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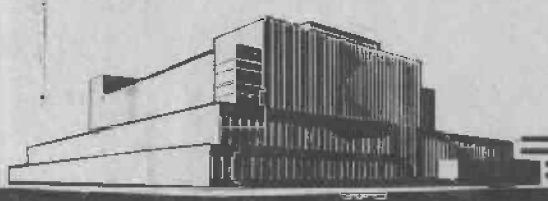

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UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
In Cooperation with the University of Wisconsin

GROUNDWOOD PULPING OF FIVE COMMON NORTHEASTERN FARM WOODLAND SPECIES[1]

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Summary

Groundwood pulping experiments were made on eastern white pine, yellow birch, red maple, American beech, and white ash, woods that grow extensively on farm woodlands in the Adirondacks and other northeastern areas. Pulps were made from each species, a naturally occurring mixture of the hardwoods, and amixture of the pine and the hardwoods. The white pine was found to be suitable for making groundwood pulp with strength and brightness comparable to that of commercial softwood groundwood pulps. Of the hardwoods, red maple produced the strongest groundwood pulps and the beech the weakest. In strength and fiber length the pulps made from these individual and mixed hardwoods were similar to those obtained from other hardwoods of similar density. Their best use would be as filler pulps in the softer, bulkier grades of paper. With the possible exception of the white ash, the hardwood pulps would need to be bleached before they could be used in appreciable quantities in white papers. The strength and brightness of the pulps made from the mixture of pine and hardwoods indicated that groundwood suitable for newsprint might be made by grinding mixtures containing up to about 35 percent of hardwoods by volume.

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[1] This investigation was conducted with funds provided under the Research and Marketing Act. Report originally dated April 1949.

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

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Introduction

Inadequate supplies of the more favored softwood species used by paper mills in New York and other Northeastern States are forcing these mills to obtain new supplies from outside of the region. In 1948, they imported 1,340,000 cords of pulpwood. The use of the remaining native woods therefore offers attractive possibilities if found technically feasible. In New York State, for example, large quantities of eastern white pine and mixed hardwoods are available as pulpwood from farm woodlands in the Adirondack region. Groundwood pulp is the most important type of pulp, from the standpoint of number of mills and quantity produced, in Northeastern New York. Information on the groundwood pulping characteristics and properties of the pulps produced from these species when ground alone and in naturally-occurring mixtures is, therefore, of importance in increasing the marketability of such woods and hence their value to the farmers owning such woodlands.

This report presents the results of groundwood pulping experiments made at the Forest Products Laboratory on eastern white pine (Pinus strobus), yellow birch (Betula lutea), red maple (Acer rubrum), and American beech (Fagus grandifolia), white ash (Fraxinus Americana), and also on a mixture of hardwoods as they occur naturally and on a mixture of the eastern white pine and the hardwoods.

Experimental Procedure

Description of the Wood

The wood used in this work had been cut near Ticonderoga, New York.[3] The hardwoods were peeled and quite dry when received. The white pine was unpeeled and fairly green. Certain physical characteristics were determined on disks cut from the logs taken for the groundwood pulping work. These are presented in table 1.

Grinding Equipment and Testing Procedure

The Forest Products Laboratory experimental three-pocket grinder is equipped with a pulpstone 54 inches in diameter and 8 inches in width. For this work, an aluminum oxide abrasive pulpstone of fine-grain size and open structure was used. The stone had been dressed with 10-cut, 1-1/2-inch

[3] The wood was supplied by the International Paper Company, Research Division, Glens Falls, New York.

lead, spiral, and 14-point diamond burrs and conditioned by grinding wood for 45 hours prior to the start of the experiments. The stone surface was considered to be sharp.

The samples of pulp were screened through an 0.008-inch slotted plate of a diaphragm-type screen, and dewatered on a suction mold. Pulp test sheets were made on a basis of about 115 pounds per standard ream (500 sheets each 25 by 40 inches), and were tested by the Technical Association of Pulp and Paper Industry standard methods. The screen analysis of the pulps was made with the Appleton selective screen.

Grinder Experiments

Grinder runs were made at three different grinding pressures (15, 20, and 25 pounds per square inch) on each of the following species and mixtures: White pine; yellow birch; red maple; beech; a mixture of hardwoods consisting of 30 percent each of paper birch and red maple, 15 percent each of yellow birch and sugar maple, and 5 percent each of ash and beech, by volume; and a mixture consisting of 50 percent white pine and 50 percent mixed hardwoods of the above composition. One grinder run at a pressure of 15 pounds per square inch was made on white ash. Since groundwood pulping experiments had been made in a previous study on paper birch and sugar maple,[4] experiments on these individual species were not included.

Discussion of Results

Eastern White Pine

The groundwood pulps produced from the white pine were about equal to or higher in strength than the average of commercial newsprint pulps with the energy consumption ranging from 57 to 76 horsepower-days per ton. They were, however, about 20 percent lower in strength than that of experimental spruce pulps of equal freeness and energy consumption.

The white pine pulp freenesses were higher, in general, than those of pulps from the individual hardwoods or from the mixtures. This may have been due at least partly to the considerably higher moisture content of the pine.

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[4] Hyttinen, Axel, and Schafer, E. R., "The Grinding of Hardwoods: Experiments on Eastern Cottonwood, Yellow Poplar, Sugar Maple, Black Tupelo, White Ash, Paper Birch, and Sweetgum." TAPPI Journal 32(No. 2)79-85, Feb. 1949; Pulp & Paper Mag. Canada 50(No. 1)82-90, Jan. 1949.

The brightness of pulp from the green, unstained pine (run 727) was good (63.5 percent), but that from comparable batches of the same wood after it had been stored in covered boxes for about 4 weeks (runs 729 and 730) was appreciably darker (56.1 percent). This shows that this wood stored under certain conditions will discolor sufficiently in a short period of time to affect materially the color of the groundwood pulp that can be made from it and thereby reduce its desirability for groundwood pulp. In bleaching experments on eastern white pine groundwood made at the Forest Products Laboratory, an increase in brightness of about 6 percentage points was obtained with a single-stage hypochlorite bleach using 15 percent of available chlorine as calcium hypochlorite. No improvement was obtained with 10 percent of available chlorine. With 2 percent of sodium peroxide, an increase of 4.5 percentage points was obtained. These results indicated that the white pine groundwood, in common with other softwood groundwood pulps, does not, by the known procedures respond well to single-stage hypochlorite bleaching[5].

Hardwoods

The pulps from yellow birch, red maple, beech, and white ash were all short fibered, as indicated by the following range of values obtained in the screen analysis: 0 to 0.5 percent retained on the 24-mesh screen, 0.2 to 1.3 percent on the 42-mesh screen, and from 76.8 to 86.0 percent passing the 150-mesh screen. The energy consumption was reasonable, ranging from 53 to 89 horsepower-days per ton, but the strengths of all the hardwood pulps were low compared to that obtained from softwood species commonly used. The stongest of these hardwood pulps was made from the red maple, and the weakest from the beech with the yellow birch and white ash pulps being intermediate.

At a grinding pressure of 15 pounds per square inch on a comparable stone surface, the grinding rate for the paper birch obtained in the previous study[4] was about the same but the energy consumption and strength were lower and the freeness higher than those obtained for the yellow birch pulp in this study. Results with sugar maple[4] and red maple followed the same trend. The average brightness of the paper birch and sugar maple pulps was 54 and 44 percent, respectively. The brightness of the hardwood pulps produced in this study was in general quite low, with the exception of white ash, which had a brightness of about 57 percent.

The similarity of the grinding characteristics of the six hardwoods indicated that they could be ground in mixture. When this was done, the pulps produced (runs 728, 739, and 740, table 2) were short fibered and intermediate in

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[5] Kingsbury, R. M., Simmonds, F. A., and Lewis, E. S. "Bleaching Groundwood Pulps with Hypochlorites." FPL Report No. 1736. 1949.

in strength between the strongest and weakest of pulps produced from the individual woods under the same conditions of grinding. The low brightness of the unbleached mixed hardwood pulp would permit it being used only in small proportions in printing or similar papers. It was found, however, that the pulp responded well to a single-stage hypochlorite bleaching treatment.[5] The brightness was raised from about 55 percent to about 77 percent with the equivalent of 10 percent of available chlorine based on the weight of pulp. Further, the strength characteristics were much improved by the bleaching treatment.

White Pine--Hardwood Mixture

When ground under the same conditions, the white pine produced pulps of greater fiber length, higher freeness and better strength than the hardwoods. The grinding rate was somewhat higher and slightly less energy was consumed in grinding the pine than the mixed hardwoods. The grinding characteristics of a mixture consisting of equal parts by volume of white pine and the mixed hardwoods (runs 759, 760, and 761) were intermediate between those of the pine and those of the mixed hardwoods. In most cases, however, the grinding characteristics were closer to those of the hardwoods than those of the pine. The pulp properties were also intermediate and, in the majority of cases, closer to the properties of the hardwood pulps than to those of the pine. These results appear reasonable, since the pine though constituting 50 percent of the mixture by volume, because of its lower density, comprised only about 37 percent of it by weight.

The properties of a pulp mixture prepared by mixing equal parts by weight of pine pulp (from run 729) and the mixed hardwood pulp (from run 740) approached the calculated average values of the two pulps more closely than did the pulp prepared by grinding the woods together in equal parts by volume (run 760). The bursting strength equaled, and the tensile strength exceeded, that of an average commercial newsprint pulp, although the tearing strength was somewhat lower.

The brightness of the pine-hardwood pulps was low. This could be increased by bleaching. Since the pine pulp did not respond well to hypochlorite bleaching, it appears that it would be more economical to bleach the separately ground hardwood pulp and then mix it with the unbleached pine pulp.[5]

Conclusions

The data obtained in this study indicate that eastern white pine is suitable for producing groundwood pulp with strength and brightness satisfactory for its

use in printing and other papers. The strength of the groundwoods made from the hardwoods indicates that their principal use would be as filler stocks. They could probably be used in small proportions in the unbleached condition, but they would need to be bleached for use in larger amounts in white papers. The results indicate that (1) the hardwoods are similar enough in their grinding characteristics to permit their being ground together, and (2) groundwood pulps with strength equal to that of average newsprint pulp, although with lower brightness, can be produced by grinding mixtures of eastern white pine and the hardwoods up to about 35 percent of hardwoods by volume.

Table 1.--Physical characteristics of the woods tested for groundwood pulp

Shipment number	Species	Average diameter	Average age	Average rate of growth	Density (Oven-dry weight and green volume)
		Inches	Years	Rings per inch	Lb. per cu. ft.
2755	Eastern white pine	7.9	35	9.1	19.2
2756	White ash	7.5	76	19.8	32.5
2757	Red maple	5.6	41	14.9	32.3
2758	American beech	6.3	51	16.2	34.0
2761	Yellow birch	7.2	47	12.9	33.8

Table 2.--Groundwood pulping of Eastern white pine, yellow birch, red maple, American beech, and white ash

Grinder run No.	Wood dryness	Grinding data[1]				Properties of pulp suspension					Properties of pulp test sheets[2]					
		Pressure of wood on stone[3]	Grinding rate per 24 hours (moisture-free wood)	Power input[4]	Energy consumed per ton (moisture-free wood)	Freeness		Screen analysis			Bursting strength (25x40-500)	Tearing strength (25x40-500)	Tensile strength		Density	Brightness
						Schopper-Riegler	Canadian Standard	Retained on 24-mesh	Passing 150-mesh	Fiber length index						
	Percent	Lb. per sq. in.	Tons	Hp.	Hp.-days	Cc.	Cc.	Percent	Percent		Pts. per lb. per ream	Gm. per lb. per ream	Lb. per sq. in.	Lb. per in. width	Gm. per cc.	Percent
Eastern white pine																
729	52.3	15	0.72	54	76	352	107	18.1	41.8	0.099	0.28	0.78	1716	25.8	0.43	56.1
730	51.8	20	1.33	75	57	373	110	16.1	49.2	.088	.21	.55	1416	22.4	.41	56.1
727	52.8	25	1.62	95	59	563	238	16.8	36.7	.106	.17	.59	1084	17.9	.39	63.5
Yellow birch																
732	77.5	15	.70	58	82	288	123	.2	82.4	.059	.10	.16	634	10.0	.40	48.4
731	77.0	20	1.10	75	68	348	105	.2	81.8	.059	.08	.11	618	9.7	.40	47.6
738	77.3	25	1.46	85	59	370	125	.5	78.2	.061	.07	.15	597	9.0	.42	49.7
Red maple																
735	81.0	15	.60	51	86	253	147	0	76.8	.061	.16	.28	1432	19.8	.47	51.0
734	80.0	20	.87	65	76	270	137	0	77.8	.061	.11	.23	992	15.7	.41	50.3
736	77.8	25	1.53	81	53	307	123	0	79.2	.060	.11	.21	946	13.8	.44	49.4
American beech																
737	84.0	15	.59	47	79	300	155	0	84.7	.058	.05	.12	582	8.2	.45	45.8
744	78.0	20	.91	62	68	343	140	0	86.0	.057	.04	.09	513	6.8	.46	46.1
741	79.0	25	1.35	76	57	375	143	0	84.2	.058	.02	.08	300	4.6	.41	45.4
White ash																
748	78.5	15	1.03	62	60	320	213				.08	.26	715	11.6	.41	57.2
Mixture of 30 percent each of yellow birch and red maple, 15 percent each of paper birch and sugar maple, and 5 percent each of white ash and beech, by volume																
740	77.0	15	.54	47	89	268	115	0	77.5	.061	.11	.22	1020	15.3	.43	52.5
728		20	.74	55	75	307	92	0	77.9	.061	.10	.13	784	12.3	.42	54.5
739	77.0	25	1.32	80	61	355	110	.5	77.0	.062	.07	.18	676	10.1	.43	50.2
Mixture of 50 percent white pine and 50 percent mixed hardwoods (proportions as above) by volume																
760		15	.70	59	78	327	75	4.2	63.4	.071	.17	.41	1093	17.2	.41	51.1
759		20	.96	67	70	340	70	3.9	60.6	.074	.15	.42	899	14.9	.40	51.0
761		25	1.24	82	66	340	78	3.5	66.0	.068	.13	.31	897	14.2	.40	49.9
(5)		15				328	72	7.1	57.9	.077	.19	.43	1164	18.3	.41	52.5

[1] An Alundum abrasive pulpstone (38A90-L10VP) was used. It had been dressed with 10-cut, 1-1/2-inch lead, spiral, and 14-point diamond burrs and had about 49 cumulative hours of service since burring when this work was started. A peripheral speed of 3,468 feet per minute was used with three pockets in use simultaneously. Pit temperature was 165° F. and stone immersion was 9 inches. By adjusting the shower water temperature the pit consistency was maintained at about 4 ± 1.5 percent.

[2] Basis weight of test sheets, 115 pounds per ream.

[3] Actual thrust of the pressure foot (determined by calibration of the cylinder pressure) divided by the area represented by the product of the pocket width and wood length.

[4] Per square foot of wood-stone contact area.

[5] A mixture of equal parts by weight of pulps from run 729 and run 740.