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CURRENT ISSUES AND RESEARCH ON WOOD PRESERVATION IN CANADA

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Summary

Some current issues regarding wood preservation issues and research needs in Canada are discussed and contrasted with issues identified 30 years ago.

1. Introduction

Nov. 4 1980 at the inaugural CWPA conference in Montreal, Neil Richardson research scientist at Domtar was tasked with this topic. He identified several key issues which are still very relevant today:

Environmental issues

In 1980, these were focused on the environmental footprint of chemicals used, emissions at plants and best practices to minimize environmental impacts at treating plants. Thirty years later, these are still important issues, although many of the concerns have been managed effectively. Environmental issues are still important with respect to meeting regulatory requirements, choice of treatment systems and site remediation. There is increasing interest in the application of Life Cycle Analysis (LCA) since this is important to LEED, Green Globes, Green Cross etc. certification of structures and products. LCA considers the following:

1. ***Extraction of the raw resource***, including wood harvesting and minerals and petro-chemical extraction.
2. ***Manufacturing requirements*** The development of Technical Recommendation Documents (TRDs) on the design and siting of treatment plants and the associated agreement by the industry to voluntarily upgrade existing plants to meet the TRD recommendations and plant audits and certification have gone a long way to reducing and standardizing environmental and occupational health risks at the treating plant.
3. ***Transportation and installation***
4. ***Use and maintenance***

There has been and will continue to be significant research on factors affecting preservative leaching and other losses to the environment and the fate of preservative components in the environment. This includes studies on:

1 Effects of different formulations – current research is focused on alternative preservative systems to CCA for residential applications, including PMRA registered systems, ACQ and CA, and as yet not approved micronized copper systems and all-organic systems.

2 Effects of lumber configuration, such as ripple patterns on appearance and longevity as decking.

3 Impacts in different ecosystems (impacts on soil, surface water and ground water)

Figure 1: Investigation of effects of CCA leaching on soil and water contamination

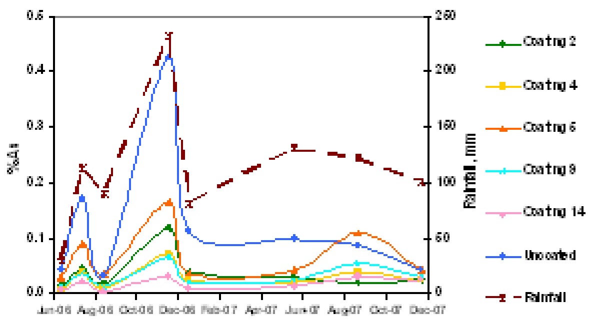
4 Prediction/modeling of preservative loss and impacts, relating leaching to amount of rainfall, duration of rain events and ambient temperature.
5 Effects of barriers such as polymer wraps (poles) and water repellents and coatings (residential lumber) on preservative leaching and serviceability. Figure 2 shows how various deck finishes are able to reduce arsenic and copper leaching from CCA treated wood during rain periods, especially early in the life of the coatings. It also shows that some coatings are much more effective than others. On ACQ (Figure 3) and CA treated wood the coatings are even more effective to reduce copper leaching. The results suggest that coatings help protect copper amine based preservatives from leaching during the first several months in service and this delayed leaching allows changes to take place that render the copper component less available to leaching. More research is needed to investigate this effect since the implications could be greatly reduced life-time leaching of copper from these systems.

5. Disposal/waste management

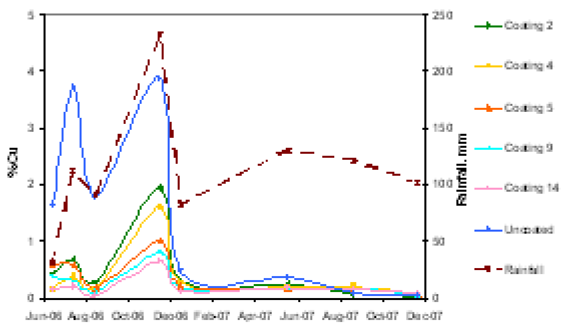
This is one of the biggest challenges to the use of treated wood in Canada and is the main driver for development of new preservative systems that can be safely burned or recycled. Industrial products such as railway ties and some poles can be used as fuel for co-generation or in cement kilns. This is a favorable approach in LCA since the energy produced substitutes for fossil fuels and it can be considered a carbon-neutral source of energy.

Currently most residential treated wood (mainly CCA) is disposed of by landfill. Current methods of life cycle analysis assume that the landfilled wood will eventually be converted to

CO_2 and methane, contributing greatly to the green house gas "footprint" of treated wood in LCA. CCA treated which is difficult to dispose of by other means but work is ongoing to develop reuse strategies such as conversion of poles into lumber and disposal of sawdust and edgings in cement kilns. Another approach is to extract the CCA components from wood with strong acid and recover the metals for reuse or disposal.



(a)



(b)

Figure 2: Leaching of arsenic (a) and copper (b) during 1 to 3 month periods during exposure to coated deck boards to natural weathering

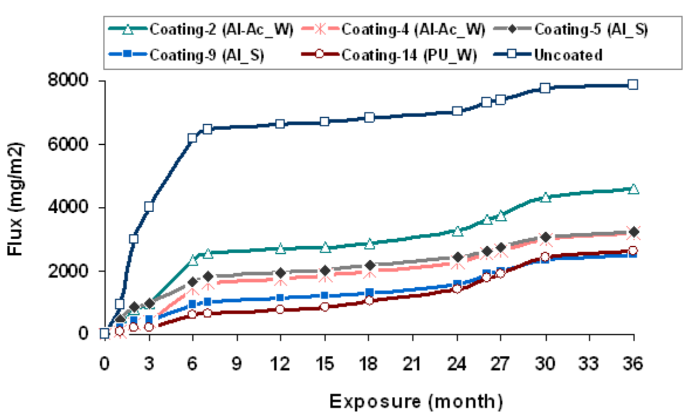


Figure 3: Cumulative leaching of copper from ACQ treated decking as affected by different deck finishes

Preservatives and Preservative Systems

In 1980, alternative preservative systems e.g., ACQ as a possible replacement for CCA for residential use and copper naphthenate for penta in oil for poles were being evaluated and optimized. Chemical suppliers continue to develop and improve systems on the basis of cost, health and environmental footprint, aesthetics and use attributes. Recent examples are discrete particle formulations (micronized copper and other components, micro-emulsions) and all organic systems. There are a number of associated research needs, including:

1 Performance on Canadian species in Canadian environments (penetration, gradients of different components, efficacy)
2 Environmental aspects (leaching, eco-toxicity, recyclability etc.)
3 Ancillary properties such as water absorption (and compatibility with water repellents), dimensional stability, colour stability, corrosion characteristics, coating and adhesive compatibility, UV resistance, weathering characteristics and mould susceptibility

Another concern and research need revolves around the debate on what the customer wants and needs in terms of service life and performance. This has been addressed through marketing and user surveys which suggest, among other things, that the average life of residential products is shorter than the normal life expectancy of treated wood (i.e., 10-12 years). This is often interpreted as an indication that the consumer only needs this life time due to changes in styles and . As a result, there is a trend within the industry to target lower preservative loadings that would better match this life expectancy. However, one of the main reasons for early replacement is the poor appearance of treated wood after a short time, emphasizing the importance of the ancillary properties noted above, since if treated wood be easily maintained to retain its appearance, issues such as disposal would be greatly alleviated.

Wood modification

There is increased interest in alternative (non–pesticidal) methods of protecting wood in service and research has focused on chemical modification by acetylation of fufurylation or thermal modification. Chemical modification involves substitution of the hydroxyl froups in wood with other chemical agents. This effectively protects wood from most biological agents and provides dimensional stability to the wood. However, very high loadings of the chemical agents must be applied and the treatments are costly.

Thermal modification requires wood to be heated to high enough temperature (typically 200-220°C) to condense the hydroxyl groups, reducing the ability of wood to adsorb moisture into the cell walls which provides some dimensional stability and limited decay resistance. In the process, the wood is turned brown in colour which has some aesthetic benefits for some uses (Figure 4). However, wood is dried extensively so drying defects are more likely; wood strength is reduced (especially toughness and abrasion resistance but also bending strength). Furthermore, the decay protection is moderate and thermally modified wood is not recommended in ground contact and no termite or other insect resistance is imparted. There are several companies in Canada with the capability to thermally modify wood and research is continuing at several universities and FPInnovations on this product.

Figure 4: Thermally modified wood structure (Montpellier France)

Industrial Treated Wood Products

Poles

In 1980, the preoccupation was with a shortage of pole quality timber and the potential of alternative species and composite poles as replacements for traditional poles. While this resulted in some evaluation of alternative pole materials, the benefits of wood poles still make them the preferred type. There appears to be more emphasis now on keeping poles in service longer. There is increasing recognition of the costs of premature failure of wood poles by utility companies and there have been great advances in the industry in surveying and mapping the pole population, combined with efforts to strategically inspect pole lines and apply remedial treatments such as diffusing preservative rods or preservative bandage treatments (Figure 4).

While there has been considerable research to develop and evaluate inspection tools and procedures to improve the accuracy of condition assessments, there is a need to develop more reliable inspection tools to determine the condition of poles along their complete length and to develop reliable models of decay rates and effects of deterioration on residual strength to ensure the maximum safe service life of treated poles.

(a) (b)

Inspection devices (a) Resistograph; (b) EDM vibration tester

(a) (b)

Remedial Treatments (a) Surface pole wrap (b) diffusing borate rods for internal treatment
Figure 4: Pole inspection and pole treatment processes

Railway ties

Railway ties make up a large volume of creosote/oil treated wood. There has been limited research to evaluate inspection and *in situ* treatment methods, but this product warrants more study to attempt to ensure longer and more predictable serviceability. Ties can fail for many reasons (e.g. Figure 5), both mechanical/physical and biological and there are many potential approaches to reduce effects of spike loosening, plate cut, internal decay, checking and splitting and their interacting effects on tie condition. The fact that creosote treated ties can be readily disposed of in co-generation facilities, reduces the imperative to extend their lives, unless a cost savings can be demonstrated. In spite of this I believe that there could be benefits to research in the following areas:

1. Inspection & remedial treatment of ties
2. Railway tie fastener alternatives to the cut iron spike
3. Plate area re-enforcement (harder wood, densified wood, polymer etc.)
4. Plate area protection (borates?) factory applied
5. Laminated ties, engineered to place different wood species strategically to maximize strength and minimize checking
6. Top dressing with plastic or mastic products to reduce checking and to prevent dirt and stones from accumulating in the checks that do form
7. Remedial treatments
8. Economics of extending the life considering all life cycle analysis issues
9. Disposal/reuse

Figure 5: Railway ties removed from service

<u>Adding Value to New Products Design/Fabrication</u>

As noted above, there are many benefits to developing treated wood products that look good and stay looking good for a long time. This can be achieved by factory (or in service) application of water repellents, pigments and other UV protected finishes. Prefabricated (factory assembled) fence and deck panels, garden structures etc. can ensure optimal construction practices and materials to produce products that will look good for a long time. Figure 6 shows examples of such fence and deck units.

There is currently great interest in use of wood for non-residential construction and for tall building applications that exceed the current limitation in most building codes of four stories or less. As building codes become more open to midrise and high rise buildings incorporating wood (e.g. Figure 7), new building products such as cross-laminated timbers and hybrid wood/concrete/steel assemblies are being introduced. These give rise to new challenges in wood preservation including management of moisture such as wind blown rain and impacts on durability and methods of primary control and remedial treatments and fire resistance and fire protection.

Figure 6: Prefabricated deck and fence units

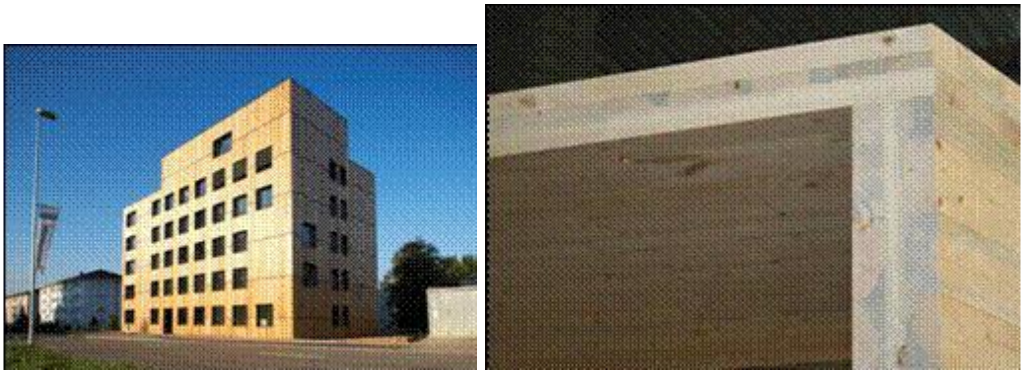


Figure 7: example of mid rise wood building - 6-storey structure in Steinhausen, Switzerland and cross laminated construction