International Crosstie & Fastening System Symposium

June 4, 2014

Creosote Performance as a Wood Preservative

Presented by

David A. Webb

Creosote Council
Creosote Pressure-Treated Wood Will Continue To Be Used as Result of FIFRA Reregistration of Creosote
<table>
<thead>
<tr>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>resiliency,</td>
<td>fungi and insects,</td>
</tr>
<tr>
<td>strength properties,</td>
<td>physical property changes caused by moisture change that result in seasoning</td>
</tr>
<tr>
<td>electrical resistance,</td>
<td>checks and splits</td>
</tr>
<tr>
<td>non-corrosive qualities,</td>
<td></td>
</tr>
<tr>
<td>spike-holding capacity</td>
<td></td>
</tr>
</tbody>
</table>
The Wood Railroad Crosstie

Advantages:
- Resiliency,
- Strength properties,
- Electrical resistance,
- Non-corrosive qualities,
- Spike-holding capacity

Disadvantages:
- Fungi and insects attack,
- Physical property changes caused by moisture change that result in seasoning checks and splits
1838

JOHN BETHELL

Pressure Impregnation of Wood with Creosote

Full-Cell Process
Creosote and Its Solutions

Wood Preservatives
Creosote Treated Wood Crossties

- Over a Century of Excellent Service Life for Railroad,
- Biological Efficacy – Fungi & Termites,
- Capacity to be a Water Repellant – Weather-ability,
- Dimensional Stability,
- Capacity to Minimize Checks and Splits.
Creosote Railroad Crossties
Service Life

- In Track Since the Late 1880’s
- Average Service Life 30 Year Plus
- Field Testing – 1958 Coop Study
1958 Creosote Coop Study

- Soil Block Bioassay
- \( \frac{3}{4} \) - Inch Stake Test
- Post Test

- All Test Material Was Southern Yellow Pine
- Five Neat Creosotes – Different Distillations
- Creosote Coal Tar & Petroleum Solutions
- Total of 17 Papers Published in AWPA
Results from 1958 Coop Test

- Data from 2% Penta, Coal Tar, and Petroleum Were Not Representative of Current Production Practices.

- AWPA, P1/P13 Standard – 1988 Change in Distillation Part of Standard to Increase the Higher Boiling Constituents,

- Creosote Distillates that Represented Creosotes P1/P13 and P2 Gave Excellent Performance After 50 years in Posts Treated to 6 pcf.
Creosote Efficacy – Lab vs. Field Tests

- Variety of creosote distillates in southern pine posts
- Good correlation between soil block tests and long term field tests

<table>
<thead>
<tr>
<th>Soil Block Rank</th>
<th>Soil Block Treatment</th>
<th>Posts ~ 6 pcf</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>25 yrs</td>
</tr>
<tr>
<td>1</td>
<td>F</td>
<td>G (96)</td>
</tr>
<tr>
<td>2</td>
<td>G</td>
<td>F (91)</td>
</tr>
<tr>
<td>3</td>
<td>D</td>
<td>C (91)</td>
</tr>
<tr>
<td>4</td>
<td>C</td>
<td>D (76)</td>
</tr>
<tr>
<td>5</td>
<td>A</td>
<td>A (29)</td>
</tr>
</tbody>
</table>

- Indicates that laboratory tests with creosote systems are good predictors of field performance
Water is removed  Preservative Creosote is added
Wood Water Relationship

- Fiber Saturation – 30%
- Conditioned to 40% Before Treatment with Creosote
- Lost of Water During Service
- Alternate Weather Cycles Create Stress in Wood Due to Moisture Changes
- Importance of Water Repellency
How Is Water Repellency Measured?

Need for a Standard
Develop a Test Procedure to Assess Moisture Resistance of Treated Wood Products Intended for Railroad Application

H. Greeley Beck

Jeffrey J. Morrell
Department of Wood Science & Engineering
Oregon State University

David A. Webb
Webb Consultants, Inc.
Creosote Dermal Studies

- Skin Penetration of Liquid Creosote
- 2nd Study-Creosote Treated Wood
- Peer Reviewed Paper
Research Objective:
Estimate Dermal Absorption of Creosote in Humans

I. Neat Creosote:
   a) Rat *in vivo* dermal absorption studies
      \(^{14}\text{C}-\text{PAH study for 21 days}\)
   b) *In vitro* kinetics in rat and human skin

II. Creosote-treated wood:
    Rat *in vivo* dermal absorption studies
    \(^{14}\text{C}-\text{PAH study for 21 days}\)
P1/P13 and P2 Creosote

- Met AWPA Specifications
- P1/P13 = 97 identifiable components >0.1%
- P2 = 93 identifiable components >0.1
- 14 Components make up about 62%
- $^{14}$C Radiochemical markers selected to span molecular weight and boiling point of all components
## North American Creosote Composite Test Substance

Radiochemicals used in test creosote

<table>
<thead>
<tr>
<th>14C-PAH</th>
<th>Concentration in P1/P13 Creosote (%)</th>
<th>Concentration in P2 Creosote (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phenanthrene</td>
<td>12.2</td>
<td>12.6</td>
</tr>
<tr>
<td>Naphthalene</td>
<td>9.0</td>
<td>8.0</td>
</tr>
<tr>
<td>Fluoranthene</td>
<td>6.8</td>
<td>6.5</td>
</tr>
<tr>
<td>Pyrene</td>
<td>6.0</td>
<td>5.7</td>
</tr>
<tr>
<td>2-Methylnaphthalene</td>
<td>5.1</td>
<td>4.6</td>
</tr>
<tr>
<td>Anthracene</td>
<td>2.2</td>
<td>2.1</td>
</tr>
<tr>
<td>Biphenyl</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>BaP</td>
<td>0.5</td>
<td>0</td>
</tr>
<tr>
<td>Total 14C-PAH markers</td>
<td>~43%</td>
<td>~41%</td>
</tr>
</tbody>
</table>
Neat Creosote In Vivo Study Design

- Creosote spiked with 8 $^{14}$C-PAH markers
- Two groups of 4 rats
- Dosing on 10.5 cm$^2$ area on dorso-lumbar surface
- Dermal contact for 8 hours
- At 8 hours, dosed surface of all rats washed
- 4 rats sacrificed for determination of radioactivity distribution
- 4 rats held for additional 496 hours
In Vivo Creosote Study: Results

- Liquid P1/P13 creosote applied to back of rats
- 8 hour contact (10.5 cm² area of skin)
- 12 $^{14}$C-PAH marker analytes (43% of creosote by mass)
- Max absorption 21 days after dosing = 8.86%
Creosote Dermal Absorption – Risk Assessment Implications

- *In vivo* (rat) dermal absorption of 14C-PAH spiked creosote = 8.86% of dose applied to skin surface
- Interspecies comparison:
  
  human absorption = 1/8 of rat

- Human creosote dermal absorption = 1.1% of dose to skin – an acceptable exposure according to EPA ( assumes use of gloves, long-sleeves, etc.)
Treated Wood Study

*In vivo rat* study followed same design as 2007 study except creosote-treated wood was applied to skin for 8 hours.

P1/P13 treated *southern pine* and P2-treated *red oak* coupons were tested to simulate freshly-treated round stock (poles & piling) and railroad crossties.
Dosing

- Wood veneer coupons were saturated with radio-labeled creosote
- Coupons placed on animals for 8 hours
- Animals held in metabolic cages
- Air, excreta, skin, blood and carcass examined for radioactivity at 8 and 496 hours post dose.
Treated Red Oak and Southern Pine coupons placed in large vacuum chamber. Floor grate is stainless-steel. Upper two coupons are from 1st set of vacuum treatment.
Treated Wood Study Results

P1/P13 Southern Pine
Total Absorbable Dose in rats = 1.54%
In humans (bare skin, 8 hours contact) Total Absorbable Dose from treated wood = 0.19%

P2 Red Oak
Total Absorbable Dose in rats = 1.81%
In humans (bare skin, 8 hours contact) Total Absorbable Dose from treated wood = 0.22%
Creosote Absorbed by Human Skin – 0.2 %

Freshly Treat Wood

Compare

With Aged Treated Wood

Would Be Less
In Summary
Creosote Railroad Crosstie Usage

• Peaked in 1929 – 203 Plants Treated 60 Million Wood Crossties During Railroad Expansion,

• Since Late 1980’s Annual Average 21 Million Wood Crossties Treated for Maintenance,

• In 2013 North American Railroads Installed 24 Million Creosote Treated Wood Crossties.
Why Is Creosote the Preservative of Choice by North American Railroads?

- Crossties Easily & Safely Installed,
- Based on Dermal/Skin Study – Safely Handled,
- Average Service Life 30 Plus Years,
- Resist Drifting Out of Position,
- Do Not Require Insulators,
- Reused and Recycled as a Biomass Fuel,
Treated Wood Railroad Crossties

- No Single Substitute Can Match These Performance Characteristics,

- Less Expensive Than Substitutes Such As Concrete, Steel, or Plastics.
THANK YOU!!

Comments

Or

Questions?