BUTT SWELLS OF WATER TUPELO FOR PULP AND PAPER

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SUMMARY

Bleached kraft and neutral sulfite semichemical pulps were made from butt swells of water tupelo. The results were twofold: The bleached kraft pulp was of good quality and well suited for use in the manufacture of greaseproof papers; the physical properties of the neutral sulfite semichemical pulps indicated these pulps were suitable for a good-quality corrugating medium

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BY J. F. Laundrie, Research Chemical Engineer,
Forest Products Laboratory [1]

AND J. S. McKnight, Principal Silviculturist
Southern Hardwoods Laboratory [2]

Forest Service, U.S. Department of Agriculture

INTRODUCTION

Water tupelo (Nyssa aquatica L.) grows most commonly in swamps and bottomlands along watercourses in the Coastal Plain from southeastern Virginia to northern Florida and southeastern Texas, and north in the Mississippi Valley to eastern Arkansas, southeastern Missouri, southern Illinois, and western Kentucky and Tennessee. It normally grows in even-aged, dense stands with or without cypress and other tupelos. The wood is exceptionally clear and defect free and is primarily used for making veneer and box lumber. Smaller dimension trees are used for crossties and pulpwood.

Water tupelo typically has a long, clean bole strongly buttressed at the base. Tupelo trees are cut near the top of the butt swell, which may be as high as 8 feet abovre ground, or they are felled and bucked to leave the basal wood, with increasing demands for wood products the question has arisen on the suitability of the butt swell portion for pulpwood.

WOOD CHARACTERISTICS AND PREPARATION

Stand and Site Characteristics

Material used in this investigation was taken from six trees in a 50-year-old stand of water tupelo just west of Berwick, St. Mary Parish, La., on the south side of U.S. Highway 90 (fig. 1). The basal area of the stand was 150 square feet per acre; the average height of the dominant trees was 70 feet. The trees were alive when cut and reasonably vigorous. The average diameter at 1 foot above the ground was 24 inches; the average height of the butt swell, 6 feet; and the average diameter at the top of the swell, 17 inches.

Until 1959, the area was typically swamp with water up to 18 inches deep in the winter and spring months. In other months the area held shallow water and only rarely dried out until the late 30's. In the 30's, the Atchafalaya River was leveed and did not continue to feed the swamps

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

[2] Maintained at Stoneville, Miss., by the Southern Forest Experiment Station, in cooperation with the Mississippi Agriculture Experiment Station and the Southern Hardwood Forest Research Group.

Figure 1.--Water tupelo (Nyssa aquatica, L.) near Berwick, La., from which bolts with butt swell were taken for pulping tests.

during dry seasons. Soil sampling indicates that the permanent water table is about 3 feet below the soil surface. The characteristics of the soil supporting the stand are given in table 1.

Physical Properties

Two adjacent 4-foot bolts cut from the butt end, or butt swell portion, and one 8-foot bolt cut

Table 1.--Soil properties beneath stand of water tupelo cut for pulping tests

Depth	Soil property									
	Sand	Silt	Clay	Texture	pH	Organic matter	N	P	K	Ca
In.	Pct.	Pct.	Pct.			Pct. per weight	Pct.	P.p.m.	P.p.m.	P.p.m.
0-6	13	14	73	Clay	5.0	16.7	0.42	140	328	5040
12					5.4	8.8	.13	122	312	4320
24					4.9	7.1	.08	190	328	2880
36					5.3	7.0	.09	156	328	3700

from the center of the normally merchantable bole, or tree length, of each tree were sent to the Forest Products Laboratory. One-inch disks were cut from the ends of each bolt for determining specific gravity. The relationship of disk specific gravity (ovendry weight per green volume basis) to the height of the tree is given in figure 2. The average specific gravity of the six trees increased from 0.250 at the 1-foot stump level to 0.412 at the 5-foot level and to 0.488 at the 9-foot level, and then decreased to 0.463 at the top of the bolt taken from the normally merchantable bole. Photomicrographs of cross sections taken at the three levels from one of the trees are shown in figure 3. The fibers in the swell butt are larger in diameter and have extremely thin cell walls compared to those in the normal wood.

Chipping and Screening

Each bolt was hand peeled and converted into nominal 1/2-inch chips in a commercial-sized four-knifed chipper. After oversized and undersized material had been screened out, the chips were thoroughly mixed and sampled to determine moisture content. They were then weighed into small lots and stored in polyethylene bags in a room at 2° C. until needed for the pulping digestions.

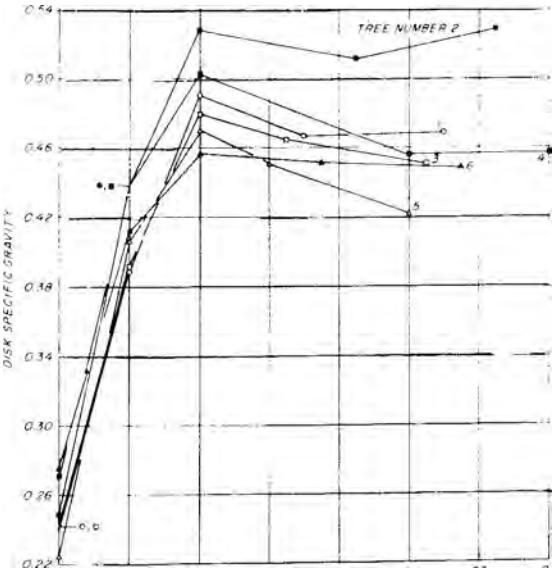

Figure 2.--Relationship of specific gravity (ovendry weight per green volume) to height above ground in disks from six water tupelo trees.
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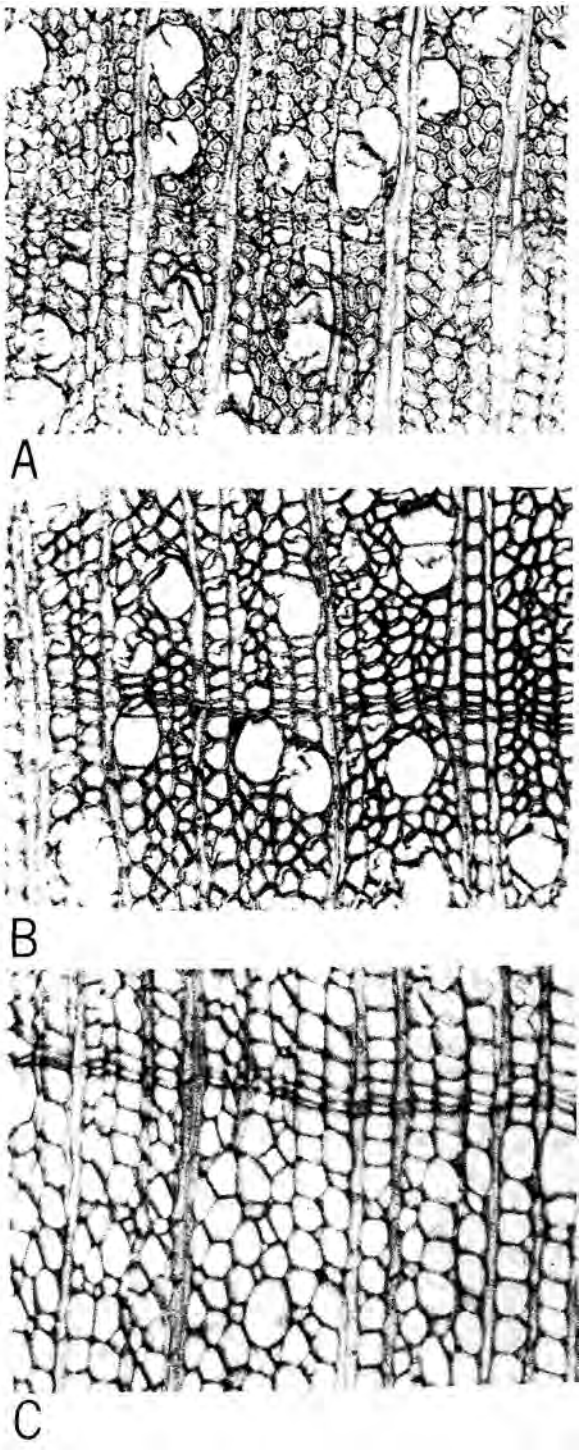

Figure 3.--Photomicrographs of water tupelo cross sections: A, Wood near center of normally merchantable bole; B, Wood near top of butt swell; and C, Wood at base of butt swell showing larger diameter fibers and extremely thin cell walls. X 120

Chemical Composition

Samples of the mixed chips were taken for chemical analyses (table 2). There were only small differences in chemical composition between the six trees used in this study, but differences between the three bolts in a given tree were significant. The wood in the two adjacent 4-foot butt bolts was quite similar and had considerably less lignin and glucose and more xylose than that in the normally merchantable bolt. These differences did not, however, appear to appreciably affect pulp yields.

KRAFT PULPING

Conditions, Equipment and Procedures

The conditions used to make all of the small-scale kraft pulps are given in table 3. Stainless-steel digesters of 0.8-cubic-foot capacity and equipped with a heat exchanger and a circulating system were used for this small-scale pulping. After the digester had been charged with chips

Table 2.--Chemical analysis of water tupelo

Bolt No.	Lignin	Carbohydrates[1]				
		Glucose	Galactose	Mannose	Arabinose	Xylose
	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
LOWER BUTT BOLTS						
1-A	23.4	64.3	2.7	3.9	1.5	27.6
2-A	25.0	64.5	2.2	3.3	1.0	28.0
3-A	24.6	63.2	2.2	4.2	1.4	28.9
4-A	26.1	62.1	2.1	4.4	1.1	30.2
5-A	24.9	63.1	2.2	5.2	1.1	28.4
6-A	24.8	62.8	1.9	4.8	1.1	29.4
UPPER BUTT BOLTS						
1-B	22.7	64.8	2.1	5.2	1.3	26.7
2-B	24.4	65.3	1.8	5.6	.8	26.5
3-B	22.5	64.3	1.9	5.1	1.4	27.2
4-B	24.8	63.7	2.0	5.9	.9	27.6
5-B	23.8	63.4	1.9	5.8	.9	28.0
6-B	23.8	63.7	2.0	5.8	1.0	27.5
NORMALLY MERCHANTABLE BOLTS						
1-C	26.0	68.8	2.3	4.4	.8	23.6
2-C	26.9	67.6	2.0	4.9	.8	24.6
3-C	26.6	67.1	2.3	4.4	.9	25.4
4-C	27.8	67.3	2.4	5.2	1.0	24.1
5-C	25.8	66.2	1.7	5.7	.9	25.5
6-C	27.7	67.3	2.0	4.9	1.2	24.6

[1] Determined according to Saeman, J. F., et al., Tappi 37:336-343. 1954.

contained in a perforated basket, air was evacuated from the digester and the cooking liquor drawn in. At the end of cooking, the chips were partially washed inside the digester by running hot water (90° C.) through them for 20 minutes. The partially washed chips were then removed and disintegrated with an electric stirrer in a stainless-steel mixing tank containing hot water. After disintegrating for 10 minutes, the pulps were drained into a 100-mesh stainless-steel screenbox and returned to the mixing tank with hot water for another 5-minute period. After draining into the screenbox a second time, the pulps were again washed with hot water followed by screening through a flat screen with 0.010-inch slots, which drained into a 100-mesh stainless-steel screenbox. The dewatered pulps were transferred to a canvas bag, and the consistency raised to about 30 percent in a hydraulic press. The pulp cakes were shredded, weighed, and sampled for consistency and kappa number determinations.

Yield

The yields of pulp obtained from the different segments of the tree do not show any apparent trends (table 3). The kappa numbers of the pulps made from the normally merchantable bolt do seem to be slightly lower than those from the butt portions of the tree, although for no apparent reason, there are exceptions.

Table 3.--Kraft pulping of water tupelo and properties of the unbleached pulps

Bolt No.	Kraft pulping[1]				Unbeaten pulp properties			Handsheet properties[2]								
	Black liquor: NaOH (Na_2O)	Black liquor: Na_2S (Na_2O)	Yield[3]: Total	Yield[3]: Screenings	Kappa No.	Average fiber length[4]	Vessel elements	Beating time at 500 CSF	Beating time at 300 CSF	Burst factor at 500 CSF	Burst factor at 300 CSF	Tear factor at 500 CSF	Tear factor at 300 CSF	Breaking length at CSF of 500	Breaking length at CSF of 300	Handsheet density at CSF of 500	Handsheet density at CSF of 300
	G. per l.	G. per l.	Pct.	Pct.		Mm.	1000 per g. of pulp	Min.	Min.					M.	M.	G. per cc.	G. per cc.
LOWER BUTT BOLTS																	
1-A	4.1	6.1	42.6	1.3	23.5	1.56	98.6	14	28	58	69	100	84	8600	9800	0.85	0.91
2-A	2.8	4.9	45.0	1.6	34.0	1.44	135.7	15	27	67	72	92	82	9400	10300	.84	.89
3-A	2.1	5.5	44.9	1.3	24.8	1.36	111.6	17	34	62	70	87	72	9000	10200	.83	.90
4-A	2.3	5.9	44.7	2.1	30.4	1.53	111.3	18	34	63	71	94	80	8500	10400	.82	.88
5-A	3.9	6.1	42.9	1.4	33.3	1.45	103.3	16	33	62	69	91	76	9100	10500	.84	.89
6-A	1.2	6.2	46.6	2.6	32.3	1.36	117.4	17	32	60	66	102	81	8700	10000	.82	.88
UPPER BUTT BOLTS																	
1-B	5.1	5.9	44.5	.9	31.6	1.68	143.2	23	34	76	80	118	106	10100	10400	.80	.82
2-B	4.3	6.1	47.2	1.6	31.3	1.60	176.6	25	38	73	80	114	104	10100	10800	.76	.79
3-B	4.4	6.1	45.5	1.1	26.7	1.72	129.0	24	35	75	80	117	103	9800	10300	.79	.83
4-B	4.5	5.9	46.9	.1	23.6	1.91	144.5	26	38	80	84	120	106	10400	11000	.77	.81
5-B	4.8	6.4	46.1	2.9	32.2	1.74	137.7	24	37	73	79	122	103	9300	10100	.77	.81
6-B	3.9	6.2	45.8	.8	26.4	1.69	167.0	26	40	75	81	119	107	10000	10700	.77	.81
NORMALLY MERCHANTABLE BOLTS																	
1-C	5.4	5.9	45.9	.1	24.0	1.72	250.6	26	37	72	81	105	94	11000	11300	.72	.76
2-C	5.2	5.6	42.7	.2	28.7	1.72	251.3	23	33	68	78	105	98	10500	11300	.70	.74
3-C	5.1	5.8	44.3	1.2	25.7	1.64	187.0	24	36	72	82	100	92	11000	11800	.73	.77
4-C	5.2	5.9	44.9	.2	25.2	1.60	293.3	25	37	68	77	105	99	10900	11500	.71	.74
5-C	4.9	5.6	46.4	.7	24.1	1.72	268.2	26	41	82	91	109	95	11700	12300	.75	.79
6-C	4.5	6.2	43.7	.4	27.6	1.62	289.9	26	41	62	73	103	92	9800	10900	.65	.74

[1] 17.0 percent active alkali, 25 percent sulfidity, 4-to-1 liquor-to-wood ratio, 60 minutes from 100° to 170° C., and 75 minutes at 170° C.

[2] Tested according to TAPPI methods.

[3] Moisture-free wood basis.

[4] Based on measurement of 50 whole fibers.

Pulp Properties

The average fiber length, determined by measuring 30 whole fibers of each pulp, was 1.48 millimeters in the lower butt bolt, 1.72 millimeters in the upper butt bolt, and 1.67 millimeters in the normally merchantable bolt. The number of vessel elements per gram of pulp increased from an average of 113,000 in the lower butt bolt, 149,700 in the upper butt bolt, to 256,700 in the normally merchantable bolt.

Fiber classifications (table 4) for three unbeaten pulps representing the three portions of the tree showed large differences between pulps in the amount of fiber retained on a 28-mesh screen and in that passing through a 200-mesh screen. This was especially true of the pulp made from the lower butt bolt and of that made from the normally merchantable bolt. Although the average fiber length of the pulp from the lower butt bolt was only 0.019 millimeter less than that of the pulp from the normally merchantable bolt, only 3.2 percent of the pulp was retained on a 28-mesh screen compared to 19.8 percent for the pulp from the normally merchantable bolt. Because of the extremely thin walls of the fibers in the lower butt bolt, these fibers, no doubt, were collapsible and flexible; therefore they may have been forced through the 28-mesh screen during fractionation.

The other large difference was in the amount of material passing through the 200-mesh screen, material which consisted primarily of short parenchyma cells. The pulp from the lower butt bolt had 24.9 percent pass through the 200-mesh screen, whereas the pulp from the normally merchantable bolt had only 4.5 percent. The percentage of pulp made from the upper butt bolt that passed through the 200-mesh screen fell between the two extremes of the pulps from the loner butt bolt and the normally merchantable bolt.

Handsheet Properties

The pulps made from the loner butt bolts developed their strength much more rapidly than those made from either the upper butt bolts or the normally merchantable bolt as shown by the beating time required to obtain a given freeness (table 3). The bursting strength of the pulps made from the loner butt bolts was about 10 percent lower than that of the pulps made from both the normally merchantable bolts and the upper butt bolts. The bursting strength of the pulps from the normally merchantable bolts and from the upper butt bolts was about the same. The pulps made from the upper butt bolts had the highest tearing resistance, about 10 percent greater than that of the pulp made from the normally merchantable bolts and about 20 percent greater than that of the pulps made from the lower butt bolts. This correlates well with the values for average fiber length.

The tensile strength, or breaking length, of the pulps made from both the loner and the upper butt bolts was about 10 percent less than that of the pulp made from the normally merchantable bolt. The density of the handsheets made from the

Table 4.--Bauer-McNett fiber classification of water tupelo kraft pulps

Item	Lower butt bolt	Upper butt bolt	Normally merchantable bolt
Bolt No.	3-A	3-B	3-C
Fiber --			
Retained on 28 mesh....Pct.	3.2	17.8	19.8
Passing through 28 mesh and retained on 48 mesh....Pct.	57.9	56.2	61.1
Passing through 48 mesh and retained on 100 mesh....Pct.	12.5	10.2	12.7
Passing through 100 mesh and retained on 200 mesh....Pct.	1.5	1.5	1.9
Passing through 200 mesh....Pct.	24.9	13.7	4.5

pulps of the different parts of the tree decreased significantly from the stump to the normally merchantable bolt. For example, at 300 milliliters Canadian Standard Freeness (CSF), the sheet density of the pulps made from the lower butt bolts averaged 0.90 gram per cubic centimeter, those from the upper butt bolts averaged 0.82 gram per cubic centimeter, whereas those from the normally merchantable bolt averaged 0.75 gram per cubic centimeter. The high density of the sheets macle from the lower butt bolt pulps suggested that they would be especially suitable for greaseproof-type papers.

PULP BLEACHING

All of the pulps from a particular section of the trees were so similar that only one pulp from each of the three different parts of the tree was bleached (table 5). A three-stage bleach consisting of chlorination, caustic extraction (sodium hydroxide), and chlorine dioxide was used to bleach the pulps to a brightness of about 85 percent. In their response to bleaching, the pulps from the three bolt locations showed no significant differences. As shown in table 6, the only pulp property that was greatly affected by bleaching other than brightness was the beating time required to attain a given freeness, which increased considerably in the pulps made from the upper butt and normally merchantable bolts.

The most significant difference between pulps was in opacity, which at 300-milliliters Canadian Standard freeness, for example, was 47 percent for the lower butt bolt, 51 percent for the upper butt bolt, and 60 percent for the normally merchantable bolt.

Table 5.--Bleaching of water tupelo kraft pulps

Bolt No.	Kappa No.	Stage No.	Chemicals: Kind	Chemicals: Applied[1] Pct.	Chemicals: Consumed[2] Pct.	Temperature °C.	Consistance Pct.	Duration Min.	pH: Initial	pH: Final	Brightness[1]: Initial Pct.	Brightness[1]: Aged[3] Pct.
LOWER BUTT BOLT												
3-A	24.8	1	Cl	5.50	5.38	25	2.0	60	2.2	2.1		
		2	NaOH	2.00		70	10.0	60	11.6	11.5		
		3	ClO_2	.57	.56	75	10.0	150		4.0	87.0	83.8
UPPER BUTT BOLT												
3-B	26.7	1	Cl	5.80	5.56	25	2.0	60	2.1	2.0		
		2	NaOH	2.00		70	10.0	60	11.7	11.5		
		3	ClO_2	.57	.56	75	10.0	150		4.2	86.2	82.3
NORMALLY MERCHANTABLE BOLT												
3-C	25.7	1	Cl	5.60	5.17	25	2.0	60	2.1	2.0		
		2	NaOH	10.00		70	10.0	60	11.7	11.6		
		3	ClO_2	.57	.56	75	10.0	150		4.2	84.0	79.0

[1] Measured with an Elrepho reflectance meter.

[2] Moisture-free pulp basis.

[3] Heated at 105° C. for 1 hour in a forced circulation oven.

Table 6.--Effect on the properties of water tupelo kraft pulps

Bolt No.	Pulp	Handsheet properties[1]											
		Beating time at CSF of		Burst factor at CSF of		Tear factor at CSF of		Breaking length at CSF of		Handsheet density at CSF of		Brightness at CSF of	Opacity at CSF of
		500	300	500	300	500	300	500	300	500	300	500	500
		Min.	Min.					M.	M.	G. per cc.	G. per cc.	Pct.	Pct.
LOWER BUTT BOLT													
3-A	Unbleached	17	34	62	70	87	72	9000	10200	0.83	0.90	....	....
	Bleached	10	38	48	67	88	61	7200	10800	.83	.92	79	70
UPPER BUTT BOLT													
3-B	Unbleached	24	35	75	80	117	103	9800	10300	.79	.83	....	....
	Bleached	29	48	75	80	96	90	9900	10800	.81	.85	77	74
NORMALLY MERCHANTABLE BOLT													
3-C	Unbleached	24	36	72	82	100	92	11000	11800	.73	.79	....	....
	Bleached	34	57	65	76	100	88	10200	10900	.76	.80	74	71	64	60

[1] Tested according to TAPPI methods, except brightness measured with an Elrepho reflectance meter.

GREASEPROOF PAPERS

Greaseproof papers are usually made from a furnish containing a high percentage of softwood Mitscherlich sulfite pulp. This type of sulfite pulp is used because it develops the desired characteristics of high density, low porosity, and high grease resistance with adequate strength at a relatively high freeness level. Consequently it requires a relatively low amount of refining energy. Only limited amounts of softwood kraft are used for these grades of paper. Kraft pulps require considerably more refining; therefore they are less economical than sulfite pulps. Mitscherlich sulfite pulps usually require beating to a Canadian Standard freeness of about 125 milliliters or less for a highly greaseproof paper, whereas a freeness of about 75 milliliters or less is usually necessary for softwood kraft pulps. By contrast the kraft pulps from the butt bolts of water tupelo appeared to have the desirable properties for greaseproof papers at a freeness level of about 200 milliliters.

Handsheet properties for bleached water tupelo pulps from different parts of the trees at a freeness of 200 milliliters are given in table 7. Although the handsheets of the pulps made from the merchantable bolt are only slightly grease resistant as measured by the time it takes for turpentine penetration, the pulps made from the upper butt bolts required 276 seconds for the penetration and those from the lower butt bolts, 996 seconds.

The time required for the penetration of turpentine varies widely and depends on the grade of greaseproof paper. Some grades require a minimum of only 30 seconds, whereas the usual requirement is between 2 and 10 minutes. For certain grades where high grease resistance is required, the minimum time may be as high as 30 to 50 minutes.

A commercial manufacturer of greaseproof pulps evaluated a sample of bleached kraft pulp from the lower butt bolt of water tupelo and found it compared favorably with a bleached Mitscherlich sulfite pulp (table 8).

If the quantity of water tupelo butt bolts is sufficient to support a kraft mill, the production of greaseproof papers should be considered.

Table 7.--Handsheet properties[1] of bleached water tupelo pulps at a Canadian Standard freeness of 200 milliliters

Properties	Location in tree		
	Lower butt bolt	Upper butt bolt	Normally merchantable bolt
Burst factor	87	80	77
Tear factor	58	83	80
Breaking length.....M.	10350	11000	11000
Density.....G. per cc.	.95	.87	.82
Brightness.....Pct.	67	72	71
Opacity.....Pct.	40	44	59
Turpentine penetration....Sec.	996	276	30

[1]Tested according to TAPPI methods, except brightness measured with an Elrepho reflectance meter.

Table 8.--Commercial evaluation of kraft pulps from water tupelo lower butt bolts for use in greaseproof papers

Properties	Pulp		
	Commercial bleached spruce Mitscherlich sulfite	Kraft pulp--water tupelo lower butt bolt	
		Unbleached	Bleached
Basis weight...lb. per ream of 500 sheets 24 by 36 inches	39.3	39.8	39.6
Freeness (Canadian Standard)...Ml.	125	125	125
Beating time.....Min.	56	66	78
Mullen.....Pct.	134	125	119
Tear.....Pct.	71	80	70
Transparency.....Pct.	51	25	47
Blister	Excellent	Excellent	Good

NEUTRAL SULFITE SEMICHEMICAL PULPING

Conditioning, Equipment, and Procedures

Small-scale neutral sulfite semichemical (NSSC) pulps were made from the normally merchantable bolt and the lower butt bolt of one tree. These pulps were made in the digesters used for the small-scale kraft digestions. After cooking, the chips were fiberized and refined in a 12-inch-diameter, single-rotating disk mill to a Canadian Standard freeness of 370 milliliters.

Results

The wood in the lower butt bolt pulped much more easily than that in the normally merchantable bolt as shown by the difference in the amount of time required to obtain the same yield (table 9). Also, less chemical was consumed.

Handsheets were made to have a thickness of about 9 mils and a basis weight of 26 pounds per 1,000 square feet, which is standard for corrugating medium. The physical properties of the handsheets are given in table 10. Except for differences in the amount of pressure needed to obtain the 9-mil thickness and differences in their folding endurance, the properties of the handsheets from the two pulps were similar.

Table 9.--Neutral sulfite semichemical pulping[1] of water tupelo

Properties	Location in tree	
	Lower butt bolt	Normally merchantable bolt
Liquor charged:		
Concentration--Na_2SO.....G. per l.	34.9	34.9
--$NaHCO_3$....G. per l.	15.0	15.0
Time at 170° C.....Min.	15	45
Residual liquor--Na_2SO_3....G. per l.	14.5	12.6
.....pH:	7.8	8.1
Yield[2].....Pct.	76.4	76.0

[1] Both digestions were 30 minutes presteaming at 10 pounds per square inch gage, 4:1 liquor-to-wood ratio, and 150 minutes from 100° to 170° C.

[2] Moisture-free wood basis.

Table 10.--Handsheet properties[1] of neutral sulfites semichemical pulps of water tupelo

Pressure used in sheet making	Freeness (Canadian standard)	Basis weight (air dry)	Thickness	Density: Moisture free	Density: Air dry	Burst factor	Folding endurance (MIT)	Breaking length	Ring crush[2]	Flat crush (CMT)
P.s.i.	Ml.	Lb. per 1,300 sq. ft.	Mils	G. per cc.	G. per cc.		Double-folds	M.	Lbs.	Lbs.
LOWER BUTT BOLT										
10	370	26.0	9.0	0.50	0.55	28.4	78	4,880	65.5	63.0
NORMALLY MERCHANTABLE BOLT										
20	370	26.3	10.0	.46	.50	20.2	7	4,420	64.0	61.7
30	370	26.4	8.3	.55	.61	27.3	10	5,150	64.2	63.7

[1] Tested according to TAPPI methods.

[2] 1/2- by 6-inch specimens.

CONCLUSIONS

1. Butt swells of water tupelo are suitable for the manufacture of good quality bleached kraft pulps. If the quantity of these bolts is sufficient to supply a kraft mill, production of greaseproof papers should be considered.

2. The physical properties of NSSC pulps from butt-swell bolts indicate they would be suitable for manufacturing a good-quality corrugating medium

ABOUT THE FOREST SERVICE. . . .

As our Nation grows, people expect and need more from their forests--more wood; more water, fish and wildlife; more recreation and natural beauty; more special forest products and forage. The Forest Service of the U.S. Department of Agriculture helps to fulfill these expectations and needs through three major activities:

* Conducting forest and range research at over 75 locations ranging from Puerto Rico to Alaska to Hawaii.

* Participating with all State forestry agencies in cooperative programs to protect, improve, and wisely use our Country's 395 million acres of State, local, and private forest lands.

* Managing and protecting the 187-million acre National Forest System.

The Forest Service does this by encouraging use of the new knowledge that research scientists develop; by setting an example in managing, under sustained yield, the National Forests and Grasslands for multiple use purposes; and by cooperating with all States and with private citizens in their efforts to achieve better management, protection, and use of forest resources.

Traditionally, Forest Service people have been active members of the communities and towns in which they live and work, They strive to secure for all, continuous benefits from the Country's forest resources.

For more than 60 years, the Forest Service has been serving the Nation as a leading natural resource conservation agency.