Chemimechanical Pulping of E. TERETICORNIS with Kraft Cooking Liquor Impregnation

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ABSTRACT

The plantation grown *E.tereticornis* constitutes the main raw material used for the production of high yield pulp component of newsprit furnish. Cold soda chemimechanical pulping process is practiced in all the three newsprint mills. Major portion of the spent liquor from this pulping process goes to recovery. However tha presence of sodium sulfide in these spent liquors will be of an advantage in sulphur make up. In the present studies chemimechanical pulps were produced by impregnating the chips with kraft cooking liquor. The objective of the study was to see the influence of the presence of sodium sulfide on the properties and bleachability of pulps It was concluded from these studies that sodium sulfide when present during impregnation stage, imparts impr ved strength and bleachability to pulps.

Study was undertaken to investigate the influence of the presence of sodium sulphide, during impregnation of chips, on strength properties and bleachability of pulps. Normally sodium hydroxide is used for impregnation in production of chemimechanical pulps However there is not much of information available on impregnation of chips, either completely with Na_2S or partially along with sodium hydroxide. From the literature[1] it was observed that the pre-treatment of chips with Na_2S prior to kraft delignification had benificial effects on the pulp properties. In the present investigations *E. tereticornis* chips were impregnated with sodium sulphide solutions. Three different methods were employed for impregnation. The resulting chemimechanical pulps were evaluated for strength properties and bleachability aspects.

RESULTS AND DISCUSSION

Initially the experimental plan included only PREX-impregnation. However in PREX-impregnation it was observed that after an initial compression of chips by about 40-50% (volume basis only about 6% volum was restored indicating insufficient expansion. This has resulted into absorption of less amounts of chemicals. So it was decided to have the other two impregnation methods to achieve maximum chemical penetration so that the effect of Na_2S could be studied.

Table-1 gives the physical data of the raw material. The basic density is in the normal range. Table-2

Table – 1

PHYSICAL DATA OF RAW MATERIAL

(E. tereticornis)

i) Basic density. kg/m³	—560				
ii) Bulk density (Moisture free basis), kg/m³	—261				
iii) Chip classification :					
Thickness, mm	—3	5	8	10	
% chips by weight	—19.5	41.3	33	6	5.6

shows the impregnation and refining conditions. Results show that in PREX-impregnation the chemicals absorbed were on lower side. This might be attributed to two reasons. The first reason is that the presteamed chips results into some moisture content in chips which leads to lower chemical concentrations within the chips. While in the former two cases the airdry chips were directly impregnated with cooking liquor. The second reason might be the insufficient expansion of compressed chips. The yields of overnight soaking experiments were slightly on lower side. However in all the cases

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the presence of Na_2S during impregnation has not reflected on pulp yields. Reject contents were higher in the case of PREX-impregnation due to less chemical absorption.

Table-3 shows the results of bleaching studies. In all the experiments with 10% hypochlorite, brightness in the range of 55 to 57% was achieved. There was a definite trend in the yield loss during bleaching. The pulps prepared with ($NaOH + Na_2S$) impregnation had lower yield losses when compared to the pulps prepared with only NaOH impregnation.

Strength & Optical Properties :

Table-4 shows the fiber classification of chemimechanical pulps. Both the fiber and fines proportions in chemimechanical pulps are important from the view point of strength and optical properties. The results show that in all the cases more than 50% of fines fraction was generated and 100 fraction was around 40%.

Table-5 shows the strength properties of the pulps. Results show that strength, to a large extent, is influenced by the amount of chemicals absorbed. The pulps produced by overnight soaking, where maximum amount of chemicals were absorbed, had excellent strength properties. A tensile index as high as 25 5 NM/g was obtained. In hydrostatic pressure and PREX-impregnation it was observed that there was a marginal increase in strengths of pulps produced with [$NaOH + Na_2S$] impregnation. All the pulps had satisfactory opacity and brightness values even at lower levels of freencss.

TABLE—2

IMPREGNATION CONDITIONS AND RESULTS OF CHEMIMECHANICAL PULPING

Particulars / Cook No.	Overnight soaking 1S	Overnight soaking 2SS	Hydrostatic pressure 2H	Hydrostatic pressure 2HS	PREX-Impregnation 3P	PREX-Impregnation 3PS
Impregnation						
Chemicals applied	NaOH	$NaOH+Na_2S$	NaOH	$NaOH+Na_2S$	NaOH	$NaOH+Na_2S$
Chemical dose,%as NaOH	12.0	12.0	12.0	12.0	12.0	12.0
Pressure applied, kg/cm²	Atmospheric		10—11		145—150 (2 minutes)	
Temperature, °C	Ambient		Ambient		40±2	
Material to liquor ratio	1:4		1:4		1:4	
Impregnation time,	18 hrs.		15 min.		30 min.	
Pulping :						
Refiner clearance, first & Second pass, mm	0.25/0.13		0.25/0.13		0.25/0.13	
Chemical consumed,%as NaOH	9.18	8.29	7.29	6.62	5.57	5.92
Total pulp yield, %	88.6	90.8	93.5	92.8	92.3	91.0
Rejects, %	1.4	0.9	1.4	1.6	5.1	5.5

Constant conditions—Liquor concentrations — 30 g/l as NaOH
White liquor sulfidity — 20%
O. D. chip charge — 400 g.

TABLE—3

BLEACHING OF CHEMIMECHANICAL PULPS OF EUCALYPTUS TERETICORNIS

S. No.	Particulars Impregnation	Overnight soaking		Hydrostatic pressure		PREX Impregnation	
		NaOH	NaOH+Na_2S	NaOH	NaOH+Na_2S	NaOH	NaOH+Na_2S
1.	**Hypo—I stage**						
	Hypochlorite as Cl_2, % applied/consumed	7.0/6.98	7.0/6.97	7.0/6.96	7.0/6.96	7.0/6.96	7.0/6.96
	Buffer used as NaOH, % to maintain pH>9.0	1.0	1.0	1.0	1.0	1.0	1.0
2.	**Hypo—II stage :**						
	Hypochlorite as Cl_2, % applied/consumed	3.0/2.98	3.0/2.98	3.0/2.96	3.0/2.97	3.0/2.98	3.0/2.98
	Buffer used as NaOH, % to maintain pH>9.0	0.6	0.6	0.6	0.6	0.6	0.6
3.	Total hypochlorite used as Cl_2, % applied/consumed	10.0/9.96	10.0/9.95	10.0/9.92	10.0/9.93	10.0/9.94	10.0/9.94
4.	Total Buffer used as NaOH,%	1.60	1.60	1.60	1.60	1.60	1.60
5.	Brightness, % ISO	56.0	55.0	56.0	56.4	57.0	55.6
6.	Post color number	7.2	7.3	6.9	8.5	6.8	8.0
7.	Yield loss during bleaching,%	3.75	2.14	3.28	1 71	3.24	1.70

Constant conditions (Hypo I & II Stage) — Consistency, % — 5.0
Temperature, °C — 40
Time, min. °C — 30

TABLE—4

BAUER McNETT FIBER CLASSIFICATION

S. No.	Pulp No.	CSF (ml)	% Fiber fraction			
			+48	−48/+100	−100/+200	−200
1.	1S	300	25.0	13.0	10.0	52.0
2.	1SS	325	21.0	13.0	10.0	56.0
3.	2H	290	24.0	16.0	9.0	51.0
4.	2HS	315	24.0	16.0	9.5	50.5
5.	3P	320	25.0	12.0	12.2	50.8
6.	3PS	165	15.0	14 0	10.0	61.0

TABLE – 5

STRENGTH PROPERTIES OP BLEACHED CHEMIMECHANICAL PULPS

Pulp Sample	PFI rev.	Freeness CSF ml	Apparent density g/cm³	Tensile Index N.m/g	Stretch %	Burst Index kPa.m²/g	Tear Index mN.m²/g	Air resistance Gurley s/100ml	Brightness %	Opacity %
IS	0	310	0.44	18.5	1.7	0.50	1.95	4.6	56.0	97.7
	2000	160	0.51	23.5	1.9	0.75	1.90	15.8	—	97.7
ISS	0	300	0.46	17.5	1.8	0.60	1.90	5.2	55.0	97 6
	2000	110	0.52	25.5	2.1	1.04	2.30	18 5	—	97.4
SH	0	305	0.38	9.5	1.2	0.15	1.30	2.5	56.0	96 0
	2000	115	0.44	16.0	1.4	0.30	1.25	9.5	—	96.5
?HS	0	325	0.40	12.0	1.2	0.20	1.20	2.2	56 4	95 0
	2000	120	0.46	17.0	1.4	0,45	1.50	10.0	—	95 3
3P	0	320	0.36	7.5	1.1	0,10	1.20	1.7	57.0	95.7
	2000	105	0.43	13.5	1.3	0.20	1.50	6.8	—	96.5
3PS	0	165	0.41	12.0	1.3	0.30	1.50	5.3	55.8	—
	2000	105	0.44	16.0	1.6	0.40	1.35	8.9	—	—

CONCLUSIONS

1. From the studies it can be concluded that the presence of Na_2S during impregnation stage does not have any adverse effect. On the contrary it is expected that even on mill scale, with more effective mechanical compression, it could have beneficial effects on strength and bleachability of pulps.
2. Studies also indicate that maximum chemical absorption is an important factor as far as the quality of pulps is concerned.
3. It appears that chemical absorption at lower temperature [around 30°C] with a prolonged time of soaking is more effective than the chemical absorption at higher temperatures with shorter soaking time.

EXPERIMENTAL :

Raw Material Preparation :

E. tereticotnis chips were screened and oversize chips were removed manually. Chips were subjected to classification for thickness and results are given in Table-1. Bulk and basic density of the chips were determined as per methods of the laboratory manual of this Institute (2).

Impregnation of Chips :

Three methods followed for impregnation were overnight soaking, hydrostatic pressure and PREX-impregnation. In overnight soaking the chips were submerged in NaOH solution of 30 g/l concentration for overnight (about 18 hrs.) before they were subjected to defiberizing. The temperature during soaking was about 30°C. The chips were not presteame d.

In hydrostatically pressurized method A.D. chips and liquor were taken into autoclaves (2.5 litre capacity) and then nitrogen gas was injected and a pressure of about 10-11 Kg/cm² was maintained. The autoclaves were fixed in series digester unit and rotated for 15 minutes.

The PREX-impregnation was carried out in a laboratory PREX unit which is illustrated in Fig. 1. Chips were presteamed in steaming tube and steamed chips

FIG-I

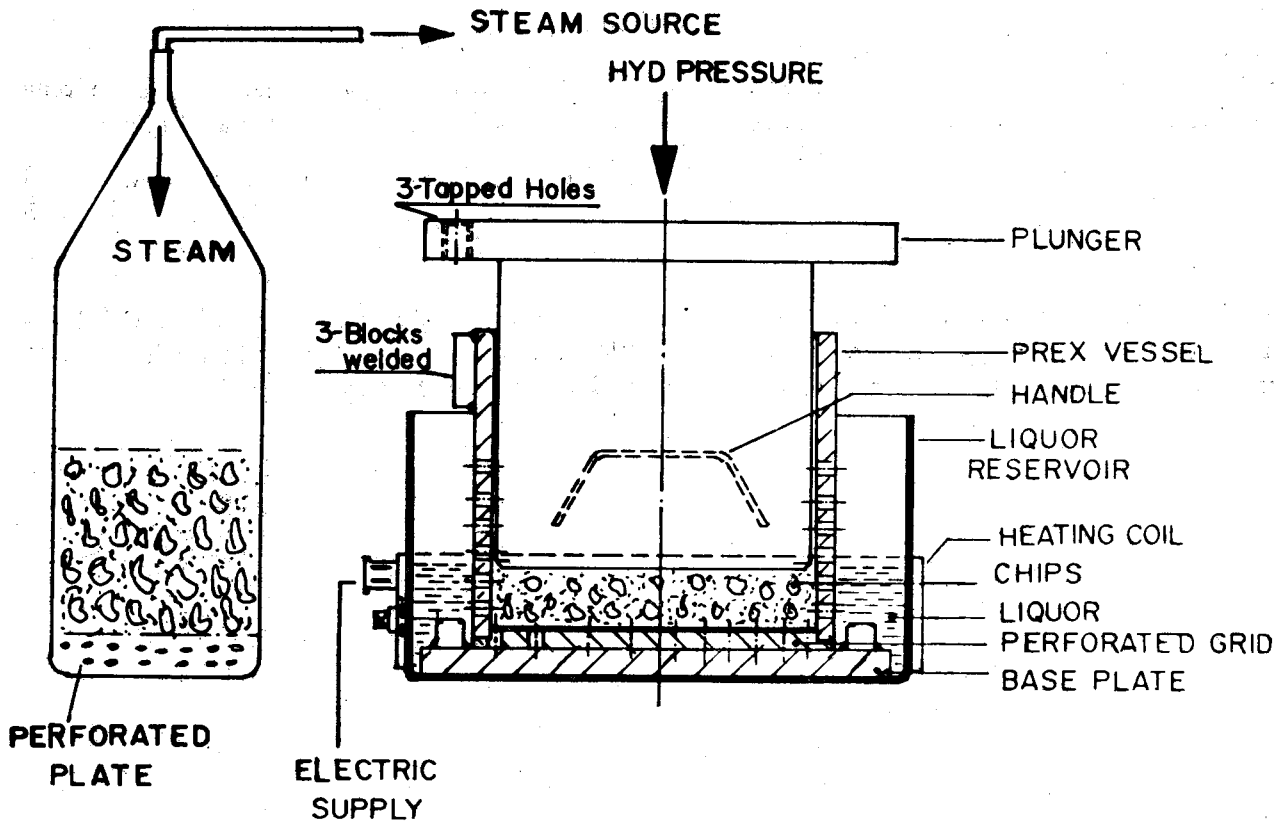

ILLUSTRATION OF LABORATORY PREX APPARATUS

were placed in PREX vessel provided with perforations. Plunger was placed and hydraulic pressure of about 140-150 Kg/cm² was applied. The pressure was maintained for 2 minutes. Meanwhile the liquor was added in a quantity so that the level of the liquor was slightly above the level of chips. Pressure was released and chips were allowed to expand in the liquor. Expanded chips were retained in the liquor for 25 minutes. Extent of chip compression and expansion was determined by noting down the movement of the plunger.

In all the cases two sets of experiments with NaOH + Na_2S were carried out under identical conditions.

Spent Liquir : The spent liquor after impregnation was withdrawn and quantity was measured. Residual alkali was determined potentiometrically. From residual alkali and volume of spent liquor the amount of chemical absorbed by the chips was calculated.

Refining :—Impregnated chips were refined in 12" Sprout-Waldron disc refiner. In the first stage a coarse pulp was produced by refining at a disc clearance of 0.25 mm Second stage refining was carried out with a disc clearance of 0.13 mm and consistency of about 5-7%. The final freeness target was around 350 ml CSF.

Bleaching : Chemimechanical pulps were screened in a Sarala flat screen and then bleached to a brightness level of 55% ISO by two stages hypochlorite bleaching. Hypochlrorite dosages were optimized on small scale experiments.

Pulp Evaluation : Bteached pulps were evaluated for their optical and strength properties. The final freeness around 125 ml was achieved by beating in PFI mill. 60 g/m² sheets were prepared in a British sheet making machine provided with recycling of back water. Sheets were conditioned at 27°C and 65% R.H. and tested according to ISO standard methods mentioned in the manual[2].

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