

CHEMONITE® / ACZA Preservative Update

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ABSTRACT: Chemonite® is a registered trademark of J.H. Baxter & Co. for the wood preservative first developed and known as ACA, then later reformulated and changed to its present form, ACZA. This ammoniacal waterborne preservative has features that should be considered in any selection process involving treatment of Douglas-fir round or sawn material along with any other refractory species of wood common to the Western United States.

The paper reviews documents and studies available to support the choice of ACZA including the environmental and safety aspects of chemical fixation and leach resistance, improved processing techniques available through Best Management Practices (BMP's), protection from Formosan termites, carpenter ants and woodpecker attack as well as from other biological organisms. Supporting information concerning corrosion, climbability and conductivity are also provided.

This paper is intended to describe the various attributes of ACZA, setting it apart from other wood treating preservatives available to design architects, engineers, professional building contractors and others with an interest in well-established structural integrity and service performance of treated wood products.

Key words: Wood Preservative, ACA, ACZA, American Wood-Preservers' Association, Ammoniacal, Best Management Practices, Carpenter Ant, Chemonite, Climbability, Conductivity, Corrosion, Fixation, Formosan Termite, Leachability, Nail-withdrawal, Sterilization, Use Category System, Utility Pole, Woodpecker.

INTRODUCTION

the purpose of this presentation is to acquaint those in the commercial, industrial and heavy construction industry with the preservative known as Ammoniacal Copper Zinc Arsenate (ACZA or Chemonite®) and characteristics of the wood treated with this waterborne preservative. The bulk of the information provided is relative to Coastal Douglas-fir, a species known to be difficult to treat with other types of waterborne preservative systems. Chemonite was specifically formulated to attain penetration into the Western refractory species of woods and provide a waterborne treatment capable of consistently meeting the requirements specified in the American Wood-Preservers' Association Standards and many National Building Codes.

The original formulation of Chemonite was known as ACA, developed and patented in the 1920's at the University of California, then first used commercially in 1934. This preservative system experienced nearly 50 years of effective treatment before a change in formulation was introduced in 1983 by J.H. Baxter & Co. The new formulation replaced half of the arsenic with zinc and the resulting preservative was recognized for environmental advantages over the previous formulation. This Chemonite II, now known as Chemonite®/ACZA, became a registered pesticide with the U.S. EPA and continues to be successfully used for pressure treating beams and timbers, poles and piling, lumber, plywood, glue laminated timbers and other engineered wood products. (14).

ACZA is a blend of active ingredients in a 2: 1: 1 ratio of copper oxide, zinc oxide and arsenic pentoxide, respectively. The copper and zinc are

supplied in a dry powder while the arsenic pentoxide is a liquid arsenic acid. These high quality raw materials are dissolved in aqua ammonia with the addition of ammonium bicarbonate to solubilize the metallic oxides. The resulting preservative provides exceptionally consistent penetration, significantly reduced surface residue, reduced corrosive properties, enhanced product appearance and improved leach resistance after fixation of the chemical takes place in the wood (19).

The AWPA Standard P5-00 for Waterborne Preservatives defines both generic formulations for Chemonite; however, in 1999 the Canadian Institute of Treated Wood and Pest Management Regulatory Authority (PMRA) of Canada approved the use of ACZA in Canada. As a result, the AWPA P-4 Subcommittee having jurisdiction over the P5 Standard, identified for removal without prejudice due to lack of use, the preservative ACA from the 2003 *Book of Standards*. At the same time, the transition to the Use Category System will be complete with the Standard Preservative Code Number 302 assigned to ACZA under ammoniacal-based waterborne systems (2).

PROPERTIES OF CHEMONITE®/ACZA

There are some definitive differences in the Chemonite treating process which separate it from other waterborne preservative systems. Some of these factors significantly influence the service performance of the treated product and should be taken into consideration when selecting and specifying a preservative for treatment of Coastal Douglas-fir or other thin-sapwood refractory species.

Sterilization

ACZA has the ability to withstand elevated temperatures during processing and allows for treatment of green or wood seasoned before treatment. Steam conditioning of Doug-fir poles prior to treatment with temperatures to 240° F for up to 8 hours as per ANSI 05.1 and AWPAC4 (1.3.2 Steaming, note 1 under waterborne treatment) can be very effective in eliminating incipient decay. Preservative temperatures during the Chemonite pressure cycle normally reach 150° F, the maximum allowed by AWPAC4. The resulting temperature combination provides sterilization during treatment, even in large cross sectional dimension Douglas fir materials.

In addition, a Best Management Practice (BMP) for ACZA includes the use of an aqua-ammonia steaming cycle following the after-press vacuum (which increases solution recovery and reduces drippage). This cycle subjects the treated material to ammonia vapor in the retort heated to 190° - 200° F, thereby reducing surface deposits while improving fixation of the chemical in the wood with increased ammonia off-gassing.

Fixation of chemical

The recent media coverage concerning potential for exposure to arsenic from treated wood has raised many questions about the safety of arsenically treated wood. Chemical fixation and leaching are terms in the wood treating industry related to this concern.

Fixation as defined in the AWPAC4 *Book of Standards* Glossary is "A physical or chemical process whereby a wood preservative system is rendered leach resistant in both water and soil applications, such that the active ingredient(s) maintain fungal/insecticidal efficacy." Although it is not stated, the reference to maintaining efficacy of protection can only be possible when the active ingredient(s) are not leached from the wood in significant quantity over the exposure time. The associated term "leaching" is defined as "The migration from wood of preservative components into surrounding environment by the movement of water" (1).

Fixation is a property of waterborne treating chemicals that has been studied and evaluated with various levels of understanding. Many earlier studies define specific mechanisms involved in making the once water soluble chemicals become attached to the wood substance or complex with other components, thereby being insoluble in water during service exposure (19). The ACZA preservative system has some chemical fixation traits that differ from the

processes associated with acid-based formulations such as CCA (chromated copper arsenate).

Lebow and Morrell (11) found that during the fixation of ACZA, as ammonia levels decreased by off-gassing, precipitation of zinc arsenate occurred first. The reaction between these components may be the basis for improved arsenic fixation reported in ACZA, and zinc is normally the most leach resistant component detected in the evaluations. Copper is thought to be more directly involved with bonding reactions with the wood, which may occur at a slower rate.

The ammoniacal systems use ammonia in water as the carrier to move the active ingredients throughout the cellular structure of the wood. This movement is necessary for the metallic ions to locate attachment sites in the wood (27). More ions in the matrix (higher retention) make it more difficult to locate an unoccupied site for the ion to fix. Processing methods reducing the immediate loss of ammonia after treatment, such as enclosure or wrapping treated material, or increasing the ammonia available in the wood such as aqua-ammonia steaming, have been successful in improving the fixation of the chemical to the wood in ACZA (13).

Analytical procedures are now being developed and proposed to the AWPAC4 that allow testing material for fixation, with more consistent and meaningful results than previously available. These tests support some of the theories based from earlier studies. Fixation periods are directly related to the retention level of waterborne treatments, therefore the higher the retention of chemical in the wood, the longer it takes to fix the chemical to an equivalent level.

Further reports have also shown the actual fixation process for ACZA is not directly related to drying the wood for removal of water. This was previously thought to be a key factor for fixation of all waterborne preservative systems. The process is more directly related to the off-gassing of ammonia which stabilizes metals in the wood by allowing them to form precipitates, or come out of solution and become insoluble compounds. The preservative retention level continues to affect this process, becoming much more complex when the retention is above 1.0 pcf of active ingredient. As a general rule, these higher retention materials require longer fixation periods (7, 22), but are not common retention levels for materials used above or in ground contact applications.

Copper oxide is more water soluble and has been identified as the last component in many waterborne copper-based preservatives to become fixed, allowing it to be used as an indicator to determine the level of fixation obtained. Methods now under

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development to determine chemical fixation should be of help in defining the specification necessary for material to be considered adequately fixed for shipment. The more "fixed" a chemical becomes, the less potential it has for leaching from wood when exposed to water and weathering while in service. This is a critical parameter for the future use of waterborne chemical treatment and encourages the use of BMP's by responsible wood treaters (15).

Leachability

ACZA leachability was studied and compared to the original ACA formulation by Best and Coleman (3). Their results indicated a significant reduction in the leaching of not only arsenic but copper as well, along with reduced leaching of all components at the higher retention levels (1.0 - 2.5 pcf). Therefore, even though the fixation period is longer for higher retentions, the resulting fixation may potentially be more stable as indicated by the lower percentage of chemical leached.

Analytical work is now being conducted at Oregon State University on soil samples to determine the amount of copper, arsenic and zinc found in soil around utility poles located in Florida, Virginia, New York and Pennsylvania to include various soil compositions. A multiple sampling grid surrounding the poles was used to provide information at differing distances and depths in comparison with unaffected control soils and a wood sample included for each pole in the test. These data will assist in determining the potential for leaching from ACZA treated poles. An added portion of this study will evaluate samples from retaining walls and highway guardrail posts.

Safety

The issues of fixation and leachability address environmental exposure concerns of the treated wood product during its intended use, but the human safety element created by exposure to the material must also be considered. This brief summary will approach those factors having the most direct relationship without going into intricate detail associated with the supporting information.

It is important to understand the three possible routes of exposure that humans have to any chemical. These include inhalation, ingestion or absorption through the skin. Before any chemical can be a threat to human health or have toxic effects it must enter the body. Tests results at the University of California in Davis by Dr. Peoples (16) show arsenic oxides in treated wood cannot be absorbed through the skin. This eliminates one such avenue for exposure.

The inhalation route of entry is confined to inhaling sawdust, surface residue or dust while working with the treated wood because these oxides are also not volatile. This means they do not evaporate into the air at normal ambient temperatures. Eating, using tobacco products or drinking without washing hands prior to performing these activities increases the risk of ingesting sawdust or surface residues from the wood.

Dr. Peoples also showed that bodily fluids could only leach approximately half of the metal oxides entering the body by ingestion. The human body routinely disposes of small amounts of arsenic it absorbs from natural sources such as drinking water, seafood, and red wine. If there were small amounts ingested from treated wood, it would be eliminated from the body in this same way (17).

The best protection from any exposure to wood treating chemicals is offered by following personal hygiene and safety precautions. These include using gloves to prevent splinters and contact with surface dust, wearing dust masks and eye protection when machining treated wood, and always washing before eating, drinking or using tobacco products. These are the same precautions recommended for working with untreated wood, and can greatly reduce the potential of chemical exposure from treated wood. Another safety precaution is that treated wood of any kind should not be burned as firewood in a residence or outdoor fire.

Registered pesticides must be reviewed on a regular basis for re-registration with the EPA. A requirement of this process includes data submission to confirm the safety of the treated wood. There have been four epidemiological studies on workers at arsenical wood preserving plants and carpenters using treated wood extensively. Even in these high occupational exposures there are no long-term effects from working with the preservatives or arsenical treated wood. ACZA-treated wood is a safe product and does not require any special protective clothing or equipment except the normal safety precautions used with any wood product, treated or not.

The formulation change for Chemonite has made a very significant effect on the safety of ACZA in the environment and for users of the treated product for several reasons. First of all the amount of the more toxic component, arsenic, was reduced in half by replacing it with zinc (a less toxic component). Therefore, the overall toxic level of the preservative system is reduced.

Zinc also acts to prevent the uptake of copper by the body if it is ingested, offering an added margin of safety. The addition of zinc to the formulation improves the fixation of arsenic by forming a less

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soluble precipitate with zinc. Also, combined with the relatively low loss of copper and zinc from treated wood, this addition of zinc presents the advantage of reducing potential environmental interaction by leaching (22). The scientific evidence available supports ACZA treated wood as a very safe product to the environment and humans who have contact with it.

Other attributes

Corrosion: It has always been recommended to use hot-dipped galvanized fasteners or hardware when in contact with ACZA treated wood. The basis for this is to have the galvanic coating sacrificed in order to afford protection to the rest of the metal over time. This creates a surface corrosion within a few years of service that may cause concern for those not familiar with this process. However, several tests have indicated that this initial corrosion rate is not sustained over a long period of time and does not effect the long term strength, service life or performance of the hardware.

Actual test data on bolts removed after 38 years of exposure in a Portland General Electric line outside of Portland, Oregon resulted in all but one sample meeting or exceeding the rated breaking strength for the bolt size. The one exception had test results at 98.5% of the rated strength value. Other accelerated and full size corrosion tests indicate similar results with ACZA being significantly less corrosive than the earlier formulation. These tests also indicate dry or material with lower ammonia levels are less corrosive to galvanizing coatings than freshly treated wood, which supports the need to have wood undergo fixation before shipment or use (9,24,26).

Note: Salt water or other extremely corrosive conditions may require the use of stainless steel or other materials and specific recommendations should be obtained from an informed source for acceptable hardware in these exposures.

Conductivity: Electrical conductivity is an appropriate concern when selecting any material as a utility pole to carry electricity. A number of studies have been conducted to evaluate and understand this particular aspect of waterborne treated wood poles. Generally speaking, even untreated wood poles will conduct electrical current when levels of moisture are above the fiber saturation point.

Testing of the metal oxides used in ACZA by applying voltage to compressed pellets of the dry powder indicate these components are non-conductive. Further testing has identified that water or treating solutions are the more conductive elements in treated wood, therefore any freshly

treated wood pole should be considered as "hot" for handling purposes.

Conductivity drops in a similar fashion as treated and untreated wood undergoes drying, therefore the moisture content is the critical factor, not the treatment. There is also evidence of decreasing conductivity over the service life of ACZA poles. Poles dried below fiber saturation do not induce the same level of conductivity measured before drying took place when they are subsequently re-wetted.

All test results show ACZA treatment does not create a shock hazard. Because there is no consistent field test method available to accurately predict if a safety hazard exists, it is recommended that under adverse conditions, ACZA or any wet pole, should be approached and handled as if it is electrically hot (10).

Woodpecker resistance: There are utility companies in the Eastern U.S. with very favorable reports of decreased woodpecker attacks on ACZA treated poles. Mike Brucato summarized Virginia Electric Power's experience with ACZA following several attempts using various other control methods and published this information in 1994 (4). Several other utilities reported similar results including Kissimmee Utility Authority (FL), North Star Electric (MN), Kentucky Power Co-op Inc., and Hoosier Energy (IN) (6).

Chemonite cannot be considered 100% effective in prevention of woodpecker damage, but it has significantly decreased the amount of damage and number of pole replacements reported by the field experience to date. Additional tests are being conducted in cooperation with EDM and other utilities to expand the understanding of this attractive feature of Chemonite for utility poles.

Formosan Termites and Carpenter Ants: Although not as wide spread as a native subterranean termite, the residents in areas of Hawaii and the Southern U.S. with infestations of the Formosan termite, fully understand the threat this voracious wood-destroying insect presents. Tamashiro, et.al. reported that ACZA provided excellent protection when exposed to this termite (25).

Carpenter ants do not ingest cellulose from wood, but excavation by these insects is extremely damaging to the structural integrity of structures they colonize. Laboratory and field testing has shown that ACZA treated material resists attack by carpenter ants with very high mortality rates (8). This is true for both freshly treated and aged or weathered material and can be a very attractive feature for products such as utility poles from the standpoint of protection from the insect itself and

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resulting woodpecker attack when these insects are present.

Climbability: One aspect of waterborne treated utility poles and ACZA treatment in particular, is the resistance and opposition by linesmen due to climbability. This property can be measured using gaff penetration tests. Past studies by Arizona Public Service and Columbia Research and Testing indicate that all waterborne treated poles have gaff penetration resistance similar to untreated wood of the same species at the same moisture content. Individual test sample variations caused by density and grain pattern of the wood are normally greater than differences attributed to the preservative treatment groups. This makes comparisons very difficult but by far, the most notable factor in gaff penetration analyses relates to the ease of penetration into oil-type preservative treated wood due to the lubricating effect of the oil (18).

Gaff penetration tests with CCA also identified sharpness of the gaffs to be a continual problem in evaluating the penetration into wood. These tests also suggested that newly designed gaffs produced some level of improvement. The Buckingham CCA model 9106 and Klein gaffs required less force than the other brands tested to penetrate ACZA treated or untreated wood (5). Most of the climbing issues relative to gaff penetration are identified as dealing with subjective problems and are difficult to resolve satisfactorily using technical information.

Nail-Holding Capacity: A study on incising and preservative treatment effects on nail-holding capacity of Douglas-fir and Hem-fir indicate no significant effects from incising on this wood property. This was also evident when placing the test nails directly into the incision on the face of the board. There was however, a marked improvement in the quality of treatment with both ACZA and CCA waterborne chemicals when the material was incised. Chemonite did obtain greater preservative penetration depth and retention, supporting the use of ammonia-based treatments in refractory species. It was also reported that ACZA treatment appears to significantly improve resistance to nail withdrawal (12).

SUMMARY

There is clearly a wealth of information to support the various attributes of ACZA in laboratory and field studies. The changes to the chemical formulation and treating process developed over the past decades have only improved the ACZA treated

product performance and expanded its attributes from environmental, health and safety aspects.

Chemonite is a very effective preservative not only in the standard application for protection against decay fungi and insects, but also providing additional qualities to consider in its Formosan termite, carpenter ant, and woodpecker repellent effects. These concerns are critically important for protecting commercial and industrial treated wood products to obtain maximum service life and performance without sacrificing the expected qualities and characteristics.

The ability of ACZA to penetrate into the heartwood and provide sterilization during treatment of Douglas -fir and other refractory Western wood species has a definite advantage in the waterborne preservative category.

Environmentally, there is no comparison between wood and any other material. Wood is an energy efficient, renewable and sustainable resource offered by nature. When utilized properly with adequate preservative protection from the natural biological modes of deterioration, it provides effective and low cost products with a history of long service performance in a multitude of exposure conditions. Chemonite has the ability to meet the needs for protection of products in all use category applications and exposures.

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Discussion

Mr. Randall T. Baileys: Thank you. If anyone has a question, I'll take it

David Pugh, Otter Tail Power Company. Did you address aluminum nails or aluminum hardware..

Mr. Baileys: No, and I should let Jeff answer the question as he did the study. I believe those were mild steel, regular fastener systems.

Unknown: Has there been any study with the non-refractory, the thick sapwood species at all with the ACZA.

Mr. Baileys: I know early on, and this was certainly before I came to J.H. Baxter, they had done some testing on pine. We do treat western species of pine. Ponderosa pine certainly treats very easily. There is no reason to expect any problems with treating pine. Pine is pretty easily treated.

For the less refractory species: we've done some work with radiata pine and red pine. ACZA treats both of those very easily. I would not expect any difference in any of those less refractory species than Douglas-fir. Generally, if you have something that treats Douglas-fir, it can treat just about anything.

Dr. Preston: Any further questions?

Mr. David White, Defense Logistics Agency: Have there ever been any specific environmental challenges or legislation against ACZA or has it just been included in the same category as the other waterbornes such as CCA?

Mr. Baileys: The traditional markets where ACZA has been used have been heavy industrial, heavy construction type materials, poles, piling, timber for use in bridges. A very limited amount going into any type of residential or what you would consider contractor use.

ACZA was not actually involved in the CCA discussions or in the agreement. I can say, however, that there are discussions taking place now, because of the re-registration process, wanting to look at should there be any changes in the label language for that product. But right now we do not expect to have to change the markets that we traditionally have been in over the years. We expect to be able to have it available for those

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uses because they are very similar to what CCA has at this point remaining for its use.

Dr. Lehong Jin, Chemical Specialties, Inc.: I just have a question for clarification concerning leaching. Did you say that chemical leaching at high retention actually has reduced leaching. Do you mean that the percentage of reducing leaching or the overall amount is less? Mr. Baileys: You see a reduced amount on a percentage basis.

Dr. Preston: There being no further questions, I'd like you to give a round of applause to Randy, [applause]

The next talk this morning is by Thomas Searles. It is on "Required Treatment for Non-Manufactured Wood Packaging."

Tom went to school at Louisiana Tech and he has been the President of the American Lumber Standard Committee for the last 32 years, served on two industry committees of the government, and has been listed in Who's Who in the World for the last 15 years.