INNOVATIVE PRODUCTS AND PROCESSING

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New generation durability solutions

- Performance gap for long-term materials and products
  - Meet or exceed the historic biocide performance
  - Be acceptable to customers / environment regulators
  - Add value to biomaterials products
  - Economical to use
  - Applicable over a range of products
  - Safe end-of-life-cycle disposability and re-use
Future of Treated Pine in NZ

- Regulation scares
  - OSH issues with LOSP
  - ERMA to revisit CCA?
    - Unlikely solely for H&S reasons
    - End of life disposal a growing concern and is likely to be major factor in any CCA use restrictions

- Boron for framing – limited use of LOSP
- LOSP Azoles for H3.1, but tightening of treatment plant practices
- CCA for H3.2 to H6 for foreseeable future
- Gradual replacement with ACQ and CuAz for domestic H3.2, but not H4 – H6
  - But not regulation driven
- Few unpleasant surprises on the horizon
  - But Oz position on CCA won’t change
### Future Overseas

- Chemical treatment and acceptance of treated product increasingly restricted in Europe and use will decline further
- EU Biocides Directive pressures
- Chemical phobia in much of Europe
- “Green Treatments”
- Wood Modification as an alternative to chemical treatment

### Scion Response

- Locked-in-Boron (LIB)
  - 10+ years research
- Natural products for antisapstain and permanent preservatives
  - Chitosan
- Wood Modification – European target
  - Acetylation
Locked-in-Boron™

- “Fixed” organo borate
  - Resurgence in commercial interest in boron wood preservatives
  - Borotrane chemistry
  - Controlled release of boric acid

Locked-in-Boron™ (LIB™)

Theory: Molecularly encapsulate boron atom as esters of amino-alcohols, N atom donating electron pair to boron - boratrane structures.

Variables: Electronic / steric molecular factors hydrophilic / lipophilic balance

Electron pair

Boron Locked-in

Boron Accessible
Biocidal mechanism of LIB™

Controlled release of boric acid -
maintenance of ‘background' concentration during wetting and drying cycles.

Incipient decay releases protons from lignin and hemicellulose hydrolysis and unlocks cage permanently to release boric acid.
Lap-joint Test

Untreated control 3 years  Timbor™ 9 years

Lap-joints at 9 years

LIB 555  0.16  0.43  1.4  1.4
% BAE    % BAE
Boric acid release rates from LIB555 treated lap-joints

Initial dose
1.4% BAE

Initial dose
0.4% BAE
Chitosan

- Chitosan (1,4-linked 2-amino-2-deoxy-β-D-glucose), is a deacetylated form of chitin
- An abundant natural biopolymer
- Waste-product of fishery industry (crustacean shells)
- Environmentally friendly
- Broad antimicrobial and antifungal activity

Mode of action of chitosan

- Chitosan induces alterations in the composition/architecture of cell plasma membrane and is mediated by reactive oxygen species (ROS)
- May inhibit mRNA synthesis
- May chelate essential trace elements
Application of chitosan

• Sapstain control
  ▶ Integrated bio-control using chitosan and white *T. harzianum*
  ▶ Combination more effective than either used alone
• Permanent wood preservative
  ▶ H1.2; H3.1
  ▶ In conjunction with other biocides

Growth of *Sphaeropsis sapinea* on wafers (50x35x7 mm) after 24 days

<table>
<thead>
<tr>
<th>Untreated</th>
<th>BCA</th>
<th>Chitosan</th>
<th>Chitosan + BCA</th>
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Wood Preservation 2009


**Acetylation**

- Well-established principles using acetic anhydride treatment
  - Increases acetyl units in wood structure, increasing wood density
    - Greater durability
    - Greater stability
    - Greater UV resistance
Acetylation research at Scion

- Strong links with Titan Wood manufacturers of Accoya™ brand of acetylated wood in Europe
- Scion research
  - Specific to radiata pine – Titan Wood's species of choice for Accoya™
  - Dramatic reduction in process times
  - Reduced accumulation of unwanted by-products

Decay resistance testing

- 7 mm thick test blocks cut from middle section of acetylated 300 x 75 x 45 mm billets
- Acetylation schedules adjusted to achieve range of weight gains
- Three decay fungi in laboratory decay test
Decay resistance

- Decay resistance clearly a function of percentage weight gain from acetylation
- Complete control of decay at weight gain of 20-25 %
Anti-shrink Efficiency (ASE)

- Standard method
- Determine swelling following water soaking
- Measure of stability

Relation Between Acetylation and Cross Sectional ASE
Acetylated wood in service

- Heavy traffic road bridge
- Constructed November 2008 at Sneek in Netherlands
- Up to 60 tonnes load capacity
- Spans 32 metres
- Cost € 3.5 million
Conclusions

- Durability of treated NZ radiata pine proven for over 50 years
- Minor regulatory changes in NZ may lead to shift in emphasis but no immediate demise of chemical treatment
- Major rules changes overseas will see general reduction of traditional chemical treatment
Conclusions

- Essential to have acceptable alternative treatments (environment, health and safety)
- Long term performance records of CCA maybe not be an essential benchmark
- LIB and Chitosan can fit the bill
- Radiata pine also very suitable for chemical modification (acetylation)

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