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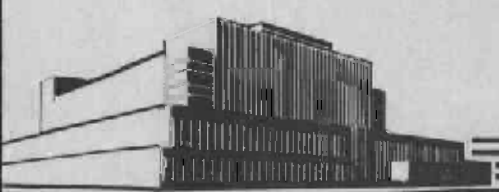

FOREST PRODUCTS LABORATORY
MADISON 5, WISCONSIN

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
In Cooperation with the University of Wisconsin

PULPING OF MESQUITE, MANZANITA, AND SNOWBRUSH

By

JAMES F. LAUNDRIE, Chemical Engineer

Forest Products Laboratory,[1] Forest Service
U. S. Department of Agriculture

Summary

Mesquite (Prosopis juniflora) was pulped by the neutral sulfite and cold soda semichemical processes to determine its suitability for making corrugating board. A sulfate pulp was also made from mesquite for comparison with that from other United States hardwoods.

Manzanita (Arctostaphylos) and snowbrush (Ceanothus velutins) were pulped by the sulfate process to determine the suitability of these pulps for use in printing-type papers. Snowbrush was also pulped by the neutral sulfite semichemical process for use in producing corrugating board.

The results showed that:

Corrugating boards produced from mesquite neutral sulfite and cold soda pulps had ring compression values comparable to those of commercial boards and Concora values about 20 percent lower. There were indications, however, that lowering the freeness of these pulps by adjusting processing conditions the Concora values would be raised.

Snowbrush pulp was not suitable for producing a good-quality corrugating board. Although the board made from the snowbrush neutral sulfite pulp was made at a low freeness of 150 milliliters (Canadian Standard), the Concora and ring compression values were below the commercial range.

Printing paper made from a stock consisting of 40 percent bleached manzanita sulfate pulp and 60 percent bleached Douglas-fir sulfate pulp had good strength properties and appearance.

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[1] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

The strength properties of mesquite sulfate pulp were considerably lower than average values obtained from other United States hardwoods.

Introduction

Mesquite grows in abundance on the river bottom lands of the Southwest but is now used only sparsely in the production of charcoal and as firewood. The slow growth of the pulping industry in this area has been due primarily to the lack of suitable raw material and water. The possibilities of pulping mesquite, especially by high-yield methods that require relatively small amounts of water, therefore, warrant investigation as a potential means of utilizing this abundant raw material.

Similarly, large stands of manzanita, snowbrush, and other chaparral species found in California not only are unused but constitute a definite fire hazard and require constant and costly fire protection. The finding of a profitable use for this brush material, such as the manufacture of paper products, might create a favorable situation whereby the land could be cleaned for replanting to more desirable trees or grass.

One of the objectives was to determine, by a study of the properties of their sulfate pulps, the possibilities of using manzanita, snowbrush, and mesquite in the manufacture of printing papers. Further, to obtain more positive information a quantity of manzanita sulfate pulp was bleached and converted into a printing-type paper.

The work also included the making of corrugating boards from snowbrush and mesquite neutral sulfite pulps and mesquite cold soda pulp.

Strength tests made on the pulps were according to TAPPI Standard Methods except that 55-pound (ream of 500 sheets, 25 by 40 inches) sheets were used and the strength values are reported on the sheet weights obtained after conditioning at 72° F. and 50 percent relative humidity. Physical tests on the board and paper were made according to standard methods.

The Wood

Manzanita (Arctostaphylos) and snowbrush (Ceanothus velutins) pulpwood were obtained with the bark on from the California Forest and Range Experiment Station Field Research Center at Redding, Calif. Because the bolts were crooked, tough, and of small diameter (1/2 to 1-1/2 inches), it was difficult

to convert these woods into nominal size 5/8-inch chips. The bark was not removed before chipping. Before pulping, the over- and under-sized materials were removed from the chips by passing them over a shaking screen equipped with 1-1/4- and 1/4-inch mesh screens. Because there was such a large amount of oversize-pieces, that portion was put through the chipper a second time and again screened. The moisture content of the manzanita and snowbrush chips averaged 27.5 and 15.6 percent, respectively.

Mesquite (Prosopis juniflora) pulpwood was obtained with the bark on from the Rocky Mountain Forest and Range Experiment Station Field Research Center at Flagstaff, Ariz. The diameter of the logs averaged about 9 inches and varied in a range of from 7 to 13 inches. Physical tests made on 1-inch disks cut from the ends of the mesquite logs showed: the average specific gravity was 0.618 (dry weight, green volume basis); average age, 60 years; average growth rate, 0.15 inch in diameter per year; and average moisture content, 19.5 percent. The bark was removed from the logs before converting them into 5/8-inch chips. The chips were also passed over a shaking screen equipped with 1-1/4- and 1/4-inch mesh screens to remove the over- and under-sized material before pulping.

Sulfate Pulping

Experiments

Small-scale sulfate pulping trials were made on manzanita in a 0.8-cubic-foot, stainless steel, tumbling digester that held about 8 pounds of chips (moisture-free basis) to determine the conditions necessary to produce a larger quantity of pulp. These digestions were made with 22.5, 25.0, and 27.5 percent of total chemical (moisture-free wood basis) which gave yields of unscreened pulp of 40.9, 38.8, and 37.9 percent and screenings of 1.4, 0.3, and 0.3 percent, respectively (digestions 3607X, 3608X, 3609X, 3610X, table 1). The pulp made with 25.0 percent of total chemical had a permanganate number of 13.9 and was considered satisfactory for bleaching. A quantity of this pulp was produced by making two pilot-plant digestions (4233 and 4234) in a 13-cubic-foot tumbling digester. These two pulps were mixed, passed through a screen equipped with 0.012-inch slots, and cleaned with a 6-inch-diameter centrifugal cleaner. Screenings and centrifugal cleaner rejects amounted to about 0.3 and 0.6 percent, respectively. The screened and cleaned pulp had a permanganate number of 11.3, slightly lower than that of the small-scale digestion. The screened and cleaned manzanita pulp was bleached in pilot-plant bleaching equipment in three stages -- chlorine, caustic extraction, and hypochlorite. Conditions used are given in table 2. This pulp was used for making printing paper.

Small-scale sulfate digestions on snowbrush and mesquite using 25.0 and 22.5 percent of total chemical gave yields of unscreened pulp of 43.1 and 40.2 percent, respectively. The screenings of 2.3 percent for the mesquite pulp was relatively high.

Results

The results of both small-scale and pilot-plant sulfate digestions given in tables 1 and 3 show that, to produce a bleachable pulp from manzanita with less than 1 percent of screening rejects, it was necessary to use 25 percent of total chemical (moisture-free wood basis). Snowbrush, cooked with the same amount of chemical gave a yield 11 percent higher than did manzanita although the percentage of screening rejects was the same. The bursting strength and the folding endurance of the unbeaten and unbleached manzanita and snowbrush pulps were about the same, while the tearing resistance and the tensile strength of the snowbrush pulp were about 2 and 1.5 times higher, respectively. Although beating the manzanita pulp did develop some strength, the usual freeness drop was not observed because fines, generated by beating, passed through the screen of the freeness tester. After beating both pulps for 60 minutes, the bursting strength, tearing resistance, and the tensile strength of the snowbrush pulp were about 2, 1.5, and 1.5 times, respectively, those of the unbleached manzanita pulp. Bleaching the manzanita pulp produced about 100 percent increase in the bursting strength, tearing resistance, and the tensile strength but after beating 60 minutes these properties were increased only about 13.6, 7.3, and 5.2 percent, respectively, over the values for unbleached pulp beat the same length of time.

Compared at a freeness of 350 milliliters (Canadian Standard), the bursting strength, tearing resistance, and tensile strength of the unbleached mesquite sulfate pulp were 42.0, 17.8, and 44.1 percent weaker, respectively, than average values for 6 U. S. hardwoods[2] (table 3).

Neutral Sulfite Semichemical Pulping

Small-scale and pilot-plant neutral sulfite semichemical cooks were made on mesquite and snowbrush in the digesters described above. The partially digested chips from the small-scale digestions were fiberized in an 8-inch-diameter, single-rotating disk mill and the resulting pulps were washed, dewatered, and sampled for yield determinations. The chips from the pilot-plant digestions, were thoroughly mixed, sampled for yield determination,

[2] Paper birch, sugar maple, American beech, red alder, sweetgum, and aspen.

and fiberized in a 36-inch-diameter, double-rotating disk mill. The resulting pulps were passed through a screen equipped with 0.012-inch slots and wet lapped. The samples taken from the pilot-plant digestions for yield determinations were fiberized in the 8-inch-diameter, single-rotating disk mill and washed.

Previous work[3] had shown that maximum strengths are obtained between 60 and 70 percent yield. A small-scale neutral sulfite digestion of mesquite (1539Y, table 4) with 21.0 percent sodium sulfite and 8.0 percent sodium bicarbonate (moisture-free wood basis) gave a yield of 61.6 percent. To obtain a more desirable yield of around 65.0 percent the conditions were changed for the pilot-plant digestion (5623N) to 14.5 and 6.94 percent sodium sulfite and sodium bicarbonate, respectively. Under these conditions a quantity of pulp was made at a yield of 65.8 percent.

A small-scale digestion (1559Y, table 4) of snowbrush with 14.1 and 8.22 percent sodium sulfite and sodium bicarbonate, respectively, gave a yield of 66.8 percent. Using approximately these same conditions a quantity of pulp was made in a pilot-plant digestion (5642N) at a yield of 64.9 percent.

The pilot-plant cooks of snowbrush and mesquite neutral sulfite pulps were used in producing corrugating board.

Cold Soda Pulping

Two small-scale cold soda treating experiments (3620X, 3638X) were made on mesquite at atmospheric pressure in a 0.8-cubic-foot, stainless steel digester. After the caustic soda treatment, the chips were drained free of liquor and weighed to determine the amount of liquor absorbed. They were then immediately fiberized to a coarse pulp in an 8-inch-diameter, single-rotating disk mill. The clearance between the disks in the mill was set before each fiberizing run so that the motor drew 6 amperes current with a constant flow of water between the plates of 3 gallons per minute. The resulting pulps were thoroughly washed, dewatered, and sampled for yield determination.

The results of small-scale cold soda treatments indicated that to make a pulp with maximum strength for corrugating board it was necessary to heat the caustic soda solution to about 60° C. and have a caustic soda concentration above 50 grams per liter (tables 5 and 6). Previous work[4] had shown that the

[3] Ceragioli, G. et al. High-Yield Neutral Sulfite Pulps. Tappi, Vol. 40, No. 1, pages 8-14.

[4] Brown, K. J., and Kingsbury, R. M. Cold Soda Pulping of a Mixture of Water Oak and Willow Oak. Progress Report, Job No. 1383, May 1958.

yield decreases rapidly above a temperature of 60° C. and that using a caustic soda concentration greater than 60 grams per liter did not increase the strength appreciably.

A quantity of cold soda pulp was made for corrugating board production, by feeding chips and caustic soda liquor simultaneously through a roll-type refining mill (KM 188).[5] During passage through this machine the chips were repeatedly compressed between a revolving cylinder and a roll rotating within the cylinder, in the presence of the caustic soda solution, for about 30 seconds before being discharged in the form of a partially fiberized pulp. Based on the results of the small-scale tests, the concentration of caustic soda was 60.8 grams per liter and the temperature was 63° C. The material discharged from the roll mill was held for 1 hour before pressing to a dryness of 52.6 percent in a 3-section, 7-inch-diameter screw press. The pressed material was fiberized in a 36-inch-diameter, double-rotating disk mill, screened through 0.012-inch slotted flat screens, and wet lapped. The yield of pulp was 82.3 percent.

Boardmaking and Papermaking

Corrugating Board

Neutral sulfite pulps made from mesquite and snowbrush and cold soda pulp made from mesquite were converted into 26-pound corrugating boards on a 13-inch Fourdrinier paper machine.

It was necessary to process the mesquite cold soda pulp to a freeness of 340 milliliters (Canadian Standard) to get approximately the same ring compression and Concora values obtained from the mesquite neutral sulfite pulp at a freeness of 450 milliliters (table 7). The Concora value of about 56 pounds for these boards was somewhat below the commercial range of 70 to 80 pounds although the ring compression resistances of these boards compared closely with those of commercial boards. Although the board made from the snowbrush neutral sulfite pulp was made at a freeness of 150 milliliters, the Concora and ring compression values were below the commercial range.

Printing Paper

Fifty-pound (per 3,000 square feet) printing paper stock was made on the 13-inch Fourdrinier paper machine from a pulp furnish consisting of 40 percent

[5] Brown, K. J., and Hilton, R. D. New -- Fast -- Continuous Cold Soda Hardwood Pulping Process. Paper Trade Journal, Vol. 10, No. 21, pages 42-46.

bleached manzanita sulfate pulp and 60 percent commercial bleached Douglas-fir sulfate pulp. The Douglas-fir pulp was beaten to a freeness of 580 milliliters, jordaned, and blended with the manzanita pulp. Twelve percent clay filler, 3 percent titanium dioxide, and 1 percent rosin size were added to the stock in the beater.

The paper had good strength properties and appearance and there were indications that the percentage of manzanita pulp could have been higher than 40 percent. The sheet was calendered lightly so that the mottled appearance produced by the felts would remain in the paper (table 8).

Table 1.--Conditions[1] and results of sulfate pulping trials made on manzanita, snowbrush, and mesquite

Digestion number	Chemicals charged						Total chemical consumed[2]	Yield[2]		Permanganate number
	Concentration		Amount[2]					Screened	Screenings	
	Total	Na_2O	NaOH	Na_2S	Na_2O	Total				
	Gm. per L.	Gm. per L.	Percent	Percent	Percent	Percent	Percent	Percent	Percent	
MANZANITA										
3607X	56.25	43.88	16.88	5.62	17.55	22.50	20.6	39.5	1.4	16.2
3609X, 3610X	62.50	48.75	18.75	6.25	19.50	25.00	21.9	38.5	.3	13.9
3608X	68.75	53.63	20.63	6.87	21.45	27.50	23.6	37.6	.3	15.0
4233, 4244	62.50	48.75	18.75	6.25	19.50	25.00	21.9	.....	.3	11.3
SNOWBRUSH										
3736X	62.50	48.75	18.75	6.25	19.50	25.00	21.0	42.8	.3	.....
MESQUITE										
3645X	56.25	43.88	16.88	5.62	17.55	22.50	20.7	37.9	2.3	.....

[1] Constant conditions for all sulfate digestions were 25.5 percent sulfidity, 4:1 liquor to wood ratio, 1.5 hours to reach 170° C., and 1.5 hours at 170° C.

[2] Based on moisture-free weight of wood.

Table 2.--Conditions used in bleaching manzanita sulfate pulp[1]

Stage 1: Chlorination, 1-hour at 25° C.		
Chlorine applied	percent	4.0
Chlorine consumed	percent	3.8
Consistance	percent	2.4
pH		3.0 - 2.7
Stage 2: Alkaline extraction, 1 hour at 50° C.		
Caustic soda applied	percent	2.0
Consistance	percent	10.8
pH		11.6 - 11.5
Stage 3: Calcium hypochlorite, 5 hours at 37° C.		
Amount applied[2]	percent	3.5
Amount consumed[2]	percent	3.2
Consistance	percent	9.6
pH		9.0 - 8.6
Bleached pulp brightness[3]	percent	82.1

[1] Digestions 4233 and 4234 mixed.

[2] In terms of available chlorine.

[3] Acidified to pH 6.5 before final wash.

Table 3.--Physical properties of sulfate pulps made from manzanita, snowbrush, and mesquite

Beating time	Freeness (Canadian Standard)	Bursting strength	Tearing resistance	Folding endurance	Breaking length	Density	Brightness G.E. equivalent
Min.	Ml.	Pts. per lb. per ream[1]	Gm. per lb. per ream[1]	Double folds	Meters	Gm. per cc.	Percent
UNBLEACHED MANZANITA PULP -- DIGESTIONS 4233 AND 4234 MIXED[2]							
0	490	0.15	0.22	0	1590	0.51	25.6
60	580	.44	.55	14	4590	.68	.....
UNBLEACHED SNOWBRUSH PULP -- DIGESTION 3736X[2]							
0	520	.19	.43	2	2415	.53	20.4
60	470	.80	.79	368	6760	.78	.....
BLEACHED MANZANITA PULP -- DIGESTIONS 4233 and 4234 MIXED							
0	695	.25	.40	2	2950	.57	82.1
60	775	.50	.59	49	4830	.76	.....
UNBLEACHED MESQUITE PULP -- DIGESTION 3645X							
24	350	.51	.83	21	4750	.61	.....
AN AVERAGE FOR UNBLEACHED PULP FROM SIX U. S. HARDWOODS[3]							
.....	350	.88	1.01	420	8500	.....	.....

[1] Ream of 500 sheets, 25 x 40 inches.

[2] After screening and centrifugal cleaning.

[3] Paper birch, sugar maple, American beech, red alder, sweetgum, and aspen.

Table 4.--Conditions and results of neutral sulfite pulping trials made on mesquite and snowbrush

Digestion number	Maximum temperature	Time		Liquor to wood ratio[1]	Liquor concentration			Chemicals applied[1]		Na_2SO_3 consumed[1]	Yield[1]
		To maximum temperature	At maximum temperature		Impregnation		Spent				
					Na_2SO_3	$NaHCO_3$	Na_2SO_3	Na_2SO_3	$NaHCO_3$		
	°C.	Hr.	Hr.		Gm. per L.	Gm. per L.	Gm. per L.	Percent	Percent	Percent	Percent
MESQUITE											
1539Y	170	2.5	3.25	4	57.4	21.3	16.8	21.0	8.00	14.3	61.6
5623N	170	2.5	2.25	3.5	45.6	21.8	10.6	14.5	6.94	10.8	65.8
SNOWBRUSH											
1559Y	170	2.5	.58	3.5	42.0	24.5	9.4	14.1	8.22	11.0	66.8
5642N	170	2.5	1.33	3.5	44.6	23.5	9.6	14.9	7.86	11.6	64.9

[1] Based on weight of moisture-free wood.

Table 5.--Conditions and results of cold soda pulping trials made on mesquite

Treatment number	Treating conditions: Temperature	Treating conditions: Sodium hydroxide concentration	Atmospheric steep time	Sodium hydroxide (moisture-free wood-basis): Total used	Sodium hydroxide (moisture-free wood-basis): Recovered in screw press	Energy consumed (per ton air-dry pulp): Roll mill	Energy consumed (per ton air-dry pulp): Screw press	Energy consumed (per ton air-dry pulp): Disk mill	Energy consumed (per ton air-dry pulp): Total	Pulp yield	Pulp freeness (Canadian Standard)
	°C.	Gm. per L.	Hr.	Percent	Percent	Hp-days	Hp-days	Hp-days	Hp-days	Percent	Ml.
BATCH											
3620X	25	48.8	2	5.41	.....	.....	.....	26.0[1]	26.0	84.1	380
3638X	61	51.6	2	11.85	.....	.....	.....	24.2[1]	24.2	62.3	580
CONTINUOUS[2]											
M188	63	60.6	.....	16.2[3]	2.8	1.95	1.28	10.5[4]	13.7	82.3	560

[1] Energy consumed in fiberizing treated chips in an 8-inch diameter, single rotating disk mill.

[2] Roller mill cylinder speed, 260 revolutions per minute; linear pressure on roll, 120 pounds per square inch; chip feed rate 206 pounds per hour, moisture-free basis. Treated chips were stored for 1-hour before screw pressing.

[3] Includes the chemical consumed by reaction and that left unconsumed in the treated chips.

[4] Conducted in a 36-inch diameter double rotating disk mill using C-914 plates.

Table 6.--Physical properties of small scale cold soda pulps made from mesquite

Treatment number	Freeness (Canadian Standard)	Bursting strength	Tearing resistance	Breaking length	Density
	Ml.	Pts. per lb. per ream[1]	Gm. per lb. per ream[1]	Meters	Gm. per cc.
3620X	350	0.04	0.17	730	0.35
	250	.05	.20	810	.37
	150	.07	.21	980	.41
3638X	350	.09	.26	1,260	.40
	250	.11	.27	1,510	.43
	150	.12	.25	1,640	.46

[1]Ream of 500 sheets, 25 x 40 inches.

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Table 7.--Physical properties of corrugating boards produced from mesquite cold soda and neutral sulfite pulps and snowbrush neutral sulfite pulp

Machine run No.	Headbox freeness (Canadian Standard)	Weight (per 1,000 sq. ft.)	Thickness	Density	Bursting strength: Mullen	Bursting strength: Unit	Tearing resistance	Folding endurance	Ring compression[1]: In machine direction	Ring compression[1]: Average	Concora[2]
	Ml.	Lb.	Mils	Gm. per cc.	Pts.	Pts. per lb. per ream[2]	Gm. per lb. per ream[2]	Double folds	Lb.	Lb.	Lb.
MESQUITE COLD SODA PULP (KM188)											
5169	560	26.4	13.8	0.37	9.2	0.099	0.37		29.9	26.4	18.3
[4]5170	400	26.6	12.0	.43	15.3	.16	.45		46.2	40.1	37.2
[5]5171	440	27.0	11.8	.44	18.0	.19	.45		48.2	42.5	38.5
[4]5172	340	26.6	10.5	.49	21.0	.22	.53		54.6	47.8	57.6
MESQUITE NEUTRAL SULFITE PULP (5623N)											
5167	525	26.4	9.9	.51	33.4	.36	.62	3	49.9	44.3	44.4
[4]5168	450	26.0	9.5	.53	37.3	.40	.63	6	56.3	49.4	54.5
SNOWBRUSH NEUTRAL SULFITE PULP (5642N)											
5250	150	26.0	7.6	.66	55.5	.62	.60	353	46.9	41.9	60.7

[1] Test specimen of 1/2 inch by 6 inches.

[2] Test specimens of 10A-flutes; 1/2 inch wide.

[3] Ream of 500 sheets, 25 x 40 inches.

[4] Pulp was jordaned.

[5] Pulp was given two passes through the 36 inch diameter disk mill.

Table 8.--Physical properties of printing paper containing 40 percent manzanita bleached sulfate pulp and 60 percent commercial Douglas-fir bleached sulfate pulp

Machine run	No.	5097
Ream weight (500 sheets, 25 x 40 inches)	Lb.	60.5
Thickness	Mils	5.3
Density	Gm. per cc.	0.63
Bursting strength	Pts. per lb. per rm.	0.24
Average tearing resistance	Gm. per lb. per rm.	1.30
Average tensile strength	Lb. per in.-width	14.2
Average folding endurance (M.I.T.)	Double folds	7
Castor oil penetration	Sec.	39
Air resistance (Gurley)	Sec. per 100 cc.	12
Opacity	percent	90.7
Brightness (G.E. equivalent)	percent	84.9
Ash	percent	8.2

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