Chlorine free bleaching of bagasse

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SUMMARY

As bagasse is proved to be an alternate source of raw material for Indian Paper Mills, a study was intiated to improve the final bleached pulp quality and also to make it environmentally friendly. With this view. laboratory experiments were conducted with bagasse kraft pulp using the bleaching sequences ODED and ODEoD. The experimental results indicated that bagasse can be bleached to 84.5 $\pm$ 0.5% brightness level without adverse effect on strength properties using ODED and ODEoD sequences. The added advantage with these sequences is the lesser bleach plant effluent color and dioxin and/or ADX levels and better optical properties compared to conventional CEHH sequence. However, the overall techno economic feasibility depends upon the individual mills requirements.

Introduction :

With the dwindling supply of conventional forest based fibrous raw materials, Indian Paper Industry has geared up to meet this challenge by their continuous in house R & D efforts to find out alternate fibrous raw materials to supplement the requirement. The Andhra Pradesh Paper Mills Limited has initiated its R & D studies way back in the year 1970 and has been carrying out pulping and bleaching studies on various non wood fibrous raw materials like Rice Straw[1, 2], Mesta[3], Bagasse. Cotton Linters, Sabai Rope, Tobacco Stalks, Sugar Cane leaves, ground nut shells, Cotton Caddies, Jute Sticks, Date Palm Branches[4], Sisal Fibre[5] etc., As bagasse is proved to be an alternate source of raw material for Indian Paper Mills, a study was initiated in our R&D Laboratory to improve the final bleached pulp quality and also to make it environmentally friendly. With this view, experiments were conducted with bagasse kraft pulp using the bleaching sequences ODED and ODEoD. The findings of the study are presented in this paper.

Experimental :

Bagasse was collected from local farmers and was subjected to wet depithing. The depithed bagasse was air dried and cooked with 12% active alkali. The pulp was made into two parts. One part was bleached with CEHH sequence. The other part of the pulp was bleached with ODED and ODEoD sequences. 0.25% Magnesium Sulphate was used as inhibitor. The final pulps were washed with 0.3% Sulphur Dioxide.

In the Eo (alkali extraction reinforced with Oxygen) stage, the inhibitor magnesium sulphate (0 05%) was added along with alkali. In case of Eo pulp the dioxide addition was reduced by 15% in the subsequent stage. The alkali extract was collected by squeezing the pulp after reaction period before washing and colour in Platinum Cobalt units was determined at 420 nm using Spectro Photometer. The chemical analysis of the final bleached pulps were done as per TAPPI standard methods. The optical properties of the final pulp were also tested. The strength properties of unbleached and bleached pulps were evaluated at 40° SR after beating in laboratory beater and making hand sheets of 60$\pm$1 gsm. The cooking and bleaching conditions, pulp properties, chemical analysis and sizing properties are presented in Tables 1 to 5.

Results & Discussion :

Delignification with molecular Oxygen (pre bleaching) :

In Oxygen delignification, Oxygen actsas a nucleophile and attacks lignin molecule at free phenolic

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groups The benzo quinones thus formed are further cleaved to aliphatic dicarboxylic acids and removed during washing. This facilitates lowering of kappa number and improvement in brightness.

Table—1
Cooking Conditions, Results and Unbleached Pulp Strength Properties

S No.	Particulars		Results
	PULPING		
1	Active Alkali as Na_2O%		12 0
2	Sulfidity,	%	17 8
3	Steaming Time,	hrs	1 5
4	Cooking Time,	hrs	.75
5	Cooking Temperature, °C		165
6	Total yield,	%	54.8
7	Screen Rejects,	%	1.0
8	Screened yield,	%	53.8
9	Kappa Number		13.6
10	Brightness,	%	31.5
11	Viscosity,	cps	43 3
12	Black Liquor pH		11 2
13	Residual active alkali, gpl		7.75
14	STRENGTH PROPERTIES AT 40°SR		
a)	Burst factor		42.9
b)	Breaking length, mts.		8060
c)	Tear factor		44
d)	Double folds, nos		16

Table—2
Oxygen Delignification

S No	Particulars		Results
1	Alkali as NaOH,	%	2.0
2	Magnesium Sulphate,	%	.25
3	Consistency,	%	12 0
4	Time to 110°C,	mts	75
5	Oxygen pressure at 110°C, Kgs/sq cm		4.5
6	Time at 110°C,	mts	60
7	Final pH		10.7
8	Alkali consumption,	%	40 4
9	Kappa Number		5.2
10	Viscosity,	cps	26 9
11	Brightness,	%	44.0
12	Yield (On unbleached pulp)	%	97.0

A reduction in kappa number by 60% (13.6 Vs 5.2) and improvement in pulp brightness by 40% (31.5% vs 44 0%) (See Table-2) was observed. Though magnesium sulphate is used as inhibitor, a decrease in viscosity of the pulp (43 3 vs 26.9 cps) was observed.

Oxidative Extraction with oxygen :

The addition of oxygen during alkali extraction stage has resulted in better brightness development (DEo brightness 70 0% Vs DE brightness 66.5%). A considerable reduction in alkali back water colour (ODEo stage 850 vs 1250 Pt—Co units in ODE stage) and a reduction of dioxide requirement in the subsequent bleaching stage about 15% was also observed. (See Table—3).

Final bleached pulp properties :

a) ODED Vs CEHH Pulps

The results in Table-3 show that ODED pulp has higher brightness (84.0% Vs 80 0%) as well as viscosity (21 0 cps Vs 14.2 cps) compared to CEHH bleached pulp. There is a considerable drop in Yellowness (6 9% Vs 10.3%). This could be traced to the negligible formation of C_2 and C_3 carbonyl groups in cellulose with dioxide. This corroborates with the drop in post colour number (0 09 Vs 0.26). There is an overall increase in strength properties with ODED pulp, especially tear factor by 7.5%.

b) ODED Vs ODEoD Pulps

There is not much change in optical as well as strength properties of ODED and ODEoD pulps.

c) Sizing property

The results in Table-5 indicate that the alum consumption for ODED and ODEoD Pulps is on lower side compared to CEHH Pulp This may be due to lower carboxyl content[6] of dioxide pulps (5.2-5.8 Vs 8.1). However, the Cobb values (lower sizing values) are one higher side at equal dosage of rosin, in case of dioxide pulps. This may be due to higher alpha cellulose content (74 0% Vs 70.9%) in dioxide pulps. Higher alpha cellulose pulps known to consume more Rosin for sizing'.

Table—3

Bleaching Conditions And Results

S. No.	Particulars		CEHH	ODED—SO_2	ODEoD—SO_2
I	CHLORINATION				
1	Chlorine,	%	2.0	——	——
2	pH		2.1/2.0	——	——
3	Kapppa Number		7.3	——	——
4	Brightness,	%	31.0	——	——
5	Viscosity,	cps	29.9	——	——
II	CHLORINE DIOXIDE				
1	Dioxide	%	——	.5	.5
2	pH (Initial/Terminal)		——	4 8/4.0	4.8/4.0
3	Brightness,	%	——	62 5	62.5
4	Viscosity, (0.5% CED)	%	——	25.7	25.7
III	EXTRACTION				
1	Alkali as NaOH,	%	.9	1.0	1 0
2	pH		11.3/10 8	11.9/11 7	11.9/11 0
3	Temperature,	°C	60/65	60/65	90
4	Oxygen pressure at 90°C, Kgs/sq cm		——	——	4.0
5	Time,	mts	90	90	60
6	Magnesium Sulphate	%	——	——	.05
7	Kappa Number		4.2	1.5	1.3
8	Brightness,	%	41.0	66.5	70 0
9	Viscosity, (0 5% CED)	cps	23.6	23 6	21.6
10	Colour of the Back water (Pt-Co units)		9000	1250	850
IV	HYPO/CHLORINE DIOXIDE				
1	Hypo 1 as Cl_2/ Dioxide as Clo_2,	%	1.5	1.2	1.0
2	Brightness,	%	78 0	84.0	85.0
3	Viscosity, (0.5% CED)	cps	18.4	21.0	19.9
4	Hypo 2,	%	.3	——	——
5	Buffer,	%	.56	——	——
6	Brightness,	%	80.0	——	——
7	Viscosity, (0.5% CED)	cap	14.2	——	——
8	Yellowness,	%	10.3	6 9	6.3
9	Whiteness,	%	59 0	70 4	72 8
10	Post colour number (16 hrs at 100±5°C)		3 0	.98	.78
V	STRENGTH PROPERTIES AT 40° SR				
1	Burst factor		35.2	36 6	37.1
2	Breaking length, mts.		7020	7260	7250
3	Tear factor		40	43	43
4	Double folds, nos		11	14	15

CONDITIONS :	C	H	D1	D2
Consistency, %	3.0	10.0	5.0	10 0
Temperature, °C	28	40	50	70
Time, mts	45	120	60	180

Table—4
Chemical Analysis of Bagasse Bleached Pulp

S. No.	Particulars	CEHH	ODED—SO_2	ODEoD—SO_2
1	Copper Number	.26	.09	.08
2	Carboxyl Content, (meq/100 gms of pulp)	8.1	5.2	5.8
3	Alpha—Cellulose, %	70.9	74.2	74.4
4	Beta—Cellulose, %	23.9	21.4	21.7
5	Gama—Cellulose, %	5.2	4.4	3.9

Table—5
Effect of Sizing on Bagasse Chlorine Dioxide Pulps

S. No.	Particulars	CEHH	ODED—SO_2	ODEoD—SO_2
1	Alum, %	3.54	2.1	2.5
2	Stock pH	4.7	4.7	4.7
3	sizing, sec	39	33	33
4	Cobb, gsm.	27/30	30/36	32/36

In all sequences rosin emulsion was added 1.0%.
Hand sheets of 100 ± 1 gsm were tested for cobb and sizing properties.

Pollution Aspects

Pre delignification with oxygen and substitution chlorine by chlorine dioxide in bleaching are known to be the effective measure in controlling the effluent load from the bleach plant, especially the dioxin and/or AOX levels[8-11] in our experiments we could not measure the either dioxine and/or AOX values due to lack of required facilities. However the alkali extraction stage back water clearly indicated a considerable reduction in colour. This will be an added advantage of ODED and ODEoD sequences besides better optical and strength properties.

Conclusions

Bagasse pulp of brightness $84.5 \pm 0.5\%$ with better optical and strength properties can be obtained with oxygen and chlorine dioxide as bleaching agents, i,e, ODED sequence. This facilitates to use this high brightness pulp for high brightness grades of papers.

By including oxygen in extraction stage (ODEoD), this is improvement in the bleachability of the pulp in the later stage, there by savings could be achieved by reducing bleach chemical. By adopting ODED/ ODEoD bleaching sequence for bagasse bleaching a more environmental friendly pulp can be obtained.

However, the overall techno economic feasibility depend upon the individual mill requirements and the prevailing cost of oxygen and chlorine dioxide generation cost as per the mode of generation and the technology adopted for oxygen prebleaching.

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