Cross Direction Profile Unstability: Evaluation and Correction

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ABSTRACT

The machine direction basis weight control cannot be achieved properly if there is fluctuation in cross direction profile. Most of the time, the gsm of paper at a particular position, normally at the front or tender side, is considered to be a representative of average profile gsm. This paper explores the possibility of misinformation by the proposed method, and possible rectification of the problem.

INTRODUCTION

It was experienced in a big paper mill with a 250 TPD paper machine, having a deckle of 5 M that the profile variation remained within 2.5-3 GSM. One used to spend 4 hours per shift in rectification of profile to zero-zero level. Every time one has to come to DCS room, note down the profile as indicated by O-frame scanner, then to head box, adjust slice and then come back to check the effect of correction. After 2-4 hours, one was able to manage the profile variation within 0.5 gsm. The machine used to run well for some time and again the variations reappeared. This indicated that there was something happening somewhere either in the wet end or in the head box itself that create cross direction profile fluctuations. The mill had no consistency control, no flow control for basis weight valve automation and no on-line basis weight measurement system. The mill experienced the problem that the profile sometimes gets disturbed chaotically and unpredictably. Many a times, the gsm was geting disturbed (mainly to upper side), resulting in moisture in paper. In absence of any further clue, it was dicided to evaluate profile unstability considering the data taken for each and every roll in the mill.

Profile unstability evaluation

To analyse the profile data, the average of profile data values were substracted from individual values. The profile thus generated can be called as absolute profile, which indicates with magnitude whether a particular sample is heavier or lighter than the average. If the profile is stable, the values at a particular position in an absolute profile must be constant. To check whether values are constant or not, the positive difference between two adjescent values is computed. The lower this value is, the better stability of profile would be there. To explain mathematically let,

$W_{i,j}$ = gsm at ith location of roll no. j.

$W_{o,j}$ = average gsm of roll no. j.

$W_{i,j} = W_{i,j} - W_{o,j}$

= Absolute profile for roll no. j.

$S_{i,j}+1 = | A_{i,j+1} - A_{i,j} |$

= Fluctuation of profile in (j+1)th roll over the previous roll

To get a roll to roll information about stability, the average of S values in a particular roll may be taken. Mathematically, it is -

$S_{avg,j+1}$ = Average ($S_{i,j+1}$, for all i values)

It is also possible to evaluate the gsm fluctuations at different position in cross direction. As a matter of fact, this is very much useful in isolating the probable causes for profile unstability. This could be written as

$S_{i,avg}$ = Average ($S_{i,j+1}$, for all j + 1 values)

Sample data and calculations for determination of profile unstability are indicated in Table 1.

Table 1. Profile unstability calculation: sample data

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Tender side										Dirive side			
2			Cross direction profile (w)											
3	1	2	3	4	5	6	7	8	9	10	11	12	Average	Variation
4	48.8	47.6	47.4	49.4	49.4	48.2	49.0	49.8	48.4	47.8	47.6	48.6	48.5	2.4
5	48.0	46.4	48.0	48.6	48.4	48.8	48.8	47.8	47.8	46.6	48.6	47.6	48.0	2.4
6	50.6	48.0	48.0	49.8	49.6	49.0	49.2	50.6	49.2	49.0	48.6	49.6	49.3	2.6
7														
8	Absolute profile (a)													
9	0.3	-0.9	-1.1	0.9	0.9	-0.3	0.5	1.3	-0.1	-0.7	-0.9	0.1		
10	0.0	-1.6	0.0	0.6	0.4	0.8	0.8	-0.2	-0.2	-1.4	0.6	-0.4		
11	1.3	-1.3	-1.3	0.5	0.3	-0.3	-0.1	1.3	-0.1	-0.3	-0.7	0.3		
12														
13	Profile unstability (s)												S (avg)	
14	0.3	0.7	1.1	0.3	0.5	1.1	0.3	1.5	0.1	0.7	1.5	0.5	0.7	
15	1.3	0.3	1.3	0.1	0.1	1.1	0.9	1.5	0.1	1.1	1.3	0.7	0.8	
16														
17	Average unstability													
18	0.8	0.5	1.2	0.2	0.3	1.1	0.6	1.5	0.1	0.9	1.4	0.6		

EXPERIMENTAL

The data were collected for a number of rolls. Over a period of time, more than 100 rolls were analysed. The samples were cut in 40x25 (MDxCD) cm size and weighted on an electronic balance having a least count of 0.02 gm. This way, GSM measurement was taken upto 0.2 gsm accuracy. The data were analysed and plotted to get detailed information about the machine capability to produce stable gsm profile.

RESULTS AND DISCUSSION

It was observed that the major fluctuation was confined to first 20% for profile from the drive side. As the stock enters from the drive side, it was obvious that the reason could have been from the wet end, either pressure screen, or centricleaner or fan pump itself. To study the flow pattern, the head box manifold flexible pipes were replaced with new transparent ones. On visual examination, in some of the pipes towards drive side, air bubbles were visible. The head box being an open type, no overflow was there. In the head box inlet pipeline, an open vent line was provided. The venting line size was kept same as that of inlet line for easier escape of air. This reduced the problem remarkably, but not fully. Another line was now provided at the pressure screen inlet, of course, with a valve throttled for minimum flow, and the results were very encouraging. The fluctuations reduced significantly throughout the deckle.

The problem of average gsm fluctuaion, i.e. MD gsm variation was still there. For this, a sampling value was provided at the head box inlet, and kept open slightly. A large number of samples were collected at small interval of 15 seconds, and consistency of each sample was checked individualy. It was surprising to note that during the one hour study, thrice the consistency shot up for about 1.5-2 minutes and then came back to the normal level. The fan pump load was found to be constant during this period. Later on it was observed that the centricleaner pit consistency seemed to be higher than normal, i.e. in between centricleaner reject consistency and dilution water consistency. As a matter of fact, the pulp slurry was getting floated due to entrained air, and after some time, when the air gets released, this slurry settled down due to gravity resulting in increased consistency in secondary centricleaner inlet and outlet and hence the consistency at input to fan pump.

The above phenomenon was more predominant in case of hard sized papers, where the possibility of foaming and hence air entrainment is more. To get rid of this, the secondary centricleaner accepts were treated separately and send to broke chest after thickening. It proved to be very encouraging. The steam valve adjustment, which was earlier done three or four times in an hour, now had to be done once in two hours or even less. A separate study revealed that this arrangement even reduced the power consumption by approx. 100 units per day. When the profile unstability data was collected again, it was in the order of 0.4-0.5 gsm. With the weighting system with a least count of 0.2 gsm, these values can be considered to be very good.

CONCLUSION

Cross direction profile data can be used effectively for studying the paper machine wet end capability to maintain gsm under control. A close study of unstability analysis not only reveals the problem but also suggests possible reasons for the problem. It is also possible to draw a number of consequent samples from a roll and analyse the data for profile analysis. If there is some pressure fluctuation due to pressure screen or fan pump, the resultant gsm fluctuation can be observed, for possible corrective actions.