper is made out of wood logs or the agro-wastes which is converted into pulp by a set of machines. The pulp is processed into heating machines and then dried to form paper. The thickness

of the paper is decided initially for pulp process control[2] The paper is then rolled on conveyor belt which is controlled by motor rotations. The set of rollers decide the paper quality and paper is drawn out as output. According to the size of paper required, the paper is cut into sets while rolling through the rollers. The quality control unit keeps the track of every batch being manufactured. All the above steps require monitoring of speed at each stage. PLC makes the whole process automated and keeps the track of speed at each stage. A human machine interface helps to produce the output readings for users and keep a track of the whole process.

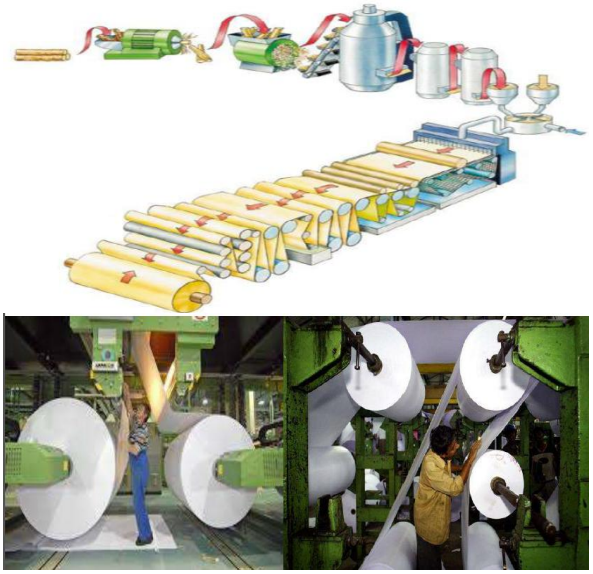


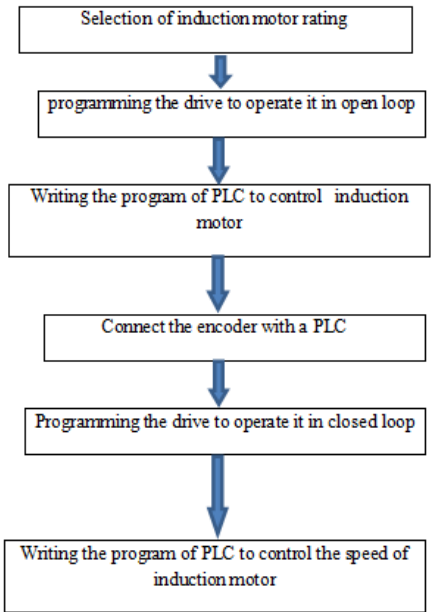
Figure1: Paper Manufacturing Process

2.1 Process Chart

Procedure

An Induction motor whose speed has to be controlled is used according to the rating.

The drive is then programmed in a manner so that it can operate in Open Loop at the initial stage. The parameters are monitored by collecting relevant data. A program is a set of instructions and commands that are made based on logics and algorithm of any control system. A PLC requires a program to be designed for monitoring and controlling the speed of IM. The program is written and tested at the initial stage by compiling and running it on simulation softwares.



The program must be tested for different conditions so that it doesn't fail at the implementation stage of the project. All the errors detected are removed out and corrected so that an efficient and optimized program is designed. The PLC is then connected to an Encoder; the function of an Encoder is to measure the speed and movements at different angles. The output of Encoder is in Electrical form which helps to process these signals easily. The contactors are also used in this system to make contacts at different positions and control the speed of motor. The second stage of the process chart is to configure the motor drive into Closed Loop configuration in order to control speed according to the changing conditions and needs.

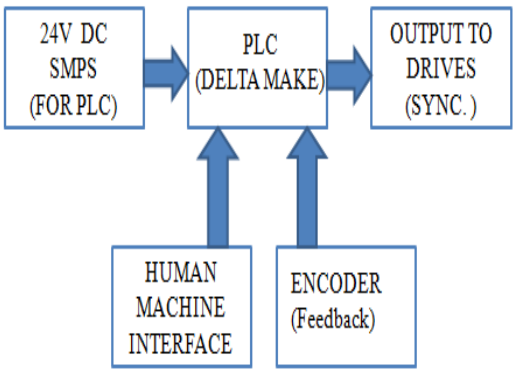


Figure 2 Block Diagram of PLC based Control Mechanism

2.2 PLC (Programmable Logic Control)

The programmable logic control is the essential element in automated systems. Above figure shows the basic block diagram of a PLC.A processor is used to process the available input information and complete tasks according to the program and logic of each application[5]

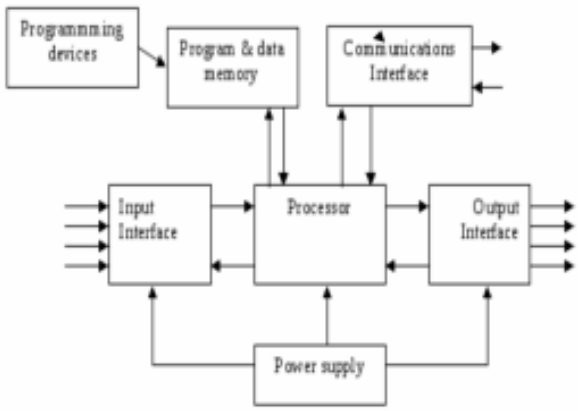


Figure 3: Block Diagram of PLC

There is a provision of input interface and output interface which is a part of UI section which enables the users to communicate with the system.

2.3Three Phase I.M

Induction motors has found its use in many manufacturing plants and industries where there is a need of machines and motors which do not require great maintenance. IM speed control is a very important aspect as there is a need in some applications to maintain a constant speed in spite of variations in different parameters as well as there is a need in some applications to frequently change the speed of Induction Motor.[5 , 6]

Figure 4 Induction Motor

III. Implementation

The implementation of this project shows different connections required for designing this system.PLC used is of delta make. The HMI used provides good interface between human and machine thus making it easy to use. The required number of input and output are shown in table 1 and table 2 shows the specifications required for designing this project

Input / Output	Required No.
Analog Input	6
Digital Input	12
Analog Output	6 (For Drives)
Digital Output	6 (For Drives)

Table 1 – Input Output Requirements

Figure 5 Connections with Motors and Press

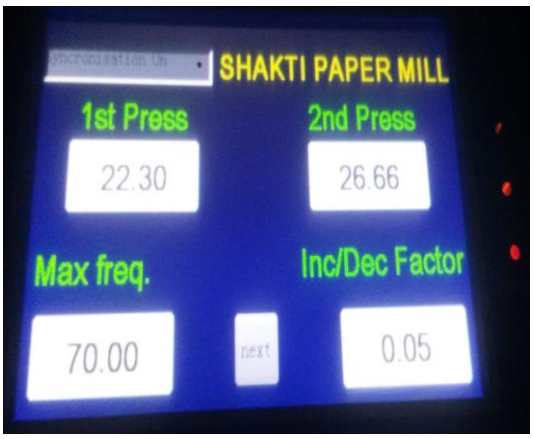


Figure 6 Controlled Output

Figure 7 HMI with PLC

Stages	Required Output
I Press	30 HP
II Press	25 HP
M.G	20 HP
Dryer	15 HP
Motor	14401 rpm

Table 2 – Stages with Specifications

IV. Conclusion

This project has been implemented for paper mill which requires automation not only to reduce manual labor but also to reduce the losses which occur due to irregular speed and unsynchronized units. The implemented project uses PLC (Programmable Control Unit) to automate the whole process; the program logic is created after carefully analyzing input, output, motor ratings and specifications of each stage. The speed of motor is found to be 14401 rpm for efficient and reliable usage. The implemented technique led to reduction of losses of paper getting torn, variations in speed and increased the quality of manufactured papers. It also reduced manual efforts of drawing paper out of rollers which got stuck due to variation in speeds. As PLC is also used for synchronization it has led to control of errors in the whole unit. All the stages are synchronized which increases reliability and also increases the profitability of a firm.

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