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## The Preservative Treatment of Aspen

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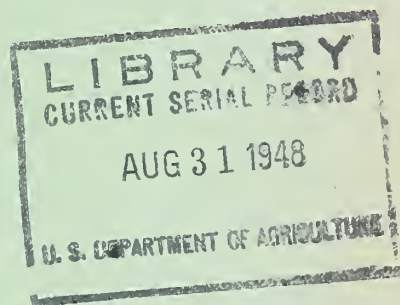
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LAKE STATES ASPEN REPORT NO. 19

# THE PRESERVATIVE TREATMENT OF ASPEN

BY  
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MAY 1948

PROCESSED BY  
U. S. DEPARTMENT OF AGRICULTURE  
FOREST SERVICE  
LAKE STATES FOREST EXPERIMENT STATION

## FOREWORD

During and since World War II, there has been increasing interest in aspen (Populus tremuloides) in the Lake States, its availability and supply, properties and uses, and management. Aspen is a tree of primary importance in 20 million acres or 40 percent of the total forest area of the three Lake States - Michigan, Minnesota, and Wisconsin.

At an informal meeting at Madison, Wisconsin, in January, 1947, forestry representatives of several federal, state, and industrial groups in the Lake States agreed that it would be desirable to bring up to date what is known on aspen and make it available to anyone interested. The job of preparing this information in the form of reports was assigned to each of the groups listed below. The reports will be duplicated as rapidly as completed, and the entire project should be finished by the end of 1947. Each report will concern one aspect of the subject. Copies will be available from the Lake States Forest Experiment Station or from each contributor.

<u>Report Number</u>	<u>Subject</u>
1	Aspen Properties and Uses
2	Aspen Availability and Supply
3	Logging Methods and Peeling of Aspen
4	Milling of Aspen into Lumber
5	Seasoning of Aspen
6	Aspen Lumber Grades and Characteristics
7	Mechanical Properties of Aspen
8	Machining and Related Properties of Aspen
9	Aspen Lumber for Building Purposes
10	Aspen for Containers
11	Aspen for Core Stock
12	Small Dimension and Other Industrial Uses of Aspen
13	Aspen for Veneer
14	Aspen for Pulp and Paper
15	Aspen for Cabin Logs
16	Aspen for Excelsior
17	Aspen Defiberization and Refining of Product
18	Chemical Utilization of Aspen
19	Preservative Treatment of Aspen
20	Marketing of Aspen
21	Possibilities of Managing Aspen

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THE PRESERVATIVE TREATMENT OF ASPEN<sup>1/</sup>

By

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Division of Forestry  
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University of Minnesota

Aspen is one of our least durable woods and is known to deteriorate or rot rapidly under conditions favoring decay. Records on aspen used under moist and severe decay conditions have shown that serious decay and failure of the product may develop in three to four years. Some present and potential uses for aspen involving conditions favorable to decay and in which this lack of natural durability is a factor are: (1) fence posts, (2) railroad cross ties, (3) mine timbers, (4) plank-ing for secondary bridges, (5) sills and other construction members in buildings, (6) the lower logs of log cabins, and (7) small items as pickets, stakes, etc.

In all of these uses the wood in service is either in contact with the soil or is exposed to moisture for considerable periods, conditions that result in rapid deterioration or development of decay in woods lacking natural durability and not protected by an effective preservative treat-ment. Actually, aspen does not differ greatly from such hardwoods as black ash, green ash, basswood, hard maple, soft maple, paper birch, yellow birch, and cottonwood in durability or behavior under conditions favoring decay. None of these woods possess heartwood that differs appreciably from sapwood in decay resistance, and all of them are classed as species of low durability. Although there is considerable prejudice against aspen for uses in which decay is not a factor when good construction practices are followed, for such uses as siding, roof boards, sheathing, rafters, etc., experience has shown that aspen is as durable as any wood, either hardwood or softwood, under use conditions where it remains dry or is exposed to moisture for rela-tively short periods.

The preservative treatment of aspen is important only for products used under conditions favoring decay, such as the products listed in the first paragraph, which are used in contact with the soil or which may become moist and remain moist for considerable periods. Unfortunately, there is relatively little published information on the treating char-acteristics of aspen treated by different processes and with different preservatives. Consequently, most of the information on treating char-acteristics on which this report is based was obtained from discussions with operators of wood preserving plants in Minnesota and Wisconsin, who have had experience with aspen, and from the unpublished results of treating

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<sup>1/</sup> Published as University of Minnesota Agricultural Experiment Station  
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tests made at the Forest Products Laboratory and the University of Minnesota. The service records included in this report were summarized from a number of volumes of the Proceedings of the American Wood Preservers' Association. This report includes discussions on the wood rotting fungi responsible for most of the decay of aspen products, decay losses that occur during seasoning, the preparation of wood for treatment and treating characteristics, experience with various treating processes, the available service records on products treated with different preservatives by several processes, recommendations, and problems in need of added research.

#### THE FUNGI RESPONSIBLE FOR THE DECAY OF ASPEN

As is true for practically all tree species, rather distinct groups of wood-rotting fungi are responsible for the heartrot found in living aspen trees and the decay that develops in aspen pulpwood in storage, in ties during seasoning, and in all aspen products used in contact with the soil or under other moist conditions.

Fomes igniarius is responsible for most of the heartrot found in living aspen. Aspen is relatively short-lived, and trees on poor sites may have considerable heartrot caused by this fungus by the time they are 40 to 50 years of age (2). The same workers (Schmitz and Jackson) also showed that on better sites decay by Fomes igniarius may not become a serious limiting factor until stands reached 60 to 70 years in age.

In contrast to the heartrot of living aspen which is caused mainly by Fomes igniarius, a large number of wood-rotting fungi are capable of attacking and causing decay of aspen products. Some of the most common and important wood-rotting fungi found on decaying aspen products are several species of Polyporus (hirsutus, pargamenus, versicolor, adustus), several species of Poria, Fomes appplanatus, Pleurotus ostreatus, and Armillaria mellea. Many other fungi may be found fruiting on decaying aspen products and may cause as rapid decay as the more common wood rots listed above.

#### LOSSES DUE TO DECAY

Because of the susceptibility of the wood to decay and the high moisture content of both sapwood and heartwood, aspen products may be severely attacked and heavy losses due to decay may occur during seasoning or storage unless special precautions are taken.

Unpeeled aspen pulpwood stored in the woods or in wood yards at mills may have numerous fruiting bodies or sporophores of wood-rotting fungi on it after storage for one summer. During particularly wet summers or under very adverse seasoning conditions, as when pulpwood is stored in brushy areas in the woods, decay may progress sufficiently in one season to cause considerable loss. Normally, however, unpeeled aspen pulpwood can be stored through one summer season without danger of serious loss, even though there may be considerable fruiting of fungi. During the second season, decay in unpeeled aspen pulpwood progresses very rapidly

and decay losses are usually high, particularly when the wood is stacked so that there is no space between stacks for air circulation or where the wood yard is located in a place with poor air drainage. Peeled aspen pulpwood usually decays more slowly unless the wood is allowed to remain on the ground too long after peeling and becomes heavily infected before stacking. Normally, peeled aspen pulpwood that has been correctly handled and is stacked under favorable conditions can be held through two summer seasons with no greater loss than occurs in unpeeled aspen during one season of storage.

The problem of reducing decay losses in aspen pulpwood during storage has been given relatively little study. It is recognized that the best practice is to limit storage to no more than one season, and this procedure normally is followed. Getting the wood off the ground as soon as possible after cutting is important because it reduces the chances of infection by decay fungi before the wood reaches the wood yard at pulp and paper mills. Stacking so that there is good air circulation between piles and placing not more than two 8-foot stacks together without an air space between them in yards where there is good air drainage are also generally recognized as being beneficial. The effect of spraying fungicides or preservatives on the exposed ends of pulpwood sticks in storage stacks was studied by the Division of Forestry of the University of Minnesota in 1940-41. Two fungicides <sup>2/</sup>extensively used in the dipping of lumber to prevent blue stain and decay during seasoning were used and were applied to the exposed ends of pulpwood sticks in storage piles by means of knap-sack sprayers. The fungicides were applied in May 1940 on unpeeled pulpwood cut and stacked in the yard during the previous winter. Adjacent sections of the same stack were left untreated and acted as controls. Examinations in August 1941, after two summers of storage, showed a marked difference in the number of fruiting bodies of wood-rotting fungi on the ends of treated sticks as compared to untreated sticks. Also, there was much less decay near the ends of treated sticks than in untreated material. However, within the stack, from 6 inches to 1 foot from the ends, there was no discernible difference between treated and untreated material. No pulping studies were made on this material, so it was not possible to say whether such treatment would be economical or worthwhile in case of wood for which storage through two summers is anticipated. End treatment of pulpwood stacks has been found beneficial by some southern paper mills, and it deserves further investigation for aspen pulpwood.

Serious decay losses may occur in aspen ties during seasoning. Much of the prejudice against aspen ties stems from the difficulty that treating plant operators have experienced during seasoning. The high moisture content of aspen combined with its susceptibility to decay by a large number of wood-rotting fungi makes it difficult to handle in the same manner as ties from other tree species without danger of serious decay losses. When regular stacking practices (one-by-nine) are followed,

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<sup>2/</sup> Lignasan (containing ethyl mercury phosphate as the active ingredient) and Dowicide G or sodium pentachlorophenate.



drying is slow, and during poor-seasoning weather decay develops rapidly and abundant fruiting of fungi occurs at the points of contact between ties. Although decay may not develop sufficiently during one summer to affect strength or the later serviceability of well-treated ties, the material presents a bad appearance, and the contrast between aspen ties and ties of other species may be so great under poor seasoning conditions that the prejudice that has developed against aspen is quite understandable.

One treating plant operator reported that decay during seasoning can be greatly reduced by more open piling of ties, by stacking one-by-seven rather than the standard one-by-nine. This practice of providing about 2-inches of space between ties permits more rapid drying. Since aspen ties are not subject to serious checking during seasoning, such open stacking can be followed for this species, whereas it would result in serious checking of red oak, hard maple, and birch. It is difficult to introduce variations in stacking practices, and the cost of such open stacking is greater than the standard one-by-nine practice, but it offers a possible solution to the problem of reducing decay losses during seasoning of aspen ties. Replacing the cross tie used in self-sticking with a dry 2-by-4 has been suggested as another means of reducing decay losses during seasoning. Whether this practice is practical is not known.

Decay and stain damage to aspen lumber seasoning can be eliminated or held to a minimum by following the practices recommended in Lake States Aspen Report No. 5 (Seasoning of Aspen). Decay damage to aspen cabin logs can be reduced by following the handling practices recommended in Lake States Aspen Report No. 15 (Aspen for Cabin Logs). Decay damage to aspen fence posts and other aspen products during seasoning can be eliminated or reduced by peeling and open stacking to promote more rapid drying. The resistance of aspen to checking makes it possible to stack posts and other aspen products to promote rapid drying without danger of serious checking.

#### TREATING PROCESSES AND PRESERVATIVES

Whereas it is possible to minimize or eliminate decay losses in aspen products during seasoning by modifications in handling practices, the only method of insuring a reasonable service life or of preventing rapid deterioration of aspen products used under conditions favoring decay is through preservative treatment. As previously mentioned, there has been less experience with the treatment of aspen than with the treatment of most of the Lake States wood species used for fence posts, ties, mine timbers, and other products commonly given preservative treatment. Also, very little has been published on the treating of aspen and most of the information given here was obtained through discussion with operators of treating plants.

## Pressure Treatment

At least five pressure-treating plants in Minnesota and Wisconsin have had experience with the pressure treatment of aspen ties, aspen bridge planking, mine timbers, and fence posts. Most of the experience has been with the Lowry and Rueping Empty-Cell Processes and with coal tar creosote, and zinc chloride has been used to a limited extent. Sawn ties incised on all four sides and hewn ties incised on the hewn surfaces and adzed and bored prior to treatment are reported to treat rather uniformly by the Lowry and Rueping Empty-Cell Processes, and no special difficulties have been reported. In general, the same is true for bridge planking and sawn mine timbers. In case of unincised sawn or hewn aspen ties, large fence posts, and round mine timbers, rather erratic penetration was reported. End penetration of preservatives was excellent, but radial penetration varied from 1/16 inch to 1 inch in the same piece. This variation in penetration of preservatives in different parts of the same piece constitutes one of the reasons why the preservative treatment of round aspen products is considered difficult. The presence of tyloses in both the sapwood and heartwood of large-tooth aspen has been suggested as a possible explanation for the irregular penetration of preservatives in wood of this species (C. H. Teesdale and J. D. Mac Lean, U. S. Dept. of Agr., Bulletin 606, 1918). The more uniform treatment of sawn aspen products can probably be traced to penetration through exposed end-grain on the sawn surfaces. This appears a logical explanation because most aspen lumber is cut from small logs, and there is abundant end-grain on the sawn surfaces associated with small knots and other defects. In case of incised material, penetration is uniform because incising makes tangential and longitudinal penetration possible in addition to radial penetration.

Excellent penetration of coal tar creosote in small aspen posts (3-4 inches top diameter) was reported by one treating plant experimenting with this material. With larger posts, however, some difficulty was experienced in obtaining uniform penetration of the preservative.

Material to be given pressure treatment with creosote or other oil preservatives should be free from bark and at a moisture content below fiber saturation, 30 per cent. Better results are claimed in treating material at moisture contents of 15 to 25 per cent than drier material.

## Hot-cold Bath Process

The hot-cold bath process (8) has been used experimentally and by a number of small commercial treating plants in the treatment of aspen fence posts and mine timbers. Coal tar creosote, water gas tar, oil solutions of pentachlorophenol, and zinc chloride have been used in this process. Both butt-treatment and full-length treatment by this process have been tried. In fence posts in particular, spotty or erratic penetration at the ground line, the critical area, has been common for large posts. Penetrations varying from 1/16 inch to 1 inch are not uncommon in the ground-line zone of individual posts. This is greater variation than is commonly encountered



with other hardwoods and far greater than for jack or red pine, for which penetration is usually very uniform and deep penetration is far more easily obtained. Excessive end penetration of preservative in aspen posts also results in waste of preservative because such end penetration rarely extends to the ground line, where it is most needed. A combination of hand incising of the ground-line area and treatment by the hot-cold bath process result in deep and uniform penetration at the ground line without excessive absorption of preservative in the butts. However, such incising is slow and expensive and has been used only experimentally.

For small aspen posts, 3-4 inches top diameter, a butt treatment by the hot-cold bath process may be all that is needed for posts used in the Lake States, but a light top treatment is good insurance against top rot and should be applied wherever possible. For larger posts, some top treatment is essential because of the danger of top rot. Top rot is common in larger posts of all non-durable species, whereas it is rather infrequent in smaller posts. This difference is probably due to the tendency of the tops of larger posts to retain moisture for long periods following heavy rains, thus favoring top rot. Smaller posts, on the other hand, appear to dry out so rapidly that there is less opportunity for top rot to develop.

Clean peeling and careful air seasoning appear to be as important in treating by the hot-cold bath process as for pressure treatment.

#### Non-pressure Processes

Cold-soaking in oil solutions of pentachlorophenol: Considerable experimental work has been done at the Forest Products Laboratory and at the University of Minnesota on the treatment of seasoned aspen posts by soaking in cold-oil solutions of pentachlorophenol (1). Treatment has been by soaking either full length or by butt treatment after air seasoning of clean-peeled posts.

The results with this process on aspen have been very disappointing and unsatisfactory when compared to results obtained on jack pine, red pine, and black ash. Penetration of preservative at the ground line has been found extremely variable, and rarely does it exceed 1/4 inch. In some posts the penetration, even after long periods of soaking, has been no more than 1/16 inch. Absorption of preservative solutions by posts may be entirely satisfactory, but most of the preservative is in the butts in butt-treated posts and in the butts and tops of full-length treated posts, with very shallow and unsatisfactory penetration at the critical ground line zone.

The process is simple, and pentachlorophenol is an excellent wood preservative, but the results obtained have been disappointing because of the poor and irregular penetration of preservative at the ground line, where treatment should be deepest. The service data available on aspen posts treated by this process with pentachlorophenol (Table 3) indicate that some posts may fail in 4 to 6 years, and that such failure is due to spotty or shallow penetration and not to any fault of the preservative.

Tire tube treatment with zinc chloride or chromated zinc chloride: A considerable number of aspen posts have been treated by this process, which is described in a statement prepared by the Forest Products Laboratory (4). The published information available indicates that zinc chloride, chromated zinc chloride, and other water-borne preservatives move rather rapidly through freshly cut green aspen posts when solutions of preservatives are applied to the butt ends by this process. Little is known regarding the quantitative distribution of preservatives in posts but the occurrence of decay in the tops of some treated posts after 5 to 8 years in service indicates that in some posts, at least, distribution is not uniform.

The results of service tests indicate that posts treated by this process should last at least 10 years (Table 3). Although considerable decay has developed in many of the posts treated by this process in the 7 to 8 years that have elapsed since they were set, their condition indicates that most of them will have at least several added years of life.

The process is time-consuming and not well adapted to the treatment of large numbers of posts. Also, there is some question as to whether the results that can be obtained are any better than those obtained by treating with the same chemicals by a simpler and cheaper process, designated as the "butt-soaking process."

Butt-soaking treatment with zinc chloride or chromated zinc chloride:

This process was first extensively tried at Clemson College, South Carolina on southern pine posts (6). The process consists of immersing the butt ends of freshly-cut unpeeled posts in concentrated solutions of zinc chloride or chromated zinc chloride placed in shallow vats, tanks, or drums. The concentrated solutions move into the posts by diffusion and possibly by capillarity. The quantity absorbed can be controlled to some extent by adjusting the concentration of the treating solution and period of immersion.

In rather extensive tests with this process at the University of Minnesota, it has been found that 27 per cent or 33 per cent solutions (3 or 4 pounds per gallon of water) of chromated zinc chloride are preferable to weaker solutions. By immersing the butts of freshly cut aspen posts in these solutions for two days and then reversing the posts and immersing the tops for one-half day, absorptions of  $\frac{1}{2}$  to  $1\frac{1}{2}$  pounds of the preservative per cubic foot of wood have been obtained (Table 1). The preservative is concentrated in the butts and tops immediately after treatment, but further distribution, sometimes rather uniformly throughout the posts, is obtained by setting the posts on their tops for two weeks to a month.

Table 1

Variation in absorption of chromated zinc chloride solutions by green aspen posts of the same lot when treated by the butt-soaking process

Post No.	Top Diameter	Treating Period		Absorption of CZC in lbs/cu.ft.
		Butt	Top	
Treatment with a 27 per cent solution				
1	3.6	2 days	$\frac{1}{2}$ day	1.139
2	3.4	2 days	$\frac{1}{2}$ day	1.157
3	4.3	2 days	$\frac{1}{2}$ day	1.416
4	3.9	2 days	$\frac{1}{2}$ day	1.270
5	3.3	2 days	$\frac{1}{2}$ day	1.256
6	3.7	2 days	$\frac{1}{2}$ day	1.800
7	3.1	2 days	$\frac{1}{2}$ day	1.975
8	4.3	2 days	$\frac{1}{2}$ day	1.015
Treatment with a 20 per cent solution				
1	4.6	2 days	$\frac{1}{2}$ day	.605
2	4.2	2 days	$\frac{1}{2}$ day	.630
3	4.6	2 days	$\frac{1}{2}$ day	.540
4	4.3	2 days	$\frac{1}{2}$ day	.544
5	3.9	2 days	$\frac{1}{2}$ day	.549
6	3.3	2 days	$\frac{1}{2}$ day	.851



Service records on aspen posts treated by this process are not available, but results should be similar to those obtained on aspen posts treated by the tire-tube method. Many problems connected with this treating procedure require additional work. Preliminary tests indicate that high concentrations of chromated zinc chloride do not injure the wood, but this point needs further study. Also, there appears to be considerable difference in the absorption of preservative by posts cut on different sites or at different times of the year (Table 2). The very low absorptions obtained for posts cut on a poor site near New Brighton, Minnesota are particularly disturbing. The necessity of using freshly cut posts or of removing discs from the ends of posts that have been cut for several days is a distinct disadvantage of the process. The low cost of the treating chemicals and simplicity of the treating process are advantages that give the process some promise for use by farmers in the Lake States.

Table 2

Variation in Absorption of a 27 per cent Chromated Zinc Chloride Solution by Green Aspen Posts of Different Lots When Treated by the Butt-Soaking Process

Lot No.	Date Cut	Source	Average Top Diameter	No. of Posts	Days Treating Period		Ave. Absorption of preservative (CZC) lbs/cu. ft.
					Butt	Top	
1	June 1947	Cloquet, Minn.	3.7	8	2	$\frac{1}{2}$	1.39
2	April 1947	New Brighton, Minn.	3.7	12	2	$\frac{1}{2}$	.15
3	Feb. 1947	Cloquet, Minn.	4.2	8	2	$\frac{1}{2}$	.77
4	Feb. 1947	Cloquet, Minn.	3.9	10	2	$\frac{1}{2}$	.99

Treatment by Steeping: Peeled aspen fence posts and mine timbers have been treated by steeping in zinc chloride and chromated zinc chloride. The process consists of soaking green peeled material in tanks of the preservatives, concentrations of 5 per cent being most commonly used (5). The preservatives penetrate by diffusion, and the soaking period is normally a week or longer. No published service records are available on mine timbers treated by this process, but one user of aspen mine ties steeped for 6 days in a 5 per cent solution of zinc chloride reported a life in excess of 10 years.

The process is slow and large tanks are required, but it has some application for mine timbers for which untreated aspen is not satisfactory and for which a service life of 10 to 12 years is all that is desired.

Treatment by the Osmose Process: A number of aspen fence posts have been treated by the Forest Products Laboratory with Osmotite and Osmosar (Table 3). These chemicals were applied in paste form to the surface of freshly peeled green posts and the posts bulk-piled and covered with a moisture-resistant paper for a period recommended by the manufacture of these preservatives. The preservatives penetrate the green posts by diffusion during the bulk-piling period and the posts can be set when removed from the pile or after seasoning.

As indicated by the results of service tests given in Table 3, aspen posts treated with these chemicals develop early decay, and the results are far inferior to those obtained with the same chemicals on pine posts. This difference in results on aspen and pine again points to lack of penetration in aspen as the probable cause of the rather inferior results obtained.

Treatment by Dry Salting: During the past two years more than four hundred peeled green aspen posts have been treated by the University of Minnesota by a process similar to the Osmose Process. This consists of applying a mixture of dry powdered copper sulphate and sodium dichromate to green, freshly peeled aspen posts as they are bulk-piled. The posts are given a half turn after the upper surface has been covered with the mixture of these chemicals, and the application is repeated to cover the remaining surface. This process permits concentration of the preservative at the ground line and top, where treatment is most important. Only enough preservative is applied to the remainder of the post to give it a uniform color.

This mixture of chemicals absorbs moisture from the wood very rapidly, and it is usually advisable to allow the peeled posts to surface-dry for a day or so to prevent excessive loss of chemicals by drainage. Although the chemicals react on the surface of the posts to form copper chromate, this material appears to be sufficiently soluble to penetrate the wood by diffusion. Leaching tests on treated wood indicate that the preservative is extremely resistant to removal once it has penetrated the wood.

Penetrations of 1/4- to 3/4-inch are normally obtained, and distribution is surprisingly uniform, considering the method of application. In posts treated to obtain an over-all retention of 1 pound of the preservative per cubic foot but with treatment concentrated at the ground line and top, analyses have shown that 5 to 6 pounds of preservative per cubic foot of treated wood may be present at the ground line.

In tests made to date, several mixtures of these chemicals have been tried:

(a)	Copper sulphate	90	per cent	and	sodium dichromate	10	per cent
(b)	"	"	75	"	"	"	25
	"	"	50	"	"	"	50

About 100 of the posts treated with these chemicals by this process are now in service tests, but it is too early to predict whether or not the results will be better than those obtained with other chemicals applied by diffusion processes. The extreme resistance to leaching shown by the chemicals once they have penetrated the wood suggests greater permance than has been obtained with other water-borne preservatives, but the effectiveness of these chemicals when applied by dry-salting needs to be established through service tests.

Advantages of the method are its low cost and simplicity, no treating equipment being required. In a trial of the process during the summer of 1947, two men cut, peeled, and treated 200 small (3-4 inch top diameter) aspen posts in one day. With copper sulphate at \$.07 and sodium dichromate at \$.12 per pound, the cost of chemicals per post averaged \$.08 when a 50-50 mixture was used, and the posts were treated to obtain a retention of approximately 1 pound per cubic foot. In addition to labor and chemicals there was a small added cost for moisture-resistant crepe paper, used in covering the bulk-piled posts.

Disadvantages of the process are its dirtiness and the difficulty of obtaining sodium dichromate. Powdered copper sulphate is available in most localities, but sodium dichromate must be obtained through large chemical companies.

The treated posts have a blue-green or brown color. Preliminary corrosion tests on wire staples and nails have shown that there is little danger of corrosion to wire or fastenings with this combination of chemicals. However, additional tests on this point are needed.

The process cannot be recommended for the treatment of aspen until service records are available, but it appears to have sufficient promise to merit additional investigation.

Treatment with "Treater Dust": About 20 years ago a number of aspen posts were treated by the University of Minnesota by applying "Treater Dust," or powdered white arsenic (3), to the fence post holes and around the posts as they were set. This treatment resulted in some increase in life of the posts but not enough to justify the cost. The average life of small untreated aspen posts in these tests was 3.5 years and for posts treated with "Treater Dust" it was 5.2 years.

Miscellaneous non-pressure treatments: Dry aspen posts have been treated by applying several brush coats of creosote to the butts. There are no service records on aspen posts treated in this manner, but experience with other species indicates that such treatment with a good grade of coal tar creosote should at least double the life of small aspen posts, or increase it from about 3 years to 5-6 years.



Brush and spray applications of clear oil solutions of pentachlorophenol have been applied to aspen cabin logs after the cabins have been erected. Except for the lower logs, which may become wet from rain dripping or splashing, decay is not a serious factor in cabin logs. Consequently, as far as prevention of decay is concerned, such applications have little value. However, such treatment seems to prevent darkening or discoloration of the logs. Untreated aspen logs, like the tops of aspen fence posts, soon take on a grey or grey-brown color, but logs and fence posts treated with light oil solutions of pentachlorophenol retain a much lighter and cleaner appearance. Whether this is due to the prevention by the preservative of growth of staining fungi and molds on the surface or to other factors is not known.

#### SERVICE RECORDS ON TREATED ASPEN

Practically all of the published service records available on aspen treated with different preservatives and by different processes are on fence posts. These records are summarized in Table 3.

Although most of these tests have not been established long enough to obtain average service lives, the condition of the posts when last examined is indicative of the effectiveness of the preservatives and treating methods.

Relatively few service records on aspen posts pressure-treated with coal tar creosote are available. The results on posts treated with this preservative in mixture with gas oil (25 per cent coal tar creosote and 75 per cent gas oil) indicate that aspen posts pressure-treated with this mixture or with other creosote-oil combinations should give good service (Table 3). Although this particular group of posts was given a rather heavy treatment, they were in excellent condition after 22 years of service. There are more service records on pressure-treated cottonwood than on pressure-treated aspen. Cottonwood posts given a good pressure treatment with coal tar creosote are known to give 20 to 25 years of service. The similarity in treating characteristics of aspen and cottonwood suggests that equally good results should be obtainable with pressure-treated aspen posts. Because of the greater uniformity in penetration obtainable with small aspen posts, more uniform results should be possible with smaller posts than with larger material. The results on posts given a pressure treatment with a 2.9 per cent solution of tetrachlorophenol in crank case oil (Table 3) indicate that aspen posts pressure-treated with oil solutions of the chlorophenols, particularly with pentachlorophenol, should give service similar to material treated with coal tar creosote.

All of the available service records on aspen posts treated by the hot-cold bath process are on full length treated material. After 10 years of service those posts treated with coal tar creosote by this process are still in excellent condition (Table 3). Because of the full-length treatment no top rot has developed. However, there is real danger of failure due to top rot in large aspen posts given only a butt treatment by the hot-cold process. As indicated previously, thorough butt treatment

of 3-4 inch aspen posts and a very light top treatment appear to be all that is needed because top rot does not develop to an important extent in small posts of nondurable species used in the Lake States. For larger posts, however, a good top treatment should be given in addition to butt treatment. This top treatment might consist of a few hours soaking in hot oil with the tops immersed to a depth of 6-12 inches.

The service tests on aspen posts treated by cold soaking in oil solution of pentachlorophenol (Table 3) have not run long enough to permit final conclusions, but the erratic and shallow penetration at the ground line zone, coupled with early failure of a number of posts, suggests that this treatment will not prove as satisfactory for aspen posts as for jack pine, red pine, and southern pine posts. More aspen posts have been treated by this process and are in service tests than for any other preservative or treating procedure. Consequently, we should have a good evaluation of the process in a few more years.

The results given in Table 3 on water-borne preservatives applied by various processes reflect not only the variability in absorption of preservative that appears to be characteristic for aspen but the lack of resistance to leaching inherent in most of these preservatives. It is questionable whether a service life of more than 10-12 years can be obtained for aspen products treated with these water-borne preservatives even though good absorption and distribution are obtained. Treatment of aspen with these water-borne preservatives appears to be advisable only for farm use and possibly for some types of mine timbers. Since treatment with these preservatives may increase the service life of aspen fence posts to 10 years or somewhat longer, as compared to 3-4 years for untreated posts, the use of these water-borne chemicals and various non-pressure treating processes can be very economical and advantageous to the farmer owning aspen timber of post size.

#### Service records on aspen ties

No published service records are available on treated aspen ties. One Lake States railroad installed a large number of pressure-creosoted aspen ties in one of their tracks 15 years ago and has observed these ties since that date. The ties were hewn on two faces and most of them were very large. The ties were not adzed or bored prior to treatment, and this fact many account for much of the difficulty that has been experienced with them. Absorption of about 8 pounds of a good grade of coal tar creosote per cubic foot was obtained, and increment-borer measurements indicated that penetration was excellent on the unslabbed surfaces but was more spotty and not as deep on the slabbed surfaces. After 15 years of service these ties have an excellent surface appearance. They are very free from checks and there is no outward evidence of deterioration. However, at the time of examination (1947), many of the spikes were loose. This loosening of spikes has been prevalent for these ties for a number of years and is attributed partly to the poor spike-holding quality of aspen and partly to the development of decay in the interior of the ties around the spike holes. The wood around the loose spikes

below the treated zone was soft and appeared to be decayed in a number of ties. Had these ties been bored and adzed prior to treatment there would have been little chance of decay developing around the spikes, and the difficulty with spike-loosening undoubtedly would have been less serious.

Several other railroads have used treated aspen ties in the past. Their greatest objection to these ties was not their durability or service lives, but the difficulty experienced in seasoning and with spike loosening. In the opinion of these users, aspen ties that are adzed and bored prior to treatment and are given pressure treatment with a good grade of coal tar creosote should have as good service lives as similar cottonwood ties, for which service lives of 20 to 30 years have been obtained (7). The problem of spike-loosening is less important with heavier tie plates and the adoption of adzing and boring prior to treatment as uniform practice, but it is still important on curves. Aspen is known to have lower nail-holding properties than woods of similar density, but whether this difference is sufficient to rule out a greater use of aspen for ties is not certain. The similarity of aspen and cottonwood in most properties, including nail-holding, indicate that it should perform as well as the latter species when given the same treatment and used under the same conditions.

#### Service records on aspen mine timber

No published service records are available on treated aspen mine timbers, but the experience of several users indicates that when properly treated this wood performs about as well as most of the hardwoods used. In general, however, results appear to be inferior to those obtained with jack pine and other conifers, probably because of the greater difficulty of obtaining uniform treatment of aspen.

#### Service records on treated aspen bridge planking

Pressure-creosoted aspen bridge planking used in secondary bridges has given excellent results in Minnesota. Several reports were obtained of planking that was in good condition after 10 years of service. The resistance of aspen to checking and to wear, under conditions where only light traffic is involved, combined with the excellent treatment that can be obtained with sawn aspen products, makes pressure creosoted aspen bridge planking a very satisfactory material.



Table 3. Service Tests on Aspen Fence Posts Treated with Different Preservatives by Several Processes

Agency Making Test	Posts Set at	Preservative	Absorption lbs. per cu. ft.	Number Set	Top Diameter (inches)	Date		Condition		Average Service Life (years)
						Set	Last Examined	Decaying	Failed	
<u>Treated by the Tire Tube Method</u>										
For. Prod. Lab.	Madison, Wis.	Zinc Chloride	.14 to 1.88	45	4-8	1937	1945	42	2	--
For. Prod. Lab.	Madison, Wis.	Chromated Zinc Chloride	.64 to 1.35	28	4-8	1937	1945	28	0	--
For. Prod. Lab.	Madison, Wis.	Sodium Chromate	.22 to 1.20	3	4-8	1937	1945	1	2	--
For. Prod. Lab.	Madison, Wis.	Copper Sulfate	.12 to .54	17	4-8	1937	1945	13	1	--
Lake States For. Exp. Sta.	La Crosse, Wis.	Zinc Chloride	.5 to .75	15 <sup>1/</sup>	4-7	1938	1945	--	0	--
Lake States For. Exp. Sta.	La Crosse, Wis.	Zinc Chloride	.5 to .75	15 <sup>2/</sup>	4-7	1938	1945	--	0	--
<u>Treated by Diffusion Process - Chemical In Paste Formed Applied to Peeled Green Posts as Recommended by Camose Corporation</u>										
For. Prod. Lab.	Madison, Wis.	Osmoear	.29	16	5-7	1936	1946	16	14	6.4
For. Prod. Lab.	Madison, Wis.	Osmotite	.23	7	5-7	1936	1946	7	6	6.6
For. Prod. Lab.	Drummond, Wis.	Osmosar	.29	49	5-7	1936	1946	45	18	--
For. Prod. Lab.	Drummond, Wis.	Osmotite	.23	55	5-7	1936	1946	51	12	--
<u>Treated With Oil Solutions of Pentachlorophenol by Cold Soaking -- Treating Time Given in Preservative Column</u>										
For. Prod. Lab.	Oregon, Wis.	8 hrs. - full length	2.8 <sup>2/</sup>	9	4	1943	1946	8	3	--
For. Prod. Lab.	Oregon, Wis.	24 hrs. - full length	3.4 <sup>3/</sup>	9	3.7	1943	1946	4	0	--
For. Prod. Lab.	Oregon, Wis.	48 hrs. - full length	4.2 <sup>3/</sup>	9	3.7	1943	1946	3	0	--
For. Prod. Lab.	Oregon, Wis.	96 hrs. - full length	5.1 <sup>3/</sup>	9	3.8	1943	1946	1	0	--
For. Prod. Lab.	Oregon, Wis.	168 hrs. - full length	5.5 <sup>3/</sup>	8	3.5	1943	1946	2	0	--
U. of Minn.	Cloquet, Minn.	18 hrs.-butt, 6 hrs.-top	4.6 <sup>3/</sup>	30	3-5	1942	1946	-	0	--
U. of Minn.	Cloquet, Minn.	40 hrs.-butt, 8 hrs.-top	3.5 <sup>3/</sup>	30	3-5	1942	1946	-	0	--
U. of Minn.	St. Paul, Minn.	18 hrs.-butt, 6 hrs.-top	3.0 <sup>3/</sup>	20	3-5	1942	1946	-	4	--
U. of Minn.	St. Paul, Minn.	40 hrs.-butt, 6 hrs.-top	2.8 <sup>3/</sup>	20	3-5	1942	1946	-	2	--
U. of Minn.	Waseca, Minn.	18 hrs.-butt, 6 hrs.-top	2.9 <sup>3/</sup>	20	3-5	1942	1946	-	2	--
U. of Minn.	Waseca, Minn.	40 hrs.-butt, 6 hrs.-top	3.4 <sup>3/</sup>	20	3-5	1942	1946	-	0	--
U. of Minn.	Cloquet, Minn.	Untreated	None	30	3-5	1942	1946	-	30	2.8
U. of Minn.	St. Paul, Minn.	Untreated	None	20	3-5	1942	1947	9	11	3-4
U. of Minn.	Waseca, Minn.	Untreated	None	20	3-5	1942	1946	3	17	3-4
Lake States For. Exp. Sta.	La Crosse, Wis.	Untreated	None	15	4-7	1938	1941	15	15	2-3
<u>Hot-Cold Bath</u>										
For. Prod. Lab.	Madison, Wis.	Coal Tar Creosote (Full length treatment)	9.4	10	4-5	1936	1947	0	0	--
For. Prod. Lab.	Drummond, Wis.	Coal Tar Creosote (Full length treatment)	11.4	25	3-5	1936	1946	0	0	--
For. Prod. Lab.	Madison, Wis.	Zinc Chloride (Full length treatment)	1.32	64	4-8	1937	1945	63	0	--
<u>Pressure Treatment</u>										
For. Prod. Lab.	Madison, Wis.	Tetrachlorophenol	7.5 <sup>1/</sup>	10	5-7	1936	1947	6	0	--
For. Prod. Lab.	Drummond, Wis.	Tetrachlorophenol	8.2 <sup>1/</sup>	22	3-6	1936	1946	3	0	--
For. Prod. Lab.	Madison, Wis.	25% coal tar creosote and 75% gas oil	16.1	20	5-7	1916	1938	0	0	--

1/ Posts set with bark on.

2/ Posts peeled before setting.

3/ Absorption in pounds of a 5.0 solution of pentachlorophenol in fuel oil or kerosene.

4/ 2.9 percent solution of tetrachlorophenol in crank case oil.

Daesee (--) indicate that records were not taken or are not available.

Summary and Recommendations  
on  
The Preservative Treatment of Aspen

Because aspen possesses no natural durability, all aspen products used in contact with the soil decay rapidly, and such products as untreated aspen fence posts rarely last more than 3 to 4 years. When aspen is used for sills of buildings, bridge planking, and the lower logs of log cabins, where the products are not in contact with the soil but may become moist and remain moist for considerable periods, deterioration by decay may also develop rapidly.

Aspen products to be given preservative treatment with coal tar creosote or with oil solutions of pentachlorophenol and copper naphthenate must be cleanly peeled and free from inner bark. All aspen products to be given treatment with any of these oil solutions must be well air-seasoned. To avoid possible losses from decay during seasoning, aspen ties, fence posts, mine timbers, and planking should be openly piled to promote rapid drying. Aspen does not check as badly as the heavier hardwoods and can be more openly stacked without danger of serious checking.

Aspen planking, sawn ties, and sawn mine timbers can be readily treated with coal tar creosote by the Rueping and Lowry Empty-Cell pressure-treating processes. The same is true for ties that are incised, adzed and bored prior to treatment. Although there has been less experience with the treatment of these aspen products with other preservatives, it is logical to assume that similar results could be obtained with oil solutions of pentachlorophenol or copper naphthenate applied by the empty-cell processes, and with water-borne preservatives, such as zinc chloride, chromated zinc chloride, and various proprietary compounds, when applied by the full-cell pressure-treating process. In case of large round aspen products, such as fence posts and mine timbers, some difficulty has been encountered in obtaining uniform penetration by the pressure treating processes.

The limited experience reported on the treatment of aspen products by the hot-cold bath process indicates that fairly satisfactory treatment can be obtained in case of sawn products and small round fence posts, but that penetration may be spotty in critical areas of large round posts (over 5 inches in top diameter) and other large round aspen products. The published information indicates that only coal tar creosote and zinc chloride have been applied to aspen by this process, but it is logical to assume that suitable oil solutions of pentachlorophenol and copper naphthenate could be applied with similar results. Small aspen posts (3-4 inches in top diameter) do not benefit as much from top treatment as large posts (5 inches and over in top diameter), but some treatment to protect the tops from top rot is advisable. When given thorough treatment by pressure or the hot-cold bath process, aspen posts with 3-4 inch top diameters should be adequate for all fencing uses except corners, and the use of larger posts is not recommended.

A considerable number of seasoned aspen fence posts have been treated with oil solutions of pentachlorophenol by cold-soaking. The erratic and shallow penetration obtained with this process to date indicates that it cannot be satisfactorily used with this species unless some cheap and simple method of incising the ground line area can be found.

Green aspen fence posts and mine timbers have been treated with water-borne preservatives, such as zinc chloride, chromated zinc chloride, and several proprietary compounds, by the steeping, the tire-tube, the butt-soaking, and several diffusion processes. Although treatment with water-borne preservatives by all of these processes is not always uniform and the results in many cases have been disappointing, the average service life of aspen products can be increased sufficiently through such treatments to warrant the consideration of these processes for the treatment of posts by farmers and for the treatment of some types of mine timbers.

Increased service or resistance to decay can be achieved by brush-coating dry aspen lumber, fence posts, or other aspen products with several coats of coal tar creosote or with oil solutions of pentachlorophenol and copper naphthenate. Such treatment is suggested when aspen must be used for farm building items subject to decay and when no more thorough method of treatment can be employed. The treatment of aspen cabin logs with several brush coats of a clear oil-solution of pentachlorophenol keeps the logs from darkening to the same extent as untreated logs.

Most of the published service records on pressure- and hot-cold bath-treated aspen products are on fence posts treated with coal tar creosote. These records indicate that service lives of over 20 years or service similar to those obtained with other woods treated with the same preservative can be obtained for aspen given thorough treatment by these processes. On the basis of the results obtained on aspen posts treated with a crank-case oil solution of tetrachlorophenol, and the generally recognized superiority of pentachlorophenol over tetrachlorophenol, results similar to those obtained with coal tar creosote should be obtainable on aspen products treated with suitable oil solutions of pentachlorophenol by pressure or hot-cold bath treating processes.

The service records on aspen products treated with water-borne preservatives indicate that service lives of at least 10 years should be obtainable for well treated products. Although some decay may develop during this period because of leaching of the preservatives, the available service records indicate that service records of 10 or more years usually can be expected of products well treated with water-borne preservatives.



Problems Associated With the Preservative Treatment of  
Aspen that Need Study

Although practically every aspect of the preservative treatment of aspen needs study, the following problems particularly need attention:

1. The air seasoning of aspen ties, mine timbers, fence posts, and other aspen products. Can the serious losses from decay now frequently encountered when following stacking practices worked out for other species be reduced by more open stacking without incurring serious checking losses?
2. Reduction of end absorption in treatment by the hot-cold bath process. Can excessive absorption of creosote and other preservatives in the butts of aspen, where it does little good, be reduced by end coatings or other methods?
3. Size of aspen fence posts. What size aspen post is needed to provide adequate strength and over-turning resistance, provided the post receives an effective preservative treatment?
4. Spike holding properties of aspen ties. Is this an important factor when ties are incised, adzed, and bored prior to treatment and when new types and larger tie plates are used?
5. Cold-soaking in oil solutions of pentachlorophenol. Can anything be done to improve the ground-line penetration in seasoned aspen posts treated by this simple and relatively low cost process, which is so promising for many other species?
6. Creosote-petroleum mixtures. To what extent can coal tar creosote be diluted with the cheaper petroleum oils and still produce effective treatment by the pressure and hot-cold bath treating processes?
7. Service records on treated aspen products. The service records on aspen treated with water-borne preservatives are completely inadequate, and much additional material should be installed in service tests. The same is true for aspen treated with oil preservatives by the pressure and hot-cold bath treating processes.
8. Treatment by simple diffusion processes. Much work is needed on the simple diffusion-treating process described in this report. Other chemicals and combinations of chemicals should be tested in addition to further tests on the chemicals already tried.
9. Butt-soaking treatment. Chemical analyses are needed on aspen posts treated by this process to determine how uniformly preservatives are distributed. Also, tests should be made on aspen posts cut from various sites at different times of the year to establish the variability that may be encountered.

10. The effect on strength of high concentrations of water-borne preservatives. Added tests are needed to determine whether the high concentrations of chromated zinc chloride in the butt-soaking process seriously affect strength.

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