Statistical Process Control Strategies for Reducing Costs in Manufacturing Treated Wood

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Abstract

This paper outlines a systematic approach for implementing statistical process control (SPC) as a strategy towards reducing the manufacturing costs of treated wood. The systematic approach examines sources of variation that increase cost during the manufacturing process. The philosophy proposed by Ishikawa that segments variation into five types: 1) measurement; 2) methods; 3) people; 4) machines; and 5) materials is exemplified for treated wood. Implementing a sustainable approach for reducing long-term variation of chemical additives using SPC is highlighted. Additional root-cause analytic techniques such as cause-mapping, correlation analysis, and Failure Mode Effects Analysis (FMEA) are discussed. The Taguchi Loss Function is developed for the treated wood manufacturing process as a methodology of estimating costs due to process variation. A "draft" handbook for applying these principles for the industry will be illustrated.

Keywords. – Treated wood, statistical process control, Ishikawa, FMEA, Taguchi Loss Function

Dysbiosis: A Potential Novel Strategy for Control of Subterranean Termites

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ABSTRACT

Although alternative control strategies using biocontrol agents have reduced populations of many pest insects, biocontrol of termites has met with limited success. Termite living conditions - crowded colonies in moist soil - are seemingly ripe for epizootic outbreaks, yet, termite colonies rarely succumb to disease. The source of their immunity comes from a multi-tiered defense system involving cellular, physiological, and behavioral mechanisms, the combination of which protects termites at individual and colony levels. Defeating termite immunity, however, may be possible by chemically inducing microbial imbalance or dysbiosis. In this study, treating solution (2% chitosan or control) and weather exposure (88 days or 0 days) were tested in a factorial design (four treatments total) to determine sublethal effects on hindgut bacterial diversity in the subterranean termite, *Reticulitermes flavipes*. The bioassay was set up according to the AWPA E1 single-choice feeding experiment. After four weeks, DNA was extracted from termite hindguts. Species abundance and richness were based on sequence analysis of the V3 and V4 region of the 16S ribosomal RNA gene using the Illumina 16S metagenomics workflow. After pre-processing the data by using data-driven methods to set thresholds for signal noise and removal of rare species, multivariate analysis was performed using the statistical package *PC-ORD*. Visualization of the phyla abundance data in a two-way cluster analysis indicated that the four treatments (CTW, chitosan-treated wood not exposed to weathering; CTW_E, chitosan-treated wood exposed to weathering; WTW, water-treated wood not exposed to weathering; and WTW_E, water-treated wood exposed to weathering) separated into two clusters, one uniquely comprised of CTW and the second formed by the other three groups. Association of CTW_E with the two controls (WTW and WTW_E) was presumably due to environmental leaching. PerMANOVA showed that treatment exerted a significant effect on phyla diversity with all four treatments being significantly different from each other. Indicator species analysis (Indicator Value $\geq$90) detected nine species specific to CTW. These species demonstrated both high relative abundance (>97% of total reads found were found in CTW) and constancy (species found in more than 90% of CTW DNA samples). Five have been isolated from human tissue infections or human tissue infections with comorbidities. Three species, *Mycobacterium abscessus, M. franklinii,* and *Sphingobacterium multivorum*, are ubiquitously found in nature and considered to be opportunistic pathogens. Based on these data, we hypothesize that antimicrobials like chitosan can chemically-induce dysbiosis to allow establishment of disease-causing pathogens.

Keywords: dysbiosis, chitosan, antimicrobial, termite, hindgut, pathogen, metagenomics

Treatments to Enhance the Resistance of Western Redcedar to Formosan Subterranean Termites

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Abstract

The termite resistance of western redcedar heartwood is highly variable. It was hypothesized that dip- and pressure-treatments with DDACarbonate and alkyl amine oxides would reduce variability and increase termite resistance in above ground exposures. An AWPA E26 test was conducted in Maunawili, Hawaii to test this hypothesis. After 42 months of exposure dip- and pressure-treated WRC samples termite attack was minimal, while untreated WRC was moderately degraded. These data suggest that treatment with DDACarbonate and alkyl amine oxides can upgrade the performance of western redcedar used in protected applications in areas with significant termite hazards.

Antimicrobial Activity of Organic Wood Preservatives against Biodeterioration Fungi: Minimum Inhibitory Concentration (MIC) via Spiral Gradient Endpoint (SGE) test

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Abstract

Efficient, reproducible, and sensitive procedures for screening antimicrobial activities of biocides are highly desirable. The goal of this study is to use Spiral Gradient Endpoint (SGE) agar plate test to measure the minimum inhibitory concentrations (MICs) of six organic biocides against wood-degrading fungi. The SGE method enjoys time and material advantages compared with conventional doubling dilution methods in agar or broth. The results compared the efficacy of 3-Iodoprop-2-yn-1-yl butylcarbamate (IPBC), chlorothalonil (CTL), 5-chloro-2-methyl-4-thiazoline-3-ketone and 2-methyl-4-thiazoline-3-ketone (CMIT/MIT), 2-Octyl-2H-isothiazol-3-one (OIT), propiconazole (PPZ), and 4,5-dichloro-2-N-octyl-4-isothiazolin-3-one (DCOIT) against mold fungi (e.g., *Alternaria alternata*, *Aspergillus niger*, *Cladosporium cladosporioides*, *Penicillium citrinum*, and *Trichoderma viride*), sap stain fungus (i.e., *Aureobasidium pullulans* and Ophiostoma pilifera), and various wood decay fungi (including *Coniophora puteana*, *Chaetomium globosum, Gloeophyllum trabeum, Postia placenta,* and *Trametes versicolor*). The findings are in agreement with previous studies, indicating the SGE method is a viable procedure to compare the relative antimicrobial activities between organic wood preservatives in a timely manner.

Indicating Penetration of Non-Aqueous Solvent with a Surrogate Agent: Hydrophobic Boron Containing Compound

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Abstract

Water-soluble boron compounds (such as boric acid, borax, and disodium octaborate tetrahydrate (DOT)) are commonly used as penetration indicators in aqueous wood treating solutions. However, aqueous wood treating solutions are not appropriate for all wood treating applications; typically, aqueous solutions tend to make wood swell and can affect the dimensional stability of the wood products. This study discovered hydrophobic boron containing compounds (borolane or borate ester, and mixtures thereof), which are soluble in solvent-based wood treating solutions and are functional with born indicator. Oil-soluble preservatives, such as pentachlorophenol (PCP), iodopropynyl butyl carbamate (IPBC), propiconazole, and tebuconazole are compatible with the new hydrophobic boron indicator. Further, this new indicator composition is chemically stable and detectable at relatively low ranges of concentration.

Development of a 3-Foot Laboratory Burning Tunnel Test for Fire Retardant Wood and Wood Composites

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Abstract

The 24-foot Steiner Tunnel test (UL 723, ASTM 84) is the most common test used to regulate the flammability of structural wood and wood composite building materials in U.S. The Steiner tunnel test requires approximately 4 m2 of product sample, which means that preparing, shipping and testing such large specimens is burdensome and costly. As a result, the 24-foot Steiner Tunnel test is not a cost-effective research and development tool for fire retardant studies. This paper reviews several laboratory methods widely used for fire retardant product screening and quality control including the cone calorimeter test (ASTM E1354), the fire-tube test (ASTM E69) and the 2-foot tunnel test (ASTM D3806). Due to the drawbacks of these methods, a cost-effective 3-foot laboratory tunnel test was developed. Comparative results using the new test procedure are provided. The data demonstrate that the new small-scale test can be a useful precursor to running the UL 723 test.

Ongoing Field Evaluation of Douglas-fir Cross Laminated Timber in An Above-Ground Protected Test in Mississippi

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ABSTRACT

Data on the effectiveness of currently labeled soil termiticides or spray on borate post construction and remedial treatments needs to be generated for cross laminated timber (CLT) structures. Current design standards do allow for preservative treated and naturally durable wood, but incorporating treatment options into CLT manufacturing is a considerable challenge that has not been addressed. Termiticide treatment is also a necessity for CLT construction, especially if installed in southeastern climates, as most species currently used in fabrication of CLT are non-durable, and current design standards have not properly addressed incorporation of treatments. In this study we be installed 12x14x4" Douglas-fir CLT pieces in an above ground protected test at the Harrison Experimental Forest (HEF) (Saucier, MS). Test samples were placed in sets of two on bricks approximately 3-4" above soil and covered with ventilated waterproof covers. A total of 20 test replicates (40 total samples) of four different treatments were installed in this test. For five sets of CLT samples, we treated the soil below the samples with a soil termiticide (Termidor®). In five other sets, one sample per set was treated with a spray on borate preventative treatment. The remaining ten sets were left as controls with no treatment. At the project action point of one year after installation, the ten control sets will be examined for termite attack. Five of the attacked sets will be treated with the spray on borate as a remedial treatment to stop active termite attack. Temperature and humidity inside some the covered units will be monitored throughout the test.

Geoclimatic Variation in Durability of Pressure Treated Solid and Engineered Wood: A Search for Causality

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ABSTRACT

Field data examining the long-term effects of chemical wood preservatives on refractory wood species with abundant heartwood is limited. This study was initiated to determine, by ground contact exposure, the effectiveness of preservative-treated solid and plywood heartwood material comprised of refractory Douglas-fir, Engelmann spruce or southern pine. The study compared incised and non-incised solid lumber treated at three retentions with either ammoniacal copper arsenate (ACA) or chromated copper arsenate (CCA) and placed in ground contact at Mississippi and Wisconsin field test sites in 1975 and 1976, respectively. Test stakes were examined and rated for decay at various intervals over a 40-year period. Results indicate that incising improved long-term performance in samples treated at lower preservative retentions, particularly southern pine and Engelmann spruce heartwood treated with CCA. Results for treated plywood samples showed that coating cut edges with a preservative solution improved performance for low retention CCA and high retention ACA treated southern pine. Additionally, unexpected higher levels of decay were noted in some of the treatments at the Wisconsin site compared to the Mississippi site. Several factors that may contribute to these differences will be discussed including soil structure, site topology and drainage, and other microclimatic effects between the two sites. Previous metagenomics studies have shown considerable differences in fungal community composition at these two sites, which may also explain the differences in decay activity at the two sites. Proper exposure site characterization is an important consideration when performing long term field testing that is often overlooked.

ISO 17025 Labs: A Brief Review of Required Testing, AWPA Guidance Appendices, and Certification

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Abstract

The purpose of this paper is to outline the rigorous upkeep and operations side of running a Certified and Accredited ISO 17025 Laboratory associated with Wood Products, with a focus on Strength, Durability, and Efficacy testing/screening. We will review our nine-year history of testing wood preservatives and prior to Accreditation, operating in an ISO-like manner, including documentation and inter-laboratory round robin participation. Examples are given to show our quality monitoring over the years through AWPA standard tests (e.g., AWPA E1).