Cost effective extension of the service life of bridge ties
Effectively applying borate during Boulton conditioning with copper naphthenate

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Wooden Railroad Bridge Ties

- Low initial cost
- Ease and expedient construction
- Ease of maintenance
- Resource/Energy/Greenhouse
- Environmental impact
- 10”x12”x12’ (25x30x360cm) in size which is about 100% larger in volume than regular 7”x9”x8’6” (18x23x255cm) cross ties
Bridge Tie Issues

- Difficult to treat due to the size
- More untreatable heartwood leads to heartwood decay and premature failure
- Creosote tolerant fungi/Termite
- Increase maintenance cost/safe bridge operation
Cannot Increase Creosote Retention
Dual Treatment of Ties with Borate

- First done by Malaysian Railway in 1960’s (Arthur 1967)
- Remedial treatment of ties in Europe (Bechgaard, 1979)
- Tie life doubled (Amburgey et al. 2003)
- Organic Borate, Emulsion in oil-borne/vac-pressure/dip diffusion + over treatment with oil borne


Dip diffusion treated red oak at 10 months courtesy UT
Pressure treated white oak over treated with creosote Courtesy Stella-Jones
Dip diffusion treated red oak at 90 days courtesy Gross & Janes
Dual Treatment of Ties with Borate (cont’d)

- Protects heartwood from decay, leading causes of premature failure
- Prevents creosote-tolerant fungi and attack/movement of termite

*N. lepideus*, “The Train Wrecker” (on a bridge tie)
So we need the Borate to protect the heart wood but can’t pressure treat or diffusion treat –

Direct Injection Approach
Materials and Methods

Sweetgum (*Liquidambar styraciflua*)
White oak (*Quercus alba*)
Hickory (*Carya spp*)

- 10” x 10” x 10 (or 12)’
  (25x25x300 or 360cm)Ties

- 2” (or 13/16”) diameter x 6” deep holes
  5 (or 2)cm diameter x 15cm deep

- 2’ (60cm) apart and 2’ from the end
- Insert re-useable, refillable tie plugs (sleeves)
- **45%** Disodium Octaborate Tetrahydrate (DOT)
- Boulton conditioned (18h) and pressure treated with CuNap
BTX Port & Filled with 45% DOT Borate
Bridge Ties after Boulton Treatment

- Surface shows some signs of borate residue but clean and dry in general
- Holes were empty but some are filled with QNAP after Boulton conditioning
Borate residue observed along all heart checks
Borate Diffusion after Boulton Treatment

Curcumin-Salicylic acid indicator
Borate Diffusion in Radial Direction
Tie Sampling Regime for DOT Analysis

2” dia x 6” deep holes

6” sections

0.5” sections

2.5” sections

6” sections
Full Cross-section DOT Analysis

- Gum
- White oak
- Hickory

Distance from the center of a hole:
- 0-2.5"
- 2.5-3"
- 11.5-12"
- 18-18.5"

DOT retention (pcf)

Toxic Threshold of 0.04pcf (Lloyd 1997)

Concluding Remarks

- Direct injection of DOT solution into ties with tie plug
- Significant diffusion of DOT into wood immediately after treatment
- Sufficiently high DOT concentration around to 18” from injection holes immediately after treatment
- Significantly less borate leaching as none at surface; concentration gradient is reversed compared to typical dual treatment with borate
- Diffused DOT will provide protection of heartwood from decay fungi and insect attack hopefully doubling tie life
- We hope wood is again more cost effective than non-wood alternatives
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