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PRESERVATIVE TREATMENT OF WOOD FOR FARM USE[1]

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Introduction

Wood has always been a highly useful material to the farmer. In the early days the forests had to be partially cleared to make room for his crops. Wood was the only readily available material to which he could turn for his shelter, his fuel, and his tools. While other materials are now available to the farmer, wood continues to have an important part in agriculture because of its favorable cost, strength, weight, beauty, working characteristics, insulation value, and availability.

With all the favorable properties that contribute to its wide use in farming, wood nevertheless needs to be used intelligently, and protected from certain natural enemies. For example, while some species of wood are naturally

[1] This is a revision of Forest Products Laboratory Report 2098, of the same title, written in 1957 and presented at the annual meeting of the American Society of Agriculture Engineers December 16, 1957, Chicago, Ill.

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resistant to attack by decay fungi and harmful insects, most species lack adequate resistance when exposed to attack, This is not serious when wood can be kept dry and away from contact with the ground. However, for such farm uses as fencing, poles, bridges, culverts, irrigation structures, silos, storage sheds, barns, and some types of vehicles, wood must be used in contact with moisture; it is thereby subject to decay and, in some areas, to termite attack. Fortunately, this can be corrected by preservative treatment.

The railroads, through preservative treatment, have demonstrated that the average life of a tie can be increased from about 5 years to more than 30 years. On the farm it has been shown that an untreated fence post that would normally last about 3 years can have its life increased to 35 years or more. When effectively treated, wood can therefore be considered on the same basis as other so-called permanent materials.

There are a wide variety of wood preservatives and several methods by which preservatives can be applied. Some of these preservatives and methods are more effective than others.

Wood Preservatives

Wood preservatives are of two general types; (1) Oils, such as creosote, creosote solutions and pentachlorophenol, and copper naphthenate in oil carriers; and (2) waterborne salts applied as water solutions.

Preservative oils are used for both commercial and on-the-job treatments. They generally have high resistance to leaching and are therefore suitable for outdoor exposures. They do not cause the wood to swell, but the wood may shrink if it loses moisture during the treating process. Creosote and solutions with the heavier, less volatile petroleum oils often help protect the wood from weathering but may adversely influence its cleanliness, odor, color, paintability, and combustibility. Preservative oils sometimes travel from treated studs or subflooring along nails, and discolor the adjacent plaster or finish flooring. Odors from creosote and petroleum oils in treatedwood are quickly absorbed by foods such as meats, fats, and apples. Creosote vapors and those of some petroleum oils are harmful to growing plants.

Water-retardant properties can be provided for wood by using preservative oils to which water-repellent components are added. Such materials retard moisture changes in wood and thereby help to reduce swelling and shrinking. They do not prevent these changes, however, when the wood is exposed to moisture for prolonged periods.

Coal-tar creosote that meets the requirements of Federal Specification TT-W-556b and American Wood Preservers Standard P 1 is generally available in small or large quantities. Pentachlorophenol, in ready-to-use 5 percent solutions and in concentrated solutions that can be diluted with petroleum oil, is also available in gallon, drum, or tank-car lots.

Where water repellency is desired, Federal Specification TT-W-572 includes water-repellent preservatives with either 5 percent pentachlorophenol (Composition A), or 2 percent copper as copper naphthenate (Composition B). The National Woodwork Manufacturers' Association also has a standard on a water-repellent preservative for millwork. These water-repellent preservatives are sold in gallon, drum, and larger lots under a wide variety of trade names, but the name and concentration of the preservative are given on the label of the container.

For most farm uses the recommended retentions of preservative oils vary from 6 to 10 pounds per cubic foot.[2]

Standard wood preservatives used in water solution include chromated zinc chloride, copperized chromated zinc chloride, Tanalith (Wolman salts), acid copper chromate (Celcure), ammoniacal copper arsenite (Chemonite), chromated zinc arsenate (Boliden salt), chromated copper arsenate (Greensalt or Erdalith), and Osmosar (Osmosalts). Recommended retentions of these chemicals vary from 0.3 pound to 1.00 pound per cubic foot for wood used on farms.[2] These preservatives are employed principally in the commercial treatment of wood for uses where it will not be in contact with the ground or water, and where the treated wood requires painting. As a general rule, they are less resistant to leaching than the preservative oils and do not perform so satisfactorily under conditions favorable to leaching. The leaching resistance of some of these preservatives has been developed to the extent that good performance can be expected in ground contact or in other wet installations. On the other hand, waterborne preservatives are generally preferable to creosote for indoor use and can give indefinitely long life where they are not subject to leaching.

Waterborne preservatives leave the wood surface comparatively clean, paintable, and free from objectionable odor. Since water is added during treatment, the wood must be dried, after treatment, to the moisture content required for use.

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[2] American Wood-Preservers' Association. Manual of recommended practice. Standard C 16-64, Wood used on farms: Preservative treatment by pressure processes.

Zinc chloride and chromated zinc chloride are frequently used as fire retardants for wood but at retentions higher than those used only for wood-preserving purposes.

The composition and other requirements for waterborne preservatives are contained in federal specifications and most of these preservatives are included also in AWPA Standard P5.

Treatment Processes

Wood-preserving methods are of two general types: (1) Pressure processes, in which the wood is impregnated in closed vessels under pressures considerably above atmospheric pressure; and (2) nonpressure processes, which vary widely as to procedures and equipment used. Pressure processes generally provide a closer control over preservative retentions and penetrations, and to this extent they usually provide greater protection than nonpressure processes. Some of the nonpressure methods, however, are better than others and are occasionally as effective as pressure processes in providing good preservative retentions and penetrations. The Wood Handbook[3] describes various pressure and nonpressure processes.

Requirements for Effective Wood Preservation

To obtain good and effective wood preservation, the user must observe several well-recognized principles as follows:

(1) Make a careful selection of the wood species and form to obtain the best possible treatment.

(2) Select the preservative best suited to use requirements.

(3) Have the wood properly conditioned and machined.

(4) Select the process of treatment best suited to use requirements.

(5) Purchase the preservative and treatment under a recognized specification.

(6) Obtain good inspection and quality control.

(7) Be certain of proper care and handling of material after treatment.

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[3] U.S. Forest Products Laboratory. Wood handbook. U.S. Department of Agriculture, Agriculture Handbook 72, 1955.

Selection of Species

For maximum protection with any wood preservative, good penetration of the wood is important. The sapwood of most species is more easily penetrated with preservatives than is the heartwood. Consequently, with other things equal, round timbers with considerable sapwood will be better penetrated than those with less sapwood; they will also be penetrated better than sawed timbers consisting mostly of heartwood. Southern pines usually have a high percentage of sapwood even in sawed lumber and timbers. Douglas-fir lumber, on the other hand, is likely to be mostly heartwood.

Fortunately, a procedure known as "incising" can be used to improve the preservative penetration in the heartwood of Coast-type Douglas-fir. Incising will also improve this penetration in the heartwood of species such as western hemlock, redwood, and several of the hardwoods. The Forest Products Laboratory has treated a wide variety of wood species and can often furnish some indication of the ease or difficulty with which different woods take treatment.

The preservative does not kill or inhibit the growth of decay fungi and harmful insects unless it is actually present in the wood that is subject to attack. Some persons assume that when wood is sterilized during treatment it will be adequately protected by a continuous, although thin, surface coating of the preservative. Investigators in Germany, however, found that fungi penetrated a coating of creosote. Termites have been known to nibble on the treated surface of superficially penetrated wood, pierce it, and damage the unpenetrated wood beneath. Checks, mechanical injury to the wood, and cutting after treatment are also likely to expose unpenetrated wood to attack by fungi and insects, particularly if the piece was not deeply penetrated by preservative initially.

Selection of Preservative

All preservatives are not equal in their wood-preserving properties, even though they may be recognized on an equal basis in treating specifications. Results of service tests and of experiments in field and laboratory show which preservatives perform best under the particular conditions used in the test. The Forest Products Laboratory for many years has conducted laboratory and field tests to determine the effectiveness of various wood preservatives and--of special interest to farmers--has published service records on posts of 91 species of wood treated by 12 processes with 73 wood preservatives.[4]

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[4] Blew, J. O. Jr., and Kulp, John W. Service records on treated and untreated fence posts. U.S. Forest Service Research Note FPL-068, 1964. Forest Products Laboratory, Madison, Wis.

Service tests on treated products, such as crossties, poles, and piling, are published from year to year in the Proceedings of the American Wood-Preservers' Association andby several railroad, telephone, and power companies. Results of these tests on crossties should indicate the service that might be expected from farm timbers when used in contact with the ground under similar climatic conditions. In the same way, results of tests on poles and posts should furnish some indication of the performance to be expected of round timbers of similar species and similarly treated when used in pole-type buildings. Treated wood used away from ground contact should generally perform somewhat better than posts and poles, although it may be more likely to check.

Stake tests[5] furnish another good indication of the performance to be expected from treated wood in contact with the ground, when results of actual service tests are not available. Laboratory accelerated tests on small blocks are useful for showing up differences in preservative effectiveness, but they cannot yet be accepted as a substitute for service and field tests that more closely simulate actual service conditions.

Conditioning and Machining Wood Before Treatment

Most wood-preserving companies are interested in doing their job in a way that will assure maximum service to their customers. These companies will not attempt to treat wood unless it has been seasoned sufficiently to take treatment satisfactorily. They will also strongly urge the user to have all machining done on the wood prior to treatment, since they recognize that cutting or drilling of the wood after it has been treated will expose unpenetrated wood to attack by decay fungi and insects. They know, furthermore, that brushing a preservative on a cut surface is a makeshift and a poor substitute for wood with the treated portions intact and uncut.

The treating companies are usually equipped to air season, kiln dry, or vapor dry wood of different species, to Boultonize (boil under a vacuum) green Douglas-fir, and to steam condition southern pine that is not adequately seasoned for treatment. Treatment tests[6] at the Forest Products Laboratory showed that, when green, Boultonized Douglas-fir and steam-conditioned pine were pressure treated with such preservative oils as creosote and pentachlorophenol solution,

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[5] Blew, J. O. Jr. Comparison of wood preservatives in stake tests. U.S. Forest Service Research Note FPL-02, 1964. Forest Products Laboratory, Madison, Wis.

[6] Blew, J. O. Jr. Study of the preservative treatment of 'lumber. Forest Products Laboratory Rpt. 2043, 1955. Reviewed and reaffirmed 1960.

results compared favorably with those obtained with air-dry material. In the case of southern yellow pine treated with a waterborne preservative such as chromated zinc chloride, better results were noted when the material had been air seasoned. In this lumber-treating investigation, incising prior to treatment resulted in much more uniform penetration of Douglas-fir lumber, and this procedure is recommended for other species that resist penetration.

Selection of the Treating Process

Good penetration of a wood preservative is important. When the wood is of a species readily penetrated, the method by which the preservative is applied will determine whether the penetration is to be deep or shallow. In the above-mentioned investigation,[6] matched unseasoned and seasoned lumber of Douglas-fir and shortleaf pine were treated by pressure and by several nonpressure processes. In the seasoned sapwood of the shortleaf pine, good preservative penetrations were obtained with the more effective nonpressure processes. However, the penetrations resulting from pressure treatment were deeper than those from the nonpressure applications in the heartwood of the same seasoned material, in the sapwood and heartwood of unseasoned pine, and in the heartwood of seasoned and unseasoned Douglas-fir. In general, therefore, and unless the wood can be properly conditioned and carefully selected for sapwood, which is easy to penetrate, pressure treatment gives better assurance of good penetration and good service. This is shown in the service records on posts referred to earlier.[4]

There are often instances where pressure treatment may not be the most practical process to use. On-the-job applications of preservatives are sometimes desirable on the farm.[7] Even the brush and dip applications, which are the least effective, provide some protection to wood, and it may be advantageous to use them when more effective methods cannot be used. Such superficial treatments have recognized value for sash and similar millwork, which is generally not exposed to a high decay hazard. The open-tank or hot-and-cold-bathprocess has had long and successful use for western redcedar poles, but the poles must be incised at the critical groundline zone to assure adequate penetration of the preservative.

Posts and poles of lodgepole pine have also given long service when carefully treated by the hot-and-cold-bathprocess. Treatment of round unseasoned wood members, a process developed by the Forest Products Laboratory and known as

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[7] Blew, J. O. Jr., and Champion, F. J. Preservative treatment of fence posts and farm timbers. U.S. Department of Agriculture Farmers' Bulletin 2049. Revised 1956.

"double diffusion,'' has been shown to provide good protection to southern pine posts,[4] There are no shortcuts or miracles in wood preservation, however, and the user can expect to gain protection commensurate with the effort, expense, and thoroughness involved in making the treatment.

Purchased and Inspection of Preservative Treatment

Users of large quantities of treated wood issue their own specifications for proper selection and conditioning of wood before it is treated, as well as for penetrations and retentions of preservative. However, the user of small quantities can neither develop his own treating specifications nor inspect the treatment of the wood he purchases. To avoid inferior products, therefore, it is advisable for the small user to purchase his treated posts, poles, or lumber from an established and reputable dealer and to obtain assurance from the dealer that the wood is selected and treated in accordance with recognized standards, such as Federal Specification TT-W-571, which covers treating practices. The American Wood-Preservers' Association has prepared a standard for pressure-treated wood for use on farms[2] and approved standards covering preservatives, treatments, and inspection procedures.

Inspection is necessary to determine whether the preservative treatment conforms to specification requirements. In cases involving premature deterioration of treated wood, failure to meet specification requirements is most commonly the reason. Careful and competent inspection of the material at the time of treatment could have resulted in rejection or retreatment of such material. For those who are not in a position to inspect the treatment of wood, commercial inspection agencies perform this service. Some users, however, prefer to obtain a certificate from the treater indicating that the requirements of the specification have been met. Reputable treating companies are willing to furnish that certification to dealers who purchase treated products for resale to farmers. It is the general practice to brand or identify poles with the name of the treating company and with symbols indicating the species, size, and class of the pole, the preservative used, and the date of treatment. Some companies also brand posts and lumber. Many users encourage this practice by requesting treated products on which the name of the treating company has been branded.

Proper Care and Handling of Material After Treatment

The user of treated wood should realize that complete penetration of the wood with preservative is generally the exception rather than the rule. The internal,

unpenetrated zone is therefore subject to attack by decay fungi and insects if the treated protective shell is broken. It is important that all possible care be taken, in handling the treated wood, to avoid breaking this treated shell. The use of picks and other sharp-pointed tools should be avoided in handling the material. Dropping the material from cars during unloading or other rough handling is harmful. Treated material that is stored in uncovered piles exposed to the weather is subject to checking, which may expose unpenetrated wood. The objectionable results of cutting into the wood after treatment have been referred to.

In farm structures, treated items that are horizontally exposed frequently show deep checking after several years of service. Filling these checks with mastic-type materials may be more harmful than beneficial, since such materials often shrink and pull away from the checks and seldom maintain a tight seal. A filler thus shrunken not only permits water to enter but retards its evaporation, thereby creating a decay hazard rather than preventing it. The periodic flushing of the checks with an oil-type preservative, on the other hand, protects the exposed untreated wood.

Farm Uses for Treated Wood

Uses for treated wood on the farm vary widely, ranging from posts and poles to buildings or truck bodies. Some require the wood to be used in contact with the ground or water; others do not.

Posts and Poles

Wood fence posts are one. of the most widely used treated items found on farms. Pole-type barns and other farm buildings, however, are popular because of their low cost, ease of construction, and demonstrated resistance to hurricane and flood. Treated wood poles are therefore becoming an important farm item.

Fence posts are sometimes treated on the farm[7] but are more commonly treated under such recognized specifications as AWPA Standard C5 and Federal Specification TT-W-571, which recommend such preservatives as coal-tar creosote, creosote-coal tar solution, creosote-petroleum solution, and a solution of 5 percent of pentachlorophenol in a specified petroleum solvent. The recommended minimum retention for these preservatives is 6 pounds per cubic foot (or 0.3 pound of pentachlorophenol) with the exception of creosote-petroleum solution, for which the recommended minimum retention is 7 pounds per cubic foot. For fence posts that will be painted, these specifications recommend the standard waterborne preservatives, which leave wood paintable.

Poles for buildings are higher in initial cost, are more costly to replace, and generally should be expected to give longer service than fence posts. It is therefore recommended that they be treated under specifications for telephone and power line poles. Service records on simple on-the-job methods generally indicate that they will not provide sufficient protection to poles for use in pole-type structures that are expected to last 25 years or longer. Federal Specification TT-W-571 and AWPA Standards C4 and C8 for poles recommend preservative oils, coal-tar creosote, or 5 percent of pentachlorophenol in a specified petroleum oil. This federal specification and AWPA Standard C4, for pressure treatment require a minimum retention of 8 pounds per cubic foot and higher retentions for severe service conditions or where climatic conditions are particularly favorable to decay and termite attack. AWPA Standard C8 for the nonpressure treatment of western redcedar poles requires that the poles be incised and prescribes definite requirements for the retention and penetration of preservative.

Lumber and Timbers for Ground or Water Contact

In addition to poles and posts, wood is used in numerous farm structures that are partially in contact with the ground or water for prolonged periods. Examples are arbors, barn sills, bridges, cattle guards, culverts, irrigation structures, root cellars, silos, splash boards, troughs, and water tanks. In general such preservative oils as coal-tar creosote or pentachlorophenol solution are best suited for these uses, although for root cellars and other food storage structures the waterborne preservatives are safer. Federal Specification TT-W-571g in note 6.1.3 refers to preferred waterborne preservatives for ground and fresh water contact where cleanliness, paintability, and freedom from odor are important requirements. AWPA Standard C2 for lumber recommends a minimum retention of 8 pounds of a preservative oil per cubic foot, and Federal Specification TT-W-571 recommends a minimum of 10 pounds per cubic foot for such uses. The experience with creosoted silos and tests with pentachlorophenol have shown that these preservatives, in the quantities used to treat wood, are not harmful to cattle. Recommended minimum retentions for waterborne preservatives will be noted below.

Wood Uses Not In Contact With Ground or Water

In items such as fence rails and pickets, fruit storage houses, grain storage bins, manure spreaders, outdoor tables, truck bodies, milk houses, and sills

and lower joists in buildings, the wood is generally exposed to a limited decay and termite hazard. The use of preservative oils may be objectionable because of their odor and because they are difficult to paint over. Waterborne preservatives can be used to treat these items, although at times there may be advantages in using one of the specially prepared pentachlorophenol solutions with a water repellent. In such cases the wood may be pressure treated; or, with easily penetrated wood such as dry sapwood of pine, some of the non-pressure applications (such as the vacuum process and methods involving the heating-and-cold-bath principle) should provide good protection. When wood is treated with pentachlorophenol solutions, the faster evaporating solvents should be used; even so, considerable time or special conditioning is required after treatment to obtain a paintable or dry surface.

The pressure treatment of lumber with waterborne preservatives is covered by Federal Specification TT-W-571 and AWPA Standard C2. The former includes the following waterborne preservatives and recommended minimum retentions:

Preservative	Retention[8] (Lb. per cu. ft.)
1. Acid copper chromate (Celcure)	0.50-1.00
2. Ammoniacal copper arsenite (Chemonite)	.30- .50
3. Chromated copper arsenate (Greensalt or Erdalith)	.35- .75
4. Chromated zinc arsenate (Boliden salt)	.50-1.00
5. Chromated zinc chloride (CZC)	.75-1.00
6. Copperized chromated zinc chloride	.75-1.00
7. Osmosar (Osmosalts)	.35- .50
8. Tanalith (Wolman salts)	.35- .50

Federal Specification TT-W-571 also provides for pressure treatment of lumber with a water-repellent pentachlorophenol preservative and calls for minimum retention of 6 pounds per cubic foot. Industry specifications, such as that of the Vacuum Preservers' Institute, cover the treatment of lumber by the vacuum process. The treatment of window sash and millwork by dipping or vacuum is covered by U.S. Commercial Standard CS 262-63.

[8] The higher retentions are recommended for posts or for lumber that may be required for uses that involve moderate leaching.

Conclusion

The experience of the farmer with fence posts has shown that the life of untreated wood may be increased from 5 to 10 times through effective wood preservation. To obtain effective wood preservation requires careful selection and preparation of the wood, care in the choice of the preservative and method of application, purchase and inspection under recognized specifications, and careful handling of the material after it has been treated. With effective treatment it should be possible for the farmer to reduce replacements on other wood structures and thus obtain better service from this material, which has such an important part in his operations.