*CWPA Proceedings, 2004, pp 149-156*


# TRENDS IN GENERAL USE WOOD PRESERVATIVES

**John Horton**
**Osmose, Inc, 1016 Everee Inn Road, Griffin, GA 30224**

## Summary

Copper chromated arsenate (CCA) preservative dominated vacuum pressure treatment of wood products for decades in North America. With the recent voluntary CCA label changes in the U.S. and Canada, the industry has been undergoing a major transition where CCA treatment is being replaced in most general use residential applications with the copper based alternative preservatives of alkaline copper quat (ACQ), and copper azole ( CBA-A, CA-B). Other copper based alternative preservatives will be commercially introduced sometime in the future. This transition has also increased industry interest to develop non-metal, organic preservatives for specialty use applications. Improvement in weather durability, dimensional stability, and minimization of preservative component release from the treated wood into the environment will be desired developments to improve market acceptance of new alternative preservative treatments in the future.

## Introduction

Until 2004, the wood treating industry has held a fairly steady course for decades with few changing trends in wood preservative use patterns. Wood preservative products for vacuum pressure treatments are generally broken into two separate categories of either water-borne or oil-borne systems. Oil-borne wood preservatives such as creosote, penta and copper naphthenate have traditionally been used for treatment of wood to be used in heavy duty commercial and industrial use applications such as utility poles, pilings, guardrail posts, bridge timbers and commercial structural timbers.

Water-borne wood preservatives have also been used for treatment of wood products for heavy duty industrial use applications. But unlike oil-borne wood preservatives, water-borne preservatives have also been the mainstay wood treatment for general use applications, which include a wide range of residential and consumer construction projects such as exterior decks, fencing, landscaping, walkways and freshwater docks. The general use residential market has long been dominated by CCA-C treated wood products which were sold in large volumes through the retail building material dealer outlets to consumers and contractors alike.

Trends in general use wood preservative treatments are driven by three important factors:

1) Market perceptions and product attribute demands;
2) Technology development and limitations; and
3) Regulatory influences, and constraints.

Of these three factors, it would seem that technology development should be the industry's easiest avenue to affect change in the markets. However, developing new wood treatment technologies can be a frustrating, long term process since it still presently takes several years of testing to bring a new wood preservative to market. This is due to requirements for many years of field testing and the time consuming regulatory registration process. Added to this long term development process is the shrinking availability of potential active fungicides and insecticides that are needed for development of newer wood preservative systems. Global biocide manufacturers continue to face growing costs to develop, register and support their biocide products due to ever increasing regulatory demands for safer biocides that have so-called "greener" environmental profiles.

## CCA Label Changes and Transition to Alternatives Preservatives

The CCA chemical manufacturers and registrant holders voluntarily made label changes that became effective on December 31, 2003, which limited the use of CCA-C treatments to mainly industrial use applications such as utility poles, pilings, marine construction and heavy structural timbers. These voluntary CCA-C label changes were made in anticipation of the growing market demand for alternative preservatives for non-industrial residential market applications. These voluntary CCA-C product label changes will potentially result in a > 80% total volume reduction of CCA-C preservative treatment of wood products and has clearly opened up more market opportunities for other alternative wood preservative treatments.

## Copper-Based Preservatives

The majority of wood treatments for use in exterior residential construction, and other general use market applications have been quickly transitioned to the use of copper-based preservative systems in North America. Preservative manufacturers have been developing copper-based preservatives as alternatives for CCA-C preservative for years. Some of these copper-based systems have already been in commercial use in other regions of the world, such as Europe.

Copper is an excellent fungicide and also effective against termite attack. Typically a copper-based preservative system is formulated with a co-biocide such as an organic fungicide which aids in the overall preservative efficacy and provides protection against copper tolerant fungi attack.

The wood treated with these copper-based preservative systems typically has a "green" to "green-brown" coloration that will weather to a "tan-brown" color upon weather exposure, and then eventually turn gray after extended exposure time. Copper metal helps maintain the integrity of the treated wood surface by helping protect against the damaging UV radiation from sunlight. The use of copper also presents relatively low mammalian toxicity.

## Alkaline Copper Quat

Alkaline Copper Quat (ACQ) is a water-borne copper-based preservative that has been developed and commercialized in recent years. The active ingredients in ACQ are copper oxide (67%) and quaternary ammonium compound, or quat (33%) (Table 1.).

There are multiple formulations of ACQ using either ammonia, or amines that help solubilize the copper for use in a treatment solution. When ammonia is used in the ACQ wood treatment the preservative has the ability to penetrate difficult to treat wood species. Where easy to treat species such as Southern Pine is to be used, the amine carrier provides for much less odor and a more uniform surface appearance of the treated wood.

ACQ formulations also use different types of quats as co-biocides. The recent trend for formulation of ACQ has been with the use of the DDA carbonate quat, which contains little to no chloride. Wood treated with an ACQ formulation will have the typical "green-brown" coloration that weathers to an attractive "tan-brown".

The ACQ formulations are recognized for a range of applications including above-ground and ground contact uses. Minimum retentions are specified for ACQ treated wood that is to be used in above-ground, and ground contact applications. (Table 1.).

## Copper Azole

Copper azole is another recently developed preservative formulation that again relies on copper as the main biocide, and incorporates an additional organic azole fungicide, "Tebuconazole", as a co-biocide. There are also multiple formulations of copper azole. The first developed which also utilized boric acid as an active in the formulation. A more recent developed copper azole formulation does not contain boric acid as an active, but relies only on the copper and azole for protection of the wood. The copper azole with boric acid containing formulation contains copper (49%), boric acid (49%), and Tebuconazole (2%) The copper azole formulation without boric acid contains copper (96%) and Tebuconazole (4%) (Table 1.).

Copper azole formulations can be used for treatment of wood products for above-ground and in-ground contact applications (Table 1.). Ammonia may also be added to the copper azole formulation to help aid in the treatment of more difficult to penetrate species. Wood treated with copper azole typically has a "green-brown" coloration, which also weathers to a "tan-brown"

**Table 1: Copper Based Preservatives**

| | Preservative Copper | Components Co-Biocide | Approved Retentions Kg/m³ (lb/ft³) | |
|---|---|---|---|---|
| | | | Above Ground | Ground Contact |
| Copper Quat(ACQ-C) | 67% CuO | 33% BAC | 4.0 (0.25) | 6.4 (0.40) |
| Copper Quat (ACQ-B, D) | 67% CuO | 33% DDAC | 4.0 (0.25) | 6.4 (0.40) |
| | | | | |
| Copper Azole (CA-B) | 96% Cu | 4% Tebuconazole | 1.7 (0.10) | 3.3 (0.21) |
| Copper Azole (CBA-A) | 49% Cu | 2% Tebuconazole 49% $H^3BO^3$ | 3.3 (0.21) | 6.5 (0.41) |

*AWPA Standards, 2004*

## Future Copper-Based Preservatives

### Copper HDO (CX-A)

Copper HDO is an amine copper-based preservative system that has been previously used in Europe. Copper HDO active ingredients are copper oxide (61.5%), copper HDO (14%) and boric acid (24.5%) (Table 2.). Reportedly the handling and treatment characteristics of the Copper HDO should be similar to other amine copper-based treatments. At present Copper HDO is only being viewed in North America as an above-ground only treatment. U.S. EPA registration is still pending for the Copper HDO wood preservative system.

### KDS

KDS (copper polymeric betaine) is another amine copper-based preservative system that has been also commercially used in Europe for wood treatment. The active ingredients in KDS are copper (56%), polymeric betaine (36%) and boric acid (8%) (Table 2.). The polymeric betaine is a proprietary quaternary biocide compound which is used as a co-biocide for the copper. In certain regions in Europe, particularly Scandinavia, KDS is limited to above-ground application only. At this time, KDS is reportedly pending registration in both the US and Canada.

### Copper Naphthenate (water-borne)

A new water-based copper naphthenate wood preservative formulation is being actively developed for use in North America as a general use preservative system. Copper naphthenate (oil-borne) has been used as a wood preservative treatment for many years in North America, primarily for treatment of utility poles. The active ingredients in the Copper Naphthenate (water-borne) wood preservative are copper (5%) and copper naphthenate (42%). Wood treated with this wood preservative will still have a distinctive

"green" coloration. Copper Naphthenate (water-borne) treatment has been developed for both above-ground and ground contact applications (Table 2.).

**Table 2 : Future Copper Based Preservatives**

| | Preservative Copper | Components Co-Biocide | Approved Retentions kg/m³ (lb/ft³) | |
|---|---|---|---|---|
| | | | Above Ground | Ground Contact |
| Copper HDO(CX-A) | 61.5% CuO | 14% CuHDO<br>24.5% $H_3BO_3$ | 3.3 (0.21) | N/A |
| Copper Polymeric Betaine (Quat) | 56% Cu | 36% PB<br>8% B | N/A | N/A |
| Copper Naphthenate WB | 5% Cu | 42% CuN | N/A | N/A |

*AWPA T-2, 2003*

**Acid Copper Chromate**

Acid copper chromate (ACC) has been used very little as a wood preservative since the early 1970s. Its primary treatment application was for wood slates used in cooling towers. ACC contains the active ingredients of copper oxide (31.8%) and chromium trioxide (68.2%). While the use of ACC treated wood has been for above-ground specialty applications, it is also listed in the American Wood Preserving Association (AWPA) standards as a ground contact treatment. It has been reported that ACC treated wood can suffer from early failure from attack by copper tolerate fungi (Lebow et al. 2003). ACC wood preservative may also have difficulty in obtaining adequate penetration in some of the more difficult to penetrate refractory wood species such as Douglas Fir due to the higher concentration of chromium trioxide. Other treatment and handling considerations for ACC wood treatment would be extended hexavalent chromium reduction times for freshly treated wood.

## Borate Wood Preservatives

Borates have received increasing attention in recent years for use in treating wood framing components for housing construction. Borates are an effective biocide against both decay fungi and termite attack. However, due to borates diffusion properties in the presence of moisture, and susceptibility to leaching upon wetting of the treated wood, the use of borate treatments should be limited to interior applications only which are protected from prolonged weather exposure and direct wetting.

Sodium salt borate preservatives such as DOT (Disodium Octaborate) easily dissolve in water and have very good treatment qualities particularly for difficult to penetrate wood species such as, Douglas Fir. Borate treatment is preferred for sill plate construction in housing on the West Coast. Borate treated wood is colorless and can be easily stained or painted when dry. Treating wood with borates for use in a whole house framing system is well established in Hawaii where there is a high hazard for wood destruction by Formosan termite infestations. This borate treatment concept for whole house framing protection

against Formosan termites is now being marketed in the Gulf Coast and Southeast regions of the United States.

## Non-Metal Organic Wood Preservatives

In recent years more emphasis has been placed on the development of potential non-metal wood preservative systems that are formulated using organic or oil-soluble biocides. These non-metal organic preservative systems have typically been developed using either water-borne micro-emulsion, or oil-borne light organic solvent formulations. These non-metal, organic wood preservatives could potentially find future use in some exterior above-ground residential specialty applications such as decking, and deck specialties i.e. spindles, railings benching and lattice.

### PXTS

PXTS is a coal-tar derivative-based organic wood preservative containing cresylic acid, sulphur chlorides, and sulphur. PXTS has been developed for use in both above-ground and ground contact applications as a creosote replacement preservative. The PXTS preservative is a solid at ambient temperatures, and requires higher temperature of approximately 60 degrees C to liquefy for use in treatment solutions. The PXTS can be used as a neat solution or can be diluted in methylene chloride or warm toluene. The PXTS final treated wood products are reported to be brown in coloration.

### Azole/Imidichlorprid

Recently, another non-metal organic preservative system has been announced in the US market. This new non-metal preservative system uses a fungicide combination of tebuconazole/propiconazole, with the addition of imidichlorprid, an insecticide. This new organic wood preservative has been submitted to the International Code Council (ICC) Evaluation Service, Inc., for approval of an Acceptance Criteria. The purpose of this acceptance criterion is to establish requirements for testing, in accordance with EPA use application labeling, of the treated wood products to be recognized in an ICC-ES, Inc. evaluation report under the 2003 International Building Code, the 2003 International Residential Code, the BOCA National Building Code, the Standard Building Code, and the Uniform Building Code. Treated wood products having gained an approved ICC-ES, Inc. evaluation report can be used for code recognized applications in residential and commercial construction in the U.S.

It is unknown at this time if this new proposed non-metal organic wood preservative system will be used for treatment as an oil-borne, and/or water-borne formulation.

## Organic Preservative Service Concerns

In the past, non-metal organic wood treatments have typically produced treated wood with little to no coloration. Unlike metal containing wood preservatives, colorless organic wood treatments can pose concerns involving poor exterior weathering performance of the final treated wood product. Wood treated with colorless organic preservatives, without being protected with a UV resistance coating, tend to exhibit noticeable surface degradation from weather exposure. Unsightly surface discoloration typically occurs in very short exposure periods. The treated wood surfaces may also begin to soften leading to wood mass erosion.

## Future Development Trends

Future developments for wood preservatives should focus not only on protection against decay fungi and insect attack, but also on improving the weather durability of the treated wood products. Improved weather durability will lead to better treated wood dimensional stability, longer lasting natural wood coloration, and resistance to wood surface degradation.

Improvements in protection against surface mold and mildew, and compatibility with a wider range of commonly used fasteners, hardware, and other building material components should also be sought in any development work.

One of the most important development areas for wood preservation is to reduce any releases of preservative components from the treated wood into the environment during service. In addition, using only the minimum amount of preservative required for each intended service application should be another high priority.

## Conclusion

The treated wood industry has undergone a major transition in 2004 with general use preservative treatments shifting from CCA to alternative copper-based preservative systems. These copper-based preservatives are considered good market replacements for CCA, but development improvements should continue to be sought for these preservatives. Research will continue on non-metal preservatives for the general use market and will become more commercially available in the future. As the treated industry continues to transition, and move forward there will likely be a more diversified range of preservative systems developed, and offered commercially which will target more specific types of service applications and uses.

## References


1. AWPA, 2004 Book of Standards. Granbury, Texas: American Wood Preservers Association
2. AWPA Subcommittee T-2 Treatment of Lumber and Timber Minutes, Boston, MA, April 30, 2003
3. Lebow, S.T., Hatfield, C.A., Crawford, D.M. and Woodward, B. 2003. Long-term stake evaluations of waterborne copper systems. In: Proceedings, 2003 American Wood Preservers Association Annual Meeting, Boston, MA.