Short Sequence Bleaching - A Step Towards Environmental Friendly Process

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ABSTRACT

Aiming at cleaner production, APPM has considered ecofriendly technologies in upgradation of it's process from time to time. The convertional CEpHHH bleaching sequence was replaced by C/DEpDED in one of it's bleach lines. This has resulted in reduction of pollution load from bleaching. As short sequence bleaching further reduces pollution load, especially, effluent volume, it is proposed to adopt the same in APPM. To facilitate this, oxygen delignification is also being considered. These steps will help APPM to meet the ultimate objective of replacing the present five stage C/DEpDED and CEpHHH bleaching sequences by C/DEpD seqeunce in both the bleach lines to make the bleaching process more environmental friendly. To study the feasibility of the approach, bench scale experiments were carried by in-house R&D. This paper presents laboratory study results of the oxygen delignifiction and short sequence bleaching

INTRODUCTION

Environmental and eco friendly processes are the order of the day. Literature clearly indicates that higher brightness pulps can be produced with three stages wherein the incoming kappa of the pulp is reduced by Oxygen Delignification (1). Kari Kovasin reported (2) 43% drop in Chlorine consumption, 60-70% drop in effluent color and 40-70% reduction in effluent COD at the same bleached pulps yield with a three stage bleaching [(DC) (EO) D] compared to five stage bleaching [(DC) EDED] for Radiata Pine pulp. As a process of extended delignification oxygen delignification is more selective than the delignification in the digester. Oxygen delignification studies by many researchers (3-9) highlights the multiple advantages of oxygen delignification.

Some of the advantages of Oxygen delignification are--

- Reduction in Kappa number of unbleached pulp by about 50% without much adverse effect on pulp strength.
- Better selectivity in delignification.
- Improved total pulp yield at a given Kappa number.,
- Reduction in shive content by 50% thereby improved final pulp cleanliness.
- The spent liquor from this stage can be recycled via Brown Stock Washers to recovery.
- Marginal increase in total solids going to recovery without appreciable change in Black Liquor Characteristics.

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- Chlorination stage becomes less intensive due to reduced bleach chemical requirement.
- Reduction in bleach effluent load by about 50%
- No much adverse effect on pulp strength properties even with 18-20% drop in pulp viscosity.

APPM APPROACH

Towards its endeavor for cleaner production, in the interest of society as well as industry, APPM has taken up various measures from time to time by upgradation of its process technology. Some of the technologies implemented are,

-- Introduction of Oxidative Extraction (Ep) in place of conventional alkali extraction (E) in two bleach lines.

-- Introduction of Chlorine -Di-Oxide bleaching in one of its two bleach lines i.e., C/DEpDED in place of CEpHHH.

Another step under implementation is installation of 320 TPD modern belt washing system of M/s Thermo Black Clawson. This reduces carry over of organics (COD) from washing stage to bleaching thereby reducing formation of chlorinated organics in bleach effluent.

To make the process further environmental friendly, it is proposed to convert the total bleaching process (2 Bleach lines) to Chlorine -Di-Oxide bleaching through the adaptation of short sequence bleaching C/DEpD.

To facilitate this approach Oxygen delignification is also proposed. To study the practical feasibility of these twin approaches, bench scale experimental studies were initiated by In-House R & D of APPM in association with prospective machinery/technology suppliers. The preliminary laboratory study results are presented in this article.

RESULTS & DISCUSSION

REDUCTION IN KAPPA NUMBER

The conditions for Oxygen delignification of unbleached pulp are selected to limit the delignification to 50-55% so that pulp yield and strength properties are not adversely affected. From the results (vide Table-1) it can be observed that, the Kappa number can be reduced from 20.6 to 10.4 i.e., 49.5% reduction by using 2.0% Sodium hydroxide, at an oxygen pressure of 5 bar, with a retention time of 60 minutes at 98°C. The Oxygen delignified pulp lignin content is 1.84% compared to 3.4% in unbleached pulp. There is a corroesponding improvement in Pulp brightness 40% vs 26.2% Elrepho.

TABLE-1

OXYGEN DELIGNIFICATION RESULTS

A. Oxygen delignification conditions		
1. Consistency	%	12.0
2. Oxygen Pressure	bar	5.0
3. Temperature	°C	98
4. Retention Time	minutes	60
5. Alkali dosage as NaOH%		2.0
6. pH Initial/Final		10.8/10.2
7. Yield	%	96.9

* As per technology supplier.

B. Pulp Properties	**Unbleached pulp**	**Oxygen delignified pulp**
1. Kappa No.	20.6	10.4
2. Brightness % Elrepho	26.2	40.0
3. Viscosity, cps	16.9	11.5
4. Klason Lignin, % (Ash corrected)	3.4	1.84
5. Pulp Evaluation		
i. PFI Revolutions, No	2000	2100
ii. Burst Factor	39.3	36.8
iii. Breaking Length, meters	6990	5890
iv. Tear Factor	68	66
v. Double Folds, Nos.	31	23

TABLE-2

Particulars	C/DEpDED	C/DEpD
UNBLEACHED PULP		
i. Kappa No.	20.6	20.6
ii. Viscosity, cps	16.9	16.9
OXYGEN DELIGNIFIED PULP		
i. Kappa No.	---	10.4
ii. Viscosity cps	---	11.5
1. C/D STAGE		
i. Total Chlorine %	5.03	2.5
ii. Chlorine as Cl_2%	3.77	1.875
iii Dioxide as ClO_2, %	0.48	0.238
iv. pH Initial/Final	2.7/2.5	3.6/3.9
2. Ep STAGE		
i. Alkali, %	2.2	1.5
ii. H_2O_2, % (50%)	1.0	1.0
iii. pH Initial/Final	11.5/10.6	11.2/11.0
3. DI STAGE		
i. Dioxide as ClO_2, %	0.70	0.66
ii. pH Initial/Final	5.7/4.1	4.0/3.8
iii. Brightness, %	81.5	87.5
iv. Viscosity, cps	13.2	9.3
4. E2 STAGE		
i. Alkali, %	0.7	---
ii. pH Initial/Final	11.2/10.6	---
5. D2 STAGE		
i. Dioxide as ClO_2, %	0.3	---
ii. pH Initial/Final	7.0/6.0	---
6. SO_2 Dosage %	0.6	0.3
7. FINAL PULP OPTICAL PROPERTIES		
i. Brightness, %	87.8	88.0
ii. Viscosity, cps	13.2	9.1
iii. Yellowness, %	4.4	4.3
iv. Whiteness, %	79.5	79.8
v. P.C. No.	1.4	1.2
8. PULP EVALUATION		
i. PFI Revolutions No.	3700	3800
ii. Burst Factor	38	37
iii. Breaking Length, meters	5714	5250
iv. Tear Factor	66	70
v. Double Folds, Nos.	48	22
9. CHEMICAL CONSUMPTIONS		
i. Total Chlorine as Cl_2 %	3.77	1.875
ii. Total dioxide as ClO_2 %	1.48	0.898
10. CALCULATED AOX kg Cl/T	4.55	2.35

BLEACHING CONDITIONS

Bleaching Stage	Cy%	Time minutes	Temp °C
C/D	3.0	45	32
EP	10.0	65	65
D	10.0	180	75
E2	10.0	65	65
D2	10.0	180	75

EFFECT ON INPUT PULP STRENGTH PROPERTIES

There is about 32% drop in the pulp Viscosity i.e., from 16.9 to 11.5 cps. However, this drop did not reflect much drop in burst factor and tear factor. The drop in burst factor is about 6% (36.8 vs 39.3) and the drop in tear factor is about 3% (66 vs 68). But the breaking length is reduced about 16%.

REDUCTION IN TOTAL CHLORINE DEMAND

From Table-2 it can be seen that there is a significant reduction (44.7%) in total Chlorine consumption for Oxygen delignified pulp to attain the same level of final pulp brightness.

The elemental chorine consumption in first stage (C/D) reduced from 3.77% to 1.875% for oxygen delignified pulp. This reduction (50.3%) correlates with the reduction in Kappa number (49.5%). Similarly the total dioxide consumption reduced by 39.3% i.e., 0.898% vs 1.48%. The reduction in dioxide dosage facilitates to cope-up with the dioxide requirement for total pulp bleaching (300TPD) while maintaining targeted final pulp brightness 87 ±1% with the existing Chlorine -di-oxide generation capacity.

REDUCTION IN AOX GENERATION

The formation of AOX in bleach effluent is proportional to the amount of elemental chlorine consumed in bleaching. Because of low elemental chlorine charge for oxygen delignified pulp, the calculated AOX value, as per Germgard equation is 2.35 kg. Cl/T with short sequence bleaching compared to 4.55 kg. Cl/T with five stage bleaching.

FINAL PULP PROPERTIES

A perusal of final bleached pulp properties (vide Table-2) indicates that the optical and strength properties of short sequence bleached pulp are comparable with five stage bleached pulp though the viscosity is on lower side.

BENEFITS OF THREE STAGE BLEACHING

With fewer bleaching stages (3 vs 5) handling of effluent volume will be reduced besides savings in utilities like power and steam. However, the process conditions are to be critically optimised, controlled and monitored, lest it is not possible to correct the final pulp brightness as in the case of five stages.

CONCLUSIONS

Though oxygen delignification is capital intensive, reduction in handling of bleach plant effluent volume and AOX load could be achieved through short sequence bleaching of C/DEpD and oxygen delignification without much adverse effect on final pulp quality. Further benefits include reduction in over all utilities due to lesser number of bleaching stages. This helps the industry to be more environmental friendly and achieving EMS certification.

EXPERIMENTAL

The Pulp furnish is 15% Bamboo and 85% Hardwoods from farm forestry. The Oxygen delignification study was carried out in Oxygen Reactor at Technology suppliers laboratory. The pulp evaluation and bleaching of Oxygen delignified pulp was carried out at APPM laboratory. The delignification conditions and results are presented in Table-1. Bleaching experiments were carried out in closed and sealed plastic bottles. Required temperatures were maintained using hot water bath. The Kappa number of pulp was determined as per T-236. The unbleached and oxygen delignified pulp viscosities (0.5M CED) were determined after chlorite treatment as per T-230. Strength properties of pulps were evaluated after beating in PFI Mill to a freeeness level of 40 ± 2°SR . The handsheets after air drying in rings were conditioned at 23±1°C and 50±2% RH and tested as per TAPPI standard procedures. Whiteness and Yellowness were determined using tristimulus reflectance values Rx, Ry and Rz with 9, 10 and 11 filters in Carl Ziess Elerpho Brightness tester using the following formulae.

$$\% \text{ Whiteness} = Ry - 3(Rx-Rz)$$

$$\% \text{ Yellowness} = \frac{(Rx-Rz)}{Ry} \times 100$$

P.C. number is determined using the formulate (N2-N1) x 100

$$\text{Where } N1 = (1-R1)^2 / 2\,R1$$

$$N2 = (1-R2)^2 / 2\,R2$$

Where R1 is initial brightness of pulp divided by 100

R2 is brightness of pulp after oven drying for 16 hours at 105°C divided by 100.

AOX was computed using Germgard equation ---

$$\text{AOX as Cl kg/T} = 0.1\,[C + 0.526\,D]$$

Where C=Chlorine consumption as Cl_2 kg/T

Where D=Chlorine-di-Oxide consumption as ClO_2 kg/T.

The bleaching conditions and results are presented in Table-2.

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