

Arsenic Speciation of Solvent-Extracted Leachate from New and Weathered CCA-Treated Wood

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For the past 60 yr, chromate-copper-arsenate (CCA) has been used to pressure-treat millions of cubic meters of wood in the United States for the construction of many outdoor structures. Leaching of arsenic from these structures is a possible health concern as there exists the potential for soil and groundwater contamination. While previous studies have focused on total arsenic concentrations leaching from CCA-treated wood, information pertaining to the speciation of arsenic leached is limited. Since arsenic toxicity is dependent upon speciation, the objective of this study was to identify and quantify arsenic species leaching from new and weathered CCA-treated wood and CCA-treated wood ash. Solvent-extraction experiments were carried out by subjecting the treated wood and the ash to solvents of varying pH values, solvents defined in the EPA's Synthetic Precipitation Leaching Procedure (SPLP) and Toxicity Characteristic Leaching Procedure (TCLP), rainwater, deionized water, and seawater. The generated leachates were analyzed for inorganic As(III) and As(V) and the organoarsenic species, monomethylarsonic acid (MMAA) and dimethylarsinic acid (DMAA), using high-performance liquid chromatography followed by hydride generation and atomic fluorescence spectrometry (HPLC–HG-AFS). Only the inorganic species were detected in any of the wood leachates; no organoarsenic species were found. Inorganic As(V) was the major detectable species leaching from both new and weathered wood. The weathered wood leached relatively more overall arsenic and was attributed to increased inorganic As(III) leaching. The greater presence of As(III) in the weathered wood samples as compared to the new wood samples may be due to natural chemical and biological transformations during the weathering process. CCA-treated wood ash leached more arsenic than unburned wood using the SPLP and TCLP,

and ash samples leached more inorganic As(III) than the unburned counterparts. Increased leaching was due to higher concentrations of arsenic within the ash and to the conversion of some As(V) to As(III) during combustion.

Introduction

Chromated-copper-arsenate (CCA) is an inorganic water-borne pesticide widely used in the wood preservation industry to extend the useful service life of wood as a building material. Through 2003, millions of cubic meters of CCA-treated wood were produced annually for the construction of many outdoor structures including decks, picnic tables, playground equipment, telephone poles, and docks. The chemical CCA, made up of hexavalent chromium, divalent copper, and pentavalent arsenic, is formulated to be leach-resistant when fixed to wood. Complete fixation of CCA to wood is defined by the reduction of hexavalent chromium to trivalent chromium resulting in the formation of insoluble complexes in the CCA-treated wood (1, 2). CCA-Type C is the most common type used, consisting of 47.5% as CrO₃, 18.5% as CuO, and 34% as As₂O₅ by weight. The amount of CCA utilized to treat wood or "retention level" depends on the particular application of the wood. Typical standard retention levels utilized by the wood preservative industry are 4.0, 6.4, 9.6, 12.8, and 40.0 kg/m³ (3) where kg refers to the mass of CCA on an oxide basis and m³ corresponds to the volume of wood. Low retention levels, 4.0 and 6.4 kg/m³, are permissible for above-ground applications. Wood treated to a higher retention, 9.6 kg/m³, is used for load-bearing structures, such as pilings and structural poles, while retention levels of 12.8 and 40.0 kg/m³ are used for foundations and saltwater applications.

Migration of chromium, copper, and arsenic from discarded CCA-treated wood and the possible environmental impacts upon disposal raise concern, most notably for arsenic. When CCA-treated wood is burned, arsenic can be released to the air, and when it is landfilled, arsenic can migrate to the leachate and possibly the groundwater. Discarded CCA-treated wood in the United States is typically disposed of in three ways: (i) disposal in landfills including construction and demolition (C&D) debris and municipal solid waste (MSW) landfills, (ii) combustion, and (iii) inadvertent land application as landscape mulch (4–6). In Florida, as well as several other states, C&D debris landfills do not require liner systems; thus, arsenic leaching from CCA-treated wood may pose a risk to groundwater. In the case of lined landfills, elevated concentrations of arsenic from CCA-treated wood could create leachate disposal problems. Leaching of arsenic from land-applied mulch or combustion ash could result in soil and groundwater contamination. An understanding of the rates and mechanisms of arsenic leaching is thus important.

Several studies have been conducted to evaluate the leaching of total arsenic from CCA-treated wood as a whole, but there are limited data pertaining to the speciation (7–11) and ash from the combustion of CCA-treated wood (12). Speciation is of interest because the different forms of arsenic exhibit different levels of toxicity. Inorganic forms of arsenic, arsenites (As(III)) and arsenates (As(V)), are generally more toxic than the organic forms, monomethylarsonic acid (MMAA) and dimethylarsinic acid (DMAA) (13, 14); inorganic As(III) is reported as more toxic than As(V) (15, 16). The research reported in this paper builds from previous work by the authors where the total concentration of arsenic leached from CCA-treated wood and ash were measured (11,

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