Need of Installation of Appropriate Control Systems For Improving Productivity in Pulp Mill

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ABSTRACT

Pulp and papermaking process like other industrial process manifest inherent variability. These variations must be minimized in the plant operation to achieve the optimum result i.e. uniform and high quality product with efficient utilization of raw material, man-power, energy and other resources. The basic objective of installation of process control system is to maintain each operation of process within the well defined limits of variation.

The present paper deals with control systems in kraft pulping process. The introduction of control system has become more or less necessary in Indian Paper industry under the present conditions of paper mills and market and visualizing the growth of industry. In this article need of installation of control system in each operation of pulp mill and its advantages are discussed in detail A few control systems are also suggested. It has been concluded that there is definite need of incorporation and installation of control system which would improve the overall productivity of the mill.

The paper industry in India has now got a long record of existence and tremendous growth has been recorded in the last decade. Inspite of its achievements in past and fairly comfortable position at present, Indian pulp and paper industry has challenging tasks ahead of fulfilling the needs of growing population with increasing literacy and industrially and technically developing country. In the recent past, in the industry, growth and capacity utilization have shown a declining trend Various factors are responsible for such discouraging state of affairs, could be high capital investment, low profitability, lack of adequate and substantial supply of fibrous raw material, shortage of power, coal and water etc. Over and above a very static level or very slow development of technology in the country and lack of timely adoption of proper technology, machinery and equipment adversely affected the already deteriorated situation.

A new phenomenon has been observed recently in the paper trade that it is gradually switching over from sellers market to buyers market. To cope up with such situation apart from maintaining the growth level, the produtivity of the individual unit is to be improved. Most of the paper units are based on a blend of imported and indigenous technology, machinery and equipments. Now under the present situation it has become quite imperative to adopt, if not fully, in a partially and phased manner a paper control system to improve paper quality and productivity.

The pulp and papermaking is a complex process involving organic and inorganic reactions, chemical technology—different engineering aspects etc, Though paper industry has learnt enough with long experience to optimise various conditions at individual stages of papermaking process, still not much amount of efforts have been made to adopt proper control systems to work under specified conditions. In most of the cases control is either manually and/or with the help of occasional testings by laboratory. There is a definite need to adopt proper control systems which would not only ease the operation but also help in improving product quality and overall productivity of the industry.

It is worthwhile to mention that in developed countries tremendous amount of efforts have been put in paper industry to evolve proper and effective control systems In most of the cases control systems are applied in individual sections of mills. Due to adoption of these

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systems their productivity has increased as compared to Indian paper industry.

The use of microprocessors, computers and robots have become common in most of the paper mills in developed countries. These control systems are employed at every stage of process to monitor the entire operation efficiently. It may be mentioned here that to reach such a stage of high technological achievements and mechanization, for our paper industry, whether big small or may not practicable in near future. However, at this stage, we should put our efforts to gradually incorporate advanced control system in the process. In the present paper the need of incorporation of control systems specifically in 'Pulp Mill' is discussed in detail to achieve better product quality and productivity.

The kraft/soda pulping process can mainly be divided in the following operations :—

(a) Chipping and Screening
(b) Cooking
(d) Brown stock washing and pulp screening
(d) Bleaching.

Though control system at different stages should be incorporated; however, the requirement of control system at different operations may vary from mill to mill depending upon various factors as well as infrastructure available with them.

CHIPPING AND SCREENING

As such wood is a compact mass of organic and traces of inorganic materials. Untill and unless the mass is broken into suitable sized pieces called chips, the process of efficient chemical digestion i e. cooking is not possible. Hence, chipping is most important though to date least controlled process operation. At this stage possibility of mechanical damage to wood chips is maximum which in turn adversely affects the pulp quality. For a given wood source, the quality of chips is measured only by uniformity (i.e. length and thickness) and also by absence of 'Contaminates'. The chips of 10 to 30 mm long and 2 to 5 mm thick are usually considered to be of good quality. The contaminants like bark, metal, rotten wood, dirt and other foreign particles should be separated efficiently.

The good quality chip is prime requisite for good quality pulp. In the kraft process due to presence of alkali, which swells the fiber, liquor impregnation takes place from all directions provided the chips are not thick. The relation between chip thickness and reject percentage is well established. In most of the Indian pulp mills chip screening is done on the basis of length by using screens having round openings. A combination of round and slotted screens would be of great advantage to control length and thickness Since, most of the big mills are presently using high percentage of hardwoods this system would be of much use, as hardwood chips must be thin in order to have uniform pulping.

The chip cleanliness can be improved by using hot air or by adopting chip washing systems The dust percentage should be as low as possible with the chips before being fed to the digester, The metallic contamlinants particularly iron particles can be removed by suspending an electric magnet over the chip conveyor. The collected iron particles may be regularly removed from the magnet.

COOKING

It is a very important stage of total process of papermaking. In this stage, first area i e. digester loading requires good control system to improve the process and productivity. At present in most of the mills chip loading is done on volume basis i.e. whatever maximum quantity of chips can be fed in given volume of digester. However, this would not give the exact quantity of oven dried chips loaded in the digester on which basis other conditions are to be maintained.

Installation of weightometer can record air dried weight of chips. But the chip moisture varies quite frequently depending on raw material quality, its storage, season, etc. The chip moisture can be measured by the use of automatic analysers or manualty at laboratory, but in both the cases considerable amount of error may be introduced, depending on sampling etc. An on-line moisture analyser may solve the problem to some extent, but out of different types of systems suggested none has proved satisfactory in practice. A combination of control system and experience would give better process monitoring results in this aspect.

The control of chip packing in stationary digester is another important area for achieving uniformity of

pulping and higher productivity. Filling the digester by overhead bins or conveyors and starting simultaneously the liquor pumping is most widely used practice for good packing. The packing can be further improved by use of 'chip packers' or distributers. The packer is located in or below the digester A point to be noted is that chip packers should be carefully used/installed because, highly packed chips may obstruct the free flow of liquor.

The charging of white liquor is also an important operation since, it plays a key role in the process of delignification. Depending on active alkali required to obtain the desired final pulp kappa number and white liquor analysis, volume of white liquor to be fed to digester is fixed An improper liquor charge will adversely affect the pulp quality and also uniformity. At present most of the methods applied in Indian pulp mills for liquor charging are based on manual operations. Installation of an automatic white liquor analyser and white liquor feed control system will give optimum results.

By maintaining the desired active alkali concentration in the digester throughout the process, delignification can be controlled efficiently. On-line conductivity measurement of liquor will indicate the trend of consumption of active alkali in the process. The other necessary controls in the digester are steaming, time to reach cooking temperature and at cooking temperature, liquor circulation, relieving and pressure control, etc., However, for correct end point prediction, 'H' factor method, accounting for time and temperature variation, can be easily applied to control process variables.

In this age of computers, one can easily assess the advantages the computerization of digestion process assures. Various problems associated with digester operation can be conveniently solved with the application of computerized control system. But, under present conditions of Indian paper mills these techniques may not be techno-economically feasible hence, are not discussed in detail in this paper.

A model of control system for digester operation for typical direct heated system is given in Fig—1. Basically the system consists of steaming and relief controls, temperature and pressure recording, control of plugging of the relief screens.

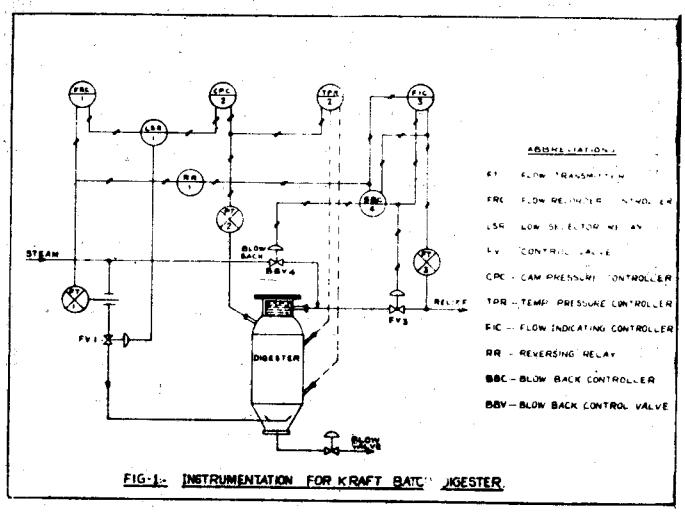

FIG-1:- INSTRUMENTATION FOR KRAFT BATCH DIGESTER

In the model, steam flow is measured by a flow transmitter, FT and this signal is transmitted to a steam flow recorder-controller FRC, the output of which goes through a low selector relay, LSR to the steaming control valve, FV. A pressure transmitter, PT sends the vessel pressure signal to a time schedule cam pressure controller, CPC., the output of which also goes to low selector relay. As the output pressure from the flow controller rises above the cam controller output, the relay smoothly transfers control of the steaming valve to cam pressure controller. The optimum rate of flow of relief gases depends on the rate of steam flow to the digester. Relief flow transmitter, FT measures flow of relief gases and transmits a signal to relief flow indicating controller, FIC. The output from the steam flow transmiter, FT is inversed by reversing relay, RR. This signal is used to continuously set the control point of the relief flow controller, the output of which is used to throttle the relief flow valve, FV. The digester circulation depends largely on the steaming rate and relief rate and is measured by temperature difference between the top and bottom of the digester at top pressure. This is accomplished with the digester temperature pressure recorder, TPR.

The plugging of the screen located in the neck to the digester is controlled by blow back controller, BBC. Blow back consists of opening blow back control valve, BBV and closing relief valve FV for a fixed period of time. The digester operation can be controiled quite efficiently if this system is applied. Similar to this other system can be evolved depending on the process equipments available and processing conditions in use, to bring efficient control of digestion.

By adopting the strict control system in digestion, uniform quality of pulp with higher yield and lesser rejects can be obtained. The optimum active alkali addition has double advantage, it gives good quality pulp and secondly the good quality of spent liquor which is easier for further processing.

BROWN STOCK WASHING AND PULP SCREENING

Following the cooking, a series of processing i. e. mechanical treatment for difibrization knots removal, washing (BSW), screening etc. is done before pulp is sent for bleaching. In the process of defibrilation, knots removal and screening, practically no intense and complex applications are involved. However, it is worthwhile to look into various aspects of brown stock washing, since the conditions maintained at this stage have direct impact on soda recovery and operations of recovery, screening and bleaching. The following are two main objectives of washing :-

1) To remove residual liquor which would contaminate the pulp during subseqent processing steps.
2) To recover the maximum amount of spent cooking chemicals with minimum dilution.

For many decades, standard method of washing is utilized, in which a series of rotary vacuum washers operating in counter current flow sequence. Presently following efficient methods are also available to replace rotary vacuum washer :-

i) Diffusion washer
ii) rotary pressure washer
iii) horizontal belt filter
iv) Wash press
v) dilution/extraction

In most of the Indian mills still rotary vacuum washers exist. The quantity of fresh water addition in this system is critical factor called as 'dilution factor'. It is defined as weight of wash water introduced in the system per unit weight of pulp washed. Efforts are needed to have a minimum dilution factor with maximum washing efficiency. In order to achieve this, proper control systems are to be installed to measure the sodium content and/or solid contents of liquor. In most of the cases it is presently done manually with the help of laboratory testing facilities. Excellent correlation between the conductivity of kraft black liquor and its sodium content is reported. Incorporation of a non-line conductivity measurement and correspondingiy control of washing would help to improve the washing efficiency.

The density measurement is another tool to control process efficiently, A model based on this principle is given in Fig-2. In this system black liquor density is measured from filtrate tank-1 and output is transmitted to controller valve where desired set point is adjusted manually. Output of controller goes to control valve and which controls the flow of wash spray. If density is higher than the set value than control valve is opened automatically. Due to this, level of FT_2 will go down and for maintaining the level of FT_2 wash spray of filter-2 will be increased with the help of opening of control valve and then process is followed for filterate tank-3. By adopting this control system a constant density liquor will be obtained in fllterate tank-1 which supplies black liquor to recovery and at the same time with minimum dilution factor, minimum soda losses can be maintained.

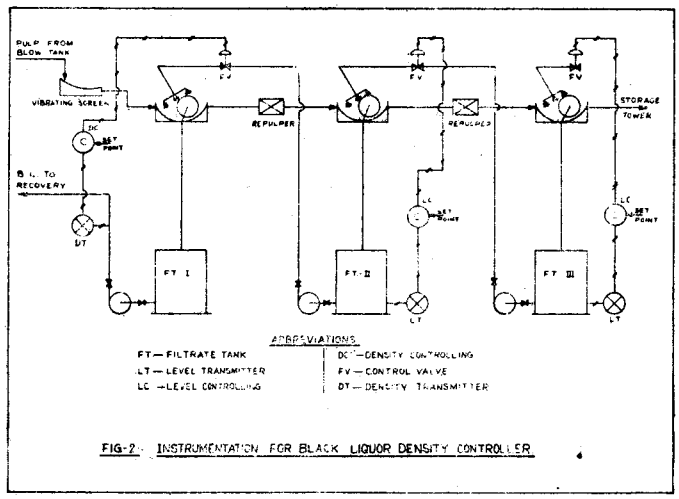

FIG-2 INSTRUMENTATION FOR BLACK LIQUOR DENSITY CONTROLLER

BLEACHING

Kraft pulp bleaching is simply extension of delignification process started in cooking. However, in this stage the fibers are more open and bleaching chemicals are also not very selective in reaction. Any lapse in process operation would lead to severe damage to the pulp in terms of quality and yield. The control systems in bleaching should be designed after taking

into consideration measurement of a flow of pulp. chemicals, concentration of chemicals, process conditions such as temperature, retention time, pH, etc.

The flow of pulp is measured generally by a magnetic flowmeter. Since, the flow of pulp is measured in slurry form hence consistency measuring device is also needed. The proper maintenance and periodical caliberation are essential for getting the desired flow of pulp. Proper flowmeters are also to be installed for measuring the liquid chemicals and gases.

The main objective of bleaching is to get the bright pulp. Measurement of optical property to know the completion of reaction particularly of the last stages of bleaching can play an important role for maintaining desired conditions of bleaching. On–line brightness test would be of great use for such purpose.

The proper control system in bleach plant will have direct impact on quality of pulp, chemical consumption, energy reqirement, pulp yield, effluent characteritics, safety, cost of bleaching, etc. One model of bleach plant control system for CEHH sequence has been given in Fig–3. In this system, we get, out of sensing element, A. The residual chlorine, the signal

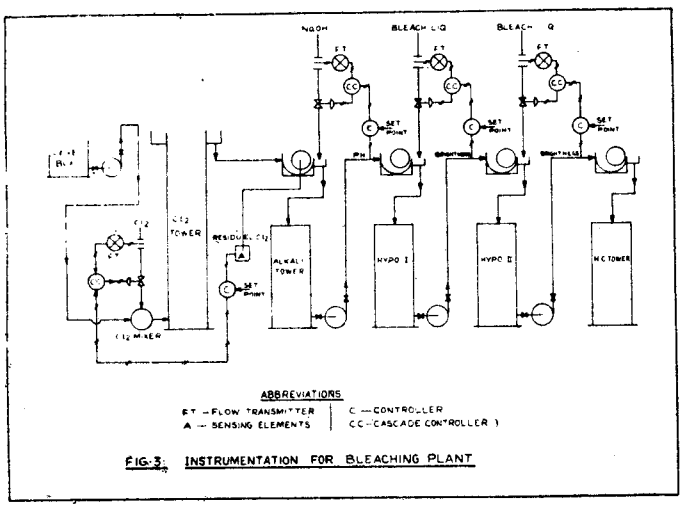

FIG-3: INSTRUMENTATION FOR BLEACHING PLANT

of which will be fed to a controller where predetermined set point is adjusted manually depending on quality of unbleached pulp. The output of controller goes to cascade controller as a new set point. On the other hand chemical flow is measured through flow transmitter out of the same also goes to cascade controller. Depending on the set points fixed, flow of the chemical is automatically radjusted. This system works for all the four stages of CEHH sequence, but for chlorination sensing element measures residual chlorine, for alkali extraction end pH for Hypo I and II stages—brightness of the pulp. Based on the principle mentioned above appropriate control system may be evolved and installed for making the bleaching process more productive.

CONCLUSION

The productivity of pulp mill mainly depends on the quality and quantity of pulp produced and also cost of production of pulp. In the present review stress has been given for installation of appropriate control systems which would have direct impact on improving overall productivity of the mill. The major operating factors affecting the pulp mill operation and productivity are cost of pulp wood, energy, chemicals, labour, etc. However, under the present conditions of paper industry, its growth pattern and market, the installation of control systems at individual stage of operation is becoming necessary to improve overall productivity of mill. However, it may be mentioned that selection of the control system should be done depending on the sensitivity, accuracy and speed of response of measuring device and it's suitability with the infrastructure availa ble at the mills. The control systems should be reliable and robust to withstand the hazards of industrial life, at the same time maintenance of the system should not pose any serious problem.

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BIBLIOGRAPHY

1. Lavigne, John.R, An introduction to paper industry Instrumentation, California, U.S.A. Miller Freeman, 1972.

2. Singh, R. P., Ed, The Bleaching of pulp, Atlanta, U.S.A., Tappi Press, 1979.

3. Casey, J.P., Ed; Pulp and Paper, manufacture Vol-I, U.S.A., Johnwiley and Sons, 1980.

4. Stephenson, N.J., Ed; Pulp and Paper manufacture Vol-4, New York, McGraw-Hill, 1955.

5. Smook, G.A., Hand Book for Pulp and Paper Technologists, Canada, Joint Text Book Committee of Paper Industry, 1982,

6. Pulp Washing '83, Int. Symp. on Pulp washing, Mont-Gabriel, Canada, Sep. 27-29, 1983.

7. Sankaranarayanan. P.E., Proc., FICCI, July 20-21, New Delhi, 1987.

8. Johnson, C. D., Process Control Instrumentation Technology U.S.A., Johnwieley and Sons, 1982.

9. Rutledge, W., INTECH, 34 (6) 26 (1987).

10. Kent, D.W., Paper Technology and Industry, 24 (2) 155 (1979).