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1. Summary

For more than fifty (50) years, a water borne salt formulation commonly known as chromated copper arsenate (CCA) has been used as wood preservative to protect the wood from degradation. However, upon impregnation, the element components fix substantially to the wood matrix, remain there and could later leach to the environment when disposed off, causing potentially severe health problems. As part of a study to device a cost effective and environmentally sustainable way of extracting the CCA from wood matrix, the chemical species in the wood were characterized. The potency of supercritical carbon dioxide using Cyanex 301 and 302 as modifiers, and Sodium tetrahydridoborate ($NaBH_4$) as reductive agent for the extraction were tested. The results obtained indicated that different complex formations of compounds and combinations of Cu, Cr and As were formed in the wood, while especially high extraction efficiencies of the CCA were obtained using Cyanex 301 and 302 in supercritical carbon dioxide. Leaching tests with $NaBH_4$ solution on the other hand gave lower extraction efficiency of As although thermodynamic calculations clearly predicted the feasibility of reducing all the elements and thereby converting As into gas phase as AsH_3. At the same time $NaBH_4$ only could leach very small amounts of Cu and almost no Cr. These results may be due to the higher solubility of Cu (I) compounds as compared to Cu (II) and the conversion of Cr into the non-soluble Cr (III) oxide. Cyanex 301 and 302 could be employed to extract CCA from CCA treated wood but the possibility of regenerating carbon dioxide and the chelating agent need to be assessed if the method shall become economical beneficial .

2. Extended Abstract

A typical environmental issue which, is matter of concern nowadays is the application of chromated copper arsenate (CCA) as a biocide to preserve wood such as telephone poles, railway sleepers, wooden silos, cable drums and many wooden products from insect, fungi and bacteria damage.

To achieve CCA-wood preservation, the wood is impregnated by an aqueous solution composed of chromium, copper and arsenic in a specially designed pressurized cylinder. The solution in the impregnated wood form different kinds of metal complexes with lignin and cellulose, with assumed documented consequent formation of chemical species such as $CuCrO_4$, $CrAsO_4$, $Cu(OH)CrAsO_4$ [1]

Besides the usefulness of CCA as a broad-spectrum preservative, in recent years however, there is a growing concern about the environmental contamination caused by CCA-treated wood, which is mostly disposed off in landfills or incinerated. Copper, arsenic and chromium leaching into aquatic environment when disposed off into landfill has been documented.[2] Furthermore the process of incineration is known to produce toxic gasses especially from arsenic into the atmosphere coupled with the high demand of energy used for incineration.[2] Other different techniques such as electrodialysis, low temperature pyrolysis, biological and or biochemical treatment of treating CCA-treated wood waste have also been documented, all showing various degrees of economic success and environmental relevance.[3]

Globally, the amount of CCA- treated wood disposed off is increasing every now and then. It is estimated that worldwide, the wood preservation industry presently treats approximately 30 million cubic metres of wood each year, consuming some 500 000 tones of preservative chemicals. Approximately two-thirds of this volume is treated with chromated copper arsenate (CCA)[2] In the EU, Germany and France alone provide about 4×10^6 tons of treated wood per year, containing about 2.4×10^6 tons of CCA which are toxic [4]

In the horizon of this escalated production of CCA, developed countries like Denmark has banned their usage and attention is now focused on organic biocides such as

Tebuconazole and many others which posses little or no danger to the environment. However, a major challenge still remains as to how effectively and at a cheaper cost, treat these scrap wood since the potential environmental and health threats pertains even if they are sent to landfills or burnt up which is known to be one of the cheapest way of waste disposal[1]

So far, having reported to be a cheaper, faster and environmentally friendly way for purification and re-crystallization operations in industries, the super critical fluid extraction method, using carbon dioxide has been investigated as an approach to extracting CCA from CCA –treated wood in the attempt of finding the appropriate method to extract the CCA compounds from the CCA-treated wood.[5] [6] [7] [8] However, the fact that direct extraction of metal ions is highly inefficient due to the requirement of charge neutralization and weak solute to solvent interactions, creates a vacuum for more research to be carried out into various ways of modifying metal extraction by supercritical carbon dioxide. In the super critical state, fluid may exhibits the solubility property of a liquid with a highly penetration power into a solid matrix, which is driven by the gas like transport properties

The subject matter for this project was thus to identify the chemical species in scrap CCA-treated wood, Compare the potency of super critical Carbon dioxide using Cyanex 301 and Cyanex 302 as complexing and a reducing agent, $NaBH_{4\ (aq)}$ to extract CCA, and finally assess the chemical and environmental Viability of apply a reductive process such as using $NaBH_4$ for the treatment of CCA in the scrap wood.

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