Nano-chitosan Particles as Wood Preservatives

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ABSTRACT

The current research work was planned to evaluate the efficacy of nano-chitosan as an environmentally friendly wood protection agent. Commercially available low molecular weight chitosan (LMW) was purified and depolymerized by nitrous acid and thus depolymerized chitosan was used to form N, N, N-trimethylchitosan. Both depolymerized and quaternized chitosan oligomers were crosslinked with TPP (tripolyphosphate) to form nanoparticles. Wood samples were treated with nanochitosan solutions under vacuum, and penetration and interaction of nanoparticles with wood were evaluated through bulking and retention tests. The characteristics of nanochitosan-treated wood are discussed.

Keywords: Nanochitosan particles, southern yellow pine and wood preservatives.

Effect of β-cyclodextrins/allyl Isothiocyanate Complexes on the Fungi Resistance of Southern Pine

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ABSTRACT

Allyl isothiocyanate (AITC) is a natural compound found in cruciferous vegetables with good fungicidal properties, but its application is limited by the high volatility, pungent odor and low solubility in water. In this study, two types of β-cyclodextrin (βCD) derivatives, methyl-βCD (MβCD) and hydroxypropyl-β-cyclodextrin (HPβCD), were used to stabilize AITC by inserting the volatile compound into the cavity of βCD. The results from attenuated total reflection Fourier Transform infrared spectroscopy (ATR-FTIR) and scanning electron microscopy (SEM) indicated that AITC was embedded in the hydrophobic cavity of βCD. The efficacy of βCD/AITC complexes as wood preservatives was tested by following the AWPA E10-16 standard. The colonization of fungi in wood was also visualized by SEM. The results showed that both HPβCD/AITC and MβCD/AITC treated wood had lower mass loss and less hyphae colonization when compared to the control group. Overall, MβCD/AITC treated wood showed better fungi resistance properties. This preliminary study suggests that the potential of HPβCD/AITC and MβCD/AITC complexes as waterborne wood preservatives.

Keywords: Methyl-β-cyclodextrin; Hydroxypropyl-β-cyclodextrin; allyl isothiocyanate; wood preservatives; fungi-resistant

Performance of Clear Coatings on Pine Modified with Low Molecular Weight PF Resin

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ABSTRACT

There is a long-standing desire for an exterior clear coating that can match the performance of opaque finishes, but the performance of clear coatings on wood is so poor they are generally not recommended for use outdoors. We describe our approach to solving this problem, and the progress we have made to develop durable clear coating systems for pine. We focused on five factors that influence clear-coating performance: dimensional stability of wood; photostability of the wood surface; moisture ingress via end-grain; coating flexibility and photostability; and finally, coating thickness. We performed preliminary research to select effective wood pre-treatments and durable clear-coatings, and then tested coating systems with good solutions to each of the aforementioned issues (factors). Radiata pine panels were modified with PF resin solutions (20 or 30 % w/w), end-sealed, and thick acrylic, alkyd or spar varnishes were applied to the panels. Panels were exposed to the weather and the level of coating defects was assessed every year over a 5-year period. After 5 years' outdoor exposure all of the coatings are performing well on panels modified with 30% PF resin. Future research will build on these promising results by developing solutions to additional factors that influence clear-coating performance.

Developing a Bio-based Wood Composite Using Refined Cottonseed Protein Adhesive

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ABSTRACT

A growing market of health conscious consumers combined with a progression toward 'greener' products has caused the wood industry to investigate adhesives containing little to no formaldehyde, which is a component of composite panel adhesives currently in use. The goal of this study is to present the adhesive and termite resistant properties of Cottonseed Protein Isolate (CSPI) and the potential for Guayule plant residuals to be used in the wood composite market. Mechanical properties and termite resistance of panel products generated by this study will be tested according to ASTM, NIST and AWPA standard methods. Preliminary testing of three-ply plywood panels constructed with CSPI, soy protein, and phenol:formaldehyde (commercial control) adhesive revealed that the novel adhesives did not perform as well as what is commercially available. The CSPI and soy adhesives generated similar shear strengths. Preliminary results for CSPI and CSPI/Guayule bonded hardwood veneers against exposure to the subterranean termite (Reticulitermes sp.) indicated a resistance to termite attack. To complete the objectives of this project, work will proceed in refining the adhesive blend and adhesive application methods, optimization of the pressing program, and reoccurring termite and mechanical property testing to achieve the most ideal panel product from the selected materials.

Effect of Chitosan on Diversity and Number of Protists in Subterranean Termites

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ABSTRACT

The goal of this study was to observe the possible effect of chitosan on protist communities harbored in hindguts of Reticulitermes virginicus. Workers of two termite colonies collected from different locations were exposed to treated wood with different concentrations of chitosan and to control wood samples over a 14-day period. While ten protist species were present in colonies exposed to the control and wood treated with 0.5% chitosan solutions, only two protist species survived in colonies exposed to wood treated with 1% and 2% chitosan solutions. Additionally, significantly lower number of protist species was found in chitosan-treated wood in comparison to control samples. The results of this study indicate that chitosan may affect termites by acting on the protist symbionts, and that some protist species may have resistance to chitosan. The protists not affected by higher chitosan concentration treatments require further attention in understanding chitosan mode of action.

Study on Recycling of Creosote-Treated Red Oak for Wood Preservation

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ABSTRACT

Preservative-treated wood products are well known to significantly prolong their service life and thus extend the forest resource and enhance its sustainability. However, disposal of treated wood has been an environmental concern because of the residual preservatives. US railroad tracks use over 680 million cross ties which are creosote-treated hardwoods and approximately 16 million of them are replaced each year. A pervious study has developed an effective liquefaction process to obtain high purity carbohydrates and lignin derivatives from wood biomass. The objective of this study is to investigate the feasibility of using the liquefaction process to separate creosote from creosote-treated red oak and to evaluate the effectiveness of the separated creosote using AWPA soil block test.

Keywords: Liquefaction, Creosote, Red Oak, Decay Resistance Performance

Effect of Seasoning Practices on Fungal Colonization of Railroad Ties

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Ties are generally air-seasoned in stacks that are 1 foot off the ground to limit potential wetting and reduce the risk of fungal colonization. This degree of separation creates safety issues when handling the ground contact stickers. Using a slightly reduced ground contact sticker height would help reduce these issues. Gum and red oak ties were sampled before and after being placed into seasoning stacks with stickers that were 6, 8 or 12 inches above ground at a seasoning yard in Guthrie, Kentucky. Ties were sampled for degree of fungal colonization before, in the middle and at the end of the seasoning period by culturing increment cores removed from each of 200 ties per species. Fungi were more prevalent in gum than red oak ties at the start of the test. Gum ties were more heavily colonized 3 months into the seasoning period, but there was no consistent effect of distance from the ground. Further tests are underway to quantify the effects of seasoning on wood properties.