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BORATE PRE-TREATED WOODEN CROSSTIES

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Summary

The results of a 15-year AAR/RTA field test using crossties pre-treated with borates and over-treated with creosote are reviewed. The commercialization of this dual treatment system is discussed

1. Introduction

Creosote-treated wooden crossties have, in general, performed well in a variety of geographic regions since the early 1900's. Increased tie life resulted from the development of new treating standards and acceptable practices by organizations such as the American Wood-Preservers' Association (AWPA), the Canadian Wood Preservation Association (CWPA) and the Canadian Standards Association (CSA) as well as the efforts of associations such as the Railway Tie Association (RTA), The Association of American Railroads (AAR), and the American Railway Engineering and Maintenance-of-Way Association (AREMA).

In spite of these efforts, however, relatively short service life of some ties continues to occur, particularly in the warm, humid areas of the southeastern U.S. that fall in AWPA Hazard Zones 4 and 5. The relatively poor performance of some refractory tie species in these regions has prompted some railroads to separate them for use in regions with lower indices of biodeterioration (AWPA Hazard Zones 1 – 3). Analysis of probable factors contributing to reduced service life of ties, assuming that ballast drainage is not an issue, indicated that (1) decay occurring in air-drying stacks and (2) the use of wood species whose heartwood is not treatable with traditional preservatives such as creosote (eg, white oaks) likely were the primary causes.

Assuming that these factors are the primary causes of the problem, the solution to achieving relatively uniform service life of wooden crossties requires their treatment prior to air-seasoning with a biocide that would penetrate the heartwood, even of refractory species. Biocides with such properties would need to be water-soluble and capable of diffusing through wood cell walls. Borates and fluorides are possible candidate biocides with such properties.

2. AAR/RTA Field Test

Borates are effective biocides against both wood decay fungi and insects, have low mammalian toxicities, are corrosion inhibitors, do not adversely affect wood strength

properties, and their presence can be verified by a color test. The efficacy of borates to protect wood from insects and fungi is documented in several publications (Cockroft and Levy, 1973; Drysdale, 1994; Hamel and Robertson, 1990). As a consequence, borates were chosen for use in a field test jointly sponsored by the RTA and AAR. Ties of different species were treated with heated borate solution, bulk-stacked under a tarp for a few weeks to permit the borate to begin to diffuse through the ties, and stacked for air-drying. The dried ties then were over-treated with creosote and placed in active rail lines in different AWPA Hazard Zones. These studies are documented in a progress report authored by T. L. Amburgey and S. C. Snyder dated Jan. 12, 1989, that was submitted to the AAR/RTA and in an undated AAR progress report authored by D. D. Davis and K. J. Laine. Five-year results were reported in Technology Digest (February 1994) and Crossties (July/August 1994) in manuscripts authored by Davis and Laine. Results of the 2002 inspection were summarized in a presentation by T. L. Amburgey at the RTA Annual Convention and in an article in Crossties (Jan./Feb. 2003) authored by James Gauntt.

After about 15 years in track, the Norfolk-Southern (NS) allowed track time and furnished personnel so that test ties could be removed from sections of their lines in Georgia. Basically, this test demonstrated that ties, including white oaks, pretreated with borates continued to perform well and had minimal decay and no spike kill. The results of this inspection are documented in a publication by Amburgey, Watt and Sanders (2003); a presentation at the 2005 RTA Convention by S. C.Kitchens and T. L. Amburgey; and a presentation at the 2005 AREMA Convention by J. Gauntt, T. L. Amburgey, and S. C. Kitchens.

Results of the early phases of this study indicated the following:

1. Borate up-take and diffusion was greater in unseasoned than in seasoned ties.
2. Borate up-take and diffusion was greater in ties bulk-stacked and covered for six weeks prior to being air-stacked than in those air-stacked following treatment.
3. Borate up-take and diffusion was greater in incised than in non-incised ties.
4. Large amounts of borate were lost from ties that were vapor-dried and treated with creosote shortly after six weeks of bulk-stacked, covered storage.
5. Very little borate was lost from air-dried ties during creosote treatment.

The 15-year inspection was at a site near Cordele, GA, on a mainline, fully signaled track. Sample ties in each treatment group were removed from track and sectioned through the inner spike holes at both ends to check for decay, insect damage and spike kill. Samples were obtained for borate analysis between the inner spike holes from the upper surface to the center and from the lower surface to the center. Results of the 15-year inspection can be summarized as follows:

1. Borates had diffused through the cross-sections and, after 15 years, were present at above toxic threshold levels for decay fungi.
2. No decay or termite damage was observed in either the creosote dip- or pressure-treated ties.

3. No spike kill was observed in borate pre-treated ties, and no evidence of excessive metal corrosion was observed in tie-plate areas. Spikes were clean and essentially free of rust.
4. Borate-treated ties did not negatively impact electronic signaling in the test track.
5. Borate retentions were higher in the lower than in the upper half of the ties, indicating how borates move to areas of higher moisture (eg, where decay would be most likely to occur).
6. Evidence indicates that the creosote over-treatment reduces the rate of borate leaching from ties.
7. White oak ties pre-treated with borates are performing well on mainline track in the South.
8. It may be possible to use reduced retentions of creosote if ties are properly pre-treated with borates and stored to maximize diffusion during the drying process.
9. Properly borate pre-treated ties will not require a sterilization cycle during creosote over-treatment.
10. Results of other phases of this study demonstrate the effectiveness of periodic supplemental treatments for protecting creosote-treated ties from decay and spike kill.

3. Commercialization

In 2004, the NS placed their first order for commercially borate pre-treated ties that were to be over-treated with creosote. From the start-up in 2004 through June 2005, 95,000 such ties were ordered by NS. Ties that have been shipped from the treating facility now are in track in AWPA Hazard Zones 4 and 5. An additional 250,000 borate pre-treated ties have been ordered by NS for 2006.

At about the same time, the Canadian National (CN) ordered borate pre-treated and creosote over-treated ties and have installed approximately 40,000 to date. In 2006, CN intends to order an additional 100,000 borate pre-treated ties and 7500 switch ties. The CN plan is to eventually use borate pre-treated ties on lines south of Memphis.

Some railroads have been reluctant to use borate pre-treated ties because they fear the borates would cause signaling problems. In spite of the fact that no signaling problems were experienced in the RTA/AAR test track areas in over 15 years, many engineers remain unconvinced that such problems will not occur. Prior to placing borate pre-treated ties in track, NS sponsored electric impedance tests. A large-scale test with white oak ties that were either only creosote–treated or borate pre-treated and creosote over-treated was established. All ties had spiked tie plates on both ends. Impedance measurements showed that only 29% of white oak ties treated with creosote without borate pre-treatment would pass the minimum 20,000 ohm resistance currently used as a standard. The test also showed that the impedance measurements of the creosote-only and the borate pre-treated ties overlapped to a significant degree. In addition, NS and CN have experienced no

unmanageable signal problems in any track sections where borate pre-treated ties have been installed.

4. Commercial Production

Proper pre-treatment with borates requires that treaters divide the process into 4 segments and that their personnel understand the importance of all four. The 4 segments are:

1. Handling of ties and treatment with borate.
    a. Maintain the concentration of borate in a heated storage tank (120 – 150 F).
    b. Insulate the pressure retort and heat it as well as ties to be treated (120 F) prior to introducing preservative. This is especially important in cold climates in winter.
    c. Deliver non-seasoned, incised ties to the treating retort.
    d. Pressurize the retort for relatively brief periods of time (eg, 15 min – 1 hr.), depending on the treatability of the wood being used.
    e. Treated ties cannot be exposed to rain wetting prior to being placed in diffusion storage.
2. Diffusion Storage
   Bulk-stacked storage in a structure where drying of ties is limited is required to permit the borate reservoir at and near the surfaces to become redistributed toward the interior. Representative ties should be bored weekly to determine when borate penetration has reached a pre-determined depth (eg, 1.5 – 2.0 inches) in the majority of the ties sampled so that diffusion can continue during air-seasoning. At that time, ties can be moved to the air-seasoning yard.
3. Air-Seasoning
   Air-seasoning stacks should be constructed in a well-drained area, separated by straight, continuous alleys, placed on adequate foundations, and fitted with pile covers (as is common with hardwood lumber drying facilities). The space between rows, or stacks within rows, is dependent on the region where the drying facility is located. Evidence suggests that borate-treated ties dry more uniformly than non-treated ties.
4. Over-Treatment
   Borate pretreated ties should be over-treated with a traditional preservative such as creosote to prevent loss of borate due to leaching and to protect the wood from soft-rot fungi.

5. Conclusions

Experience to date indicates that borate pre-treated ties that are over-treated with creosote have experienced essentially no biological or iron-mediated (spike kill) deterioration when exposed in AWPA Hazard Zones 4 and 5. In addition, track sections containing borate pre-treated ties have experienced no unmanageable signal problems. Two Class 1 railroads, NS and CN, now are procuring borate pre-treated ties for use in their tracks in AWPA Hazard Zones 4 and 5.

6. Literature

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