Proceedings of the International Convention of Society of Wood Science and Technology and United Nations Economic Commission for Europe – Timber Committee
October 11-14, 2010, Geneva, Switzerland

Preservative-Treated Yellow Poplar for Above-Ground Use

Michael O. Hunt†*
Professor *emeritus* of Wood Science
Wood Research Laboratory, Purdue University
West Lafayette, Indiana, USA

Terry Amburgey
Giles Distinguished Professor *emeritus* of Forest Products
Department of Forest Products, Mississippi State University
Mississippi State, Mississippi, USA

Daniel L. Cassens†
Professor of Wood Products
Wood Research Laboratory, Purdue University
West Lafayette, Indiana, USA

H. Michael Barnes†
Thompson Professor of Wood Science & Technology
Department of Forest Products, Mississippi State University
Mississippi State, Mississippi, USA

Ramsay Smith†
Global Research Director
Arch Wood Protection, Inc.
Conley, Georgia, USA

Tom Kohlmeier
Chairman of the Board
SEEMAC , Inc.
Carmel, Indiana, USA

Kris Owen
Manager, Codes and Product Applications
Arch Wood Protection, Inc.
Valparaiso, Indiana, USA

Robert R. Leavitt
Professor *emeritus*
Purdue University
West Lafayette, Indiana, USA

Daniel Warner
Technician
Wood Research Laboratory, Purdue University
West Lafayette, Indiana, USA

*Corresponding author: huntm@purdue.edu
† SWST member

Abstract

Yellow poplar was a standard building material east of the Mississippi River from colonial days to the early 1900s. Thus old-growth yellow poplar is prevalent, especially as siding, in historic buildings. New-growth yellow poplar is abundant, fast grown, fast drying, easily worked, relatively low-valued, good strength to weight ratio, and located near major construction markets. However, new-growth yellow poplar is especially susceptible to decay. For new-growth yellow poplar lumber to be considered for new exterior construction it should be preservative-treated for adequate protection for above-ground use while maintaining its outstanding paint weathering performance (Purdue/USFPL research). Cooperative research by Purdue University, Mississippi State University and Arch Wood Protection, Inc. addresses this challenge. Research results show that sapwood and heartwood of new-growth yellow poplar treated with Wolman® AG with water repellent is as decay resistant as similarly treated southern yellow pine. AG with water repellent treated southern pine is commercially available as *Wolmanized® L³ Outdoor® Wood*[1]. Wolman® AG is a nonmetallic, water and carbon-based, low impact preservative. Long-term paint weathering performance of AG with water repellent treated yellow poplar, as predicted by comparative lab tests, is expected to be comparable to the outstanding performance shown earlier in Purdue research. Market analyses by SEEMAC, Inc., Tri State Forest Products and Arch Wood Protection, Inc. are planned to determine the financial feasibility of introducing Wolman® AG with water repellent treated yellow poplar in the new construction market and for historic preservation/restoration. Will something old be new again?

Keywords yellow-poplar (*Liriodendron tulipifera*), southern pine (*Pinus* spp.), preservative treatment, above-ground use, heartwood, sapwood

---

[1] The use of trade names is for the convenience of the reader only and does not constitute endorsement by Purdue University or Mississippi State University over other products equally suitable.

Introduction

Today's yellow poplar species is a tremendous timber resource (Cassens et al. 2009) specifically in Indiana and in general in eastern United States. It grows fast, tall, straight, and in dense stands. It is easy to harvest, saw, dry, and machine. Large old growth trees composed mostly of heartwood were used for numerous functional uses such as flooring, furniture, and interior and exterior millwork including siding and windows. Its performance was excellent and authors, Daniel Cassens and Michael O. Hunt, of this report own structures in excess of 125 years in age where yellow poplar windows and siding are still in serviceable condition. Unfortunately, today's "millwork grade" yellow poplar is mostly sapwood and many contractors have continued to use it just as the old growth supply but very often with the resulting problem of early decay.

Yellow poplar constitutes 13% of the timber volume in Indiana. In terms of volume it is surpassed only by the oaks. It is a medium to low valued species. Recognizing a growing national and international trend that affects markets, all Indiana state forest lands and all Indiana classified forests are certified as being sustainable. Landowners are disappointed because these beautiful timber trees do not have a high value and the hardwood lumber industry complains that it is difficult to turn a profit when processing this species. There is not enough demand for the volume available. As mentioned above, yellow poplar was used widely from the eastern seaboard to the Mississippi River valley for siding, trim and ornamentation in the construction of historic buildings well into the 20^{th} century. If new-growth yellow poplar is to be used as a "replacement in kind" material in historic restoration and rehabilitation projects, its decay resistance property must be improved.

A research project was designed to create preservative-treated yellow poplar for above-ground use (Hunt and Cassens 2008). The basis for determining the success of the research was twofold: 1) to produce preservative-treated yellow poplar lumber that had at least equal decay resistance when compared to similarly preservative-treated southern pine and 2) the treatment would not alter the outstanding paint performance of yellow poplar (Hunt *et al* 2003). The premise for comparing the decay resistance of treated yellow poplar to treated southern pine is that preservative-treated southern pine is commercially accepted and widely used. The plan was modified to use AWPA E10-08 Standard Method of Testing Wood Preservatives by Laboratory Soil-Block Cultures (AWPA 2008) to evaluate comparative decay resistance.

Western red cedar is generally considered to be the preferred species for exterior weathering of painted surfaces. The earlier research on the weathering of painted wood construction (Hunt *et al* 2003) determined that painted yellow poplar weathered on a par with similarly painted western red cedar.

Materials and Methods

Test Materials

Test specimens for comparative decay resistance were fabricated from the following categories of wood material: sapwood of new-growth yellow poplar; heartwood of new-growth yellow poplar;

sapwood of new-growth southern pine; heartwood of new-growth southern pine; heartwood of old-growth yellow poplar; and heartwood of old-growth southern pine. Specimens for paint performance evaluation were prepared from this array of wood materials with the exception of heartwood of old-growth yellow poplar and heartwood of old-growth southern pine.

New-growth yellow poplar specimens were produced as follows. Logs from four yellow poplar trees felled on Purdue University property west of West Lafayette, Indiana, were milled into lumber. Test specimens representing logs from the different trees and positions (sapwood and heartwood) within the logs were fabricated. Sapwood and heartwood specimens of new-growth southern pine were machined from southern pine dimension lumber that was obtained at a local building materials store. Specimens of heartwood of old-growth yellow poplar and old-growth southern pine were cut from salvaged timbers that were at least one hundred years old.

After air-drying, selected new-growth yellow poplar specimens along with new-growth southern pine specimens were shipped to the Arch Wood Protection, Inc. development laboratory in Conley, Georgia, for treatment with Wolman® AG preservative corresponding to the Standard P45-08 Standard for Propiconazole Tebuconazole Imidacloprid (PTI) (AWPA 2009) requirements.

Preservative Treatment

Material was treated according to the American Wood Protection Association Standards (AWPA) P45-10, P5-09, and treated to a retention for Use Category 3B – Above Ground, Exterior, Exposed or Poor Water Run-Off. Each charge was treated to a desired retention of 0.21 kg/m^3Wolman AG according to a treating cycle of 25 minute initial vacuum (81 kPa), 45 minute pressure (1207 kPa), and 30 minute final vacuum (81 kPa). Mold, corrosion, and foam inhibitors were included in the treating solutions. Six hundred ten mm segments were retained by Arch from the end of each board for analysis, and the remaining portions of the boards were returned to Purdue for additional testing. Cross sectional wafers from each board were visually evaluated for penetration using a spray indicator, and a 15 mm boring was removed from each board for analysis of tebuconazole, propiconazole, and imidacloprid, the active biocides in Wolman AG. Thirty two samples of end matched nominal 25- x 150- x 610-mm yellow poplar containing all heartwood were end sealed by Purdue and labeled with individual board numbers. Matched pieces were labeled with the same board number. One set of matched boards were treated with Wolman AG containing a water repellent, and the other set treated without water repellent. An additional thirty two samples of end matched 25- x 150- x 610-mm yellow poplar containing all sapwood were end sealed, labeled, and treated in the same manner.

Comparative Decay Resistance

Cubes measuring 19 mm in each direction were cut from the same stock described above and treated with PTI to 0.27 kg/m^3 and exposed in accordance with AWPA Standard E10. The brown-rot fungus *Gloeophyllum trabeum* (ATCC 11539) was used as the test organism. Untreated samples were used as controls for comparison. Five replicates for each treatment group were exposed.

Paint Performance Estimation
The outstanding long-term weathering performance of yellow poplar (Hunt *et al* 2003) was determined by full exposure to natural weathering over at least a three year period. The nature of the current feasibility evaluation requires a reasonable estimate of expected long-term performance using a quickly completed test. Thus it was postulated that adhesion of the primer paint coat to the substrate surface would be a predictor of long-term weathering performance.

In the prior painted wood construction research it had been determined that optimum paint performance resulted from a particular protocol. The protocol was that 100% acrylic resin latex primer was applied to the wood substrate that had been previously brush coated with Woodlife® water repellent preservative. Paint adhesion associated with this protocol was the frame of reference for comparison of the new preservative treatments.

ASTM D 3357-08 Standard Test Methods for Measuring Adhesion by Tape Test (ASTM 2008) was used to evaluate the comparative paint adhesion quality of new-growth yellow poplar pressure treated with a variety of Wolman® AG preservative products and new-growth yellow poplar pretreated with Woodlife® (Leavitt and Hunt 2008).

Results and Discussion

Comparative Decay Resistance
The following table reports the percentage decay of specimens in the indicated categories of wood material that had been subjected to optimum conditions of decay for a three month period.

Table 1. Summary of the percent weight losses for the individual blocks after exposure to a brown rot-fungus (G. trabeum) for 12 weeks.[1]

	Yellow-poplar		Southern pine	
	Sapwood	Heartwood	Sapwood	Heartwood
Untreated, new growth	78 (2)	58 (7)	68 (5)	42 (8)
Treated, new growth	3 (4)	1 (0.6)	7 (3)	1.4 (0.3)
Untreated, old growth		28 (7)		32 (26)

[1] (Standard deviation)

It is noted that the AG® with water repellent treatment provides good protection for the recognized refractory heartwood of new-growth yellow poplar. The difficult to treat heartwood of southern pine is also well treated. The large variation in the decay of southern pine heartwood indicates the large variability in the decay resistance of this material. Values ranged from 9.2-60.7% weight loss.

Paint Performance Estimation
The following table summarizes the results of comparative ASTM D 3357-08 determined paint adhesion of a 100% acrylic latex primer applied to a variety of new-growth yellow poplar lumber specimens. The basis of comparison is yellow poplar pretreated with Woodlife® water repellent

prior to coating with primer. The table reports the percent of the total paint surface in contact the tape that is removed when the tape is quickly pulled from the surface. The smaller the percentage of paint removed the stronger the paint adhesion. Two scratch tests were made on each specimen. Tabulated data indicates consistency of paint adhesion over the surface of the specimens.

Table 2. Scratch test results (ASTM D3357-08)

Treatment	Average Paint Peel (%)	
	1st scratch test	2nd scratch test
Woodlife® + paint*	8	10
AG® + paint	3	3
AG® + Woodlife® + paint	18	18
AG® w/ water repellent + paint	4	4

The water repellent component in Woodlife® is thought to improve long-term paint performance by slowing and reducing water adsorption and thus reducing the cycles of shrinking and swelling of the surface fibers of the substrate. In the case of pressure treatment with AG® preservative with water repellent it is postulated that beneficial volumetric stabilization occurs and thus cycles of shrinking and swelling will be reduced and corresponding stress of the surface paint film will be reduced. It is noted that the surface paint adhesion of AG® with water repellent treated specimens is even better than for the outstanding performer, Woodlife® pretreatment.

Conclusions

Heretofore, in the wood material science literature heartwood of old-growth yellow poplar has not been credited with significant decay resistance. However, “heart” of old-growth southern pine has been commonly recognized with a significant degree of decay resistance. This research has shown that indeed heartwood of old-growth yellow poplar is at least as decay resistant as “heart” (heartwood) of old-growth southern pine.

Specimens of new-growth yellow poplar, pressure treated with Wolman® AG preservative and water repellent, are as decay resistant as similarly treated (and commercially accepted) southern pine.

Paint adhesion testing suggests the Wolman® AG with water repellent treated new-growth yellow poplar has no reduction in the excellent paint weathering performance of Woodlife® pretreated yellow poplar.

Treated new-growth yellow poplar is acceptable for above-ground use.

References

American Wood Protection Association (2009) Standard P45-08 Standard for Propiconazole Tebuconazole Imidacloprid (PTI). Book of Standards, Am Wood Prot Assoc, Birmingham, AL.

______________ (2008) Standard E10-08 Standard method of testing wood preservatives by laboratory soil-block cultures. Book of Standards, Am Wood Prot Assoc, Birmingham, AL.

ASTM (2008) Standard test methods for measuring adhesion by tape test. D 3359-08. Book of Standards, Vol 6.01 Paint, American Society for Testing and Materials, West Conshohocken, PA.

Cassens, DL, MO Hunt, and HM Barnes (2009) Yellow poplar lumber for exterior architectural applications in new construction and for historical restoration. Purdue Extension FNR-410-W. Purdue University. West Lafayette, IN.

Hunt, MO, AJ O'Malley, WC Feist, GP McCabe, JW Evans, and DL Cassens (2003) Weathering of painted wood construction: façade restoration. Forest Products Journal. 53(4): 51-60.

Hunt, MO and DL Cassens (2008) Yellow poplar problem - or – yellow poplar opportunity. Wood Research Laboratory, Purdue University http://www.agriculture.purdue.edu/fnr/faculty/hunt/index_files/poplar.htm. (8/9/2010)

Leavitt, RR and MO Hunt (2008) Yellow poplar paint adhesion test. Wood Research Laboratory, Purdue University http://www.agriculture.purdue.edu/fnr/faculty/hunt/pdf/testreport.pdf. (8/9/2010)