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Control and Synchronisation of Motorsand Rollers in Paper Mills using PLC

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Abstract: ***Paper mill Industry is one of the most popular industry owing to large scale use of paper in all sectors of society be it stationery material, currency material and all sort of billing papers , butter paper etc. With the ever increasing demand of paper, it has also lead to identification of problems that causes losses to the mills in terms of wastage of raw material or defective paper output. After careful analysis it has been understood that due to variation in speed of motor drives and rollers, the paper when heated starts forming bubbles due to air.***

The unsynchronized unit causes losses in terms of capital as well as manual labor. To get rid of all these disadvantages there is a need to monitor and maintain the motor speed constant and all the press, drive, rollers should be in synchronization with each other. In paper mills different variety, sizes and quality of paper are manufactured which requires different speeds and power. PLC is used in cases where a manual system has to be converted in a fully automated system using a set of logics which can be physically implemented using programs.

A HMI (Human Machine Interface) makes the works of interaction with machine much more easy in terms of usage. A screen displays all the power ratings , speed ratings and the PLC maintains it constant in case of variations and also synchronizes the whole unit.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. In this project PLC is used to keep machine interface simple, where in different parameters can be monitored in a paper mill. There are 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 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.

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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. 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.



Figure 1 – Paper Mill

A. Process Chart

1) *Procedure:* An Induction motor whose speed has to be controlled is used according to the rating and application in which it has to be used. 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 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.The encoder continuously provides feedback to PLC in order to maintain constant speed. If there are variations in speed it results in tearing down of paper or it also leads to paper getting stucked in machines and eventually resulting in a degraded quality output. As it is not possible to monitor each parameter manually, an automated system helps to remove all the disadvantages of conventional system and replacing it with a more advanced accurate and efficient system.

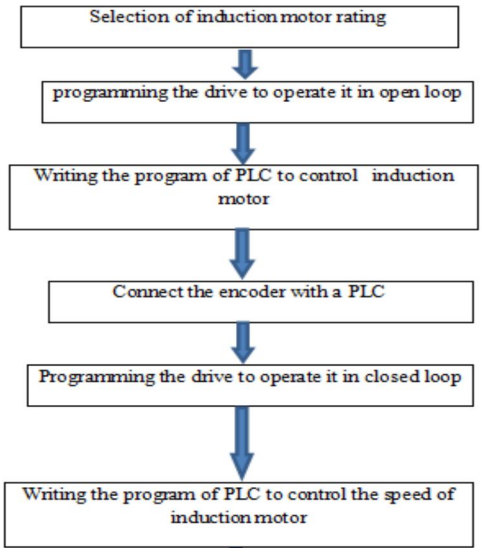


Fig 2.1 Process Flowchart

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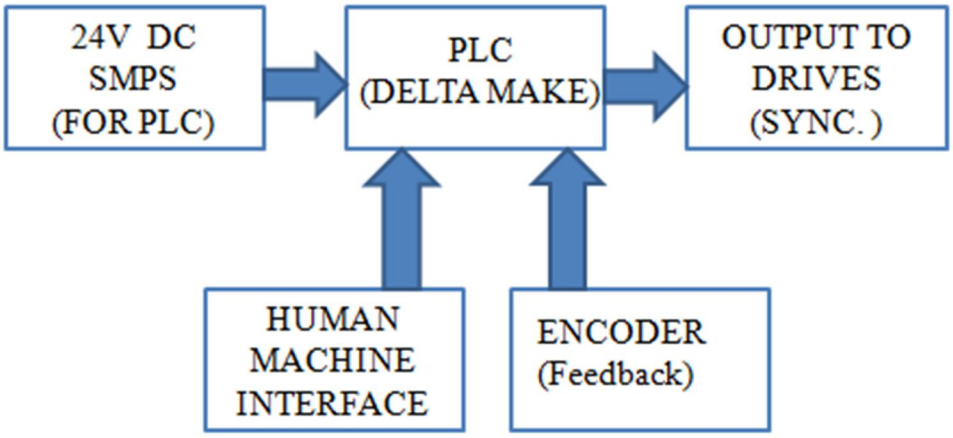


Figure 2.2 Block Diagram of PLC in paper mill

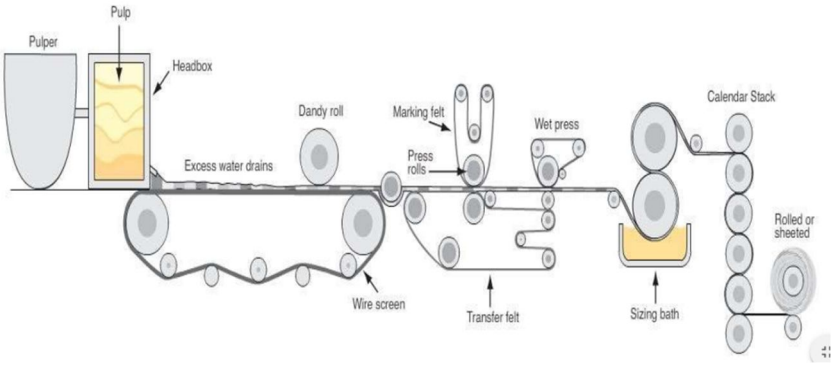


Figure 2.3 Paper manufacturing plant

B. PLC (Programmable Logic Control)

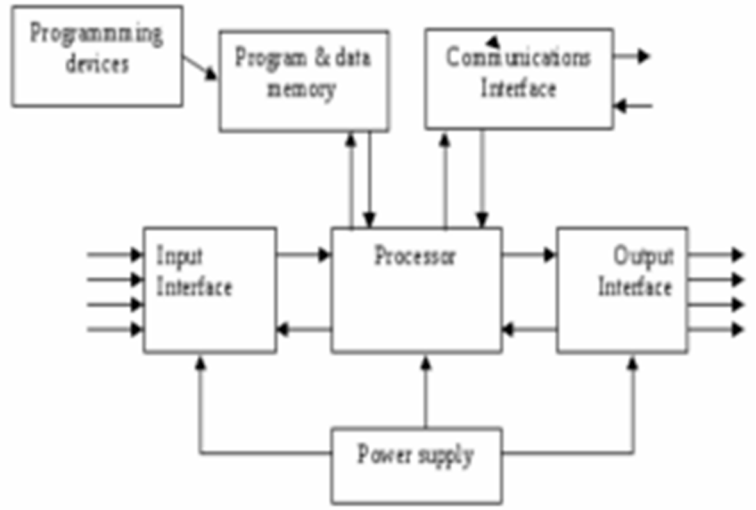


Figure 2.4 Block Diagram of PLC

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. 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.

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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.

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

Table 1



Figure 3.1 Connections with Motors and Press



Figure 3.2 HMI with PLC

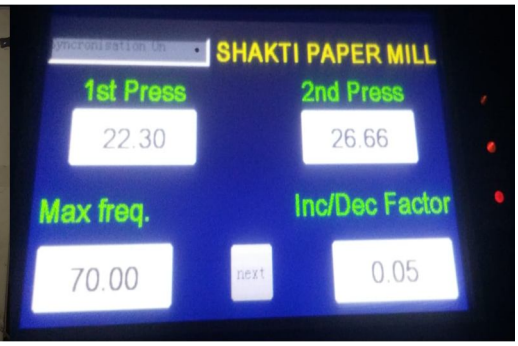


Figure 3.3 Display Ratings

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

Table 2

IV. CONCLUSION

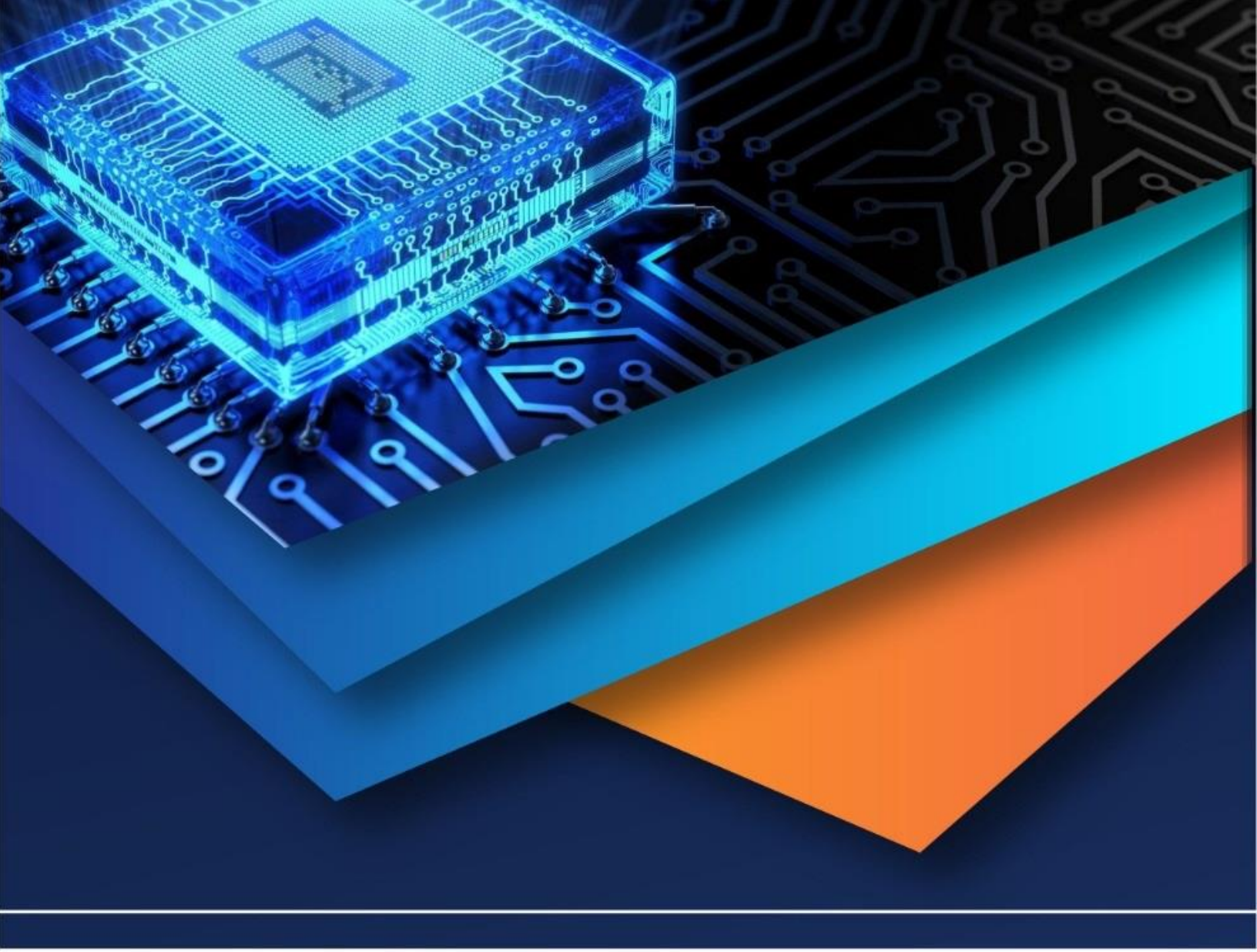
This project has been implemented for paper mill which requires automation not only to reduce manual labor but also to reduce the losses which occur due to irregular speed and unsynchronized units. The implemented project uses PLC (Programmable Control Unit) to automate the whole process; the program 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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