Treated Wood Poles at Hydro-Québec

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Summary

Hydro-Québec (HQ), a business-driven publicly owned company, generates, transmits and distributes electricity, mainly using renewable energy, especially hydropower. Hydro-Québec, through its research institute (IREQ), has being doing research in the field of wood chemistry for the last 20 years. Different aspects have been looked at from the leaching of wood preservatives, the development of a polymer additive for better climbability, the development of new wood preservatives, the thermal treatment of wood and the reduction of environmental impacts of treated wood poles on soil and water at pole storage facilities. Among then, three projects will be discussed in more details.

1 Introduction

Hydro-Québec (HQ), a business-driven publicly owned company, generates, transmits and distributes electricity, mainly using renewable energy, especially hydropower. HQ Production operates a fleet of 59 hydroelectric generating stations (34 118 MW). HQ Trans-Énergie possesses the most extensive transmission system in North America system, comprising 33 000 km of lines, including 10 000 km of 735-kV lines, 505 substations and 18 interconnections with power grids outside Québec. HQ Distribution provides Quebecers with a reliable supply of electricity with a distribution system of 110 000 km of lines, 10% of which are underground.

2 Research and Development

Hydro-Québec invests about $100 million annually in R&D at its Research Institute (IREQ). HQ supports a Technological Innovation program (stage gate process) for the development of more efficient processes and products. Amount the various research projects, several are focusing on reducing the global impact of HQ activities on the environment in order to achieve a sustainable development.

2.1 R&D on treated Wood Poles

The department of Material Sciences is working on different research projects related to wood poles. Among then, three projects will be discussed in more details.

- Development of a new additive for chromated copper arsenate (CCA)
- Remediation of pentachlorophenol (PCP) wood poles

- Reduction of environmental impacts of treated wood poles on soil and water at pole storage facilities.

2.1.1 Development of a new Additive for CCA treated Wood Poles

Over the last decades, the popularity of CCA poles has increased significantly in North America; they are now widely accepted by utility pole engineers and linemen. Despite all this, there are still concerns expressed about CCA poles being harder initially to climb and to work compared to PCP and creosote treated poles. CCA poles also change somewhat upon ageing. In order to limit this phenomenon, additives have been developed. Many of these additives tend to lose their efficacy with time.

With the lack of long term efficacy of additives, Arch Wood Protection, Inc., in partnership with Hydro-Québec, has developed a polymer-based additive which, when injected into CCA treated wood poles, gives them a degree of climbability comparable to that of poles treated with pentachlorophenol. The polymer-based additive is water-soluble in its initial state. It is part of a patented mixture that is injected under pressure into the wood being treated with CCA. The wood is heated and the additive is polymerized to form a three-dimensional network that is water-insoluble.

A series of tests was done during which, a group of control poles were monitored to determine additive retention, pole hardness, the degree of climbability and the washing out of preservatives. Two series of climbing tests were carried out at IREQ pole testing site. It was concluded that the climbability of the CCA-PA (polymer additive) treated poles is similar to that of PCP treated poles. All these tests were conducted with red pine poles.

Recently, Southern Yellow Pine (SYP) poles treated with CCA-PA have been tested for ease of climbability with an instrument (mini-bench) developed by Hydro-Québec. With data collected by this instrument on the ease of penetration of the gaffs, it was concluded that of CCA-PA treated SYP have similar climbability to that of PCP poles.

2.1.2 Inspection and Remediation of PCP Poles

HQ distribution network is composed of about 2 million wood poles. From this perspective, it is obvious to optimise the service life of these wood poles. The expected service life of a wood pole initially treated with PCP should be between 35 and 40 years. Early fungal degradation was observed for some of HQ wood poles. In order to asses this phenomena, measurements were done in 2002 in order to determine the residual concentration of PCP in wood poles as a function of the number of years in service. Results showed that after 20 years in service roughly 20% of poles have PCP concentration below the toxicity threshold (3,0kg/m^3). This number increase to 40% after 25 years in service. A concentration below the toxicity threshold value means that fungal degradation could take place. These results are shown in figure 1 for three different regions in Québec and explained the early failure observed for some poles. These early failures are costly for the utility as well as for the environment.

Degradation of wood poles usually appears at the ground line level where conditions for fungal attack are observed. In order to reduce fungal degradation, enhance of the local toxicity is possible by the use of bandage, liquid, fumigant or solid rod containing chemical components.

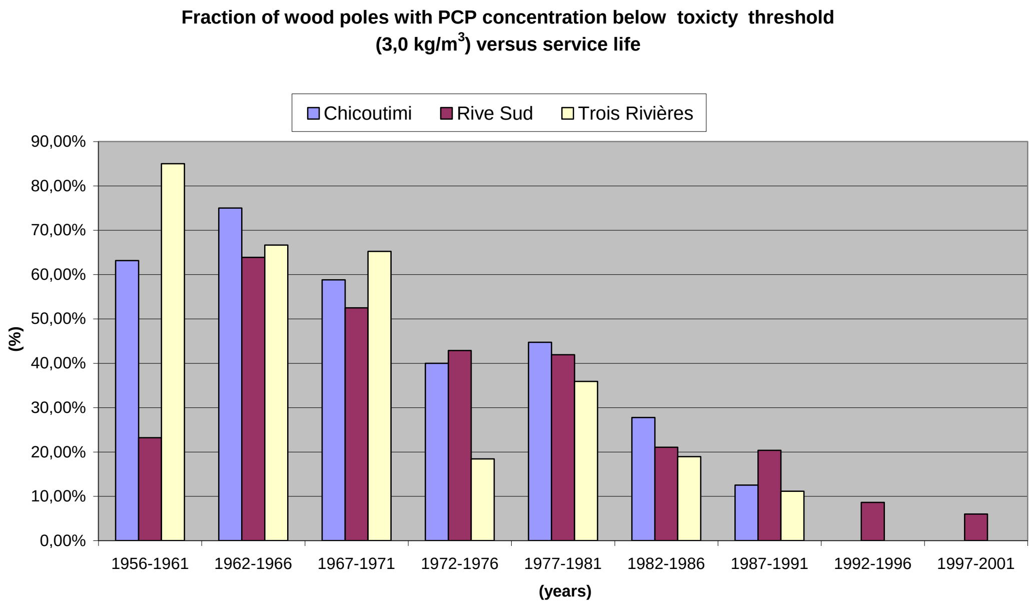

Figure 1: Percentage of PCP poles below the toxicity threshold as a function of time

A program tests is undergoing at the HQ research center to asses the efficacy of solid rods to enhance the service life of PCP wood poles. Three companies are selling solid rods for remediation: Genics with the CobraRods, Sasco Products with ImpelRods and Osmose with Flurods. An example of theses rods is shown in figure 2.

Figure 2: Solids rods (Genics)

Pole sections (6 feet) were used without initial chemical treatment to accelerate the degradation process. Comparisons were made between reference pole sections (without using rods) and pole sections treated with one of the three different rods. Three holes were made (separated by 120°) around the pole at a 45° angle as shown in figure 3. Two rods were inserted in each hole (6 for each section) and a wood treated plug was used to seal the hole. Part of the HQ outdoor test site is shown in figure 4.

Figure 3: Drilling of the pole section to insert the rods

Figure 4: Outdoor test site at HQ research facility

According to the manufacturers, solids rods should dissolve when the water content of the wood sections is above 30% and diffuse in the wood to protect locally against fungal degradation. The rods should be effective for about 10 years. Their efficacy was monitored by measuring the concentration of chemicals (either boric acid equivalent or fluorine concentration) after a giving amount of time. Since the slowest diffusion in wood is tangential, the chemical concentration was monitored between the holes drilled for rod insertion in the wood pole sections.

The water content was determined for each sample and only samples with water content above 30% have been kept for the determination of the concentration of the chemicals.
Figure 5 shows the diffusion of the chemicals contained inside the rods after 2 years of testing at HQ research facility. In order to make a better observation of the diffusion process, non-treated wood sections were used. As a function of ageing, wood sections became greyish (blue section) without initial treatment because of the presence of fungi. In the red section (just above where the rods were inserted), the color of the wood is unchanged meaning that the fungi are not able to colonize this section. The same result was observed for the three rods.

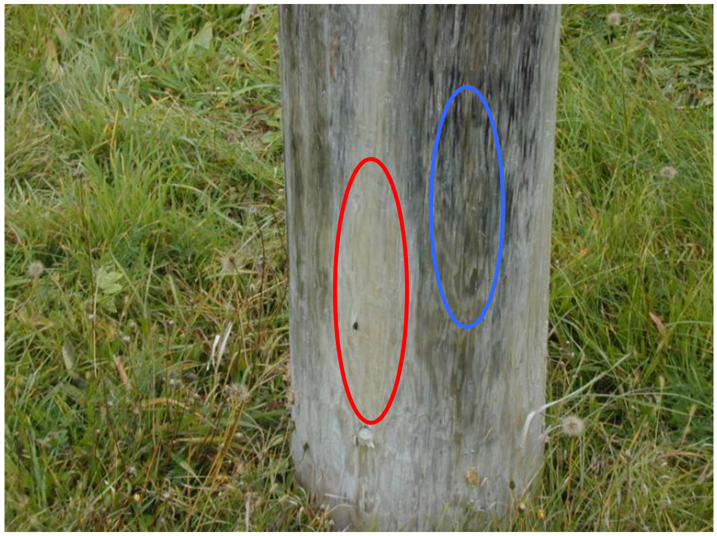

Figure 5: Diffusion of chemicals after 2 years

Figure 6 shows the same results but after 7 years of testing at HQ research center. As it can be seen by the color, the base of the pole section (red part) was still protected against fungi.

The same result was observed for two of the rods. The other one seems to diffuse faster at the beginning of the test but also leach faster out of the wood and become less effective for the long term protection. In comparison, degradation for some of the reference was observed, as shown in figure 7.

Figures 5 and 6 have shown visually the diffusion of the chemicals contained inside the rods. Measurements were also done to determine the concentration of each of the chemicals as a function of time. From each poles section (4 sections for each of the different rods), three samples were taken and each sample was separated in two. These results are presented in table 1.

Figure 6: Diffusion of chemicals after 7 years

Figure 7: Degradation at the ground level for a reference section

For the different chemicals contained inside the rods, the toxicity threshold is around 1 kg/m^3. In order to determine the efficacy of these rods, the number of wood pole sections with chemical concentration above the toxicity threshold was tabulated.

Table 1: Number of sections with chemical concentration above 1kg/m³.

Rods	# of sections of concentration > 1 kg/m^3 After 2 years	# of sections of concentration > 1 kg/m^3 After 7 years
#1	15	4
#2	10	19
#3	9	19

These measurements were in accordance with visual observations mentioned before. For two of the rods, we observed an increase in the number of section, as a function of time, with concentration above the toxicity threshold. For the other rod, we observed that the diffusion takes place very quickly after the beginning of the test but also that the chemicals are leaching faster outside the pole sections as it can be seen by the decrease of the number of pole sections with concentration above 1 kg/m³ after 7 years.

The results observed for two of the rods indicated that it is be possible to increase the service life of HQ utility poles by the implementation of the test and treat program. For the following years, approximately 100 000 poles per year will be inspected. At the present time, already the program has given a very good payback as the service life of HQ wood poles is now expected to be around 45 years comparing to 35 years before HQ test and treat program.

2.1.3 Reduction of Environmental Impacts of treated Wood Poles on Soil and Water at Pole Storage Facility

HQ electrical distribution network comprises two millions of wood poles, mainly treated with PCP. A number of around 20 000 poles are stored in storage yards per year to meet supply needs for pole replacement and new lines installation. Since 2004, the company has switched to the CCA water-borne preservative.

During storage, treated wood poles are exposed to rainfall. There is leaching of CCA and PCP wood preservatives during precipitation events and a progressive contamination of soils is possible related to storage of large amount of treated wood poles.

The *Ministère du Développement Durable, de l'Environnement et des Parcs du Québec* enforced new guidelines for treated wood storage yard of more than 50 m³ of treated wood (around 35 poles). The new guidelines require protection of treated wood from the rainfall in temporary shelters, in warehouses or containers. Otherwise, implementation of special dispositions is required to prevent the release of contaminants in the environment, like protection of soil by an impermeable surface and collecting and treating the run-off water containing wood preservatives before its reject in the environment.

At HQ Distribution, different strategies to prevent or mitigate the release of wood preservatives in storage yards are adopted. The company uses best management practices for wood pole acquisition to avoid troublesome wood poles with excessive leaching of preservatives including specifications for the treatment fixation process and a delivery inspection program. A management strategy is under elaboration to optimize the number and size of storage yards. The option of an indoor storage of poles was evaluated and rejected because of prohibitive cost of large building size, possible release of odours and volatile organic compounds and difficulties for heavy trucks to move adequately.

An R&D project is undergoing to evaluate the feasibility of technical methods to prevent or mitigate impacts of leaching of wood preservatives at large storage yards. Due to the high number of storage yards, several commercial techniques to extract contaminants in water like flocculation/ precipitation need too many exhaustive operations and are inconvenient to the present purpose. One option under evaluation is to pave the soil surface under poles to avoid new soil contamination and to treat the storm water runoff with a passive system to meet storm water discharge standards regulations. The use of stains to mitigate the leaching of wood preservatives is the other option under evaluation.

The R&D project technical targets include meeting storm water discharge regulations, a low purchase and disposal cost with a low maintenance and an optimal useful life of the water treating system or stains. The feasibility studies comprise laboratory tests and bench scale tests conducted at an outdoor site. The effectiveness of the technical options are evaluated on the nature and extent of wood preservatives in the runoff water of stored treated wood pole sections exposed to natural rainfall with the intensity and duration of rain, the number of stacking row, the pH of water and the rain ambient temperature. The R&D project is in the prototype development stage.