TREATMENT OF PCBS CONTAMINATED SOIL USING AN INTEGRATED SYSTEM

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ABSTRACT

This research describes the full scale evaluation and testing of an integrated PCBs treatment system. Experiments were conducted on organic soil contaminated with PCBs. The result showed that a removal efficiency of 95% can be achieved using a three cycle isopropyl alcohol (IPA) extraction. It also showed that at least 80% of IPA can be recycled and reused for further extraction of PCBs. The concentrated PCB extracts can be photodechlorinated in an alkaline condition. The successful testing of this integrated PCB treatment system demonstrates this technology to be a promising solution to a very difficult problem.

Keywords: PCBs, Extraction, IPA, UV

1. BACKGROUND

PCBs are a group of nonpolar compound, consisting of a biphenyl ring bounded with one to ten chlorine atoms. PCBs have been widely used in different industrial products due to its high chemical stability, low dielectric constants, high thermal conductivity and low flammability. The extensive usage of PCBs and improper disposal of PCBs products have resulted in soil contamination world widely. Concern about adverse effects of PCBs has led to a ban on PCB production in the United States since 1979. Despite a ban on their production, a combination of high persistence, bioaccumulation potential and negative effects on humans and the environment make PCBs remain a major environmental contaminant of concern. The primary treatment technology for the remediation of PCB contaminated soils is thermal incineration (Arrtis, 2007). Other processes such as bioremediation, solvent extraction, soil washing, and stabilization were also developed to treat PCBs contaminated soils (Arrtis, 2007). Photochemical treatment methods were reported to degrade PCBs in organic solvent (Hawari et al., 1992; Izadifard et al., 2010). However, so far, except the costly thermal processes, no complete robust technology has been used to treat PCB contaminated soil.
on a large scale. In this research, a pilot scale remediation system integrating extraction and photochemical methods were tested on the PCBs contaminated organic soil.

2. PCB MOBILE TREATMENT SYSTEM

A pilot scale integrated PCB treatment system has been developed at University of Calgary. It is housed in a 45-feet trailer fitted with a paddle mixer, a hydrocyclone, a bag house filter, a solvent recycler, and a UV reactor. PCBs in the contaminated soil can be extracted with IPA in the paddle mixer. Following extraction, the treated soil is removed from the IPA using a multistage process. Separation is accomplished using a hydrocyclone, followed by a bag filter. The resulting treated soil is then distilled to concentrate, while the distillate is reused for further extraction. Finally, sodium hydroxide is added to the concentrated IPA/PCB mixture, which is then treated in a UV reactor to achieve dechlorination of PCBs.

3. MODIFICATION AND TEST OF TREATMENT SYSTEM

During the pilot test of this system, site conditions necessitated certain modification of the original modules, although the processes involved remained unchanged. A volume of soil appropriate to demonstrate the technology was treated. Soil from a test site was pretreated by hand sieving to remove large pieces of organic matter followed by drying under ambient conditions. Modifications to the system consisted of utilizing a mixing container (90L) that was fitted into the system in place of the large mechanical mixer. Thorough mixing was accomplished using a pump to mix the IPA/soil mixture through turbulent action. For each extraction cycle, one pail (20L) of soil (containing 16 ppm of PCBs) was tested; the volume ratio between IPA and soil was set to be 3:1 and the mixing time was set for one hour. After mixing, most of soil particulates were removed from the IPA through settling for 3 hours. Following settling, the IPA was further cleaned by passing it through one micron bag filters. The cleaned IPA was then distilled using a commercial solvent recycler, with about 80% of IPA being recycled for reuse. The distillate bottom containing concentrated PCBs was made alkaline by adding 0.1N NaOH and then passed through to a UV reactor for dechlorination. PCB analysis was conducted both at University of Calgary and Maxxam Labs.

4. FINDINGS

The integrated PCB remediation system was found to successfully treat PCB contaminated organic soil. The results are shown in Figure 1. Figure 1(a) showed that around 95% of PCBs can be extracted from organic soil with three-cycle IPA extraction. One-cycle IPA extraction can approximately extract 45% of PCBs from organic soil. As the number of extraction cycle increased, the overall extraction efficiency increased. Figure 2(b) showed that the extracted PCBs in IPA can be dechlorinated with UV in presence of sodium hydroxide. More than 50% of PCBs can be dechlorinated within 5 hours of UV irradiation.

![Figure 1(a) PCBs extraction](image1.jpg)  
![Figure 1(b) PCBs photodechlorination](image2.jpg)  

Figure 1. (a) PCBs extraction; (b) PCBs photodechlorination
REFERENCES


Izadifard Maryam, 2010. Direct and Sensitized Dechlorination of polychlorinated Biphenyls (PCBs), PhD thesis, University of Calgary