

Suitability of Andaman Hardwoods for Papermaking-2

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SUMMARY

Suitability of Andaman hardwoods (Sample Plot II) was evaluated by optimising the cooking conditions using the novel method of Plackett and Burman statistical experimental design. Large scale pulping experiments were carried out under optimum conditions and the pulp was bleached by CEHH sequence to a brightness of 78.7% ISO. Pulping, bleaching and strength evaluation results indicate the suitability of Andaman hardwoods (Sample Plot II) for paper making.

Andaman islands offer an hitherto unexploited source of rich tropical forests. This investigation deals with pulping and bleaching studies of the composite hardwoods obtained from sample plot II i.e. Austin X. This sample plot consists of 18 species out of which three are commercial species and rest non-commercial species.

SAMPLING

Random sampling plan was applied and the samples of 15 non-commercial species were collected in the form of discs after classifying the existing non-commercial species in the two dia classes of 10-40 cms and 41-100 cms. Further, the lops and tops of three commercial species were also mixed as they would be available for the pulp wood. The discs sample received at the project site were treated with 1% sodium pentachlorophenate solution to prevent fungus infection. Chipping was carried out after slicing them into suitable sizes. The composite sample was prepared mixing the chips in the proportion of their occurrence in the forest as given in Table 1.

EXPERIMENTAL

Pulping experiments were carried out in series digester consisting of six bombs each of 2.5 litres capacity rotating in electrically heated polyethylene glycol bath. In each bomb 400 gm OD chips were taken. Pulping and washing was carried out as described in laboratory Manual¹. Optimization of chemical demand in different stages of bleaching viz C, E and H stages was carried out as reported in Laboratory Manual¹. Proximate analyses were

TABLE—1 COMPOSITION OF ANDAMAN HARDWOODS OF SAMPLE PLOT II

Sl. No.	Name of the species	% contribution in each girth class	
		30 cms-120 cms % w/y	121 cms-300 cms % w/y
1.	Stephygyne diversifolia	15.03	6.20
2.	Dillenia pentagyna	3.94	0.50
3.	Oroxylum indicum	5.80	2.68
4.	Phyllanthus columnaris	1.47	—
5.	Gardenia coronaria	1.98	—
6.	Sterculia villosa	8.50	10.48
7.	Sterculia colorata	2.05	1.23
8.	Eugenia spp.	1.12	—
9.	Dracaena angustifolia	1.82	—
10.	Aglaia andamanica	2.55	—
11.	Diospyros pilosula	5.07	—
12.	Celtis wightii	4.95	—
13.	Pterospermum aceroides	1.54	—
14.	Cleistanthus myrianthus	1.86	—
15.	Polyalthia spp. (Agiya)	1.31	—
COMMERCIAL SPECIES			
16.	Terminalia bialata	6.92	—
17.	Pterocarpus dalbergiodes	8.76	—
18.	Lagerstroemia hypolenca	4.14	—

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carried out according to APPITA and TAPPI methods except holocellulose which was carried out according to Wise and coworkers². Kappa number, intrinsic viscosity of the pulp, black liquor analysis, pulp evaluation, physical testing and optical properties were carried out according to standard methods described in Laboratory Manual¹.

RESULTS AND DISCUSSION

The proximate analysis results given in Table 2 show high lignin content, low pentosans and high extractives and the results are comparable to those of sample plot I.

TABLE—2 PROXIMATE ANALYSIS RESULTS OF SAMPLE PLOT II

Sl. Particulars	% on O. D. Wood
1. Ash	1.5
2. Solubility in	
a) Water	5.7
b) Alcohol benzene	5.4
c) N/10 Sodium hydroxide	16.8
3. Holocellulose	63.5
4. a) Klason lignin	28.9
b) Acid soluble lignin	1.6
5. Pentosans	13.6

The influence of the following process variables on pulp properties was studied using Plackett and Burman statistical experimental design:—

- (1) Top temperature,
- (2) Time at top temperature,
- (3) Active alkali,
- (4) Black liquor addition

The cooking conditions and results are given in Table 3. The strength properties of the unbleached pulps evaluated at 300 ml CSF are also included in the same table. Based on the mathematical interpretation of the experimental results, described in earlier reports³, optimum cooking conditions were chosen to attain a pulp of kappa number about 30. Large scale pulping was carried out under the above optimum conditions. The cooking conditions and results are given in Table 4. The pulp was bleached using CEHH sequence to a brightness of 78.7% ISO under optimum conditions. Bleaching conditions and results are given in Table 5. The strength properties of both unbleached and bleached pulps are given in Table 6. Comparison of pulping, bleaching and strength properties is made between Central Indian hardwoods, Andaman hardwoods sample plot I and sample plot II in Table 7.

It could be seen from the Table 7 that sample plot II

TABLE—3 OPTIMISATION OF PULPING CONDITIONS FOR ANDAMAN HARDWOODS SAMPLE PLOT II

Sl. Particulars No.	I	II	III	IV	V	VI	VII	VIII
1. Chemical as Na ₂ O, %	20	16	20	16	16	20	20	16
2. Cooking temperature, °C	175	175	175	165	175	165	165	165
3. Cooking time, min.,	180	180	90	180	90	90	180	90
4. Black liquor added for dilution, %	0	20	0	0	20	20	20	0
5. H-Factor	4545	4545	2470	2025	2470	1110	2025	1110
6. Total pulp yield, %	42.8	48.3	45.5	49.6	50.7	50.0	47.0	51.1
7. Screen rejects, %	0.4	3.0	1.6	3.0	5.0	5.4	1.7	5.2
8. Kappa number of the unbleached pulp,	22.1	32.1	26.4	31.5	34.5	32.4	26.9	38.5
9. Black liquor :								
a) PH,	11.9	11.2	11.7	12.0	11.4	11.2	11.2	12.0
b) Total solids, % w/w,	22.4	21.6	21.5	18.6	20.4	22.4	23.8	19.2
c) Residual active alkali as Na ₂ O at 20% gpl total solids, g/l	11.8	5.1	13.8	6.4	6.5	15.5	13.7	9.2
Strength properties at 300 ml, CSF,								
a) Burst index, kPa.m ² /g,	3.15	4.22	3.68	4.35	4.45	4.05	3.70	4.55
b) Tensile index, Nm/g,	49.5	61.0	58.5	64.5	68.0	60.0	58.5	65.2
c) Tear index, mNm ² /g,	7.0	9.05	8.30	9.55	9.30	9.45	8.95	10.20

TABLE-4 LARGE SCALE PULPING OF
ANDAMAN HARDWOODS
SAMPLE PLOT II

Particulars	
Chemical as Na_2O , %	= 17.0
Sulphidity of the cooking liquor, %	= 25.0
Chips to liquor ratio,	= 1:3
Cooking schedule :	
Raising time to 100°C, Min.,	= 30
from 100°C to 170°C, min.,	= 105
at 170°C min.,	= 120
H-Factor,	= 2125
Total pulp yield, %	= 49.5
Screen/rejects, %	= 1:3
Kappa number of the unbleached pulp,	= 20.3
Black liquor :	
a) pH,	= 11.0
b) Total solids, % w/w,	= 20.2
c) Residual active alkali as Na_2O , g/l (at 200 g/l total solids)	= 9.4
d) Swelling volume ratio, ml/g,	= 58
e) Brooke field viscosity at 80°C	
at 35% w/w solids, cps	= 2.8
at 45% w/w solids, cps	= 5.0
at 50% w/w solids, cps	= 8.0
at 55% w/w solids cps	= 16.0

composite requires high chemicals (17% Na_2O) and drastic conditions (H factor—2130) than required for sample plot I composite (16% Na_2O and H factor—1660) to attain a bleachable grade pulp (Kappa number about 30). The total pulp yield for sample plot II composite is higher (49.5%) than for sample plot I composite (48.0%). The pulp yield is also high when compared to Central Indian hardwoods (43.4%). Bleachability of sample plot II pulp is quite good. With 9.4% total chlorine, final brightness of 78.7% ISO could be achieved. Bleachability is comparable to sample plot I pulp. The burst and tensile index of unbleached and bleached pulps of sample plot II are higher than those for sample plot I, though tear index is slightly lower. The strength properties of Andaman hardwoods pulps are better than those of Central Indian hardwoods.

From the black liquor properties, it can be seen that precipitation point is quite high (i.e. at 46.3% total solids) and comparable to that of sample plot I. Viscosity at 55% solids is very low (16 cps). Swelling volume ratio is very high (58 ml/g).

TABLE-5 LARGE SCALE BLEACHING OF
ANDAMAN HARDWOODS
SAMPLE PLOT II PULP

S. No.	Particulars	
1.	Kappa number of the pulp,	30.3
1.	Chlorination	
	Chlorine added on pulp, %	6.8
	Final pH	1.7
	Chlorine consumed on pulp, %	6.41
2.	Alkali extraction	
	Alkali applied as sodium hydroxide, %	2.0
	Initial pH	10.9
	Final pH	10.7
3.	Hypo I stage	
	Hypochlorite applied as chlorine, %	1.8
	Buffer added as sodium hydroxide to maintain pH > 9.0, %	0.8
	Hypochlorite consumed as chlorine, %	1.77
4.	Hypo II stage	
	Hypochlorite applied as chlorine, %	0.8
	Buffer added as sodium hydroxide to maintain pH > 9.0, %	0.2
	Hypochlorite consumed as chlorine, %	0.51
5.	Yield loss during bleaching, %	8.65
6.	Total chlorine applied, %	9.4
7.	Total chlorine consumed, %	8.69
8.	Total sodium hydroxide used, %	3.0
9.	Brightness of the pulp, % ISO	78.7
10.	Intrinsic viscosity of the pulp cm^3/g	390

Constant conditions:—

	Chlori- nation	Alkali Extrac- tion	Hypo I stage	Hypo II stage
Consistency, % =	3	8	8	8
Temperature, °C =	30	60	40	40
Time, min =	30	60	120	120

TABLE—6 STRENGTH PROPERTIES OF UNBLEACHED AND BLEACHED PULPS OF ANDAMAN HARDWOODS SAMPLE PLOT II

Particulars	PFI (revs)	Free-ness CSF	D. time s	Appa- rent densi- ty g/cm ³	Burst index kPa.- m ² /g	Tensile index Nm/g	Stretch %	Fold koh- ler Mo- lin log	Tear index mN- m ² /g	Air res. Gur- ley s/100 ml	Bright- ness ISO %	Sp- Scat- tering co- effi- cient m ² /kg
Unbleached pulp	0	615	3.67	0.61	1.30	30.0	2.2	1.00	9.35	2.0	—	—
	2000	465	4.24	0.59	3.35	53.5	3.2	2.11	10.20	13.4	—	—
	4000	380	4.60	0.74	4.00	63.5	3.8	2.50	10.00	25.0	—	—
	6 00	290	5.45	0.77	4.20	64.5	4.4	2.58	9.30	51.3	—	—
	8000	250	6.86	0.79	4.60	69.5	4.7	2.81	9.00	81.0	—	—
Bleached pulp	0	595	3.55	0.66	1.45	32.0	3.2	1.04	8.55	3.0	74.1	34.9
	2000	440	5.25	0.74	3.30	55.5	3.2	1.87	8.90	10.2	73.5	28.9
	4000	370	5.92	0.78	3.70	59.0	3.4	2.00	8.30	35.2	—	28.2
	6000	245	7.71	0.80	3.90	63.0	3.5	2.26	7.45	43.2	71.5	26.0
	8000	215	10.75	0.81	4.25	63.5	3.7	2.46	7.40	68.5	71.0	25.0

TABLE 7 - COMPOSITION OF PULPING AND BLEACHING

Sl. No.	Particulars	Central Indian hardwoods (4)	Andaman hardwoods sample plot I	Andaman hardwoods sample plot II
1.	Cooking conditions,	16% Na ₂ O, 170°C, 1.0 min	16% Na ₂ O, 170°C, 90 min	17% Na ₂ O, 170°C 120 min
2.	H-factor	2130	1660	2130
3.	Total pulp yield %	43.4	48.0	49.5
4.	Screen rejects, %	1.1	3.3	1.3
5.	Kappa number of the pulp	27.0	30.3	30.3
6.	Black liquor			
	Residual active alkali as Na ₂ O, g/l	7.4	8.0	9.4
	(at 200 gpl total solids)			
	Precipitation point at % solids,	40.0	46.0	46.3
	Bleaching sequence	C _{6.5} E _{1.5} H _{2.5} H ₁	C _{6.8} E _{1.4} H _{0.5}	C _{6.8} E ₂ H _{1.8} H _{0.8}
	Chlorine applied/ consumed %	10.0/8.6	8.7/8.2	9.4/8.7
	Brightness, % ISO	78.1	77.0	78.7
	Viscosity, cm ³ /g,	370	620	390

CONCLUSIONS

- 1) A pulp of kappa number about 30 at an yield of 49.5% can be obtained by cooking with 17% Na₂O at 170°C for 120 minutes.
- 2) Bleachability of the pulp is good. With 9.4% total chlorine a pulp of final brightness 78.7% ISO can be achieved by CEHH sequence.
- 3) Strength properties of both unbleached and bleached pulps are comparable to those of sample plot I and better than those of Central Indian hardwoods.

REFERENCES

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