High Brightness Pulps from Bamboo-Mixed Hardwoods

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ABSTRACT: The ever increasing competitive domestic market demand and the entrance into the International market, necessitated Indian Paper Mills to switch over to high quality papers with good optical and physical strength properties. For making such quality papers, pulp with good optical, physical and chemical properties is required to get high brightness (90 ± 1%) pulp, Bleaching with chlorine dioxide and oxidative extraction with oxygen/ peroxide are generally being adopted. In India, few paper mills have already gone in for chlorine-di-oxide bleaching and few more mills are expected to adopt in near future. We present, In This paper the results of laboratory bleaching studies with mixed hardwood and bamboo (75:25) blend pulps with CEHDED, CEHDE$_p$D, CEDED AND CEDE$_p$D sequences.

INTRODUCTION

High quality papers with good optical and physical strength properties is the present day demand and it is likely to go up in near future. For making these quality papers, pulp with good optical, physical strength properties and chemical properties is required. At present, in our country, generally it is achieved by using imported high brightness softwood and hardwood pulps. For better realisation of the product, it is essential to develop pulps of reasonably good quality to supplement the costlier imported pulps. As it is very difficult to achieve 90±1% brightness with conventional CEHH sequence without severe pulp degradation, it is imperative to go in for well proven selective bleaching agent like Chlorine-Di- Oxide and/ or latest bleaching technologies like Oxygen/ Peroxide/ Ozone bleaching. In India already a few paper mills have gone in for Chlorine-Di-Oxide bleaching on commercial scale and a few more are expected in near future. To obtain high degree of pulp brightness with minimum fibre degradation and better brightness stability, the commonly adopted multistage sequences are CEHDED and CEDED. Generally, CEDED sequence is widely used in advanced countries. Further Oxidative Extraction with Peroxide and / or Oxygen is also widely being adopted from environmental point of view.

Hence, our studies were initiated to find out the suitable bleaching sequence for our furnish of 75:25 mixed hardwood and bamboo pulp using the well proven selective bleaching agent Chlorine-Di-Oxide.

EXPERIMENTAL

Unbleached pulp of 75:25 mixed hardwood (MHW) and bamboo, as well as alkali extracted pulp collected from bleach plant were used in the bleaching studies. The MHW blend comprises about 64% casurina (Casurina Equisitifolia), 21% of local seasonal hard

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woods like Mango (Mangifera Indica) and Cashew (Anacardium Occidentale) and 15% Eucalyptus and Subabul (Leucaena Leucocephala).

In alkali/ peroxide (Ep) stage no stabiliser like Magnesium Sulphate and / or Sodium silicate were used.

The chemical analysis of the final bleached pulps were done as per the TAPPI standard methods. Strength properties of the final bleached pulps were evaluated at 40 °SR after beating in laboratory valley beater and making hand sheets of 60±1 gsm. The bleaching conditions and pulp properties are presented in Tables 1 to 5.

Table-1.

Bleaching Conditions and Pulp Properties
(With out SO_2 Treatment)
Unbleached pulp Kappa No. 21.4
Viscosity (0.5% CED) cps 18.2

S.No.	Particulars	CEHDED	CEHDEpD	CEDED	CEDEpD
1.	Chlorine, %	4.54	4.54	4.54	4.54
	Extraction Stage (E1)				
2.	Alkali as NaOH, %	2.0 2.0	2.0	2.0	2.0
3	Kappa number	3.9	3.9	3.9	3.9
4.	Viscosity (0.5%CED), cps	11.0	11.0	11.0	11.0
5.	Brightness, % Elrepho	40.0	40.0	40.0	40.0
	Hypo Stage				
6.	Hypo, %	1.0	1.0	--	--
7.	Buffer, %	0.45	0.45	--	--
8.	Brightness, % Elrepho	70.5	70.5	--	--
9.	Viscosity (0.5%CED), cps	10.5	10.5	--	--
	Dioxide Stage (D1)				
10.	Dioxide, %	0.8	0.8	1.2	1.2
11.	Consumption, %	84.6	84.6	97.9	97.9
12.	Brightness, Elrepho	82.5	82.5	83.5	93.5
13.	Viscosity (0.5%CED), cps	10.4	10.4	11.2	11.2
14.	Yellowness, % 10.0	10.0	10.0	7.8	7.8
15	Whiteness, %	64.4	64.4	68.2	68.2
16	post colour number (16hrs at 100 5C)	2.4	2.4	2.1	2.1
	Extraction Stage (E2)				
17.	Alkali as NaOH, %	0.5	0.4	0.5	0.4
18.	Peroxide, %	--	0.25	--	0.25
19.	Brightness, % Elrepho	81.5	85.0	80.0	84.5
20.	Viscosity (o.5%CED), Cps	10.2	10.1	10.9	10.6
	Dioxide Stage (D2)				
21.	Dioxide added, %	0.5	0.5	0.5	0.5
22.	Consumption, %	89.7	90.2	92.6	92.1
23.	Brightness, % Elrepho	87.0	88.0	87.0	88.5
24.	Viscosity (0.5%CED), cps	10.0	10.0	10.8	10.4
25.	Yellowness %	6.5	4.7	5.5	4.1
26.	Whiteness, %	74.8	78.7	75.9	81.1
27.	Post colour number (16hrs at 100 5 C)	0.7	0.7	0.6	0.5

Bleaching conditions :

	C	E1	H	D1	E2	D2
Consistency,%	3.0	10.0	10.0	10.0	10.0	10.0
Temperature, C	Ambient	60-65	40-45	70	60-65	80
Time, mts	45	90	120	180	60	180
pH	2.4/2.1	11.2/10.7	8.5/9.0	7.1/4.0	10.6/10.3	7.0/5.1

Table-2.

Bleached Pulp Properties at 40 °SR
(Without SO_2 Treatment)

S.No.	Particulars	CEHDED	CEHDEpD	CEDED	CEDEpD
1.	Burst factor	40.6	39.5	42.6	41.8
2.	Breaking length, meters	7140	7090	7420	7200
3.	Tear factor	63	60	64	61
4.	Double folds, nos	21	20	22	16

Table-3

Alkali Extracted pulp kappa number 5.5
Viscosity (0.5% CED), cps 13.7

S.No.	Particulars	CEHDED	CEHDED	CEHDEpD	CEDED	CEDEpD
	Hypo Stage					
1.	Hypo, dosage %	1.5	1.5	1.5	--	--
2.	Buffer, NaOH, %	0.45	0.45	0.45	--	--
3.	Brightness, % Elrepho	73.0	73.0	73.0	--	--
4.	Viscosity (0.5%CED), cps	9.9	9.9	9.9	--	--
	Dioxide Stage (D1)					
5.	Dioxide, %	1.0	0.8	0.8	1.8	1.5
6.	Consumption, %	97.9	96.4	96.4	96.1	97.4
7.	Brightness, Elrepho	85.0	83.0	83.0	78.0	76.0
8.	Viscosity (0.5%CED), cps	9.7	9.7	9.7	13.6	13.6
9.	Yellowness, %	9.3	10.3	10.3	14.2	15.0
10.	Whiteness, %	66.1	62.3	62.3	50.2	47.2
11	post colour number (16hrs at 100 5C)	2..4	2.6	2.6	2.9	3.1

Extraction Stage (E2)					
12. Alkali as NaOH, %	0.5	0.5	0.4	0.5	0.4
13. Peroxide, %	--	--	0.2	--	0.3
14. Brightness, % Elrepho	79.5	79.5	83.0	76.0	80.5
15. Viscosity (o.5 %CED), Cps	9.3	8.8	9.3	13.1	13.3
Dioxide Stage (D2)					
16. Dioxide, %	0.5	0.5	0.5	0.5	0.5
17. Consumption, %	85.1	86.0	85.8	99.2	94.2
18. Brightness, % Elrepho	87.5	87.0	88.0	86.0	88.0
19. SO_2, %	0.3	0.3	0.3	0.3	0.3
20. Brightness, % Elrepho	88.5	88.0	89.0	87.0	88.6
21. Viscosity (0.5%CED), cps	8.4	8.2	8.6	11.2	11.3
22. Yellowness %	6.1	7.1	5.7	7.5	6.4
23. Whiteness, %	76.1	75.4	77.3	74.3	75.5
24. Post colour number (16hrs at 100 5 C)	1.2	1.2	1.1	1.1	1.0

Bleaching conditions :

	H	D1	E2	D2
Consistency,%	10.0	10.0	10.0	10.0
Temperature, °C	40-45	70	60-65	80
Time, mts	120	180	60	180
pH	8.5/9.0	6.9/3.8	10.8/9.6	6.3/4.0

Table-4.

Bleached Pulp Properties (With SO_2 Treatment) at 40 °SR

S.No.	Particulars	CEHDED	CEHDED	CEHDEpD	CEDED	CEDEpD
1.	Burst factor	38.8	38.2	39	40.1	41.5
2.	Breaking length, meters	6980	6920	7100	7250	7180
3.	Tear factor	64	64	63	66	66
4.	Double folds, nos	24	22	20	28	23

RESULTS AND DISCUSSION

A. Brightness Development

Either with CEHDED (at a dosage of 1.3 to 1.5% ClO_2) or CEDED (at a dosage of 1.7 to 2.3% ClO_2) 86/87% brightness is obtained. The introduction of peroxide (0.2 to 0.3% on pulp) in second extraction stage and 0.3% sulphur dioxide addition before final pulp washing improved the brightness to 88/89%. The SO_2 washing helps to improve the brightness as the coloured metallic ions are solubilised by SO_2 treatment and washed out during washing.

B. Final Pulp Properties

a. Viscosity and strength properties

The viscosity of CEHDED pulps (8.4-10.0 cps) is on lower side compared to CEDED pulps (10.8-11.2 cps). However, the strength properties of CEHDED pulps are more or less comparable to that of CEDED pulps.

No pronounced adverse effect on viscosity and strength properties is observed with the inclusion of peroxide in the second alkali extraction stage.

b. Brightness stability

The brightness stability of CEHDED/ CEHDEpD and CEDED/ CEDEpD pulps is better compared to CEHH pulp of 80% brightness. The post colour number of dioxide pulps is in the range of 0.6-1.3

Table-5.

Chemical Analysis of Bleached Pulps

S.No.	Particulars	* CEHH	Set-I (With out SO_2 treatment) CEHDED	CEHDEpD	CEDED	CEDEpD	Set-II (With SO_2 treatment) CEHDED	CEHDEpD	CEDED	CEDEpD
1.	Copper number	0.77	0.61	0.63	0.34	0.49	0.57	0.67	0.44	0.48
2.	Carboxyl content meq/ 100 gms pulp	7.0	3.9	3.7	3.2	3.0	3.8	3.9	3.5	3.4
3.	Alpha cellulose, %	78.3	83.2	82.7	84.0	84.2	82.9	82.7	84.1	84.0
4.	Beta cellulose, %	15.6	14.1	14.3	13.9	14.1	14.2	14.0	13.9	14.1
5.	Gama cellulose, %	6.1	2.7	3.0	2.1	1.7	2.9	3.3	2.0	1.9

*Pulp brightness: 79% Elrepho (Plant pulp).

compared to 5.6 of CEHH pulp. However, amongst CEHDED/ CEHDEpD and CEDED/ CEDEpD pulps, the brightness stability is more in case of CEDED/ CEDEpD pulps. This can be traced to the fact that hypochlorite causes cellulose degradation and hence results in more number of carbonyl groups, while the chlorine dioxide removes lignin and resins by selective oxidation without causing much carbohydrate degradation (1) and it is reflected in alpha cellulose content and copper number values, (vide Table 5). Also, the second extraction stage improves brightness stability by rupturing carbohydrate molecule near carbonyl groups, dissolving the smaller fragments and thus eliminating the carbonyl groups which cause brightness reversion (2). Further this results in lower carboxyl group content (3.4-4.0 Vs 7.0 meq/ 100 gms of pulp of CEHH pulps) which reduces the alum requirement in stock preparation due to lesser ion exchange capacity of the pulp.

CONCLUSIONS

1. 87-88% pulp brightness can be achieved by either CEHDED or CEDED sequence without much adverse effect on viscosity and strength properties.
2. Inclusion of (0.2-0.3%) peroxide in the second extraction stage and SO_2 wash in the final stage further improves brightness by about 1-2 units.
3. The total chlorine dioxide requirement for CEDED (1.7-2.3%) is higher compared to CEHDED (1.3-1.5%). However, the dioxide requirement depends upon the individual pulps as per the permangnate number and the furnish of the pulp.
4. High brightness pulps can be used as a supplement for costlier imported pulps required for making papers with good optical properties.
5. The selection of bleaching sequence depends upon the individual mills reuirements and constraints.

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