Efficacy of Copper Borax Preservative Against Wood Decay

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Abstract

In this study, a wood preservative containing active ingredients of 43.5% borax and 3.1% copper hydroxide was evaluated in soil-block tests in accordance with AWPA E10. Results suggested that the copper hydroxide was not contributing to fungal toxicity at preservative threshold levels. Thresholds determined for this preserv-ative were very close to those previously reported for sodium borate. For this preservative, the soil-block test results in this study were less effective than field test results.

Introduction

For centuries, wood has been treated with a variety of organic and inorganic additives to protect it from bacterial, fungal, and insect decay (Warner and Solomon, 1990).

Copper has been one of the most widely used ingre-dients in wood preservatives because of its fungicidal properties. But because some fungi are resistant to copper, it has always been used in combination with other additives, some of which cause considerable environmental concern. Borate is used as a fire retardant and a preservative, is low in mammalian toxicity, and has minimal environmental impact, making it an ideal additive for environmentally friendly wood preservatives. Interest is likely to grow in standardizing boron treatments for products exposed outside because of environmental concerns about other treatments (Johnson and Foster, 1991). However, the high solubility of borates limits the use of borate-treated wood to applications where water exposure is not a factor. But, field test results for posts treated internally and at the ground line with borax–copper hydroxide indicate that water exposure may not be as critical (Abbott et al., 2000).

Methods and Materials

Soil-block tests were performed in accordance with AWPA E10: Standard Method for Testing Wood Preservatives by Laboratory Soil-Block Cultures. The preservative tested contained 43.5% sodium tetraborate decahydrate and 3.1% copper hydroxide as active ingredients. Southern pine and sweetgum sapwood blocks, treated and untreated, were exposed to decay caused by four brown-rot and one white-rot fungi, respectively.

Brown-rot fungi

- *Neolentinus lepideus* (M534), creosote-tolerant fungus
- *Gloeophyllum trabeum* (M617), arsenic- and phenolic-tolerant fungus
- *Postia placenta* (M698), copper-tolerant fungus
- *Coniophora puteana* (M515), copper-tolerant fungus

White-rot fungus

- *Trametes versicolor* (M697)

Five blocks for each test fungi were treated to retentions in accordance with the treating schedule in Table 1.

Table 1- Retentions for treating soil blocks and exposing blocks to decay fungi

Retention, lb/ft³ (kg/m)	Decay fungi				
	N. lepideus	***G. trabeum***	***P. placenta***	***C. puteana***	***T. versicolor***
0.00 (0.00)	x	x	x	x	x
0.21 (3.36)	x		x	x	
0.41 (6.56)	x	x	x	x	
0.53 (8.48)					x
0.62 (9.92)	x	x	x	x	
0.74 (11.84)					x
0.83 (13.28)		x			
0.96 (15.36)					x

Results

Table 2 - Efficacy of copper borate in soil-block test to resist fungal decay

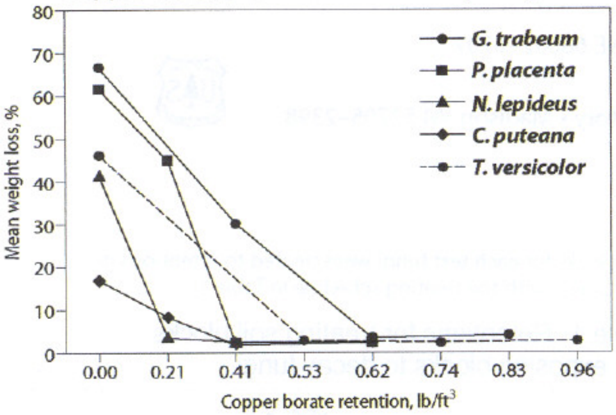
Copper borate retention, lb/ft³ (kg/m)	Mean percentage weight loss due to fungal decay (standard deviation)				
	N. lepideus	***G. trabeum***	***P. placenta***	***C. puteana***	***T. versicol***
0.00 (0.00)	41.39 (2.99)	66.59 (3.03)	61.38 (1.14)	16.69 (1.22)	46.13 (2.5
0.21 (3.36)	3.47 (0.65)		44.93 (9.00)	8.33 (7.83)	
0.41 (6.56)	2.31 (0.36)	30.17 (7.39)	2.22 (0.19)	1.76 (0.36)	
0.53 (8.48)					2.81 (0.8
0.62 (9.92)	2.35 (0.17)	3.55 (1.66)	2.35 (0.09)	2.35 (0.17)	
0.74 (11.84)					2.29 (0.2
0.83 (13.28)		4.07 (1.87)			
0.96 (15.36)					2.70 (0.4

Table 3 - Threshold concentrations for sodium borate and copper borate

Fungus	Retention, lb/ft³ (kg/m³)	
	Copper borate	Sodium borate*
N. lepideus	0.21 (3.33)	0.05–0.07 (0.80–1.12)
C. puteana	0.21 (3.36)	0.05–0.07 (0.80–1.12)
P. placenta	0.41 (6.56)	0.05–0.07 (0.80–1.12)
T. versicolor	0.53 (8.48)	0.11–0.18 (1.76–2.88)
G. trabeum	0.62 (9.92)	0.08–0.12 (1.28–1.92)

*Baechler and Roth, 1956; Fahlstrom, 1964.

Figure 1 - Threshold determination of copper borate for five wood-decay fungi



Discussion

Some biologists contend that laboratory soil-block tests are not an effective way to evaluate diffusible preservatives such as borates. They postulate that actual retention of the diffusible preservative in wood is difficult to maintain at a constant level because the salt is readily leached from the wood block and preservative diffusing into the soil and feeder strip has the potential to inhibit microorganisms used in the test (Goodell et al., 1995). The latter issue was of most concern to us, but the high weight losses shown in Figure 1 at retentions of 0.41 and 0.21 lb/ft^3 of copper borate showed that this was not the case.

The retentions in Table 2 were determined by weight gain and were estimates based on copper borate retention.

Table 3 compares thresholds for copper borate based on its sodium borate equivalent and for sodium borates as reported by Baechler and confirmed by Fahlstrom. Previous laboratory tests indicate that copper metal retentions of 0.08 lb/ft^3 are needed to protect wood against pure cultures of *G. trabeum* and *T. versicolor*, while for copper-tolerant species, a minimum retention of 0.10 lb/ft^3 is needed (Johnson, 1983; Kamden et al., 1995). The threshold level of the copper component is only about 10% of the copper borate threshold for the test fungi.

Conclusion

Although Baechler, and later Fahlstrom, found borax more effective in soil-block tests than in field tests, we found just the opposite with copper borate.

There may be several factors involved. Copper is known to protect wood in the field at retentions below its soil-block thresholds. Even in test plots where copper-tolerant fungi are prevalent, many copper-treated stakes escape decay by these resistant fungi. This is probably because, as the borax component leaches from copper borate treatments, it is probably providing the extra protection that belowthreshold copper needs to provide long-term protection. Retention levels required to prevent decay by creosote and copper-tolerant fungi are lower than retention levels required to prevent decay by phenolic-tolerant and white-rot fungi.

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