Leaching of CCA from treated wood: pH effects

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Evaluation of chromated copper arsenate (CCA) wood preservatives by laboratory tests, field tests and in-service performance has demonstrated the excellent resistance to leaching and long-term efficacy of this preservative. While it is known that the Cu, Cr and As constituents can be more easily removed by leaching solutions with high salt contents and low pH's (Evans, 1987; Plackett, 1984), limited tests suggest that losses are not a significant problem at pH's as low as 4.5 - 6.0 (Willeitner and Illner, 1986; Evans, 1978).

However, recent studies at the University of Guelph (Warner et al., 1989) suggest that massive amounts of CCA constituents, particularly copper, may be extracted at pH's as high as 5.5 when exposed to water buffered with sodium hydroxide and citric acid (SHCA).

These discrepancies suggest that the SHCA buffered system may not be representative of leaching by acidic precipitation. It is possible that the sodium content could result in cation exchange removal of the copper, or as suggested by the Society of American Wood Preservers (1989), the citric acid may promote solution of the copper by a sequestering effect. There is also the question of wood species effects; most published leaching tests and field studies have been conducted on species other than the jack pine used in the Guelph study.

This short study was designed to consider these questions.

Methods:

Specimens for leaching were cut from pole sections of Douglas-fir, red pine, lodgepole pine and western red cedar, treated with 2% CCA-C at a commercial treating plant. Pole sections were stored indoors at the Faculty of Forestry for three months after treatment and had never been exposed out-of-doors.

Ten millimetre square by 40mm long specimens were cut from the outer sapwood area of the treated poles. This geometry was selected so they would fit in standard polyethylene scintillation vials (6 dram size) for neutron activation analysis. Four pole sections of each species were sampled and four samples were taken from each pole for extraction by a different leaching solution.

The leaching solutions consisted of a buffered water solution at pH 5.5 consisting of 1.0g NaOH and 1.50g citric acid per litre of solution and water adjusted to pH's 5.5, 4.5 and 3.5 by addition of an equimolar sulfuric acid/nitric acid solution.

The initial Cu and As content of each specimen was determined by non-destructive neutron activation analysis of the whole specimen. The samples were leached according to a modified version of the AWPA (1983) procedure for leaching of treated soil block samples; i.e., the four replications for each species and leaching solution were vacuum-impregnated with 50mL of the leaching solution; after 6 hours, the unabsorbed leaching solution was replaced with an equal volume of fresh solution. This was repeated after cumulative leaching times of 1, 2, 3, 4, 6, 8, 10, 12 and 13 days.

After each exchange of leaching water, the pH and Cu, Cr and As content of the leach water were measured using a pH meter (± 0.01 units) and an atomic absorption spectrophotometer respectively.

Results:

The NaOH/citric acid buffered solution caused a much greater extraction of all elements compared to the acidified water treatments (Figures 1 - 3). The leaching effect was greatest for copper, followed by arsenic and chromium (Figure 4). Of the acidified water leachates, the most acidic (pH 3.5) extracted only slightly more Cu than the higher pH solutions.

The Douglas-fir samples showed the least amount of CCA lost while red pine showed the highest leaching (Figures 5 - 7). This could be related to species differences such as chemical characteristics or permeability or may result from different initial levels of treatment.

The pH measurements show that wood buffers the acidic solutions resulting in reductions in acidity in the leach water (Figure 8). The pH was observed to rise immediately on contact of the wood with the acidified water although several hours were required for the wood to neutralize it. This effect will help protect wood in service from the effects of exposure to acidic precipitation. The pH of the buffered solution remained relatively constant.

A short-term test was done to determine whether the large difference in leaching potential of the solutions resulted from the ability of the citric acid solution to maintain the slightly acidic conditions, or from the effects of the buffer itself. Red pine samples were prepared as above and extracted with 50mL of NaOH/citric acid solution at pH 7.0 and acidified water maintained at pH's 3.5 and 4.5 by periodic addition of the sulfuric acid/nitric acid solution. After two days, the Cu concentration in the leach water was 4.5, 31.9 and 95 ppm for the pH 4.5, 3.5 and 7.0 solutions respectively. The corresponding values for Cr and As were 0.5, 1.45 and 7.1 ppm and 8, 17 and 26 ppm respectively.

It is evident that the SHCA solution has a strong potential to remove the CCA constituents even at pH 7.0. Also, the solutions maintained at acidic conditions leached more CCA than acidic solutions allowed to equilibrate with the wood.

These results show that the extraordinary high copper losses from CCA-treated lumber in the Guelph study were caused by the use of the

NaOH/citric acid buffered leaching solution.

When treated wood is exposed to acidified water maintained at a low pH, the CCA losses are increased compared to more neutral water. However, the wood has a high capacity to control its environment by rapidly neutralizing acidic water in contact with it. More work is needed to determine the rate of buffering of acidic precipitation by wood in service and to evaluate the actual leaching characteristics of treated wood in service in areas of acidic precipitation.

References:

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Fig 1 : Rate of Copper leaching
-Red pine

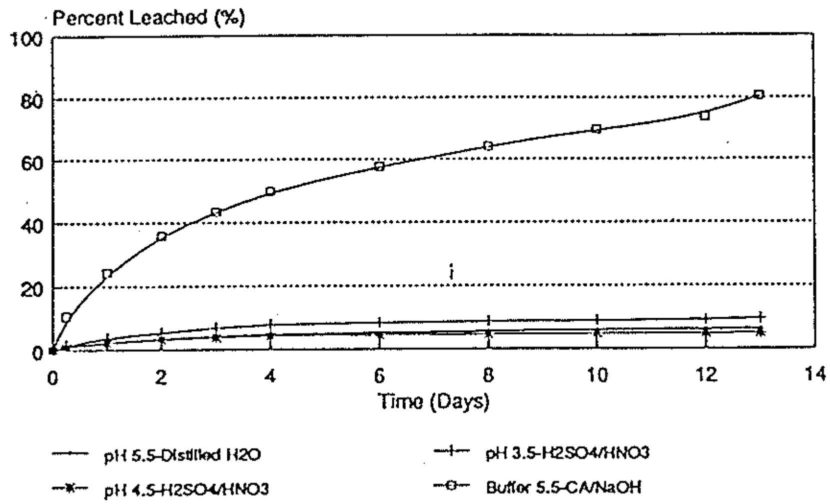


Fig 2 : Rate of Chromium leaching
-Red pine

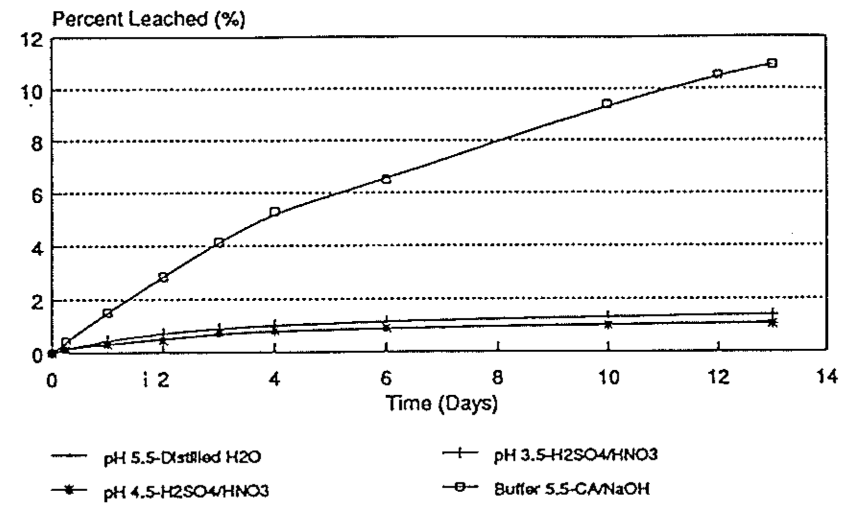


Fig 3 : Rate of Arsenic leaching
-Red pine

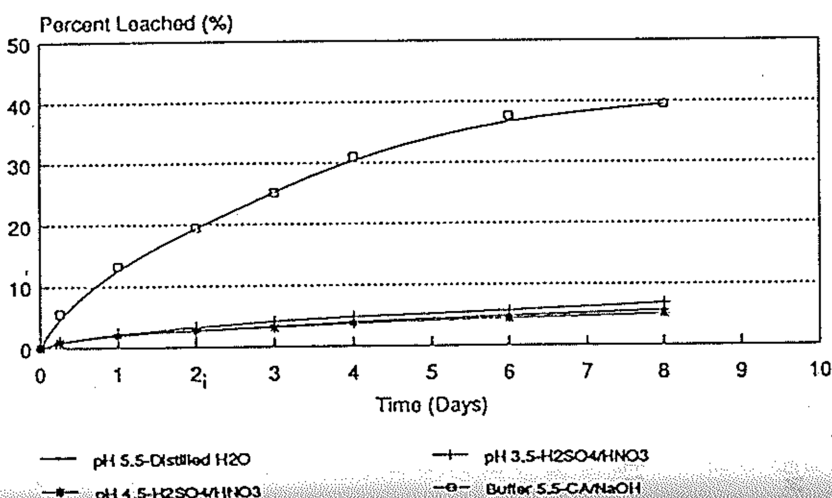
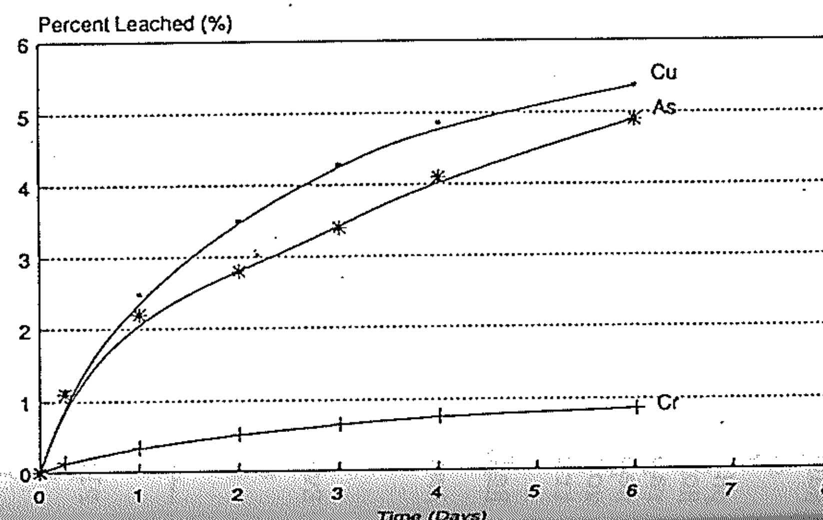


Fig 4 : Rate of leaching among elements
-Red pine in distilled water



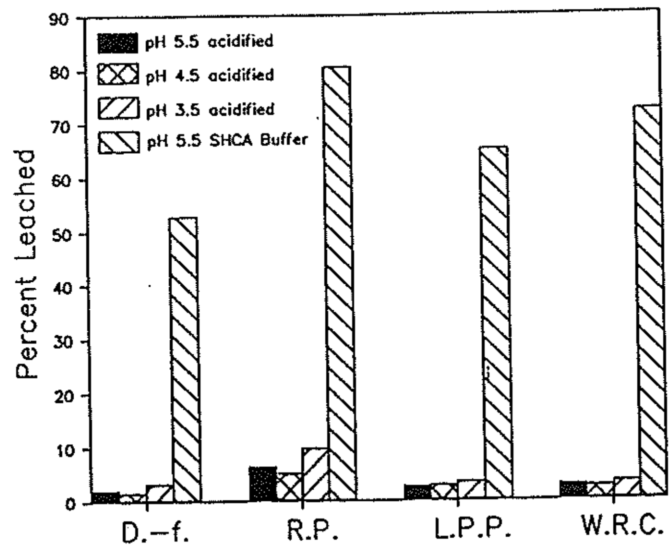


Fig 5: Leaching of Copper among species

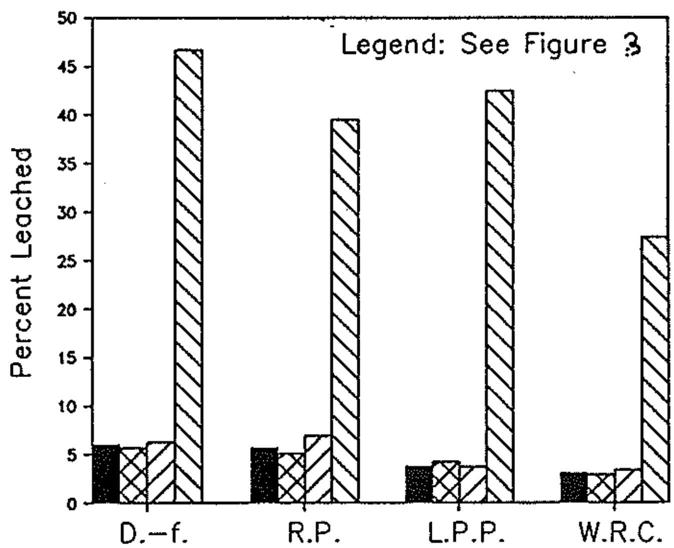


Fig 6:Leaching of Chromium among species

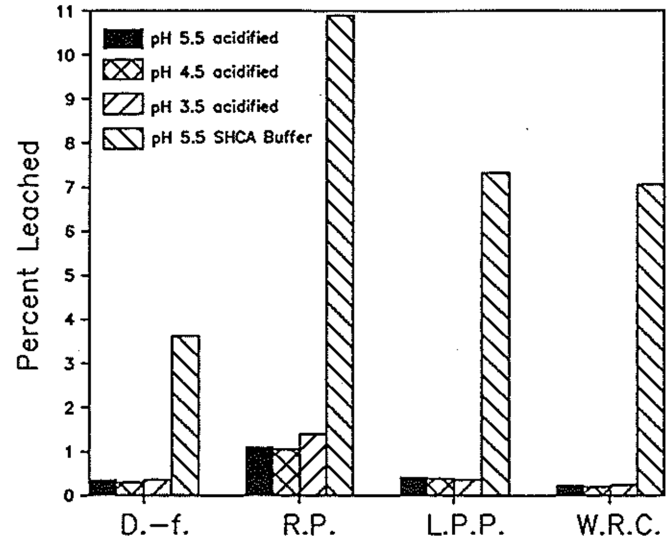


Fig 7: Leaching of Arsenic among species

Fig 8: Buffering effect of treated red pine wood on leaching solutions