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Distribution of Boron from Fused Borate Rods in Douglas-fir Transmission Poles

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SUMMARY

The diffusion of boron from fused borate rods (disodium octaborate tetrachydrate) was monitored over 42 months in CCA-treated Douglas-fir transmission poles. The boric acid equivalent was estimated by the curcumin/salicylic acid color test on increment cores removed from the poles. Moisture content of the poles was quite variable but was always above 20 percent. The percent of increment core length showing boron was also variable with time of sampling from individual poles and between poles. Diffusion of boron increased until 18 months then decreased slightly at 30 and 42 months. Boron was almost always detected downward from the treatment holes at a distance of 25 cm. Likewise, boron was usually detected laterally from the insertion hole at a distance of 7.6 cm. Movement of boron upward from the insertion holes was often nil and not exceeding 5 cm. Thus, because of the variable penetration of boron in the Douglas-fir heartwood, untreated areas are present that are susceptible to decay.

INTRODUCTION

Pressure-treated utility poles have given many years of excellent service, but their lifetime can be shortened by internal decay of the untreated heartwood center, particularly in refractory apecies, such as Douglas-fir. An area of active research is the use of borate rods to protect the inner untreated heartwood portion of utility poles from internal decay (Morrell, 1993; Schmidt, 1990). Movement of boron from fused rods installed in Douglas-fir heartwood has been studied recently. (Morrell and Freitag, 1995)

Generally, the movement of boron in Douglas-fir heartwood has been limited to short distances and its penetration rather variable (Highley and Ferge, 1995; Morrell and Freitag, 1995). In a laboratory study, however, boron diffused well from boron rods in Douglas-fir heartwood blocks at moisture contents above 40% (Morrell, et al ., 1990).

Recently, we (Highley et al ., 1994) reported on the distribution of boron from fused borate rods installed in copper-chrome-arsenate (CCA)-treated Douglas-fir transmission poles through 18 months. Boron was almost always detected downward from the treatment at a distance of 25 cm (10 inches). Movement of boron sapwood from the treatment hole, however, was poor, not exceeding 5 cm (2 inches). This paper reports the distribution of boron from fused borate rods installed in these same poles through 42 months.

Method[1]

Treatment of Poles with Fused Borate Rods.

Douglas-fir poles (30.5m and 32m) were pressure treated in 1970 with copper-chrome-arsenate (CCA) and installed at a government facility in the early 1970's near Chicago, IL. In March 1992, the poles were supplementary treated with fused borate rods (sodium borate). Rods were inserted at 38 cm intervals starting at the bottom of a pole, and rotating 90° at each 30 cm interval. Three 1.9cm X 7.6cm borate rods were inserted into 2cm X 50.8cm holes drilled downward at a 45° angle. The placement was a 7.6cm borate rod, a 2cm wood plug, a 7.6cm borate rod, a 7.6cm wood plug, and a 7.6cm borate rod. A 2.4cm wood plug was used to seal the hole.

Evaluation of Borate Treatment.

Eleven poles were sampled for evaluation of borate movement. Six of the poles were sound and 5 had evidence of interior decay. Poles were evaluated 6 and 18 months after insertion of boron rods. Four to eight borings were removed from each pole with an increment borer around a borate treatment hole, approximately 1 to 4 feet aboveground. Cores were taken above, below, and laterally to the treatment hole. The boric acid equivalent was roughly monitored through a two stage curcumin/salicylic acid color test. (Collister, 1990) In this test, a bright red color indicates a BAE of 0.25 percent or more; red-brown indicates 0.20 percent; brown-yellow is 0.15 percent: no color change (yellow) indicates a level less than 0.10 percent. A bright red color is generally accepted as sufficient for elimination of decay fungi and was used as a positive indication of boron in cores.

Increment cores were also removed from poles at 18-48 months for determination of moisture content, based on oven dry weight.

Presence of viable decay fungi in the poles was determined by placing increment cores on 2% malt extract agar medium in petri dishes.

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RESULTS AND DISCUSSIONS

The moisture content in randomly selected areas of poles at 42 months is given in Table 1. Moisture contents were quite variable between poles as well as from different areas in a pole. Moisture content from areas sampled for boron content were always above 20 percent (Table 2). Berates are reported to diffuse rapidly from the point of treatment if the water content is greater than 25-30% (Edlund et al ., 1983). In a laboratory study, however, Morrell et al ., (1990) found that in Douglas-fir, moisture contents above 40 percent, were required for good diffusion of boron. Previously, we (Highley and Ferge, 1995) found very poor movement of boron from fused borate rods installed in Douglas-fir timbers that never reached moisture content above 20 percent. Borate formulated with glycol moves better in wood with lower moisture contents than borate alone. However, Morrell and Freitag (1995) report variable penetration of borate in Douglas-fir lumber (20 to 35 moisture content) treated with Boracare (disodium octaborate plus glycols). Chemical analysis showed that most of the borate remained within 5 mm of the wood surface, although concentrations were variable.

The movement of boron from rods installed in 11 poles, and evaluated by application of curcumin dye to increment cores removed from the poles through 42 months is given in Tables 2 and 3. In Table 2, the percentage of increment core length containing boron is given. For exampls, 129.5 lineal cms of increment cores were removed from pole one at 6 months. Fifty-six lineal cms of the cores or 43 percent of the total length of increment cores removed from the pole showed boron. Table 3 is an attempt to demonstrate distribution of boron about a treatment hole. A plus indicates that an increment core removed from that area had at least 2.5 lineal cms of boron. Seldom was boron detected for the total length of 15.2 cm long core.

The total percent of core length showing boron maximized at 18 months (61 percent) and declined slightly at 30 and 42 months (Table 2). Boron moved best downward from the treatment hole, almost always being detected at least 25 cms below the treatment hole (Table 3). Likewise, boron was usually detected laterally from the insertion hole at 7.6 cms. Boron moved poorest upward from the insertion hole, not being detected at 5 cms. The diffusion of boron showed considerable variation between poles. Good diffusion of boron in wood is associated with high moisture content. However, the diffusion of boron from rods in the Douglas-fir poles did not always correlate with the moisture content. For example, at 42 months, pole one with 21 percent moisture content had 58 percent of the boring length with boron. Pole eleven at 42 months with 59 percent moisture content had boring length of only 27 percent with boron. Thus, there are untreated areas in the poles with sufficient moisture to support decay activity.

No decay fungi have been cultured from increment cores removed from the poles through 42 months despite the absence of detectable boron in some areas with high moisture content. The presence of decay was noted in five poles prior to installation of boron rods but isolations for viable decay fungi were not made at that time. Thus, although no decay fungi have been isolated from any of the poles through 42 months, we cannot definitely attribute this to the killing

effect of boron. Nor is there assurance that decay activity will not eventually resume in the interior heartwood of the poles.

REFERENCES

Collister, L.
1990. Dip diffusion treatment of log home logs. First international conference on wood protection with diffusible preservatives. pp. 102-105.

Edlund, M.L., B. Henningsson, A. Kaarik and P.E. Dicker.
1989. A chemical and mycological evaluation of fused borate rods and a borate/glycol solution for remedial treatment of window joinery. Inter. J. Wood Preservation 3(1):3-22.

Highley, T.L. and L. Ferge.
1995. Movement of boron from fused boron rods implanted in southern pine, Douglas-fir, red oak and white oak timbers. Inter. Res. Group on Wood Preservation, Doc. IRG/WP/95-30061.

Highley, T.L., W. Finney and F. Green III.
1994. Borate diffusion from fused borate rods in Douglas-fir transmission poles. Inter. Res. Group on Wood Preservation, Doc. IRG/WP/94-30042.

Morrell, J.J.
1993. Conserving energy by environmentally acceptable practices in maintaining and procuring transmission poles, 13th Annual Report, Cooperative Pole Res. Program, Oregon State Univ., Corvallis, OR, 82 pp.

Morrell, J.J. and C.M. Freitag.
1995. Effect of moisture content on diffusion of boron-based biocides through Douglas-fir and western hemlock lumber, Forest Prod. J. 45(3):51-55.

Morrell, J.J., C.M. Sexton and A.F. Preston
1990. Effect of moisture content of Douglas-fir heart-wood on longitudinal diffusion of boron from fused borate rods. Forest Prod. J. 40(4):37-30.

Schmidt, E.
1990. Remedial decay treatment with fused borate rods: recent developments and opportunities, First International Conference on Wood Protection with Diffusible Preservatives, pp. 91-92.

Table 1. Moisture content of samples removed from Douglas-fir poles 42 months after borate rod treatment.

Pole	Sample Location (distance aboveground)	Moisture Content (%)
1	30.5 cm (12 in.)	21.2
2	30.5 cm (12 in.)	25.0
2	Groundline	142.5
2	25.9 m (85 ft.)	18.8
3	Groundline	30.2
4	45.7 cm (18 in.)	67.3
4	Groundline	169.7
5	30.5 cm (12 in.)	25.6
5	9.2 m (30 ft.)	73.8
6	30.5 cm (12 in.)	22.6
7	30.5 cm (12 in.)	31.4
8	45.7 cm (18 in.)	22.9
9	45.7 cm (18 in.)	58.5
10	30.5 cm (12 in.)	28.9
11	4.8 m (15 ft.)	169.7
12	Groundline	19.0
13	Groundline	84.3
14	Groundline	120.8
15	Groundline	105.1

Table 2. Diffusion of borate from rods at various time after insertion in Douglas-fir poles.

Pole	Condition of pole	Moisture Content (%) Months			Percent of Boring Length With Boron[a] Months			
		18	30	42	6	18	30	42
1	Sound	38	37	21	43	9	17	58
2	Sound	30	24	30	25	62	37	14
3	Sound	28	26	23	40	87	21	28
4	Sound	25	24	28	21	50	50	64
5	Sound	72	52	29	23	9	60	N/A
6	Sound	25	51	N/A	22	32	33	63
7	Decay	101	27	25	39	80	8	50
8	Decay	51	32	67	14	91	83	46
9	Decay	23	66	26	9	33	80	42
10	Decay	38	45	31	20	67	100	47
11	Decay	27	44	59	31	67	50	27
Total percent showing Boron					26	57	49	40

[a]60 borings were taken at 6 months for a total length of 1265 cm (498 inches)
49 " " " " 18 " " " " " " 627 cm (247 inches)
54 " " " " 30 " " " " " " 823 cm (324 inches)
73 " " " " 42 " " " " " " 1105 cm (435 inches)

Table 3. Distribution of boron from treatment hole[a]

	Boron Treatment Above Hole 5cm (2 in.)				Boron Treatment Below Hole 25cm (10 in.)				Boron Treatment Lateral To Hole 7.6cm (3 in.)			
Pole	6M	18M	30M	42M	6M	18M	30M	42M	6M	18M	30M	42M
1SE	+	-	-	+	+	+	+	+	+	+	-	+
8W	-	+	-	-	+	+	-	-	+	NC[b]	+	-
12W	-	+	-	-	+	+	+	-	+	+	-	+
16W	-	+	NC	+	+	+	+	+	+	+	+	+
20S	+	+	+	-	-	+	+	-	+	+	+	-
SY-1	-	-	+	+	+	+	-	+	+	+	+	+
6E	-	+	+	+	+	+	+	+	-	+	+	+
9E	+	-	-	-	+	+	+	+	+	+	+	+
11E	-	+	+	+	-	+	+	NC	-	-	+	-
13W	+	+	NC	-	+	+	-	+	+	+	+	+
17W	+	NC	NC	-	+	+	+	+	+	+	+	+

[a]Boron present in at least 2.5cm (1 inch) of core +, boron absent-.

[b]NC, no core sample