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Automation of Sectional Drive Paper Machine Using PLC and HMI

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Abstract— This paper aims at automation of a Paper machine for industrial purpose which will replace the existing linear shaft paper machine system into Sectional Drive paper machine to overcome all the drawbacks of old system. The current linear Drive paper machine used in paper making cannot easily maintain coordination for all operating condition. Hence linear Shaft Drive paper machine is replaced by a Sectional drive paper machine using individual drives and motors for each section and Automating the machine using PLC and HMI .Coordination for all operating conditions are obtained irrespective of the gear ratio.

Keywords— Forming Section, Human Machine Interface (HMI) , Linear Drive , Meter Per Minute(MPM),Pop Reel, Press Section, Dryer Section, Programmable Logic Controller (PLC) , Sectional Drive.

1.INTRODUCTION

The objective of choosing this work is, in paper industry Linear Shaft Drive motion control method is used. This method is not sufficient to get the synchronized speed of the entire rolling cylinders. Due to Linear drive paper machine, lot of problem like paper breaking, different paper thickness arises. To overcome this issue the linear Shaft Drive paper machine is replaced with the sectional Drive paper machine and automated using PLC and HMI.

1.1 PAPER MAKING PROCESS

Fig.1 shows the schematic diagram of paper making process, the paper making process is basically a large dewatering operation where a diluted solution of pulp suspension with less than 0.5% fiber solid is used. The paper machine consist following major sections such as forming section, press section and drying section. In the forming section, the fibers present in the diluted pulp and water slurry form paper web through drainage by gravity and applied suction below the forming fabric. In the press section additional water in removed by mechanical pressure applied through the nips of a series of presses or rotating rolls and the wet web is consolidated in this section. Most of the remaining water is evaporated and inter-fiber binding developed as the paper contacts a series of steam heated cylinder in the dryer section. Water removal from the wet web to the final moisture level between 6% and 7% is a critical step of papermaking. Majority of the functional properties of paper are developed in this section. In the final stage the paper is rolled to the pop reel.[4]

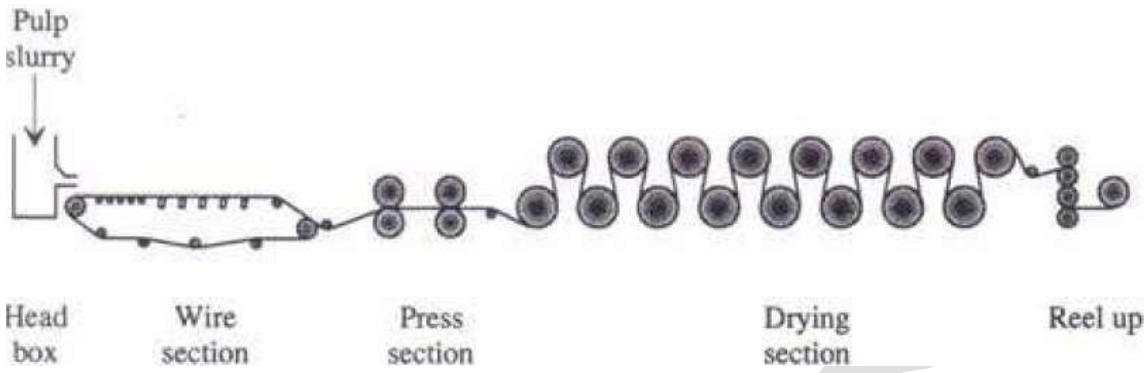

Figure 1: schematic diagram of paper making process

1.2 LINEAR SHAFT DRIVE SYSTEM

Early paper machine drives were constructed with mechanical interconnection components that produced motion with respect to a common line-shaft input. The mechanical power was produced by a single motor driving a line shaft to which all of the in-shafts were attached.

Fig.2 shows a simplified arrangement of a linear-shaft drive. It consists of a speed-controlled motor driving a long shaft all the way along the different mechanical sections. Each section is coupled to the line shaft through a gear box, conical pulleys, and the section connecting shaft. Conical pulleys allow draws to be set in the different mechanical sections. Assuming no belt slip in the conical pulleys, this mechanical arrangement assures that all the system shafts will remain rigidly locked to each other through the common line shaft, even in the presence of disturbances on individual sections. The only steady-state relative motion is due to torsional windup of shafts transmitting the driving torque. [3]

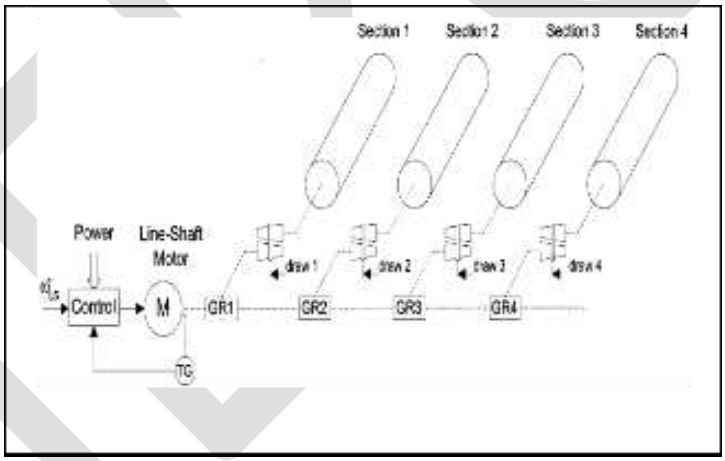

Figure 2: Linear Shaft Drive System

1.3 SECTIONAL DRIVE SYSTEM

As advances in power electronics and high-performance drives became available, the line-shaft structure evolved into modern, individual ac sectional drives, which allow an increase in the operating speed and sectional power of paper machines. Fig.3 shows a simplified arrangement of a sectional drive. Each mechanical section is driven by a fully controlled drive . All the sectional drives are electronically synchronized‖ through the master reference command and the draws are set adding an auxiliary signal to the master reference. During a load disturbance in such a system, the speed in the disturbed section will decrease momentarily until the drive control is able to restore it to the reference speed. [3]

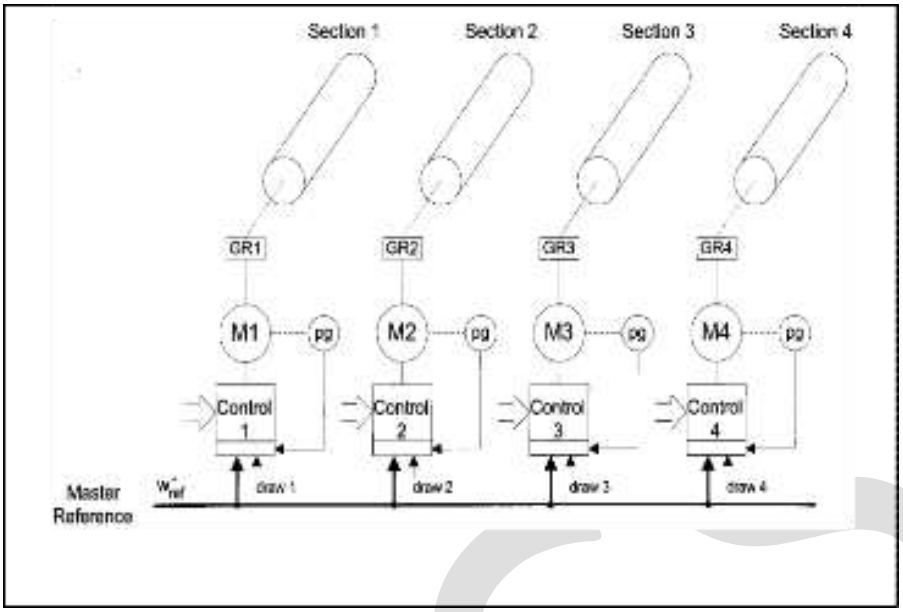

Figure 3: Sectional Drive System

2. PROPOSED SYSTEM

Fig. 4 Shows the block diagram of proposed system .This control structure aims at Automation of sectional drive paper machine using PLC and HMI. The Drive is interfaced with the PLC and the HMI . The input commands are all given using HMI and the output are also displayed in the same HMI Screen.

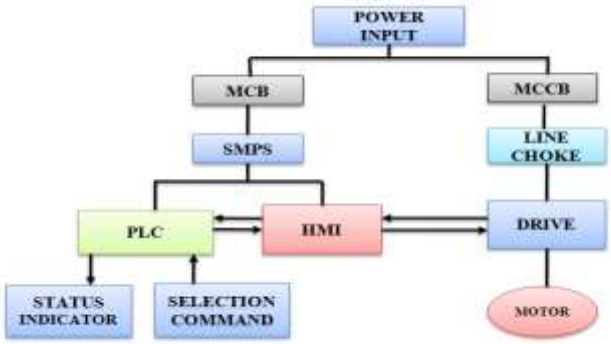

Figure 4:Block Diagram of Sectional Drive paper Machine

The slurry is prepared by mixing pulp and additives in water .This slurry consists less than 1% of dry substance . There are three basic steps in the paper manufacturing process (i) forming (ii) pressing and (iii) drying. In the forming stage, the slurry is distributed evenly across a moving wire mess. The de watering in this part of the paper machine, known as the forming section, occurs mainly under gravitational forces. A continuous web, with a dry solids content between 15% and 25%, is formed at the end of the wire section. The web enters the press section. Where Mechanical compression in the press section removes water to solid level between 33% and 55%, depending on the paper grade and press section design. The third section of the paper machine is the drying or dryer section. The paper web passes over rotating, heated steam rollers and the most of the remaining water is removed by evaporation. The solid content of the paper is increased to about 90-95% when the paper leaves the dryer section. Thermal energy is used for the dewatering in the dryer section.

The Sectional Drive paper machine has for Sections i)Size press Top ii) size press bottom iii) Dryer Section iv) Pop reel. Four Sections of paper machine flow diagram is shown in Figure 5

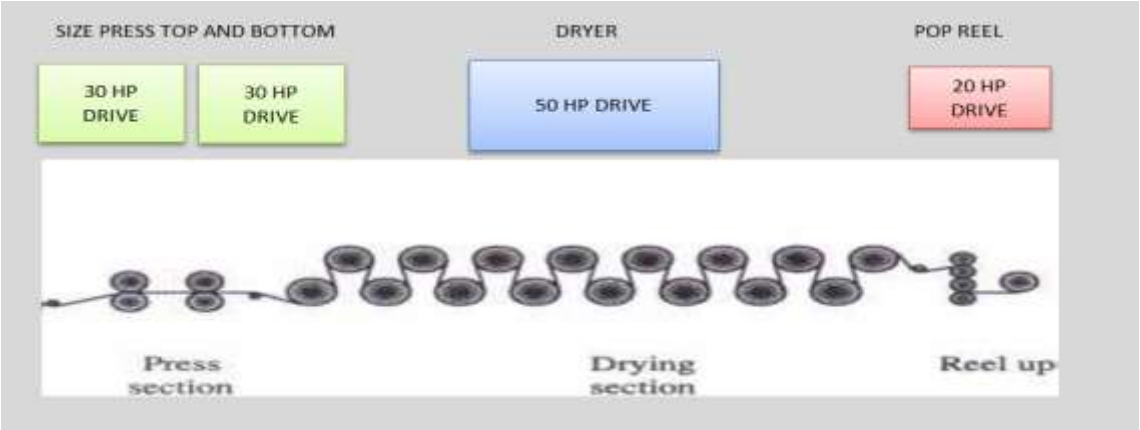

Figure. 5 : Sections of paper machine flow diagram

2.1SOFTWARE REQUIREMENTS

In this paper programming of PLC is done by the WPL Soft 2.33 version software . This software integrates all the modules connected to the PLC and the devices connected to its HMI, VFD, Induction motor .Also the monitor and control are through HMI and thus HMI screen is developed using DOP Soft 1.01.04 version Software[6][7]

2.1.1DEVELOPED HMI SCREEN

Fig 6: Shows the developed HMI screen.The Master value and the set speed is set and the respective set frequency , run speed , output current is displayed .

Figure.6:Developed HMI Screen

Formula used to calculate the Synchronized set frequency

$$\text{Synchronize set frequency} = \frac{\text{Value of master in \% X Value of individual section in \%}}{200}$$

Formula to calculate MPM

$$\text{MPM(Meter per minute)} = \text{RPM X 0.00314 X DIAMETER}$$

Diameter(dia of pop reel)= 38mm

Using the above formulae, Synchronize set frequency, MPM, interlocks are all written in the background macro to develop a HMI operating screens. The Induction motor used to run the rollers of the sectional drive paper machine is given input from the Drive via Field wiring . Drive control panel is given three phase supply and Drives are turned ON .Drive is communicated with the HMI and PLC using RS 485 communication. By giving input command the rollers of the Dryer Section starts to operate.

The frequency and RPM is calculated and tabulated and few trials are done and verified .The Synchronized set frequency and RPM table is shown in table 1

Table 1: Synchronized set frequency and RPM table

SL NO .	MASTER VALUE IN %	INDIVIDUAL SECTION VALUE IN %	SYNCHRONIZED SET FREQUENCY IN HZ	RPM
1	25	50	6.25	187.5
2	20	50	5	150
3	50	30	7.5	225
4	60	60	18	540

3.ACKNOWLEDGMENT

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4.CONCLUSION

In the automated sectional drive paper machine control of Dryer Section and the pop reel is controlled using PLC which is time saving process and HMI enables the operation of the machine easier for non-skilled labors too. Also the machine operation requires less labor power, no production loss with good quality of product. This will fulfill the requirements of the industry with good levels of accuracy and repeatability thereby yielding a more robust industrial process. In case of fault, tracing of circuit is not required as all the commands are given through HMI .Hence reliability is more

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