Wet web properties of some indigenous pulps and possibilities to improve the paper machine runnability for Rice straw pulp

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ABSTRACT

Rice straw pulp on a fourdrinier machine with open draw often poses runnability problem. Relatively slower machine speed coupled with frequent breaks results in excessive prod ction losses. Laboratory studies aimed at improving the machine runnability for rice straw pulp included investigations of the influential factors like wet web tensile, wet web elongation & water retention value The pulps taken for the studies were actual mill pulps (bleached) of rice straw, softwoods, rags, eucalypt and mixed woods blended with bamboo Rice straw pulp had 0 78 Nm/g wet web strength at 20% dryness which was comparable to other pulps Its wet web elongation at 20% dryness was relatively lower i e. 11 0% as compared to 17.5% for the softwood pulp, 27.0% for the pulp from rags and almost equal to eucalypt pulp i e. 10 5%. The water retention value 204% for rice straw pulp was higher than any of the pulps studied From the known behaviour of the pulps of different raw materials it was found that moderate wet web tensile (WWT), high wet web elongation (WWE) and low water retention value (WRV) were desirable for better machine runnability Rice straw pulp which have relatively lower wet web elongation & higher water retention value could be improved to a certain extent to achieve better machine runnability by blending the pulp with appropriate quantity of long fibred pulp from softwoods or rags. Recent trends of employing different types of additives have been reported in literature to be quite effective in improving the machine runnability. Other possible methods could be adoption of suitable cooking methods/conditions where the degree of cooking is precisely optimised by monitoring the water retention value, and/or employing suitably modified design of wire part to accommodate the slow draining stock

Introduction :

Paper machine runnability has a direct impact on the final production. Long fibred pulps generally give very good machine runnability followed by short fibred pulps from various hardwood species. Pulps from agricultural residues like bagasse, wheat and rice straw are still inferior. Generally paper making from agro-pulps encounters relatively more frequent wet end breaks than for wood pulps furnishes. This is usually ascribed to the weaker wet web strength of these pulps (1). Couch breaks are more common in open draw machines running with agro pulps as the moist web is not at every point strong enough to support its weight and overcome the inherent dynamic and adhesive forces during the transfer of the web from one section to the next Water removal is also an important aspect which is affected mainly by machine design, speed & stock quality. If the stock is too difficult to dewater machine speed is limited due to crushing, softdraws, instability, breaks, difficulty in rethreading after breaks or dryer capacity. Measurement of dewatering resistance of pulps could be carried out by freeness tester, however, another method based on centrifuging wet pulp is relatively better as it simulates mill conditions more closely (2, 3). This method first introduced in textile mills gives a measure of the quantity of water which remains intact with the fibers even after centrifuging

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TABLE—1

Wet web tensile index of different pulps at 20% dryness

Particulars	Rag	Soft wood	Mixed woods + Bamboo (90:10)	Eucalypt	Rice straw
CSF, Ml	365	300	300	300	155
Wet web tensile (WWT) Index at 20% dryness (Nm/g)	0.74	0.80	0.87	0.92	0,78

TABLE—2

Wet Web Elongation of different pulps at 20% dryness

Particulars	Rag	Soft wood	Mixed woods + Bamboo (90:10)	Eucalypt	Rice straw
CSF, ml	365	300	300	300	155
Wet web elongation (%) at 2[illegible]% dryness	27.0	17.5	12.3	10.5	11.0

TABLE—3

Water Retention Value of Different Pulps

Particulars	Rag	Soft wood	Mixed woods + Bamboo (90:10)	Eucalypt	Rice straw
CSF, ml	365	300	300	300	155
Water retention Value (%)	130	154	183	171	204

and could only be removed by drying at elevated temperature. This value is known as Water Retention Value (WRV). It is affected by pulping process & pulp yield, degree of beating, drying and rewetting and treatment with swelling agents & other chemical additives.

Due to the typical characteristics of fibres while manufacturing paper with agro pulps, the required dryness before leaving the couch is not achieved. Some studies on wet web properties of bamboo and mixed hardwood chemical & chemi-mechanical pulps were carried out by Pant et al (4). In the present studies, wet web properties & the factors affecting the wet web behaviour of mill chemical pulps of different varieties i e. rice straw, Eucalypt, mixed woods blended with bamboo, softwoods and rags were investigated. The aim was to improve the rice straw pulp for better machine runnability through blending different proportions of various pulps.

Results and Discussion :

Wet web properties of different pulps

Wet web properties i. e. wet web tensile, wet web elongation and water retention values of different pulps are shown in Tables 1, 2 and 3 respectively. At 20% dryness wet web tensile index of rice straw pulp is 0.78 Nm/g which is comparable to softwood pulp 0.80 Nm/g and slightly more than even the rag pulp used which had a value of 0.74 Nm/g. These values of WWT index alone do not indicate correlation with the machine runnability of these pulps as softwood and rag pulps are definitely superior to rice straw pulp but have comparable WWTI.

There is however marked difference in the values of web elongation at the same 20% dryness. (Table-2). Eucalypt pulp has the minimum value of 10.5% almost equal to 11.0% for rice straw. The rag pulp has the maximum value 27 0% followed by softwood 17.5%. This is expected as the long fibred pulps will naturally have higher elongation.

Water retention values of these pulps (Table-III) have also wide variation. Rice straw pulp has the maximum 204%, rag pulp has the minimum 130% and softwood pulp has 154% WRV. This clearly suggests that the dryness of the web after couch will be lesser in case of Rice straw pulp which means low wet web strength resulting in more frequent breaks.

Hand sheets prepared from different pulps pressed under similar conditions of applied pressure & time had different dry contents, (Fig. 1).

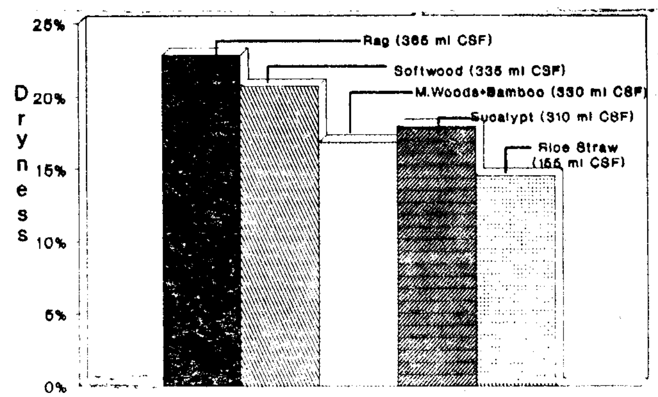

Fig. 1: Change in Dryness on Pressing Wet Handsheets of Various Pulps at Constant Load & Time.

Rice straw pulp had minimum dryness around 17 5% compared to 22.8% for rag pulp confirming the fact that rice straw pulp had more affinity towards water & thus difficult to drain The high water retention value of the rice straw pulp is its characteristic feature due to higher hemicelluloses within the pulp & large surface area due to higher amount of fines, Panda (5), Roy et al (6).

Blending of pulps

A perusal of the Tables I, II and III suggest that for better machine runnability like in the case of softwood, rag and wood pulps, in general, the pulp should have high tensile energy absorption (which is a function of wet web tensile and elongation), and low water retention value. For rice straw pulp both these parameters are unfavourable. Since these properties are additive a suitable blend of pulps may improve the situation. Rag pulp and softwood pulp separately in different proportions were blended with rice straw pulp.

The blend consisting of 80% rice straw pulp and 20% softwood pulp has WWTI 0 92 Nm/g (Table 4) which is equal to that for eucalypt pulp (Table 1), wet web elongation 12 0% which is near to that for mixed woods plus bamboo pulp i. e 12.3% (Table 2) and water retention value of 184% which is again near to that for mixed woods plus bamboo pulp 183% (Table 3), thus indicating that a blend of 80% rice straw and 20% softwood should be nearly similar to the above two pulps i, e. eucalypt and mixed woods with bamboo pulps from the machine runnability angle (factors other than wet web properties ofcourse if not considered) When the same rice straw pulp was blended with rag pulp, in the proportion 90:10, it yielded similar values of WWTI, WWE & WRV (Table 5) Higher proportion of softwood or rag pulp may yield still better results.

Other Possibilities

The important factor for improving the machine runnability for rice straw pulp is to reduce its water retention value so that drainability improves and the web after couch becomes more drier. In view of the fact that hemicelluloses and fines content in the pulp affect the WRV, modified pulping and bleaching methods may produce the desired effect. The optimization of pulping and bleaching parameters may then be carried out by monitoring the WRV of the pulp Modification in the wire part is another area which can help in improving the drainage Recent developments in chemical additives (electrolytes dual polymers etc.) have also been reported to be very helpful in improving drainage & subsequently machine runnability (7,8).

Material & Methods

Pulps

Bleached chemical pulps from rice straw, eucalypt (mainly eucalyptus tereticornis), mixed woods blended with bamboo in the ratio 90:10 and rags and softwood were taken for the studies. Softwood pulp was imported and was in the form of sheets This pulp was rewetted for studies Other pulps were obtained from mills in moist stage & had not undergone drying operation.

Beating

All the pulps except that of rice straw which already had low freeness were beaten in PFI mill as per the method given in ISO DP 5264 Part II. Freeness values were determined as per ISO DP 5267.

Measurement of wet web strength

The pulps after freeness determination were further diluted to 0 18% consistency and wet web strips measuring 20 mm wide and 180 mm in length were made by placing a stainless steel mould on top of the wire mesh of British sheet making machine during hand sheet preparation. These strips were then pressed by placing 3 kg. weight for 40 to 60 seconds before transferring them on to the blotter. For getting a wider range of dryness values these strips were subjected to further pressing and changing the blotters. The strips after pressing were tested for wet web tensile index and elongation using L&W wet web strength tester as per SCAN C : 31 : 77 method. Dryness values of the tested strips were determined subsequently.

Measurement of Water Retention Value (WRV)

Water Retention Values were determined using a centrifuge machine—Labofuge—III equipped with steel tubes and capable of attaining a speed of 6000 rpm. Each tube was 5.5 cm in diameter and was fitted with a short inner sleave for holding a coarse grid supporting a 100 mesh screen about 4 cm. above the bottom of the tube. To start an experimental run samples of moist pulp weighing equivalent to 1 g o d. were placed on the screens and centrifuged at 5500 rpm for 10 minutes. The pulp samples which were still moist were taken out and immediately weighed. These were then dried in an oven at 105°C & moisture content determined. From this value the water retained by the pulp after centrifuging as percentage of the o.d. fibre was taken as water retention value.

Conclusions :

Wet web tensile index (Nm/g) values at 20% dryness of rice straw pulp (0.78), softwood pulp (0 80) eucalypt (0.92) mixed woods pulp blended with bamboo pulp, in (90:10) ratio (0 87) and rag pulp (0.74) are not very much different. This implies that wet web tensile index alone is not sufficient to predict the paper machine runnability aspect of the pulp.

Wet web elongation values (%) of these pulps i. e. Rag pulp (27 0), softwood pulp (17.5) mixed woods pulp b ended with bamboo pulp (12.3) eucalypt (10.5) and rice straw (11.0 indicate some relation with the paper machine runnability behaviour as the values are higher for good pulps and lower for bad pulps.

Water retention value of rice straw pulp was highest 204% as compared to all other pulps studied. Due to higher water retention value of rice straw, the wet web having rice straw pulp as the main furnish component will achieve relatively lesser dryness after the couch due to its stronger affinity for water. At this lower dryness the tensile & elongation will also be relatively lower than those at 20% dryness strongly indicative of poor machine runnability of rice straw pulp.

The laboratory scale studies show that a simpler way to improve machine runnability of rice straw pulp would be to blend it with about 10% rag pulp or 20% softwood pulp The wet web properties i. e. wet web tensile index, wet web elongation and water retention value of such blends improve and become comparable to eucalypt or mixed woods blended with bamboo pulps employed in the studies. The over all paper quality will also improve substantially.

TABLE—IV
Wet Web Properties of Rice Straw and Soft Wood Pulp Blends

Particulars of the pulp blends	CSF ml	At 20% Dryness		Water Retention Value (%)
		WWT Index Nm/g)	wet web Elongation (%)	
100% Rice Straw	155	0.78	11.0	204
90% R.S. + 10% S W.	180	0 87	12.5	196
80% R.S +20% S W.	190	0 92	12 0	184
70% R.S + 30% S W.	230	0 94	13 0	180
60% R.S.+40% S W.	235	0.97	14 3	176
1000% Soft Wood	365	1.06	17.4	171

TABLE—V
Wet Web Properties of Rice Straw and Rag Pulp Blends

Particulars of the pulp blends	CSF ml	At 20% Dryness		Water Retention Value %
		WWT Index Nm/g	wet web Elongation %	
100% Rice Straw	155	0.78	11 0	204
90% R.S +10% Rag	220	0.78	13 0	185
80% R.S.+20% Rag	220	0.77	14 4	184
70% R.S +30% Rag	230	0.77	14.4	172
100% Rag	365	0.74	27.0	130

References :

1. Shi-Jun Kuang and Ingrid Fineman—How to improve the runnability of wheat straw pulp. International nonwood fibre pulping and paper making conference, Beijing, People's Republic of China, July 11–14th, 1988.

2. A. J. Barnet and D M. Harvey—Stock properties required for high speed papermachines, Pulp and Paper Canada, Vol. 80, No. 4/April 1979.

3. A. M. Scallan and J. E. Carles—The Correlation of the water retention value with the fibre saturation point, Svensk Papperstidning arg. 75 Nr. 17.30 September 1972.

4. Moorthy, K. S., Mantry, T. C. and Pant, R.—Studies on the wet web properties of some Indigenous Pulps, IPPTA Vol. 22, No. 3, Sept.' 1985.

5. Abanish Panda—Water Retention Value Test as a control parameter of the Beating Process, Indian Pulp and Paper, July, 1967.

6. Roy, T. K., Subrahmanyam, S. V. etal—Paper making Properties of Wheat Straw Fibre, CPPRI Research Report No. CPPRI/RR-32/92.

7. Lars Wagberg etal—Effects of Retention aids on Retention and Dewatering of Wheat Straw Pulp, Tappi April 1990, 177.

8. Wu Subin, 'The Failure envelope' curve of the soda-AQ wheat straw pulp, Second International Non-wood Fibre Pulping and Paper Making Conference—April 6-9, 1992 Shanghai, People's Republic of China.