Evaluation of Bamboo+Mixed Hardwood (65:35) Mill Pulp for achieving High Brightness

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ABSTRACT

Bamboo and Mixed hard woods in the proportion of 65:35 are cooked together to produce bleachable grade pulp in the mill at Kappa No. 24-26. Bleachable grade pulp of 18-20 Kappa no. was produced at the pulp mill but resulted in higher percentage of fines and affected the paper machine runnability. For the present bleaching studies, mill Decker pulp of 24.8 Kappa was utilized and bleached under CE_pH, CE_pHD, CE_pHE_2D, CE_pHDP and CDE_pHD sequences to attain 90% brightness. Under the bleaching sequences CE_pHD and CE_pHED, the brightness achieved was 87-88% P.V. but for acheiving 90% pulp brightness, CE_pHDP and CDE_pHD bleaching sequences were found suitable. Pollution load under CDE_pHD sequence was observed to be much lower than CE_pHDP sequence. Fibre retention on 40 mesh and pulp strength properties were found to be higher in CDE_pHD sequence than in CE_pHDP sequence.

INTRODUCTION

The goal of achieving very high brightness pulps has increased as never before in the Paper Industry due to the demand of high brightness papers especially in the face of global competition. Alternative aproaches are being continously developed to tackle the problem. Pulp bleaching is an area where much attention has been focussed and further efforts are required to reduce the pollution load generated during bleaching, reduction of bleaching chemicals, energy and other utilities to achieve the high brightness levels of 90% P.V. brightness.

The bleaching sequence to be selected, depends upon traget brightness and the most common sequences adopted (1) for bleaching of Kraft pulps are CEH, CEHH, CEHHEH, CEHED and CEDED. Bleaching sequences CEH and CEHH are still followed in Indian Paper Industry for achieving around 80% P.V. brightness of pulp. The advantage of alkaline condition as well as high temperature at the extraction stage was exploited and Hydrogen peroxide was introduced at the alkali extraction stage (2, 3) to utilize the dead retention time to get the final brightness higher by one or two degrees. The alkaline conditions in alkali extraction stage help in the formation of per hydroxyl ions (OOH^-) which oxidizes the colour and renders the pulp with increased brightness. Under the alkaline conditions only etherified phenolic nuclei or monomer unit having side chains containing carbonyl groups appears susceptible to attack (4).

Bleaching sequence CE_pHD alone can not lift the final pulp brightness beyond 85.0% P.V. without sacrificing strength properties. There should be sufficiently high brightness in hypochlorite stage to further improve the final pulp brightness. This is achievable using Hydrogen peroxide at the alkali extraction stage in CEHD sequence (4, 9) for attaining pulp brightness around 87.0% P.V. To achieve 90 brightness, sequential bleaching CDE_pHD was investigated. Incorporating Chlorine dioxide in small quantity in sequential bleaching (10, 11) helps in improving strength properties and in marginal reduction of pollution load. Further Hydrogen peroxide in the 5th stage of bleaching in CE_pHD sequence was investigated to achieve the target brightness 90% P.V.

EXPERIMENTAL

Bamboo (U.P., Assam and M.P. Bamboo) and mixed hardwoods (Eucalyptus, al, Subabool and other hard woods) are used in 65:35 ratio to produce bleachable grade of pulp. In the present studies mill Decker pulp of 24.8 Kappa No. was bleached in our R&D laboratory to achieve the target brightenss of 90.0% P.V.

Table 1. Bleaching of mill decker pulp under different bleaching sequences

Decker pulp kappa No. 24.8

Particular		Bleaching sequence			
		CE_pH	CE_pHD	CE_pHE_2D	
Chlorination Stage					
i) Cl_2 applied/consumed (%)		5.0/4.5	5.0/4.5	5.0/4.5	
(ii) End pH		1.8	1.8	1.8	
Alkali Extraction Stage-1					
i) NaOH applied, (%)		1.5	1.5	1.5	
ii) H_2O_2 applied, (%)		0.4	0.4	0.4	
iii) End pH		10.6	10.6	10.6	
Calcium Hypochlorite Stage					
i) Hypochlorite applied/consumped, (%) as available Cl_2		3.0/2.5	3.0/2.5	3.0/2.5	
ii) Sulphamic Acid, (%)		0.1	0.1	0.1	
iii) Buffer added, (%)		0.6	0.6	0.6	
iv) End pH		8.4	8.4	8.4	
Alkali Extraction Stage-2					
i) NaOH applied, (%)		--	--	0.2	
ii) End pH		--	--	10.0	
Chlorine dioxide Stage					
i) ClO_2 applied/consumed, (%)		--	0.7/0.6	0.7/0.58	
ii) End pH		--	6.5	6.7	
Final Results					
i) Total Cl_2 applied/consumed, (%)		8.0/7.0	8.0/7.0	8.0/7.0	
ii) Total ClO_2 applied/consumed (%)		--	0.7/0.6	0.7/0.58	
iii) Total H_2O_2 applied, (%)		0.4	0.4	0.4	
iv) Pulp Brightness, % P.V.		82.0	87.0	88.0	
v) Pulp Viscosity, (0.5% CED, cps)		7.3	7.2	6.7	
Constant bleaching conditions					
	C	E_p	H	E_2	D
Consistency %	3.0	10.0	10.0	10.0	10.0
Temp. °C	Room	65±1	40±1	60±1	70±1
Time, mts.	60	60	120	60	120

In the first set of bleaching experiments, Decker pulp was bleached under CEpH, CEpHD and CEpHED sequences to achieve the target brightness of 87.0% P.V. The bleaching conditions and results are given in Table 1. The total effluent load generated in the form of COD, Suspended solid, Dissolved solid, Chloride and Colour per tonne of pulp is reported in Table 2. Fibre classification of the bleached pulps was carried out to visualize the effect of belaching sequences on pulp quality (Table 3). Effect of bleaching the pulp under different sequences on strength properties is show in Table 4.

To achieve the high brightness of 90.0%, P.V. Decker pulp of 24.8 Kappa No. was bleached under CE_pHDP and CDE_pHD sequences with variation in peroxide dosages 0.2% and 0.4% in the final stage of bleaching. The bleaching conditions and results are given in Table 5. The total pollution load per tonne of pulp is represented in Table 6. Fibre classification of the bleached pulps was also carried out and results are given in Table 7. The effect of achieving high brightness on pulp strength properties is shown in Table 8.

Table 2. Effluent characteristics of Mill Decker pulp bleached under different bleaching sequences

Particulars	CE_pH	CE_pHD	CE_pHE_2D
C.O.D., Kgs/Ton of pulp	36.0	37.0	40.1
S. Solid, Kgs/Ton of pulp	7.5	8.8	9.8
D. Solid, Kgs/Ton of pulp	266.2	289.6	296.2
Chloride, Kgs/Ton of pulp	83.0	85.3	86.1
Coour, Kgs/Ton of pulp	72.4	72.4	72.5

Table 3. Fibre classification of pulp bleached under different bleaching sequences

Mesh Size, mm	CE_pH	CE_pHD	CE_pHE_2D
+ 40,	43.24	47.0	44.61
- 40, + 70	19.37	21.4	21.68
- 70, + 100	15.97	15.04	16.35
- 100, + 140	4.74	4.49	5.24
- 140,	16.68	12.03	12.12

Table 4. Physical strength properties of pulps bleached under different bleaching sequences

Particulars	Bleaching sequences		
	CE_pH	CE_pHD	CE_pHE_2D
Number of beating revolution in P.F.I. mill	4000	4000	3500
Final Freeness as, °SR of pulp	33	32	32
Bulk, c.c./gram	1.42	1.42	1.41
Tear Index, Nm^2/g	6.6	6.3	5.3
Tensile Index, Nm/g	57.7	58.4	51.5
Burst Index, $KPam^2/g$	4.0	4.0	3.4
Double fold	128	112	75

RESULTS AND DISCUSSIONS

Bleaching of Decker pulp for 87.0% brightness

Mill pulp (Kappa No. 24.8) was bleached under CE_pH sequence and the pulp brightness achieved was 82% P.V. In order to improve pulp brightenss chlorine dioxide was added in the 4th stage of bleaching under CE_pHD sequence and the brightness achieved was 87.0% P.V. To further improve the pulp brightness 2nd alkali stage was introduced after hypochlorite stage under CE_pHE_2D sequence but the final brightness achieved was 88.0% P.V. The viscosity of the pulp under CE_pH and CE_pHD sequences was nearly same aournd 7.3 cps but had dropped to 6.7 cps under CE_pHE_2D sequence (Table 1).

Pollution load generated during bleaching

The total pollution load under CE_pH, CE_pHD and CE_pHE_2D bleaching sequences was calculated based on each bleaching stage for COD, Suspended solid, Dissolved solids and Colour. COD, Chloride, Suspended solid and Dissolved solid were on higher side in CE_pHD sequence compared to CE_pH sequence but colour load was nearly same. Introduction of 2nd alkali extraction stage in CE_pHE_2D sequence has resulted in significant increase in COD and Dissolved solid load (Table 2). AOX per tonne of pulp was calculated and found to be around 6.0 Kg.

Fibre classification

Fibre classification of bleached pulps recorded in Table 3, shows that the fibres retained on 40 mesh was on

Table 5. Bleaching of mill decker pulp under different bleaching sequences for high brightness pulp

Decker pulp kappa No. 24.8

Particular	Bleaching sequence				
	CE_pH		CE_pHD	CE_pHE_2D	
Chlorination stage					
i) Cl_2 applied/consumed (%)	5.0/4.5		5.0/4.5	5.0/4.5	
ii) ClO_2 applied, (%)	--		--	0.5	
(iii) End pH	1.8		1.8	1.5	
Alkali Extraction stage-1					
i) NaOH applied, (%)	1.5		1.5	1.5	
ii) H_2O_2 applied, (%)	0.4		0.4	0.4	
iii) End pH	10.6		10.6	10.8	
Calcium Hypochlorite stage					
i) Hypochlorite applied/consumped, (%) (as available $Cl_{2)}$	3.0/2.5		3.0/2.5	3.0/2.3	
ii) Sulphamic Acid, (%)	0.1		0.1	0.1	
iii) Buffer added, (%)	0.6		0.6	0.5	
iv) End pH	8.4		8.4	8.3	
Chlorine dioxide stage					
i) ClO_2 applied/consumed, (%)	0.7/0.6		0.7/0.6	0.7/0.57	
ii) End pH	6.5		6.5	6.2	
Peroxide stage					
i) H_2O_2 applied/consumed, (%)	0.2/0.14		0.4/0.36	-	
ii) Buffer added, (%)	0.2		0.2	-	
iii) End pH	9.7		9.8	-	
Final results					
i) Total Cl_2 applied/consumed, (%)	8.0/7.0		8.0/7.0	8.0/7.0	
ii) ClO_2 applied/consumed (%)	0.7/0.6		0.7/0.6	1.2/1.07	
iii) Total H_2O_2 applied, (%)	0.6/0.54		0.80/0.76	0.4/0.4	
iv) Pulp Brightness, (% P.V.)	89.0		90.5	89.5	
v) Pulp Viscosity, (0.5% CED, cps)	6.6		6.2	6.6	
vi) P.C. No.	2.5		1.8	1.9	
Constant bleaching conditions					
	CD	E_p	H	D	P
Consistency %	3.0	10.0	10.0	10.0	10.0
Temp. °C	Room	60±1	40±1	70±1	60±1
Time, mts.	60	60	120	120	120

higher side under CE_pHD sequence compared to CE_pH sequence but reverse trend was observed with fines passing through 140 mesh. In CE_pHE_2D bleaching sequence, fibres retained on 40 mesh are on lower side than CE_pHD sequence.

Physical strength properties of the bleached pulps

Physical strength properties of CE_pH and CE_pHD sequence bleached pulp were nearly same in spite of higher pulp brightness in CE_pHD sequence (Table 4). Under CE_pHE_2D sequence the physical strength properties of the bleached pulp were on lower side compared to other two bleaching sequences.

Bleaching of Decker pulp for 90% brightness

Introduction of hydrogen peroxide stage after chlorine dioxide stage (13, 14) for attaining a few points

Table 6. Effluent characteristics of mill Decker pulp bleached under different bleaching sequences

Total Pollution load generated	Bleaching sequence		
	CE_pHDP		CDE_pHD
	Expt.-1	Expt.-2	
C.O.D., Kgs/Tonne of pulp	41.1	41.8	35.5
S. Solid, Kgs/Tonne of pulp	9.6	10.2	10.3
D. Solid, Kgs/Tonne of pulp	298.8	297.1	263.2
Chloride, Kgs/Tonne of pulp	86.0	85.7	90.9
Colour, Kgs/Tonne of pulp	72.4	72.4	44.2

Table 7. Fibre classification of pulps bleached under different bleaching sequence

Mesh Size, mm	Bleaching sequences		
	CE_pHDP		CDE_pHD
	Expt.-1	Expt.-2	
+ 40,	43.66	41.78	50.30
- 40, + 70	21.88	21.23	20.35
- 70, + 100	16.18	19.47	12.63
- 100, + 140	4.81	6.93	3.69
- 140,	13.45	10.35	13.03

Table 8. Physical strength properties of pulps bleached under different bleaching sequence

Particulars	Bleaching sequences		
	CE_pHDP		CDE_pHD
	Expt-1	Expt-2	
Number of beating revolution in P.F.I. mill	3600	3300	4200
Final Freeness as, °SR of pulp	34	32	32
Bulk, c.c./gram	1.42	1.41	1.40
Tear Index, Nm^2/g	5.4	4.6	6.5
Tensile Index, Nm/g	53.6	52.7	59.4
Burst Index, $KPam^2/g$	3.5	3.4	4.1
Double fold	72	68	130

increase in brightness was possible to improve brightness stability. Therefore Decker pulp of Kappa No. 24.8 was bleached under CE_pHD sequence using 0.2% and 0.4% Hydrogen peroxide in the final stage of bleaching. The pulp brightness achieved was 89.0% and 90.5% P.V. respectively. P.C. No. was reduced with increase in Hydrogen peroxide dosage.

There was limitation for ClO_2 generation plant at our mill for using it in sequential bleaching and even then utility of ClO_2 was investigated under CDE_pHD sequence for further consideration. The final brightness under CDE_pHD sequence achieved was 89.5% P.V. and the pulp viscosity was 6.6 cps. The bleaching conditions and results are given in Table 5.

Pollution load generated

COD, Colour and Dissolved solid load per tonne of pulp under CDE_pHD sequence was lower than CE_pHDP

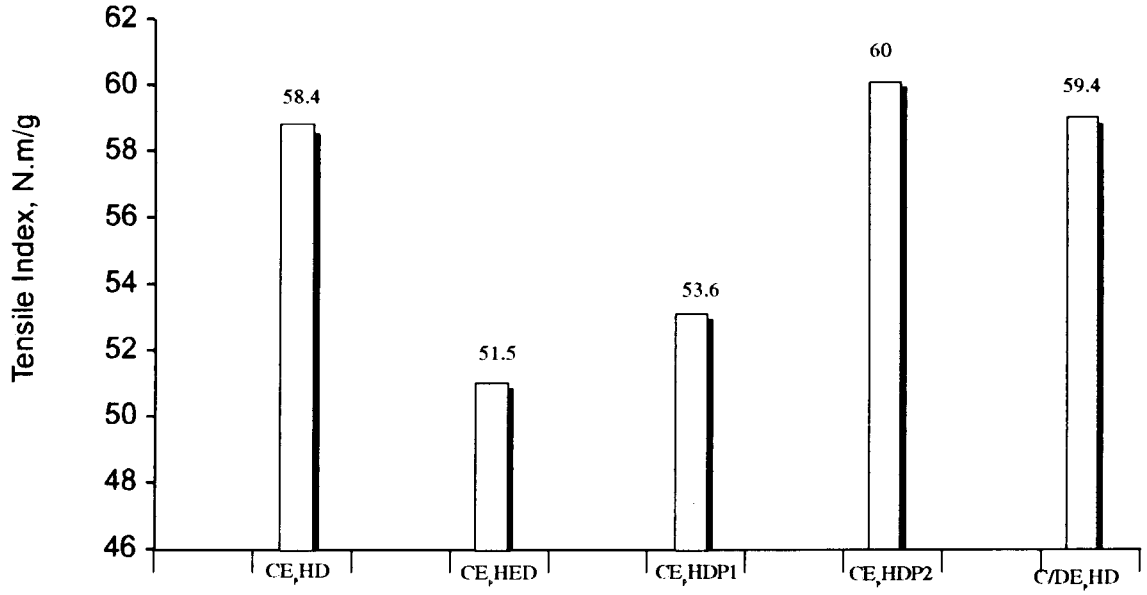

Fig. 1 Comparision of Tensile Index of bleached pulps from different bleaching sequences

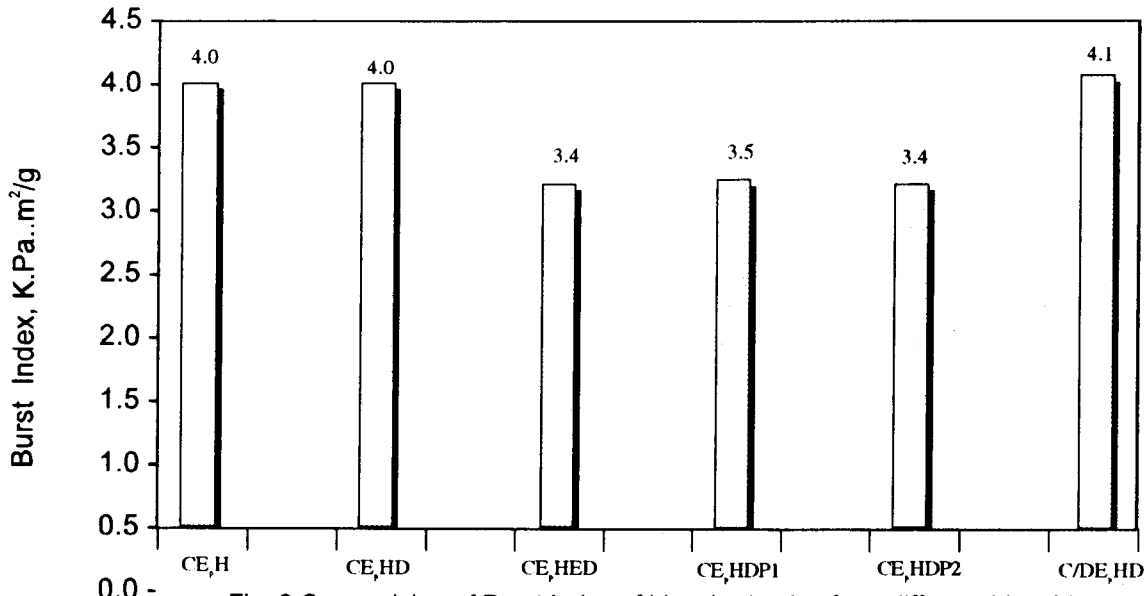

Fig. 2 Comparision of Burst Index of bleached pulps from different bleaching sequences

sequence but reverse trend was observed in Chloride load generation (Table 6). Increase in Hydrogen peroxide dosage in the final stage of belaching had marginally increased COD and suspended solid load. Pollution load of AOX was calculated to be around 6.0 Kg.

Fibre Classificaion

Fibre classification results repoted in Table 7 shows that with increase in Hydrogen peroxide dosage, fibres retained on 40 mesh was reduced from 43.66% to 41.785 but reverse trend was observed with fines passing through 140 mesh. In sequential bleaching, fibres retained on 40 mesh was much higher than CE_pHD bleaching sequence.

Physical strength properties of bleached pulp

Physical strength properties under CDE_pHD was higher than either of the two pulps bleached under CE_pHDP sequence (Table 8). Increase in Hydrogen peroxide dosage in the final stage of bleaching resulted

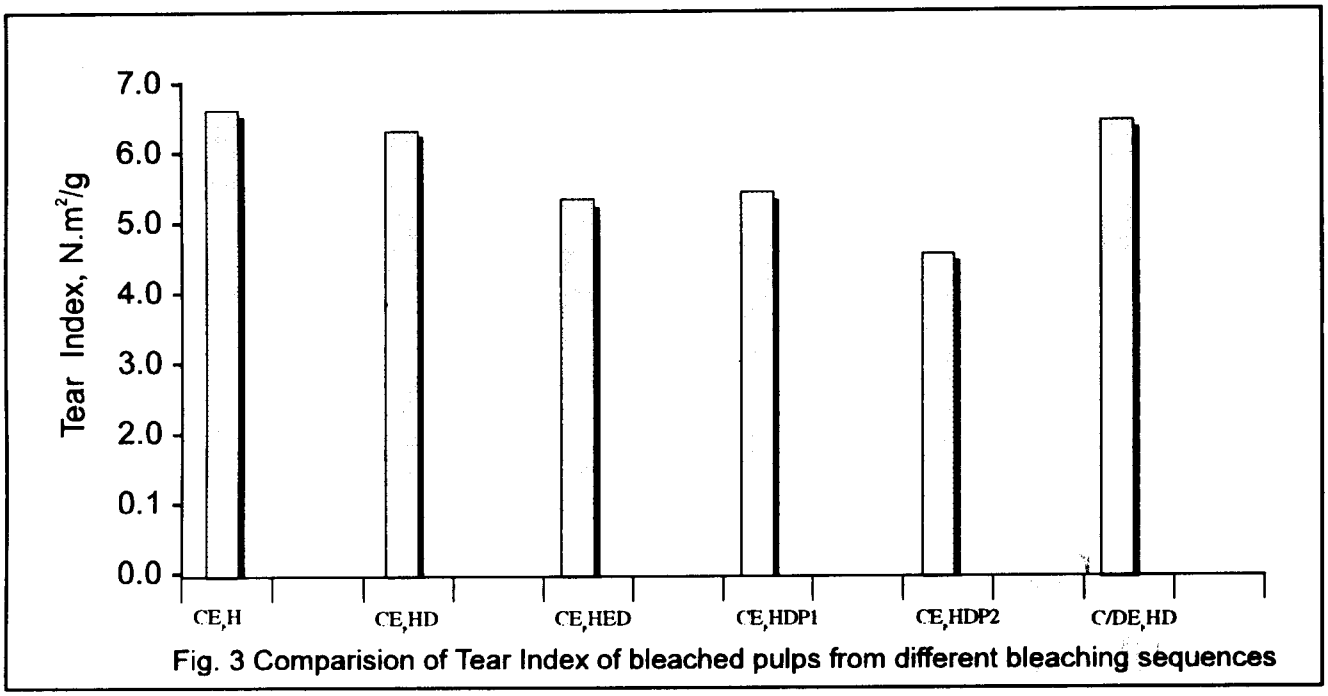

Fig. 3 Comparision of Tear Index of bleached pulps from different bleaching sequences

in lowering of strength properties. Physical strength properties viz Tensile Index, Burst Index and Tear Index of pulps of different bleaching sequences are projected and compared in Fig. 1, 2 and 3 respectively.

CONCLUSION

Mill Decker pulp was bleached under CE_pH, CE_pHD, CE_pHED and CDE_pHD bleaching sequences. The two bleaching sequences suitable for achieving 89-90% P.V. pulp brightness are CE_pHDP and CDE_pHD. Incorporating H_2O_2 in the final stage of bleaching needs treatment with SO_2 to decompose the residual H_2O_2. Chlorine Dioxide in sequential bleaching under CDE_pHD sequence has limitations due to Chlorine dioxide plant capacity at our pulp mill and could be considered for further requirement.

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