The Role of Test Methodology on the Outcome of Preservative Development Programs

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Topics covered

- Learning from the AAC experience
- ACQ & CuAz
- Millwork/Joinery treatments
- Siding
- Framing treatments - termites
- Ecolife
- FR treatments for lumber and roundwood?
FRI developments with AAC

- Mid to late 1970s FRI worked on AAC development
- Laboratory based program, very limited field testing
- Commercial introduction for above ground applications quickly saw decay issues
- Ascribed to treatment problems
Lessons from AAC

- Wood moisture interactions not well illustrated in standardized tests
- Multiple exposure tests and methodologies allow for multiple organism exposures across a range of moisture regimes
- Best case scenario assumptions in wood protection will inevitably lead to disappointment in reality

Impact on our development program

- Based on a multi-disciplinary approach to preservative development:
  - Chemistry
  - Wood science
  - Biology
- Much emphasis on multi-site field testing using test methods appropriate for anticipated end-uses
- Testing targets worst case scenario application of developed products
Field Test Sites

Example Sites
Ground contact copper preservatives

- Our field testing with soluble copper preservatives commenced in 1987
- Many different field test sites, soil conditions, fungal hazards, pH conditions, and climate
- A wide variety of in-ground and above ground test methods used with CCA as the standard control
- Led to successful commercialization that continues to this day
- Data shows that performance of these systems is directly related to the content of available copper

Performance versus retention

Field stake test, 19mm stakes
Exterior millwork – joinery treatment

Project Origination

- Millwork manufacturer approach
- Concern with performance aspects of existing treatment system
- Sought performance of treated millwork components comparable to that previously seen with PCP dip treatments
- Colorless treatment required
- Made an open-ended commitment to take a look at this
Options considered

- Borates
- Other biocides for dip treatments
- Double vacuum solvent treatments
- Heat treatments
- Wood modification
- Organic water based emulsions
- Vapor phase treatment
- Super-critical fluids
- Others

Product and process developed

- Pressure treatment of rough lumber
- Water repellent Organic emulsion system
- Patented process developed
- KD after treatment
- Machined after KD
- Re-use of machine waste
Project Outline

- Develop technology for WR penetration of Ponderosa pine
- Formulation development
- Performance testing and appraisal
- Re-formulation in the light of results
- Process development, including drying
- Re-formulation with process
- Analytical methods development
- Environmental aspects
- Commercialization

Methodologies employed

- Wood science and physical chemistry
- Pesticide science
- Formulation chemistry
- Microbiology
- Analytical chemistry
- Wood drying
- Wood process technology
Test Methods

- L-joint tests
- Soil block tests
- Termite lab tests
- Termite field tests
- Depletion tests
- Other above ground test methods
- Physical performance testing
- Environmental chemistry of treated wood
Anti-swelling efficiency

E10 Soil block decay test

Gloeophyllum trabeum
E10 Soil block decay test

Trametes versicolor

E1 Termite test

Coptotermes formosanus
Field sites used

- Hilo, HI
- Gainesville, FL
- Harrisburg, NC
- Scotia, CA
L-joint test, Greenhouse

Soundness %

Year: 0, 1, 2, 3

L-joint test, Hilo, HI

Soundness %

Year: 0, 1, 2, 4, 6, 8
L-joint test, Gainesville, FL

Moisture content changes with time
Painted joints, MC with time

Un-painted joints, MC with time
Termite Field Test

Field termite test
Hilo

Wood Preservation 2009
Corrosion of fasteners

- Mild steel
- Aluminium
- Galvanized Mild steel
- Aluminium Hot-dip Galvanized

PT WR: Untreated

Commercialization
Plant aspects

- Fully enclosed system
- Automated process
- HPLC analysis of solution for every charge
- HPLC analysis of wood from every charge
- Zero discharge of water from treatment and KD process
- Every process improvement caused effects that needed to be dealt with
Outcome

- Project criteria met
- Initial research work on a project is just the tip of the development iceberg
- All process and product improvement suggestions led to even more quirks and needs
- Established project bookends and end-user involvement make for success
- Customer committed very significant management and marketing resources to the treated product
- Commercialization has been successful and on-going

Pine siding - weatherboards
Pine siding project

- Approached by U.S. importer of radiata pine siding regarding treatment options
- Drafted project outline, meantime importer lost interest, went with borate treatment at source
- Continued with development project
- Test method development
- Formulation outlines and completion
Future work

- Refine systems
- Optimize cost/performance parameters
- Treatment trials
- Service tests
- Commercialization
Framing treatments for termite areas

Our history in this area

- Early work in 1988 showed successful diffusion of borates into D.fir lumber for Hawaii
- Initial treatments failed when exposed to Coptotermes
- Mini-house test with range of retentions also problematic
- Much criticism but all our studies showed same trends
- Set about developing enhanced borate formulations with termiticidal components
- Commercialized earlier this decade
- Then became interested in Australian dip treatment of framing lumber approach
Pressure Treatments

- Southern Pine “1x4” boards
- Full Cell
- Two test samples and retain cut from each treated board for exposure at 2 locations

Dip Treatments

- Southern Pine “1x4” boards, end-sealed
- 600 mm boards dip treated
- Four test samples and retain cut from each treated board after drying
  - Two locations
  - Ends dipped or not dipped after cutting
Termite Ground Proximity Test
Hilo, HI

- Samples 100 mm above ground on cinder blocks
- Untreated wood on bottom and sides of test samples
- Samples protected from rain with vented covers

Termite Ground Proximity Test

- Untreated wood replaced every year after inspections
## Termite Ground Proximity Test

**Hilo, Hawaii**

- Coptotermes formosanus

### Pressure Treated Southern Pine (Hilo, HI)

**Deep Preservative Penetration**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Retention (kg/m³)</th>
<th>Months Exposure</th>
<th>Final Ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>DDAc</td>
<td>BAE</td>
<td>Imid</td>
</tr>
<tr>
<td>Control (water treatment)</td>
<td></td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>DDAcarb/Borate/Imidacloprid (1:3:0.01)</td>
<td>0.57</td>
<td>1.72</td>
<td>0.006</td>
</tr>
<tr>
<td>DDAcarb/Borate (1:3)</td>
<td>1.12</td>
<td>3.37</td>
<td>0.001</td>
</tr>
<tr>
<td>DDAcarb/Borate (3:1)</td>
<td>0.99</td>
<td>1.74</td>
<td></td>
</tr>
<tr>
<td>DOT Borate</td>
<td></td>
<td>3.33</td>
<td>3.38</td>
</tr>
<tr>
<td>DDAcarb/Borate/Thiacloprid (1:3:0.01)</td>
<td>0.55</td>
<td>1.65</td>
<td>0.005</td>
</tr>
<tr>
<td>DOT Borate</td>
<td>3.21</td>
<td></td>
<td>8.81</td>
</tr>
</tbody>
</table>
**Dip Treated Southern Pine (Hilo, HI)**

Shallow Preservative Penetration

<table>
<thead>
<tr>
<th>Type</th>
<th>Treatment Solution</th>
<th>Cut ends exposed</th>
<th>Dipped ends exposed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (water treatment)</td>
<td>0.00%</td>
<td>37</td>
<td>24</td>
</tr>
<tr>
<td>Borate/Glycol</td>
<td>0.00%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bifenthrin EC</td>
<td>0.01%</td>
<td>4</td>
<td>100 (8-9)</td>
</tr>
<tr>
<td>Cyfluthrin EC</td>
<td>0.00%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Imidanoprid EC</td>
<td>0.01%</td>
<td>49</td>
<td>100 (8-9)</td>
</tr>
<tr>
<td>Imid Borate/Glycol</td>
<td>0.02%</td>
<td>20</td>
<td>100 (8-9)</td>
</tr>
</tbody>
</table>

**Spruce-Pine-Fir, Hilo, HI**

Dip-treated, including ends (thin treated shell)

<table>
<thead>
<tr>
<th>Type</th>
<th>Treatment Solution</th>
<th>Untreated</th>
<th>Untreated</th>
<th>Untreated</th>
<th>Untreated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (water treatment)</td>
<td>0.00%</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Borate/Glycol</td>
<td>0.00%</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bifenthrin EC</td>
<td>0.01%</td>
<td>5</td>
<td>100</td>
<td>26</td>
<td>27</td>
</tr>
<tr>
<td>Cyfluthrin EC</td>
<td>0.00%</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Imidanoprid EC</td>
<td>0.01%</td>
<td>13</td>
<td>100</td>
<td>40</td>
<td>75</td>
</tr>
<tr>
<td>Imid Borate/Glycol</td>
<td>0.02%</td>
<td>35</td>
<td>100</td>
<td>60</td>
<td>90</td>
</tr>
</tbody>
</table>

Termite Soundness (% after Months Exposure)

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<tr>
<th>Type</th>
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<th>Untreated</th>
<th>Untreated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (water treatment)</td>
<td>0.00%</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Borate/Glycol</td>
<td>0.00%</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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Organic Systems for Above Ground Uses

- Based on Organic fungicides and insecticides
- Presence of suitable water repellent/stabilizer system is essential for long term performance
- Our first system is now standardized by the AWPA for up to UC3B applications
- Future work focused on expanding the types of biocides as well as further developments with moisture control agents
Engineered wood decking

- Attempts to address the gradual inroads from WPC decking into traditional wood markets
- Stability of vertical grain decking long recognized from early days with old-growth redwood
- Work seeks to combine treatments and adhesive technology to provide a long-lasting treated wood deck that minimizes cracking and splitting
WPC decking

Old growth vertical grain Redwood
Southern pine VG engineered decking

Radiata pine VG engineered decking
Engineered decking

- Work to date shows that combinations of stabilizing wood treatments and suitable exterior adhesive systems can provide potentially durable decking systems
- UV stability of adhesives used is important as well as the treatment system used
- Overcoming surface graying remains an issue for all wood treatments in exposed situations

Conclusions

- Negative early experience engendered a conservative approach to product development
- Understanding developments’ strengths and weaknesses through long term laboratory and field test protocols is essential
- This approach has served to provide products with proven long term performance in a variety of commodities and exposure situations
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