Semichemical Pulping of Bagasse

MANTRI, T.C.*, SHARMA, Y.K. & RAO, A.R.K.*

SUMMARY

Pulping studies on depithed bagasse were carried out using two-stage cooking process according to Simon Cusi method using sodium hydroxide and/or sodium sulphite in the first stage and with and without chemical additon in the second stage. The pulps were bleached by direct hypochlorite in single and two stages. Bagasse pulps were blended with commercial bleached bamboo pulps in the ratio of 70:30, 50:50 and 30:70. The strength properties of bagasse semichemical pulps are satisfactory. The opacity, which is slightly low, needs to be improved.

INTRODUCTION

Bagasse, the fibrous residue of sugar cane is produced in large quantities in various parts of India. It contains about 48.5% fibrous materials and pith, 48% water, some residual sugar and 0.5% minor constituents. Bagasse after suitable treatment, is used for production of paper especially in those countries where wood suitable for pulping is not readily available. In India, bagasse is not freely available for the production of paper as most of it is used as fuel in sugar mills. If alternative fuels are made available, large quantities of bagasse will be available to the paper industry.

There are a number of publications dealing with laboratory research on semichemical and chemimechanical pulps from bagasse [1,2,3,4].

The investigation undertaken for production of newsprint grade pulps from bagasse using two stage process are reported in this paper.

EXPERIMENTAL

RAW MATERIALS

Depithed bagasse from Mandya National Paper Mills was used in this investigation. The moisture content was between 8.5% and 9.5%.

PULPING METHODS

Cooking was carried out using two stage process according to the Simon-Cusi method. In the first stage bagasse was cooked with sodium hydroxide and sodium sulphite separately and together at 170°C for periods of 15 or 30 minutes as specified in table 1. The cooked bagasse was disintegrated for five minutes in a British disintegrator and screened on a Lambort screen having a slot width of 0.35mm. The coarse f action retained on the screen plate was collected for second stage cooking. The fraction passing through screen plate was dewatered and designated as "First stage screened pulp".

The second stage cooking was carried out with the coarse fraction both with and without further chemical add tion at 130°C for 15 or 30 minutes as the case may be. The cooked stock was defiberized in a 12" Sprout Waldron disc refiner using disc No, 17577-B in a single pass at a clearance of 0.05 mm. The refined stock was screened on the lambort screen. The pulp passing through the screen was collected and designated as "Second stage screened pulp".

Screened pulps collected from the first and second stage c oking were subjected to Kappa number and screened yield determination. Pulp brightness at each stage was measured using an Elrepho Brightness Tester according to the SCAN Method P3:75. The weak black liquor was also analysed for residual active alkali, and pH according to TAPPI Method (T624-ts-68). The pulping data are presented in Table 1.

UNBLEACHED PULP EVALUATION

The pulps were beaten in a PFI mill according to ISO Standard (DP-5264) to various freeness levels. Sheets making and testing were carried out

*Central Pulp And Paper Research Institute,
Vishal Bhawan, 95, Nehru Place,
New Delhi

according to ISO Standard (DP 5269:5270). The sheets were conditioned at 65±2% RH and 27±1°C. The pulp evaluation results are given in table 2. Unbleached pulp wet web tensile index at 20% sheet dryness was measured according to SCAN proposed method (SCAN P 18 × M).

BLEACHING AND EVALUATION OF BLEACHED PULP

Bleaching was carried out with single stage and two stage hypochlorite sequence. The parameters for the individual bleaching stages are given in Table 4.

BLENDING

Bagasse pulps were beaten to freeness of 125 CSF (ml) and commercial bleached bamboo sulphate pulp was beaten to 385 CSF (ml). Mixtures of 70:30, 50:50 and 30:70 of bagasse to bamboo pulps were prepared. Blended pulps were evaluated for physical and optical properties using the procedures described for bagasse pulps.

RESULTS AND DISCUSSIONS

Mixture of sodium hydroxide and sodium sulphite was more effective pulping agent than either of these used separately (Table 1), with regard to screened pulp yield and Kappa number, Addition of more cooking chemicals and increase in the cooking times reduced Kappa number with minor effect on the screened pulp yield.

Cook No. 4 (Table 1) though was two stage cook, differs from the remaining in the fact that cooking liquor was added in the second stage (instead of water) to maintain alkaline conditions and the cooking time in each stage was increased from 15 minutes to 30 minutes. It would be expected that pulp from cook no. 4 should have lower Kappa number due to increased cooking chemicals and longer cooking time.

The strength properties of unbleached pulps prepared with different cooking condition were found to vary over a wide range (Table). Tear index values of 3.1 to 3.8 were obtained for bagasse cooked without chemical addition in the second

TABLE—1 SEMICHEMICAL PULPING DATA

Particulars	Unit	Semi-Chemical Cooks			
Cook Nos.		1	2	3	4
First Stage (I)					
(a) Chemical					
(1) NaOH	%	8.0	—	—	—
(2) $Na\ SO_3$	%	—	8.0	—	—
(3) 50% NaOH + 50% $Na\ SO_3$	%	—	—	8.0	—
(4) 80% NaOH + 20% Na_2SO_3	%	—	—	—	8.0
(b) Cooking temperature	°C	170	170	170	170
(c) Cooking time	min.	15	15	15	30
Second Stage (II)					
(a) Chemical					
80% NaOH + 20% Na_2SO_3	%	—	—	—	2.0
(b) Cooking temperature	°C	130	130	130	130
(c) Cooking time	min.	15	15	15	30
Yield					
Ist stage screened pulp	%	16.6	7.9	9.1	16.6
IInd stage screened pulp	%	61.7	71.8	65.0	57.6
Total screened pulp	%	77.5	79.7	74.1	74.2
Rejects	%	1.5	1.3	5.9	1.9
Total yield	%	79.8	81.0	80.0	76.1
Kappa number					
I + II mixed pulp	%	103.1	106.2	74.2	64.0
Unbleached pulp brightness					
I + II mixed pulp		20.0	26.0	27.5	20.7
Spent liquor					
Ist stage : pH		9.5	6.3	7.8	9.1
R.A.A. as Na_2O	gpl	0.62	—	0.12	0.31
IInd stage : pH		—	—	—	9.5
R.A.A. as Na_2O	gpl	—	—	—	0.22

Note : All chemicals are expressed as sodium hydroxide.
Liquor to material ratios in Ist stage and IInd stage were kept at 4 : 1 and 5 : 1 respectively.

stage (cook nos. 1 to 3). When chemicals were used in the second stage, the tear index was 5.6. The pulp strength properties improved after bleaching. The specific scattering coefficient value was low. The wet web tensile index values for both unbleached and bleached pulps (Table 3) show little variation.

It is evident from the examination of the results (Table 4) that the single stage bleaching carried out on samples from cook nos. 1, 2 & 3 produced little improvement in brightness.

It was considered that the poor response to bleaching might have been due to possible condensation of lignin during the second stage cook with water. Though addition of Hypochlorite produced some improvement in brightness during the early stages of bleaching there was a colour reversion after 20-30 minutes. It was decided therefore to apply the hypochlorite in two stages, filtering and washing at the end of the first stage. The two stage bleaching was much more effective giving pulp of Elrepho brightness of 48.8% (cook no. 4).

Considering 70:30 Bagasse : bamboo blends, it can be seen (Table 6) that the presence of 30% of bamboo pulp gives little improvement in tear index. However, more bamboo pulp has to be included in the furnish to produce a significant improvement in tearing strength. The bagasse bamboo blends showed little change in opacity and scattering coefficient. It is evident that the presence of 30% of bamboo pulp improves the wet web tensile index (Table 3). Trials have been made to find out the effect of the addition of filler in an endeavour to improve the optical properties. The data on these pulps are given in the Table 7. The pulp processed without filler and with filler were compared. Pulp with filler gave improvement in opacity and scattering coefficient values but lowered the strength properties.

Wet web properties of bleached bagasse pulp and eucalyptus cold soda pulps have been shown in Table 8. It can be seen that wet web strength of bagasse pulp is relatively high compared to eucalyptus pulp. TEA index is also favourable.

TABLE—2 STRENGTH CHARACTERISTICS OF SEMICHEMICAL BAGASSE PULPS

Pulp cook no.	Freeness CSF	Bulk cm^3/g	Burst index $kPa.m^2/g$	Tensile index Nm/g	Stretch %	Tear index mNm^2/g	K.M. fold log	Air resistance s/100 ml
1.	280	1.95	1.30	23.0	2.5	3.85	0.88	124
	104	1.72	1.75	32.0	3.5	3.55	1.22	475
2.	405	2.33	0.55	16.0	1.7	3.10	—	12.7
	180	2.05	0.70	20.0	1.6	2.90	—	43.8
3.	325	2.26	0.70	17.0	2.5	3.60	0.48	21.4
	120	1.99	1.15	25.0	3.4	3.55	0.70	155
4.	455	1.63	1.60	28.5	4.1	5.60	1.40	66
	145	1.39	2.95	48.5	4.6	5.05	2.10	1007

TABLE—3 INITIAL WET WEB TENSILE INDEX OF PULPS AT 200 CSF

Pulp Cook No.	Wet web tensile index Nm/g		
	Unbleached pulp	Bleached pulp	30 : 70 Bamboo Bagasse blend
1.	0.32	0.25	0.44
2.	0.40	0.32	0.33
3.	0.26	0.39	0.49
4.	0.38	0.39	0.63

TABLE—4 BLEACING CONDITIONS FOR PULPS

Cook Nos		1	2	3	4
Kappa No. (mixed pulp)		103.1	106.2	74.2	64.0
First Stage Hypochlorite					
Hypochlorite added as Cl_2,	%	14.0	14.0	14.0	8.0
Hypochlorite consumed,	%	13.97	13.98	13.97	8.0
Second Stage Hypochlorite					
Hypochlorite added as Cl_2,	%	—	—	—	6.0
Hypochlorite consumed	%	—	—	—	6.0
Pulp Yield					
Unbleached pulp basis	%	96.7	94.9	98.2	93.1
A. D. raw Material basis	%	77.3	76.0	78.6	71.3
Brightness Elrepho	%	30.6	31.2	31.8	48.8

TABLE—5 STRENGTH CHARACTERISTICS OF BLEACHED SEMICHEMICAL BAGASSE PULPS (COOK No. 4)

Freeness CSF	Bulk	Burst index	Teasile index	Stretch	Tear index	K. M. Fold	Air resistance	Elrepho brightness	Opacity	Specific scattering coefficient
ml	cm^3/g	$kPam^2/g$	Nm/g	%	mNm^2/g	log	s/100 ml	%	%	m^2/kg
320	1.30	2.8	42.5	4.4	5.3	1.8	1300	46.0	75.2	17.9
145	1.17	3.5	54.0	4.7	5.0	2.2	1800	41.9	76.1	16.1

TABLE—6 STRENGTH CHARACTERISTICS OF BAGASSE—BAMBOO BLENDS

Pulp blend	Freeness CSF	Bulk	Burst index	Tensile index	Stretch	Tear index	K.M. Fold	Air resistance	Elrepho brightness	Opacity	Specific scatt. coeff.
	ml	cm^3/g	$kPam^2/g$	Nm/g	%	mNm^2/g	log	s/100ml	%	%	m^2/kg
Cook No. 4 Blends Bagasse:Bamboo*											
100 : 0	125	1.28	3.50	48.0	5.5	4.80	1.67	1800	45.7	80.8	14.1
70 :30	140	1.29	3.50	48.0	5.9	4.90	2.02	1800	48.4	82.0	17.6
50 :50	210	1.35	3.30	43.0	5.8	5.30	1.64	274.0	49.9	81.6	20.6
30 :70	250	1.37	2.80	42.0	5.5	5.75	1.62	125.0	55.8	82.2	23.8
0 :100	385	1.44	2.25	33.0	4.6	7.10	1.32	11.0	68.1	77.7	25.5

* Commercial bamboo pulps used.

TABLE—7 STRENGTH CHARACTERISTICS OF BLAECHED SEMICHEMICAL BAGASSE PULPS

Sample particulars	Freeness USF	Bulk	Burst index	Tensile index	Stretch	Tear index	K.M. Fold	Air resis-tance	Elrepho bright-ness	Opacity	Specific Scatt. Coeff.	Ash
	ml	cm^3/g	$kPam^2/g$	Nm/g	%	mNm^2/g	log	s/100ml	%	%	m^2/kg	%
Bagasse Cook No 4												
*Bleached pulp (without filler)	320	1.30	2.8	42.5	4.4	5.3	1.8	1300	46.0	75.2	17.9	3.7
	145	1.17	3.5	54.0	4.7	5.0	2.2	1800	41.9	76.1	16.1	3.7
*Bleached pulp (with 10% filler)	320	1.30	1.9	34.5	3.3	4.8	1.3	452	43.5	82.3	21.2	10.1
	145	1.18	2.6	42.5	4.2	4.6	1.7	1800	41.7	79.9	18.4	12.2

*100 gsm sheets were prepared with circulation and opacity figures were calculated on 60 gsm.

TABLE—8 WET WEB PROPERTIES OF BLEACHED SEMICHEMICAL PULPS AT 20±1% DRYNESS

Particulars		CSF	Initial wet web tensile index	TEA index
	gsm	ml	Nm/g	mNm/g
1. **Bagasse (Cook No. 4)**				
a. Bleached pulp (without filler)	100	145	0.66	42.6
b. Bleached pulp (with 10% filler)	100	145	0.44	33.0
2. **Eucalyptus species (cold soda pulp)**				
E. grandis	100	105	0.28	5.1
E. globulus	100	105	0.55	23.5
E. tereticornis	100	100	0.15	4.4

CONCLUSIONS

1. Two stage pulping process produces a good quality pulp in the high yield range though warrants further study on the pilot plant.
2. Two stage hypochlorite bleaching process is much more effective than single stage bleaching using the same amounts of available chlorine. Optimization of pulping and bleaching conditions can result in pulps having a satisfactory brightness for use in newsprint furnish. The opacity of bagasse pulp is to be improved.
3. The addition of 30% bleached bamboo pulp produces little improvement in tearing strength but wet web tensile strength is increased. More detailed studies will be required to determine the best way to process the pulps and the most suitable bagasse-bamboo blends.
4. Addition of filler to the pulp showed an improvement of opacity and scattering coefficient while strength properties were slightly reduced.

ACKNOWLEDGEMENT

The technical assistance of Shri V. Raghunath, Shri Y. V. Sood and Shri T. K. Roy is gratefully acknowledged.

REFERENCES

1. Dugal, H.S.; Appita **29** (4) :262–71.
2. Samaniego, R.; et. al.; Proc. Intern. Sec. Sugar Cane Technologies, XV Congress 3, 1821–29 (1974).
3. Garayblas, L.E.M. et. al.; *Sugar News* (Phillipines). **46** (10): 467 (October (1970).
4. Janci, Jea, Bulletin Pulp Paper Res. Inst. (Bratislava), X/I (1968).