

**RECOVERY AND REUSE OF THE WOOD AND CHROMATED COPPER ARSENATE
(CCA) FROM CCA TREATED WOOD – A TECHNICAL PAPER**

Kazem Eradat Oskoui, PhD

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Director, Engineering Services, West Central Environmental Consultant, Inc.
11253 - 91st Avenue North, Maple Grove MN55369.
Tel. 763 425 7496
Fax. 763 425 7235
e-mail: oskouike@wcec.com

ABSTRACT

Chromated Copper Arsenate (CCA) impregnated waste materials are generated during the treating process and from treated wood removed from service. This material is currently land-filled, which creates concerns because of the bulky nature of wood and the potential for leaching of some Cr, Cu and As components of the preservative. A recycling process has been developed whereby up to 99% of the CCA components are extracted from the waste material. CCA treated wood waste is chipped and reacted with a proprietary lixiviant which mobilizes the CCA components and brings them into solution. The Aclean® wood and other residues pass the TCLP test and can be reused for paper or composite products or disposed of in a normal landfill. The pregnant solution is then passed through another proprietary process to separate the CCA components from the Clean water. The extracted solution, containing Cr, Cu and As can be reprocessed to a condition where it is compatible with CCA treating solutions and could be re-used for treating new wood.

1.0 INTRODUCTION

There was a rapid expansion of the use of chromated Copper arsenate (CCA) wood preservative between 1975 and 1990, as a result of high consumer acceptance of the product for decks, fences and other residential applications. It is therefore expected that in the next two decades, the amount of CCA treated wood that will be removed from service will expand greatly. Approximately 65.3 Million kilograms (144 Million pounds) of chemicals were used in US during 1997 to produce 12.7 Million m³ (450 Million ft³) of treated wood products (1). Currently, American and Canadian environmental regulations allow the disposal of CCA treated lumber in landfills, and most of the out-of-service or Aspent® treated wood ends up in landfills. In the future, treated wood will use increasing volumes of landfill space. In addition to leaching and environmental impacts, there are considerable human and animal health implications associated with the use of CCA treated wood. According to a document published by Origen Network (2), A It is incredible, but a single 12 foot 2 x 6 contains about 27 grams of Arsenic - enough Arsenic to kill 250 adults.®

In order to avoid the adverse environmental impact of increased CCA treated wood waste as well as its impact on human and animal health and, reduce the burden on the nation's landfills, finding an economical, environmentally friendly and, cost effective recycling and disposal method is becoming more important everyday. A practical, simple and cost effective process for removing up to 99% of the CCA components from CCA contaminated waste is described

2.0 LITEATURE CITED

During the past few decades, several attempts been made to propose a cost effective and environmentally sound process for recycling the CCA contaminated waste products. The literature describing the disposal methods for the CCA contaminated waste is voluminous. A simple search using the keywords “CCA Disposal” resulted in 4985 returns in the World Wide Webb. Similar search using “CCA Extraction” resulted in 2896 returns. Since it is impractical to present and cite all the literature relevant to this subject here, only a few are mentioned. Omission of any such work does not diminish its importance or relevance to this subject. Extensive and exhaustive review of the CCA issue has been described in numerous articles and publications by Florida Center for Solid and Hazardous Waste Management (3).

Several procedures such as acid extraction, burning, pyrolysis, re-using in composite wood products, and biological detoxification have been proposed. Among these processes extraction of CCA components have been both prominent and most promising. Extraction alone (4,5) and extraction combined with biological detoxification (6) have produced substantial removals of (up to 99%) the CCA components from the CCA contaminated waste. Although the extraction have provided viable results, very limited cost information is available on these process. Some researchers estimate the extraction cost at over US\$300 per metric ton of wood extracted (5).

Pyrolysis (7) has also been proposed as a process for recycling CCA contaminated wood. Although the technology has shown satisfactory CCA components removal efficiency, no cost information has been provided.

3.0 OBJECTIVES

The main objective of this article is to introduce a cost effective, simple, practical, and environmentally benign technology which can be used by waste management industry to remove CCA components from CCA contaminated waste products prior to disposal or recycling.

5.0 MATERIALS AND METHODS

Samples of commercially available CCA pressure treated wood (0.25 pcf) was obtained and ground to a mean particle size of 10 to 20mm. The protocol adopted in the previous bench scale study (not published) was used for the data reported here. Mean particle sizes selected are much larger than those used in the previous study.

To obtain a baseline characterization of the contaminated wood, a 100g dry treated sample (sample ID: SW1) was sent to the laboratory for analysis to determine the Cr, Cu and As contents in the wood.

A series of proprietary compounds “lixivients” were used to demobilize the CCA components in the wood into solution. These compounds are non-corrosive, organic, and biodegradable proprietary compounds which can extract CCA salts from spent wood or sludge with a very high efficiency.

The five different protocols used are identified as follows:

- \$ WT1WH
- \$ WT2ED-H
- \$ WT3ED-HD
- \$ WT4ED-D
- \$ WT5ED-A

Each protocol represents a specific temperature-lixivient-wood combination. Intellectual property

protection restricts further explanation of these combinations.

The extraction is a 4 hour process which consists of the following steps:

- Particle size reduction
- Hydrolysis and reaction
- Settling
- Decanting
- Solids Separation
- Water treatment

5.1 Particle Size Reduction

Waste wood is ground or chipped to a mean particle diameter of about 10 to 20 mm (1/2 to 1 inches) using a commercial grinder or chipper. Size reduction can be conducted as needed or in a batch form where ground wood is stored in a covered area for use in the extraction process.

5.2 Hydrolysis and Reaction

Size reduced particles are conveyed to the reaction tank. In this tank water is introduced while is being mixed with appropriate amount of lixivient. Typical water:solids ratio is 0.25:1 by volume. Introduction of heat has shown an increase in the performance of the lixivient. An optimum (economical) temperature of 40°C has yielded the best extraction efficiency. Upon introduction of the water and lixivient, the mixture is agitated by mixing air which also introduces heat to the mixture to maintain the desired temperature. This process continued for 2 hours.

5.3 Settling

After two hours the mixture is allowed to settle where the clean wood is settled at the bottom of the tank and pregnant solution (solution containing the CCA components) is stratified at the top. Setting is typically carried out over a one hour period.

5.4 Decanting

The supernatant is decanted using a floating decanter. This solution has a light green color and contains a mixture of lixivient and CCA components. Up to 3000 ppm of As, 2000 ppm Cu and 3000 ppm of Cr was measured in the decanted solution.

5.5 Solids Separation

Upon Completion of the decanting process, the settled solids are conveyed to a screw press which separates the solids from the residual liquid. This process removes the most of the residual contaminants from the solids thus leaving a clean semi-dry (55% to 65% moisture content) wood cake which can be used for reprocessing or disposal.

5.6 Water Treatment

Both the decanted water and the pressate from the screw press are directed to the water treatment plant where the CCA component are separated from the lixivient using a patented technology. The technology uses a zirconium based exchange medium with strong affinity to CCA components. Upon saturation of the medium, it is regenerated. CCA components are separated in a concentrated sludge form.

6.0 ECONOMIC ANALYSIS

Despite its failure of TCLP tests, CCA contaminated waste is currently exempted from the Environmental Protection Agency's hazardous waste characterization. Due to this exemption, these wastes can be disposed of in Construction and Demolition (C&D) landfills in most States in the US and Canada. Most European countries and other industrial nations as well as some States in US (Minnesota) however, have more stringent rules governing these wastes. The exemption from hazardous waste classification has considerably reduced the cost of disposal of these wastes in the US and Canada and have removed the incentive from finding a more environmentally benign disposal process. Disposal cost varies from as low as \$20/ton in Midwestern States to as high \$160/ton in some East Coast and California Cities. These costs of course, do not include the possible environmental clean-up costs, future liability litigation costs as well as any potential human and animal health costs. Individual and class action law suits are increasing which make the landfill owners more cautious in accepting CCA contaminated waste products. For example most landfills in the Twin Cities of Minneapolis and St. Paul area have started refusing to accept CCA contaminated waste products fearing future liabilities.

The system described here is simple, practical, and environmentally sound as well as economical and cost effective. The cost of processing one ton of CCA contaminated waste wood is between US\$120 to US\$150. This cost may seem high when compared to low cost of C&D landfill tipping fees but once all the other costs as describe above are included in the equations, it becomes more comparable to the actual cost of lanfilling. This cost does not include the revenue from the recycled wood which may be between US\$15 to US\$25/ton depending on the final use. There is also a small amount of income (US\$6/pound) from the recovered CCA components.

7.0 RESULTS AND DISCUSSION

7.1 Extraction Results

Following the completion of the reaction process, a mixed sample of cleaned wood and the liquid containing the extracted solution was sent to the Laboratory for analysis. Solution from each sample was strained using 1Φ screen and solids were dried to be used for testing. The filtrate was analyzed for Cr, Cu, Cd, and As. The dried baseline sample was also tested for these elements.

Results are tabulated in Table 1. The baseline sample indicated no trace of Cd thus, subsequent samples were not tested for this elements. As it can be seen from the table, there is a considerable amount of Cr, Cu, and As in the initial wood sample. The values are expressed in mg/kg or parts per million (ppm). Amount of Arsenic in the base sample (SW1) was 3020 ppm or 0.3% , Chromium was 3380ppm or 0.34%, and Copper was 1991ppm or 0.2%. These levels are higher than the allowable level in the environment by several orders of magnitude.

Results from the wood samples indicate about 80% to 90% removal of Arsenic, 78% to 82% removal of Chromium and 95% to 99% removal of total Copper concentration.

TABLE 1. Sample Extraction Results (solids)

Sample ID	Arsenic			Chromium			Copper		
	Baseline	Value	Removal	Baseline	Value	Removal	Baseline	Value	Removal
	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%
WT1WH	3020	203	93.28	3380	525	84.47	1991	88.73	95.54
WT2ED-H		110	96.36		309	90.86		32.83	98.35
WT3ED-HD		118	96.09		308	90.86		04.88	99.75
WT4ED-D		374	87.62		375	90.89		78.50	96.06
Average		201	93.34		379	89.27		51.24	97.43

As it can be seen in Table 2., levels of Arsenic in the filtrate ranged from 22,800 parts per billion (ppb) to 57,600 ppb considering that the current drinking water Arsenic level is 50ppb which is under revision and may be reduced to as low as 10ppb. Copper levels in the filtrate was in general 3 to 4 times of the Arsenic except in one sample where Copper concentration was slightly less than the Arsenic concentration. Levels of the Chromium in the solution were about 1/4 of the levels of Arsenic. This is due to the fact that Chromium is less soluble than the other two elements at a give pH level. These concentration levels will vary with varying wood:liquid ratios during the extraction process.

TABLE 2. Sample contaminant concentration levels in the extracted solution

Sample ID	Contaminants (mg/l)		
	Arsenic	Chromium	Copper
WT1WH	22.80	4.00	79.00
WT2ED-H	29.80	5.67	69.60
WT3ED-HD	57.60	19.60	40.00
WT4ED-D	24.00	6.86	120.00

7.2 Toxic Characteristic Leachability Process (TCLP) Test

Since the cleaned wood still contained some residual CCA compounds, additional tests were conducted in order to determine the leachability of cleaned wood. A series of cleaned samples were then tested for TCLP (Toxic Characteristic Leachability Procedure) by EPA SW846-1311 and SW846-351 method.

Average TCLP levels for the cleaned wood samples were 0.737 mg/kg for Arsenic, 0.06 mg/l for Copper and 0.18 mg/l for Chromium. These levels are well below the maximums levels set for hazardous waste characterization for these elements.

8.0 CONCLUSIONS

The results of this study and previous bench scale studies indicate that, in a suitable environment, almost 90% of the CCA components leach to the environment in less than 2 hours. It also indicates that most of these components (up to 99%) can be removed from the waste stream before its disposal into the environment. This can be done economically, safely and in an environmentally sound manner.

9.0 REFERENCES

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