Effect of Hydrogen Peroxide Addition in the Bleaching Of Bamboo Pulp in C.E.H. & C.E.D. Sequence

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ABSTRACT

The results of Laboratory trials on the effect of Hydrogen Peroide addition in the alkaline extraction stage of C.E.H. as well as C E.D. bleaching of bamboo pulp, on the final bleached pulp properties are presented. The overall advantages by the inclusion of Hydrogen peroxide in the Extraction Stage (Ep) are also discussed in this paper.

Peroxide bleaching processes for wood pulps evolved during the period 1940-1960. The advantages of peroxide lie in its ease of handling and application, its versatility, and the relatively non-toxic and innocuous nature of its reaction product. Literature survey[1—4] shows that peroxide has been used mainly in the bleaching of mechanical, chemimechanical, semi-chemical pulps and as a final stage in the bleaching of chemical pulps to impart additional brightness and brightness stability to the pulp.

The use of peroxide in the first extraction stage was first reported in 1936[5]. Subsequent papers[6-12] confirmed that the incorporation of small amounts of peroxide to the extraction stage (Ep) increases the efficiency of a conventional bleaching sequence. Hydrogen peroxide was also found to lower the color of the effluent, coming out from the extraction stage and it has been adopted on a commercial basis specifically for this purpose[13,14]. But, so far, there is no published data on the effect of hydrogen peroxide incorporation in the alkali extraction stage of Indian Fibrous Raw materials, *viz.* bamboo, tropical mixed hardwoods, agricultural residues etc. Hence, a detailed laboratory study was conducted and the results are presented in this paper.

We report in this paper, for the first time, the effect of hydrogen peroxide in the extraction stage on the properties as well as brightness reversion of the final bleached pulp of bamboo kraft pulp bleached by C.E.H. and C.E.D. sequence.

EXPERIMENTAL :

Bamboo Kraft Pulps were chlorinated in laboratory and washed thoroughly after chlorination. The chlorinated pulp was divided into four parts to carry out the EH, EpH, ED and EpD stages bleching. In the Ep (alkali extraction stage reinforced with hydrogen peroxide) stage, the inhibitor magnesium sulfates 0.05% was added along with the alkali before peroxide addition. In case of CEp-pulps, the hypocholorite and chlorine dioxide addition was reduced by 50%.

The final bleached pulps were tested for brightness, viscosity (0.5% C. E. D.), 16 Hrs Post colour (P. C.) Number, Copper Number, Carboxyl group content and strength properties after beating to 40°SR in laboratory valley beater.

The alkali extract was collected by squeezing the pulp after reaction period, before washing and color was determined at 420 nm using systronics spectrophotometer in platinum Cobalt Units.

The bleaching conditions and results are presented in Tables 1 and 2.

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Table—1

EFFECT OF HYDROGEN PEROXIDE IN EXTERACTION STAGE

PARTICULARS		I — Set		II — Set	
		E	Ep	E	Ep
Alkali added as NaOH	%	2.75	3.50	3.00	3.50
$H_2 O_2$	%	—	1.0	—	1.0
$MgSo_4$ added	%	—	0·05	—	0.05
pH (Initial/Final)		11.1/ 10.4	11.3/ 10.4	11.8/ 11.1	11.1/ 10.8
Alkali consumption as NaOH	%	1.37	1.57	1.03	1.37
Brightness of Pulp	%	31.8	43.2	35.4	47.0
Viscosity (0.5% CED)	cps	17.0	16 0	12.5	11.1
Kappa Number		7.8	4.7	5.8	3.5
Lignin	%	4.20	2.53	4.23	2.18
Colour of the alkali extract, pt-Co unit		11.500	9.000	8.500	6.000

Note : I-Set : Chlorinated Pulp Kappa No. = 16.8

II-Set : Chlorinnted Pulp Kappa No. = 9.7

Table—2

PROPERTIES OF BLEACHED PULPS

PARTICULARS		CE		CEp	
		H	D	H	D
Hypo/Dioxide added	%	4.0	1.6	2.0	0.8
Buffer as NaOH	%	1.37	0.40	0.71	0.35
Terminal pH		8.5	4.9	8.4	5.1
Consumption (Hypo/Dioxide) (on O.D. Pulp basis)	%	3.69	1.58	1.87	0.70
Brightness of Pulp	%	80.5	80.0	82.4	81.1
Viscosity (0.5% CED),	cps	6 9	12.0	8.1	11.7
Yellowness	%	11.92	8.8	9.4	8.4
Post colour number (16 Hrs)		5.7	2.7	3.2	2.1
Copper number		1.35	0.53	1.01	0.65
Carboxyl Content (m.eq/100 gm 0. Pulp)		6.41	2.83	4.64	2.76
Strength Properties at 40°SR					
Burst Index,	kpa.m^2/g	2.70	3.45	3.00	3.60
Tear Index,	mN.m^2/g	5.88	9.31	6.27	9.60
Breaking length,	km	3.92	5.01	4.12	5.19

RESULTS AND DISCUSSION

From the perusal of the laboratory results, in Tables 1 and 2, the following facts emerge :

Incorporation of 1.0% hydrogen peroxide in the extraction stage :—

i) Increases significantly the brightness of the alkali extracted pulp and also results in reduction of the Kappa No. and lignin content.

ii) A slight decrease in viscosity of the extracted pulp.

iii) A significant decrease in the color of the alkali extract.

iv) About 50% reduction in the bleachig chemical (hypochlorite chlorine dioxide) addition in the final stage, to get the same level of final pulp brightness.

v) There is an increase in final pulp viscosity in case of hypochlorite bleaching and no much change in case of chlorine dioxide bleaching.

vi) There is a decrease in yellowness, post color number, copper number and carboxyl group content of the hypochlorite bleached final pulp.

vii) There is only slight decrease in yellowness and post color number in case of chlorine dioxide bleached pulp.

viii) There is an increase in strength properties of the final bleached pulp.

In hydrogen peroxide bleaching, it is now well established that the active bleaching agent is the per hydroxyl ion, (pka of H_2O_2 is 11.6), OOH^-.

$$H_2O_2 + OH^- \longrightarrow OOH^- + H_2O$$

As the earlier studies has shown that the maximum brightness is achieved in the extraction stage, when the terminal pH is in the range of 10.0 to 10.5, excess alkali as NaOH was added in the Ep stage, to get the required terminal pH, than in the E stage.

The pH of the aqueous phase in a peroxide bleaching system tends to fall as the reaction proceed, probably owing to the formation of Carboxyl groups, during the ring opening reaction of lignin with per hydroxyl ion. The excess alkali solubilizes the dicarboxylic acids formed and thus prevents the reabsorption of lignin on pulp. The higher alkali consumption in Ep compared to E and the lower Kappa No. and lignin content of the CEp-pulp, vide Table 1, corroborates this view point.

Brighter Pulp after C. Ep—Stage :

Because of greater delignification with the reinforcement of the extraction stage by the addition of H_2O_2, higher brightness could be achieved in C. Ep—stage than in the C.E.—stage. The brightness values of C. Ep. pulps in Table—1 illustrates this advantage.

Reduction in E—Stage Effluent Color :

The major contributor for the dark color of the bleach plant effluent is the E-stage washings. By incorporating hydrogen peroxide in the extraction stage this can be reduced considerably. Perusal of the results in Table—1, clearly indicates that the color of the alkali extract is reduced by about 20-30%. The Weyerhaeuser Canada Pulp Mill Complex in Kamloops, B. C., adopted the addition of H_2O_2 to the first extraction stage and reported that the peroxide was effective in reducing the effluent color[13]. The reduction in E-stage effluent color will definitely be an added advantage because of the stringent pollution control parameters to be met by the pulp and paper mills.

Saving of Bleach Chemical in the Subsequent Stages :

As there is a significant lignin removal in the alkali extraction stage by H_2O_2, the demand for the bleach chemical in the subsequent (final) stages will be less, hence the dosage of hypochlorite/chlorine-di-oxide should be reduced proportionately, lest there will be cellulose degradation. The results in Table—2, illustrates that by reducing the hypochlorite as well as Chlorine-di-oxide even to an extent of 50%, there is no reduction in brightness of C.Ep. H and C Ep. D pulps. Weyerhaeuser Canada Ltd., Kamloops[13] reported that by adding 15 lb/adt peroxide in the first extraction stage of their CDE/P D E D sequence, Chlorine-di-oxide was saved to an extent of 10 lb/adt. Hence, an Ep-stage instead of E-stage reduces chemical cost, but the economics depend upon the relative costs of the various chemicals.

Final Bleached Pulp Properties :

A. C. E. H. Vs C. Ep.H Pulps :

The results in Table—2 shows that even with reduced hypochlorite in H-stage of C.Ep.H sequence, there is a slight improvement in the brigntness as well

as viscosity of the final bleached pulp. There is a sharp drop in yellowness. This could be traced to the less formation of C-2 and C-3 Carbonyl groups in the cellulose. The C-2 and C-3 Carbonyl groups are known to be responsible for yellowness[14]. This is also responsible for the sharp drop in the P.C. No. (2.7 Vs 5.6). There is a corresponding decrease in Carboxyl group content and copper number also. There is an improvement in over all strength properties by the incorporation of peroxide in E-stage.

B. **C. E. D. Vs C. Ep. D Pulps :**

The improvement in the Chlorine-di-oxide bleached pulp is not that much pronounced as in the case of hypochlorite bleached pulp. This may be due to the lesser degradation in D-stag, under proper conditions, compared to H-stage thereby the improvement achieved in the Ep-stage is not reflected in the final pulp properties.

Adaptability of the Ep-stage in place of conventional E-stage :

The hydrogen peroxide along magnesium sulfate (an easily soluble H_2O_2 protector) and alkali can be added to the repulper of chlorine washer. However, care is to be taken to select proper material of construction for handling the H_2O_2, magnesium sulfate solution and for the Ep-system.

CONCLUSIONS :

The addition of H_2O_2 (1.0%) in an extraction stage improves the bleachability of the pulp in later stages thereby savings could be achieved by reducing the bleach chemicals in the subsequent stages.

The C. Ep. H/C. Ep. D final pulp properties are better than the conventionally bleached pulps.

By including H_2O_2 in the extraction stage, 20-30% less color of effluent emanating from the extraction stage could be achieved.

However, the possibility of reinforcing the alkali extraction stage with H_2O_2 in C.E.H./C.E D. sequence depends upon the relative costs of various chemicals and the overall benefits that the individual mill could achieve.

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