High yield pulps from eucalyptus using the new sulphonated chemi-mechanical pulping process

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ABSTRACT

Attempt has been made to produce good strength high yield pulps from plantation grown Eucalyptus tereticornis by the sulphonated chemi-mechanical process to reduce chemical component in the newsprint furnish. Chemical treatments using sodium sulphite solutions were given to chips for softening the wood fibre and reducing the damage caused to it during refining. Two modes of chemical treatment ie. treatment during and prior to refining has been studied as a function of time, temperature and chemical concentration. It has been observed that with this process good strength pulp in the yield range of 85% can be obtained by cooking at 150°C for 45 mts. Unbleached pulp brightness is 46% which can be easily bleached to 58% by a single stage hypochlorite treatment. Spent libuor can be recycled effectively without any adverse effect on either brightness or strength properties, Pollution load at the high yields maintained is low.

Introduction

Large scale eucalyptus plantations are being carried out in the country to meet the demands of paper industry. Considerable work has been done on the various plantation grown eucalyptus species, using various pulping processes. However mechanical pulps from such species have poor strength properties which are not improved even by pressurised refining. Development of newer methods for high yield pulping like TMP which were suitable for softwoods again could not give pulps of appreciable strength from hardwoods, and it was found that chemical treatments were still necessary. During a chemical treatment the chemicals present make fibrisation easy with more efficient use of energy in the subsequent mechanical steps. Reason for inferior quality of pulps from hardwoods lies in their morphlogy. Unlike the fines in softwoods which are highly fibrillated hardwoods have abundance of vessels and cells which produce low quality fines, and these have an adverse effect on the pulp strength[1]. Because of the rigid structure in hardwoods peeling off of S_1 and then fibrillation of S_2 is difficult. Hardwoods can be made to behave like softwoods under refining by a suitable chemical treatment of chips.

A number of chemicals were tried and of many sodium sulphite has been widely recommended as a possible choice. In fact work on chemical treatment first involved the post treatment of mechanical pulps. This treatment through its action by increasing the hydrophilicity of the lignin improves the paper strength properties like tensile index and bursting index but does little to improve the tearing strength which is important for newsprint, because the damage to the fibre length has already been caused during refining. Therefore the chemicals should be added at such a stage so that the damage to the fibre during refining is minimum, ie. either during the refining stages or before refining. A new process called the sulphonated chemimechanical pulping for producing a low shives and high strength mechanical pulps which uses a high conc. of sodium suiphite as the cooking liquor has been patented and commercially exploited by the Gatineau newsprint mill and (CIP) which produces 380t/d of this pulp[2]. Strength properties of SCMP are much better than refiner mechanical pulps and close to those of chemical pulps.

Present work has been carried out to explore the possibility of producing good quality high yield pulp from indegeneous hardwoods to reduce the chemical component in the newsprint furnish. Eucalyptus tereticornis was taken for the study. Earlier work at the institute has shown that cold

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soda pulps from this wood has poor strength which could be slightly improved by the alkaline sulphite process. Chemical treatments using sodium sulphite were studied to soften the wood fibre during and prior to refining for reducing the fibre damage and optimise the cooking time, temperature and chemical conc. for a minimum yield and brightness loss.

Experimental

Billets of E. tereticornis were sawn into dimensions suitable for chipping in the pilot plant waterous disc chipper. The chips were screened on the pilot plant waterous vibrating screen, chips passing a 44 mm square and retained on a 6.5 mm square mesh were collected. Screened chips were stored in plastic bags till used.

Chemical Treatment of chips a) Pre-treatment : Chips were pre-steamed in a pressurised vessel at 130°C for 10 mts prior to cooking with sodium sulphite for different time and temperature condition.

b) Inter stage treatment : Chips were soaked in water for overnight and reduced to coarse size by giving a single pass in the refiner and cooked with sodium sulphite for different time and temperature conditions.

Refining : Cooked chips were refined in a laboratory sprout waldron disc refiner in two stages, first pass at 0.62 mm clearance at 8.0% consistency and the second pass at 0.05 mm clearance at 10% consistency. Refined pulp was collected and screened over a flat screen having a 0.26 mm slot width.

Chemical analysis : Chemical analysis like chemical consumption (% SO_2), total solids, COD, colour, pH of the liquor was determined as per laboratory manuals[8]. Sulphonate content of the pulp was determined by the combustion of sample in an atmosphere of oxygen and then gravimetric determination of the barium sulphate.

Pulp evaluation : Pulp evaluation was carried out using PFI mill. Handsheets made on the British sheet making machine were evaluated for its strength and optical properties as per standard ISO method.

Results & Discussion : Sulphonated chemimechanical pulps were prepared by the two treatments ie. pre-treatment and inter stage treatment, using sodium sulphite solutions from 10-100 gpl, wood to liquor ratio being 1:5. Temperature range studied was 120-150°C and cooking time being 30 and 45 mts respectively. Cooked chips were refined screened and evaluated for strength properties, Table-I gives pulping data for an inter stage. treatment.

TABLE — 1

Sl.	Sodium Sulphite (g/1	Yield %	Rejects %	Chemical consumption (% SO_2)	Total solids %	COD (g/l)
1.	10	90.0	1.5	83.3	1.65	14.5
2.	20	89.2	2.2	73.3	2.65	17.3
3.	30	88 2	1.8	62.5	2.54	16.2
4.	40	87.5	0.8	63.0	3.51	17.5
5.	60					
	i) —120°C	86.2	1.2	41.7	4.60	15.5
	ii) —140°C	86.5	0.6	46.6	5.42	18.7
	iii) —150°C	84.7	1.1	41.7	6.30	26.9

(Cooking condition—45 mts. at 150°C, wood to liquor 1:5).

Yield obtained for the SCMP pulps are in the range 85-90% and have a low shives content. Increasing the sodium sulphite concentration has a small effect on the decrease in yield, and same is true for temperature increase from 120-150°C. Even after cooking at 150°C the yield are still about 85%. As will be seen later that strength properties are much better at 150°C so this temp. has been taken as the optimum cooking temp, for the study. COD values at the hige yields maintained are low and comparable to those of cold soda spent liquors.

Effect of temp and sodium sulphite conc : Pulp properties are markedly affected by chemical conc., time and temp. of cooking, as illustrated in Fig (1,2) and Table II. At lower temp. the strength properties are low and not very much affected by the chemical conc. Increasing the temp. to 150°C results in appreciable improvement of strength properties and at this temp. sulphonate content was also found to increase sharply. Preliminary experiments showed that cooking at 160°C for 45 mts results in un-necessary loss in yield. Therefore a temp of 150°C can be taken as optimum which not only maintains higher yields (about 85%) but at the same time gives pulp of good strength.

Comparison of the two chemical treatment : Fig. 1,3,4 and Table III shows a comparison of some of the pulp properties obtained by the two treatments ie. pre-sulphonation and inter stage sulphonation. Higher conc. of sodium sulphite

TABLE—2

Na_2SO_3 conc. (g/l)	10	20	30	40	50	80
1. Yield (%)	90	89.2	88.2	87.5	84.7	84.7
2. Tensile index (N.m/g)	9.0	11.0	20.0	29.0	36 0	38
3. Burst index (kPam²/g)	0.2	0.2	0.25	0.6	0.8	0.8
4. Tear index (mN.m²/g)	1.4	1.3	1.75	2.4	2.8	2.8
5. Brightness (%)	41.5	42.8	44.4	45.5	45.6	46 0
6, OPacity (%)		> 98%				

(Conditions – 45 mts. at 150°C
strength properties at 150 ml CSF).

TABLE—3

Sl. No.		Inter stage sulphonation 60 gpl	80 gpl	100 gpl	Pre-sulphonation 60 gpl	80 gpl	100 gpl
1.	Yield %	84.7	83.0	82.7	85.1	83.5	82.0
2.	Reject %	1.1	1.0	1.1	1.5	1.3	1.0
3.	Tensile index (Nm/g)	36.0	38.0	38.0	26.0	38 0	48.0
4.	Tear index (mN.m²/g)	2.8	2.8	2.8	3.0	3.3	3.3
5.	Burst index (kPa.m²/g)	0.8	0.8	0.8	1.0	1.5	1.3
6.	Brightness %	45.6	46.2	46.0	33.0	32.5	32.3
7.	Opacity %		Above 98%			Aboue 98%	
8.	COD (g/l)	26.9	25.3	26.4	27.7	—	29.8

(Cooking conditions—45 mts. at 150°C, wood to liquor 1:5, strength properties at 150 ml CSF).

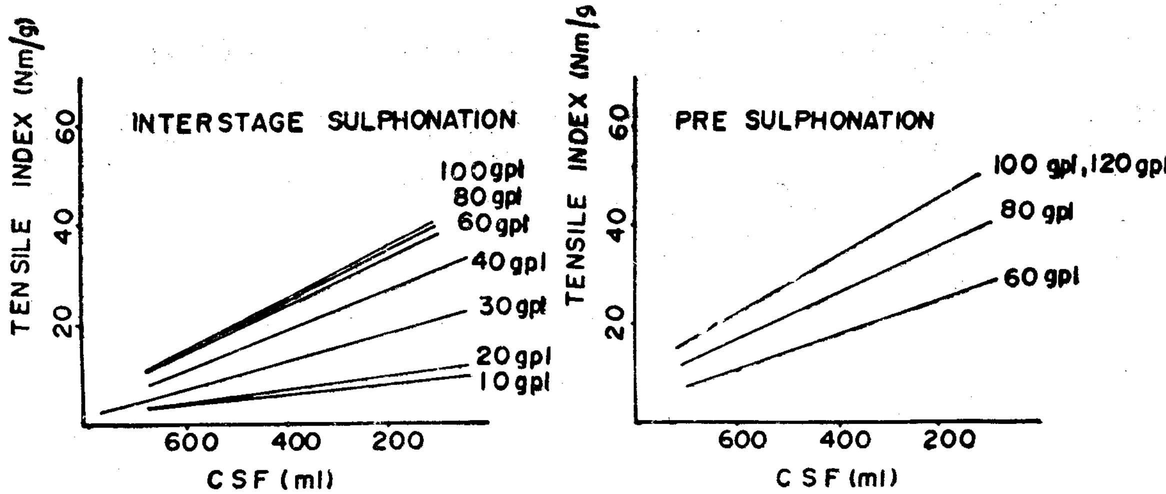

Fig-1. EFFECT OF INCREASING CHEMICAL CONC. ON TENSILE INDEX.

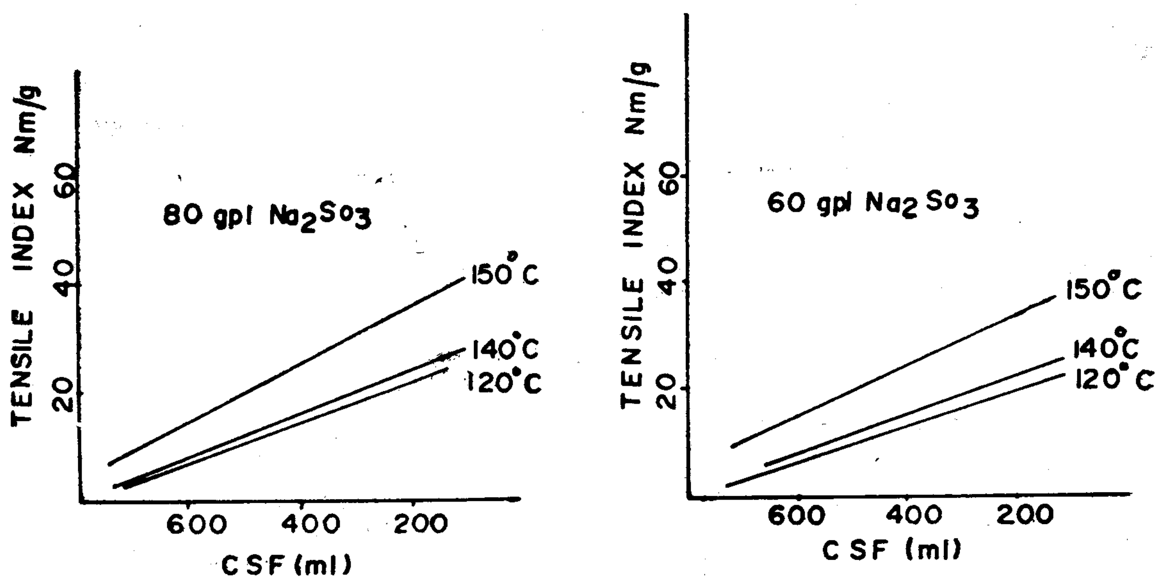

FIG.2 - EFFECT OF TEMP. ON TENSILE INDEX FOR DIFFERENT SODIUM SULPHITE CONC.

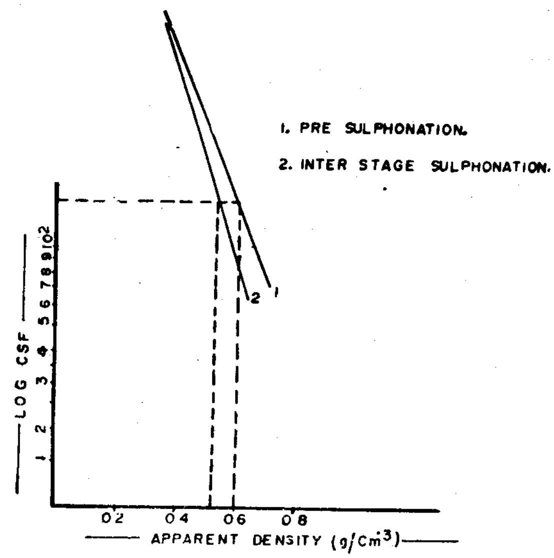

Fig-3. PLOT OF LOG CSF VS HANDSHEET DENSITY FOR THE TWO TREATMENTS AT A GIVEN FRENESS.PRE SULPHONATION FORMS HANDSHEETS WHICH ARE MORE DENSE.

solution has also been studied because at a lower concentrations and during pre-treatment chips are not softened enough.

From the table-III and figures it is opparent that strength properties like, tensile and tear index increase with chemical concentration, and cooking temp. for the two treatments. Cooking at 150°C give pulp of better strength properties. A limiting value for strength properties is reached for inter-stage sulphonation at 60 gpl, where as for the other treatment it is reached at only 100 gpl. At 60 gpl sodium sulphite conc. pre-sulphonation does not soften the chips for a pulp of appreciable strength and requires a high chemical conc., use of a higher concentration of sodium sulphite is undesirable because of the higher costs. However with this treatment and provided a suitable racovery is available, high strength SCMP pulps can be made from eucalyptus tereticornis having strength properties approaching those of chemical pulps (Fig. 4). Tensile and tear index are respectively 5 times and 3 times higher than those of cold soda pulps. Of the two treatments pre-sulphonation forms denser and less bulkier sheet

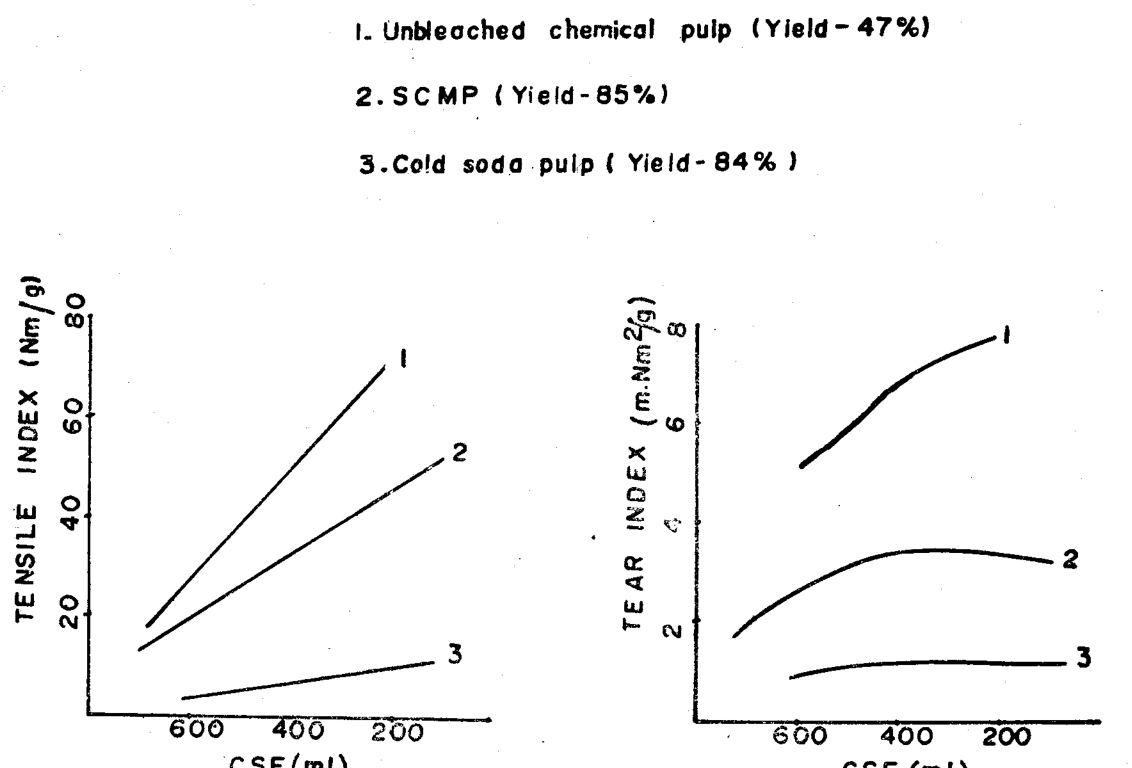

Fig-4. COMPARISON OF SCMP PULPS WITH - DIFFERENT PULPS OF EUC TERETICORNIS.

at a given freeness level. In addition to higher doses of chemicals required in pre-treatment for the softening of wood fibre as compared to inter stage treatment, another disadvantage is the unbleached pulp brightness which is about 32% as compared to 45-47% in the latter. Therefore for a better utilisation of chemical with some sacrifice in the strength properties interstage treatment could be used, for both softening and subsequent brightening of the pulp.

Effect of spent liquor recycling : Few experiments were conducted on recycling of spent liquor from an economy point of view and study the effect on strength properties, brightness, colour and chemical oxygen demand of spent liquor. Treatment followed was interstage treatment and in this whole of the spent liquor could be easily recovered from the coarse fibres by pressing. Spent liquor was recycled four times after supplimenting the spent liquor with sodium sulphite to bring the cooking liquor conc. to the desired level. Table-IV shows that there is no adverse affect on either the strength properties or the brightness though the chemical oxygen demand and colour did increase to a little extent.

Bleaching : The sulphonated chemimechanical pulps unlike mechanical pulp responds favourably to bleaching and it has been observed that a inter stage sulphonated pulp with an initial brightness of 45-47% could be easily bleached by a single stage treatment using 6% hypochlorite to about 58% brightness.

Blending experiment : Table-V shows the strength and optical properties of the blends of sulphonated chemimechanical pulps with bleached

TABLE-4

Sl. No.			Spent liquor recycling 1	2	3	4
1.	Yield %	88.9	88.0	88.2	88.5	88.1
2.	Rejects %	2.2	1.8	2.0	1.5	2.1
3.	Tensile index (N.m/g)	7.0	6.1	6.2	6.1	6.1
4.	Tear index (mN.m²/g)	1.2	1.1	1.0	1.2	1.3
5.	Brightness (%)	42.8	42.2	40.8	42.3	43.1
6.	Opacity %	above 98%				
7.	COD (g/1)	17.3	19.4	22.5	23.0	23.6
8.	Colour (kg pt/kg wood)	0.12	0.12	0.13	0.15	0.15
9.	Total solids (%)	2.6	2.8	3.3	3.4	3.4

(Conditions sodium sulphite – 20 gpl, 45 mts. at 150°C strength properties at 150 ml CSF).

TABLE—5

Sl. No.		Blend SCMP : Bamboo 90 : 10	SCMP : Bamboo 80 : 20
1.	Tensile index (N.m/g)	27.0	33.5
2.	Tear index mN.m²/g)	2.8	3.3
3.	Burst index (kPa.m²/g)	0.8	1.3
4.	Brightness %	47.3	48.3
5.	Opacity %	96.4	95.3
6.	Scattering Coefficient (M²/kg)	38.6	39.9

(Strength properties at 150 ml CSF).

chemical bamboo pulp having an initial brightness of 70%. This particular SCMP was prepared by interstage sulphonation using a low sodium sulphite solution (30 gpl) and cooking at 150°C for 45 mts. It can be seen that with a blend of 20% chemical pulp we get a pulp of appreciable strength having opacity about 95%. Amount of chemical component can be further reduced if we use a SCMP produced using a higher sodium sulphite solution.

Conclusions : Using sulphonated chemimechanical pulping process for the plantation grown Eucalyptus tereticornis it is possible to obtain good strength high yield pulps (85-90%) with a low shives content and thus help reduce chemical component in newsprint furnish. Strength properties increase with time, temp. and conc. of sodium sulphite used. Cooking at 150°C for 45 mts. gives pulp of optimum strength. Of the two modes of chemical treatment studied on the chips i.e. presulphonation and interstage sulphonation, the former pulp forms handsheets which are more denser and less bulkier at a given freeness level, but requires a higher chemical conc. to reach a limiting value for strength properties, however interstage sulphonation utilises chemical in a better way by its more efficient use in softening and subsequent brightening of the pulp. Unbleached pulp brightness is 45-47% and unlike mechanical pulps can be easily bleached to 58% using single stage hypochlorite treatment. If a suitable recovery is available high strength pulps can be obtained by this process whose strength properties approach those of chemical pulps. Effluent load from the spent liquor at the high yields maintained is quite low. Inspite of the slightly higher price of sodium sulphite, its use in this process can be justfied by the high yield and good strength of the pulp obtained. Spent liquor can also be recycled a number of times without any adverse effect on either brightness or strength properties.

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