PERFORMANCE OF COPPER-NAPHTHENATE-TREATED POLES IN SERVICE

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ABSTRACT

Copper-naphthenate-treated poles in service were inspected for deterioration, penetration, retention, and serviceability. The study included poles in all hazard zones in the United States. Poles installed by 12 different utilities and treated by 8 different treating companies are included in the survey. Both southern pine and Douglas-fir poles and distribution and transmission poles are included in the survey. Only two of the surveyed poles were considered failures, indicating that properly treated copper naphthenate poles are performing satisfactorily.

Many studies have confirmed the effectiveness of copper naphthenate (CN) as a wood preservative (4-7). Southern pine pole stubs from the trials on the impact of post-treatment conditioning on performance conducted at Mississippi State University still show excellent performance after ground contact exposure for over 12 years in Mississippi (2,3). These steam-conditioned and air-dried stubs were post-treatment conditioned by steaming or expansion (fixation) bath. Kiln-dried poles installed in 1988 in Ohio, Virginia, and West Virginia showed no indication of inadequate performance 4 years later (4). Migration of preservative was typical of oilborne systems.

Thousands of CN-treated poles are currently in service throughout the United States, but due to some premature failures, a task force was formed by AWPA Subcommittee T-4 in 1996 to investigate the performance of CN-treated poles in service. This report documents our survey of poles in service.

METHODS AND MATERIALS

TEST POLES

CN-treated poles of different ages, sizes, and species from different geographical areas were identified, and the cooperation of the pole owners was secured. Individual poles were numbered and a random number generator was used to identify which poles would be examined, depending on the wishes of the cooperating utility. If the physical location of a pre-chosen pole precluded its examination, the pole was replaced by the next number chosen.

A total of 137 Douglas-fir and 170 southern pine CN-treated poles were examined for this report. These poles represent 12 different utilities and 8 different treaters and include assessments of poles in all deterioration zones in the United States (1).

POLE INSPECTION

All poles chosen for this study were examined for signs of deterioration by independent inspectors, both aboveground and 1 foot below the groundline. Test poles were excavated to 2 feet below the groundline, sounded from groundline to as high as the inspector could reach, examined for signs of external decay both above and below the groundline, and bored three or four times near grade and once within 1 foot of the brand to determine internal decay and preservative penetration. These cores were combined for assay as described below. Selected poles were bored above the brand in a spiral pattern in 5-foot increments in order to more thoroughly assess the condition of the aboveground portion of the pole. These cores were assayed separately as a group. Cores were placed in straws and shipped to the

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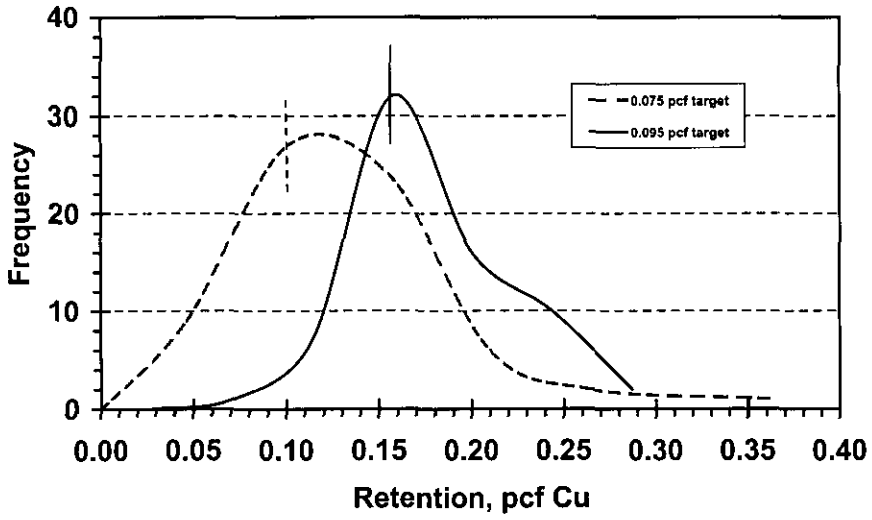

Figure 1. — Retention distributions for Douglas-fir poles treated to 0.075 pcf and 0.095 pcf Cu target retentions (vertical lines indicate mean values).

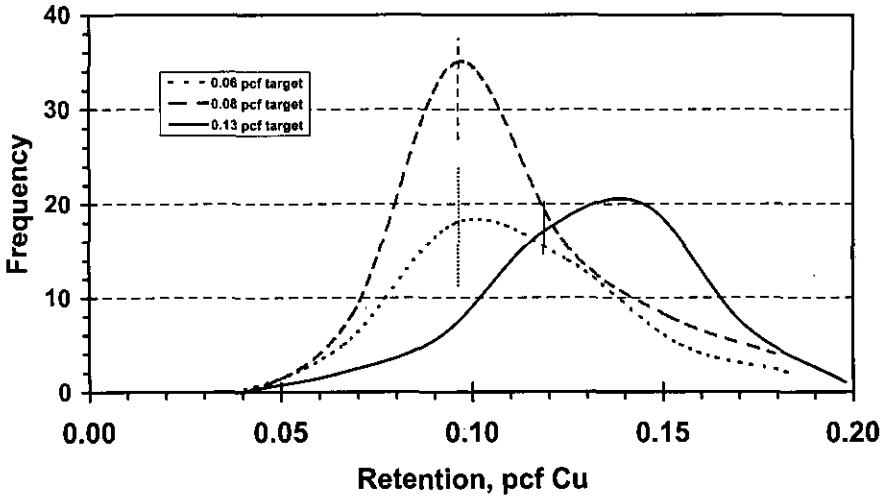

Figure 2. — Retention distributions for southern pine poles treated to three target retentions (vertical lines indicate mean values).

TABLE 1. — Distribution data for poles evaluated.

	Douglas-fir		Southern pine		
Target retention (pcf Cu)	0.075	0.095	0.06	0.08	0.13
Mean	0.101	0.157	0.096	0.096	0.119
Standard error	0.007	0.005	0.004	0.003	0.004
Median	0.094	0.145	0.093	0.092	0.120
Mode	0.124	0.129	0.132	0.070	0.096
Standard deviation	0.054	0.043	0.029	0.028	0.026
Sample variance	0.003	0.002	0.001	0.001	0.001
Kurtosis	6.644	-0.191	0.111	0.278	-0.084
Skewness	1.757	0.439	0.467	0.777	-0.264
Range	0.342	0.200	0.136	0.130	0.121
Minimum	0.019	0.064	0.040	0.043	0.052
Maximum	0.361	0.264	0.176	0.173	0.173

Mississippi Forest Products Laboratory (MFPL) where each core was examined for signs of internal decay and the penetration of preservative was rechecked. Cores were then ground to pass a 30 mesh screen, and assayed using x-ray fluorescence spectroscopy according to AWPA Standard A9-97 (1).

RESULTS AND DISCUSSION

The Douglas-fir poles inspected had been in service for 6 to 8 years. Twenty-four (18%) Douglas-fir poles failed to meet the target assay. About 71 percent of the poles treated to a 0.075 pcf target met retention requirements. Of those treated to a 0.095 pcf target, 94 percent met the retention requirements. The average for all 0.075 pcf target poles was 0.101 pcf or 35 percent greater than the specified target. For the 0.095 pcf target, retention averaged 0.157 pcf or 65 percent more than target. One penetration failure was noted. No insect problems were noted in any of the treated poles, and a small, remediable decay pocket was present in one pole.

Retention distribution data are shown in **Figure 1** and **Table 1** for the Douglas-fir poles. The data suggest that treaters are having some problems in meeting the lower (0.075 pcf) retention target. On average, however, most Douglas-fir poles are over-treated. Penetration does not seem to be a concern with only one penetration failure in the total Douglas-fir pole sample.

The southern pine pole data show that 91 percent of the poles treated to a 0.06 pcf target met or exceeded retention requirements. The average retention for this group was 0.096 pcf. Decay was found in two of the 0.06 pcf target poles. The group average for the 0.08 pcf target group was identical to the 0.06 pcf group with 71 percent of the poles treated to the target or above. One pole in the 0.08 pcf target group had penetration problems and an additional pole failed from decay and was removed from service. The 0.13 pcf target group was the least well treated with 59 percent of the pole not meeting target. Average retention for this group was 0.119 pcf by assay. For the 0.13 pcf target group, one pole had spotty penetration and a second pole, which failed from decay, also had spotty penetration. No penetration failures were noted. The data suggest that treaters are having difficulty in meeting the 0.13 pcf target.

TABLE 2. — Comparison of retentions for pole tops (above brand) and bottoms (brand down).

Treated		Pole		Target		Assay		Difference	Ratio
Month	Year	class	Length	retention	Zone	Bottom	Top	(bottom-top)	(top:target)
			(ft.)	(pcf Cu)		(pcf Cu)			(%)
Douglas-fir									
7	91	3	45	0.075	1	0.054	0.103	-0.049	137
7	91	3	45	0.075	1	0.094	0.066	0.028	88
7	91	3	45	0.075	1	0.024	0.039	-0.015	52
							Avg.	-0.012	92
							SD[a]	0.039	43
Southern pine									
4	90	5	40	0.06	2	0.090	0.141	-0.051	235
9	93	4	40	0.08	2	0.092	0.117	-0.025	146
5	91	5	40	0.08	4	0.054	0.078	-0.024	98
5	91	5	40	0.08	4	0.075	0.098	-0.023	123
9	93	4	40	0.08	2	0.070	0.089	-0.019	111
4	88	4	40	0.08	4	0.070	0.083	-0.013	104
4	90	5	40	0.06	2	0.081	0.094	-0.013	157
4	88	5	40	0.08	4	0.071	0.083	-0.012	104
4	88	5	40	0.08	4	0.123	0.135	-0.012	169
4	90	5	40	0.06	2	0.086	0.097	-0.011	162
8	96	5	30	0.13	5	0.105	0.116	-0.011	89
4	90	5	40	0.06	2	0.083	0.094	-0.011	157
9	93	4	40	0.08	2	0.061	0.069	-0.008	86
4	90	5	40	0.06	2	0.084	0.092	-0.008	153
6	92	5	40	0.06	1	0.040	0.047	-0.007	78
10	92	5	35	0.06	1	0.064	0.071	-0.007	118
4	96	5	30	0.13	5	0.096	0.102	-0.006	78
4	90	5	40	0.06	2	0.118	0.120	-0.002	200
4	88	5	40	0.08	4	0.080	0.081	-0.001	101
4	90	5	40	0.06	2	0.122	0.123	-0.001	205
4	90	5	40	0.06	2	0.101	0.100	0.001	167
4	90	5	40	0.06	2	0.120	0.116	0.004	193
4	90	5	40	0.06	2	0.110	0.106	0.004	177
4	88	5	40	0.08	4	0.082	0.076	0.006	95
4	88	5	40	0.08	4	0.100	0.094	0.006	118
4	90	5	40	0.06	2	0.079	0.073	0.006	122
5	91	5	40	0.08	4	0.101	0.095	0.006	119
6	93	3	45	0.08	2	0.119	0.112	0.007	140
4	90	5	40	0.06	2	0.072	0.061	0.011	102
4	90	5	40	0.06	2	0.102	0.089	0.013	148
10	92	5	35	0.06	1	0.075	0.056	0.019	93
4	90	5	40	0.06	2	0.111	0.092	0.019	153
9	93	4	40	0.08	2	0.112	0.092	0.020	115
3	94	5	30	0.13	5	0.115	0.095	0.020	73
5	94	5	35	0.13	5	0.093	0.07	0.023	54
6	93	4	40	0.06	1	0.132	0.102	0.030	170
5	93	5	35	0.06	1	0.093	0.062	0.031	103
5	91	5	40	0.08	4	0.098	0.063	0.035	79
4	90	5	40	0.06	2	0.157	0.104	0.053	173
5	91	5	40	0.08	4	0.149	0.056	0.093	70
							Avg.	0.004	128
							SD	0.024	43

[a] SD = standard deviation.

The oldest poles in the southern pine survey group were installed in 1988.

Retention distribution data are shown in **Figure 2** and **Table 1** for southern pine poles. Considerably more variation was shown in the southern pine poles tested. Most non-conforming poles failed to meet the specified assay requirement. Only two seriously decayed southern pine poles were found, and they were removed from service after 7 to 8 years. One pole had a break below the bottom conductor in the decayed area near the crossarm. The other had a large decay pocket containing some preservative at groundline. In both instances, decay appeared to result from conditioning problems (wet pockets), or inadequate sterilization. Other researchers (8) have observed this problem in poles treated with oilborne preservatives.

Several southern pine poles were severely under-treated, with one being only 40 percent of the target retention specified. These poles are candidates for early failure. It was noted that some poles had bleached tops, but this observation did not correlate with under-treatment, decay, or other defects.

Data comparing assays from pole tops (above brand) to those taken from the brand down are shown in **Table 2**. This was done since, in discussion, some have indicated that differential treatment along the pole may contribute to early failure in service. There was no consistent trend with respect to assay location, with half of the poles having higher retentions in the top portion and half with higher retentions in the bottom portion. All but eight poles showed bottom to top differences within ± 0.025 pcf Cu. For Douglas-fir, the average retention in pole tops was 92 percent of the target retention. Owing to the small sample size, the Douglas-fir data should be considered informational. Southern pine tops averaged 128 percent of target. For the most part, these comparisons fall within what might be expected and do not seem to indicate differential treatment.

CONCLUSIONS

This study has shown CN to be a very effective preservative when properly applied to wood poles. The failure rate in this study (< 1%) is well below the 5 percent exclusion limit found in a normal distribution of samples. Some difficulties in meeting some of the target retentions are indicated, but performance does not seem to be impacted so long as proper penetration is achieved. Failure of poles in this study seemed to arise from conditioning problems and/or inadequate sterilization.

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