

Wood Preservation

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INTRODUCTION

The history of wood preservation dates to 2000 B.C.E. when natural oils and other materials were used to preserve wood. Modern industrial timber preservation can be traced to John Bethell in England, who developed a process for pressure treating ship timbers with creosote in 1838 (1). Today, wood preservation accomplishes two main tasks. First, it allows us to conserve timber. Experts estimate that the failure to control wood-destroying insects and fungi in the United States alone requires the additional cutting of 360,000 acres of forests yearly. Secondly, wood preservation allows us to increase the service life of wood. Treatment of wood affords protection from the principal agents of wood deterioration—fungi, wood-destroying insects (primarily termites), marine borers, fire, and weathering. A better understanding of the causal agents of wood deterioration will help the scientific community design more effective systems for protecting wood while minimizing environmental impact and improving service life. An excellent discussion of causal agents can be found in a recently published treatise (2).

In recent years, two principal factors have spurred changes in treatment technology and preservative systems worldwide: 1) environmental concerns, including air and water quality standards, and the effect of treated wood on man and nontarget organisms; and 2) the energy crisis, especially in regard to oil and oil-based preservative systems. Of these two, environmental concerns predominate.

CLASSICAL WOOD PRESERVATIVES

Wood preservatives should be safe to handle and use, efficacious, cost-effective, permanent, and should not corrode metal or degrade wood components. Worldwide, the major preservative systems are creosote, oilborne penta-

chlorophenol, and the waterborne arsenicals, primarily chromated copper arsenate (CCA). These three systems have been designated Restricted Use Pesticides by the United States Environmental Protection Agency (US EPA), but wood scraps and discarded components that have been treated with these preservatives are not listed as hazardous wastes. The major concern with the disposal of treated wood is the lack of sanitary landfill space to accommodate a large volume of treated wood.

Creosote is a broad-spectrum biocide composed of a complex mixture of chemicals containing polyaromatic hydrocarbons, which can have immediate and chronic effects on exposed organisms. Fortunately, creosote is easily broken down in the environment and can be readily disposed of by high-temperature incineration. While creosote is an oil, it is often diluted with heavy oil or coal tar for use. It is primarily used to treat pilings or piles, poles, and crossies (sleepers).

Pentachlorophenol is a broad-spectrum biocide that is dissolved in organic solvents (often fuel oil). It is of concern because of its toxicity to aquatic organisms. It is banned in several countries and is strictly controlled in the United States. Pentachlorophenol is used primarily for treatment of crossarms and treatment of poles not exposed in tidal areas. Wood treated with pentachlorophenol can also be disposed of by high-temperature incineration.

The arsenic and/or chromium in CCA and other waterborne systems can result in toxic reactions in aquatic organisms and pose an additional hazard because of their cumulative effect. Fortunately, such systems are well bound within the wood structure once it has been dried and fixed following treatment. A recent study showed that, while there were measurable biocide increases in the water column and sediment around treated wood in a wetland boardwalk, no taxa were excluded or significantly reduced near treated wood structures (3). Waterborne arsenicals are the primary preservatives used to treat lumber and timbers.

NEW GENERATION WOOD PRESERVATIVE SYSTEMS

Heavy metals like chromium and arsenic have undergone close environmental scrutiny spurring efforts to replace or reduce their use in waterborne systems. This has led to the development and introduction of several new copper-based preservative systems into the worldwide market. These include copper-quaternary ammonium, chromated copper borate, copper azole, copper dimethyldithiocarbamate, bis-(*N*-cyclohexyldiazoniumdioxy)-copper, and copper citrate systems for above ground and ground contact applications. The biocidal properties of borate compounds have long been used in Australasia and are coming into wider use in North America for wood exposed in protected, nonleaching environments, especially in areas threatened by the introduced Formosan subterranean termite. Borate formulations are being used in remedial treatment systems and zinc borate is being used for the protection of composite wood products. Borate-treated house framing components have been available in Hawaii for several years and now are available on the U.S. mainland.

New generation oilborne systems have also come to the fore in recent years. Many, such as substituted isothiazolones, chlorothalonil, thiazoles, carbamates, and triazoles, are under development or are in use as a component in multiple component preservative systems. Others, such as oxine copper and copper naphthenate, are re-emerging as commercial preservatives. Copper 8-Quinolinolate has United States Food and Drug Administration (US FDA) approval for use in wood products in contact with foodstuffs (e.g., pallets) and is being used for preventing sapstain and mold fungi in freshly sawn lumber, or for uses in aboveground exposures. Copper naphthenate in heavy oil carriers is finding use as a pole preservative and is not currently listed as a Restricted Use Pesticide by the US EPA.

TREATING PROCESSES

Commercial pressure treating processes have remained largely unchanged since the early 1900s. Modifications to the standard practices include the modified full-cell process and the addition of a posttreatment fixation cycle with CCA preservatives. The modified full-cell cycle has been utilized to reduce the total solution injected into the wood while maintaining penetration and retention specifications. The net benefit is to reduce the potential release of excess preservative solution into the environment (4–6). Accelerated fixation cycles have improved compliance with environmental regulations and eliminated, or greatly

reduced, posttreatment dripping. Rapid in situ fixation schemes with chromium and arsenic-containing preservatives generally use hot air heating, hot water fixation, steam fixation, or hot oil heating. The key factors affecting fixation are wood moisture content, temperature, concentration, and time. Since the fixation reactions are essentially ionic, moist wood is essential to proper rapid fixation (5).

Novel treating processes being developed may lead to improved treated products having reduced environmental impact. Among the emerging technologies are sonic treatment, gas/vapor-phase treatment, and super-critical fluid treatment. Of these, vapor-phase treatment using boron to treat composite materials is the closest to commercial use.

Detailed guidelines for Best Management Practices have been issued for all major commercial wood preservatives in the United States (7). Use of these guidelines has been shown to reduce the impact of preservatives on the environment. Consumer Information Sheets have been issued for all wood preservatives to guide users in the proper use and handling of treated wood (7).

MANAGEMENT AND CONTROL OF PRESERVATIVE SYSTEMS

In the United States, preservative systems are managed and controlled by the Environmental Protection Agency, under the Federal Insecticide, Fungicide, and Rodenticide Act, and other governmental agencies through statutes designed to protect the environment. These long-standing statutes provide for air and water quality standards, discharge limits to the environment, certification, registration, remediation, and penalties for noncompliance.

In the European Union (EU), the Biocidal Product Directive was implemented in May 2000. Under its guidelines, those active biocidal ingredients, which are approved or in use in any of the member countries, must be listed and categorized as either “Identified” or “Notified” substances by March 2002. If a substance is considered “Identified”, its registration will be valid until 2005 or 2006. For the case of a “Notified” substance, data concerning human toxicity and its impact to environment must be provided by March 2002. In this case, and in the case of new biocide actives, full data, as required in the technical annex of the Biocidal Product Directive, must be provided for evaluation prior to approval for use. All wood preservative formulations will be registered at the member state level through existing national channels. It is intended that these registrations will be mutually recognized throughout the EU member states.

FUTURE CONSIDERATIONS

Many of the newer, more environmentally benign compounds suffer from a lack of broad-spectrum activity needed for ground contact application, or are highly leachable. This suggests that future systems will be based on combinations of narrow-spectrum biocides, similar to the co-biocide systems recently developed. The use of multiple biocides seems especially cogent if the biocides act synergistically. Anchored biocides, which are covalently bonded to the wood, seem to offer another approach that would result in systems with lower depletion rates. To overcome energy-related problems, new organic preservatives requiring an oil-based carrier system need to be developed so that less oil carrier is needed.

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