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Assessment of the Treatability of Small-Diameter Grand Fir Posts

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Abstract

The value of small-diameter grand fir round stock could be increased if this material could be successfully treated with preservatives and marketed as posts and poles. This paper reports the treatability of suppressed-growth grand fir posts with several common preservatives. Ammoniacal copper zinc arsenate (ACZA) and oilborne copper naphthenate were found to provide adequate treatment. Acceptable treatment was not achieved with chromated copper arsenate (CCA). The pattern of preservative penetration was erratic, especially with CCA.

Keywords: grand fir, small diameter, treatability, preservative, chromated copper arsenate, copper naphthenate, ammoniacal copper zinc arsenate

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Assessment of the Treatability of Small-Diameter Grand Fir Posts

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Introduction

In some areas of the western United States, National Forests contain dense stands of small-diameter grand fir (*Abies grandis*). Management objectives for these forests often call for removal of a portion of this material, but these trees currently have low commercial value. The value of small-diameter grand fir round stock could be increased if this material could be successfully treated with preservatives and marketed as posts and poles. However, the treatability of this species is not well established. One study of western species reported that the treatability of grand fir lumber with chromated copper arsenate (CCA) was greater than that of western hemlock and the true firs (Lebow and others 1996), while earlier work suggested that grand fir was among the least treatable of the commercial Hem–Fir group (Kumar and Morrell 1989, 1990). In a more recent trial (Rhatigan and Morrell 2000), grand fir round stock was adequately treated with ammoniacal copper zinc arsenate (ACZA), but penetration was substandard with CCA (Table 1). Although greater penetration is typical with the ammoniacal preservatives, the extent of the disparity in penetration between ACZA and CCA was greater than expected.

Copper naphthenate presents another possibility for treating grand fir. This preservative may offer marketing advantages over both CCA and ACZA because it does not contain arsenic and is not a restricted use pesticide.[1] Copper naphthenate is the reaction product of naphthenic acids and copper compounds dissolved in oil. Copper naphthenate is used for treating utility poles and in highway construction; it is not used as widely as creosote or pentachlorophenol. The properties of copper naphthenate, like those of pentachlorophenol, depend on the type of oil in which it is dissolved. Commonly used oils are fuel oil and mineral spirits. The color of the treated wood varies from light brown to dark green, depending on the type of oil and the treating process.

The purpose of this study was to further investigate the treatability of grand fir round stock with CCA and develop data on the treatability of this species with copper naphthenate.

Table 1—Penetration of ACZA and CCA in grand fir posts at Oregon State University post farm[a]

Preservative	Average penetration (mm)	Cores meeting penetration standard[b] (%)
ACZA	42	100
CCA	15	56

[a]Rhatigan and Morrell 2000.
[b]AWPA Standard C5.

Materials and Methods

Sections of grand fir round stock were obtained from the Wallowa Mountains in Wallowa County, Oregon. Twenty 0.9- to 1.2-m-long sections were cut, debarked, air dried to below 25% moisture content, and shipped to the Forest Products Laboratory in Madison, Wisconsin. Two posts were discarded because of heavy sapstain, which can sometimes increase permeability. The remaining 18 posts, which ranged in diameter from 69 to 112 mm, were further conditioned to between 10% and 15% moisture content. Approximately 76 mm was removed from the end of each post; the posts were then cut into three 254-mm-long specimens.

[1]The Environmental Protection Agency has determined that some pesticides, even with proper handling and application, might result in an adverse effect on human health and/or the environment. These pesticides are classified as restricted use pesticides, and can only be applied by persons who have been trained in their use. CCA, creosote, and pentachlorophenol are examples of wood preservatives that are restricted use pesticides.

The specimens were end-coated with neoprene rubber sealant to limit end-grain penetration. One specimen from each post was randomly assigned to one of the following treatment groups:

1. CCA–C treatment: 2% solution—Full cell, 30 min initial vacuum (–85 kPa) followed by 60 min pressure at 1,035 kPa
2. CCA–C treatment: 2% solution—Full cell 30 min initial vacuum (–85 kPa) followed by 300 min pressure at 1,035 kPa
3. Copper naphthenate treatment: 1% solution (as copper, in #2 fuel oil)—Full cell, 30 min initial vacuum (–85 kPa) followed by 300 min pressure at 1,035 kPa

All treatments were performed at room temperature. Following treatment, the specimens were allowed to air dry, cut in half to expose the cross-sectional face, and sprayed with a Chrome Azurol-S copper indicator solution. The distance from the edge to the first void in preservative penetration was measured at four equally spaced points around the circumference of each post. The depth of penetration was compared to American Wood Preservers' Association (AWPA) Standard C5 for fence posts (AWPA 2001).

Results and Discussion

Despite their small diameter, many grand fir trees evaluated in this study were more than 50 years old and had more than 16 growth rings/cm in the outer 25 mm (Table 2). Most trees contained some readily visible areas of compression wood. These characteristics all reflect the adverse growing conditions endured by the trees.

Penetration of CCA into the grand fir specimens was generally poor, in agreement with the findings of Rhatigan and Morrell (2000). Penetration was only slightly improved by increasing the pressure period from 1 to 5 h (Table 3). The greatest degree and uniformity of penetration was achieved with copper naphthenate. It appears that copper naphthenate will provide penetration sufficient to comply with AWPA Standard C5 (AWPA 2001) for difficult-to-treat western species used as round fence posts.[2] That standard calls for a minimum of 9 mm of preservative penetration in the outer portion of at least 80% of the posts sampled. For specimens treated with copper naphthenate, 67 of 72 measurements (93%) met or exceeded the 9-mm requirement (Table 3). Neither of the CCA charges would have met this penetration standard. These results illustrate that the type of solvent used can greatly influence the ability of a preservative to penetrate the wood.

[2]Grand fir is not currently listed in Standard C5. For the purposes of this report, preservative penetration for grand fir was compared to the criteria for the combined Douglas-fir, western hemlock, and western larch listing.

The treatability of grand fir varied greatly between trees. There appeared to be a slight correlation between the rate of growth of the tree and the degree of copper naphthenate penetration. Younger, faster-growing trees tended to be more treatable with copper naphthenate (Fig. 1). This suggests that grand fir growing under conditions more favorable than those in this study might be more readily treated. Little correlation was apparent between treatability and either stem diameter or extent of compression wood.

The pattern of preservative penetration was erratic and unusual, especially for the CCA treatments (Fig. 2). Unlike the "treated shell" appearance that usually results when only the sapwood portion of round stock is penetrated, many CCA-treated grand fir specimens had a thin layer of treatment on the outside, a broad band of untreated sapwood, and another band of treated wood near the center of the tree. CCA apparently penetrated the inner portion by flowing into drying checks until it reached more permeable wood. It then spread tangentially around the stem in those areas. Even with the copper naphthenate treatment, occasional skips or breaks in penetration occurred (Fig. 2). Incising would help to eliminate these irregularities in penetration, but the cost of acquiring equipment capable of incising small round-stock might be prohibitive. Further investigation may be warranted to determine the wood microstructure characteristics responsible for these unusual preservative penetration patterns.

Table 2—Characteristics of grand fir posts treated with CCA or copper naphthenate

Post number	Age (years)	Growth rings/cm[a]	Post diameter (mm)	Degree of compression wood
1	>50	11	103	Severe
2	>50	>16	91	Moderate
3	>50	>16	93	Mild
4	>50	>16	80	Mild
5	>50	>16	91	Moderate
6	45	10	100	Severe
7	>50	>16	74	Mild
8	>50	>16	78	Mild
9	>50	>16	76	Moderate
10	20	6	79	None
11	>50	>16	69	Mild
12	>50	14	112	Moderate
13	19	5	72	Moderate
14	19	6	97	None
15	20	4	96	Mild
16	20	6	87	None
17	31	8	100	Mild
18	>50	>16	94	Mild

[a]As counted in outer 25 mm of post.

Table 3. Preservative penetration measured in 4 quadrants in grand-fir post sections pressure treated with CCA or copper naphthenate

Treatment and post no.	Penetration (mm)					Number failed posts	Percentage passed posts[a]
	Quad. 1	Quad. 2	Quad. 3	Quad. 4	Post avg.		
CCA—1 h pressure							
1	30	1	35	10	19.0	1	
2	1	10	1	1	3.3	3	
3	1	28	1	1	7.8	3	
4	15	1	1	1	4.5	3	
5	1	1	14	1	4.3	3	
6	1	30	2	20	13.3	2	
7	2	15	1	1	4.8	3	
8	1	1	1	1	1.0	4	
9	20	1	15	2	9.5	2	
10	1	2	30	20	13.3	2	
11	20	2	2	2	6.5	3	
12	15	2	5	20	10.5	2	
13	1	1	6	1	2.3	3	
14	3	1	1	2	1.8	3	
15	1	8	2	2	3.3	4	
16	10	11	10	5	9.0	1	
17	2	4	2	2	2.5	4	
18	2	3	1	1	1.8	4	
				Charge average 7		**Total 50**	**31%**
CCA—5 h pressure							
1	1	3	5	30	9.8	3	
2	4	3	2	5	3.5	4	
3	1	15	1	1	4.5	3	
4	5	2	1	3	2.8	4	
5	2	2	2	10	4.0	3	
6	32	30	2	3	16.8	2	
7	2	2	2	2	2.0	4	
8	33	1	30	1	16.3	2	
9	1	12	1	15	7.3	2	
10	7	20	10	12	12.3	1	
11	12	1	3	2	4.5	3	
12	2	9	10	2	5.8	2	
13	2	2	2	5	2.8	4	
14	24	2	2	5	8.3	3	
15	10	20	37	3	17.5	1	
16	21	5	28	40	23.5	1	
17	20	23	1	2	11.5	2	
18	10	1	8	1	5.0	2	
				Charge average 9		**Total 46**	**36%**
Copper naphthenate—5 h pressure							
1	40	31	30	20	30.3	0	
2	23	20	25	24	23.0	0	
3	10	10	8	30	14.5	1	
4	10	30	5	24	17.3	1	
5	10	11	13	15	12.3	0	
6	30	35	35	32	33.0	0	
7	10	22	8	12	13.0	1	
8	30	12	2	10	13.5	1	
9	12	25	18	20	18.8	0	
10	18	20	19	21	19.5	0	
11	18	17	20	15	17.5	0	
12	12	20	35	15	20.5	0	
13	28	28	28	28	28.0	0	
14	30	35	28	29	30.5	0	
15	30	35	20	29	28.5	0	
16	29	27	20	18	23.5	0	
17	20	21	25	30	24.0	0	
18	30	38	2	12	20.5	1	
				Charge average 22		**Total 5**	**93%**

[a]Based on minimum of 9 mm penetration for round posts of western species.

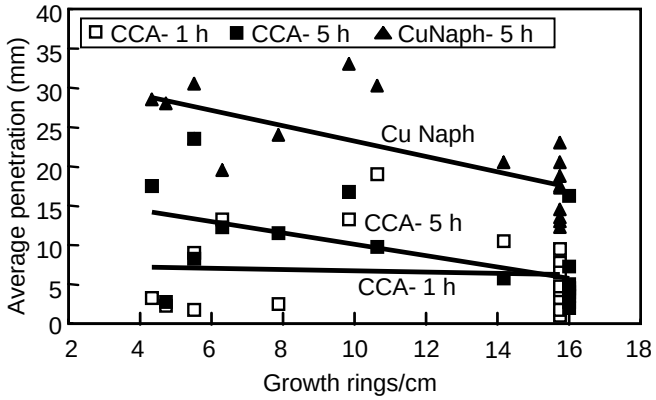

Figure 1. Relationship between growth rate and preservative penetration in grand fir posts.

Conclusions

Although the small-diameter grand fir evaluated in this study does not appear to be readily treated with CCA, it does appear to be treatable with copper naphthenate in #2 fuel oil. Penetration of copper naphthenate exceeded that specified by AWPA standards in over 90% of the measurements. ACZA has also been demonstrated to be a viable treatment option for grand fir round stock. The erratic nature of the penetration in the posts in this study warrants further consideration. Some posts that might have passed penetration inspection based on removal of a single increment core had significant gaps in penetration in other portions of the sapwood. On the other hand, most posts evaluated in this study had grown very slowly and may represent somewhat of a worst-case scenario. The results indicate that treatability is affected by growing conditions. It is possible that grand fir grown under more favorable conditions than those in this study may be treated more readily.

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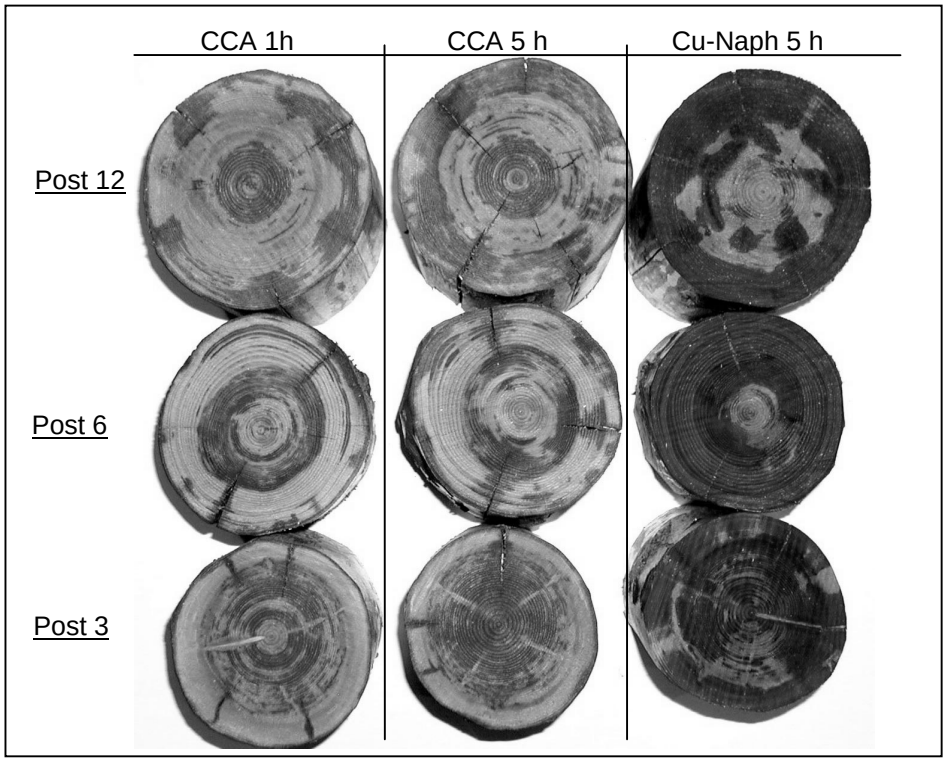

Figure 2. Examples of pattern of preservative penetration for CCA and copper naphthenate treatments. Treated areas appear dark.