A Novel Dismantling Process of Waste Printed Circuit Boards Using Water-soluble Ionic Liquid

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Keywords: Waste printed circuit boards; Dismantling; Water-soluble ionic liquid; Mass balance; Economic analysis;

Abstract. Recycling processes for waste printed circuit boards (WPCBs) have been well established in terms of scientific research and field pilots. However, current dismantling procedures for WPCBs have restricted the recycling process, due to their low efficiency and negative impacts on environmental and human health. This work aimed to seek an environmental-friendly dismantling process through heating with water-soluble ionic liquid to separate electronic components and tin solder from two main types of WPCBs—cathode ray tubes and computer mainframes. The work systematically investigates the influence factors, heating mechanism, and optimal parameters for opening solder connections on WPCBs during the dismantling process, and addresses its environmental performance and economic assessment. The results obtained demonstrate that the optimal temperature, retention time, and turbulence resulting from impeller rotation during the dismantling process, were 250 ┐ C, 12 min, and 45 rpm, respectively. Nearly 90% of the electronic components were separated from the WPCBs under the optimal experimental conditions. This novel process offers the possibility of large industrial-scale operations for separating electronic components and recovering tin solder, and for a more efficient and environmentally sound process for WPCBs recycling.

Introduction

Please keep a second copy of your manuscript in your office. When receiving the paper, we assume that the corresponding authors grant us the copyright to use the paper for the book or journal in question. Should authors use tables or figures from other Publications, they must ask the corresponding publishers to grant them the right to publish this material in their paper.With the development of industry and agriculture, many water bodies have been severely contaminated with heavy metals, nitrogen, phosphorus, and so on [1-2]. Consequently, many effective measures have been developed to restore contaminated water body, and sediment dredging is a typical one. Sediment dredging is an excavation activity carried out at least partly underwater, in shallow seas or fresh water areas with the purpose of gathering up contaminated bottom sediments to reduce contaminants [3].

Baihua Lake, one of the five drinking water sources for Guiyang City in China's southwestern province of Guizhou, has been seriously polluted by phosphorous, nitrogen, organic matter and heavy metals. This phenomenon has received close attention from local governments and environmental researchers.

Experimental

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Core sediment samples collection. On July 31st 2012, twelve core sediment samples were collected at sampling site GYSZ (N26°39'341", E106°31'693") with core sediment sampler equipped with mm×100 mm plexiglass pipe, as shown in Figure 1. Collected core sediment samples were cut at 10, 20 and 30 cm depths, respectively, to simulate dredging at different depths, and the remaining sediments were pushed up into a new 80 mm×100 mm plexiglass pipe. Each dredging depth was prepared for 4 samples.80

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Fig. 1 Sampling and experimental site

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Sediments dredging simulation. The prepared core sediment samples were immersed in the water body at site GYSZ for heavy metals release potential research. At site GYSZ, the water depth is about 11 m.

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Analysis of heavy metals. For analysis of heavy metals (Cd, Cr and Cu), 0.5000 g sediment samples were weighed (air dried at room temperature) accurately into a polytetrafluoroethylene tube and 3 ml of hydrogen chloride (HCL) and 2 ml of nitric acid (HNO_3) were added. The polytetrafluoroethylene tubes were put on adjustable electric heating plate and heated with low temperature for ca. 60 min.

As shown in Figure 3, the concentrations of Hg and Cd in the top 10 cm sediment samples demonstrate similar trend at all dredging levels. At initial days, concentrations of Hg in the top 10 cm sediment samples increased, and then decreased in the following days.

Table 1 Extractable concentrations of heavy metals in the top 10 cm sediment samples

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Dredging depth and simulation times (cm	Concentrations (mg/kg				
	Cu	Cd	Cr	As	Hg
10-1	1.18	0.039	0.40	0.40	0.0045
10-5	0.68	0.023	0.16	0.28	0.0041
Minimum	0.68	0.023	0.067	0.25	0.0020
Maximum	1.80	0.057	1.15	2.11	0.082

Mean	1.13	0.034	0.33	0.59	0.016

Equations. Equations (refer with: Eq. 1, Eq. 2, ...) should be indented 5 mm (0.2"). There should be one line of space above the equation and one line of space below it before the text continues. The equations have to be numbered sequentially, and the number put in parentheses at the right-hand edge of the text. Equations should be punctuated as if they were an ordinary part of the text. Punctuation appears after the equation but before the equation number, e.g.

$$c^2 = a^2 + b^2. \quad (1)$$

Conclusions

The present study revealed that Cu and Cr in sediments from the water body would possibly be potential dangerous element if sediment dredging occurred for the remediation of Baihua Lake. However, Cd and As remained in the top 10 cm sediment, after the sediment dredging was taken, may present a higher mobility than Cu, Cr and Hg based on the TCLP method.

Acknowledgment

This work was financially supported by the National Science Foundation of China (Project No.20967003), the Government of Guizhou Province (No. [2011] 8) and the Government of Guiyang City (No. [2010] 5-2).

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