Process Control Computers in Pulp and Paper Industries

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SUMMARY

Papermaking process is a continuous one with numerous operating variables requiring accurate control and involves machines with strict starting and stopping sequences. Hence this process is highly suited for instrumentation and automatic control.

Recent developments in the process control instrumentation and computers have made it possible to automate various plants of a papermill in foreign countries.

Growing demand for paper with its product uniformity and quality may require our Indian paper mills to go in for a better instrumentation and control system. An attempt has been made to study the need, scope and the problems associated with automation in Indian papermills. The details of the process control along with the results of the study are discussed in this paper. (This paper was discussed in the 12th Annual Convention of the Computer Society of India held at Poona in 1977).

INTRODUCTION

Though there has been a significant growth in our paper industry we are still not yet self sufficient in quite a few special grades of paper. In order to meet the demand by the end of Fifth and Sixth plan fully from indigenous production, it would be necessary to create a total installed capacity of 1.5 and 2 million tonnes/annum respectively as against the present built in capacity of 0.992 million tonne/annum.

Under the constraints imposed by the raw materials shortage, higher cost of chemicals, market trend and an almost saturated process technology, the only way to achieve our production target is by the optimization of raw material usage and better process control. At this stage the most powerful tool yet to hit this industrial scene is a modern, high speed, digital process computer, for online, real time, time-shared, process, product and manufacturing control.

A preliminary survey has been conducted to find out the need, scope and the problems of process automation in Indian pulp and paper industries. This paper discusses the results of the survey along with the details of the process and its control by computers.

THE PAPER MILL SYSTEM DESCRIPTION

In order to give an idea of the papermaking process, the various departments in a typical paper mill are shown in the flow chart (Fig. 1).

AREAS OF CONTROL

The mill control system concept is modular and consists of the following areas of application.

1. Digester control
2. Washer monitoring
3. Screen monitoring

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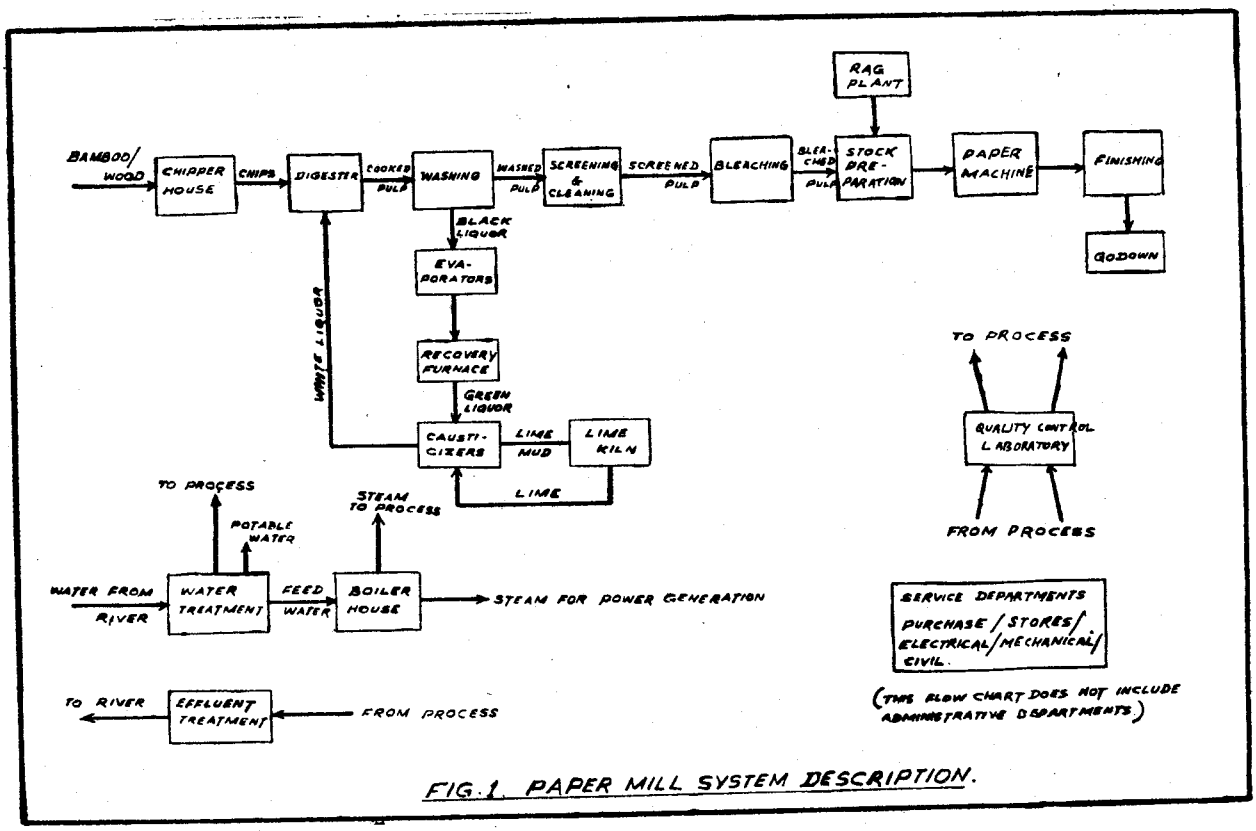

FIG. 1. PAPER MILL SYSTEM DESCRIPTION.

4. Bleach plant control
5. Stock preparation : additive monitoring, refiner monitoring, proportionating the stock
6. Paper machine : basis weight control, moisture control, grade changes
7. Chemical recovery : evaporator, recovery furnace control, causticizing monitoring and lime kiln control
8. Utilities optimization : energy management by least cost fuel mix, steam and electrical generation and distribution monitoring and power demand control
9. Effluent treatment : total treatment plant and receiving stream monitoring, chemical addition control
10. Online data entry/inquiry : online maintenance tracking and costing,stores inventory management purchasing, quality control, laboratory tests
11. Central mill control and optimization : creation of data bases, calculation of optimization strategies, stores alternative control strategies, payroll, accounts payable, production reporting, cost and budgetary control

COMPUTER CONTROL

OBJECTIVE

For a long time papermaking was treated as an art rather than a science. It is wellknown that the papermaking process is complex and the job of the papermaker is a difficult one. A small alteration to any one of the numerous controls may trigger off a series of other changes-most of them undesirable. The basic objective of the introduction of computer control is to inter-relate the controls so that when a change is made to any one of the variables (like the machine speed, for example), the computer automatically makes a series of other changes of the correct order and at the correct time so that paper quality is maintained. With the computer looking after the interrelation of the process variables, the papermaker is thus free to concentrate on the optimization of the quality and output. Even for this, the computer can be made use of.

TYPES

The implementation of computer control on todays processes can and does take many forms. In order to understand the trends in the technology better, four distinctly different types of control computer system are briefed here.

1. Analog computer system : Analog computer is the one in which the basic computations are performed by representing the values of the variables by the value of one or more physical quantities. The growth of the basic component of Analog computer, the Operational amplifier, made it possible to use them for continuous control purposes. Inexpensive for simple operations and flexibility for any type of use are the major advantages of this system. But the limited accuracy and range, difficulties in applying adaptive control to an operational amplifier,

problems in generating time functions lasting several hours because of the amplifier drift, and the tediousness of the complex control strategies limit their use as control computers separately.

2. Supervisory Control System: This is the first example of 'closed loop control. A digital computer control system scans analog sensor inputs and performs the necessary control calculations to determine the most desirable operating position. It then electronically positions the set points of the analog controllers or valves (when no controllers are needed) through the necessary transducers. The frequency of control action in this system is typically in minutes. Fig. 2 represents the block diagram of a simple supervisory control system. This system is also called as Digital Directed Analog (DDA) Control System.

3. Direct Digital Control (DDC) System: This system replaces the function of the analog controllers. In this fashion all the process sensors are time multiplexed into the computer and the output to the process actuators is time multiplexed from the computer. The frequency at which the computer samples each point must be approximately once per second to perform in a fashion comparable with the continuous analog controllers. As the digital computer is not wholly available, it is necessary to provide backup analog controllers for critical loops (about 10% of the loops on a process). The initial incentive for DDC was that of analog replacement. The added capability of DDC are:

1) flexible control equations
2) flexible cascade
3) extensive signal checking
4) less maintenance and
5) advanced control techniques. Fig. 3 shows the DDC system.

4. Mini computers and Microprocessors : Now-a-days the treand is towards a minicomputer process control with a small special purpose computer performing DDC and communicating with a larger computer performing supervisory control.

INTEGRATED SYSTEM

Apart from process control, the computer can also be utilised for production planning, production evaluation and reporting, quality control and for repid flow of information. The fig. 4 represents an integrated computer control system performing the above operations.

ECONOMIC INCENTIVES

The economic incentives claimed by an integrated computer control system are :

1. Improved process control that will reduce process variations, shorten the time required to bring production into equilibrium, speed up production, improve overall paper quality and reduce the consumption of raw materials.
2. Improved planning that will reduce trim losses, reduce grade change losses and cut both machine and pulp costs.
3. Improved quality control that will assure more accurate data on which to base the rejection of unsatisfactory paper rolls (due to improved control of quality governing variables).
4. A more rapid and comprehensive flow of information to machine operators, shift foremen and company management that will enable the papermaking process to be carried out more efficiently.

REQUIREMENTS

The demand for the computer is partly scheduled and partly random as it meets and performs the process calculations with periodic functions and random functions.

It is desired to develop new process control programmes, assemble or compile, dubug, simulate and integrade into the system even while the computer is actually controlling the process along with non-process programmes.

These two requirements demand that the computer should have time sharing and simulation capabilities. Programming for process control computers has been a very expensive part of most computer systems installed todate. It has often been the culprit blamed for slipping schedules and causing delays by getting on closed loop computer control. Hence it is required that the real time programming is to be done with an user oriented programming language which can describe functions for analog inputs, calculations, logical but manipulations, priority interrupt response, operator demand functions and analog outputs. It is also desired that the programming language should aim for easy communication between process engineer and computer, extremely good documentation, easier debugging, convenience for making changes and reduce programming time.

SYSTEM DEVELOPMENT

The individual activities in a typical computer project starts with a feasibility evaluation and the writing of specifications, and ends with the documentation and the monitoring of progress, schedule and cost.

The procedure for establishing the motivation and its validity so that the inherent features of the computer can be matched against process and product objective involves two steps: the first step is to select and define the variables of process, the characteristics of product, the indices of the system whose magnitude and variability are of significant technical and economic importance to the company, the second step is to apply analytic and diagnostic techniques to process variables, product characteristics, and production indices in order to study such factors as trends, profiles, specifications adherence, crew comparative performance and competetor comparative performance.

For process optimization a mathematical model is most often required to allow the computer control system to describe the inter-relationship between all economic, physical, chemical and operational variables so as to achieve the operating point that produces an on-specification product at the highest possible profit.

SYSTEM IN SERVICE

A few typical computer control systems under operation are given below:

1. IBM 1800 process control computer with IBM 1710 at Gruvor Mills, Sweden, installed as an integrated computer control system covers about 70% of the whole papermill operations.

2. ABACUS system developed by Digimatics Ltd, UK has been installed at Grove Mill Paper company UK for control and data processing of traversing gauge, control of the paper machine, paper break management, and operator, production management facilities. It is worth nothing that their production has increased by 15% grammage control is within ± 0.5 g s m, moisture is controlled to the extent of $\pm 0.3\%$ and the reduction in grade change time is about 20%.

3. FOX 2/30 computer developed by Foxboro-Yoxall Ltd., UK installed at Bleached Board Mll in Augusta for supervisory control in their bleach plant. It is reported that the yield of bleached pulp has increased by 1% and there has been 6.5% overall chemical cost reduction.

PAST TRENDS

In Indian Paper Industry the research and production management were run on an emperical basis. Decisions were usually based on experience and the experience was generally based on the results of trial and error. The problems were not investigated analytically.

Apart from this, there was no comparable growth instrument technology as applied to pulp and paper industry. The market situation for paper was in favour of the mills. Hence this problem of going for better control was not viewed seriously, thus leaving Paper Industry in a condition of poor instrumentation and control. This is likely to be a major problem in the computerisation of process control as it is necessary to bridge the existing gap between the process and the computer by instruments. Much research work in this area was not also done as the concerned technical personnel were involved in routine work rather than developmental activities, and no separate research and development section exists. The poor utilisation of existing technical manpower was also a reason for this state of our Industry.

SURVEY

The idea for this survey was originated from Prof. H.N. Mahabala of IIT Madras. This was carried out with the active guidance of Sri S.G. Rangan, Production Superintendent, Seshasayee Paper and Boards Limited, Erode-7. A questionnaire was prepared and sent to a selected number of medium and large sized pulp and paper mills.

The response to this survey was quite good and the results are given below:

The survey shows that

1. most of the mills are adopting standard processes and are having standard unit process equipments (this is expected to reduce the complexity in designing control systems)
2. the instrument sections are moderately staffed with qualified people
3. the investment on instruments is around 2% as against the normal requirement of 5 to 10%.
4. the production loss due to instruments varies from 0.5 to 3%
5. the down time is comparable with production time
6. the down time due to grade change is quite high as there are a large number of grades of paper produced
7. sizable amount of control equipments supplied by the original collaborators (wherever applicable) were removed due to non-availability of indigenous quality spares
8. most of the mills are expanding
9. no positive decision regarding going for computerisation of processes is taken by the mills
10. more than 50% of the mills are quite away from big industrial towns where servicing facilities for computers are available.
11. the nature of complaints received by the mills shows that they could be easily avoided by better process control
12. many mills are working on improving their process control
13. better Management Information System is desired by the mills.
14. in general, going for computerisation in Indian paper mills is a must, subject to the assurance from the manufacturers of control systems for possitive and long term financial benefits and

15 the scope for better instrumentation and control is wide.

Though it has been felt by most of the paper mills that better control of papermaking process is definitely an advantage to them, they are not able to implement it because of the following reasons :

1. At existing higher cost of production and less sales realisation, it is considered that process control is nothing but a luxury rather than a necessity for production optimisation.

2. Huge initial investment is considered as a financial risk.
3. High recurring maintenance expenditure is warranted in terms of salaries of highly qualified personnel to manage these sophisticated systems.
4. Considerable amount of investment in the inventory of spares as immediate replacement is needed to avoid interruptions in production.
5. Non-availability of indigenous quality equipments and if at all available their long delivery periods.
6. Inadequate facilities for after sales service, spares and operation (training)
7. Shortage of well qualified and trained technical personnel in particular instrument engineers and technicians.
8. Poor adaptability of control to old, small capacity machines existing.
9. Apart from these techno-economic problems, unemployment, a major social problem in the short run expected by process automation.

(The Automation creates a very great demand for well qualified personnel leaving unemployment *only in the sector of unskilled labour*. Thus it forces our country to improve our cultural and educational standards. The growth of the industries by the way of automation will definitely aim for further developments in industries thus raising the employment opportunities. Hence this should not be considered as a major problem.)

CONCLUSION

The first and immediate step; before going for high level of control with computers is to minimise the gap between the process and the computer by developing the intermediate control equipments. It is felt in general that installing computerised control system for new mills which are coming up may be more advantageous and easy compared to existing mills where already the labour force is in large number, the processes were stabilised much early and as it is not desirable to disturb these systems.

The interest shown towards process control by Indian mills indicate that there is a lot of scope for computerisation of paper mill processes, subject to some problems anticipated. Hence further techno-economic feasibility studies should be initiated and carried out by Indian Pulp and Paper Technical Association in association with Computer Society of India and the manufacturers of process control equipments.

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