A Comparative Study Of Eucalyptus Hybrid Pulp Properties For Conventional Batch Cooking And Superbatch™ Cooking

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ABSTRACT

The differences in the process of Kraft pulping in conventional batch digester and super batch digester was studied and presented. Conventional batch cooking is followed by CEPHH bleaching sequence and superbatch cooking is followed by oxygen delignification and D_{HT}(EOP) D_1 bleaching sequence. Cooking parameters for both digesters was analysed and presented. The proximate analysis for the wood was carried out. The pulp was collected from each stage and the hand sheets were formed for 60 gsm. The pulp hand sheets was analysed for strength properties and optical properties according to the TAPPI test methods T220 sp-01. The strength properties of the pulp for both cooking were compared and presented. The formation and presence of Hexenuronic acid in conventional cooking and superbatch cooking was also studied. Hexenuronic acid presence was determined using TAPPI test method T282 pm-07 and the result was presented.

Key words: conventional cooking, superbatch cooking, Hexenuronic acid

INTRODUCTION

The superbatch system is a batch pulping process that recycles black liquor from a completed batch to pretreat the raw chips in the next batch. White liquor is charged to the digester after pretreatment. In case of conventional batch system there is no pretreatment process. The black liquor pretreatment heats the chips and drives out air, neutralizes wood acids, and fills the chips with high-sulfidity liquor [1][2][3]. This high sulfidity liquor reacts with the carbohydrates of the wood and forms products such as Hexenuronic acids at the initial stage of cooking.

The primary advantage of the superbatch process is a decrease in digester steam consumption, with a reduction of 60-80% compared with conventional batch kraft pulping. The energy savings accure from the shorter steaming time required to reach white liquor cooking temperature [1][2][4][5]. In addition, superbatch pulping extends delignification, making it possible to produce pulps with lower kappa numbers than the conventional batch pulping. Delignification is also faster than in conventional batch pulping. This improved pulping performance provides practical economic benefits in terms of increased production savings in bleach plant chemicals and effluent load reduction[1][2][6].

Most of the plant studies in superbatch pulping have focused on softwood species [7]. For Indian conditions superbatch cooking is done on hardwoods. This paper presents the results of a plant study of superbatch cooking with hardwoods in T.N.P.L.,Tamilnadu.

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RESULTS

The Proximate Analysis Of The Wood

The proximate analysis of the wood chips (eucalyptus hybrid) was carried out and the results are shown in Table No.1.

TABLE.1
Proximate Analysis Of Edcalytpus Hybrid Wood

PARAMETER	EUCALYPTUS HYBRID
ASH (%)	0.86
SILICA (%)	0.20
HOT WATER SOLUBLITY (%)	8.60
1% NaOH SOLUBLITY (%)	24.85
Alcohol Benzene EXTRACTIVES (%)	3.31
ACID INSOLUBLE LIGNIN (%) (Ash corrected)	28.60
PENTOSANS (%)	13.75
HOLLO CELLULOSE (%) (Ash corrected)	62.20

PULPING CONDITIONS

The Table.2 shows the pulping conditions maintained in both

TABLE-2
Pulping Conditions For The Digester

PARAMATER	CONVENTIONAL BATCH DIGESTER	SUPERBATCH DIGESTER
TEMPERATURE(°C)	165	162
COOKING TIME (min) At max temp.	75	90
H-factor	1200-1300	800-1000
LIQUOR-TO-WOOD RATIO	3:1	3:1
ACTIVE ALKALI CHARGED (%)	15	19
SULPHIDITY (%)	18-19	18-19
CHIPS CHARGED (tons)	28-30	70-75
YEILD (%)	40-44	43-47
SPECIFIC STEAM CONSUMPTION(tons/ton of unbleached pulp)	1.89	1.34

conventional batch digester and superbatch digester. The cooking temperature maintained in conventional batch digester is about 165°C and in superbatch digester it is about 162°C. The capacities of the digesters are 80 m^3 and 200 m^3 for conventional batch digester and superbatch digester respectively.

Kappa Number And Viscosity Of The Pulp

The kappa number and viscosity of the pulp is measured at various stages in conventional batch cooking followed by CEPHH bleaching sequence and in superbatch cooking followed by oxygen delignification and ECF sequence. The results are shown in the figure 1.

Hexenuronic Acid In The Pulp

The Hexenuronic acid content of the pulp in conventional batch cooking and superbatch cooking was analysed. The final pulp after their respective bleaching sequence was also analysed for Hexnuronic acid. The figure 2 shows the results.

TABLE-3
Strength Properties Of Conventional Batch Cooking And CEPHH Bleaching

PARAMETER	UNIT	UNBLEACHED HARDWOOD WASHERS	CL_2 – CHLORINATION STAGE	EXTRACTION STAGE	HYPO-1 STAGE	HYPO-2 STAGE
Freeness	mL CSF	410	400	450	420	390
Substance	g/m^2	59.9	61.5	59.2	60.4	60.1
Breaking length	m	4300.0	4590.0	3980.0	4120.0	4910.0
Tear factor	(no Unit)	79.0	69.7	92.7	59.5	72.3
Burst factor	(no unit)	36.0	25.7	33.7	30.9	28.6
Brightness	%	29.0	38.3	39.2	79.6	83.9
Scattering coefficient	m^2/kg	38.0	44.7	45.0	51.3	51

TABLE-4
Strength Properties Of Superbatch cooking And ECF Bleaching

PARAMETER	UNIT	UNBLEACHED WASHING PRESS	POST OXYGEN PRESS	D_{HT} PRESS	Eop PRESS	D_1 PRESS
Freeness	mL CSF	310	320	350	340	320
Substance	g/m^2	60.8	59.3	59.5	59.7	61.7
Breaking length	m	6340	6050	5700	5840	6120
Tear factor	(no Unit)	93.6	84.7	72.97	70.5	94.0
Burst factor	(no unit)	38.2	37.2	32.7	35.8	41.5
Brightness	%	24.4	40.5	55.1	66.9	83.6
Scattering coefficient	m^2/kg	30.3	43.0	58.9	58.3	49.3

FIGURE-1
Kappa Number And Viscosity Variation In Cooking And Bleaching

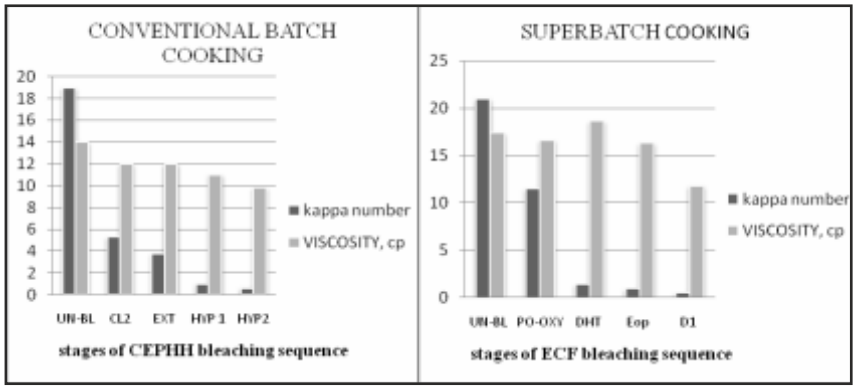
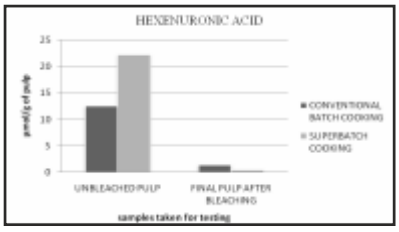


FIGURE-2
Hexenuronic Acid Content Of The Pulp



Physical Properites Of The Pulp

The pulp hand sheets of Eucalyptus Hybrid pulp for both pulping process were tested for strength properties. The final pulp of the bleaching sequences of CEPHH and ECF was also tested for strength properties. Table.3 and Table.4 shows the strength properties and optical properties for the entire cooking and bleaching sequence of their respective cooking.

DISCUSSION

Effect On Cooking Coditions

The most of the cooking conditions are same for both cooking the difference is only with the procedure of cooking. The superbatch includes a pretreatment process sequence and displacement sequence. These sequences modify the cooking parameters as the H-factor reduced by 300 to 400 for the pulp with same kappa number when cooked with conventional batch cooking process. The temperature around 140-155°C was attained at the end of the hot liquor filling sequence. Hence the digester steam consumption reduces as only small amount of steam is used to further increase the temperature to 162°C (cooking temperature).

Kappa Number Of The Pulp

The pulp from superbatch cooking process are cooked to a higher kappa number than the conventional batch cooking. This is due to the process of oxygen delignification present in superbatch cooking sequence. Oxygen delignification reduces the pulp kappa

number to 40% of the initial value without degrading the pulp. The kappa number of the pulp obtained after oxygen delignification is only about half of the kappa number of the pulp from conventional batch cooking. Hence this reduces the bleach chemical consumption in further bleaching process.

Hexenuronic Acid Content Of The Pulp

The pulp from conventional batch cooking contains less amount of Hexenuronic acid than the pulp from the superbatch cooking. This may be due to the reason a high initial HS^-/OH^- concentration maintained during pretreatment of the pulp. The initial HS^-/OH^- ion concentration determines the maximum value of the Hexenuronic acid at the start point of the cooking process.

Gustavsson[8] showed that Hexenuronic acid is formed rapidly at the point of start of the cooking and gradually degrades with the cooking time. This shows that the pulp with short cooking time will have more Hexenuronic acid than the longer cooked pulp. But superbatch which has longer cooking time than conventional batch cooking also has more Hexenuronic acid.

Hexenuronic acid groups react with electrophilic bleaching chemicals such as chlorine dioxide, ozone etc and results in more consumption of bleaching chemicals. Hexenuronic acid groups are non reactive in alkaline oxygen and peroxide bleaching stage. Its presence in the final bleached pulp causes colour reversion in the pulp.

Effects On Physical Properties Of The Pulp

The discharge sequence of superbatch cooking creates a major difference in pulp strength properties with pulp from conventional cooking. Blow of the digester in conventional cooking process damages the cell wall and hence reduces the strength properties, but discharge of pulp from superbatch digester preserves the fiber and hence higher strength properties are recognized. ECF bleaching sequence also guides the pulp towards higher strength properties with low degradation of the pulp. Brightness of the pulp also increased with ECF bleaching sequence. The figure.3 and 4

FIGURE-3
Physical Properties Of conventional Batch Cooked And CEPHH Bleached Pulp

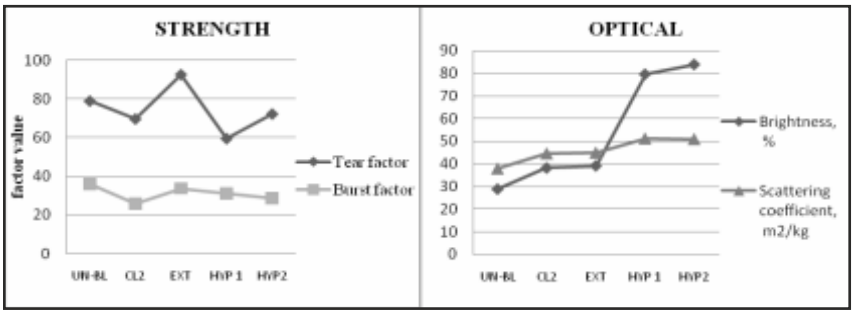
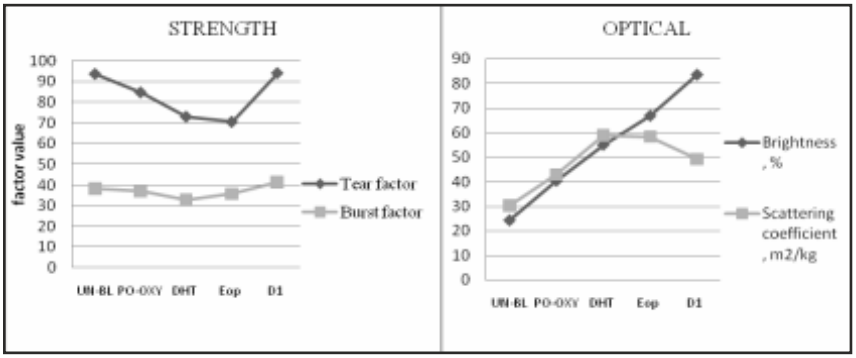


FIGURE-4
Physical Properties Of Superbatch Cooked And ECF Bleached Pulp (With Oxygen Delignification)



shows the comparisons.

CONCLUSION

Form the study it is concluded that

A. Superbatch cooking process is superior to the conventional batch cooking process.
B. The H-factor is reduced in superbatch cooking due to pretreatment process and hot liquor filling.
C. Filling the Hot liquor rapidly into the digester holds the key for low steam consumption.
D. Discharge of the pulp from the digester preserves the strength of the pulp.
E. Oxygen delignification in superbatch reduces the kappa to 40% of initial value.
F. ECF bleaching sequence increases the pulp brightness without degrading the pulp.
G. Hexenuronic acid content is higher in superbatch cooked pulp than in conventional batch process cooked pulp.

EXPERIMENTAL

Pulps

All pulp samples used in the study was collected freshly from the plant sites in T.N.P.L on the day of each analysis.

Kappa Number, Hexenuronic Acid And Viscosity Measurement

Pulp kappa number is measured according to the TAPPI test methods T236 om-99 and the Hexenuronic acid content in the pulp is measured according to TAPPI test method T282 pm-07. The viscosity of the pulp is measured according to T230 om-99.

Proximate Analysis For The Wood Chips

The proximate analysis for the wood chips was carried out according to the standards of TAPPI methods. The proximate analysis include Ash (T211 om-93), silica (T245 cm-98), hot water solubility (T207 cm-99), 1%NaOH solubility (T212 om-98), Alcohol benzene extractives (T204 cm-97), Acid insoluble lignin (T222 om-02), Pentosans (T223 cm-01) and Hollocellulose (T9 wd-75).

Forming Hand Sheets

The pulp samples were used to produce 60 gsm (g/m^2) hand sheets for the purpose of physical property testing. Before the hand sheets were made the pulp samples were refined using PFI mill according to TAPPI test methods T248 sp-00 to the required CSF (Canadian standard freeness). The hand sheets were formed according to the T205 sp-02.

Physical Testing Of The Hand Sheets

All sample hand sheets were pre-conditioned for 4 hours before testing. The physical testing of the hand sheets was carried out according to TAPPI test methods T220 sp-01.

H-Factor Of The Cook

H-factor for conventional batch digester cooking was determined according to the method described by Vroom [9]. H-factor for superbatch cooking is calculated according to the method described by Satyavolu.V [10], which provides an analytical equation.

Analysis Over Digester Pulping Conditions And Parameters

The digester parameters such white liquor analysis, black liquor analysis, sulphidity etc., was determined according to TAPPI Standard methods.

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LITERATURE CITED

1. Evans, J.C,W., pulp paper 63(7): 132 (1989)
2. Young,J., pulp paper 63(10): 61 (1989)
3. Tikka, P.O., TAPPI Pacific section annual seminar Proceedings, TAPPI PRESS, Atlanta, Sept. 1990.
4. Kaiser, M. and Pierre, R., TAPPI 1986 Pulping Conference Proceedings, TAPPI press, Atlanta, pp. 627-32.
5. Sainiemi, J., TAPPI 1986 Pulping Conference Proceedings, TAPPI PRESS, Atlanta, p. 643.
6. Mera, F. E. and Chamberlin, J. L., Tappi J. 71(1): 132(1988).
7. Brenda, A. M. and Richard, R.G., Tappi J. 79(5): 180 (1996).
8. *G*ustavsson*, C.* and Al-Dajani*, W.,* Nordic Pulp Paper Res. J.: *15*(2), 160-167, (2000).
9. Vroom,K.E., Pulp Paper Mag.Can. 58(convention issue): 228(1957)
10. Satyavoul. V.N, Nadh Jagannadh, Peter. W.H and Jeffery.S.H., Tappi J.76(6): 75(1993).