# Trends in Waterborne Treated Wood Production and Implications for Wood Waste Disposal

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**ABSTRACT**

Changes in the production of waterborne treated wood will be likely reflected in the wood waste stream. The objective of this paper is to compile statistics of waterborne treated wood production over time and use this information to discuss potential impacts of the wood waste disposal sector. Results of our analysis show that there have been significant changes in the production of waterborne treated wood due to the impacts of the 2008 recession and the phase-out of residential

CCA-treated wood. Prior to the 2004 phase-out, CCA-treated wood represented 98% percent of the waterborne market. Since the phase-out, CCA-treated wood represents about 30% of the waterborne treated wood. Transitions have been observed in the alternatives for the remaining 70%. Alternatives range from dissolved formulations of copper-based alternatives, to micronized copper, and most recently organic preservatives free from metals. These changes will likely be reflected in the disposal sector making it easier for waste recyclers to meet regulatory guideline levels for arsenic and eventually copper within their recycled products.

# Comparison of Performance of Wood Extractives as Preservatives in Field Tests Against Termites and Decay in USA and Pakistan

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**ABSTRACT**

Current environmental constraints limit the use of broad spectrum synthetic poisons as wood preservatives, creating a need for new environmentally benign wood preservatives. Biocidal compounds from natural products have been proposed as alternatives to commercial wood preservatives, but field data on long term performance is lacking. The goal of this study is to evaluate extractives of durable wood species of Pakistan and their suitability as solvent

born treatments for non-durable wood species. Stakes (45.7×1.09×1.09 cm) and blocks (12.5×3.75×2.5 cm) of Southern yellow pine (SYP) and cotton wood (CW) were treated with the heartwood extractives of four durable species (*Tectona grandis*, *Dalbergia sissoo*, *Cedrus deodara* and *Pinus roxburghii*) commonly used in Pakistan. Extractives alone (7.5 mg/ml) and in combination with linseed oil (4.25 mg/ml + 20 % oil) along with positive control were vacuum – pressure impregnated at 150 psi for 60 minutes. The treated samples were exposed to decay and termites using AWPA E-26 and AWPA E-7 standard tests in Mississippi (USA) and Punjab (Pakistan). After one year in the field in Pakistan the solvent treated stakes and blocks were completely destroyed by *Heterotermes indicola*. Ratings for control SYP were higher than CW (avg. ratings less than 1.5). Wood treated with extractives from *Pinus roxburghii* and *Cedrus deodara* appeared to attract some termites at both sites. Decay ratings for *D. sissoo*, *C. deodara* and *P. roxburghii* treated wood were also lower than other treatments at both sites. Heartwoods samples (stakes) of *P. roxburghii* and *C. deodara* had average decay ratings of less than 5. There was more termite pressure by *H. indicola* in Pakistan compared to *R. flavipes* in the USA. There was no significant attack of decay and termites on woods treated with extractives in combination with linseed oil at either site.

# Reducing the Thickness Swelling of Wood Composites using Z-Direction Adhesive Cross-links

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**ABSTRACT**

Wood composites undergo irreversible thickness swelling and strength losses when they are exposed to water, and there is strong interest in developing cost-effective solutions to this problem. We hypothesized that a composite with more adhesive connections in the Z (thickness) direction would be less susceptible to moisture-induced thickness swelling. We test this hypothesis here using a model composite consisting of perforated veneer that allowed a polyurethane adhesive to create cross-links in the Z-direction. Model composite specimens were submerged in water, air-dried and their irreversible thickness swelling and surface topography were measured. Z-direction cross-links significantly reduced the thickness swelling of both yellow cedar and white spruce specimens. Confocal profilometry, macrophotography and scanning electron microscopy revealed pronounced dimpling in areas around the Z-adhesive connections suggesting that the connections restrained swelling. The inter-connected adhesive network retained its integrity better in spruce specimens subjected to water immersion and subsequent drying than in cedar specimens subjected to the same conditions. We conclude that the creation of coarse adhesive cross-links in the Z-direction is a promising approach to reducing the thickness swelling of wood composites. Further research is needed to develop practical ways of creating Z direction cross-links in composites that more closely resemble commercial products.

# Assessment of Volatile Metabolites for In-Situ Detection of Fungal Decay of Wood

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**ABSTRACT**

Despite the fact that incipient decay may be difficult to detect visually or by weight loss with certainty, it causes a significant decrease in wood mechanical properties of standing structures. Due to high costs of replacement of decayed wood, it is necessary to develop reliable methods of wood decay identification. In this study, we describe a method of examining volatile organic compounds (VOCs) released by two brown rot fungi (*Gloeophyllum trabeum* and *Postia placenta*) and two white rot fungi (*Trametes versicolor* and *Irpex lacteus*), based on solid phase microextraction (SPME) coupled to gas
chromatography–mass spectrometry (GC-MS). In addition, mechanical strength was tested on the same samples that were analyzed for VOCs.

Volatile emissions from the cultures of four decay fungi grown on pine and aspen were investigated over 12 weeks and comparison of VOCs among fungi and wood species was performed. The majority of VOCs were identified as mono- and sesquiterpenes, aldehydes, ketones, aliphatic alcohols, and some other aromatic compounds. VOC patterns of four studied fungi showed that stage of decay can be associated with VOCs released and correlated to mechanical strength and that the chosen analytical method was useful for incipient decay detection.

**Keywords**: Volatile Organic Compounds, Solid Phase Microextraction, Gas Chromatography-Mass Spectrometry, Brown Rot, White Rot, Mechanical Strength, Incipient Decay

# Understanding the Interactions Between Photodegradation and Biological Degradation by Black Stain Fungi

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**ABSTRACT**

Research to understand the loss of performance of exterior wood coatings has generally involved separate laboratory experiments for each weathering factors.

In order to consider other possible relationships between photodegradation and biological degradation, wood samples painted with clear coatings were degraded under xenon lamps for different lengths of time and then inoculated with two black stain *fungi* (*Aureobasidium pullulans* and *Epicoccum nigrum*). Fungal colonization was followed with a visual scale similar to AWPA-E24 and colorimetric analysis. Chemical changes were monitored by FTIR, and physical changes characterized by microscopic analysis and coating adhesion tests.

The microscopic analysis revealed coating thickness, porosity and degradation after both photodegradation and biological degradation. The chemistry of the coating did not appear to be altered by exposure to light and *fungi*. Black stain colonization was instead associated with physical changes to the coating. Coating adhesion and thickness were significantly decreased with the appearance of numerous bubbles. The ability of the black stain *fungi* to colonize photodegraded wood is not only due to their capacity to metabolize lignin breakdown products, but also to their ability to physically penetrate the coating. The bubbles present in the coating appeared to be more prone to pop when coating thickness decreased.

# Development of A Method for Assessing Water Repellency and Dimensional Stability of Preservative Treated Railroad Ties

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**ABSTRACT**

Untreated wood is inherently hygroscopic and repeated wood/water interaction can affect dimensional stability leading to the development of deep surface checks that enhance moisture uptake and encourage deterioration. Water repellency and dimensional stability are particularly important in railroad applications given the horizontal exposure of crossties. Wood used in such applications is typically preservative treated to prolong its service life. Preservatives protect against insect and fungal attack, but many also alter hygroscopicity and enhance dimensional stability. While understanding these properties is important, there is no standard method for assessing the water repellency and its interaction with dimensional stability in large wooden members such as railroad ties.

Potential methods for assessing these properties was investigated on four wood species treated with creosote, pentachlorophenol or ammoniacal copper zinc arsenate. Untreated controls were also assessed. The materials were subjected to eight to ten accelerated wetting and drying cycles. Dimensional stability and water repellency were evaluated after each cycle. Water repellency varied widely with cycles, but creosote and pentachlorophenol treated samples performed best. Dimensional stability was more variable and dependent on wood species rather than treatment.

The results of this work will be used to develop a rapid, easily reproducible and cost effective method for assessing the water repellency and dimensional stability of preservative treated wood used in railroad applications.