Basis Weight Control For Small Paper Mills

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ABSTRACT:-- On a paper machine, Basis weight control is very important. In the present paper it is shown how a simple stratagy can be used very effectively to develop a low cost basis weight control system. Normally the basis weight valve is applicable using thumb rules to control the basis weight. A better approach is to monitor consistency, flow rate, machine speed etc. simultaneously, and neccessory correction is to be taken instantaneously while any of the variable changes. Also, manual control and feed forward control is discussed. Basis weight control with feed forward control is a good choice for the small paper mills who cannot afford a costlier complete QCS system.

INTRODUCTION

With the opening of global economy & liberal import policies our pulp & paper industry need to compete with International players who maintain high quality standards through automation. Therefore it is the need of hour to go on for automation as far as affordable. It is also time that smaller mills find it difficult to spare heavy Investment for complete automation.

With the recent trend going on for automation due to strict quality norms; existence of smll mills is becoming more & more difficult. Smaller mills often find it hard to invest a huge sum for automation projects. DCS & QCS systems are well known in the industry now, but high cost of implementation has made the smaller units into a stage of indecisiveness. The present approach describes a way to automate plants by using automation packages based on decades old logics.

MANUAL CONTROL

Let us imagine a paper machine, where the stock line from S.R. Box to fan pump contains only a manually operated knife gate valve-which is not very accurate & linear-there is no flowmeter or consistency control installed in the line. The machine, say is running initially at a controlled condition (by chance).Suddenly, the operator touches the paper at pope reel, & feels that moisture is increased. Well, it may be a sign of steam shortage, or freeness change, or press part vacuum/ load reduction or basis weight increase. He knows by experience that steam valve opening is same as it should be, press part vacuum/load is same for the quality of the paper and running machine condition. He goes towards wire part, & by observing the wire pit level, he finds that the level has gone down. He may conclude that freeness is higher, so he reduces the load on refiner and problem is solved. Else, wire pit level was OK. Now he goes at machine chest & looks into it or checks pulp from SRB by hand. He may feel that consistency of machine chest pulp has increased. He reduces the basis weight valve slightly & then the basis weight & moisture are controlled. This approach for basis weight control is given in figure-1.

This is a real life example observed & used by one of the author a few years back. Now we'll model this approach to decide for our automation

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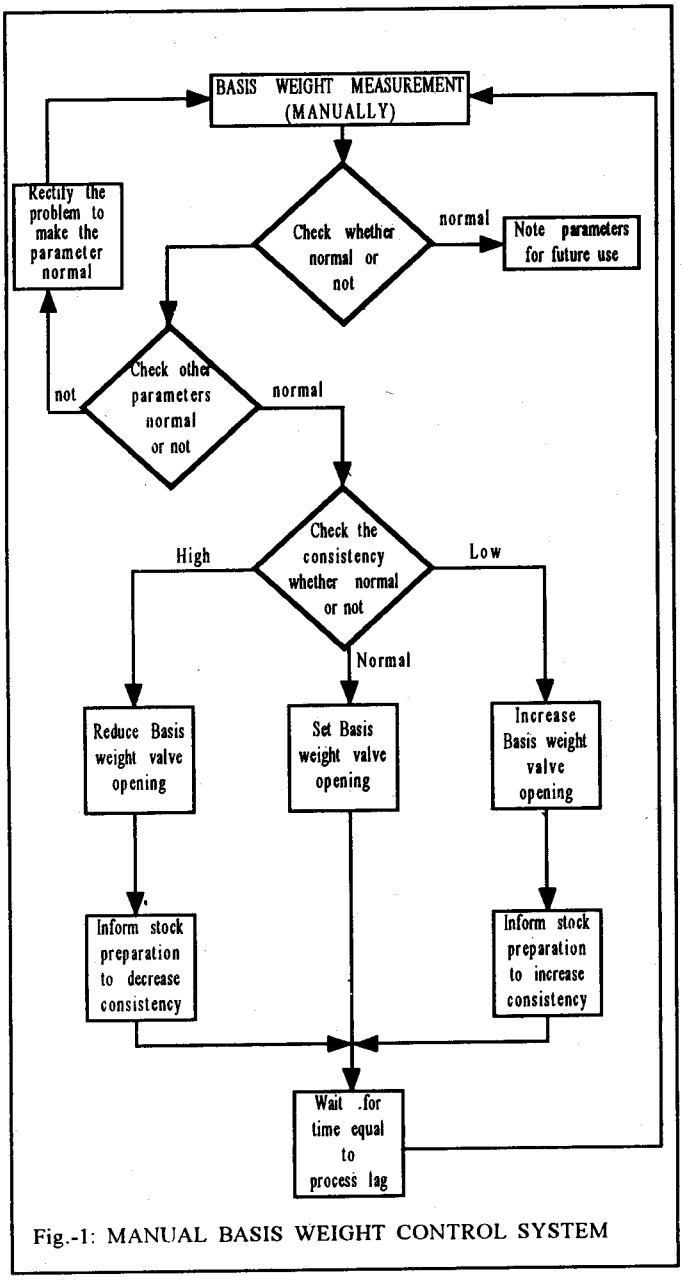

Fig.-1: MANUAL BASIS WEIGHT CONTROL SYSTEM

plan, Here we see that the operator observes basically two things - namely the change in paper properties (e.g. moisture, temperature, thickness etc.) indicating the possibility of basis weight variation, and consistency of pulp provided other machine parameters are same. Or in other words, to control basis weight, he uses a fuzzy formula or thumb rule (one half thread opening in basis weight valve results in an 1 gsm basis weight increase, for example) to decide upon the magnitude of basis weight valve throttling. With this background, we move to develop our control system.

As obvious, our control system should encompass

(1) Basis weight measurement

(2) Measurement & control of consistency

(3) Stock flow measurement and control

Out of these three, particularly the basis weight measurement is a costly affair, Now we can begin with two parameters namely stock consistency and flow. The flow through basis weight valve dose not vary so much as consistency does. So, we,ll control the consistency first. Say, for example, the flow rate is fixed. At this stage, a closer look at the material balance gives us a clear idea about the control advantages. The input, output and recirculation to the paper machine are listed in table 1.

Table-1

INPUT, OUTPUT AND RECIRCULATION TO PAPER MACHINE

INPUT	OUTPUT	RECIRCULATION
Stock from S.R. Box	Paper web to press part	Back Water (Recirculated)
	Trims to couch pit	Head Box recirculation
	Centricleaner rejects	Head Box overflow
	Pressure screen rejects	Secondary Centricleaner accepts
	Back water to saveall/ pulp mill	

From the above table it is clear that the fibre inputs are constant if the consistency is controlled. In case of output, paper web to press part and trims to pit are constant and the total of this two is equal to retention multiplied by stock quantity; Centricleaner and pressure screen rejects are comparitibily in much lesser quantity (of the order of 1%) and excess back water, which is going to saveall or pulp mill contains very low quantity of fibres. This way we can say that the output which is not utilised for paper making is in lower quantities and thus it effects the basis weight which is insignificant. It is possible to prove that in case the overall retention is 90%, 1% change in retention will result in 1.1% change in GSM, which is satisfactory.

Now, let us compare the above conclusion with change in consistency. For a 1% change in

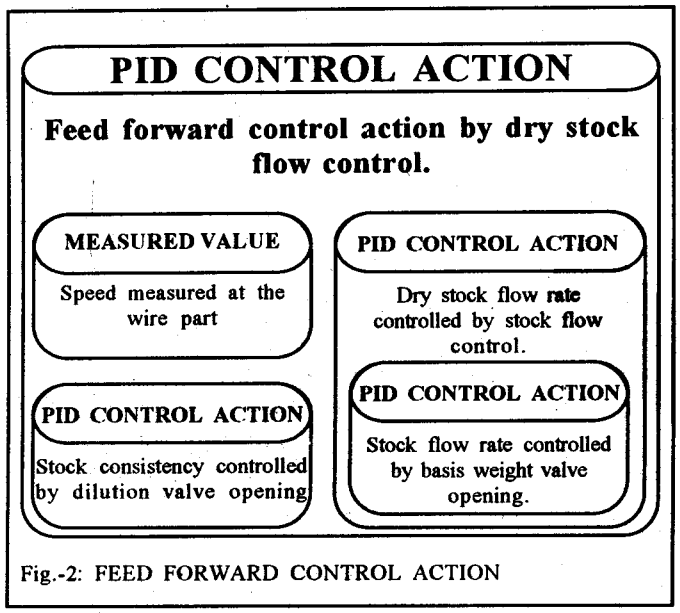

Fig.-2: FEED FORWARD CONTROL ACTION

consistency value, the direct effect on basis weight will be 1% additionally due to higher head box consistency the retention will increase and thus the total effect may be of the order of 2% or above. Here it is interesting to note that a 1% change in retention is likely less to occur than a 1% change in consistency particularly when the consistency is not controlled. With this exercise it is possible to conclude that the consistency is most important for basis weight control.

FEED FORWARD CONTROL

Feed Forward Control (figure-2) is basis control theory applied for basis weight control by most of the QCS systems. The theory may be explained as under

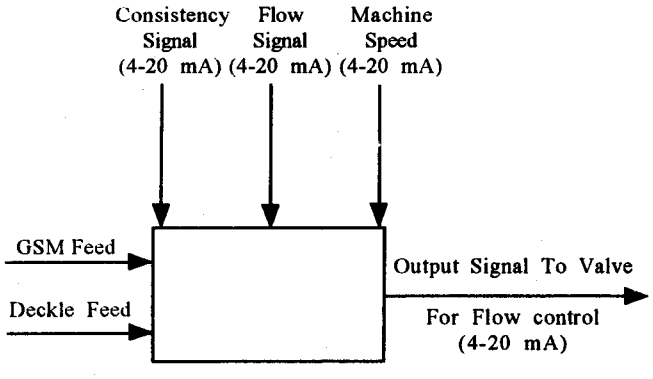

Fig.-3: Signal Flow Diagram for Feed Forward Control

Basis weight, at any instant is a function of following parameters-

SR Box consistency
Stock flow through basis weight valve
Retention on wire
Machine speed
Process time lag

The QCS system, initially controls with consistency of SR Box and then sets the basis weight valve to a precalculated value which is calculated as per the above parameters, Today, many mills are using this approach and finding it useful. The major advantage after the process time lag is that it checks the basis weight actually by means of scanner (Gamma rays sensor) if there is any difference between the desired value and the actual one, it regulates the basis weight valve to maintain a dry stock flow value (Stock flow through basis weight valve multiply by SR Box consistency) interpolated to give the desired basis weight.

The feed forward control action shown in figure-2 clearly indicate the components of a basis weight control systems. In most of the QCS systems this concept to use for basis weight control for small paper mills it is possible to develop such a system for basis weight control where basis weight is measured manually at an interval of about 1/2 to 1 hour and feed forward control action is used for controlling the basis weight. In case mill feels such a system too complicated and ordinary dry stock flow control can be used effectively. The following tabels II and III show the result of such a control on a high speed paper machine where basis weight measurement was done continuously by the scanner and the control was done manually by controlling the flow rate calculation to give the desired dry stock flow rate.

Table-II

Basis weight (desired) : 70
Machine Speed : 380 mpm
Consistency setpoint : 2.8%
Duration of Study : One shift

Consistency	Flow rate Calculated	Flow rate Maintained	Actual basis weight
2.85	294	293	
2.8	299	300	$70^{+1.0}_{-0.4}$ %
2.75	305	307	

Table-III

Basis weight (desired) : 60
Machine Speed : 360 mpm
Consistency setpoint : 2.9%
Duration of Study : 6 hours

Consistency	Flow rate Calculated	Flow rate Maintained	Actual basis weight
2.87	237	238	
2.9	235	235	$60^{+0.9}_{-0.6}$ %
2.94	231	230	

Today, many mills are using this approach and find it useful. The major advantage of this approach is that it needs only a investment of around couple of lakhs against around a crore for complete QCS system excluding field instruments.

Many people feel that with QCS the control is better. If we go in detail, we'll find that the control is exactly the same except that the QCS offers a continuous measurement of basis weight, and takes care of any speed change, consistency change or flow rate change instanteniously. Though this is important for high speed machine, on low speed machine we know that the consistency or flow rate variation does not effect much on basis weight and any speed change followed by basis weight value opening change does not affect much production loss due to off quality. In addition to above the advantage of the QCS system is that the sampling is not required and hence number of breaks per reel is reduced which is very important in case of reel order.

Here it is worthwhile to say that the controllers available today are much improved over older models. Comparable to older models of single input, single output PID controllers, today we have capabilities of arithmetic, binary & logical operations & can process several inputs & outputs at the same time. These provide facilities of even logical operations & can be used for advance interlocking requirements also.

The main objective to design the Basis Weight control system for small paper mills is the very low cost of system. On line scanner for big mill cost around Rs. 1.5 to Rs. 2 crore which is not affordable to small mills. But this basis weight control system cost for 60 TPD capacity plant is approximately Rs. 10 lacs. The pay back period of Rs. 10 lacs is about 4 months. The following instruments are incorporated in this system:

1. Consistency Transmitter (Blade type)
2. Dual Loop PID Controller
3. Basis Weight Valve
4. Dilution Valve
5. I/P Convertor
6. Magnetic Flow Meter
7. M/c Speed Transmitter and some hardware like cable etc.

The all instruments are available indigenuously except consistency transmitter. So repair and service are also affordable by small mills.

CONCLUSION

Basis weight control particularly when manufacturing reel orders is very important. The small paper mills who cannot afford costly QCS system will find feed forward technology highly beneficial for them.