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BLEACHED CHEMICAL PULP FROM KENAF

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BLEACHED CHEMICAL PULP FROM KENAF BY SODIUM BISULPHITE PROCESS

By Chien Chu,* Naiyana Niyomwan,* and Anchalee Puangvichit*

SUMMARY

Bleached chemical pulp from Cuban kenaf stalks (Hibiscus cannabinus) was prepared by sodium bisulphite process. Fresh kenaf is easier to pulp and bleach than dry kenaf.

Fresh kenaf chips were heated in sodium bisulphite solution to 150°C in 2 hours and cooked at 150°C for 4½ hours with liquor ratio 4:1 and total SO_2 16 per cent on ovendry chip weight. The crude pulp was defibred in a disc refiner and washed. The yield was 62 per cent.

The pulp was bleached with a total of 10 per cent equivalent chlorine by a C/E/H/D sequence to brightness 75. The bleached yield was 85 per cent based on the unbleached pulp or 53 per cent on ovendry chips. The bleached pulp indicated good strength comparable to kenaf kraft pulp.

Dry Cuban kenaf chips were cooked under the same conditions as the fresh kenaf chips, except the time to reach 150°C was 2½ hours instead of 2 hours to allow better impregnation. The cooking yield after refining and washing was 54.5 per cent, much lower than that from fresh kenaf. Bleaching the pulp from dry kenaf required 12 per cent equivalent chlorine. The bleaching sequence was DC/E/D/H for brightness 85. The bleached yield was 79 per cent based on unbleached pulp or 43 per cent on ovendry chips. The pulp strength was slightly lower than that from fresh kenaf but showed quality comparable with that of bleached kraft pulp from dry Cuban kenaf.

The great difference of bleached yields and bleach consumption between fresh kenaf and dry kenaf is significant.

INTRODUCTION

Sodium bisulphite pulping of wood has found extensive use in recent years. The application of this process for kenaf chips may have some of the advantages as found in the pulping of wood, as follows:

1. Yields are usually higher than those obtained by the conventional kraft and soda processes.

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2. Quality: the pulp is comparable to kraft pulp in strength; brightness of the unbleached bisulphite pulp is much better than that of kraft.

3. The process can accommodate a wide range of raw materials including resinous pinewood, as reported before in this series of study on raw materials for pulp in Thailand.*

4. Waste effluents from pulping are amenable to disposal by combustion, with recovery of inorganic chemicals.

Selection of the most favourable process for pulping kenaf will depend on the ultimate use of the kenaf pulp and on availability of a suitable system to recover the pulping chemicals. No report has been found in the literature of the investigation of sodium bisulphite process for kenaf pulp with a view towards an integrated pulp and paper mill to produce printing and writing paper and paper board. This is a preliminary investigation of the subject.

EXPERIMENTAL

Cuban kenaf (Hibiscus cannabinus) was used in the experiments. Kenaf stalks submitted for pulping experiments were cut to about 2 cm segments with scissor shears. All cooking was carried out in a tumbling stainless steel digester of 10-litre capacity. The vessel is equipped with electric heating and automatic temperature control.

In most digestions, an impregnation period of about one hour was allowed. The usual procedure was as follows: A known amount of chips (usually 1 kg, moisture free basis) was charged to the digester and cooking solution prepared by dissolving sodium bisulphite powder in water, was added at a liquor to chip ratio about 4:1. Heat was applied for about 30 minutes. Then the digester was sealed. The temperature was raised to about 145-150°C in 1½ hour. The heating was controlled at this maximum temperature for 4-4½ hours. The digester was vented for

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*"Pulp and paper from pinewood by sodium bisulphite process" by Chien Chu, Naiyana Niyomwan, and Amphika Krairit. Report No. 1 on Miscellaneous Investigation No. 32 (ASRCT unpublished report).

15 minutes to drop the temperature to 110°C before opening. Some excess SO_2 gas was noticed during venting. The crude pulp was removed to a wash tank with a screened bottom. The pulp was washed with tap water. The washed pulp was refined in one pass on a single-disc laboratory refiner to open all fibre bundles. The pulp slurry from the refiner was further washed and dewatered in a laboratory centrifuge. The dewatered pulp cake was weighed and part of it was used in bleaching tests. The wet cake was ovendried and weighed to calculate unbleached yield values.

Multi-stage bleaching was done mostly with wet pulp samples containing about 100 g ovendry pulp. Usually a bleaching sequence of chlorination, caustic extraction, hypochlorite bleaching and chlorine dioxide bleaching was followed. The chlorination stage was carried out in a polyethylene bottle at room temperature for 30 minutes with occasional shaking. Caustic extraction was done at 60-70°C for 30 minutes in a 5-litre beaker set in a water bath to maintain the extraction temperature. Hypochlorite bleaching was done in the same vessel as the caustic extraction, but the temperature was maintained at about 40°C for two hours. Chlorine dioxide bleaching was performed in a closed polyethylene bottle in a hot water bath to keep a high bleaching temperature of about 60-70°C.

In the chlorination stage with pulp at 3% consistency, chlorine was generated by acidifying sodium hypochlorite solution to pH 1.8 with 10% hydrochloric acid with vigorous shaking for five minutes. Most of the chlorine was consumed by the pulp.

Pulp strength properties of bleached pulps were determined by performing beater evaluations and handsheet tests using TAPPI testing methods. Usually sizing materials consisting of 2% rosin size, 4% alum, 5% kaolin, 2% tamarind kernel powder as dispersing agent and 0.30% Whitin as brightening agent were used to simulate commercial sizing practice. The handsheets were prepared with Karl Frank handsheet machine at the Royal Forest Department, Ministry of Agriculture.

RESULTS AND DISCUSSION

The data shown in Table 1 are values obtained in various cooking and bleaching experiments. Tables 2 and 3 indicate comparative physical properties of pulps from fresh Cuban kenaf and dry Cuban kenaf respectively.

The quality of bleached pulp from fresh Cuban kenaf is good. The high yield of bleached pulp and moderate bleach demand make the sodium bisulphite process amenable to industrial application. The applied sodium bisulphite was not all consumed as evidenced by the presence of SO_2 gas after cooking. Further analytical investigation will be needed to determine the amount consumed. However recycling part of the waste cooking liquor and SO_2 gas vented from cooking, and recovery of chemicals from the waste cooking liquor would be required in industrial production of the pulp.

Based on stoichiometric amount in the preparation of sodium bisulphite solution containing 16 per cent sulphur dioxide on the weight of moisture free kenaf chips, about 8 per cent sulphur and 10 per cent caustic soda would be required based on ovendry chips.

The bleached pulp has higher strength than the unbleached pulp. Fresh kenaf gave better pulp and higher yield with less bleach consumption than air dry kenaf. Bleached kenaf sodium bisulphite pulp has higher strength than bleached kenaf magnefite pulp, but is inferior to kenaf kraft pulp.

Semi-chemical pulp with lower strength was obtained in sample No. 5 with high yield by cooking with lower concentration of sodium bisulphite and less cooking time.

The sodium bisulphite process requires a chemical recovery system. However the process does not respond to the conventional direct recovery system as in the case of magnesium bisulphite process or kraft process. One possible way is cross recovery system similar to NSSC recovery in a kraft pulp mill. This cross recovery system limits the capacity of bisulphite pulp production to about 25-30 per cent of the kraft pulp production.

TABLE 1

PULPING AND BLEACHING CONDITIONS IN THE SODIUM BISULPHITE PULPING OF KENAF STALKS

Sample	1	2	3	4	5	6
Cook No.	216	418	216	462	222	462
Raw material	Fresh Cuban kenaf	Fresh Cuban kenaf	Fresh Cuban kenaf	Air dry Cuban kenaf	Air dry Cuban kenaf	Air dry Cuban kenaf
Total SO_2 on ovendry chips, %	11.0	16.0	11.0	16.0	14.4	16.0
Sodium bisulphite, $NaHSO_3$ on ovendry chips, %	18.0	26.0	18.0	26.0	23.4	26.0
Liquor ratio, ml/g	5:1	4:1	5:1	4:1	4:1	4:1
Max. temp., °C	155	150	155	150	150	150
Time to max. temp., hours	1½	2	1½	2½	1	2½
Time at max. temp., hours	4	4½	4	4½	4	4½
Pulp yield, % on ovendry chips	64.2	62.0	64.2	54.5	69.2	54.5
Bleaching sequence	$DC/E_1/D/E_2/H$	C/E/H/D	-	-	$C_1/C_2/E/H$	DC/E/D/H
Total equivalent chlorine applied, %	14.0	10.0	-	-	12.0	12.0
Chlorination stage (DC)						
ClO_2, %	3.9	-	-	-	C_1, 6.0	1.2
Cl_2, %	2.5	7.5	-	-	C_2, 4.0	5.0
Alkali extraction stage (E) NaOH, %	E_1, 2.0 E_2, 0.5	2.0	-	-	2.0	2.0
Hypochlorite bleaching stage (H) Available chlorine, %	0.7	0.5	-	-	2.0	2.0
Chlorine dioxide bleaching stage (D) ClO_2, %	0.75	0.75	-	-	-	0.75

Table 1 (continued)

Sample No.	1	2	3	4	5	6
Bleached yield on ovendry basis						
% on unbleached pulp	83.3	85.2	-	-	75.0	78.8
% on chips	53.5	53.0	-	-	52.0	42.7
Paper no.	126	188	100	207	131	208
Physical properties of handsheets under 50% RH, 23°C						
Basis weight, g/m^2	55.3	77.0	56.6	76.2	55.0	74.7
Bulk, ml/g	1.08	1.16	1.39	1.28	1.29	1.11
Burst factor	42.7	50.0	25.0	48.4	18.2	53.4
Tear factor	53.5	92.8	76.3	91.0	52.4	67.5
Breaking length, m	8,528	9,522	6,150	9,068	5,556	9,284
Brightness, %	80	75	45	-	77	85
Folding endurance	508	520	23	43	28	274
Freeness, S.-R.						
Initial freeness, ml	750	675	720	660	800	660
Final freeness, ml	300	490	360	510	330	400
Beating time, min	4	3	6	2	3	2

TABLE 2

PHYSICAL PROPERTIES OF HANDSHEETS PREPARED FROM FRESH CUBAN KENAF BY VARIOUS PROCESSES

Physical property	Bleached Cuban kenaf (fresh) pulp, sodium bisulphite process, Cook No. 418	Bleached Cuban kenaf (fresh) pulp, magnefite process, Cook No. 399	Bleached Cuban kenaf (fresh) pulp, kraft process Cook No. 407
Freeness, S.-R., ml	490	455	440
Burst factor	50	40	58
Breaking length, m	9,522	6,872	9,558
Tear factor	93	83	99
Folding endurance	520	193	596

TABLE 3

PHYSICAL PROPERTIES OF HANDSHEETS PREPARED FROM DRY CUBAN KENAF BY VARIOUS PROCESSES

Physical property	Bleached Cuban kenaf (dry) pulp, sodium bisulphite process, Cook No. 462	Bleached Cuban kenaf (dry) pulp, magnefite process, Cook No. 426	Bleached Cuban kenaf (dry) pulp, kraft process Cook No. 428
Freeness, S.-R., ml	400	465	460
Burst factor	53.4	32.5	72.4
Breaking length, m	9,284	6,830	9,842
Tear factor	67.5	60.7	141.5
Folding endurance	274	20	1,442

Also the electrodialysis process has been investigated by the Sulphite Pulp Manufacturers' Research League and offers promise for recovery of inorganic chemicals for pulping and organic by-products derived from the spent liquor organics. Thus pollution control can be effected without resorting to the conventional concentration and burning of the spent liquor.

CONCLUSIONS

1. Sodium bisulphite process shows good promise for pulping fresh Cuban kenaf stalks (Hibiscus cannabinus) for its high bleached yield, about 53 per cent on ovendry chip weight, and moderate bleach consumption, in the order of 10 per cent on unbleached pulp for brightness about 75. The pulp strength compares favourably with kenaf kraft pulp and better than kenaf magnefite pulp.

2. A chemical dosage with 16 per cent total SO_2 on ovendry chip weight in sodium bisulphite solution and liquor ratio 4:1, for 2 hour heating period to 150°C and 4 hour cooking period at 150°C, appear to be the optimum conditions for 62 per cent high yield of bisulphite pulp from fresh Cuban kenaf.

3. Dry Cuban kenaf responds to the same cooking conditions except that with 2½ hour impregnation and heating to 150°C. A lower yield of 55 per cent unbleached pulp with good quality is obtained.

4. Pulp from fresh kenaf has less bleach demand, 10 per cent chlorine, compared to 12 per cent chlorine for pulp from dry kenaf.

5. The bleached yield of pulp from fresh kenaf at 53 per cent appears far above the bleached yield from dry kenaf at 42.7 per cent. The pulp quality from dry kenaf is inferior to that from fresh kenaf but is comparable to kenaf kraft pulp from dry kenaf.

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