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BLEACHED CHEMICAL PULP FROM KENAF

REPORT NO. 3
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BLEACHED CHEMICAL PULP FROM KENAF BY AMMONIUM BISULPHITE PROCESS

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

SUMMARY

Kenaf stalks of Hibiscus cannabinus yields 45 per cent bleached pulp by ammonium bisulphite pulping and 3-stage bleaching. Air dry kenaf chips were pulped at liquor ratio 4:1 with ammonium bisulphite solution containing 18 per cent total SO_2 on chip weight. The chips were heated with the cooking solution at pH 3.2 in a tumbling digester to 150°C in 2 hours and cooked at 150°C for 4½ hours. The softened chips were refined for defibration. The unbleached yield was 52 per cent on ovendry chips.

The pulp was bleached by C/E/H/D sequence with a total of 8 per cent equivalent chlorine. The bleached yield was 86 per cent on pulp weight with brightness 80. The quality of bleached pulp was better than hardwood kraft pulp and comparable to softwood sulphite pulp except for tearing strength.

Pulping fresh Cuban kenaf stalks by ammonium bisulphite process was done with a total of 16 per cent total SO_2 on chip weight under similar conditions. The yield was 51 per cent. The pulp was bleached in the same way as that for pulp from dry kenaf. The bleached yield attained 91 per cent on pulp weight with brightness 80. The pulp quality was inferior to that from dry kenaf.

INTRODUCTION

Pulping tests of kenaf stalks by bisulphite process with magnesium and sodium bases all indicated difficulty in the delignification of air dry stalks although fresh stalks respond quite well with good yield and strength. Ammonium base bisulphite process has been applied for pulping of wood. This process is noted for its good penetration and mild reaction for high yield.

Disposal of the waste effluent from ammonium bisulphite pulping by evaporation and drying may yield a by-product as soil conditioner and fertilizer. Recovery of ammonia by dry distillation of the concentrated waste effluent with lime is feasible. The calcium salt can be burned and

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recovered as lime for recycling. Work on the by-products and recovery system has not yet completed. The preparation of bleached pulp is evaluated in this study for comparison with other bases of bisulphite pulps.

EXPERIMENTAL

Ammonium bisulphite solution was prepared by absorbing SO_2 gas in a 2% ammonia solution until the pH of the solution reached 3-4. About 1 kg kenaf chips were cooked with the solution at liquor to kenaf ratio 4:1 in a stainless steel laboratory tumbling digester. The digester was electrically heated to 150-155°C in 1½-2 hours to allow impregnation. Then the digester was maintained at this temperature for 4-4½ hours. At the end of cooking, blowing the digester for 15 minutes to cool the temperature to 110°C before opening the digester permitted discharge of the crude pulp at lower temperature for better quality. The crude pulp was washed and passed through a single disc refiner to open the fibre bundles. The refined pulp was washed and dewatered in a laboratory centrifuge to form a wet cake. Part of the cake with dry weight about 100 g was used in the bleaching test. The remaining wet cake was dried in an oven for determination of unbleached yield.

The wet pulp was bleached by C/E/H/D sequence with a total equivalent chlorine at about 8 per cent on dry unbleached pulp.

In the chlorination stage, the pulp at 3% consistency was mixed with sodium hypochlorite solution in a plastic bottle at 30°C and acidified with dilute 10% hydrochloric acid to pH 1.8 for generation of chlorine. After shaking 5 minutes, the pulp slurry was allowed to stand 25 minutes with occasional shaking. The chlorinated pulp was washed.

In the caustic extraction stage, the pulp at 10% consistency was treated with 1.5 per cent caustic soda on pulp weight for half an hour at 70°C. A dark brown extract resulted and the pulp was washed.

In the hypochlorite bleaching stage, the pulp at 10% consistency was treated with sodium hypochlorite solution containing one per cent available chlorine on pulp weight. The bleaching was done in 3 hours at 40°C. Then the pulp was washed.

In the chlorine dioxide bleaching stage, the pulp at about 10% consistency was mixed with sodium chlorite solution in a closed plastic bottle and acidified with 10% hydrochloric acid to pH 3-4 for generation of ClO_2 gas. The temperature of bleaching was controlled in a water bath at 70°C for 4 hours.

The bleached pulp received a final acid wash at 30°C for one half an hour with dilute sulphurous acid about 0.5 per cent on pulp weight. The washing improved the brightness.

The pulp was evaluated by converting into handsheets with addition of sizing materials as follows:

Rosin size	1.5%
Alum	3.0%
Tamarind kernel powder	2.0%
Whiten	0.3%

The tamarind kernal powder served as a dispersing agent. Whiten was used as brightening agent. The initial freeness of the pulp was measured. The pulp at 0.3% consistency was treated in a laboratory Hollander beater for a few minutes to final Schopper-Riegler (S.-R.) freeness of about 500 ml.

All handsheets prepared were conditioned overnight in a conditioned room maintained at 23°C and 50% relative humidity. Physical tests of handsheets were done according to TAPPI testing methods.

RESULTS AND DISCUSSION

The data shown in Table 1 are conditions of cooking and bleaching and results of testing the pulps and handsheets. Table 2 compares the results of physical testing of handsheets made from different bisulphite processes.

The ammonium bisulphite process gave higher yield of pulp with less bleach consumption from air dry kenaf than sodium bisulphite pulping. However, the strength of ammonium bisulphite pulp was lower than that of sodium bisulphite pulp. For fresh kenaf the ammonium bisulphite process is not as good as the sodium bisulphite process. The magnesium bisulphite process stands between the sodium base and the ammonium base when

TABLE 1
PULPING AND BLEACHED CONDITIONS IN THE AMMONIUM BISULPHITE PULPING OF KENAF STALKS

Sample No.	1	2
Cook No.	421	420
Raw material	Cuban kenaf, air dry	Cuban kenaf, fresh
Cooking liquor analysis		
pH value	4.8	4.7
Total SO_2, %	4.2	4.6
Free SO_2, %	2.4	2.34
NH_3, %	1.5	1.69
Total SO_2 on ovendry chips, %	18.0	16.0
Liquor to chips ratio, ml/g	4.4	5.5
Max. temp., ^oC	150	150
Time to max. temp., hours	2	2
Time at max. temp., hours	4.5	4.5
Pulp yield, % on ovendry chips	52.4	50.5
Bleaching sequence	C/E/H/D	C/E/H/D
Chlorination stage, (C)		
Cl_2, %	5.0	5.0
Alkali extraction stage (E)		
NaOH, %	1.5	1.5
Hypochlorite bleaching stage (H)		
Available chlorine, %	1.0	1.0
Chlorine dioxide bleaching stage (D)		
ClO_2, %	0.75	0.75
Total equivalent chlorine applied, %	8.0	8.0
Bleached yield		
% on ovendry unbleached pulp	85.6	90.9
% on ovendry chips	44.7	46.0
Paper No.	187	189
Physical properties of handsheets		
Initial freeness, S.-R., ml	720	690

Table 1 (continued)

Sample No.	1	2
Final freeness, S.-R., ml	500	540
Time of beating, min	5	3
Basis weight, g/m^2	76.7	74.5
Bulk, ml/g	1.28	1.36
Burst factor	35	29
Tear factor	91	62
Breaking length, m	6,672	5,834
Folding endurance	172	4
Brightness, %	80	80

TABLE 2
PHYSICAL PROPERTIES OF HANDSHEETS PREPARED FROM KENAF BISULPHITE PULPS

Raw material	Fresh Cuban kenaf			Air dry Cuban kenaf		
Base of bisulphite pulping	Na	Mg	NH_3	Na	Mg	NH_3
Cook No.	418	399	420	462	426	421
Paper No.	188	180	189	208	190	187
Bleached yield, % on chips	48.7	40.7	46.0	42.7	42.2	44.7
Bleach demand, % Cl_2 on unbleached pulp	10.0	8.0	8.0	12.0	8.0	8.0
Freeness, S.-R., ml	490	470	540	400	465	500
Breaking length, m	9,522	6,872	5,834	9,284	6,830	6,672
Tear factor	93	83	62	68	61	91
Burst factor	50	40	29	53	33	35
Folding endurance	520	193	4	274	20	172
Brightness, %	75	80	80	85	80	80

pulp strength characteristics from fresh kenaf and dry kenaf are compared. In a pulp mill using bisulphite process, it is quite convenient to change from one base to the other. With fresh kenaf, sodium base would be favoured. When only air dry kenaf is used, ammonium base can be applied. Magnesium base is an alternative, as pulp strength is comparable to the other two bases and easy recovery of pulping chemicals by burning the concentrated effluent is possible. If the pulp mill has an integrated kenaf farm, the ammonium base may warrant favourable consideration for possible disposal of the waste effluent for fertilizer value in the irrigation system.

Some difference of colour of unbleached pulps from various bases was noticed. The unbleached ammonium bisulphite pulp from dry kenaf was brighter than pulps from magnesium and sodium bases. The sodium bisulphite pulp from dry kenaf was darker than the magnesium bisulphite pulp. The brighter ammonium bisulphite pulp had better strength than the magnefite pulp from dry kenaf.

When bisulphite pulps from fresh kenaf were compared, the pulp from sodium base was the brightest and the strongest after bleaching, whereas the ammonium base gave the lowest folding endurance and poorest strength.

CONCLUSIONS

1. Ammonium bisulphite process can be applied for pulping air dry kenaf stalks for good yield of bleached pulp and moderate bleach consumption when compared with other bisulphite pulps of dry kenaf. The pulp quality appears better than magnefite pulp but inferior to sodium bisulphite pulp.

2. Pulping dry kenaf by ammonium bisulphite process calls for higher concentration of total SO_2 18 per cent on chip weight with liquor ratio 4:1 at 150°C for 4½ hours. Fresh kenaf needs about 16% total SO_2 in the cooking solution under similar conditions.

3. Pulping fresh Cuban kenaf stalks by ammonium bisulphite process gives result similar to magnefite process except with lower pulp strength but higher bleached yield at about 46 per cent.

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