

Neutron Activation Analysis for Quality Assurance of Wood Preservative Retention

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ABSTRACT

Neutron activation analysis (NAA) is a non-destructive analytical technique that can measure the concentrations of the signature elements of several wood preservative chemicals directly, on wood chips or wafers, without sample destruction. The elements copper, iodine, arsenic, bromine or chlorine can be detected at ppb levels. The NAA Laboratory at Ecole Polytechnique Montreal has more than 20 years experience analyzing treated wood and provides accurate analysis because of the good reproducibility of the neutron flux of its SLOWPOKE nuclear reactor and the efficiency of its gamma-ray spectrometer and the fact that neutrons and gamma-rays can easily penetrate a solid sample of wood. In addition, the reactor is available five days a week, resulting in one day turn-around times for the analysis of most wood preservatives. With automated irradiation and counting systems, the NAA laboratory can handle up to 200 samples per day. All these advantages qualify NAA as the method of choice for quality assurance measurements of preservative retention in wood products. The NAA method is described and examples are given of measurements of wood preservative retention and penetration.

Durability of Alaska Yellow-Cedar in Stake Tests

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ABSTRACT

Alaska yellow-cedar (AYC) is increasingly used for durable applications, but the extent of the natural durability of this species remains unclear. This paper reports on stake tests conducted as part of a larger project to evaluate the properties of AYC timber in Alaska. AYC trees felled from Tongass National Forest were divided into "small" and "large" diameter classes. Stakes were cut from the inner and outer heartwood of each size class and placed into exposure plots in Mississippi and Wisconsin. Southern pine stakes were included for comparison. The stakes were visually rated for evidence of decay and/or termite attack for 8 years in Mississippi and 12 years in Wisconsin. AYC stakes were more durable than Southern Pine stakes in both Mississippi and Wisconsin, but there was little practical difference in the durability of AYC cut from different diameter classes or heartwood locations. AYC stakes in Mississippi suffered noticeable attack by both decay and termites within one year. This deterioration progressed steadily, with over 50% of the stakes destroyed within 7 years. Deterioration of AYC stakes was slower in Wisconsin, with over 70% of the stakes remaining in test after 12 years. However, average ratings declined to between conditions "7" and "8" within 4 years in Wisconsin. These results indicate that although AYC is more durable than Southern Pine, untreated AYC may not be sufficiently durable for ground-contact applications where longevity is critical.

Exposure Location Issues in Preservative Treated Stake Studies

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ABSTRACT

Interpretation of stake test results for evaluating the effectiveness of preservative treatments and species combinations in multiple environments is difficult at best. A 10-year study of two locations, five species, and nine treatments (several at multiple levels) is statistically evaluated to highlight and address some of the issues. One of the main goals of the study was to address the issue of exposure location and whether results in one harsher environment may act as a surrogate for exposure in one less harsh, and if so, under what circumstances.

The Usual Suspects: Fingerprinting Microbial Communities of Fungi and Bacteria Involved in Wood Decay

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ABSTRACT

Current standards for soil-block testing have long been based on the effectiveness of preservative systems against only a small number of wood decay fungi and even fewer bacteria. Culture independent molecular methods offer simple, reproducible means to obtain a more holistic view of the microbial communities that colonize wood throughout the decay process. By using a culture independent PCR-based method called terminal restriction fragment length polymorphism (T-RFLP) analysis, we were able to detect shifts of fungal and bacterial communities in wood treated with sub-lethal concentrations of ACQ-C and CTN. T-RFLP takes into account all species of an taxonomic group and creates a community profile or 'fingerprint', where each peak in the profile represents a unique species. Both compounds appeared to change the patterns of bacterial succession completely, so that beginning and ending communities were significantly different in regards to species composition. Fungal species community structure was initially changed, but became more similar to untreated controls over time, presumably as the preservatives were depleted from samples. Subsequent depletion analysis found >60% depletion of preservatives from treated field stakes after 15 months exposure. Proposed modifications to this process will eventually enable us to accurately identify fungal and bacterial species making up the microbial communities found in treated and decaying wood and offer new insights into the decay process.

Synthesis and Evaluation of Dialkylaminoborates in Wood for Fungal Decay Protection

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ABSTRACT

The aim of this study was to evaluate dialkylaminoborates in wood for fungal decay protection. Dialkylaminoborates were synthesized by refluxing dialkylamines with boric acid in 1:1 molar ratio in ethanol for 3 hours. The products were characterized by Nuclear magnetic resonance (NMR) and Fourier transform infrared spectroscopy (FTIR). Wood impregnated with dihexylaminoborate (DHAB) after 2 weeks water leaching with retention of 44.5 mmole had weight losses of 1.2% by the brown-rot fungus *Gloeophyllum trabeum* (*Gt*). Dioctylaminoborate (DOAB), with retention of 44.3 mmoles, had weight loss of 0.4% by *Gt*. The control had 51.1% weight loss by *Gt*. Leaching greatly decreased decay resistance. Research is needed to make more leach resistant dialkylaminoborates by changing the hydrophobicity of the alkyl groups.

Synthesis and Evaluation of Dialkylamino Catechol borates in Wood for Fungal Decay Protection

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ABSTRACT

The aim of this study was to evaluate dialkylaminocatechol borates in wood for fungal decay protection. Dialkylamino catechol borates were synthesized by refluxing dialkylamines, boric acid and catechol in 1:1:1 molar ratio in ethanol for 4 hours. The products were characterized by Nuclear magnetic resonance (NMR) and Fourier transform infrared spectroscopy (FTIR). Wood impregnated with dihexylamino catechol borate (DAACB) after 2 weeks water leaching with retentions of 69.3 and 78.3 mmoles had weight losses of 0.6 and 0.4% by the brown-rot fungus *Gloeophyllum trabeum* (*Gt*) and the white-rot fungus *Trametes versicolor* (*Tv*), respectively. Dihexyl-3-methyl catechol borate (DHAMB) with retentions of 84.9 and 74.0 mmoles had weight losses of 0.8 and 1.3% by *Gt* and *Tv*, respectively. The control had 34.7% weight loss by *Gt* and 46.4% by *Tv*. Leaching greatly decreased decay resistance. Research is needed to prepare more leach resistant dialkylamino catechol borates by changing the hydrophobic alkyl groups.

Effects of Surface Topography on the Properties of Superhydrophobic Wood

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ABSTRACT

Fungal decay of wood in service results in billions of dollars of losses annually in the United States. Excess moisture is the single most important factor that degrades the performance and facilitates the growth of fungi in wood. Without sufficient moisture, fungi will fail to grow even in products such as wood utility poles that are exposed to exterior environments. Superhydrophobic treatment could be an environmentally benign alternative to wood protection and wood preservation. The aim of this study was to examine the effects of surface topography on the hydrophobic properties of superhydrophobic wood.

The Resistance of Modified Hardwood Material to Subterranean Termite Attack

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ABSTRACT

Lignocellulosic ethanol production currently uses expensive and harsh methods to extract wood sugars from small-diameter hardwood trees that otherwise would have little or no marketability. A byproduct that adds no value to the conversion process results, thus alternative methods are needed to make this fuel source cost-effective. One possible procedure partially hydrolyzes southern hardwoods, extracting some polysaccharides for ethanol fermentation while leaving behind a modified wood material for manufacturing structural composite lumber. This study was conducted to determine whether the hydrolysis treatments affected the durability of the modified woods, particularly their resistance to the eastern subterranean termite *Reticulitermes flavipes* Kollar as termite damage exceeds one billion dollars in the United States annually. We heated water-saturated yellow-poplar, sweetgum, and red oak samples at 150°C for 30 minutes in two solutions, water and 1 percent NaOH; controls were also utilized. We subjected samples to the AWPA E1-09 no-choice termite test and determined mass loss due to *R. flavipes* feeding. The species and treatments independently and significantly affected the mass loss. Yellow-poplar averaged a significantly higher mass loss than the other two species, and all samples treated in water or NaOH showed a higher degree of termite degradation than the controls. An inverse relationship was noted between wood density and mass loss by termite feeding. Utilizing partially hydrolyzed hardwood flakes in structural composite lumber will likely require pressing to higher target densities to impart some termite deterrence.

Comparison of Different Methods to Determine Basidiomycete Species Richness on Preservative-Treated Wood

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ABSTRACT

The process of wood decay is an intricate series of biochemical and chemical reactions that are greatly influenced by the hundreds of fungal species found on environmental samples of wood. There are a wide assortment of molecular techniques that can be used to identify wood decay organisms and their specific activities. In this study, three prominent molecular procedures were used to analyze the number of unique basidiomycete species present in the wood decay community of individual preservative-treated samples. Denaturing gradient gel electrophoresis (DGGE) is an acrylamide gel-based physical separation technique that is used to rapidly determine the number of species in a mixed culture. For this study, DGGE was performed as a rapid preliminary assay to detect the species count within each sample. Terminal restriction fragment length polymorphism (T-RFLP) utilizes fluorescent tags (primers) to identify multiple species in a given sample. T-RFLP was performed as an alternative method to rapidly determine the species count in a given sample. The third technique explored in this study, cloning, is a highly sensitive procedure that inserts DNA fragment mixtures into a vector then promotes growth of exact replicates that can be sequenced to determine the identity and number of species in a sample. In this study, DNA fragment mixtures from environmental samples were cloned into an *Escherichia coli* vector and sequenced for comparison to known species. The goal of this study was to compare these varying techniques and determine which method is more efficient for evaluating the range of species contained in individual environmental samples.

Assessment of Biodiesel as an Alternative Carrier for Pentachlorophenol (PCP)

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ABSTRACT

Biodiesel is regarded as an environmentally friendly carrier when mixed with petroleum diesel for pentachlorophenol (PCP) mainly due to its co-metabolic function and its high degradability in soil. A six month study is currently underway to evaluate the degradation of biodiesel and diesel in soil. Clean dried garden soil (100g) was mixed with three milliliters of biodiesel with and without petroleum diesel plus PCP and/or co-solvents. The soil mixture was placed in 250 ml amber glass jars with lids containing air holes and incubated at room temperature. Moisture adjustment and aeration are provided twice weekly. Ten grams of samples are being taken bimonthly for oil and grease, PCP concentration, and microbial enumeration. In addition toxicity will be determined on days 0 and 180. However, results are incomplete at this time, but data taken at the end of day 120 showed that an increasing proportion of biodiesel accelerated the degradation rate of diesel. The collected results from this study will be presented in the conference.

It's Not Easy Being Green- Consumer Perceptions of Treated Wood as a Sustainable Material

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ABSTRACT

How does treated wood constitute as a sustainable material? Understanding the “how” just may be the answer that removes the variability in the terminology of “green” that has created confusion in the public’s perception of treated wood products. Wood products are created by environmental stewards, such as foresters, wood scientists and engineers, who are caretakers of our natural resources. Treating these products supplies power, recreation, structurally secure homes, and improved access to our forests for both youth and the handicap. Studies have shown that treated wood structures not only provide economic, environmental, and social benefits to humans, but they also provide increased diversity in habitats. A survey is being compiled to assess consumers and non-consumers perception of treated wood, it will aid in creating information to help educate the general public of the volume of wood inventories, the environmentally responsible industrial practices of wood products, proactive approaches to creating new safe products, and recycling steps taken by the industry. The intellectual merit of this research is that the treated wood industry will add social as well as environmental and economic value to their products by promoting their use of wood as a sustainable material. Wood is renewable and wood treatments increase wood products life span by reducing the need for more wood from the forest; responsibly reducing use is the first step of Reducing, Recycling, Reusing, and Renewing.

Investigation into Copper Indicators for Treated Wood

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ABSTRACT

Currently most of the non-industrial treated wood in the USA is preserved with a copper based product and over 30 percent of the industrial treated wood is treated with copper based preservatives as well. Three commonly employed copper indicators have been in wide spread use for determining either pressure treatment preservative penetration or simply the presence of copper in treated wood. All three of these systems are currently standardized by the American Wood Protection Association but the systems vary in their sensitivity. This work was undertaken to investigate the current third party trends in the USA to use Rubeanic Acid for Copper penetration detection over that of Chrome Azurol S and at the same time investigate other possible copper indicators for treated wood.

Percentage of Heavy Metal Removal and their Distributions in Liquefied CCA-treated Wood Sludge from Different Liquefaction Conditions

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ABSTRACT

Wood liquefaction was studied as a recycling method for Chromated copper arsenate (CCA)-treated wood waste. The effects of liquefaction temperature and time on the removal of the heavy metal and the distribution of heavy metal in liquefied CCA-treated wood sludge were investigated. The residue content decreased as the temperature increased from 120 to 180 °C regardless the reaction time. It decreased gradually as the reaction time increased from 30 to 90 min. at 120 and 150 °C while it increased when the reaction time increased to 90 min. at liquefaction temperature 180 °C due to the re-condensation of decomposed wood components. The total concentrations of all three heavy metals in the sludge samples increased while the percentage of the metals that been removed decreased with increasing liquefaction temperature, which could be related to the changes of wood residue content and the fate of the heavy metals under different liquefaction conditions. The exchangeable/acid extractable fraction of all three heavy metals decreased as the liquefaction temperature increased. At the same time, Cr and As gained an increase in both oxidizable and reducible fractions. The amount of Cr in oxidizable fraction increased 40% as the liquefaction temperature increased from 120 to 180 °C. The major change of Cu distribution is the increase in reducible fraction with the increase of liquefaction time. The results from this study suggested that high liquefaction temperature is not suitable when liquefaction is used as a recycling method for CCA-treated wood waste.

Long-term Durability of CCA and ACA: How is 0.4 Doing?

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ABSTRACT

For decades the phrase “point 4” was often synonymous with wood treated for use in contact with the ground. In this paper we review how and why the 0.4 lb/ft³ (6.4 kg/m³) became such an accepted standard, and then evaluate how well this retention has performed in long term stake testing. Data from plots near Saucier, Mississippi that contained Southern Pine 2 by 4 nominal (38 by 89 mm) stakes pressure treated with either ACA, CCA-A, CCA-B or CCA-C was evaluated. The plots ranged in age from 20 to 60 years. The data indicates that the 0.4 lb/ft³ (6.4 kg/m³) retention has provided good, but not unlimited, protection of wood placed in contact with the ground. Durability was notably diminished at retentions below 0.4 lb/ft³ (6.4 kg/m³) and greater durability was observed in retentions above 0.4 lb/ft³ (6.4 kg/m³). The 0.4 lb/ft³ (6.4 kg/m³) retention appears to be near the minimum for long-term ground-contact, and the selection of 0.4 lb/ft³ (6.4 kg/m³) for general ground contact applications and 0.6 lb/ft³ (9.6 kg/m³) for critical applications appears to have been a wise choice. The data also indicates that the 0.4 lb/ft³ (6.4 kg/m³) CCA retention is not excessive, and is an appropriate choice for comparison to test formulations intended for use in ground contact applications.

Molecular Identification of Pentachlorophenol (PCP) Tolerant Bacterial Communities in Contaminated Groundwater Undergoing Air-Sparging Remediation

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ABSTRACT

Pentachlorophenol (PCP), a highly toxic and recalcitrant wood preservative, contaminates groundwater aquifers in many areas of the United States. Improper handling, storage, and disposal practices in the past have led to the contamination of groundwater at many wood treatment facilities. Air sparging, the injection of clean air under pressure into the groundwater system, has emerged as a viable in-situ treatment option for removal of this type of contamination. Previous studies in this area have relied on growth media cultures for isolation and identification of the bacterial community that is responsible for the degradation of the pollutant. However, molecular identification of DNA extracted from the contaminated groundwater will provide a more accurate description of the microbial community. The goals of this study were to identify the bacterial community from the DNA extracted from contaminated water samples, and compare differences in PCP-tolerant bacteria in the communities with and without air sparging and addition of nutrients. Eight biosparging wells located at a wood treatment facility with a PCP groundwater contamination in central Mississippi have been monitored since 2001. Groundwater samples from these existing wells were taken quarterly and analyzed for total PCP concentration by GC-ECD. DNA was extracted from these water samples using a WaterMaster DNA purification kit. The 16s region from this DNA was also amplified using bacterial specific primers and then cloned into *E. coli* cells. Cloned *E. coli* cells were extracted and sequenced for identification. PCP concentration shows a greater than 1ppb concentration in upstream wells, while concentrations of PCP near the air injection wells and downstream of the air injection wells were near or below 1ppb. PCP-tolerant bacteria are also being identified by growth on exclusion media. Work to be done includes RT-PCR to examine the expression of genes encoding enzymes known to participate in the PCP degradation pathway by the identified bacteria.

The Insecticide/Termiticide Imidacloprid- A Sound Choice for Sustainability: Keeping Bugs out of Boards

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ABSTRACT

Each year in the United States alone, the damage due to termites exceeds \$11 Billion dollars. In the southern US and Hawaii, the Formosan Subterranean Termite (FST) is responsible for in excess of 2 billion dollars damage annually. This paper reviews the physical properties, chemical properties and the efficacy of one of the newer neonicotinoic insecticides, Imidicloprid and how it provides for the continued sustainability of forest products in the USA. By protecting wood from attack by wood destroying insects, the potential use for Imidicloprid saves in excess of 58 million acres of sustainable forestland resources.

Keywords: Insecticide, Termites, Imidicloprid, Sustainability, Wood-destroying Insects, and Preservative