

Automatic Filtering of Starch in a Paper Manufacturing Industries using Distributed Control System

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ABSTRACT: Paper is a thin material mainly used for the purpose for writing , printing , drawing, packaging etc., It is produced by pressing together the moist fibers, typically cellulose pulp derived from wood, rags or grasses and drying them into flexible sheets. Starch coating process is the most final step carried out in the paper manufacturing process. Starch coating process mainly gives two characteristics such as softness to the surface of the paper and also the paper thickness. So, starch coating is very important in thickness determination. The amount of starch coated on the either sides of a paper determines the thickness of the paper which is measured in terms of GSM (Grams per Square Meter). Tapioca is a rich source of starch and therefore tapioca is crushed to get starch. When coating on the partially made paper, starch should be of pure liquid form and should not contain any solid particles, even if tiny. In order to filter the solid particles, simple mesh filters are used. These mesh filters filter the solid particles in the liquid starch continuously. It has to be cleaned periodically for better filtering. At present filtering system, these filters are cleaned manually by removing one out of three in certain intervals of time. This causes lag in the coating process and thus resulting in loss of production. The proposed system is to increase the number of filters and flush these filters using Distributed Control System. It is used to control the opening and closing of control valves in order to flush the filters. This system results in continuous constant starch coating on the paper which subsequently yields a higher paper manufacturing rate[1].

I. INTRODUCTION

Paper is a cellulose material which produced by pressing together moist fibers, typically cellulose pulp derived from wood, rags or grasses and drying them into flexible sheets. There are approximately 600 paper mills in India, of which twelve are major players. The Indian Paper Manufacturing Association (IPMA) is functioning with 19 member mills, namely, Abhishek, APPM, BILT, Century, Emami, HPC, ITC, JKPL, Khanna, MPM, OPM, udumjee, Rama, SPB, Sirpur, Star, TNPL, WCPM and Yash. According to the IPMA, per capita paper consumption increased to 8.3 kg as of December 2008, compared to 7.5 kg during 2007-08. Still, the figure is low (8.5 kg) compared to 42 kg in China and 350 kg in developed countries. At the same time, the Indian paper industry is poised to grow from 8.5 million tons in 2008-09 to 13.95 million tons in 2015-16. The IPMA member mills alone will invest Rs 120 billion to Rs 150 billion over the next ten years. The installed capacity in the country is also estimated to have grown to 11.2 million tons per annum. Currently, the Indian paper industry accounts for about 1.6 per cent of the world's production of paper and paperboard. The growth rate is 8 per cent per year. Paper in India is made from 40 per cent of hardwood and bamboo fiber, 30 per cent from agro waste and 30 per cent from recycled fiber.

There are some parameters which decide the quality of paper according to its application. For instance paper used in the field of printing such as newspapers, magazines should possess great printability.

In the Existing system, the starch filtering and coating process takes place in a module called speedsizer in a Voith paper machine. The Speedsizer unit in a Paper machine 3 of the Tamilnadu Newsprint and Paper limited has 3 filtering units. The job of this filter is to filter the sludge and solid particles from the crushed tapioca juice. Once it keeps on filtering the crushed tapioca it gets settled over the mesh arrangement of the filters this will make the filtering process

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inefficient further. The mesh arrangement inside the filters needs to be cleaned in order to increase the efficiency of the filtering process. The Fig 1 shows the block Diagram of the Existing system.

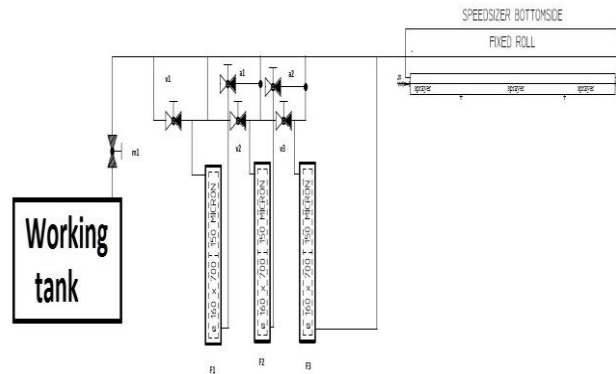


Fig 1. Block Diagram of Existing Filtering System

Some of the limitations of the existing system are

- Due to manual cleaning, the entire flushing process can get delayed because of human errors
- Damages of mesh kit is possible due to manual flushing
- Time elapsing of flushing process is not constant
- Due to inconsistent time of flushing, the production of paper is not constant
- Coating process will not be consistent due to inappropriate output from the filter setup.

II. PROPOSED SYSTEM

A. Process Description

The Speedsizer unit in the Paper machine has 3 filtering units. Now, the proposed system increases the number to 5. The job of this filter is to filter the sludge and solid particles from the crushed tapioca. Once it keeps on filtering the crushed tapioca it gets settled on the mesh arrangement this will make the filtering process inefficient further.

The mesh arrangement inside the filters needs to be cleaned in order to increase the efficiency of the filtering process. So, In case Filter 1 has to be cleaned, the valve V1 is automatically closed thus stopping the input from the working tank. Now the filter is not removed from the arrangement and it is cleaned automatically by the usage of warm water in order to make it more effectively. By the meantime, the filtering process is carried out by the other four filters. Which means, only 1.25 times of the load is taken over by other filters, rather than 1.5 in the previous existing system. And the output from the total filter arrangement gets increased to a reasonable percentage. Now the output of the filter arrangement is sent to the sprayer which evenly sprays the starch all along the paper roll. At one point of time, the sludge which gets settled in the filter wanted to be cleaned.

The proposed system filters automatically by closing the input valve from the working tank and opening the Warm water valve and cleaning the filter in a constant temperature and pressure. The computer program is controlled using DCS which monitors and controls the plant. All the automatic opening and closing of valves is carried out by the DCS panel. The filtering process is done automatically and it increases the output rate of the filter, thus increase in coating rate and further increase in productivity of paper[2].

Paper manufacturing rate is based on the coating of starch on both sides of the paper. When the coating rate is increased, simultaneously the amount of paper manufactured will also increase. DCS panel will take care of the

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working pattern of the valves opening and closing timing. The coating of starch on both sides of paper will decide the size of the paper which is generally expressed in terms of GSM.

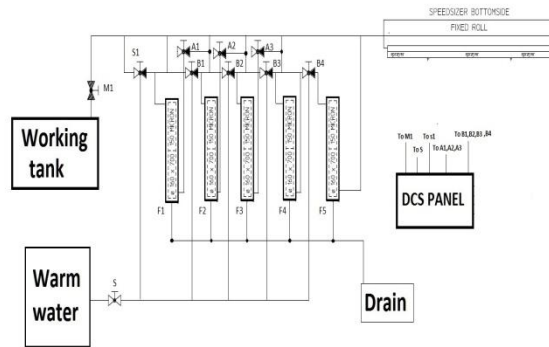


Fig 2. Block Diagram of Proposed Filtering System

The working tanks are supplied with surface starch or coating color from coating kitchen. Each working station, for fixed and pivoted roll, has its own working tank. The control for filling is mostly done in working station control system. There are signals between working station and coating kitchen for filling for each working tank.

From working station surface starch or coating color is supplied to applicators speedsizer. Each applicator, fixed roll (bottom side) and pivoted roll (top side), has its own working station. From working tank surface starch or coating color is pumped with variable speed volumetric pump through an ECO-S filter-station with 5 filter elements over circulation line back to working tank. A common stand-by pump can be used either for applicator fixed roll or applicator pivoted roll.

There are two circulation modes. Lower circulation (short circulation) circulation will by-pass applicator short before entry to applicator and the Upper circulation will be done over applicator[3].

Flow of Lower circulation is controlled by pump speed only. Upper-circulation flow is controlled by a flow-controller with magnetic flow meter.

After upper circulation is stopped (manual or automatic) flushing can be start manually at operator desk. Starch size or coating color in applicator nozzle will be discharged back to working tank and after discharging nozzle will be flushed to drain and flush water will be automatically drained.

B. Distributed control system:

A Distributed Control System (DCS) refers to a control system usually of a manufacturing system process or any kind of dynamic system, in which the controller elements are not central in location (like the brain) but are distributed throughout the system with each component sub-system controlled by one or more controllers. In simple words, DCS (Distributed Control System) is a computerized control system used to control the production line in the industry[4].

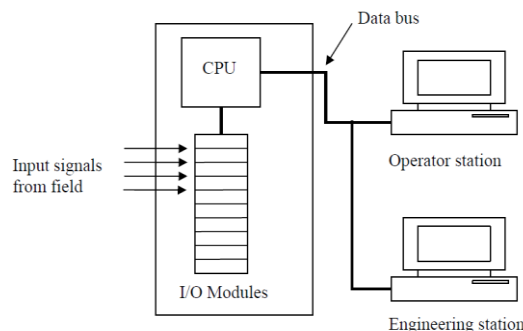


Fig 3. Basic Blocks of a DCS System

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Important elements of a DCS are

- Field Control station (FCS): It consists of input/output modules, CPU and communication bus.
- Operator station: It is basically human interface machine with monitor, the operator man can view the process in the plant and check if any alarm is presents and it can change any setting, print reports Etc...
- Engineering station: It is used to configure all input & output and drawing and any things required to be monitored on Operator station monitor.

A type of automated control system that is distributed throughout a machine to provide instructions for different parts of the machine. Instead of having a centrally located device controlling all machines, each section of a machine has its own computer that controls the operation. For instance, there may be one machine with a section that controls dry elements of cake frosting and another section controlling the liquid elements, but each section is individually managed by a DCS. A DCS is commonly used in manufacturing equipment and utilizes input and output protocols to control the machine[5][6]. DCS is a very broad term used in a variety of industries, to monitor and control distributed equipment.

- Electrical power grids and electrical generation plants
- Environmental control systems
- Traffic signals
- Radio signals
- Water management systems
- Oil refining plants
- The control software supports powerful control applications through the straightforward configuration of function blocks. A wide range of process control capabilities includes:
- Data Acquisition
- Continuous Control
- Logic Control

C.Solenoid Valve

A solenoid valve is an electromechanical device used for controlling liquid or gas flow. The solenoid valve is controlled by electrical current, which is run through a coil. When the coil is energized, a magnetic field is created, causing a plunger inside the coil to move. Depending on the design of the valve, the plunger will either open or close the valve. When electrical current is removed from the coil, the valve will return to its de-energized state.

In direct-acting solenoid valves, the plunger directly opens and closes an orifice inside the valve. In pilot-operated valves (also called the servo-type), the plunger opens and closes a pilot orifice. The inlet line pressure, which is led through the pilot orifice, opens and closes the valve seal. The most common solenoid valve has two ports: an inlet port and an outlet port. Advanced designs may have three or more ports. Some designs utilize a manifold-type design. Solenoid valves make automation of fluid and gas control is possible. Modern solenoid valves offer fast operation, high reliability, long service life, and compact design.

The illustration below depicts the basic components of a solenoid valve. The valve shown in the picture is a normally-closed, direct-acting valve. This type of solenoid valve has the most simple and easy to understand principle of operation.

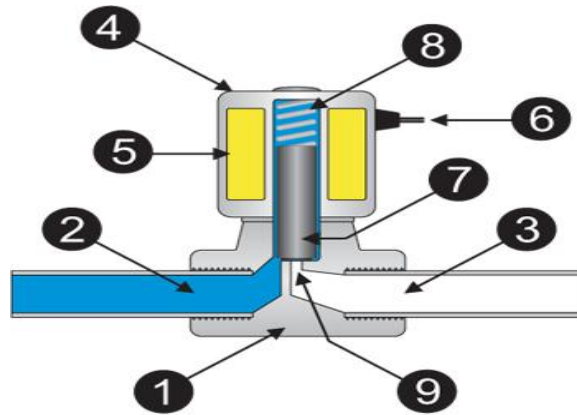


Fig 4. Schematic Sketch of a Solenoid Valve

The major components of Solenoid Valves are

- 1. Valve Body 2. Inlet Port 3. Outlet Port
- 4. Coil/Solenoid 5. Coil Windings 6. Lead Wires
- 7. Plunger 8. Spring 9. Orifice

The media controlled by the solenoid valve enters the valve through the inlet port. The media must flow through the orifice (9) before continuing into the outlet port (3). The orifice is closed and opened by the plunger (7). The valve pictured above is a normally-closed solenoid valve. Normally-closed valves use a spring (8) which presses the plunger tip against the opening of the orifice. The sealing material at the tip of the plunger keeps the media from entering the orifice, until the plunger is lifted up by an electromagnetic field created by the coil. There are many valve design variations. Ordinary valve can have many ports and fluid paths. A 2-way valve, having two ports is connected and fluid may flow between the ports if the valve is open, then ports are isolated. If the valve is open when the solenoid is not energized, then the valve is termed normally open (N.O.). Similarly, if the valve is closed when the solenoid is not energized, then the valve is termed normally closed. There is also 3-way and more complicated designs. A 3-way valve has 3 ports; it connects one port to either of the two other ports (typically a supply port and an exhaust port).

III.RESULTS AND DISCUSSIONS

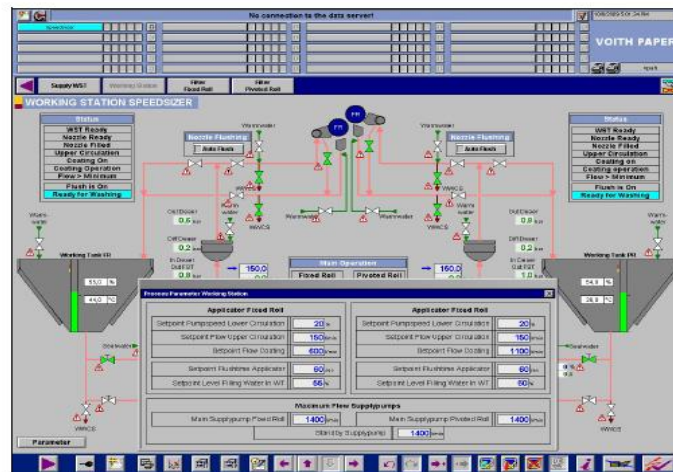


Fig 5. Working station of Speedsizer

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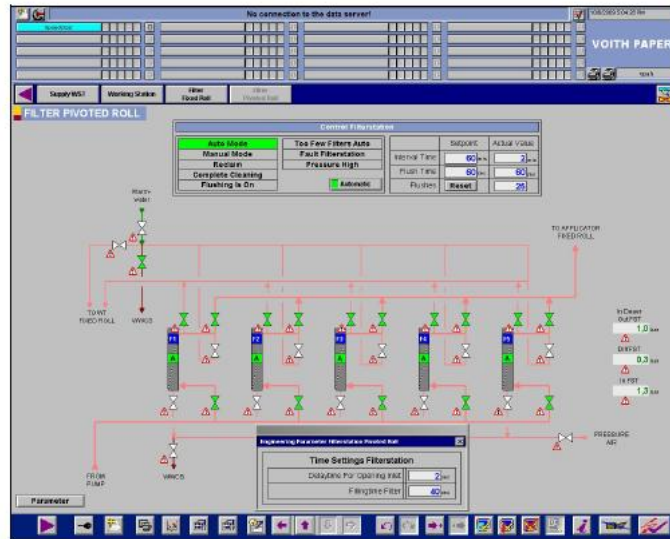


Fig 6. Diagram showing the Filtering Process

Upper circulation is switched off, and lower circulation is running. Applicator nozzle is still filled with surface starch or coating color and working station is ready for upper-circulation or flushing the applicator.

An automatic discharge & flushing sequence starts if the selection auto-flush” at process picture 1P2 in DCS system is selected, upper circulation is on and the signal “sheet break” from speedsizer (Voith) goes on. Automatic discharge & flushing of applicator starts if: Signal “sheet break” from speedsizer control (Voith) goes on and automatic flush is selected

IV. CONCLUSION

The paper manufacturing process is enhanced by automating the control valves involved in filtering of starch. Thus by automating this process, flaws which happens because of human errors and logical disadvantages of manual filtering has been removed. Since the total process is automated, the output of the starch filter is increased to a reasonable extent. Almost 23% of rate of starch coating has been increased due to this process. Subsequently, the total paper production rate is increased from 775 metres per minute to 1025 metres per minute. Cost of production is also reduced. This method can be included in order to make it completely an efficient filtering system[7][8].

The proposed system is applicable to any industry wherever filtering process is involved. The whole soul of this system is to automate the control valves by giving control signals from a DCS panel in various time intervals according to the necessity of the process. This system can be improved by any other enhanced automatic logic control system in the future for filtering process in any industries

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