Chemi-Mechanical Pulping of Tropical Hardwoods for Newsprint Manufacture

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ABSTRACT

Tropical hardwoods from the natural forests and plantations have been studied in the last few years by thermomechanical. Chemi-thermomechanical and chemi-mechanical processes. Chemimechanical process, in view of its greater adaptability to green to air dry, medium to dense, light to some what deeper colour hardwoods in mixture or alone, has found better ecceptance. Compared to other methods like hydrostatic pressure impregnation, evacuation and mechanical compressing, extended presteaming of chips is more effective in improving uniformity of impregnation with the softening chemicals. Both the atmospheric and presteaming may be preferred. Other important fetures in successful production of chemi-mechanical pulps from tropical hardwoods for use at the main component in newsprint furnish are also discussed.

Interest in hardwoods pulping available from the tropical natural forests of plantations has been growing. However, so far only the conventional kraft process has been mainly used because of its applicability to practically all types of hardwoods. In view of the importance of using hardwoods for the production of mechanical pulp type printing papers especially newsprint, extensive investigations were carried out in the last few years in various laboratories and approaches to production of ultra high yield pulps (>80 percent) were investigated. Few wood species have responded well to chemi-mechanical pulping using cold soda or neutral or slightly alkaline Sodium Sulphite solutions. Treatment with neutral/slightly alkaline Sodium Sulphite solutions usually requires use of elevated temperatures. When temperatures near to ambient and atmospheric pretreatment is practiced, use of strong caustic soda solutions during treatment is normally resorted to. There are many considerations in successful chemi-mechanical pulping of tropical hardwoods and these include basic wood raw material properties, appropriate steps in the treatment for which selection of the process and system for economical production of chemimechanical pulps for use as the main component in newsprint manufacture is necessary. It has to be understood that chemimechanical pulping involves a mild chemical treatment in which there is no major change in the amount of lignin followed by a mechanical treatment to separate the fibres. For their use as newsprint furnish a combination of optical and strength properties is required. In view of the increasing trend towards lowering of substance of newsprint (48 g/m^2 & below) to provide for fewer roll changes, cheaper transportation, less storage space and primarily more surface per tonne, in a two furnish component viz. chemi-mechanical and chemical pulp of newsprint, the demand on uniformity in quality of chemimechanical pulp is all the more challenging, since the pulps should have the bulk and opacifying properties of groundwood pulps but at the same time sufficiently high physical strength characteristics to meet the minimum requirements of performance of newsprint. In a three furnish component viz groundwood pulp, chemimechanical pulp and chemical pulp of newsprint, the small variations in the quality of chemimechanical pulps can be tolerated since the intention to some extent in this case is to use the chemimechanical pulp as a reinforcement pulp in order to bring down the use of chemical pulp.

The discussion that will follow will be focussing on some of the important issues in chemi-mechanical pul-

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ping of tropical hardwoods from the natural forests and plantations. Among the plantation hardwoods, discussion will be confined only to Eucalyptus hybrid. The preferred hardwood species for chemimechanical pulping should have a density around 0.60 g/cm³ a small amount of heart wood, low extractives, lighter colour and a fairly high proportion of fibres etc. Obviously differences in these charactaristics of wood species contribute to varying pulp yield, colour and brightness of unbleached and bleached pulp, strength characteristics, compressibility and printability of pulp etc. A number of hardwood species from Andhra Pradesh forests when tested[1] under identical conditions of cold soda pulping gave widely different results as will be seen from Table I. This only shows that some wood species, should preferably be excluded from chemi-mechanical pulping. Studies carried out on E. hybrid have shown[2] (Table II) that formation of heartwood and the colour of the wood is very much dependent on the age and the regrowth eucalyptus has the advantage of having brighter wood and this in turn influences the quality of chemimechanical pulp.

Tests[3] carried out on the hardwood species from Karnataka forests including on Eucalyptus hybrid, bamboo and Pine where the treatment conditions with caustic soda were kept constant, revealed interesting information as will be seen from Table III A & B. In view of the wide differences in results, it would be expected that even when wood species considered suitable for chemi-mechanical pulping are used, the pulping conditions and system should be such that it is less sensitive to quality of fibrous raw material to avoid wide variations in chemi-mechanical pulp quality. Invariably an imortant step in the chemi-mechanical pulping of hardwoods is the treatment of accepted chips with a solution of caustic soda. A good impregnation is a necessity in order to make the fibres free without too high a power consumption and with the highest possible fibre strength still intact. The penetration of the liquor (caustic soda) into the chips can be helped in many ways.

TABLE—II

E hybrid wood meal (—60 mesh) Data on Brightness & heartwood content with Age.

	3 year old (Coppice)	5 year old.	10 year old.
Sapwood by volume%	87.5	84	80.5
Heartwood by volume%	12.5	16	19.5
Brightness of Sapwood% Elrepho.	44.7	33.8	30.9
Brightness of heartwood% Elrepho.	38.2	28.7	22.5

TABLE—I

Cold Caustic Chemimechanical Pulps of different wood species. Data on Pulp yield & pulp brightness.

	Total unbleached pulp yield. %	Unbleached pulp brightness. %	Bleached Pulp brightness. %
Buchanania lanzan	87.0	27	52
Kydia calycina	85.0	50	56
Anogeissus Latifolia	85.0	49	60
Syzygium cumini	83.5	47	55
Terminalia chebula	83 0	36	53
Bursrra Serrata	83.0	23	41
Schrebera swieteinioides	82.5	53	55
Gamga pinnata	82.0	52	62
Xylia xylocapa	80.5	16	34
Pterocarpus marsupium	80.0	44	51
Mangifera indica	78.5	46	63
Mitragyara parviflora	78.5	44	58
Lannea grandis	77 0	47	59
Lagerstroemia parviflora	75.0	37	42
Diospyras melanoxylon	74.5	37	52
Terminalia tomentosa	74.0	28	49
Dillenia Pentagyna	72.5	34	49

Chemimechanical pulps were prepared under constant conditions of soaking viz. treatment with 50 g.p.l. NaOH solution for 2 hrs. The NaOH absorbed varied between 5 to 8%. After draining of excess liquor, disc defiberizing in two steps was done. The pulps were then washed and evaluated for pulp yield and unbleached pulp brightness. **A portion of the pulp** was bleached using 10% av cl_2 as calcium hypochlorite in all the cases.—Consistency 5%, Temp. 40°C, Time 30 minutes.

TABLE—III A

Chemi-Mechanical Pulps from different wood species.
Pulping & Pulp Evaluation Results.

	Total unbleached pulp yield %	Unbleached pulp brightness. % (Elrepho)	Hypochlorite bleached pulp handsheets (60 g/m²) Pulp Slowness °SR	Brightness. %	Yellow ness. %	Specific scattering coefficient cm²/g	Opacity %
1. Pine	82.7	27.2	85	33 5	—	448	98.5
2. Lagerstroemia lanceolata	82.7	33.5	79	48.7	40.7	610	96.5
3. Tectona grandis	87.2	42 3	72	55.0	35 6	632	94.8
4. Kydia calycina	86.0	42 2	69	57.2	33 4	522	91.3
5. Anogeissus latifolia	80.0	35.2	75	55.2	35.2	518	92.2
6. Grewia tiliaofolia	92 2	33.2	49	54 8	34.4	547	93.5
7. Adina cordifolia	80.8	32 0	—	Shects	could not	be formed	—
8. Eucalyptus hybrid (7 year old)	90 0	35 1	50	54.0	35	567	93.8
9. Mitragyna Parviflora	82.0	29.0	—	Sheets	could not	be formed	—
10. Terminalia belerica	85.0	31.5	60	40.5	45.3	431	94.8
11. Bamboo	86.1	20.6	72	32.6*	48.1	435	98.4

In all the cases atmospheric presteamed chips were treated under constant conditions of caustic soaking followed by disc defiberizing. The washed unbleached pulps were bleached with 10% av cl_2 as calcium hypochlorite and acidified to pH 4 by sulphuric acid at the end of bleaching.

* 15% av cl_2 as hypochlorite was used.

TABLE — III B

Data for Hypochlorite followed by peroxide Bleached Pulp Handsheets (60 g/m²)

	Pulp slowness °SR	B.L. K.m.	B.F.	T.F.	Brightness %	Specific Scattering coefficient Om²/g	Opacity %	Yellowness %
1. Pine	85	1.6	9	24	33.5	448	—	—
2. Lagerstroemia lanceolata	81	3.8	18	35	53 4	633	95.7	35.5
3. Tectona grandis	76	4.6	21	35	57.2	633	94.5	33 0
4. Kydia calycina	68	4.5	22	52	60.4	486	89.0	30.6
5. Anogeissus Latifolia	67	2.6	13	39	57.7	516	90 3	32.1
6. Grewia tilioefolia	70	5 6	21	62	61.9	602	91.5	29.3
7. Adina cordifolia	Sheets could not be formed possibly due to very low strength.							
8. Eucalyptus hybrid	67	3 0	13	35	61.5	597	92.3	27.9
9. Mitragyna parviflora	Sheets could not be formed possibly due to very low strength.							
10. Terminalia belerica	68	1.5	4	23	50.2	450	92.5	37 2
11. Bamboo	72	2.3	11	40	37.8	472	97.8	44.4

Constant conditions of Hypochlorite bleaching

Consistency %	5
Temp. °C	45
Available chlorine on pulp %	10
Time minutes	20
End pH	8.5-9

The pulp was acidified to pH 4 by sulphuric acid then washed with fresh water.

Constant conditions of Hydrogen peroxide bleaching

Consistency %	10
H_2O_2 on pulp %	1
$MgSO_4$ on pulp %	0.05
Sodium Silicate on pulp %	0.7
Time minutes	120
Temp. °C	70
End pH	9-9.5

At the end of peroxide bleaching the pulp was acidified to pH 4 by sulphuric acid and then washed with fresh water..

1. By the application of hydraulic pressure and the recommended pressure is about 10 kg/cm^2.
2. By subjecting the chips to a vacuum of about 25 to 28 in Hg just prior to the introduction of liquor.
3. Mechanical compressing of chips prior to the release under liquor.
4. Presteaming of chips which could be atmospheric or pressurised. However, with atmospheric presteaming efficiency is improved, the equipment cost and the building volume is considerably reduced and the elimination of a low pressure feeder means the elimination of a maintenance item.

In view of the fact that air dry to green wood with medium to fairly high density may be available for use, of the measures suggested above for improving the effectiveness of liquor penetration, atmospheric presteaming of chips for 10-15 minutes has been found to be very useful. The effect of presteaming is to expel the air in the chips and replace by the steam which condenses as it is cooled by the liquor. The liquor is drawn into the chips by the partial vacuum which is created. The atmospheric presteamed chips are treated with caustic solution in such a way that about 5 to 6% NaOH is absorbed on chips. Treatment with caustic soda solution of 30-50 g.p.l for 30-60 minutes is normally required. In some cases the lightly presteamed chips are compressed in a screw press and released under the surface of caustic soda solution for required absorption of caustic soda. The chips free of excees liquor and with 5 to 6% NaOH absorbed are dumped into a holding bin, then passes through presses where part of the alkali soluble material is expressed out, then through disc refiner in two stage. Of the 5-6% NaOH absorbed, the liquor released with alkali soluble material can be returned to a sulphate Mill so that the net caustic consumption on B.D. wood is around 2.5%. In view of the high cost of caustic soda in this country returning of any caustic soda from the chemi-mechanical pulp Mill to the sulphate mill helps in improving the economics. The Bowater Southern Paper Corporation in U.S A. practices cross recovery and the caustic returned with the expelled liquor is neutralised by sulphuric acid and used as make up salt cake. Returning of the expelled liquor to the Kraft Mill also significantly reduces the pollutant load as measured by the BOD, COD and colour.

In the two stages of disc defiberizing that are normally used, application of power in each stage is of importance in determining the pulp quality in addition to variables like consistency, plate pattern and temperature of refining. Fines/crill produced during refining play an important part in consolidation of sheet during newsprint making and in determining optical and physical properties. The material passing through 200 mesh screen is of the order of 25-30 percent and is of both technical and economic significance. The necessity of its retaining during newsprint making through highly closed white water system or use of retention aids cannot be ignored.

The unbleached pulp after two stages of refining (Pulp of 300-350 csf). then washed, screened, thickened, and then subjected to bleaching. Bleaching of chemi-mechanical pulps is normally carried out by calcium hypochlorite solution in single or two stages. Sometimes a two step procedure consisting of first treating the pulp with hypochlorite and then bleaching with hydrogen peroxide is also useful. Bleaching of chemi-mechanical pulps by hypochlorite alone in reality is a "surface" bleaching as it mainly results in decolouration without dissolution of the lignin. As the reaction is fast for proper brightness development, it is necessary to use (i) lower temperature, (ii) low consistency, (iii) reduced retention time or (iv) high alkalinity. The pH during initial stages is between 11 to 12. At the end of bleaching acidfication to pH 4 by use of sulphurous, sulphuric or hydrochloric acid has to be followed for brightness gain stopping some reverison. The pulp then being washed with fresh water to remove acid soluble material. The washed, bleached chemi-mechanical pulp is then subjected to low consistency post refining for optimum strength development. The post refined pulp is normally of 100-150 csf. This is then blended with refined chemical pulp for newsprint making. Bleached chemi-mechanical pulps of tropical hardwoods normally have brightness of 50-60 percent and shows higher yellowness which is reflected in the yellow tint of the newsprint. Addition of very small amount of water soluble blue dyes is helpful to get rid of this tint.

From the discussions that followed above, it can be interpreted that for chemi-mechanical pulping of tropical hardwoods from the natural forest and plantations a systematic and logical approach is necessary for evaluating their suitability in the mauufacture of mechanical pulp type printing papers.

References

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Acknowledgement

The author is very much indebted to the Management of the West Coast Paper Mills Ltd. for having utilized some data in this paper earlier obtained by him and some colleagues while working at the West Coast Paper Mills Ltd.