WOOD PRESERVATIVES

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WOOD PRESERVATIVES

Requirements

Wood preservatives are chemicals that, when injected into wood, make it unpalatable or uninhabitable to wood-destroying organisms. For protection against decay, marine borers, and most insects, preservatives must be poisonous or toxic. Protection against powder-post beetles can be accomplished by any film that covers the surface of the wood so that the insects cannot deposit their eggs in the pores. There may also be some chemicals that are repellent to insects rather than poisonous. For general use, however, a preservative must have high toxicity. It must also be chemically stable and permanent so that it will remain in the wood for many years, have good penetrating properties, be safe to handle, harmless to wood and metal, readily available, and reasonably cheap. Additional requirements for special uses may include cleanness, paintability, freedom from odor or color, fire resistance, moisture repellence, freedom from swelling, or various combinations of these properties.

A number of these properties can be tested in the laboratory and within a period of 3 to 6 months it can be determined whether the material being tested is sufficiently toxic and sufficiently promising in other respects to receive favorable consideration. There is no acceptable laboratory test of permanence, however, and so far as all around effectiveness is concerned no substitute for long-time exposure tests under actual use conditions. It is necessary, therefore, to continue observations on a new preservative for many years before its effectiveness can be evaluated with confidence or compared with that of older materials. This fact is seldom recognized by the promoters of new preservatives.

There are many materials that are capable of extending the life of wood. Naturally some are more effective than others;[1] all possess certain disadvantages that limit their use, as well as advantages that make them especially suitable for specific purposes. With few if any exceptions, these preservatives fall into three general classes: the toxic oils, like creosote, which are relatively insoluble in water and of low volatility; the salts that are injected into wood in the form of water solutions; and preservatives that consist of a small percentage (usually about 5 percent) of a highly toxic chemical in a solvent or mixture of solvents other than water.

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[1] The effectiveness of preservative treatment, of course, depends on the amount of preservative absorbed and the depth of penetration, as well as on the preservative used, and the importance of this fact must not be overlooked.

Coal-Tar Creosote

Coal-tar creosote is a black or brownish oil made by distilling coal tar. The first fractions collected in tar distillation are the light oils, the residue is pitch, and in between is the portion that is saved for wood-preserving purposes. The character of the tar used, the method of distillation, and the temperature range in which the creosote fraction is collected all influence the character of the creosote oil. The character of the various coal-tar creosotes available, therefore, may vary to a considerable extent. Small differences in character, however, do not prevent creosotes from giving good service, and satisfactory results in preventing decay may be expected from any coal-tar creosote that complies with or closely approaches the requirements of standard specifications.

Coal-tar creosote is the most important and most generally useful wood preservative. Its advantages are (1) its high toxicity, which makes it extremely poisonous to wood-destroying organisms, (2) its relative insolubility in water and its low volatility, which impart to it a great degree of permanence under the most varied use conditions, (3) its ease of application, (4) the ease with which its depth of penetration can be determined, and (5) its general availability and relatively low cost (when purchased in wholesale quantities).

Although for general outdoor service in structural timbers there is, as yet, no better preservative than coal-tar creosote, for some special purposes it has certain properties that are a disadvantage. Without question, freshly creosoted timber can be ignited easily and will burn readily, producing a dense smoke. After the timber has seasoned some months, however, the more volatile parts of the oil disappear from near the surface and the creosoted wood usually is but little, if any, easier to ignite than untreated wood. On the other hand, after untreated wood has started to decay, often within a few years, it is easier to ignite than timber that has been kept sound by creosote treatment. The extent to which creosoted wood should be regarded as a fire hazard has never been satisfactorily determined. The only recommendation that can be made in this respect is that some preservative other than creosote should be used in places where fire hazard is considered of utmost importance, unless the treated wood is covered with a fireproof coating of some kind, or other protection is provided.

The odor of creosoted wood is unpleasant to some persons and may be considered objectionable in dwellings. Foodstuffs that are sensitive to odors should not be stored near creosoted wood. Workmen sometimes object to the use of creosoted wood because it soils their clothes and because it burns the skin of the face and hands of some individuals, causing an injury similar to sunburn. There need be no fear, however, that creosoted timber has a serious effect on the health of workmen handling or working near it, or on the health of the occupants of buildings in which creosote-treated material has been used.

Creosoted wood can very often be used in sills and foundation timbers, floor sleepers embedded in or resting on concrete, and even subflooring, with little danger of the odor becoming objectionable.

The color of creosote and the fact that it usually cannot be painted over satisfactorily make it unsuitable for finish lumber or other material where appearance and paint receptivity are of major importance.

Creosote Specifications

A number of specifications prepared by different organizations are available for creosote oils of different kinds. Although the oil obtained under most of these specifications will probably be sufficiently effective in preventing decay, the rules of some organizations are unnecessarily difficult to meet and others are unnecessarily loose. Specification TT-W-556a for coal-tar creosote, adopted in 1941 for use by the United States Government, will generally prove satisfactory and under normal conditions, can be met without difficulty by most creosote producers. Since the entry of the United States into the war, however, a shortage of coal-tar creosote has developed and it is much more difficult now to obtain creosote with a low distillation residue above 355° C. The Government, therefore, has changed this specification for the duration of the war as indicated on page 4. The requirements of this specification are the same as those of the American Wood-Preservers' Association for Grade 1 coal-tar creosote, with the exception that the Government specification places a minimum limit on the amount of distillate up to 355° C., while the AWPA specification does not. The requirements of specification TT-W-556a are as follows:

Coal-tar creosote shall have the following properties:[2]

The creosote shall be a distillate of coal-gas tar or coke-oven tar[3] and shall comply with the following requirements: (Footnote 3 and table on page 4.)

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[2] Creosote conforming to the current issue of Specification 4 of the American Wood-Preservers' Association and that has a distillate up to 355° C. of not less than the limits stated in Section E-1a, based on water-free oil, will meet these requirements.

	Method of analysis, AWPA Standard No.	For pressure treatment of poles or for mixing with petroleum		For treating ties, lumber, piles, posts, and miscellaneous structural timber or for butt treating poles	
		Not more than	Not less than	Not more than	Not less than
Water, percent by volume	(10d)	3		3	
Material insoluble in benzol, percent by weight[4]	(8b)	0.5		0.5	
Coke residue, percent by weight	(7d)	2		2	
Specific gravity at 38° C. compared with water at 15.5° C.	(18c)		1.03		1.03
Distillate shall be within the following limits (percent by weight, water-free basis)	(11e)				
Up to 210° C.		5		5	
Up to 235° C.		25		25	
Up to 355° C.[5]			75*		65

**65 during the war

[3] Owing to the complexity of the chemical composition and physical properties of coal-tar creosote, and to the fact that some of the same compounds and properties which characterize coal-tar creosote are found in certain petroleum derivatives, the determination of the purity of creosote is difficult. When there is not certain assurance that the oil is a pure product, the following tests will aid in arriving at an opinion as to its coal-tar origin:

A. Fraction distilling between 210° and 235° C. is usually solid or contains some solids when cooled to 25° C.

B. All of the fractions up to 315° C. contain tar acid in varying amounts, usually at least 1 percent, calculated on the amount of the fraction tested (26b).

C. The specific gravity of the fraction between 235° and 315° C. is usually not lower than 1.025 and specific gravity of the fraction between 315° and 355° is usually not lower than 1.085 at 38° C. compared with water at 15.5° C. However, some pure coal-tar distillates fall slightly below these limits.

If the sample does not comply with at least one of the foregoing tests, it is undoubtedly not a pure coal-tar creosote.

(Footnotes 4 and 5 on page 5)

A list of producers and dealers in coal-tar creosote can be obtained, upon request, from the Forest Products Laboratory, Madison, Wis.

OTHER WOOD-PRESERVING OILS

Crystal-Free Coal-Tar Creosote

This term applies to a coal-tar creosote from which some of the crystal forming materials have been removed so that the oil will flow freely at ordinary temperatures and will not deposit crystals in its container. These oils are more convenient to handle than ordinary creosotes, but their general properties and effectiveness are similar. AWPA and Federal specifications are available.

Carbolineums

Carbolineums (anthracene oils) are coal-tar distillates of higher specific gravity and higher boiling range than ordinary coal-tar creosotes, but their general properties and preservative effectiveness are similar to those of coal-tar creosote. They are usually sold under proprietary or trade names. AWPA and Federal specifications are available for anthracene oils.

Water-Gas-Tar Creosote

Water-gas-tar creosote is made from water-gas tar in much the same way that coal-tar creosote is made from coal tar. Water-gas tar is the tarry residue remaining from the use of petroleum oils in the manufacture of water gas. It is therefore a petroleum product and not a coal product, and the composition of both the water-gas tar and its creosote are somewhat different from the respective coal products. Although water-gas-tar creosote is not considered so toxic or so generally effective as

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[4] Samples of creosote taken from working tanks may show an increase in matter insoluble in benzol due to treating operations. Such increase is permissible if it does not exceed the specification limit by 1 percent, and if it can be shown that the original fresh creosote was of specified quality.

[5] Samples of creosote taken from working tanks may show a decrease in distillate up to 355° C., due to treating operations. Such decrease is permissible if the minimum does not fall below the specification limit by 2 percent and if it can be shown that the original fresh creosote was of specified quality.

coal-tar creosote, it is known to be a good preservative; wood that has been deeply penetrated with it will have satisfactory resistance to decay. Aside from lower toxicity, the advantages and disadvantages of water-gas-tar creosote are generally similar to those of the coal-tar product.

Wood-Tar Creosote

Wood-tar creosotes are made by distilling wood tar. Just how they compare in effectiveness with coal-tar creosote has not been established, but it is certain that when of good quality and properly injected they are highly effective. Wood-tar creosotes are not extensively used for the commercial preservation of wood because they have not been produced in sufficiently large quantities of satisfactory and uniform quality and price to attract the attention of large consumers.

Tar

Coal tars have seldom been used alone (except occasionally in treating railway ties) for preserving wood, because obtaining good penetration with them is usually difficult and because they are less poisonous to wood-destroying fungi than the creosotes. Service tests have demonstrated that surface coatings of tar are of little value, but, when good absorptions and deep penetrations are obtained, it is reasonable to expect a satisfactory degree of effectiveness from treatment with coal tar.

Water-gas tar has been used less extensively than coal tar but, in certain cases where fence posts have been thoroughly impregnated with it, the results have been excellent. Wood tar also probably has value but little information is available about it.

Creosote-Coal-Tar Solutions

Creosote-coal-tar solutions are very commonly used in the treatment of railway ties in the eastern part of the United States. The addition of the tar, sometimes in proportions as high as 50 percent, not only reduces the cost of the preservative, but it also decreases the tendency of the treated wood to check in service. The tar used should be of relatively low viscosity and free from water and suspended solids. Wood that is thoroughly impregnated with a good creosote-tar solution will probably last about as long as wood similarly treated with straight coal-tar creosote. Tar solutions do not penetrate so readily as creosote, they leave the wood dirtier to handle, and they are more likely than creosote to cause trouble by "bleeding" to the surface of the wood. AWPA and Federal specifications for creosote-coal-tar solutions are available.

Petroleum Oils

Crude petroleum, fuel oil, gas oil, and waste crank-case oil are frequently suggested as possible wood preservatives and many experiments have been made with them. Experience has demonstrated, however, that petroleum oils used alone are not to be relied upon. Occasionally good results have been obtained, but in many instances complete failure has resulted.

Creosote-Petroleum Solutions

Petroleum is often added to coal-tar creosote, in proportions of 40 to 60 percent, but the more commonly used mixtures have from 45 to 55 percent of petroleum. Creosote-petroleum solutions are very extensively used for the treatment of ties, lumber, and timber in the western and middlewestern parts of the country. The petroleum must be selected with care, to avoid the precipitation of sludge that occurs upon the addition of some petroleums to creosote. The creosote-petroleum solution is less toxic and penetrates less readily than straight creosote, but long experience has shown that wood, well impregnated with creosote-petroleum solution, has similar decay resistance to that of wood treated with straight creosote. A Federal specification for creosote-petroleum solution is available.

Zinc Chloride

Zinc chloride is the water-soluble wood preservative that was for many years most extensively used in the United States. It has been displaced to a considerable extent in recent years by chromated zinc chloride and certain proprietary salt preservatives which have found extensive use. The principal advantages of zinc chloride are relative cheapness, general availability, uniformity of quality, cleanliness, lack of odor, ease of shipment, and lack of fire hazard. Its chief disadvantage is its tendency to leach out of wood that is in contact with water or soil. The water that is injected with the zinc chloride temporarily adds considerably to the weight of the wood and, in order to avoid shrinkage troubles, must be dried out before the wood is used in buildings.

When injected into wood in the usual quantity (about 1/2 to 1 pound of dry salt per cubic foot) zinc chloride has a slight effect in reducing inflammability. In quantities of several pounds of zinc chloride per cubic foot of wood the inflammability of the wood is reduced markedly, but such high absorptions would be likely to damage the wood and are not used where the maintenance of maximum strength is necessary.

Zinc chloride treated wood, properly dried after treatment, finds use in the construction of buildings, especially in the roof planking of factory buildings where high relative humidity favors the rapid decay of

the roofs. The facts that the net weight of the wood (after seasoning) is not greatly increased by the treatment and that the treated wood is clean and paintable favor its use in such places.

Zinc chloride is shipped either in the solid form (fused or granulated) or in concentrated solutions. When the freight haul is not too great, the concentrated solution, usually about 50 percent strength, is shipped in drums or tank cars. For long freight hauls, the salt is shipped in solid form in air-tight drums. The air-tight containers are necessary because solid zinc chloride attracts moisture from the air. For use in treating wood, water solutions of 3 to 5 percent strength are prepared from the concentrated material.[6]

Following is the zinc chloride specification of the AWPA:

"The zinc chloride shall be acid free and shall not contain more than 0.1 percent iron. Fused or solid zinc chloride shall contain at least 94 percent chloride of zinc. Concentrated zinc chloride solution shall contain at least 50 percent chloride of zinc."

Chromated Zinc Chloride

Chromated zinc chloride contains approximately 18-1/2 percent sodium dichromate and the remainder is zinc chloride conforming to AWPA specifications. This preservative is extensively employed in place of zinc chloride. Reports of laboratory and field tests indicate that chromated zinc chloride may be superior to zinc chloride, but it has not been in use long enough to have established by actual service records how it compares in effectiveness with zinc chloride and other preservatives. A Federal specification for chromated zinc chloride is available.

Sodium Fluoride

Sodium fluoride (in mixture with other materials) has been used to a considerable extent in Europe for preserving wood, especially mine timbers. In the United States it has been used alone experimentally in railway ties and in mine ties and timbers and has also been used to some extent commercially in the treatment of factory roof timbers. The evidence thus far available indicates that it is a good wood preservative. It is not so soluble as zinc chloride, since the maximum strength of solution is about 4 percent. The chief disadvantage of sodium fluoride is its price, which in recent years has been roughly 1-1/2 times that of zinc chloride, without any compensating advantage over zinc chloride. Sodium fluoride is an important ingredient in several proprietary or patented preservatives, some of which are finding considerable use in the treatment of building lumber and structural timber.

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[6] A list of dealers in zinc chloride may be obtained from the Forest Products Laboratory free upon request.

Arsenic

Arsenic in various forms, either alone or mixed with other substances, has been used as a wood preservative for a number of years, and considerable numbers of poles, ties, and other material treated with it are now in service. It is still too early to tell how effective the various forms and combinations of arsenic will be, but some of them have given very promising results thus far.

Copper Sulphate

Copper sulphate, which has been used in Europe as a wood preservative for many years, is known to be effective in retarding decay. It is probably no more effective than zinc chloride or sodium fluoride, however, and has no important advantages over them. The chief disadvantage of this preservative is the fact that it attacks iron and steel and therefore cannot be used in ordinary treating equipment. It has never been used extensively in the United States for preserving wood.

Mercuric Chloride

Mercuric chloride (corrosive sublimate) was first employed for preserving wood in 1705, and its use was patented in 1832. The first commercial treating plant in the United States, built in 1848, used this preservative and, at last report, was still doing so. The use of mercuric chloride in the United States, however, has not greatly increased in all this time. Undoubtedly it is very effective in prolonging the life of wood, but its relatively high price, its extremely poisonous character, and its corrosiveness to metal have operated against it. Although it is still used to an appreciable extent in Europe either alone or mixed with sodium fluoride, there is no indication that it will ever be used extensively in the United States.

Clean Non-Swelling Millwork Preservatives

A group of preservatives has been developed in recent years to meet the need for a treatment that will not swell the wood or require long drying and will leave the wood clean, paintable, and odorless. These preservatives are being used to a considerable extent for the treatment of window sash and frames, but they may also be used for the treatment of doors, flooring, furniture, millwork, and similar products. Ordinarily they are applied by immersion without heat.

Acceptable preservatives of this type contain not less than 5 percent by weight of a good toxic chemical. Pentachlorphenol, tetrachlorphenol, and 2-chlororthophenylphenol are now most commonly used for the purpose because of their cheapness and high toxicity. Beta naththol and alphanitronaphthalene are also employed to some extent and other toxicants will no doubt come into use. The remainder of the preservative, in some formulas, consists mainly of volatile solvents, such as solvent naphtha, in other formulas it is chiefly a petroleum oil of domestic fuel oil grade, and in others it may be a mixture of volatile and nonvolatile oils of various kinds.

These preservatives have good toxicity and are very promising for the treatment of window sash and other millwork, but they have not yet been in use long enough to show by actual experience how effective or dependable they are in different uses.

Pentachlorphenol Solutions for Structural Timbers

Five percent solutions of pentachlorphenol in petroleum solvents are finding increasing use in the treatment of lumber, timber, posts, poles, and other structural items. When a light colored petroleum oil is used there is but slight change in the color of the wood treated with it and little danger of subsequent dripping or bleeding of the preservative from the wood. Dark colored petroleum oils are cheaper and, for many uses, the dark color they give to the wood is of no disadvantage. In some cases, the dark color is advantageous in that it makes it easy to determine the depth of penetration by taking borings. With proper care, waste crank case oil can be used as the carrier for pentachlorphenol. Aromatic petroleum residues are said to be better solvents for pentachlorphenol than ordinary types of fuel oil.

The results obtained over a period of 7 to 9 years from fence posts pressure treated with tetrachlorphenol or pentachlorphenol solutions are very favorable although the data are not sufficiently comprehensive and the observation periods have not been long enough for complete evaluation. The treatment of material with these preservatives applied by cold-soaking or other nonpressure processes cannot be expected to provide results equal to those obtainable through pressure impregnation unless similar absorptions and penetrations are obtained.

Proprietary Preservatives

Many preservatives are sold under trade names of various kinds. Some of them are ordinary coal-tar creosote or coal-tar creosote that has been modified slightly by taking out some of the solid ingredients. Others, including the carbolineums, have had the lighter fractions removed, making them higher boiling than the ordinary run of creosotes. In the main, preservatives thus derived from coal-tar creosote are good preservatives and may be used with assurance. Whether it is economical to use them depends upon their convenience and their cost as compared with coal-tar creosote or zinc chloride.

Other proprietary preservatives contain wood-tar products or other oils. Their value is not so well established, but no doubt some of them have considerable merit.

In a third group are preservatives injected in water solutions. Whether or not these are good depends upon the material of which they are composed. A few, containing arsenic, sodium fluoride, copper, chromium, or zinc are giving promising results and are finding rather extensive use.[7] Before buying a preservative of this kind the purchaser should insist upon knowing its ingredients and their proportions; investing money in secret preservatives is usually unnecessary and generally unwise.

In a fourth group are various proprietary preservatives of the clean nonswelling type described on page 9. Some, whose composition is disclosed, are of promising character.

The literature advertising some of the proprietary preservatives not infrequently contains extravagant claims as to their properties and their effectiveness. Obviously such claims should be greatly discounted.

Paints and Varnishes

The paints, varnishes, enamels, and similar coatings commonly used for interior and exterior decoration do not effectively protect wood against decay, marine borers, and most insects and would not need mention here except for the fact that there is a rather common belief that they have value as preservatives. These materials, as a rule, are nontoxic. Furthermore, they are almost invariably applied to only the faces or the faces and edges of the boards to be protected, leaving the hidden parts uncoated. Decay fungi, termites, and other destroyers ordinarily attack the hidden surfaces first and are not deterred by any coatings applied to exposed surfaces. When conditions are favorable for their growth, fungi readily penetrate through ordinary paint films.

Water Repellents and "Waterproofers"

Coatings of linseed oil, tar, asphalt, and the great variety of other nontoxic materials that are commonly considered as waterproofers or water repellents merely retard moisture changes, but do not prevent them. Coatings of these materials have very little, if any, value for retarding decay. They are not sufficiently effective to keep the wood dry enough to prevent the growth of wood destroying fungi.

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[7] Brief mimeographed statements about some of the more prominent proprietary preservatives of this group can be obtained from the Forest Products Laboratory. Several of these preservatives are acceptable under Federal Specification TT-W-571b covering the pressure impregnation of structural lumber and timber for Government use.

REFERENCES

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Manual of Recommended Practice, Standard Specification for Creosote (4f); Standard specification for creosote-coal tar solution (5e); Standard specification for preservative oils for nonpressure treatments (24f).

(2) Bateman, Ernest.
Coal-tar and water-gas tar creosotes; their properties and methods of testing. U. S. Dept. Agr. Bul. 1056, 1922, 111 p., illus. Out of print (copies probably available in the larger libraries).

(3) Federal Specifications Executive Committee.
A list of federal specifications on wood preservatives and preservative treatment can be obtained from the Forest Products Laboratory.

(4) Hunt, G. M., and Garratt, G. A.
Wood Preservation, McGraw-Hill Book Co., New York City, 1938. 457 p., illus. $5.

(5) Hunt, G. M., Baechler, R. H., and Blew, J. O., Jr.
Preservatives, Processes and Priorities. American Wood-Preservers' Assn. Proceedings 1942. (Forest Products Laboratory Mimeograph R1284).

Note: For detailed and general information on wood preservation refer also to the annual proceedings of the American Wood-Preservers' Assn., and the American Railway Engineering Assn. The Forest Products Laboratory will furnish, on request, a list of its publications on wood preservation.