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MILLWORK TREATMENTS: THE STORY OF ONE DEVELOPMENT PROJECT

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Summary

This paper describes the inception, conceptualization, research, development and commercialization of a process to provide protection to wood millwork products through the use of a water-based organic emulsion preservative system applied by a pressure treatment process.

Introduction

The millwork industry in the U.S. has long relied on solvent-based dip treatments of finished millwork components to provide acceptable performance for wood windows and door components in applications where decay and termite protection may be necessary. For many years the active biocide in these treatments was pentachlorophenol used at 5% a.i., but this evolved over the years to tri-n-butyl tin oxide (TBTO) and later iodo-propynyl-butyl-carbamate (IPBC). Today IPBC is still used although mixtures with triazoles have recently come on to the market. The purpose of this development was to address concerns with the performance of millwork components using the current existing treatments and technology, and find new systems that provided performance comparable to that previously observed with 5% pentachlorophenol treatments.

Project criteria

The project involved close interaction between us as a chemical supplier, and a millwork manufacturer, concentrating on all aspects of the research, development and commercialization of a new process, including product performance and all treatment, handling, and machining through to the final end millwork product. An open-ended commitment was made to take a look at all options and aspects, with the only initial limitations that the treatment must be colorless and provide superior performance against biological deterioration, and with good water repellent properties to maintain physical performance in the end applications.

Options Considered

All preservative treatment technologies, chemical and other options were initially considered as potential options. These included borates, existing biocides using both dip and double vacuum solvent treatments, heat treatments, wood modification, organic water based emulsions as dip or double vacuum treatments, vapor phase treatments, super-critical fluids, and others. After considering the pros and cons of potential available technologies that could be developed for this application, with strong emphasis on limiting environmental impacts of the technology, we concentrated on and developed a system using water based pressure treatment of the rough millwork pre-machined stock. The process would use a water repellent organic preservative emulsion system using a patented treatment process. The treated stock would then be kiln dried after treatment before final parts are machined to final requirements.

Project Outline

Proceeding along the development of a pressure treatment for millwork stock before final machining required the develop technology for complete WR and biocide penetration of Ponderosa pine millwork stock. Formulation development, with numerous re-formulations was required to respond to critical results observed for both product end performance and process development requirements. In addition, emphasis was placed on analytical methods development for quality control of both the treatment solutions and final treated wood products.

Formulation

Extensive effort was put into developing formulations that would allow full penetration of ponderosa pine sapwood and would remain stable throughout continual use in the treatment process. The successful formulations that arose from this work produce milky white treatment solutions that do not impart any color to the treated wood.

Test Methods

Excellent performance against decay fungi and insect attack was the primary performance requirement of the system, and has been tested extensively in both laboratory and field trials. In addition, depletion testing, physical performance including water repellency testing, and compatibility testing for the treated wood with other product components and hardware was necessary.

Laboratory tests for wood treated with this system have included swellometer tests to determine the anti-swelling efficiency of both the preservative formulations as well as the final treated wood. This has included testing the formulation by treating wafers, and testing the final product by cutting wafers from the center of millwork stock after treatment, and evaluating the anti-swelling efficiency of the wood. The formulations have easily met the standard requirement for other solvent-based millwork formulations, even when test wafers are cut from the center of treated stock. The formulations have also been tested in AWPA E10 Soil block decay test and AWPA E1 laboratory termite tests. In each case, the retentions required to control the decay organisms are well below the target retentions for the preservative system (Figures 1 and 2).

Wood treated with this system has also been tested extensively in the field for both decay and termite performance. Material has been exposed in L-joint and other tests at sites in Hilo, HI, Gainesville, FL, Harrisburg, NC, and Scotia, CA. These studies have included tests both on the formulations (L-joints treated in final form) as well as the process, where L-joints are machined from previously treated stock. Results show excellent performance at retention levels less than 20% of the target retentions using treated L-joints, and also superior performance when L-joints are machined from the center of large dimension treated stock (Figures 3, 4 and 6).

Besides the decay performance that these tests have investigated, L-joints have also been monitored for moisture uptake in service by measuring their weight changes during exposure. The pressure treated material performs very well, outdoing the current dip treatments and with moisture uptakes similar to that observed for 5% pentachlorophenol treatments (Figure 5).

Wood treated with this system has also been tested for other physical parameters and compatibility including corrosion of fasteners and cladding used in window constructions, sealants and caulking, paint systems, and glues, with no problems for use of the wood in millwork applications.

Plant aspects

The commercialization of this technology arose directly from and was intertwined with the development process. The treatment and processing plant involved the establishment of a fully enclosed system using an automated process. The treatment and drying cycles provide a zero discharge of water situation from either the treatment and or the kiln drying processes. The success of the automated process is dependent on the requirements and maintenance of the use of HPLC analysis of the treating solution prior to every charge, and the HPLC analysis of wood samples from every charge. Through the development process many potential improvements and efficiencies were identified and research. Almost invariably every potential improvement or process change caused collateral effects in the system that then required adjustment and implementation.

Conclusions

The project started out as an open-ended research project and proceeded through many steps and twists and turns to a commercialized conclusion. The initial project criteria that were established were met or exceeded. One benefit of carrying out this project was a deeper understanding from a research perspective that the initial research studies are merely the upper tip of the development iceberg, and that success involves tenacity and a continuing commitment to work through the inevitable roadblocks that science and nature place in one’s path. All process and product improvement suggestions led to even more work and scientific and engineering thought. Undoubtedly the success of this project was in large part due to having a client who provided project bookends and the involvement of the end-user at appropriate times in order to make this development a technological and commercial success.

Acknowledgements

Many contributed to the outcome of this project, but in particular we would like to acknowledge the support and contributions from Kelly Guy, Jack Nicholson, Rick Parker, Jeff Morrell, Mike Milota, Kevin Archer, Kevin Brown, Trevor Semenchuk, Charles Rector, Seble Tadessee and Yancie Weathers.

Figure 1. AWPA Standard E10 Soil-block testing of water based millwork formulations against the brown rot fungus *Gloeophyllum trabeum* (left) and the white rot fungus *Trametes versicolor* (right) at different retentions expressed as a percent of the target retention.

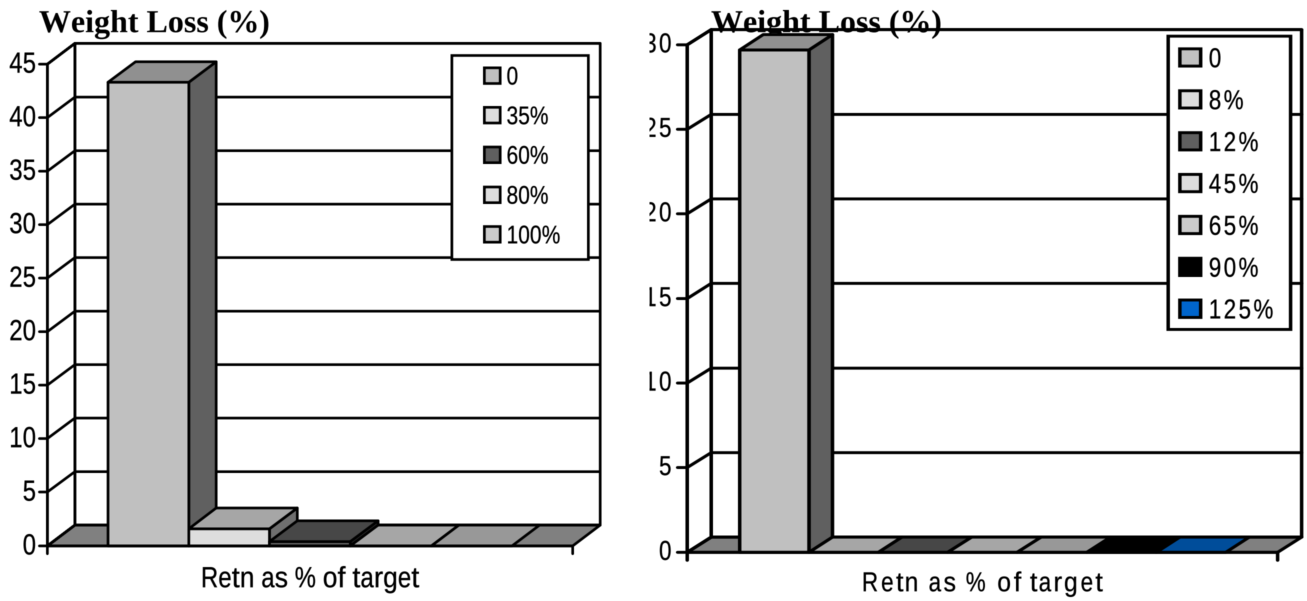

Figure 2. AWPA Standard E1 Laboratory Termite test of a water-based millwork formulation against the Formosan termite (*Coptotermes formosanus*) at different retentions expressed as a percent of the target retention.

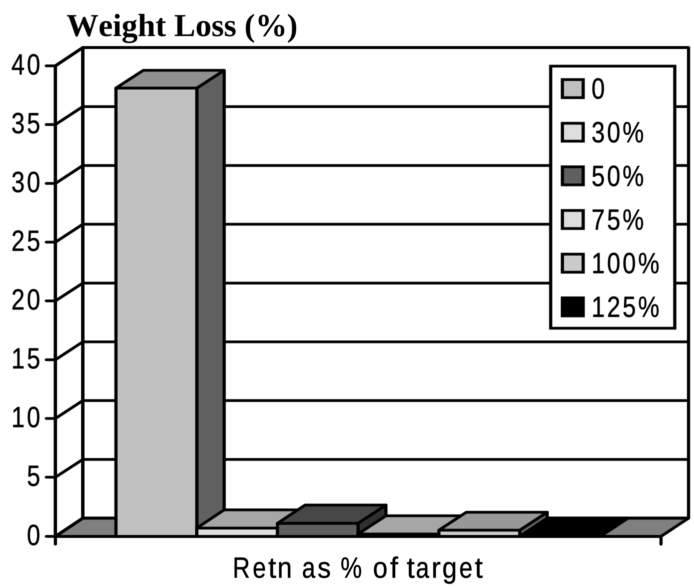

Figure 3. Decay results from a ponderosa pine L-joint test exposed in a greenhouse using an artificial water spray after 1, 2, and 3 years.

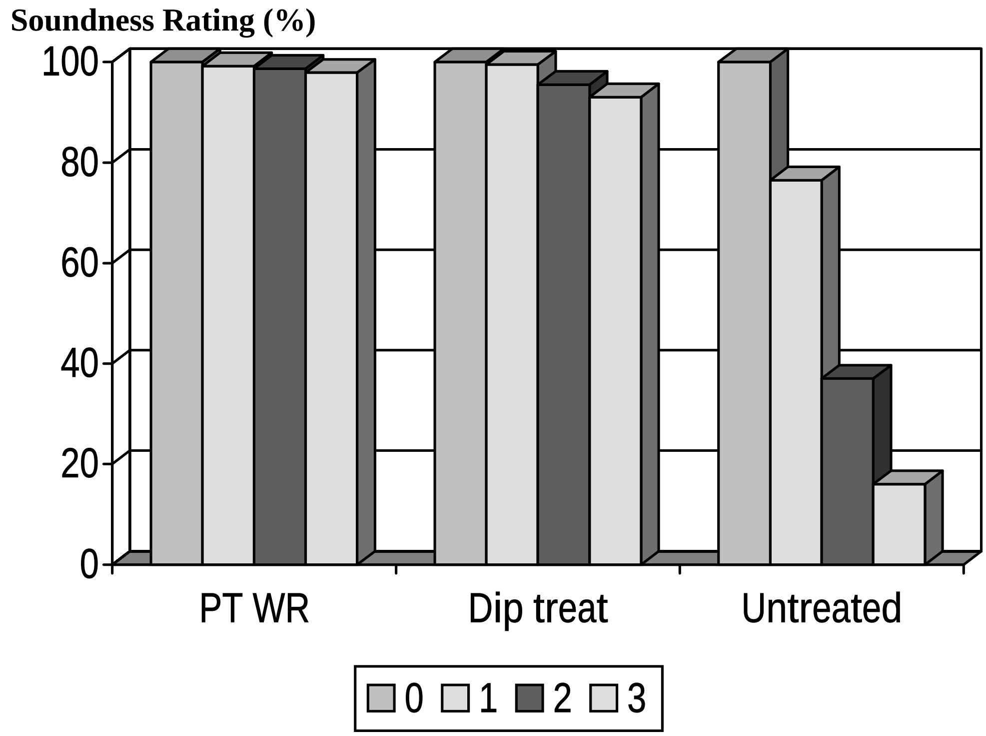

Figure 4. Decay results from a ponderosa pine L-joint test exposed in Hilo, Hawaii after 1, to 4 years.

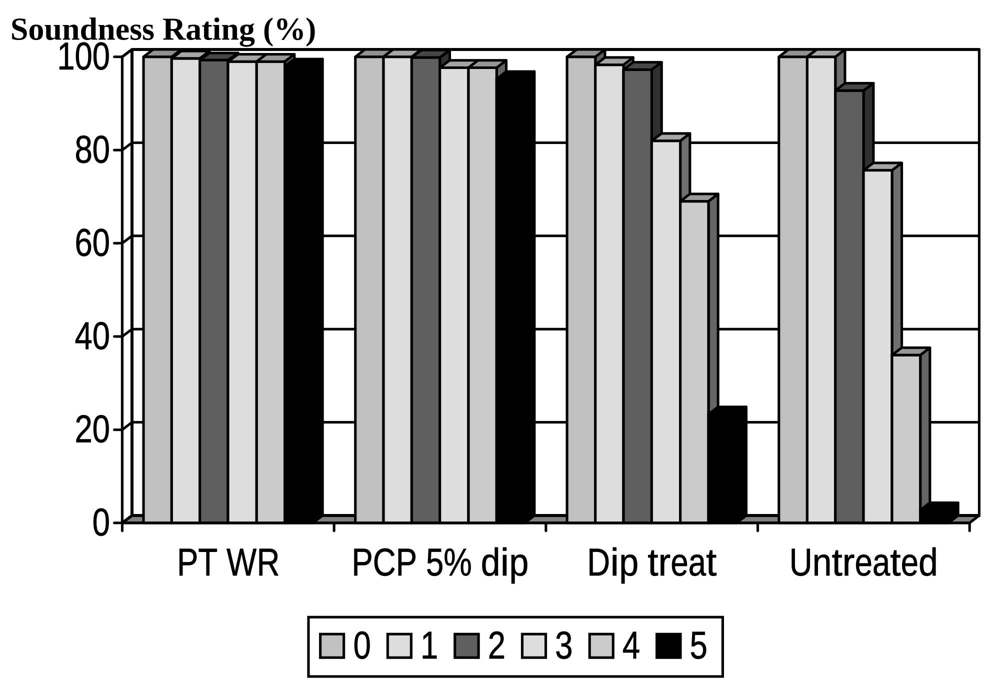

Figure 5. Moisture uptake and loss in L-joint under a 2 day cyclical artificial water spray in a greenhouse. The Penta and IPBC treatments were organic solvent dip treatments, while the PT treatment was the pressure treated water-based organic treatment.

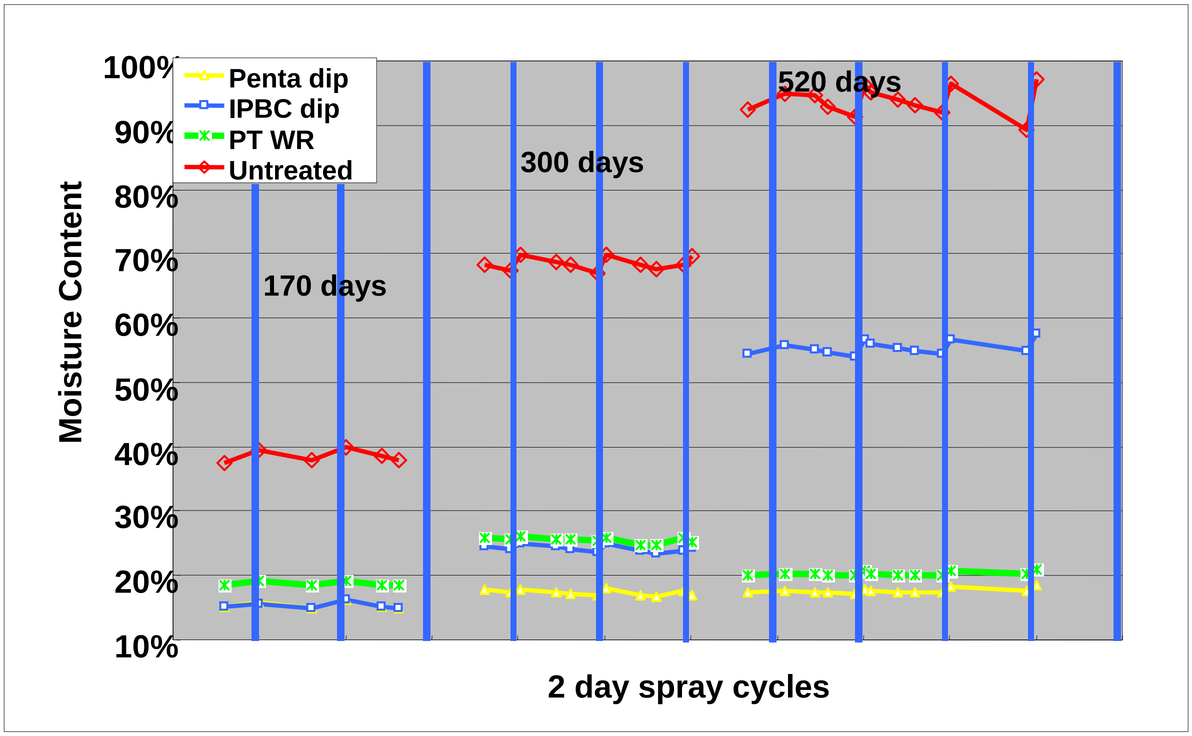

Figure 6. Field termite performance of pressure treated water repellent treated ponderosa pine and untreated wood after 9, 15, and 34 months exposure in Hilo, HI. Termite species was the Formosan termite (*Coptotermes formosanus*).