# Bleaching of bamboo cold soda pulps

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#### SUMMARY

In the present investigations different sequences were tried for bleaching of bamboo Cold Soda pulps Bleaching response of bamboo pulps is poor. The initial brightness of unbleached pulp is very low (19 4% ISO). Even with 25% hypochlorite, brightness achieved under normal conditions is only 45%. Brightness development Is rapid in initial stages and then decreases. So, bleaching time should not exceed more than necessary for complete exhaustion of hypochlorite which in the case of cold soda pulps is very short. Pre-So<sub>2</sub> or Pre-acid treatment improves the brightness by 2-3 points. Pretreatment with a dye (victoria blue) though reduces the yellowness of the pulp. does not improve the bleaching response significantly on further two-stage bleaching with hypochlorite. Pretreatment with alkali at 80°C, improves the brightness the brightness.  $E_3$  ( $P_{0.5}$ )—H $_{10}$ —H $_{10}$  sequence gives brightness of about 48% ISO. Brightness increase is invariably accompanied by yield loss, For increasing the brightness by 6-7 points about 5-6% yield has to be sacrifised.

Bleaching studies were carried out on bamboo cold.soda pulp, with a view to attain a brightness of about 50% ISO, for use in making newsprint. The present investigations were undertaken at the instance of the National Newsprint and Paper Mills Limited, Nepa Nagar. Results of the laboratory investigations are presented in this report.

### **RESULTS AND DISCUSSIONS**

The Unbleached pulp characteristics were as below :---

Kappa number of the pulp	:	158	
Brightness of the pulp % ISO	:	19.4	
Yellowness of the pulp %	:	53.8	

The analysis of the pulp is given in Table 1.

TABLE-1 PROXIMATE ANALYSIS OF BAMBOO COLD SODA PULP

_		The second se
S.NO.	Particulars	% on OD pulp
1.	Ash	2.50
2.	Silica	1.20
3.	Solubility in	
	(i) Cold water	2.74
	(ii) N/10 sodium hydroxide	11.36
4.	Klason lignin*	23.31
5.	Acid soluble lignin	<b>0.9</b> 0
6.	Holocellulose	71.14
7.	Pentosans	15 60
-		

\*Corrected for ash.

As is the case with chemi-mechanical pulps, lignin content in the pulp is high i.e. most of the lignin is retained in the pulp.

Bleaching experiments were carried out with increasing dosages of hypochlorite. The bleaching conditions and results are given in Table 2.

FABLE-2	BLEACHING	OF	BAMBOO	COLD
	SODA PULP			

S. NO.	Particulars	I	11	Ш	1V	v	VI
1.	Hypochlorite as					•••	0.6
	Cl <sub>2</sub> %	0	5	10	15	20	25
2.	Time min		60	120	120	120	120
3.	Brightness%ISO	19.4	21.1	24.4	30.2	35.8	44.5
4.	Yellowness %	53.8	54.8	49.9	51.9	48-6	42.0
Con	stant Conditions Consistency Temperature pH maintaine	°C °C	1 1	8 0 40 Abov	ve 9		

Even with 25% hypochlorite, the brightness attained was only 45% ISO. During the bleaching

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IPPTA Vol. 20, No. 3, Sept., 1983

experiments it was observed that the brightness development in the initial stages was rapid and then, brightness decreases with prolonging time. The effect of retention time on brightness in hypochlorite bleaching is given in Table 3.

TABLE-3 EFFECT OF RETENTION TIME ON BRIGHTNESS

S.NO.	Particulars	I	н	Ш	1V
1.	Hypochlorite as chlorine	20	20	20	20
2.	Bleaching time min	10	15	30	120
3. 4.	Brightness % ISO Yellowness %	39.9 48.5	40.1 49.5	38.7 50.3	35.8 48.6

It can be observed that maximum brighiness is achieved in 10-15 minutes by which time, the hypochlorite is exhausted completely. Prolonging the time in the absence of hypochlorite under alkaline conditions will reduce the brightness. So, just sufficient time for complete exhaustion of hypochlorite with efficient mixing has to be given.

Pulp treated with SO<sub>2</sub> has a brightness of 22-24%ISO i.e. 3-4 points more than the unbleached pulp.

Two-stage hypochlorite improves the brightness by 2-3 points more than the single stage hypochlorite bleaching.

### Pretreatment with acid

The effect of pretreatment with acid and sulfurdioxide is given in Table 4.

# TABLE-4 HYPOCHLORITE BLEACHING WITH PRE-ACID TREATMENT

Particular	s I	11	III
Sequence Total NaO	H <sup>10</sup> -H <sup>10</sup>	SO <sub>2</sub> -H <sub>10</sub> -H <sub>10</sub>	$H_2SO_4-H_{lq}H_{10}$
used % Brightness	2.6	3.3	3.6
ISO	41.0	43.5	43.2
Yellowness	% 46.6	45.1	46.4
BLEACHI STAGES	NG COND	ITIONS IN	DIFFERENT
Stage (	Consistency	Temp °C	Time pH
$SO_2 \\ H_2SO_4 \\ H_1 \\ H_2$	2 2 5 5	Ambient Ambient 40 40	15     4-5       15     3       10-15     Above 9       15     Above 9

Acid pretreatment improves the brightness further.  $H_2SO_4$ - $H_{10}H_{-10}$  and  $SO_2$ - $H_{10}$ - $H_{10}$  are having similar brightness which is some what higher than  $H_{10}$ - $H_{10}$  sequence.

### Pretreatment with alkali

Pre-extraction of the pulp with alkali at different temperatures ranging from 80-100°C were carried out prior to two-stage hypochlorite bleaching. The bleaching conditions and results are given in Table-5.

TABLE-5 HYPOCHLORITE BLEACHING WITH PRE-EXTRACTION

Sequence	$H_{10} - H_{10}$	H <sub>10</sub> -H <sub>5</sub>
Temperature 80°	C	
$\mathbf{E_2}$	44.6	36.0
E <sub>2</sub> P <sub>0.5</sub>	45.8	37.6
E₃	44.8	36.0
E <sub>3</sub> P <sub>0.5</sub>	46.4	38 <b>9</b>
Temperature 90°	°C	
$E_2$	42.8	35.6
$E_{2} P_{0.5}$	45.6	38.4
$\mathbf{E}_{3}$	44.5	37.4
E <sub>3</sub> P <sub>0.5</sub>		39 9
<b>Temperature</b> 10	0°C	· · · · · · · · · · · · · · · · · · ·
E,	42.3	34.6
$E_2 P_{0.5}$	45.6	37 0
$E_3$	44.5	38.3
E <sub>3</sub> P <sub>0.5</sub>	47.6	39.2

# Bleaching conditions in different stages

Stage	С	onsistency %	Temperature °C	Time min	рН		
E and I	E(P)	10	80-100	60	Above 11		
н.	-(- )	5	40	15	Above 9		
H.		5	40	15-30	Above 9		
113			(until complete				
			ez	chaustic	on)		

It can be observed that pre-extraction improves the brightness and extraction at  $80^{\circ}C$  seems to be optimum.

IPPTA, Vol. 20, No. 3, Sept., 1983

### Effect of peroxide in alkali pretreatment

Use of 0.5% H<sub>2</sub>O<sub>2</sub> in alkali pre-extraction improves the brightness of the subsequent two-stage hypochlorite bleached pulp. The results are given in table 5. The sequence  $E_3P_{0.5}$  provides the maximum brightness.

### Pretreatment with dye

The unbleached pulp has 53% yellowness, which hinders in brightening of the pulp. With a view to reduce the yellowness of the pulp, the pulp was treated with 0.05% to 0.75% victoria blue dye at 2% consistency in a disintegrator, thoroughly mixed and dewatered prior to bleaching with two-stage hypochlorite. Though addition of dye reduce the yellowness of the pulp considerably, further bleaching does not improve the brightness more than that achieved in the absence of dye.

Addition of dye for the final bleached pulp, to reduce the yellowness and then use of optical whitening agent (Ranipal) to improve the brightness further was also not effective significantly.

### H<sub>2</sub> O<sub>2</sub> treatment

The pulp was given pre-edta treatment, to complex the metal ions and then bleached with increasing dosages of  $HO_2$ . Bleaching conditions and results are given in table 6.

TABLE-6. BLEACHING OF BAMBOO COLD SODA PULP WITH HYDROGEN PEROEXIDE.

S. No.	Particulars	I	II	III	IV	V	VI
		······································					
1. H <sub>2</sub> O	2 applied %	1	2	3	5	3	5
2. Rete	ntion time min	60	60	60	<b>6</b> 0	120	120
3. H <sub>2</sub> O	, consumed %	0.60	0.83	1.20	2.18	1.27	2.65
4. Brig	htness % ISO	22.7	23.8	24.9	26.5	26.7	27.4
5. Yelle	owness %	57.8	57.6	58.6	59.1	52.8	56 0
Pre-Edta	treatment :						
	N <sub>2</sub> Edta %	= 0.05	· .				

Consistency %	==	3.0
Temperature °C		Ambient
Time min		30

# H<sub>2</sub>O<sub>2</sub> Bleaching :

pH		Above 10
Consistency %	=	8.0
Temperature °C	=	60
Mg So4 %	=	2.0
Na <sub>2</sub> Sio <sub>3</sub> %	=	1.5

IPPTA, Vol. 20 No. 3, Sept., 1983

			$H_{10} - H_{10}$					$H_{10} - H_5$		
<b>S</b> .	Sequence	Brightness	Yellowness	PC	Bleached %	Brightness	Yellowness	PC	Bleached	
No.	,	%	%	No	on OD	%	%	No	yield % on	
	tha a th	ISO			pulp	ISO	•		OD pulp	
1.	So₂—H—H	42.3	50 2	9.6	97.1	35.4	52.5	9.1	97.9	
<b>2.</b> 1	E <sub>3</sub> —H—H	46.9	43.6		93.0	36 8	48.1	7.9	96.7	
3.	$E_{3} - (P_{0}) - H - H$	48.1	41.4	9.1	91 <b>.2</b>	41.8	46.6	8.6	93.1	
4.	$\mathbf{E}_{5}\left(\mathbf{P}_{\mathbf{q}\cdot5}\right)-\mathbf{H}-\mathbf{H}$	49.3	39.7	6.9	90.2	-	· <u> </u>			

Temperature °C

Ambient

40

**4**0

80

Time (min)

15

15

60

unit complete exhaustion Above 9.0 (about 30 min)

# TABLE-7. BLEACHING OF BAMBOO COLD SODA PULP

STRENGTH PROPERTIES OF BAMBOO COLD SODA PULPS (UNBLEACHED AND BLEACHED TABLE-8

Consistency %

2

5

5

10

Stage

So<sub>2</sub>

 $H_1$ 

 $H_2$ 

E and E (P)

Parti- culars	PFI (rev)	Free ness	D. Time (s)	Appa- rent den-	Burst index	Tensile index	Stretch	Fold Kohler	Tear index	Air res <sub>.</sub> Gurley
· · · · · · · · · · ·		CSF		(g/cm <sup>3</sup> )	(kPam²/g)	(N.m/g)	(%)	log. (1	mN.m²/g)	(s/100 ml.)
Unbleached	0	630	3.90	0.40	0.30	16.5	1.4	0.48	4.70	1.2
Pulp	1000	415	5.40	0.44	0.85	27 <b>.0</b>	2.1	0.78	5.55	5.5
	2C00	345	6.55	0.46	1.00	30.5	2.1	0.95	5.30	10.7
	4000	205	13,40	0.50	1.55	35.0	2.2	1.00	6.25	24.5
	6000	135	20.70	0.53	1.70	37.0	2.2	1.15	5.05	57.5
H <sub>10</sub> -H <sub>10</sub>	0	505	4.54	0.44	0.75	23.0	1.8	0.70	5.40	3.7
	10(0	325	6.63	0.48	1.40	32.0	2.5	1.04	5.74	13.0
	2000	250	10.05	0.51	1.50	35.0	2.7	1.28	5.78	19.5
· .	4000	185	13.89	0.53	1.70	36.5	2.8	1.32	5.8 <b>2</b>	46.9
$H_{10} - H_5$	0	515	4.35	0.43	070	20.0	2.4	0.69	5.71	3.5
	1000	330	5.81	0.47	0.90	27.5	2.5	1.04	5.83	6.5
	200 <b>0</b>	265	7.52	0.50	1.54	33.0	2.7	1.08	6.00	14.0
18 - 1 1	<b>4</b> 00 <b>0</b>	160	13.99	0.51	2.00	36.0	2.8	1.15	5.58	30.5

IPPTA Val. 20, No. 3, Sept , 1983

81

pН

4-5

Above 9.0

Above 11.0

The brightness achieved by  $H_2O_2$  bleaching is very low.

Based on the scale experiments, the following sequences were selected for large scale bleaching.

- 1.  $SO_2$ -H<sub>10</sub>-H<sub>10</sub> and  $SO_2$ -H<sub>10</sub>-H<sub>5</sub>
- 2.  $E_3$ - $H_{10}$ - $H_{10}$  and  $E_3$ - $H_{16}$ - $H_5$
- 3.  $E_3$  (P<sub>0.5</sub>)-H<sub>10</sub>-H<sub>10</sub> and  $E_3$  (P<sub>0.5</sub>)-H<sub>10</sub>-H<sub>5</sub>

The bleaching conditions and results are given in Table7. It can be observed that sequence with peroxide gives maximum brightness of 48% with 20% hypo-

chlorite and 41.8 with 15% hypochlorite. With increasing brightness bleached pulp yield drops down. Bleached pulp yield for two-stage hypochlorite is 97% whereas with pre-extraction in presence of peroxide it is 91%. So, for attaining 6 points gain in brightness, about 5-6% yield has to be sacrifised. The unbleached and bleached pulp strength properties are given in tables 8 to 10 and strength properties are compared at 200 ml CSF in Table 11.

It can be observed, that strength properties of pulps bleached by different sequence are similar, though bleached pulps with pre-extraction possess somewhat higher burst and tensile strength.

TABLE-9	STRENGTH PROPERTIES OF BAMBOO COLD SODA PULPS	(BLEACHED)
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Particulars	PFI (rev)	Free- ness CSF	D. Time (s)	Appa- rent Density (g/cm <sup>3</sup> )	Burst index (kPam <sup>2</sup> /g)	Tensile index (N.m/g)	Stre- tch (%)	Fold Kohler Molin log	Tear index (mN. m <sup>2</sup> /g)	Air res. Gurley (s/1(0 ml.)
E <sub>3</sub> H <sub>10</sub> H <sub>10</sub>	0	520	4.30	0.47	0.70	21.0	2.5	0.85	5.50	3.5
	1000	305	7.30	0.51	1.60	31.0	2.6	1.18	6.15	12.9
	2000	215	10.20	0.55	1.90	36.0	2.8	J.34	5.70	29.3
	4000	120	21.95	0.57	2.10	40.5	2.9	1.38	5.30	63.8
E <sub>3</sub> -H <sub>10</sub> -H <sub>5</sub>	0	505	4.50	0.44	1.30	25.0	2.4	0.90	5.70	3.9
	1000	335	6.40	0.48	1.40	31.0	2.5	1.16	6.20	9.6
	2000	250	9.10	0.52	1.70	37.0	2.7	1.17	5.90	22.3
	4000	145	17.85	0.54	2.10	41.0	2.8	1.30	5.25	59.0

TABLE-10 STRENGTH PROPERTIES OF BAMBOO COLD SODA PULPS (BLEACHED)

Particulars PFI (rev)	Free- ness CSF	D. Time (s)	Appa- rent density (g/cm <sup>3</sup> )	Burst index (kPam <sup>3</sup> /g)	Tensile index (N.m/g)	Stre- tch (%)	Fold Kohler Moline log.	Tear index (mNm <sup>2</sup> /g	Air res. Gurley ) (s/100 ml.)
$\begin{array}{c} 0\\ E_{3}P_{0.5}H_{10}-H_{10} 1000\\ 2000\\ 4000 \end{array}$	490	4.8	0.48	1.00	25.5	2.2	0.90	6.50	4.5
	205	7.2	0.51	1.65	33.0	2.7	1.32	6.30	18.4
	215	11.0	0.55	1.95	40.0	2.9	1.39	6.00	37.3
	130	25.4	0.59	2.40	45.0	3.3	1.49	5 30	98.5
$\begin{array}{c} 0 \\ E_{3}P_{0.5}H_{10}-H_{5} 1000 \\ 2000 \\ 4000 \end{array}$	495	4.6	0.47	0 80	23.0	2.4	0.92	6.65	4.1
	325	7.8	0.50	1.55	33.0	2.5	1.21	5.75	13.4
	240	9.4	0 51	1.80	35.5	2.7	1.24	5.30	23 0
	135	18.0	0.55	2.10	41.5	2-7	1.38	4.85	51.0

IPPTA Vol. 20, No, 3, Sept., 1983

### Table-11. STRENGTH PROPERTIES OF UNB-LEACHED AND BLEACHED PULPS FXTRAPOLATED AT 200 ml CSF

Particulars	Drainage Time (s)	Burst index kPam <sup>2</sup> /g	Tensile index Nm/g 1	Tear index mNm²/g
Unbleached pulp	13.4	1.55	35.0	6.25
$H_{10}-H_{10}$	13.0	1.65	36.2	5.81
$H_{10} - H_5$	11.5	1.82	34.9	5.74
$E_3 - H_{10} - H_{10}$	13.6	1.93	36.7	5.64
$E_{3}-H_{10}-H_{5}$	13.3	1.89	38.9	5.59
$E_3 (P_{0.5}) H_{10} H_{10}$	13.8	2.03	4 <b>0.9</b>	5.88
$E_3 (P_{0.5}) H_{10} - H_5$	12.7	1.91	37.8	5.13

### CONCLUSIONS

- 1. Unbleached pulp brightness is very low (19.4% ISO) and yellowness is high (53%).
- 2. Use of even 25% hypochlorite does not improve the brightness and above 45% ISO, if bleached under normal conditions.
- 3. Minimum bleaching time just sufficient for complete exhaustion of hypochlorite has to be given coupled with efficient mixing. In twostage hypochlorite bleaching, 15 minutes was found sufficient for first stage in the laboratory trials. Prolonging the bleaching time after exhaustion of hypochlorite reduces the brightness.
- 4. SO<sub>2</sub> treatment increases the brightness by 3-4 points (22.3% ISO).
- 5. Two-stage hypochlorite preceded by  $SO_2$ treatment or  $H_2SO_4$  treatment gives good brightness (about 42% with 20% hypochlorite).
- 6. Pretreatment with a dye (0.05-0.075% Victoria Blue) though reduces the yellowness of the pulp, does not improve the response for brightness development with hypochlorite.
- 7. Pretreatment with alkali improves the brightness on subsequent two-stage hypochlorite bleaching. Extraction at 80°C gives good brightness results.
- 8. Presence of a small amount of peroxide  $(0.5\% H_2O_2)$  in pre-alkali extraction stage, further improves the brightness. E<sub>3</sub>  $(P_{0.5})$ -H<sub>10</sub>-H<sub>10</sub> sequence gives the maximum brightness of about 48% ISO.
- 9. Bleaching with  $H_3 O_2$  does not improve the brighness significantly.
- 10. For increasing the brightness by 6-7 points about 5-6% yield has to be sacrifised.

IPPTA Vol. 20, No. 3, Sept, 1983

### Experimental

# **Raw Materials**

Screened bamboo cold soda pulp was received from National Newsprint and Paper Mills Ltd., Nepanagar. The dryness of the pulp was 88%. Requisite amount of dry pulp was soaked overnight in water and disintegrated and dewatered, before taking the above pulp for bleaching trials. Promixate analysis of the pulp was carried out according to standard methods mentioned in Laboratory Manual<sup>1</sup>.

### Bleaching

For small scale bleaching trials about 20 g OD pulp was taken. Consistency was kept at 5%, to facilitate thorough mixing. After bleaching the pulps were washed thoroughly and then subjected to SO<sub>2</sub> treatment at pH 4-5 and 2% consistency for 15 minutes and then washed again.

Brightness aud post colour number were measured on bleached pulp sheets according to standard methods given in Laboratory Manual<sup>1</sup>. Yellowness is expressed as the difference between the reflectance obtained with the amber (A) filter and the reflectance obtained with the blue (B) filter divided by the reflectance obtained with Green (G) filter i.e.

Yellowness = 
$$\frac{A-B}{G} \times 100$$

Pulp evaluation and paper testing were carried out according to standard methods given in Laboratory Manual<sup>1</sup>.

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### REFERENCE

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