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BLEACHABILITY of a CLEAN FRACTION from ASPEN SEMICHEMICAL CORRUGATING PULP

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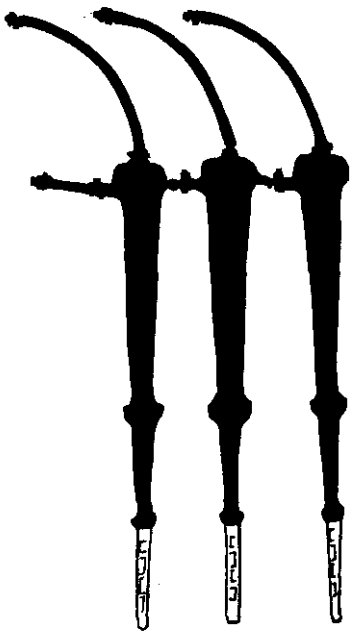

Abstract

A clean portion of fiber suitable for bleaching was separated by centrifugal cleaning when a commercial aspen corrugating grade of neutral sulfite semichemical pulp and experimental pulps varying in yield were used. Relations were also shown between yield of unbleached pulp, the chemical requirements for pulping and bleaching, and pulp quality.

BLEACHABILITY OF A CLEAN FRACTION FROM ASPEN SEMICHEMICAL CORRUGATING PULP[1]

by
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U.S. DEPARTMENT OF AGRICULTURE

Introduction

This study was made at the Forest Products Laboratory to determine; (1) if a bleachable fiber fraction could be separated from a commercial corrugating grade of aspen neutral sulfite semichemical pulp; (2) the chemical requirements for bleaching the clean fiber portion by one- and three-stage processes, and the quality of the bleached pulps; and (3) possible advantages of using unbleached pulp of lower yield for producing the bleached pulp.

Results and Discussion

1. A commercial corrugating grade of aspen neutral sulfite semichemical pulp like the one used in this study can be centrifugally cleaned satisfactorily for the production of clean bleached pulps by the use of 12-, 6-, and 3-inch cleaners in series. The rejects, which could be as much as 50 percent in commercial operation, would be usable in furnishes for corrugating media.

2. Chemical requirements for bleaching the cleaned corrugating grade pulp by one- andthree-stage processes are normal for aspen semichemical pulps of the same yield.

3. Fully bleached pulps that are equal

[1] This work was done earlier in association with the late Ralph M. Kingsbury, chemist, Forest Products Laboratory.

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

in quality to those from unbleached pulps with yields as low as 65 percent can be produced from cleaned corrugating grade pulp providing the freeness of the corrugating pulp is as high as 500 milliliters, Canadian Standard.

4. Cleaning treatments are essential to the production of clean, bleached aspen semichemical pulp regardless of the yield of the unbleached pulp in the range of about 65 to 80 percent.

5. One-stage bleaching with hypochlorite and three-stage chlorine bleaching are about equally effective inbleaching the small amount of fiber bundles and minute specks remaining in the centrifugally cleaned pulps. and are somewhat more effective than bleaching with either sodium or hydrogen peroxide.

6. Aspen semichemical pulps can be bleached in one stage to a higher degree of brightness with hypochlorite than with feasible amounts of sodium or hydrogen peroxide. The brightness of the pulps bleached with sodium peroxide, however, receded only about one-third as much as that of hypochlorite bleached pulps.

7. The chlorine required in the three-stage bleaching to about 85 percent brightness decreased linearly to 57 percent as the yield of unbleached pulp decreased from about 80 to 65 percent and the lignin content decreased as much as 50 percent. In one-stage bleaching with hypochlorite and sodium peroxide, pulp brightness increased about 10 percent with decreasing yield of unbleached pulp.

8. The energy required for fiberizing cooked chips and the amount of bleaching chemicals required per ton of bleached pulp are directly proportional to yield ofunbleached pulp. The amount of wood and pulping chemicals required per ton of bleached pulp are inversely proportional to the yield of unbleached pulp.

9. The strength of aspen semichemical pulps in the yield range of 65 to 80 percent can be increased about 5 to 20 percent by bleaching with the three-stage chlorination, caustic soda extraction, and hypochlorite process, because of removal of lignin in the bleaching process. Little if any change in pulp strength can result from one-stage peroxide or calcium hypochlorite bleaching, because of limited removal of lignin by these treatments (tables 1 and 2).

10. The high brightness pulps show no consistent difference in strength over the range of about 65 to 80 percent yield of unbleached pulp. The strength of the unbleached and one-stage bleached pulps, however, is somewhat better for the lower yield pulps than those in the upper yield range.

Cleaning Treatments

The appearance of the commercially cleaned pulp showed that the 12- and 6-inchcleaners remove practically all of the shives and a high proportion of the fine dirt particles. Recleaning centrifugally with the 3-inch cleaner removed a small amount of dirt.

Rejects from one pass of the experi-

Table 1.--Strength values for certain commercial and experimental aspen unbleached semichemical pulps

Cleaning	Time beaten	Freeness (Canadian Standard)	Density	Burst factor	Tear factor	Breaking length	Folding endurance (MIT)
	Min.	Ml.	G. per cc.			M.	Double folds
COMMERCIAL PULP, ABOUT 80 PCT. YIELD							
Centrifugal[1]	0	360	0.58	20	67.5	4,720	19
DIGESTION NO. 5565-N, 80.5 PCT. YIELD							
By screening	0	545	.57	29.6	80.6	5,850	27
	25	[2]300	.72	56.2	44.0	9,400	420
By screening and centrifugal[3]	0	540	.60	33.5	90.0	6,400	58
	40	[2]300	.75	60.4	50.0	9,800	680
DIGESTION NO. 5566-N, 72 PCT. YIELD							
By screening	0	560	.59	34.0	86.0	6,300	52
	26	[2]300	.77	62.5	45.5	9,800	750
By screening and centrifugal	0	550	.66	39.6	88.5	6,900	78
DIGESTION NO. 5564-N, 66.4 PCT. YIELD							
By screening	0	520	.68	46.0	86.4	7,500	81
	14	[2]300	.82	77.5	46.5	9,950	480
By screening and centrifugal	0	545	.66	33.0	97.5	7,650	138

[1]Cleaned with 12- and 6-in. centrifugal cleaners in series at the mill and then with two 3-in. cleaners at the Forest Products Laboratory. The freeness before cleaning with the 3-in. cleaners was 260 ml., Canadian Standard.

[2]Interpolated values.

[3]Cleaned at the Forest Products Laboratory with two 3-in. cleaners in series.

Table 2.--Strength values for certain cleaned and bleached commercial and experimental aspen semichemical pulps[1]

Bleach No.	Bleaching treatment[2]	Brightness	Time beaten	Freeness (Canadian Standard)	Density	Burst factor	Tear factor	Breaking length	Folding endurance (MIT)
		Pct.	Min.	Ml.	G. per cc.			M.	Double folds
COMMERCIAL PULP, ABOUT 80 PCT. YIELD									
3247	3-stage	82.0	0	160	0.79	52.0	59.0	9,300	639
3252	$Ca(OCl)_2$	72.0	0	335	.64	23.4	67.5	5,600	29
DIGESTION 5565-N, 80.5 PCT. YIELD									
2956	3-stage	84.5	0	425	.77	52.4	95.5	5,830	524
			7	300	.88	75.4	75.8	10,400	1,350
2940	$Ca(OCl)_2$	76.0	0	530	.61	30.4	78.5	5,940	35
			18	300	.77	55.5	60.0	9,100	545
2937	Na_2O_2	68.0	0	535	.63	34.0	89.5	6,550	62
			35	300	.79	60.5	75.0	10,290	640
DIGESTION 5566-N, 72 PCT. YIELD									
2953	3-stage	86.2	0	370	.85	72.0	88.5	10,600	1,098
			7	300	.89	107.0	76.2	14,700	1,700
2946	$Ca(OCl)_2$	75.7	0	555	.64	39.6	82.5	6,620	74
			17	300	.77	60.0	66.5	9,300	750
2938	Na_2O_2	70.0	0	550	.63	43.8	90.0	7,680	147
			27	300	.90	67.0	70.0	10,700	1,200
DIGESTION 5564-N, 66.4 PCT. YIELD									
2944	3-stage	85.3	0	455	.76	55.0	97.5	9,000	147
			12	300	.88	81.0	79.0	11,300	1,350
2947	$Ca(OCl)_2$	77.8	0	520	.70	53.0	89.0	8,500	263
			13	300	.83	76.0	67.5	10,700	1,350
2934	Na_2O_2	76.0	0	480	.72	57.6	91.0	9,400	373
			12	300	.80	72.5	71.5	11,500	1,350

[1] Values for 300 ml. freeness are interpolated.

[2] $Ca(OCl)_2$ and Na_2O_2 signify 1-stage bleaches.

mental pulps through the 3-inch cleaner ranged from 9 percent for the low yield pulp to 15 percent for the high yieldpulp (table 3). It was necessary to remove shive-type material by riffling, because the amount of pulp was too small to use the large centrifugal cleaners.

Table 3.--Centrifugal cleaning data for experimental aspen neutral sulfite semichemical pulp[1]

Item	66.4 pct. yield[2] (digestion no. 5564-N)	72 pct. yield[2] (digestion no. 5566-N)	80.5 pct. yield[2] (digestion no. 5565-N)
Cleaned accepts, basis pulp.....pct.	84.7	87.1	90.7
Cleaned accepts, basis wood.....pct.	56.2	65.9	73.0
Shive removal.....	Poor	Poor	Poor
Speck removal.....	Incomplete	Satisfactory	Satisfactory
Rejects, basis pulp.....pct.	15.3	12.9	9.3
Rejects, basis wood.....pct.	10.2	9.8	7.5

[1] Two 3-in. cleaners in series.
[2] Unbleached. uncleaned pulp.

Pulp Freeness and Brightness

In the production of bleached neutral sulfite semichemical pulps of maximum brightness, it is necessary to maintain the highest freeness in milling that will provide adequate shive reduction (about 500 to 600 milliliters). This range became apparent in previous workonneutral sulfite semichemical pulps from mixed hardwoods.[3] It was found that the pulps refined to about 140 milliliters freeness required 1 to 1.5 percent more chlorine (based on pulp) to bleach to 85 percent brightness than when the pulp was refined to 250 to 550 milliliters. Similarly, the brightness of an aspen semichemical pulp beaten to 260 milliliters freeness and bleached by a three-stage processwas 2.4 points lower than that for the same pulp beaten to 410 milliliters.

Probably the lower brightness at the lower freeness was due to an increase in the bonded area of the sheets. This

[3] McGovern, J. N., and Simmonds, F. A. Bleached semichemical pulps from mixed eastern hardwoods for use in high-grade bond paper. Tappi 36 (9): 385-390. 1953.

is a decrease in the area of fiber surface available for scattering the incident light. The final result is an increased absorbance of light. This is essentially the explanation given by Rapsonforthe decrease in the brightness ofbleached pulp during beating.[4]

Allowance should be made for a decrease in freeness during bleaching, which may be as much as 100 or 200 milliliters.

Bleaching Treatments

Results of previous work at the Forest Products Laboratory show that the shives and dirt in aspen semichemical pulps can be bleached effectively with the three-stage chlorination process by using 30 to 35 percent of the total chlorine in the form of hypochlorite. However, the removal of shives and dirt by centrifugal cleaning is a more effective method. Furthermore, this treatment prevents the formation of "shiners" from bleached shives if the pulp is used for calendered papers. A distribution of chlorine somewhat more favorable to strength retention can be used in the three-stage bleaching of centrifugally cleaned pulps.

Strength, Cleanliness, and Pulp Yield

The bursting strength increased about 30 percent with decreasing yield of unbleached pulp from 80 to 66 percent, but tearing resistance remained essentially the same. The cleanliness of the bleached pulps and the strength of the pulps after bleaching with the three-stage process showed that these qualities were independent of the yield of unbleached pulp.

Cost Factors

Wood, chemicals, and power requirements for the production of the bleached pulps given in table 4 can be used for calculating the cost per ton of bleached pulp at various yields of unbleached pulp.

Procedure

Commercial Pulp

A quantity of commercial aspen semichemical pulp that was cleaned centrifugally with 12- and 6-inch cleaners was obtained for bleaching experiments at the Forest Products Laboratory. Some dirt and small shives remained in the pulp, so the pulp was processed further with 3-inch cleaners at the Laboratory. The cleanliness of the unbleached pulp was improved by this treatment.

[4] Rapson, W. H., Anderson, C. B., and Avon, G. L. The effect of beating on pulp brightness. Pulp and paper Mag. Can. 60: T-167-T-172, illus. June 1959.

Table 4.--Wood, chemicals. and power required per ton of bleached pulp at three levels of unbleached pulp yield

Item	Bleaching process					
	Three-stage[1]			One-stage[2]		
	80 pct. yield[3]	72 pct. yield[3]	66 pct. yield[3]	80 pct. yield[3]	72 pct. yield[3]	66 pct. yield[3]
Wood[4,5] ..... lb.	3,015	3,266	3,356	2,494	2,829	3,073
Unbleached pulp[5] ..... lb.	2,427	2,347	2,229	2,008	2,037	2,041
Pulping chemicals:						
Sulfur ..... lb.	74	134	201	62	66	159
Soda ash ..... lb.	402	611	885	332	374	727
Energy for fiberizing chips ..... hp.-days	15.1	11.3	10.1	12.5	9.8	9.3
Bleaching chemicals:						
Total chlorine ..... lb.	485	329	192	201	163	123
Sodium hydroxide ..... lb.	63	56	51	70	51	25
Sodium silicate ..... lb.				80	81	50

[1] Chlorination, extraction, hypochlorite.
[2] Calcium hypochlorite.
[3] Unbleached pulp yield.
[4] Chips ready for digestion.
[5] Moisture-free basis.

The cleaned pulp was bleached in three stages consisting of chlorination, caustic soda extraction, and calcium hypochlorite, and in one stage with calcium hypochlorite. The details of the bleaching treatments are given in tables 6 and 7.

Experimental Pulps

Unbleached pulps. --Three aspen neutral sulfite semichemical pulps with yields of 80.5, 72, and 66.4 percent were produced at the Forest Products Laboratory. Pulping conditions and values for brightness and lignin content are given in table 5. The unbleached pulps were cleaned by screening through 12- and 8-cut flat plate screens followed by centrifugal cleaning in one pass through two 3-inch cleaners in series.

Bleached pulps. --Bleached pulps in the brightness range of 84.5 to 87 percent were produced with the three-stage process used for the commercial pulp (table 6).

The amount of hypochlorite used in the last stage of each bleach was selected as adequate for bleaching residual shives and dirt, and low enough to avoid harm to pulp strength. For effective removal of chlorinated lignin in the extraction stage, sodium hydroxide was added to a pH of 11 to 12. Although the temperature during ex-

Table 5.--Neutral sulfite semichemical pulping of aspen

Item	Digestion No.		
	5565-N	5566-N	5564-N
Impregnation conditions:[1]			
Temperature, °C.	120	120	121
Time at temperature, hr.	1.0	1.0	1.0
Impregnating liquor:			
Sodium sulfite, g. per l.	45.3	77.5	125.3
Sodium bicarbonate, g. per l.	25.0	25.7	32.6
Chemicals absorbed:			
Sodium sulfite, pct. of wood	9.7	16.2	23.6
Sodium bicarbonate, pct. of wood	8.2	8.1	10.4
Cooking conditions:			
Temperature, °C.	170	170	180
Time at temperature, hr.	0.75	2.5	2.5
Pressure, p.s.i.	150	150	160
Spent liquor (sodium sulfite), g. per l.	9.2	9.9	6.4
Total digestion time, hr.	3.75	5.5	5.75
Refining conditions:[2]			
Plate clearance, in.	0.002	0.002	0.002
Consistence, pct.	9.6	10.0	12.5
Unit energy consumed, hp.-days per ton	12.5	9.6	9.1
Canadian Standard freeness, ml.	565	565	550
Unbleached pulp:			
Yield, pct.	80.5	72.0	66.4
Brightness, pct.	55.5	56.2	61.7
Lignin content, pct.	13.3	10.0	6.7

[1] Chips steamed 0.5 hr. at atmospheric pressure before impregnating.

[2] 36-in. double disk refiner.

tractionis not critical, a higher temperature was used in bleaching the commercial pulp as a possibility for producing a cleaner bleached pulp.

Slender shives not removed by the 3-inch cleaner and not completely bleached by the three-stage process, were removed by riffling with a cascade-type riffler. This was done before bleaching the 66-percent-yield pulp, and after bleaching the 72- and 80-percent-yield pulps.

Bleached pulps in the range of 68 to 78 percent brightness were produced by one-stage treatments with calcium hypochlorite, sodium peroxide, and hydrogen peroxide. The conditions used in these treatments are given in table 7.

In the hypochlorite treatment, the high initial pH (about 11.5 to 12), is essential for maximum brightness. The moderate temperature and use of silicate solution help to maintain pulp strength.

Brightness recession values of the

Table 6.--Three-stage bleaching of aspen neutral sulfite semichemical pulps

Bleach No.	Bleaching treatment					Bleached pulp	
	Stage 1[1]	Stage 2[2]		Stage 3[3]		Brightness	Yield basis, wood
	Amount of chlorine	Amount of sodium hydroxide	Temperature	Chemical	Amount		
	Pct.	Pct.	°C.		Pct.	Pct.	Pct.
COMMERCIAL PULP, ABOUT 80 PCT. YIELD							
3237	15.5	2.0	30	$Ca(OCl)_2$	2.5	80.2	.....
3238	15.1	2.0	30	$Ca(OCl)_2$	3.8	81.8	.....
3239	15.1	2.0	70	$Ca(OCl)_2$	3.8	82.1	.....
3242	15.5	2.0	71	$Ca(OCl)_2$	4.0	84.0	.....
3243	15.5	2.0	71	$Ca(OCl)_2$	3.5	83.6	.....
3247	15.5	3.5	71	$Ca(OCl)_2$	4.2	82.1	62.5
EXPERIMENTAL PULP, DIGESTION 5565-N, 80.5 PCT. YIELD							
2954	17.0	2.0	31	$Ca(OCl)_2$	2.0	78.7	.....
2955	17.0	2.0	31	$Ca(OCl)_2$	3.0	74.0	.....
2956	17.0	2.0	31	$Ca(OCl)_2$	3.0	84.5	66.3
EXPERIMENTAL PULP, DIGESTION 5566-N, 72 PCT. YIELD							
2949	13.5	2.0	32	$Ca(OCl)_2$	2.0	87.4	.....
2951	13.0	2.0	36	$Ca(OCl)_2$	1.0	85.6	.....
2953	13.0	2.0	31	$Ca(OCl)_2$	1.0	86.2	61.3
EXPERIMENTAL PULP, DIGESTION 5564-N, 66.4 PCT. YIELD							
2936	8.0	2.0	31	$Ca(OCl)_2$	.6	85.6	.....
2944	8.0	2.0	31	$Ca(OCl)_2$	.6	85.3	59.5
2957	7.0	2.0	30	$Ca(OCl)_2$	1.6	86.9	.....

[1] Chlorination 1 hr. at 25° C., 2 to 2.5 percent consistence.

[2] Alkaline extraction 1 hr. at 10 percent consistence. Initial pH 11.1-12.4, final pH 10.2-12.0.

[3] Hypochlorite stage: 4 hr. at 36°-38° C. and 10 percent consistence; pH held in the range of 8.4-10.4 with caustic soda. Percentages for hypochlorite are in terms of available chlorine.

Table 7.--One-stage semibleaching of aspen neutral sulfite semichemical pulps

Bleach No.	Bleaching treatment[1]						Bleached pulp	
	Bleaching agent		Buffers		Duration	Alkalinity	Brightness	Yield basis, wood
	Chemical	Amount	Sodium hydroxide	Sodium silicate				
		Pct.	Pct.	Pct.	Hr.	pH	Pct.	Pct.
	COMMERCIAL PULP, ABOUT 80 PCT. YIELD							
3252	$Ca(OCl)_2$	10.0	3.5	4.0	1.75	11.8-9.9	71.9	[2]79.6
	EXPERIMENTAL PULP, DIGESTION 5565-N, 80.5 PCT. YIELD							
2940	$Ca(OCl)_2$	10.0	3.5	4.0	4.0	11.7-10.0	75.9	80.2
2937	Na_2O_2	2.0	.....	6.0	3.0	12.0-11.1	68.0	78.0
2941	Na_2O_2	2.0	(3)	6.0	3.0	10.8-9.7	68.2	.....
2939	H_2O_2[4]	1.75	.5	6.0	90	10.2-9.8	73.8	.....
	EXPERIMENTAL PULP, DIGESTION 5566-N, 72 PCT. YIELD							
2946	$Ca(OCl)_2$	8.0	2.5	4.0	4.0	11.5-9.6	75.7	70.7
2938	Na_2O_2	2.0	.....	6.0	4.0	11.2-10.8	69.9	72.0
2948	H_2O_2[4]	1.75	.5	6.0	120	10.4-9.5	72.4	.....
	EXPERIMENTAL PULP, DIGESTION 5564-N, 66.4 PCT. YIELD							
2942	$Ca(OCl)_2$	6.0	1.2	2.4	2.5	11.3-8.6	76.7	.....
2943	$Ca(OCl)_2$	8.0	1.6	3.2	3.75	11.6-8.6	78.9	.....
2935	$Ca(OCl)_2$	10.0	2.0	4.0	4.0	11.5-9.5	84.5	66.3
2947	$Ca(OCl)_2$	6.0	1.2	2.4	4.0	11.3-8.5	77.8	65.0
2934	Na_2O_2	2.0	.....	6.0	5.0	11.4-11.0	76.0	64.6
2933	H_2O_2[4]	1.75	.7	6.0	72	11.1-9.2	73.4	.....

[1] Temperature and consistence were 35°-36° C. and 10 percent for hypochlorite, 50°-51° C. and 13 percent for sodium peroxide, and room temperature and 30 percent for hydrogen peroxide. The sodium peroxide and hydrogen peroxide bleaching solutions contained 0.05 percent of epsom salts based on pulp to stabilize the bleaching solution.

[2] The yield based on unbleached pulp was 99.5 percent.

[3] 0.75 percent of sulfuric acid added.

[4] 50 percent solution, cold steep process.

Table 8.--Recession of brightness of pulps after different bleaching treatments

Yield of unbleached pulp	Bleaching treatment	Brightness	Recession: Heated 1 hr. at 105° C.	Recession: Stored 14 days at room conditions, shielded from light
Percent		Percent	Points	Points
80.5	Three-stage	84.5	6.3	.....
	$Ca(OCl)_2$ (10 pct. chlorine)	75.9	7.2	2.6
	Na_2O_2 (2 pct.)	68.2	2.3	0
	H_2O_2 (1.75 pct. of 50 pct. solution)	73.8	3.7	0
72.0	Three-stage	86.2	6.7	.....
	$Ca(OCl)_2$ (8 pct. chlorine)	75.7	6.8	2.6
	Na_2O_2 (2 pct.)	69.9	1.0	1.1
	H_2O_2 (1.75 pct. of 50 pct. solution)	72.4	2.1	.7
66.4	Three-stage	85.3	.....	.4
	$Ca(OCl)_2$ (10 pct. chlorine)	84.5	7.3	3.1
	Na_2O_2 (2 pct.)	76.3	1.6	.8
	H_2O_2 (1.75 pct. of 50 pct. solution)	73.4	1.5	.8

pulps after the different bleaching treatments are given in table 8.

Evaluation of Pulp Strength

The strength evaluation of unbleached and bleached pulps was made according to TAPPI methods.

Strength data for the unbeaten pulps, and for the beaten pulps, interpolated at 300 milliliters freeness are given in tables 1 and 2.

SUBJECT LISTS OF PUBLICATIONS ISSUED BY THE FOREST PRODUCTS LABORATORY

The following are obtainable free on request from the Director, Forest Products Laboratory, Madison 5, Wisconsin.

List of publications on Box and Crate Construction and Packaging Data

List of publications on Chemistry of Wood and Derived Products

List of publications on Fungus and Insect Defects in Forest Products

List of publications on Glue, Glued Products, and Veneer

List of publications on Growth, Structure, and Identification of Wood

List of publications on Mechanical Properties and Structural Uses of Wood and Wood Products

Partial list of publications for Architects, Builders, Engineers, and Retail Lumbermen

List of publications on Fire Protection

List of publications on Logging, Milling, and Utilization of Timber Products

List of publications on Pulp and Paper

List of publications on Seasoning of Wood

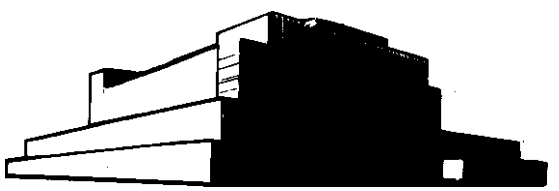
List of publications on Structural Sandwich, Plastic Laminates, and Wood-Base Aircraft Components

List of publications on Wood Finishing

List of publications on Wood Preservation

Partial list of publications for Furniture Manufacturers, Woodworkers and Teachers of Woodshop Practice

Note: Since Forest Products Laboratory publications are so varied in subject, no single list is issued. Instead a list is made up for each Laboratory division. Twice a year, December 31 and June 30, a list is made up showing new reports for the previous 6 months. This is the only item sent regularly to the Laboratory's mailing list. Anyone who has asked for and received the proper subject lists and who has had his name placed on the mailing list can keep up to date on Forest Products Laboratory publications. Each subject list carries descriptions of all other subject lists.



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