Control and Automation of Dump Valves in Paper Industrial Process Using Programmable Logic Controller

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Abstract: In the past, the automation and control has seen an enormous development. The traditional technologies like PLC, SCADA and DCS has greatly influenced the industrial automation process. It can be effectively used in applications ranging from simple control like replacing small number of relays to complex automation problems. This work applies in screening area of the paper industry to separate high density particles while flowing through the tube to the dump valve. This system is called as waste disposal system. In the screening process, destoner separates the high density particles from the weightless useful pulp and the outlet is lead into the dump valve. The dumping and discharging operations of high density particles in the dump valve is controlled by the Programmable Logic Controller which is used for automation and control of the valve movement sequentially and continuously until the pulp is available [1]. Thus by automation of the waste disposal system, time of the manual operator is saved. This proposed system will increase the disposal rate. There is an advantage of low running cost reduced time cycle and increased precision.

Keywords: Automation, Control valves, Dump valve, PLC.

I. Introduction

Automation can be classified as high and low cost automation. For rapid industrial growth in developing countries like India, which is basically a nucleus of small industries, it is primarily important to put the wheels of efficiency of these industries properly geared accelerate productivity, to increase profitability and to achieve these goals present juncture is low cost automation as high cost automation is not within the reach of developing countries. Always there is tendency and thirst with human beings to develop a better technique in any working process to attain or to provide less fatigue and mental stress and more comfort to the operators. In the paper industry, the paper is produced from the pulp that is extracted from the wood brought from various places around the industries. The pulp extraction has various processes like digestion, screening, cleaning and refining. During the digestion some of the woods will not be completely digested which should be separated from the digested pulp. Along with the pulp there will be unwanted accumulations such as stones and others wastes which should be completely removed before using the pulp for making paper. This is done by using the cyclone separator. The rejects of the separator are disposed out with the help of dump valve [2]. Manual operation of valve is practiced earlier whereas this paper gives the use of Programmable Logic Controller for the control of the dump valve.

II. Problem Statement

The first process of pulping process is the process of removing lignin and other components of the wood from the cellulose fibers which will be used to make paper. The important step is to remove lignin. During this process the lignin may not be properly removed which will not be fair for the production of paper [3]. So the undigested wood along with the impurities has to be removed. This is done with the help of destoner block.

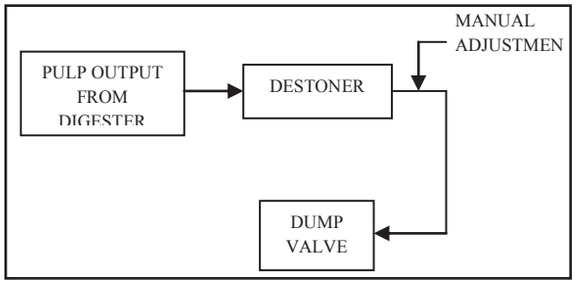

Fig. 1: Manual Control for Operation of Dump Valve

The block diagram for the existing model is shown in Fig. 1. In this type of system the valves has to be manually controlled. This is tedious process and will consume more amount of time. In order to increase the efficiency of the system and to reduce human effort control is completely automated using PLC. It uses its programming memory for storage of instructions

and operations like logic, sequencing, timing, counting and arithmetic to control through digital or analog modules, various types of machine or process. In case of the existing system, it needs a continuous supervision of the unit and also increases the installation cost.

III. Controller Design

In the proposed model, the Programmable logic controller controls the opening and closing of the ON / OFF control valve. In this we use PLC as a digitally operating device that works by electronic means.

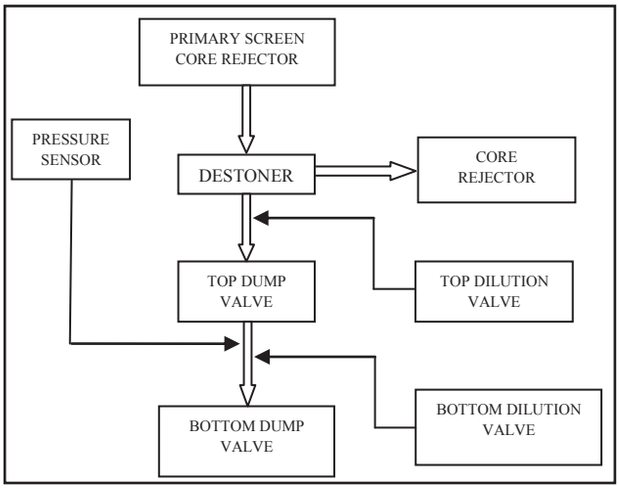

Fig. 2: Proposed Block Diagram for Operation of Dump Valve

A. Primary Screen Rejector

The output from the boiler consists of both useful pulp and the uncooked pulp. The uncooked pulp is primarily separated from the pulp in order to reuse it by cooking it again. The completely cooked pulp is separated along with the liquor in the destoner. This pulp is light coloured and have very low density when compared with the uncooked pulp. The feed coming out from the primary screen rejector is given to the destoner for further process [4].

B. Destoner

In the destoner block it uses the cyclone separator to remove the stones and other high density particles from the feed [5].

A cyclone separator uses the principle of centrifugal force to move the high density particles downwards through a cone shaped bottom and lifts the light weighed pulp upwards which will be heading towards the crusher where the pulp is estranged from the fluids [6]. The pulp in the feed moves very quickly as soon as it enters the chamber at the top of thecylinder and thus creates a diminutive hurricane [7].

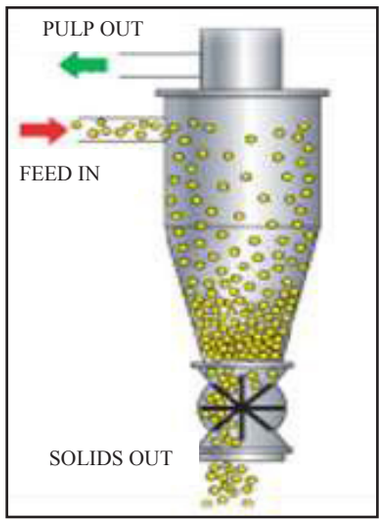

Fig. 3: Schematic View of a Cyclone Destoner

C. Pressure Sensor

The opening and closing of the top valve and the bottom valve are based on the pressure at the bottom valve. The pressure obtained at the bottom valve when it is completely filled is made as set point. The pressure at the bottom valve is compared with the set point. Based on the comparator value the valves will be operated. The valve operates on two conditions on the basis of obtained pressure value (PV) and set point (SP).

i. *When PV<=SP*: When the obtained pressure value is less or equal to than the actual set point then the top valve and the top dilution valve will be in open condition and the bottom valve and the bottom dilution valve will be closed.

ii. *When PV>SP*: When the obtained pressure value is greater than the actual set point then the bottom valve and the bottom dilution valve will be in opened and the top valve and the top dilution valve will be closed.

D. Core Rejector

The core rejector will get the cooked pulp and makes use of it for the further process in the manufacturing of paper.

E. Valves

There are four valves which will be used to remove the wastes. It includes two dump valves and two dilution valves. The top and bottom dump valve will be operated alternatively for the disposal of wastes [6]. The removed high density particles will be very solid and will get struck at the pipeline. Hence two dilution valves are used here to flush it out.

F. Programmable Logic Controller

A Programmable Logic Controller (PLC) or programmable controller is a modern computerized PC which has been ruggedized and adjusted for the control of assembling procedures, for example, sequential construction systems, or automated gadgets, or any action that requires high unwavering quality control and simplicity of programming and process blame finding [7].

PLCs can extend from little "building block" gadgets with several I/O in a lodging fundamental with the processor, to huge rack-mounted measured gadgets with a check of thousands of I/O, and which are frequently organized to other PLC and SCADA frameworks [8]. They can be intended for different game plans of advanced and simple sources of informationand yields (I/O), developed temperature ranges, invulnerability to electrical commotion, and imperviousness to vibration and effect [9]. Projects to control machine operation are commonly amassed battery-went down or non-unstable memory.

The ladder logic is generated for the system. With the help of the generated logic the valves are operated. The pressure is sensed at the top valve and if it reaches the set point the top valve will get closed and the bottom valve will get opened. Initially all the valves are closed. The Fig. 4 shows the ladder logic developed for the proposed system.

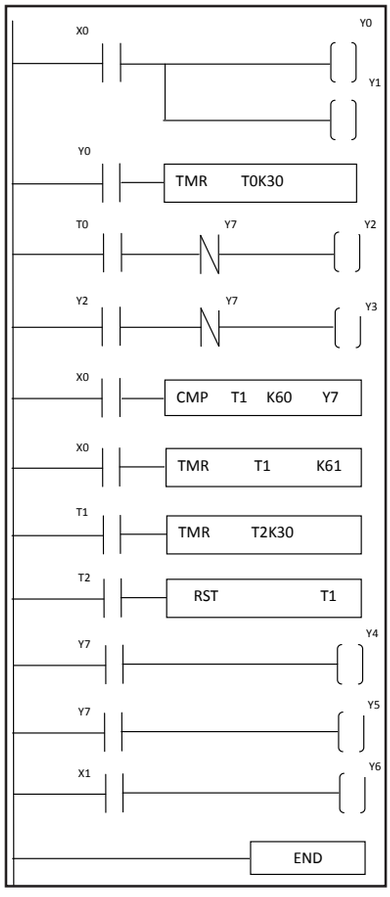

Fig. 4: Ladder Logic for Valve Operation

In the above shown logic once the input feed pump gets ON then after 30 seconds, the top valve and the top dilution valve will get opens and the feed starts to get settled at the bottom valve, since it is closed. Once the set point is reached the opened valves will get closed and the bottom valve and the bottom dilution valve will get opened thus emptying the heavy density particles into the tank. If the pressure becomes zero, again the valves will open alternatively. This process will carry on until the feed pump gets off.

G. Supervisory Control and Data Acquisition

The Supervisory control and data acquisition (SCADA) is a control framework engineering that utilize PCs, organized information correspondences and graphical UIs for abnormal state handling supervisory administration, however utilizes other fringe gadgets, for example, programmable rationale controllers and discrete PID controllers to interface to the procedure plant or hardware. The administrator interfaces which empower checking and the issuing of process charges, for example, controller set point changes, are dealt with through the SCADA supervisory PC framework. Be that as it may, the constant control rationale or controller manipulations are performed by arranged modules which interface with the field sensors and actuators. Here the working of the system is simulated and demonstrated by using SCADA.

IV. Result and Discussions

The ladder logic is implemented in the PLC software and the operation of the valves based on the pressure is obtained. Once input the x0 is ON, then the inlet valve and the outlet valve will be turned ON. After 30 seconds of operation of the timer T0, the top valve Y2 and the top dilution valve Y3 gets opened. The pressure value at the bottom valve is continuously compared with the set point and when the obtained value increases the set point the comparator output will make the bottom valve Y4 and the bottom dilution valve Y5 to open and the valves Y2 and Y3 to close. This will remain until the pressure value becomes zero. The zero value of pressure will make the Y2 and Y3 to open and the valves Y4 and Y5 to close. This result is simulated using SCADA. The SCADA software will reduce the cost of implementation incase of failure and the flow of control can be effectively viewed. The inlet valve and the outlet valves are opened when the inlet feed is opened. Then the top valves, top dilution valve, bottom valve and bottom dilution valve remains closed until the pressure attains the set point. Then the bottom valve and the bottom dilution valve get opened. This is demonstrated using the SCADA software. This gives the easy understanding of the flow and working of the system in the gradual manner.

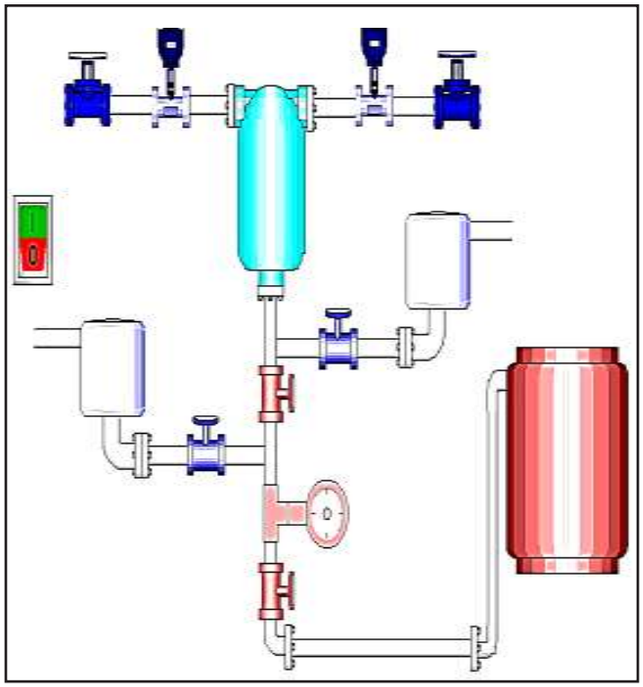

Fig. 5: SCADA Schematic for Automatic Control of Dump Valve

The Fig. 5 gives the simulation output in the SCADA software. Various components controlled in the system are simulated and opening and closing of the valve is obtained. As a result of which the heavy density particles are separated from the useful pulp and it is disposed.

V. Conclusion

The manual operation of dump valve in order to dispose the waste materials in the paper industry seems to be hazardous. Hence the automation of the valves in the screening area is implemented. Here the automation of the control valves is done with the help of programmable logic controller and the working is simulated using SCADA. Implementing this kind of automated control will drastically reduces the risk of danger and thus provides safety, efficient time management and eventually increases the plant efficiency.

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