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20-Year Evaluation of Millwork Preservatives

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Notice

Summary

A field test of six millwork preservatives has been ongoing for 20 years, using a simulated window corner, or "Y-joint", as the test unit. Three preservatives provided excellent protection to white pine and white spruce: 5% pentachlorophenol in varsol, phenyl mercury oleate in varsol, and 0.75% oxine copper in varsol.

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1 Objective

To assess the performance of six preservatives used to treat millwork, after 20 years of exposure in a field test.

2 Introduction

When this field test was set up, the most commonly used preservatives in the Canadian millwork industry were phenyl mercury oleate (PMO), pentachlorophenol (PCP) and tributyltin oxide (TBTO). The first two have been phased out. These preservatives are all used in organic solvents. Problems involving volatilization, breakdown, and detoxification of TBTO have been demonstrated, although never proven to cause preservative failure in practice. Furthermore, TBTO has become the target of criticism for its potential adverse environmental effects in aquatic systems.

In 1978, Forintek Canada Corp. (then the Eastern Forest Products Laboratory) initiated a field test of six millwork preservatives at its test site at Petawawa, Ont. This study was begun before the L-joint was established as the standard method for evaluating millwork preservatives (American Wood Preservers' Association 1997), and a post and rail – or "Y-joint" design – was used instead.

Petawawa is within the zone of medium out-of-ground decay potential as calculated by Setliff (1986) using Scheffer's climate index (1971). This zone includes most of the major population centres of North America. Petawawa is therefore a good location for an evaluation of the effectiveness of experimental preservatives in protecting window joinery.

Results from this test were previously reported after 10 years of exposure (Doyle 1989). This report describes the condition of the samples after 20 years.

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4 Materials and Methods

4.1 Y-Joint Preparation and Treatment

Eastern white pine (*Pinus strobus* Laws.) and white spruce (*Picea glauca* [Moench] Voss) lumber, 3.5 x 8.6 x 30.5 cm, were used to construct separate test units. This material contained both sapwood and heartwood. One piece was cut diagonally at 45° and bolted to a vertical component to form an asymmetrical "Y-joint". The joint was designed to act as a water-trap, encouraging decay in the joint. Ten assembled units were treated by a 3-minute dip for the first seven of the following eight preservative formulations:

- Pentachlorophenol (PCP) in varsol (5%)
- Copper naphthenate (Cu-N) in varsol (1% copper)
- Tributyltin oxide (TBTO) in varsol (0.4%)
- Tributyltin oxide (TBTO) in varsol (0.8%)
- Roz Tox, a commercial formulation of phenyl mercuric oleate
- Oxine copper (PQ20) in varsol (0.75%)
- Oxine copper (PQ20) in varsol (0.38%)
- Zinc ammoniacal arsenate (ZAA) in water (4% oxide)

The ZAA dip treatment was for 5 minutes, since it was assumed the water-based formulation would not penetrate as well as the organic systems. Samples were weighed before and after treatment to determine preservative solution uptake. Ten untreated samples were included as controls. The test units were left unpainted.

4.2 Exposure and Inspection

In June 1978, the 90 units were installed in a random pattern on a rail fence approximately 1.2 m above the ground at the Petawawa test site. This site is located on the grounds of the Petawawa National Forestry Institute (now closed) near Chalk River, Ont. It is cleared natural forest surrounded by mixed coniferous/deciduous trees and has mean daily maximum and minimum temperatures of –7 and –18°C in January, and 25 and 13°C in July. It receives a mean annual precipitation of 822 mm. During the last 10 years, the natural forest re-grew and closed in around this test, creating a very high decay hazard.

After 10 and 20 years of service, the extent of decay was visually evaluated using the AWPA rating scale of 0 to 4, taking into consideration both the vertical and diagonal components, particularly at the joint (Table 1). If decay was suspected, the area was gently probed for softness. For reporting purposes, results were converted to the AWPA 100 to 0 scale and a mean logscore was calculated.

Table 1: AWPA rating system

AWPA rating	AWPA logscore	Description
0	100	Sound
1	90	Signs of slight surface decay
2	70	Small zones of obvious decay
3	40	Extensive decay
4	0	Rejected (the specimen is no longer an integral unit because of decay)

5 Results and Discussion

Preservative retentions determined at the time of treatment are given in Table 2. The refractory nature of white spruce compared to white pine was evident by the approximately 50% greater solution uptake of the pine samples. Solution uptake of the ZAA was highest due to the longer dip time. Concentration of the active ingredient was not known for Roz Tox.

Mean decay ratings of the 10 replicates per treatment, expressed as logscores, are shown in Table 3. The superior decay resistance of pine compared to spruce is evident in the untreated controls, and in all preservative treatments. This was due both to the greater natural durability of pine and to the higher preservative content of these samples. However, the relative pattern of preservative performance was similar for both species. Pentachlorophenol, Roz Tox, and 0.75% oxine copper were the most effective preservatives for both pine and spruce. After 20 years of exposure, the mean logscores of pine samples treated with these three preservatives were over 90, compared to untreated pine controls at 66, and over 80 in spruce compared to 37 in untreated spruce controls. Two untreated spruce units had failed from decay.

In pine, copper naphthenate, 0.38% oxine copper, and 0.8% TBTO were intermediate in performance, with logscores of 80 or above, while 0.4% TBTO and ZAA were the least effective, with logscores of less than 80. In spruce after 20 years, only samples treated with PCP, Roz Tox, and 0.75% oxine copper maintained mean logscores above 70 – the level below which a preservative is generally regarded as no longer providing adequate protection. One unit treated with 0.8% TBTO and one treated with 0.38% oxine copper had failed from decay.

As mentioned earlier, pentachlorophenol and phenyl mercury oleate are no longer used for treatment of millwork in Canada. The excellent performance of 0.75% oxine copper is therefore of interest. Environmental and health concerns for oxine copper are insignificant, as evidenced by the fact that it is the only wood preservative standardized by the CSA for contact with foodstuffs.

Table 2: Chemical uptake retentions

Preservative	Solvent	% Solution uptake		a.i. Retention by uptake (kg/m^3)	
		Pine	Spruce	Pine	Spruce
5% PCP	Varsol	2.9 (0.4)	2.0 (0.6)	0.61	0.43
Cu-N (1% Cu)	Varsol	2.8 (0.5)	2.1 (0.5)	0.12	0.09
0.4% TBTO	Varsol	2.4 (0.6)	1.4 (0.2)	0.04	0.03
0.8% TBTO	Varsol	2.6 (0.6)	1.6 (0.2)	0.09	0.06
Roz Tox	Varsol	2.7 (0.4)	2.0 (0.3)	-	-
0.38% oxine copper	Varsol	2.7 (0.4)	1.7 (0.4)	0.04	0.03
0.75% oxine copper	Varsol	2.4 (0.5)	1.5 (0.4)	0.08	0.05
ZAA (4% oxides)	Water	4.1	3.3	0.72	0.58

Table 3: Mean logscores after 10 and 20 years' exposure

Treatment	Pine		Spruce	
	10 years	20 years	10 years	20 years
None	80.0	66.0	41.0	37.1*
5% PCP	100.0	91.0	98.9	88.9
1% Cu-N	96.0	81.0	87.8	60.0
0.4% TBTO	91.0	78.0	85.6	64.4
0.8% TBTO	95.0	80.0	87.0	62.2
Roz Tox	99.0	94.0	98.0	82.2
0.38% oxine copper	97.0	83.0	83.0	56.0
0.75% oxine copper	100.0	93.0	96.0	86.0
ZAA	94.0	77.0	83.0	57.0

* Replicates had been lost

6 Conclusions

During 20 years of above-ground exposure, three preservatives used to dip-treat simulated window sash units afforded excellent protection against decay: oxine copper, pentachlorophenol, and phenyl mercury oleate, all in varsol as the solvent. Tributyltin oxide, copper naphthenate, and zinc ammoniacal arsenate were less effective. The treated pine test units were in better condition than corresponding spruce units because of both the higher natural durability of pine heartwood and the higher preservative loading achieved in the pine during treatment.

7 Recommendations

Oxine copper should be considered for increased use for the protection of millwork. The material in this study should be re-inspected after a further 10 years of exposure.

8 References

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