Retreatment of Spent Creosote-Treated Wood with Copper Hydroxide and Sodium Tetraborate

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Abstract

Southern pine sapwood blocks, treated with creosote at sub-threshold level, were retreated with either copper hydroxide or sodium tetraborate and evaluated by laboratory soil-block tests to determine efficacy of retreating creosote-treated wood with short chain amino copper compounds and borates. The unexpected copper synergism with creosote confirms that amine copper complexes from copper hydroxide are highly synergistic with creosote for controlling *Neolentinus lepideus*, the creosote-tolerant fungus. The compatibility of copper hydroxide and sodium tetraborate decahydrate with creosote suggests that these chemicals can be used effectively for retreatment of creosote poles.

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Introduction

Creosote, one of the most potent fungicides, has an extremely complex composition containing phenols, aromatic hydrocarbons, nitrogen bases, and other toxicants. But as potent as this fungicide is, some fungi are not deterred by this mixture of compounds. In the search for compounds that may enhance its fungicidal properties, creosote has been fortified with copper naphthenate (Duncan and Richards, 1950), pentachlorophenol (Duncan and Richards, 1950 and Snoke, 1954), chlorinated hydrocarbons (Fahlstrom, 1971), and more recently with synthetic pyrethroids (Cragg and Eaton, 1997). The target for these enhancements has been to provide protection for marine piling against *Limnoria*, *Teredo*, and pholads.

Understanding compounds that may be useful for synergism when combined with creosote must include an understanding of the ionic nature of these compounds. Copper naphthenate is frequently found in wood protection chemicals, where it is recommended for use in combination with both creosote and Duncan and Richards (1950) proved that copper naphthenate was not synergistic with either creosote or pentachlorophenol. Snoke (1954) determined that when creosote is fortified with pentachlorophenol, the increased effect of the preservative system is related directly to the amount of pentachlorophenol added to the mixture. Although this is used and is highly effective, it is also highly corrosive to treatment plant equipment when any water is present. We hope to find a copper pesticide that can be used with creosote emulsions to give a synergistic effect against creosote- and copper-tolerant fungi and that is not corrosive.

Methods and Materials

The experimental approach followed AWPA E10: Standard Method for Testing Wood Preservatives by Laboratory Soil-block Cultures.

Wood

- Three-fourth-inch cubes of southern pine sapwood were used for the wood substrate.
- Blocks were treated with chemical listed in Table 1 in a two-phase process (Table 2).

Fungi

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

Table 1. Chemicals used in preparation of treating solution

Chemical	Source
P1/P13 Creosote	Distillate derived entirely from tar produced by the carbonization of bituminous coal
Copper hydroxide ($Cu(OH)_2$)	Aqueous amine formulation containing 10% active ingredient
Sodium tetraborate decahydrate ($Na_2B_4O_7$)	Crystal containing 100% active ingredient

Table 2. Treatment retentions obtained in ¾-in. Southern Pine soil blocks

	Calculated retention			
	Phase I		Phase II	
	kg/m^3	lb/ft^3	kg/m^3	lb/ft^3
Control	0.00	0.000	N/A	N/A
Creosote	32.00	2.000	N/A	N/A
$Cu(OH)_2$	0.32	0.020	N/A	N/A
	0.80	0.050	N/A	N/A
$Na_2B_4O_7$	0.48	0.030	N/A	N/A
	0.64	0.040	N/A	N/A
	0.80	0.050	N/A	N/A
Creosote/$Cu(OH)_2$	32.00	2.000	0.13	0.008
	32.00	2.000	0.26	0.016
	32.00	2.000	0.40	0.025
	32.00	2.000	0.53	0.033
Creosote/$Na_2B_4O_7$	32.00	2.000	0.48	0.030
	32.00	2.000	0.64	0.040

pentachlorophenol. This compound contains cationic copper and the anionic naphthenate radical. It is possible for the copper element in copper naphthenate to be extremely synergistic with creosote, yet have that synergism reversed due to antagonism between the naphthenate and the creosote.

Results

Figure 1. Synergism of $Cu(OH)_2$ with Creosote in Unleached Soil-blocks

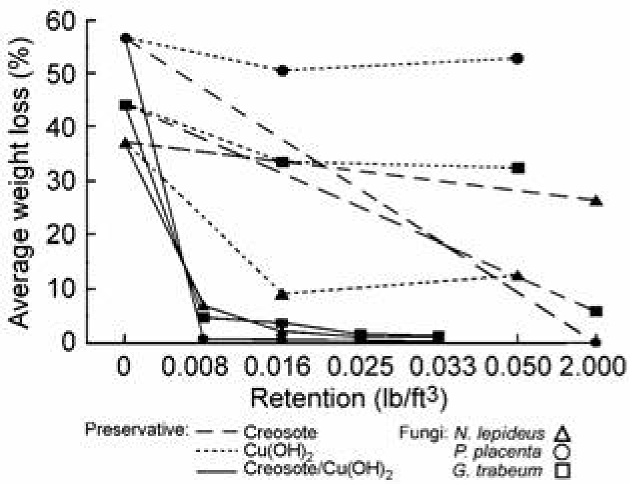

Figure 2. Synergism of $Na_2B_4O_7$ with Creosote in Unleached Soil-blocks

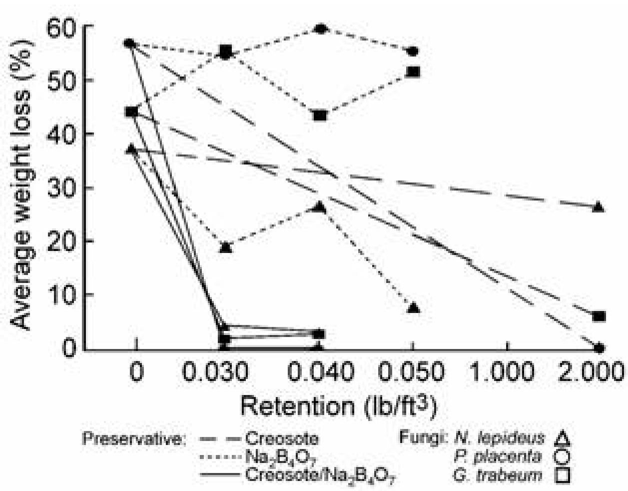

Table 3. Synergistic effect of creosote with copper hydroxide and sodium tetraborate

Chemical treatment	Retention		Average weight loss (%)		
	kg/m^3	lb/ft^3	*N. lepideus*	*G. trabeum*	*P. placenta*
Control	0.00	0.000	37.24	44.21	56.62
Creosote	32.00	2.000	26.89	6.31	0.37
$Cu(OH)_2$	0.32	0.020	9.34	33.76	50.81
	0.80	0.050	12.97	32.92	53.20
$Na_2B_4O_7$	0.48	0.030	19.17	55.50	54.62
	0.64	0.040	26.70	43.47	59.79
	0.80	0.050	7.78	51.77	55.74
Creosote/$Cu(OH)_2$[a]	0.13	0.008	7.05	4.91	0.79
	0.26	0.016	2.32	3.78	0.75
	0.40	0.025	1.33	1.76	0.47
	0.53	0.033	1.45	1.58	0.38
Creosote/$Na_2B_4O_7$[a]	0.48	0.030	4.43	2.01	0.28
	0.64	0.040	3.46	3.13	0.28

[a]For dual treatments, retentions listed are for the second chemical treatment only.

Discussion

DeGroot and Evans (1999) showed statistically that with creosote, increased retention levels increased product longevity in the field. But in a health conscious society, wise choice. From our data we were able to confirm that amine copper complexes from copper hydroxide (Fig. 1) and borates (Fig. 2) are highly synergistic with sub-threshold levels of creosote for control of the creosote-tolerant fungus *N. lepideus*.

Duncan and Richards (1950) determined that copper naphthenate was not synergistic with either creosote or pentachlorophenol, and Fahlstrom (1971) found that chlorinated hydrocarbons were also not synergistic with creosote. Our results show an unexpected copper synergism with creosote, which confirms that amine copper complexes from copper hydroxide are highly synergistic with creosote for controlling *N. lepideus*, the creosote-tolerant fungus. The compatibility of copper hydroxide and sodium tetraborate decahydrate with creosote suggests that either of these chemicals (creosote-copper hydroxide or creosote-borate) can be used effectively for remedial treatment of creosote poles.

Conclusions

From the results in Table 3, we can make the following conclusions:

- Creosote is effective against decay caused by *Gloeophyllum trabeum* and *Postia placenta*.
- $Cu(OH)_2$ at the lower retention and $Na_2B_4O_7$ at the higher retention are effective against decay caused by *Neolentinus lepideus*.
- For blocks treated with $Cu(OH)_2$, an average weight loss above 30 percent was achieved with *G. trabeum* and above 50 percent with *P. placenta*.
- Weight loss was above or comparable to controls in blocks treated with $Na_2B_4O_7$ and exposed to *G. trabeum* and *P. placenta*.
- Weight loss significantly decreased in blocks that were retreated with $Cu(OH)_2$ and $Na_2B_4O_7$ when exposed to *G. trabeum* and *P. placenta*.

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overloading a product with a chemical that bleeds is not a