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Enhancing the Production Efficiency in Paper Recycling Plant through Thickness Measurement

Hepsiba. D, L.D. Vijay Anand

Abstract*— The whole world is moving towards recycling or green campus; such an initiative is focused here. In order to make use of the recycled raw materials completely without any wastage, certain measurements are necessary. Such measurement is the paper or board thickness has been proposed in this paper. The paper thickness measurement plays a vital role in order to minimize the pulp wastage and increase the production rate. The measurement technique utilized for paper thickness measurement is the ultrasonic method. The ultrasonic sensor-based paper thickness measurement helps in getting optimized results of maximum utility and minimal wastage. The thickness measurement indicator is designed to monitor the paper or card board thickness in an effective way. The improves the productivity of the paper production plant.

Keyword: Paper Production, Thickness Measurement, Ultrasonic Sensor, Pulp Wastage, Optimization.

I. INTRODUCTION

Paper production is done by pressing the moist fibres of cellulose pulp obtained from grasses, rags and wood by drying them into flexible sheets. Paper is a useful material that is used for printing, decorating, writing, packaging etc, and also essential for legal and non-legal documentation. In the paper manufacturing process, instrumentation and chemical engineering plays a important role in the paper production. Pulp production is the basic element in the paper production. The non-destructive measurement of dielectric thickness is done based on quasi static resonator [1] and complementary split ring resonator (CSRR). When the CSRR is supported by the conductive medium with a dielectric layer. Therefore, the resonance frequency of CSRR gives the relationship to the thickness of the dielectric layer. Ultrasonic sensors also have scope in the measurement of wall thickness [2] in thermal power stations.

The ultrasonic inspection for non-destructive testing is used for surface testing and also inspection of railway tracks. Ultrasonic thickness gauge helps in measuring the pipe wall thickness, distance measurement [4], liquid level measurement [5], depth measurement [6] and many more applications.

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***** Correspondence Author
Hepsiba. D*, Department of Instrumentation Engineering, Karunya Institute of Technology and Sciences, Coimbatore, India. Email: hepsiba@karunya.edu
L.D. Vijay Anand, Department of Instrumentation Engineering, Karunya Institute of Technology and Sciences, Coimbatore, India. Email: vijayanand@karunya.edu

Therefore, to check the reliability of inspection results, probability of detection function [3] is found based on the measured output of the pipe wall thickness inspection.

II. PAPER MANUFACTURING PLANT

The two major processes involved in paper manufacturing is conversion of raw material into pulp and conversion of pulp into paper.

The wood taken from the trees are processed in order to separate the fibres from the wood. The pulp produced is done by a mechanical or chemical process. Bleaching and processing of the pulp is done depends on the type and quality of paper to be produced. The pulp produced is dried and pressed into paper sheets.

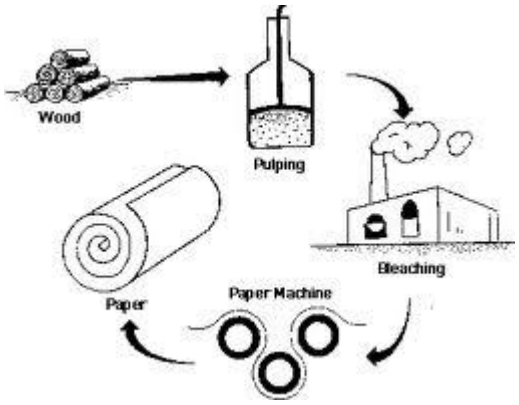

Fig. 1. Stages of Pressure Ulcer

A. Preparation of Raw Material

Wood presented to the pulp mill may be different forms, therefore it is chipped into small sizes using a chipper. The wooden chips are cleaned and checked for size and stored for further operations.

B. Separation of Fibre

In the Kraft Chemical Pulping method, the wooden chips are placed in a digester with the appropriate chemicals. The chips get chemically digested with the steam at particular temperatures to separate the fibres. The cooked pulp is kept inside a pressure vessel in order to remove the steam and other volatile materials.

C. Bleaching Process

The pulp produced contains large amount of lignin and discolouration, therefore it has to be bleached to produce white papers. The chlorination and oxidation process help in the removal of lignin from the fibres.

D. Paper Making

Bleached or unbleached pulp is refined in order to cut the fibres and coarsen the surface of the fibres to improve bonding and formation of the fibres as it enters the paper machine.

Water is added to the pulp to make a thin mixture and cleaned using cyclone cleaners and screening in centrifugal screens before feeding it to the paper production machine. The dilute mixture passes through the head box uniformly and produces the paper sheet.

Fig. 2. Paper Recycling Plant

Fig. 3. Pulp travelling in the Conveyor Belt

III. PAPER RECYCLING PLANT

The Figure 2 shows the Paper Recycling Plant present in the department. All the waste paper materials are dumped into the digester. After processing those waste materials with chemicals in the digester, the slurry pulp is formed. The obtained pulp is spread all over the moving conveyor belt as shown in figure 3. As they were heated along the conveyor, finally it reaches the heated drum for rolling as the sheet or board. In this plant Paper, Card Boards, Files are being manufactured.

For example, if the thickness setpoint is fixed as 1.5 inches, sometimes it may be exactly the same but most of the times it goes beyond the expected set value due to the manual calculation or trial & error method. The optimised results were not obtained because of the trail and error method of making the card boards. Hence more concentration should be given to the thickness of the board to avoid wastage of pulp.

IV. DESIGN AND IMPLEMENTATION OF PAPER THICKNESS MEASUREMENT PROCESS

The paper thickness regulatory system is a closed loop system and it is an automatic process which takes the control action by itself depending on the feedback. The output feedback is checked with the set point. Initially, the required thickness is given as a reference input or set point.

The Arduino programming is done to give indications through the buzzer and the LED indicators. The ultrasonic sensor is connected with the Arduino Board which acts as a controller by controlling and processing the received signal as a result through LED indicators. In case the received signal is above the set point or the reference input the buzzer connected with the circuit will give an alarm signal. This signal alerts the technicians who are working in the plant such that they will be taking out the sheets from the roller.

This process is a closed loop system, therefore human intervention does not take place. Currently the thickness measurement is mainly concentrated. The required output should be in mm, which tested out programming abilities in such a way, this is programmed in ordered to convert the ultrasonic sensor output which is in centimetres into millimetres. As the obtained output is in millimetres it makes the people working there easy in way that they can easily monitor the LED indicators and can easily remove the sheets from the roller as soon as they reach the desired thickness.

This reduces the pulp wastage and increase the production rate, which is achieved after implementing the sensor to measure the thickness, which is the main aim of this work. The Paper/board thickness indication circuit is shown in figure 5

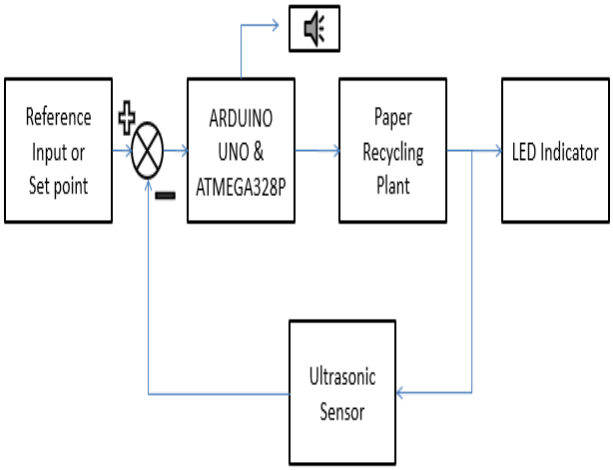

Fig. 4. Block Diagram of the Thickness Control System

V. RESULTS & DISCUSSION

The thickness of the paper roll produced is measured and programming is Arduino is done to indicate the thickness through LED lights and Alarm. When the thickness of the paper produced ranges between 1-2, LED 1 glows, between 2-3 LED 2 glows, between 3-4 LED 3 glows and above 4 alarm rings. These indicators are to indicate to the technician about the thickness of the paper roll produced for verification purpose. Table 1 shows the paper/board thickness indication.

Table–1: Indication of Paper/Board Thickness

Thickness(mm)	LED Indicators
1- 2	LED 1
2- 3	LED 2
3- 4	LED 3
Above 4	ALARM

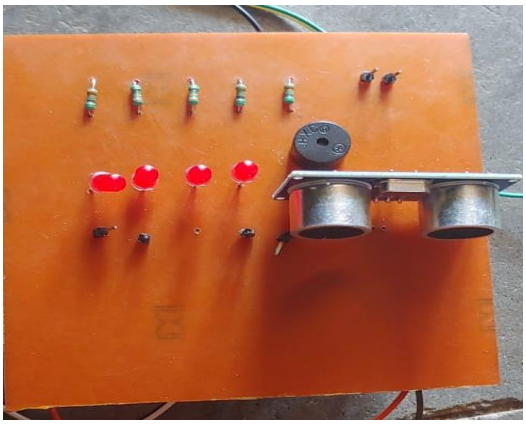

Fig. 5. Ultrasonic Thickness Indicator

VI. CONCLUSION

The thickness of the paper/board is measured with the help of ultrasonic sensor and programming in Arduino UNO & ATmega328P. Finding the thickness plays a key role in regulating the thickness of the board. After the effective implementation, the following are the expected outcomes:

- Effective Production of uniform thickness product
- Time Saving
- Reduced Pulp Wastage
- Reduction of Human intervention in weight calculation

In future, control algorithms can be implemented to regulate the thickness of the manufactured products. Further leading to the implementation of thickness controlling module in the outlet part the manufacturing unit.

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AUTHORS PROFILE

Mrs. Hepsiba. D has completed the Bachelor of Engineering in Electronics & Instrumentation Engineering at Karunya Institute of Technology & Sciences and received Masters in Instrumentation Engineering from St. Peter’s University. She is currently working as Assistant Professor in the Department of Instrumentation Engineering in Karunya Institute of Technology & Sciences (Deemed University) from 2011. She is pursuing her Ph.D in Biomedical Instrumentation Engineering at Avinashilingam University She has published her Research articles in more than 20 International Conferences and Journals.

Dr. L.D. Vijay Anand received the Bachelor degree in Electronics & Instrumentation Engineering from Karunya Institute of Technology & Sciences and completed Master Degree in Control Systems in PSG College of Technology. He has received Ph.D Degree in Electronics & Instrumentation Engineering from Karunya Institute of Technology & Sciences (Deemed University) and for the past one decade working as Assistant Professor in the Department of Instrumentation Engineering in Karunya Institute of Technology and Sciences (Deemed University). He has published more than 30 research articles in International Conferences and Journals.