Preliminary

Evaluation of Mobility of Metal Elements in CCA-treated Wood for Efficient Recycling and Safe Disposal

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1. Introduction

In recent decades, chromated copper arsenate (CCA)-treated wood has been widely used because of its high resistance to rot and weathering over a long period of time. However, a large amount of CCA-treated wood has become waste material, and the disposal of these treated wood products poses a serious problem. In Japan, it is estimated that 200,000 m^3 of CCA-treated wood will be removed from service annually and that this phenomenon will continue over at least 30 years.

In this study, the characteristics of the behavior of toxic metals in the treated wood against heating and leaching were investigated. Also, we examined a novel method for efficient recycling and safe disposal of the heavy metals in CCA-treated wood waste.

Previous reports have strongly suggested that the combustion of CCA-treated wood by conventional methods could produce environmental pollutants because toxic metals, particularly arsenic, are gasified at normal combustion temperatures and may be easily released into the atmosphere[1–3].

Landfilling has often been used as a practical method of disposing of this type of wood waste. However, environmental pollution may occur when applying this method to CCA-treated wood wastes. When the wood is landfilled, it is difficult to trace the diffusion of the toxic metals from the waste wood into the soil and then into the groundwater. Before waste wood is disposed in landfills, it is essential to know the behavior of toxic metals, particularly when leached.

Pyrolysis, defined as "the degradation of polymers only by heating without oxygen", is considered as a controllable chemical reaction in a lab-scale. Under pyrolysis, arsenic was released at around 350–400°C and at higher temperature zones larger amounts of arsenic were easily gasified[4]. A temperature of approximately 300–350°C was found to be suitable to pyrolyse CCA-treated wood preventing the release and/or gasification of arsenic from CCA-treated wood[4]. Further research is needed to find a method for separating heavy metals from pyrolysis residues, for example milling and centrifugal separation.

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2. Materials and Methods

The immobility of toxic metals in the pyrolysis residue was evaluated by means of a forced extraction test. CCA-treated wood was milled to the size of 100-mesh passing. The milled wood was then pyrolyzed at 300°C for 60 min. in an N_2 atmosphere. Solvent extraction of pyrolyzed and un-pyrolyzed CCA-treated wood was conducted. Sulfuric, phosphoric, citric and oxalic acid at a concentration of 1 N were used as the extraction solvent, and the leaching test was conducted at a temperature of 25°C for 1 hour. CCA contents of each element were measured by fluorescent X-ray analyzer (JSX-3220, JEOL) quantitatively.

3. Results and Discussions

As a typical example, only the sulfuric acid extraction was summarized as follows: 1) When normal CCA-treated wood powder (unpyrolyzed) was submitted to the leaching test, 21.7% As, 81.2% Cu, and 45.7% Cr of the original amounts in the wood were present the solvent. 2) However, 0% As, 4.3% Cu, and 0% Cr were recovered from the pyrolyzed wood powder. This result shows that pyrolysis immobilized the toxic metals in the residue. In our hypothesis, the mechanism of immobilization may be explained by the following equations:

$$4CrAsO_4 \cdot 6H_2O \rightarrow 24H_2O + 2CrO_3 + 2As_2O_5$$
$$2As_2O_5 \rightarrow 2As_2O_3 + O_2$$

In the process of the chemical reaction, chromium trioxide, a highly stable compound, can be formed during pyrolysis. Also, it is possible to reduce arsenic from the arsenic pentoxide to arsenic trioxide.

We consider the landfilling of CCA-treated wood or its pyolysis residue would be an improper method. For example, arsenic trioxide in pyrolysis residue is known as one of the most toxic inorganic compound. Landfilling only postpones the collection of the toxic metals from the environment, and causes problems in the future. From the results of this experiment, it was confirmed that the CCA elements in the pyrolysis residue became highly stable against leaching. However, arsenic trioxide, formed in the pyrolysis residue, is more toxic than arsenic pentoxide. The landfilling of pyrolysis residues, because of their high toxicity, is not an acceptable solution to the problem of disposal.

To date, no workable solutions have been proposed for disposal of CCA-treated wood waste, although it is

essential that appropriate disposal technology should be developed soon. The development of a technique for purifying CCA-treated wood is needed in order to prevent the release of potential environmental pollutants and as to efficiently recycle resources as well.

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