Wood Preservation

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CHAPTER 15

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Contents

Many commonly used wood species can deteriorate if exposed to conditions that support growth of wood-degrading organisms (see Chap. 14). Wood products can be protected from the attack of decay fungi, harmful insects, or marine borers by applying chemical preservatives. Preservative treatments greatly increase the life of wood structures, thus reducing replacement costs and allowing more efficient use of forest resources. The degree of protection achieved depends on the preservative used and the proper penetration and retention of the chemicals. Some preservatives are more effective than others, and some are more adaptable to certain use requirements. To obtain long-term effectiveness, adequate penetration and retention are needed for each wood species, chemical preservative, and treatment method. Not only are different methods of treating wood available, but treatability varies among wood species—particularly their heartwood, which generally resists preservative treatment more than does sapwood. Although some tree species possess naturally occurring resistance to decay and insects (see Chap. 14), many are in short supply or are not grown in ready proximity to markets.

In considering preservative treatment processes and wood species, the combination must provide the required protection for the conditions of exposure and life of the structure. All these factors are considered by the consensus technical committees in setting reference levels required by the American Wood Protection Association (AWPA, formerly American Wood-Preservers' Association)) and ASTM International (formerly American Society for Testing and Materials). Details are discussed later in this chapter. The characteristics, appropriate uses, and availability of preservative formulations may have changed after preparation of this chapter. For the most current information on preservative formulations, the reader is encouraged to contact the appropriate regulatory agencies, standardization organizations, or trade associations. ***Note that mention of a chemical in this chapter does not constitute a recommendation.***

Wood Preservatives

Wood preservatives must meet two broad criteria: (1) They must provide the desired wood protection in the intended end use, and (2) they must do so without presenting unreasonable risks to people or the environment. Because wood preservatives are considered to be a type of pesticide, the U.S. Environmental Protection Agency (EPA) is responsible for their regulation. Federal law requires that before selling or distributing a preservative in the United States,

Synopsis of EPA-approved consumer information sheets for wood treated with CCA, ACZA, creosote, or pentachlorophenol

NOTE: This is only a synopsis of information contained in consumer information sheets. For complete consumer information sheets, contact your treated wood supplier or the website of the Environmental Protection Agency.

Handling Precautions

Avoid frequent or prolonged inhalation of sawdust from treated wood. When sawing, sanding, and machining treated wood, wear a dust mask. Whenever possible, these operations should be performed outdoors to avoid indoor accumulations of airborne sawdust from treated wood. When power-sawing and machining, wear goggles to protect eyes from flying particles. Wear gloves when working with the wood. After working with the wood, and before eating, drinking, toileting, and use of tobacco products, wash exposed areas thoroughly. Avoid frequent or prolonged skin contact with creosote- or pentachlorophenol-treated wood. When handling creosote- or pentachlorophenol-treated wood, wear long-sleeved shirts and long pants and use gloves impervious to the chemicals (for example, gloves that are vinyl coated). Because preservatives or sawdust may accumulate on clothes, they should be laundered before reuse. Wash work clothes separately from other household clothing.

Treated wood should not be burned in open fires or in stoves, fireplaces, or residential boilers, because toxic chemicals may be produced as part of the smoke and ashes. Treated wood from commercial or industrial use (such as construction sites) may be burned only in commercial or industrial incinerators or boilers in accordance with state and Federal regulations. CCA-treated wood can be disposed of with regular municipal trash (municipal solid waste, not yard waste) in many areas. However, state or local laws may be stricter than federal requirements. For more information, please contact the waste management agency for your state.

Use Site Precautions

All sawdust and construction debris should be cleaned up and disposed of after construction. Do not use treated wood under circumstances where the preservative may become a component of food or animal feed. Examples of such sites would be use of mulch from recycled arsenic-treated wood, cutting boards, counter tops, animal bedding, and structures or containers for storing animal feed or human food. Only treated wood that is visibly clean and free of surface residue should be used for patios, decks, and walkways. Do not use treated wood for construction of those portions of beehives which may come into contact with honey. Treated wood should not be used where it may come into direct or indirect contact with drinking water, except for uses involving incidental contact such as docks and bridges.

Logs treated with pentachlorophenol should not be used for log homes. Wood treated with creosote or pentachlorophenol should not be used where it will be in frequent or prolonged contact with bare skin (for example, chairs and other outdoor furniture), unless an effective sealer has been applied. Creosote- and pentachlorophenol-treated wood should not be used in residential, industrial, or commercial interiors except for laminated beams or building components that are in ground contact and are subject to decay or insect infestation and where two coats of an appropriate sealer are applied. Do not use creosote- or pentachlorophenol-treated wood for farrowing or brooding facilities. Wood treated with pentachlorophenol or creosote should not be used in the interiors of farm buildings where there may be direct contact with domestic animals or livestock that may crib (bite) or lick the wood. In interiors of farm buildings where domestic animals or livestock are unlikely to crib (bite) or lick the wood, creosote- or pentachlorophenol-treated wood may be used for building components that are in ground contact and are subject to decay or insect infestation and where two coats of an appropriate sealer are applied. Sealers may be applied at the installation site. Urethane, shellac, latex epoxy enamel, and varnish are acceptable sealers for pentachlorophenol-treated wood. Coal-tar pitch and coal-tar pitch emulsion are effective sealers for creosote-treated wood-block flooring. Urethane, epoxy, and shellac are acceptable sealers for all creosote-treated wood.

a company must obtain registration from EPA. Before registering a new pesticide or new use for a registered preservative, EPA must first ensure that the preservative can be used with a reasonable certainty of no harm to human health and without posing unreasonable risks to the environment. To make such determinations, EPA requires more than 100 different scientific studies and tests from applicants. This chapter discusses only wood preservatives registered by the EPA.

Some preservatives are classified as "restricted use" by the EPA and these can be used only in certain applications and can be applied only by certified pesticide applicators. Restricted use refers to the chemical preservative and not to the treated wood product. The general consumer may buy and use wood products treated with restricted-use pesticides; EPA does not consider treated wood a toxic substance nor is it regulated as a pesticide. Although treated wood is not regulated as pesticide, there are limitations on how some types of treated wood should be used. Consumer Information Sheets (EPA-approved) are available from retailers of creosote-, pentachlorophenol-, and inorganic-arsenical-treated wood products. The sheets provide information about the preservative and the use and disposal of treated-wood products (see Synopsis of EPA-Approved Consumer Information Sheets for Wood Treated with CCA, ACZA, Creosote, or Pentachlorophenol). The commercial wood treater is bound by the EPA regulation and can treat wood only for an end use that is allowed for that preservative. Some preservatives that are not classified as restricted by EPA are available to the general consumer for nonpressure treatments. It is the responsibility of the end user to apply these preservatives in a manner that is consistent with the EPA-approved labeling. Registration of preservatives is under constant review by the EPA, and a responsible State or Federal agency should be consulted as to the current status of any preservative.

Before a wood preservative can be approved for pressure treatment of structural members, it must be evaluated to ensure that it provides the necessary durability and that it does not greatly reduce the strength properties of the wood. The EPA typically does not evaluate how well a wood preservative protects the wood. Traditionally this evaluation has been conducted through the standardization process of the AWPA. The AWPA Book of Standards lists a series of laboratory and field exposure tests that must be conducted when evaluating new wood preservatives. The durability of test products are compared with those of established durable products and nondurable controls. The results of those tests are then presented to the appropriate AWPA subcommittees for review. AWPA subcommittees are composed of representatives from industry, academia, and government agencies who have familiarity with conducting and interpreting durability evaluations. Preservative standardization by AWPA is a two-step process. If the performance of a new preservative is considered appropriate, it is first listed as a potential preservative. Secondary committee action is needed to have the new preservative listed for specific commodities and to set the required treatment level.

More recently the International Code Council–Evaluation Service (ICC–ES) has evolved as an additional route for gaining building code acceptance of new types of pressure-treated wood. In contrast to AWPA, the ICC–ES does not standardize preservatives. Instead, it issues Evaluation Reports that provide evidence that a building product complies with building codes. The data and other information needed to obtain an Evaluation Report are first established as Acceptance Criteria (AC). AC326, which sets the performance criteria used by ICC–ES to evaluate proprietary wood preservatives, requires submittal of documentation accredited third party agencies in accordance with AWPA , ASTM, and EN standard test methods. The results of those tests are then reviewed by an evaluation committee to determine if the preservative has met the appropriate acceptance criteria.

Wood preservatives have traditionally been divided into two general classes: (1) Oil-type or oil-borne preservatives, such as creosote and petroleum solutions of pentachlorophenol, and (2) waterborne preservatives that are applied as water solutions or with water as the carrier. Many different chemicals are in each of these classes, and each has different effectiveness in various exposure conditions. Some preservatives can be formulated so that they can be delivered with either water or oil-type carriers. In this chapter, both oil-borne and waterborne preservative chemicals are described as to their potential end uses. Tables 15–1 and 15–2 summarize preservatives and their treatment levels for various wood products.

Waterborne Preservatives

Waterborne preservatives are often used when cleanliness and paintability of the treated wood are required. Formulations intended for use outdoors have shown high resistance to leaching and very good performance in service. Waterborne preservatives are included in specifications for items such as lumber, timber, posts, building foundations, poles, and piling (Table 15–1). Because water is added to the wood in the treatment process, some drying and shrinkage will occur after installation unless the wood is kiln-dried after treatment.

Copper is the primary biocide in many wood preservative formulations used in ground contact because of its excellent fungicidal properties and low mammalian toxicity (Table 15–3). Because some types of fungi are copper tolerant, preservative formulations often include a co-biocide to provide further protection.

Inorganic arsenicals are a restricted-use pesticide. For use and handling precautions of pressure-treated wood containing inorganic arsenicals, refer to the EPA-approved Consumer Information Sheets.

Acid Copper Chromate (ACC)

Acid copper chromate (ACC) contains 31.8% copper oxide and 68.2% chromium trioxide (AWPA P5). The solid, paste, liquid concentrate, or treating solution can be made of copper sulfate, potassium dichromate, or sodium dichromate. Tests on stakes and posts exposed to decay and termite attack indicate that wood well impregnated with ACC generally provides acceptable service. However, some specimens placed in ground contact have shown vulnerability to attack by copper-tolerant fungi. ACC has often been used for treatment of wood in cooling towers. Its current uses are restricted to applications similar to those of chromated copper arsenate (CCA) (Table 15–4). ACC and CCA must be used at low treating temperatures (38 to 66 °C (100 to 150 °F)) because they are unstable at higher temperatures. This restriction may involve some difficulty when higher temperatures are needed to obtain good treating results in woods such as Douglas-fir.

Ammoniacal Copper Zinc Arsenate (ACZA)

Ammoniacal copper zinc arsenate (ACZA) is commonly used on the West Coast of North America for the treatment of Douglas-fir. The penetration of Douglas-fir heartwood is improved with ACZA because of the chemical composition and stability of treating at elevated temperatures. Wood treated with ACZA performs and has characteristics similar to those of wood treated with CCA (Table 15–1).

ACZA should contain approximately 50% copper oxide, 25% zinc oxide, and 25% arsenic pentoxide dissolved in a solution of ammonia in water (AWPA P5). The weight of ammonia is at least 1.38 times the weight of copper oxide. To aid in solution, ammonium bicarbonate is added (at least equal to 0.92 times the weight of copper oxide).

ACZA replaced an earlier formulation, ammoniacal copper arsenate (ACA) that was used for many years in the United States and Canada.

Table 15–1. Typical use categories and retentions for preservatives used in pressure treatment of Southern Pine species[a]

	Retentions (kg m^{-3})[b] for each type of exposure and AWPA use category designation						
		Exterior above-ground		Soil or fresh water			
	Interior, dry or damp	Vertical, coated	Horizontal	General	Severe/ critical	Very severe/ critical	
Preservative	1, 2	3A	3B	4A	4B	4C	4C (piles)
Waterborne: Listed by the AWPA							
ACC	NL[c]	NL[c]	4.0	8	—	—	—
ACZA	4.0	4.0	4.0	6.4	9.6	9.6	—
ACQ–B	4.0	4.0	4.0	6.4	9.6	9.6	—
ACQ–C	4.0	4.0	4.0	6.4	9.6	9.6	—
ACQ–D	2.4	2.4	2.4	6.4	9.6	9.6	—
CA–B	1.7	1.7	1.7	3.3	5.0	5.0	—
CA–C	1.0	1.0	1.0	2.4	5.0	5.0	—
CBA–A	3.3	3.3	3.3	6.5	9.8	9.8	—
CCA	NL[c]	NL[c]	4	6.4	9.6	9.6	12.8
CX–A	3.3	3.3	3.3	—	—	—	—
CuN (waterborne)	1.12	1.12	1.12	1.76	—	—	—
EL2	0.30	0.30	0.30	—	—	—	—
KDS	3.0	3.0	3.0	7.5	—	—	—
PTI	0.21	0.21	0.21/0.29[d]	—	—	—	—
SBX	2.8/4.5[e]	—	—	—	—	—	—
Oil-type: Listed by the AWPA							
Creosote	128/NR[f]	128.0	128.0	160	160	192	192
Penta P9 Type A Oil	6.4/NR[f]	6.4	6.4	8.0	8.0	8.0	9.6
Penta P9 Type C Oil	6.4/NR[f]	6.4	6.4	8.0	8.0	8.0	9.6
CuN (oilborne)	0.64/NR[f]	0.64	0.64	0.96	1.2	1.2	1.6
Cu8	0.32	0.32	0.32	—	—	—	—
Waterborne: Evaluation reports from ICC Evaluation Service, Inc.							
ESR–1721	0.8	0.8	0.8	2.2	3.6	5.3	5.3
ESR–1980	2.4	2.4	2.4	5.4	9.6	9.6	—
ESR–2067	0.3	0.3	0.3	—	—	—	—
ESR–2240	1.0	1.0	1.0	2.4	3.7		
ESR–2325	1.1	1.1	1.1	2.6	3.8	—	—
ESR–2711	2.1/2.7[g]	2.1/2.7[g]	2.1/2.7[g]	4.5	6.9	—	—

[a]Some exceptions exist for specific applications. See AWPA Standard U1 or ICC ES Evaluation Reports for details on specific applications. See Table 15–2 for seawater applications.
[b]To convert to retention expressed as lb ft^{-3}, divide these values by 16.0.
[c]NL, not labeled. EPA labeling does not currently permit use of wood newly treated with these preservatives in most applications within these use categories. See Table 15–4 for more details.
[d]Higher retention specified if the preservative is used without a stabilizer in the treatment solution.
[e]Higher retention for areas with Formosan subterranean termites.
[f]NR, not recommended for interior use in inhabited structures.
[g]2.1 kg m^{-3} retention limited to decking and specialty use items.

Chromated Copper Arsenate (CCA)

Wood treated with CCA (commonly called green treated) dominated the treated-wood market from the late 1970s until 2004. However, as the result of the voluntary label changes submitted by the CCA registrants, the EPA labeling of CCA currently permits the product to be used for primarily industrial applications (Table 15–4), and CCA-treated products are generally not available at retail lumber yards. CCA can no longer be used for treatment of lumber intended for use in residential decks or playground equipment. It is important to note that existing structures are not affected by this labeling change and that the EPA has not recommended removing structures built with CCA-treated lumber. These changes were made as part of the ongoing CCA re-registration process, and in light of the current and anticipated market demand for alternative preservatives for nonindustrial applications. Allowable uses for CCA are based on specific commodity standards listed in the 2001 edition of the AWPA standards. The most important of these allowable uses are based on the standards for poles, piles, and wood used in highway construction. A list of the most common allowable uses is shown in Table 15–4.

Although several formulations of CCA have been used in the past, CCA Type C has been the primary formulation and is currently the only formulation listed in AWPA standards. CCA–C was found to have the optimum combination of efficacy and resistance to leaching, but the earlier formulations (CCA–A and CCA–B) have also provided long-term protection for treated stakes exposed in Mississippi (Table 15–5). CCA–C has an actives composition of 47.5% chromium trioxide, 34.0% arsenic pentoxide, and 18.5% copper oxide. AWPA Standard P5 permits substitution of potassium or sodium dichromate for chromium trioxide; copper sulfate, basic copper carbonate, or copper hydroxide for copper oxide; and arsenic acid, sodium arsenate, or pyroarsenate for arsenic pentoxide.

High retention levels (40 kg m^{-3} (2.5 lb ft^{-3})) of CCA preservative provide good resistance to attack by the marine borers *Limnoria* and *Teredo* (Table 15–2).

Alkaline Copper Quat (ACQ)

Alkaline copper quat (ACQ) has an actives composition of 67% copper oxide and 33% quaternary ammonium compound (quat). Multiple variations of ACQ have been standardized. ACQ type B (ACQ–B) is an ammoniacal copper formulation, ACQ type D (ACQ–D) is an amine copper formulation, and ACQ type C (ACQ–C) is a combined ammoniacal-amine formulation with a slightly different quat compound. The multiple formulations of ACQ allow some flexibil chieving compatibility with a specific pplication. When ammonia is used as the proved ability to penetrate difficult-to- However, if the wood species is readily thern Pine sapwood, an amine carrier e a more uniform surface appearance. en formulated using small particles opper solubilized in ethanolamine. discussed in more detail in the Pre- Evaluation Reports section. Use of ulations of ACQ is currently limited ch as species of pine with a high but efforts continue to adapt the nge of wood species.

ACD)

CD) is a recently proposed formu- hanolamine that utilizes 4,5-di- olin-3-one (DCOI) as co-biocide

Table 15–2. Preservative treatment and retention necessary to protect round timber piles from severe marine borer attack[a]

	Retention (kg m^{-3})[b]
Marine borers and preserva	
Limnoria tripunctata only	
Ammoniacal copper zinc a	
Chromated copper arsenate	
Creosote	
Limnoria tripunctata and Pho (dual treatment)	
First treatment	
Ammoniacal copper zinc ars	
Chromated copper arsenate	
Second treatment	
Creosote	
Creosote solution	

[a]See AWPA Commodity Specificati
[b]To convert to retention expressed as
[c]Lower retention levels are for marin Jersey northward on the East Coast a West Coast in the United States.

Table 15–3. Active ssure treatments

Active ingredient	
Inorganic actives	
Arsenic	ACZA, CCA
Boron	CBA–A, CX–A, SBX, KDS
Chromium	ACC, CCA
Copper	ACC, ACZA, ACQ–B, ACQ–C, ACQ–D, CA–B, CA–C, CBA–A, CCA, CXA, ESR–1721, ESR–1980, ESR–2240, ESR–2325, KDS, KDS–B, ESR–2711
Zinc	ACZA
Organic actives	
Alkylbenzyldimethyl ammonium compound	ACQ–C
DCOI	EL2, ESR–2711
Didecyldimethyl ammonium compound	ACQ–B, ACQ–D
HDO: Bis-(N-cyclo-hexyldiazeniumdioxy)Cu	CX–A
Imdiacloprid	EL2, PTI, ESR–2067
Propiconazole	CA–C, PTI, ESR–1721
Polymeric betaine	KDS, KDS–B
Tebuconazole	PTI, ESR–1721, ESR–2067, ESR–2325