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COATING EFFICIENCY IN REDUCING PRESERVATIVE LEACHING

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Abstract

Penetrating stains are recommended for exterior applications such as decks; however, there is not enough information about ability of these stains to reduce preservative leaching from treated wood. To investigate the efficiency of different penetrating stains in leaching reduction, five different commercial formulations of penetrating stains were applied on the top and end grain of Chromated Copper Arsenate (CCA), Alkaline Copper Quaternary (ACQ), Copper Azole (CA) and untreated wood samples and exposed to natural weathering in Toronto. Cumulative leaching was estimated by analysis of the leachate amounts and concentrations. This paper focuses on the results of 27 months of natural weathering. Results show all coatings effectively reduced cumulative leaching after 27 months, even though there were significant coatings failures in as little as 12 months.

1. Introduction

Preservative treated wood is the main type of decking material in North America; however, leaching of As, Cu and Cr from existing CCA decks and Cu from ACQ and CA treated wood is a major issue (West 2001, Taylor *et al.* 2001, Lebow 2004, Townsend *et al*. 2005, and Zagury 2005). Some studies found that film forming coatings were able to reduce leaching of CCA components, but film forming coatings are not recommended for decking application since they crack and peel during dimensional changes of the wood (swelling and shrinking) (Cobb and Levenson 2005, Stefanovic 2005). While penetrating stains have been recommended for deck application (Satas and Tracton 2001, Health Canada 2005) the efficiency of these stains in reducing leaching is not known.

This study focuses on measuring efficiency of different water based and solvent based stain formulations in reducing preservative leaching from different types of preservative treated wood in long term natural weathering.

2. Materials and Methods

Sixteen foot flat grained sapwood 1” X 6” (19mm X 140mm) boards of southern pine (SP) were cut into four pieces. Three pieces were treated, each with a different preservative and one left as untreated control sample. Preservatives used were as follows: CCA-C (47.5% CrO_3, 18.5% CuO, and 34% As_2O_5), ACQ-C (66.7% copper oxide, 33.3% quat as alkyl dimethyl benzyl ammonium chloride) and CA-B (96.1% copper, 3.9% Tebuconazole). All samples were targeted to above ground retention, but the actual retention results were slightly higher.

Five coatings (Table 1) selected out of fourteen coatings, based on the results of initial screening lab tests (Nejad and Cooper 2006, 2007) were applied on the face exposed to the weathering and to the end grain according to manufacturers' instructions. Three replicates samples for each treatment (CCA, CA, ACQ and untreated control) were exposed to natural weathering in Toronto, Ontario from May 2006 to date (Figure 1). Collected leachate was measured for volume and analyzed by inductively coupled plasma atomic emission spectroscopy (ICP-AES) for As, Cu and Cr amounts and cumulative leaching and specimen moisture content changes monitored periodically over 27 months.

Table 1: Description of selected coatings systems

Coating ID	**Coating Based**	**Resin Type**	**Number of Coats**
Coating -2	Water-based	Alkyd-Acrylic	One
Coating -4	Water-based	Alkyd-Acrylic	One
Coating -5	Solvent-based	Alkyd	One
Coating -9	Solvent-based	Alkyd	One
Coating -14	Water-based	Polyurethane	Three

Figure 1- Natural weathering set up

3. Results and Discussion

Figure 2 shows the moisture content change of ACQ-treated coated and uncoated samples during 27 months of natural weathering. Most coatings had lost their water repellency after the first year of exposure. Coating number-9 which is an alkyd solvent- based stain was more effective in excluding moisture from wood samples than the others.

Figure 2: Moisture content change of ACQ-treated samples during 27 months of natural exposure

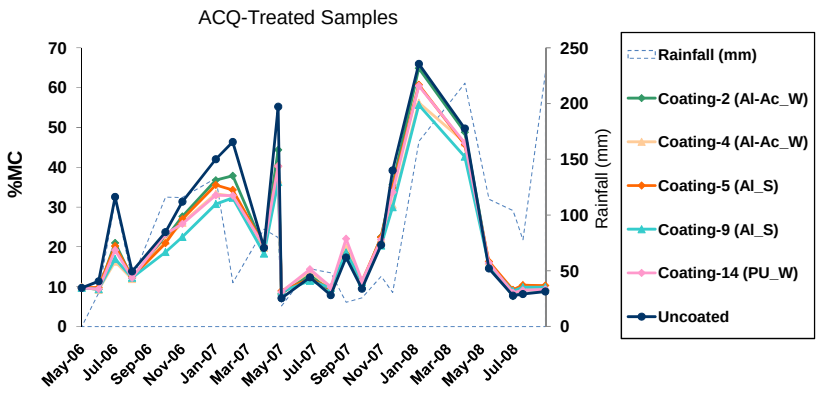
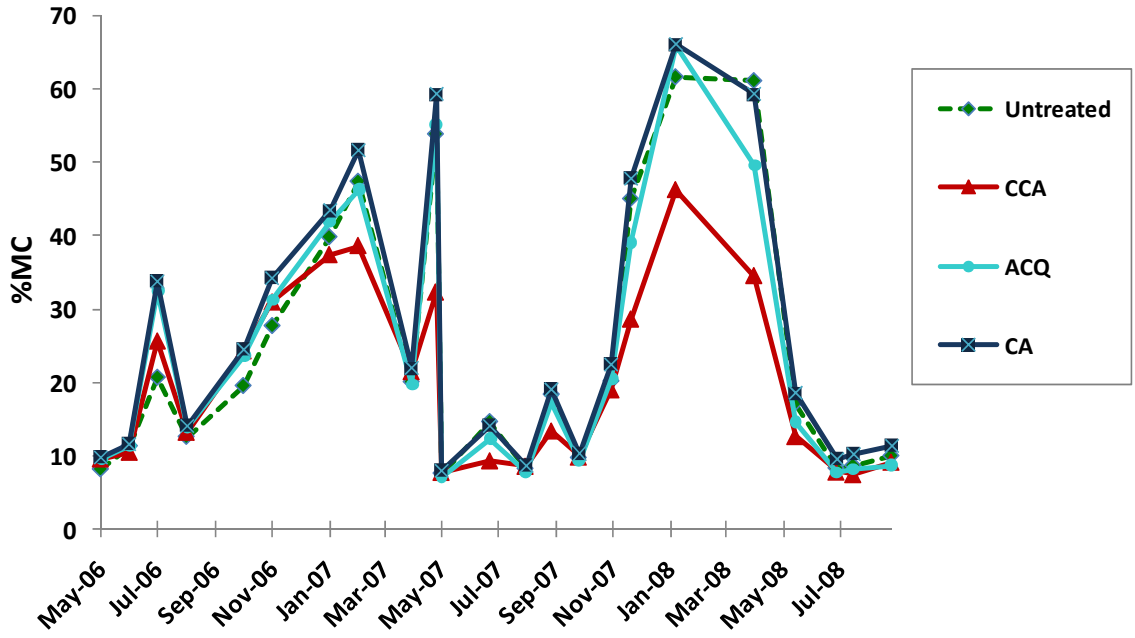


Figure 3: Moisture content change of uncoated- treated and untreated samples during 27 months of natural exposure



In general ACQ and CA treated samples had higher water uptake than CCA and even untreated wood samples (Figure 3).

Cumulative leaching results of As from CCA and Cu from ACQ and CA-treated wood samples during twenty seven months of natural exposure are presented in Figures 4-6. All coated samples had much lower cumulative leaching than uncoated samples even after they failed (based on their appearance-after one year).

Figure 4: Leaching of As from CCA-treated natural weathering samples

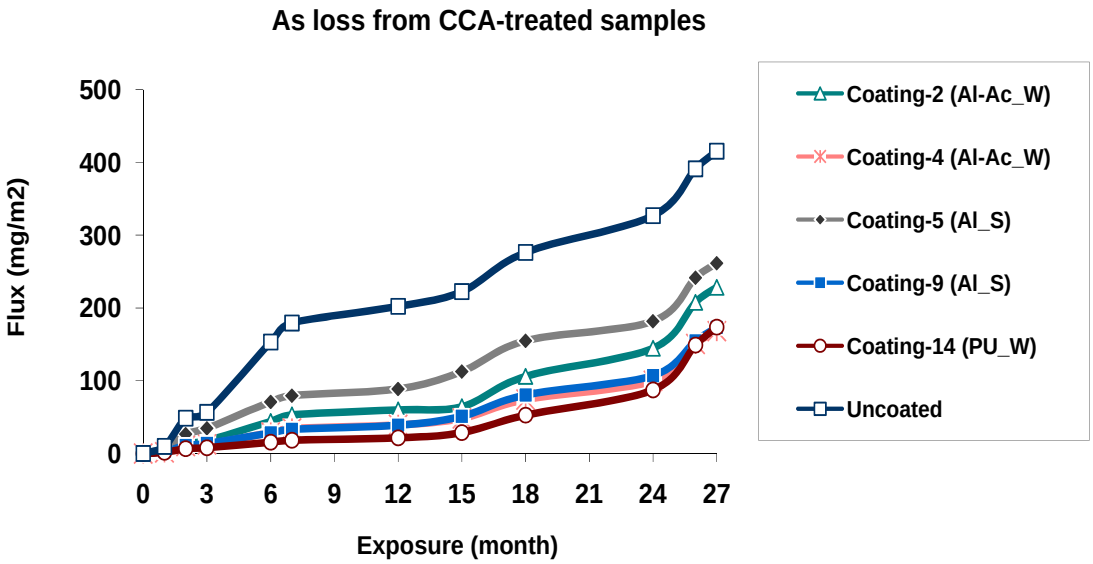


Figure 5: Leaching of Cu from CA-treated natural weathering samples

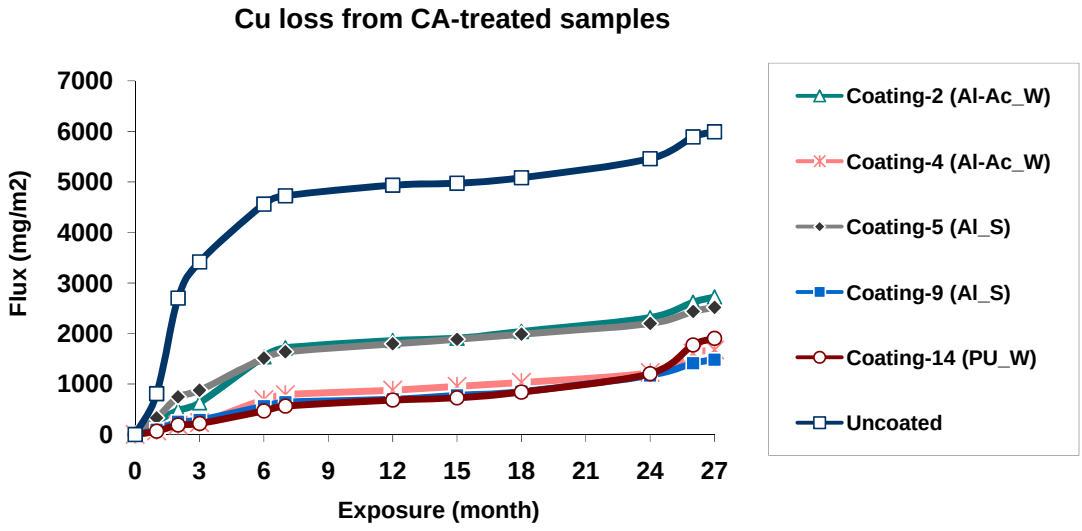
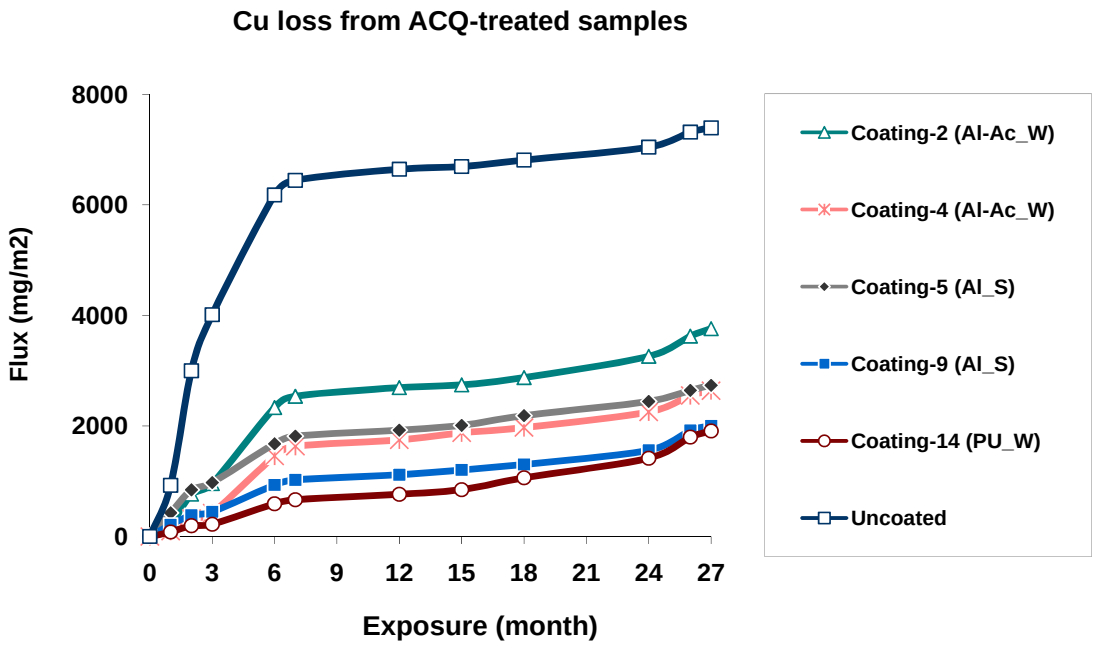


Figure 6: Leaching of Cu from ACQ-treated natural weathering samples



Coatings were more effective in Cu reduction from ACQ and CA treated samples than CCA component reduction.

Figure 7 and 8 show efficiency of different coatings in comparison with uncoated samples in reducing CCA and CA preservative leaching after 27 months of natural exposure. In terms of CCA component reduction they ranged from as low as 25% for Cu to as high as 71% for Cr and Cu (Figure 7). In terms of absolute As leaching the best coating (number-4) reduced cumulative As leaching from 415 to 160 mg/m^2.

Figure 7: Efficiency of coatings in reducing of As, Cu and Cr from CCA-treated samples after 27 months of natural weathering

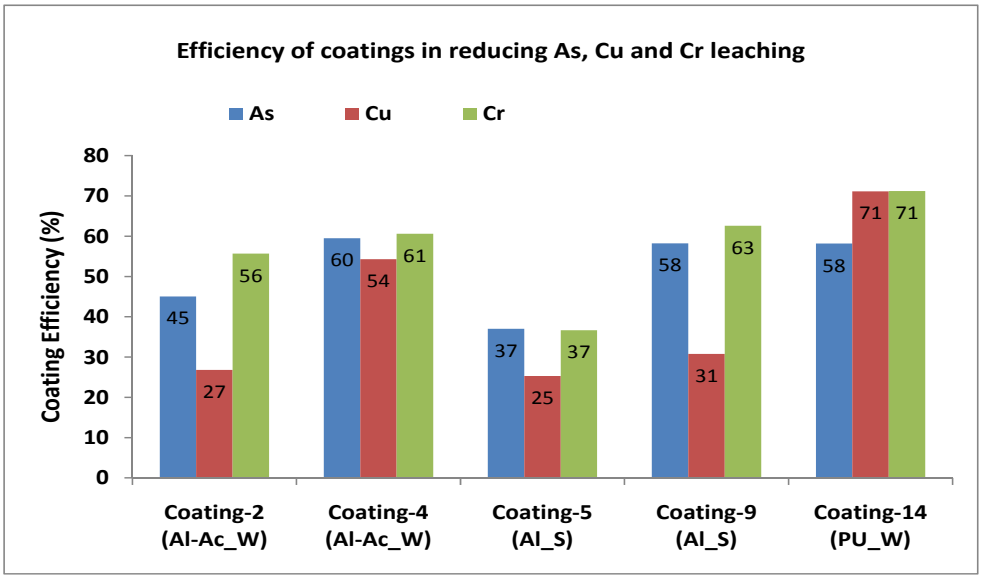
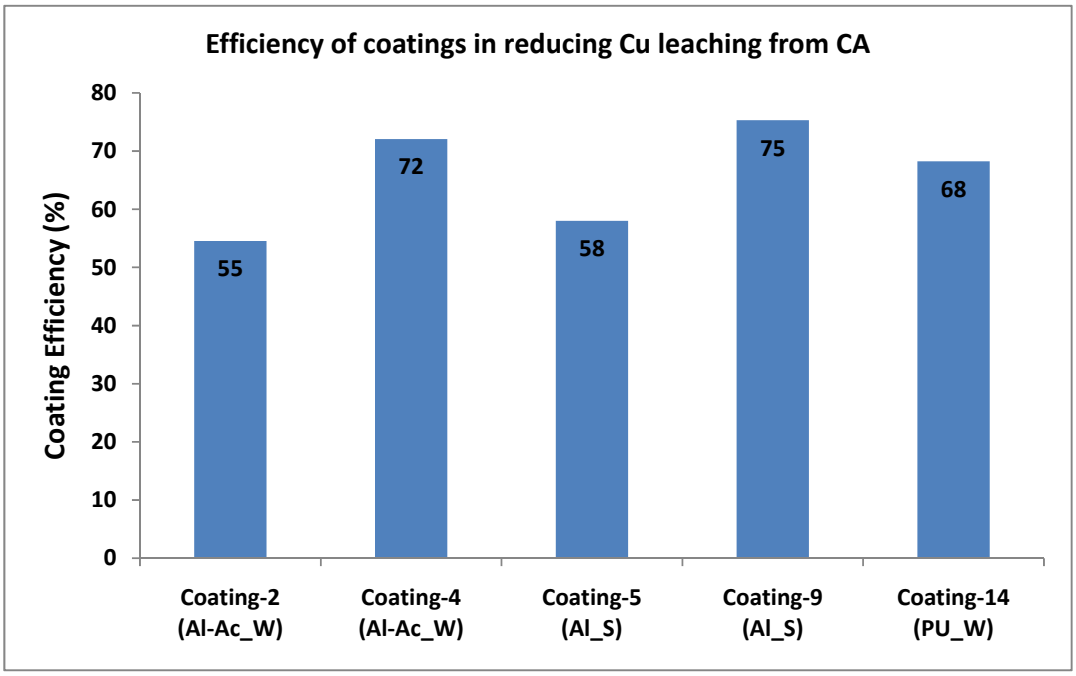


Figure 8: Efficiency of coatings in reducing Cu leaching from CA-treated samples after 27 months of natural weathering



Coatings reduced Cu leaching from CA-treated wood samples between 55%-75%. The best coating (number-9) reduced the cumulative absolute Cu leaching from 5900 to 1500 mg/m^2 (Figure-8). Results were similar for ACQ treated wood.

4. Conclusions

Coatings effectively reduced cumulative preservative leaching and this reduction persisted even after the coatings had failed. Generally the coatings showed different performances on different treatments and performed very effectively on the copper amine treatments even though ACQ and CA treated coated and uncoated samples had higher moisture uptake than CCA and even untreated wood samples. Up to now, coating number-9 which is an alkyd solvent based stain had the lowest water uptake and was the most effective one in Cu leaching reduction from ACQ and CA, but has not shown the same efficiency in CCA leaching reduction. Coating number-14 which is a polyurethane water based had the highest water uptake, but was the second best in leaching reduction, indicating that higher water uptake does not necessary result in higher leaching.

5. Literature

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