SULFATE PULPING OF PONDEROSA PINE THINNINGS

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SULFATE PULPING OF PONDEROSA PINE THINNINGS

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Introduction

Ponderosa pine (Pinus ponderosa) wood obtained in thinning operations on a stand near Blanchard in western Idaho was experimentally pulped by the sulfate process to determine its pulping characteristics. In such thinning operations, some trees are cut to give better spacing to the remaining trees, and some trees of poor form and vigor are removed to improve the quality of the stand. If satisfactory pulps could be produced from the pine thinnings, a use would be provided for the wood cut in such forest-management practices.

Test Material and Pulping Procedures

The test material consisted of 88 bolts, each 4 feet in length, and was representative of wood obtained by a combination of thinning operations at the crown and lower levels of the tree. It was obtained from a small stand of pure ponderosa pine containing trees 20 to 40 years old, 4 to 10 inches in diameter at breast height, and 15 to 30 feet in height. Pure stands of lodgepole pine occurred in the general area.

The physical characteristics of the ponderosa pine[2] are given in the following tabulation, which lists average values obtained on representative transverse sections, approximately 1 inch thick:

Specific gravity		0.40
Density	pounds per cubic foot	25.0
Diameter	inches	4.9
Age	years	36.8
Rate of growth	rings per inch	14.9
Heartwood, by volume	percent	1.9
Bark, by volume	do.	20.9
Bark, by weight (dry basis)	do.	19.9

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

[2] Pinus ponderosa. Shipment No. 2814.

The density of the ponderosa pine, 25 pounds per cubic foot (based on weight of moisture-free wood and volume of green wood), was within the range of common northern coniferous pulpwoods, such as jack pine, Douglas-fir, western hemlock, Pacific silver fir, and lodgepole pine. If it is satisfactory as a pulpwood, the ponderosa pine might be expected to compete in the same market as these woods.

The ponderosa pine resembled jack pine, a wood used extensively in the Lake States pulping industry, closely enough in chemical composition to indicate similar sulfate-pulping characteristics for both species. It has a slightly lower lignin content and a little higher solubility in alcohol-benzene and in ether than jack pine (table 1).

Various ratios of pulping chemical to wood were used to produce sulfate semichemical, kraft, and bleaching sulfate pulps. The pulping digestions were made in a spherical, rotary autoclave, which was indirectly heated by steam and had a capacity of 0.5 cubic foot. Semichemical pulps were fiberized in an attrition mill having an 8-inch, single rotating disk, and yields and strength properties of the fiberized pulps were determined.

Results and Discussion

In the semichemical pulping series, an increase in the amount of chemicals (calculated as sodium oxide) from 7.8 to 11.7 percent of the weight of moisture-free wood caused a normal decrease in pulp yield from 73 to 54 percent, a decrease in chemical consumption, an increase in the density of the black liquor, and progressively higher strength properties of the semichemical pulps (tables 2, 3). The pulps cooked with less than 11.7 percent of chemicals were very dark in color, as measured by brightness values, and were similar in brightness to high-yield pulps from softwood species. In the digestion in which the smallest amount of chemicals was used, cooking was stopped when the maximum temperature was reached, thereby making the total cooking time one-half that of the other digestions. The result was a higher pulp yield of 75 percent and lower strength properties, except for tearing strength, which showed no change. While all the sulfate semichemical pulps appeared to have more than adequate strength for corrugating board, the ponderosa pine sulfate pulp produced in a yield of 54 percent also appeared to have sufficient strength for use in liner board of high quality.

The pulping of ponderosa pine by conditions suitable for producing a kraft-type pulp (13.7, 15.6, and 17.6 percent of sodium oxide) showed that the lowest quantity of chemicals was sufficient to produce the maximum yield of screened pulp, a low yield of screening rejects, and the highest pulp strength (tables 2, 3). The yields of screening rejects obtained for the kraft digestions were lower than those normally obtained from jack pine and many softwood species, which indicated very favorable pulping characteristics for ponderosa pine by the sulfate process. Ponderosa pine kraft pulps were higher in bursting strength and lower in tearing strength (table 3) than southern pine pulps. The bursting strength of ponderosa pine kraft pulps was considerably lower than that of spruce and balsam kraft pulps. The kraft pulps from ponderosa pine were quite similar in strength to those from jack pine and appear to be suited for use in the same

types of papers, such as wrapping and kraft specialties, as the jack pine kraft pulps.

Ponderosa pine was readily cooked to produce a bleaching sulfate pulp that was sufficiently low in lignin content and permanganate numbers and sufficiently high in brightness after a one-stage bleach test to indicate satisfactory bleaching qualities with a normal quantity of chlorine (table 2). The additional amounts of chemicals used for producing the bleaching pulps over those required for the kraft-type pulps caused a normal reduction in pulp yield and in pulp strength and an improvement in the chemical purity of the pulps.

Conclusions

Except for the lower chemical requirements and the lower yields of screening rejects in production of ponderosa pine kraft pulps, ponderosa pine was, in general, very similar in sulfate-pulping characteristics and in the strength of the pulps produced to jack pine, a pulpwood of accepted satisfactory quality.

Table 1.--Chemical Constituents of ponderosa pine chips and sulfate pulps

Chemical constituent	Type of material produced in --			
	Chips	Pulp		
		Digestion No. 2165X	Digestion No. 2098X	Digestion No. 2106X
Lignin.....percent.	25.1	26.6	4.6	2.9
Holocellulose.....do...	67.7	69.8	95.0	95.6
Alpha cellulose.....do...	45.0	53.8	78.1	80.0
Total pentosans.....do...	10.2	10.7	10.2	6.8
Ash.....do...	.5	.....	.....	.....
Alcohol-benzene extractables.....do...	5.6	.....	.....	.....
Ethyl ether extractables.do...	4.1	.....	.....	.....
Hot water extractables...do...	2.9	.....	.....	.....
Sodium hydroxide[1] extractables.....do...	13.4	.....	.....	.....

[1] The concentration of sodium hydroxide in water solution was 1 percent by weight.

Table 2.--Cooking conditions and yield data for sulfate pulping of ponderosa pine

Digestion number	Moisture content of wood	Cooking[1] and yield data: Chemicals charged: Initial concentration calculated as Na_2O	Chemicals charged: Per 100 pounds of moisture-free wood: NaOH plus Na_2S as Na_2O	Chemicals charged: Per 100 pounds of moisture-free wood: Calculated as Na_2O	Chemicals consumed	Black liquor density at 15° C.	Duration at maximum temperature	Yield of pulp (moisture-free) per 100 pounds of moisture-free wood: Screened	Yield of pulp (moisture-free) per 100 pounds of moisture-free wood: Screenings	Yield of pulp (moisture-free) per 100 pounds of moisture-free wood: Total	Brightness of pulps: Unbleached pulp	Brightness of pulps: Pulp bleached with 8.75 percent chlorine	Permanganate number of pulps
	Percent	Grams per liter	Pounds	Pounds	Percent	°B.	Hours	Pounds	Pounds	Pounds	Percent	Percent	
Sulfate Semichemical Pulps													
2166X	13.1	19.5	10.0	7.8	95.3	5.4	0			74.8	12.8		
2165X, 2167X	35.8	19.5	10.0	7.8	98.2	5.6	1-1/2			72.9	11.9		
2110X	58.5	22.0	11.25	8.8	97.5	6.2	1-1/2			67.5	12.1		
2104X	58.6	24.4	12.5	9.8	95.5	7.0	1-1/2			62.9	12.7		
2103X	58.6	29.3	15.0	11.7	91.2	8.3	1-1/2			54.1	18.3		
Kraft-type Pulps													
2097X, 2100X, 2181X	54.6	35.2	17.5	13.7	87.0	9.7	1-1/2	47.8	0.6	48.4	24.4		31.0
2098X, 2101X, 2182X	54.6	39.1	20.0	15.6	82.1	10.6	1-1/2	46.7	.1	46.8	25.8		24.6
2099X, 2102X, 2183X	54.6	43.9	22.5	17.6	78.1	11.4	1-1/2	44.3		44.3	28.3	59.0	20.6
Bleaching Sulfate Pulps													
2163X, 2164X	58.7	48.8	25.0	19.5	75.2	12.2	1-1/2	43.3		43.3	29.0	61.9	18.6
2106X, 2107X	58.9	53.7	27.5	21.5	68.3	13.1	1-1/2	41.8	.1	41.9	32.2	73.1	14.9

[1]The cooking conditions other than those tabulated were as follows: Weight of moisture-free wood, 4.0 pounds; maximum temperature, 170.0 °C.; temperature-pressure increase period, 1.5 hours; sulfidity (based on active alkali), 30.0 percent; and liquor-wood ratio (including moisture in chips), 4 to 1.

Rept. No. R1909

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Table 3.--Strength properties[1] of sulfate pulps made from ponderosa pine

Digestion number	Duration of beating to freeness of[2]		Bursting strength at freeness of[2]		Tearing strength at freeness of[2]		Breaking length at freeness of[2]		Folding endurance at freeness of[2]		Sheet density at freeness of[2]	
	450 cc.	250 cc.	450 cc.	250 cc.	450 cc.	250 cc.	450 cc.	250 cc.	450 cc.	250 cc.	450 cc.	250 cc.
	Minutes	Minutes	Points per pound per ream	Points per pound per ream	Grams per pound per ream	Grams per pound per ream	Meters	Meters	Double folds	Double folds	Grams per cc.	Grams per cc.
Sulfate Semichemical Pulps												
2166X			0.73	0.77	1.13	0.97	6,100	6,800	190	310	0.61	0.68
2165X, 2167X			.82	.89	1.16	.92	6,900	7,600	350	500	.67	.73
2110X			.95	.98	1.22	.97	7,200	7,900	475	510	.68	.74
2104X			1.05	1.14	1.34	1.01	7,500	800	860	1,020	.69	.77
2103X			1.22	1.26	1.51	1.40	7,700	8,300	1,650	2,150	.74	.80
Kraft-type Pulps												
2097X, 2100X, 2181X	60	87	1.34	1.43	1.60	1.39	9,100	9,700	1,800	2,300	.78	.85
2098X, 2101X, 2182X	58	83	1.33	1.42	1.52	1.37	8,600	9,600	1,700	2,000	.80	.85
2099X, 2102X, 2183X	57	86	1.25	1.32	1.55	1.33	8,400	8,900	1,550	2,000	.82	.87
Bleaching Sulfate Pulps												
2163X, 2164X	51	77	1.20	1.30	1.28	1.13	9,400	10,100	1,600	2,000	.83	.91
2106X, 2107X	56	81	1.17	1.19	1.49	1.31	7,500	8,100	1,350	2,100	.74	.81

[1] Interpolated test-beater strength data on unbleached pulp. Test sheets were conditioned and tested at 23° C. and 50 percent relative humidity. Ream size was 500 sheets, each 25 by 40 inches.

[2] Canadian-standard freeness.

Rept. No. R1909

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