Enhancement of Multi-loop Level Control with Optimized Ratio and Split Range Controller using DCS PCS7

K. POOVENTHAN[1], K. SOWNDARYA[2], T. MYTHILY[3], V. DHARHINI[4]

Assistant Professor[1], PG Student[2], Student[3], Student[4]
[1,2]Department of Electronics and Instrumentation Engineering, Sri Ramakrishna Engineering College, Coimbatore, Tamil Nadu, India

Abstract: In the industry, the Paper making process happens to be of multi-loop trainer kit mounted with the tank whose level is to measured using ratio and split range control. The cascade control is replaced by ratio and split range control and the flow of the process is the measured inputs to the designed Proportional Integral Derivative (PID) will be given by the level transmitter. The virtual PID is replaced by hardware PID. The total outcome of the process is based on the consistency level. The split range control splits the control element over a particular place as the ratio control segregates by ratio level the result in the consistency level is low so that good grade quality level papers can be determined. Thus the flexibility and the reconfiguration happens to be a freedom in the papermaking process.

Keywords: PID, Paper Making Process, Multi-loop, Cascade control, Ratio control, Split Range Control

INTRODUCTION

In the industry, the process happens to be of multi-loop trainer kit mounted with the tank whose level is to measured using ratio and split range control. The cascade control is replaced by ratio and split range control. The flow of the process is the measured inputs to the designed PID will be given by the level transmitter. In a cascade control system is taking one final value as next state initial value whereas the spilt range control is dividing single set value into two individual set points. Ratio control system is a technique where the two various values are given a single set point correspondingly.

The designed PID will be generating a necessary controlled electronic signal. The electronic signal is 4-20mA into a pneumatic signal which is 3-15PSI to actuate the control value. The virtual PID is replaced by hardware PID. The total outcome of the process is based on the consistency level. The split range control splits the control element over a particular place as the ratio control segregates by ratio level the result in the consistency level is low so that good grade quality level papers can be determined. Thus the flexibility and the reconfiguration happen to be a freedom in the papermaking process.

OVERVIEW OF COMPONENTS

The multi-loop control automation process is controlled using DCS and PLC. The project involves the usage of the following components namely,

- Distributed Control System (DCS)
- Programmable Logic Controller (PLC)
- Proportional Integral Derivative (PID)

2.1 Distributed Control System

Generally, the concept of automatic control includes accomplishing two major operations; the transmission of signals (information flow) back forth and the calculation of control actions (decision making)[2]. This operation requires a set of hardware and instrumentation which serve as the platform to perform tasks. It stands as the infrastructure not only for all advanced control strategies but also for the lowest control system[3].

The idea of the DCS control system infrastructure is old. To appreciate and select the current status of affairs in industrial practice it is of interest to understand the historical perspective on the evolution of control systems implementation philosophy and hardware elements. The evolution concerns the heart of any control system which is how the information flow and decision making is advanced.

IJSER

2.2 Programmable Logic Controller

The sequential relay control, motion control, process control, distributed control systems and, networking is some of the functionality of the PLC. It is important to note that they have not been generally accepted in the heavy industry regarding the practicality of these desktop computer-based logic controllers. In addition to the, operating systems for deterministic logic execution will not have hardware limitations of desktop-based logic with the result in which the logic may not always respond to changes in input state or logic status with the extreme consistency in timing as is expected from PLCs.

2.3 Proportional Integral Derivative Controller

A proportional-integral-derivative controller is generally used in industrial control systems which is a generic control loop feedback mechanism. A PID controller calculates an "error" value which is the difference between the desired set point and a measured process variable. The PID controller algorithm involves three separate constant parameters and based on this sometimes it is known as the three-term control that is named as, the proportional(P), the integral(I) and the derivative(D) values. Simply put, these values can be interpreted in terms of time. P depends on the present error, I on the accumulation of past errors, and D is a prediction of future errors, based on the current rate of change. The sum of all three weighted control actions will adjust the process with a control element.

SOFTWARE DETAILS SIEMENS (PCS7)

An Instrument and control plant will comprise a large number of heterogeneous components with specific parameters and settings. As the plant gets older, it becomes more difficult to keep track of the current state of hardware and software. Without system support, achievement and retention of the required transparency are furthermore extremely complex. The current status of the installed hardware and software components can be called at any time.

PAPER-MAKING PROCESS

Figure 1 shows the flow diagram of the paper manufacturing process. The pulp is prepared for the paper machine including the blending of different pulps, dilution and the addition of chemicals.

IJSER

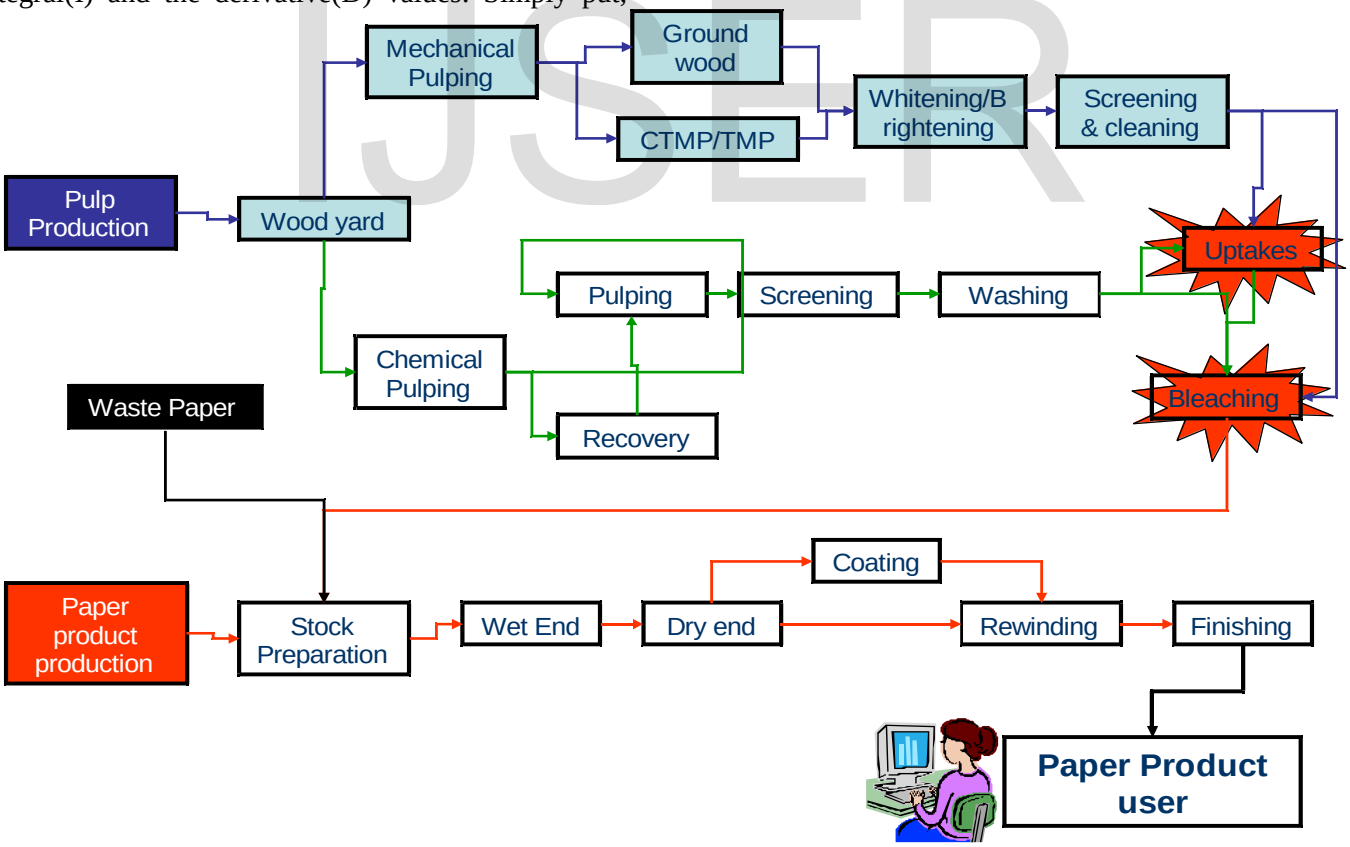

Fig. 1 Flow diagram of the paper manufacturing process

For instance, in the case of pulp being pumped directly from the pulp mill, the slushing and defacing stages are omitted. The operations performed in the paper-making process are Dispersion, Beating/Refining, Metering, and blending of fiber and additives. The Cellulosic pulp is manufactured from the raw materials, using chemical and mechanical means. Through the mechanical, chemi-mechanical and chemical methods[5] the pulp for cardboard and paper can be prepared.

The Multi-loop level process reduces human effort and increases productivity. Automation in an industry cultivates innovation with increased system flexibility and technical risk mitigation. The Multi-loop process is capable of a small machine control with advanced features and options. Flexible I/O options to control and measure a multitude of the process including various instrumentation parameters and the parameter taken here is the level.

SPLIT RANGE CONTROL AND RATIO CONTROL LOOP

The Multi-loop level deals with the dynamic systems with the inputs and their behavior is modified by the feedback. The basic controlling element is the plant so its output follows the desired control signal, which monitors the output and compares it with the reference. The Multi-loop level control over here works with the multiple loops and generally, the difference between the actual and desired output is called the error and in such cases, the stability is increased.

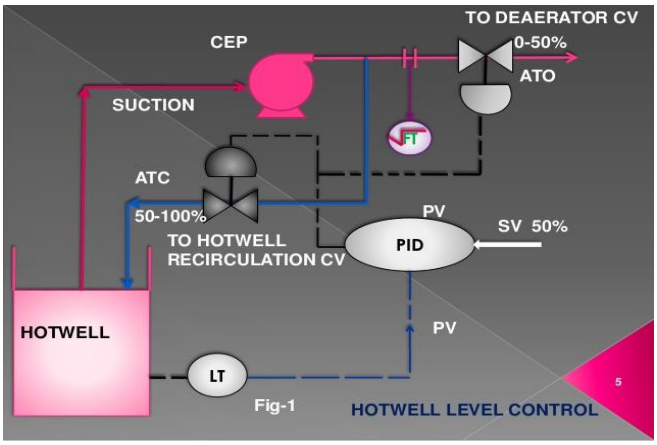

Fig. 2 Diagram of split range control

In split range control, the output the controller is split and sent to two or more control valves. In the most split range applications, the controller adjusts the opening of one of the valves when its output is in the range of 0 to 50 % and the other valve when its output is in the range of 50 to 100%. The diagram for the spilt range control is shown in figure 2. The objective of the ratio control system is to maintain the ratio of two variables at a specified value. The diagram for the ratio control loop is shown in figure 3.

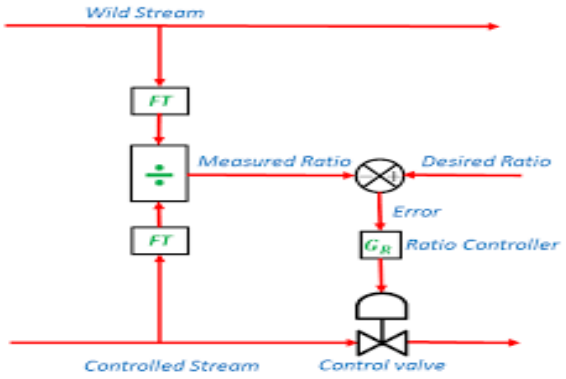

Fig. 3 Diagram of ratio control

DCS IMPLEMENTATION ON MULTILOOP LEVEL CONTROL

In the past, if we found that a number of methods are there which can be applied to control different process parameters. Fuzzy logic potentially applicable to a wide range of processes and a task that normally require a human experience. In computer normally values are available in the form of 0 and 1 which will correspond to either true or false status in the process parameters normally? Thus the truth values may be ranges in 0 and 1 in continuous manner fuzzy logic is the method for representing information in such way that it the coincidence with the natural human communication process.

Generally, it is functional and graphical process it's having following advanced facility that compact to contain on or off controller, control algorithm changes do not call for hardware changes, reduced complexity and easy to expandability and high speed of the control of the processing operation. Developing Distributed Control System is a part the major industrial concern since those Systems are more and more complex with the different variable parameter and involved in many safety-critical applications.

To overcome these difficulties engineers have developed solutions of their own programming and supervisory control and data accusation. Computer

IJSER

control is usually carried out in two modes that supervisory control or direct digital control. The basic objective in stock preparation is to mix fibrous raw materials (pulp), non-fibrous components (additives), and water into a uniform paper making for cup stock paper. Imported Fibrous raw material cost increasing; it's difficult to maintain production cost. For controlling production cost, planned to consume local hardwood and bagasse pulp with ratio and split range controller for achieving the same quality grade paper.

CONCLUSION

Figure 4 shows the overall simulation result of ratio and split range control. The three main parameters to be controlled during the paper-making process namely the level, consistency and vacuum pressure are controlled using the PLC software.

Fig. 4 Overall simulation result of ratio and split range control

This automation process reduces labor cost and saves time. Only for the particular range of temperature and vacuum pressure the consistency value can be maintained less than or equal to 50 units. Hence those two parameters are maintained first in order to control the consistency value of the pulp. The Siemens PCS 7 DCS software is used for simulation purpose and using the results, the ladder diagram is developed. Hence the use of PCS 7 DCS in the industry makes the process efficient and reduces manpower to a greater constraint.

FUTURE SCOPE

The future scope of the automation of Paper-making process lies in implementing SCADA system for monitoring the real-time process values from the control room. The final unusable consistency from the third boiling system should be made use effectively by using it in other product manufacturing processes. Hence the maximum amount of product recovery can be made and the wastages from the process can be minimized.

ACKNOWLEDMENT

This work was supported and carried out at Department of Electronics and Instrumentation, Sri Ramakrishna Engineering College, Coimbatore. We would like to thank our Management, Director (Academics), Principal and faculty friends for supporting us with the infrastructure to carry out the research work.

REFERENCES

[1]. Abd El-Geliel .M, El-Khazendar M.A "Supervisory fuzzy logic controller used for process loop control in DCS system" Proceedings of 2003 IEEE Conference on Control Applications vol.1 pp. 263 - 268 2003.

[2]. Agrawal .A, Tratnyek P.G, "Reduction of nitroaromatic compounds by zero-valent iron metal" Environ. Sci. Technol. vol. 30 pp. 153-160 1996.

[3]. Ali Davoudi , Ali Bidram "Flexible simulation of multifrequency averaged a nd high-fidelity switch-level models with control loops " 2012 Twenty-Seventh Annual IEEE Applied Power Electronics Conference and Exposition (APEC)pp. 1914 – 1920 2012.

[4]. Ali .M, Sreekrishnan .T.R"Aquatic toxicity from pulp and paper mill effluents: a review" Advances in Environmental Research vol. 5 pp. 175-196 2001.

[5]. Andersson K.I, Pranovich A.V, Norgren M., Eriksson .M, Holmbom .B, "Effect of biological treatment on the chemical structure of dissolved lignin-related substances in effluent from thermomechanical pulping" Nord. Pulp Paper Res. J. vol. 23 pp. 164-171 2008.

[6]. Aravindhan .K,.Karthiga .R.R, "One-time Password: A Survey" International Journal of Emerging Trends in Engineering and Development, vol.1(3), pp. 613-623.

[7]. Aravindhan. K, Kavitha .G, Suresh Gnana Dhas .C, "Plummeting data loss for multihop wireless broadcast using position based routing in VANET" 2014 International Conference on Science Engineering and Management Research PP. 1-5.

[8]. Avsar .E, Demirer G.N "Cleaner production opportunity assessment study in SEKA Balikesir pulp and paper mill" Journal of Cleaner Production vol. 16 pp. 422-431 2008.

[9]. Choe .S, Liljestrand H.M, Khim .J "Nitrate reduction by zero-valent iron under different pH regimes" Appl. Geochem. vol. 19 pp. 335-342 2004.

[10]. Dadenkov .A, Anton N. Kamenskikh, Efim L. Kon "Algorithm for design fieldbus infrastructure of DCS design of fieldbus-network" 2017 XX IEEE International Conference on Soft Computing and Measurements (SCM) pp. 213 – 216 2017

[11]. Dries .J, Bastiaens .L, Springael .D, Kuypers .S, Agathos .S.N, Diels .L "Effect of humic acids on heavy metal removal by zero-valent iron in batch an continuous flow column systems" Water Res. vol. 39 pp. 3531-3540 2005.

[12]. Franta .J, Helmreich .B, Pribyl .M, Adamietz .E, Wilderer .P.A, "Advanced biological treatment of paper mill wastewaters: effects of operation conditions on COD removal and production of soluble organic compounds in activated sludge systems" Wat. Sci. Technol. vol. 30 pp. 199-207 1994.

[13]. Hanieh Asadipooya, Ali Akbar Safavi " Enhancement of model predictive control implementation on a DCS PCS7" 2016 24th Iranian Conference on Electrical Engineering (ICEE) pp. 1272 – 1277 2016.

[14]. Pooventhan .K, Achuthaperumal .R, Kowshik .S, Manoj Balajee .C.R, "Surveillance Robot Using Multi Sensor Network" 2015 International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering vol. 3(2) pp. 113-115.

[15]. Perey .J. R, Chiu .P. C, Huang C.P, Cha .D.K "Zero-valent iron pretreatment for enhancing the biodegradability of azo dyes" Water Environ. Res. vol. 74 pp. 221-225 2002.

[16]. Ruangchainikom C., Liao .C, Anotai .J, Lee .M " Characteristics of nitrate reduction by zero-valent iron powder in the recirculated and CO 2 -bubbled system " Water Res. vol. 40 pp. 195-204 2006.

[17]. Subhashini .N, Aravindhan .K, "A Survey on Infrastructure Abstraction of Wireless Sensor Network" International Journal of Computer Science & Engineering Technology, vol. 5, pp. 1030-1033.

[18]. Walden C.C, Howard .T.E "Toxicity of pulp and paper mill effluents - a review of regulations and research" Tappi J. vol. 60 pp. 122-125 1977.

[19]. Westerhoff.P, James .J, "Nitrate removal in zero-valent iron packed columns" Water Res. vol. 37 pp. 1818-1830 2003.

[20]. Xiao .X, Chen .Z, Chen .Y, Liu .M "Paper making middle-stage effluent treatment with micro-electrolysis method and its mechanism" China Pulp & Paper vol. 24 pp. 14-17 2005.

IJSER