Remediation of Polychlorinated Biphenyls (PCBs) contaminated soils using ultrasonic washing process

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1. Introduction

Polychlorinated Biphenyls (PCBs) are widely used in the industrial field insulator and synthesized from the diphenyl by changing hydrogen to chloride. Although it is a convenient material that is widely used, remediation process is essential when it is released into nature(like air, water, and soils). Recently, researches are underway to remediate soil contaminated with PCBs. [1)]

Ultrasounic process is one of the methods to treat hazardous materials in the soil through soil washing process. The contaminated soils with heavy metals, such as Zn, Cu, and Pb, were remediated by applying US/Mixing process in acid.[2)] To extract organic pollutants like PCBs, it is useful to apply organic solvents rather than water.

In this research, focus on removal of two kinds of PCBs in the soil samples using the 28 kHz double-bath type ultrasonic system. Moreover, aluminum foil test was conducted to analyze the sonophysical effect for removing PCBs in the soil.

2. Materials and Methods

Methanol (99.9%, HPLC grade) and n-hexane (95.0%, HPLC grade) were acquired from Samchun Chemials Co., Ltd. (KOR). Aroclor 1242 (1,000 μg/mL), Aroclor 1254 (1,000 μg/mL), and Aroclor 1260 (1,000 μg/mL) were purchased acquired from Dr. EhrenstorferTM (UK). All chemicals were used as received.

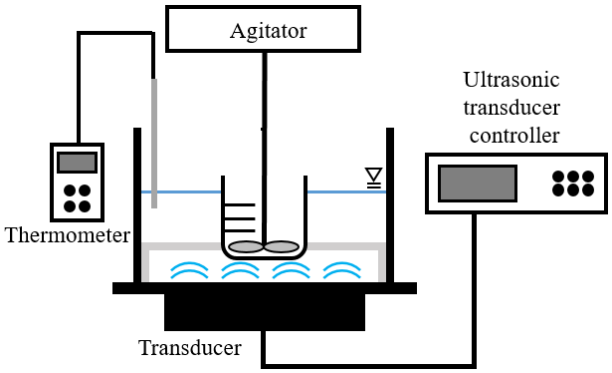

Fig. 1 Schematic of the double-bath type ultrasonic system

A schematic of the double-bath-type ultrasonic system used in this study is shown in **Fig. 1.** It consisted of a rectangular acrylic sonoreactor (L × W × H: 25 cm × 25 cm × 21 cm) equipped with a 28 kHz ultrasonic transducer module (Mirae Ultrasonic Tech., KOR), an acrylic support plate with a circular hole at the center, and a 500 mL circular glass vessel, which was submerged in the sonoreactor. The transducer module included nine transducers and the working power was 480 W. The calorimetic power was calculated. The sonoreactor was filled with 4 L of water. An overhead stirrer with a Teflon coated blade was applied for violent mixing in the vessel. The mixing rate was 100 rpm. The initial concentrations of the polluted soil samples are 2.5 mg/L(sample 1) and 0.8 mg/L(sample 2). The soil:liquid ratio are 1:5(20g: 100g), 1:10(20g: 200g), and methanol and hexane were used in ultrasonic soil washing process.

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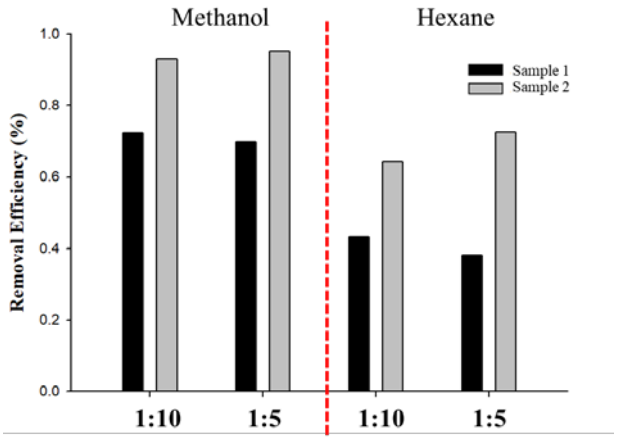

Fig. 2 Removal Efficiencies under various experimental conditions

The aluminum foil test is performed by fixing the foil in an acrylic frame(8 cm × 14 cm). The thickness of aluminum foil is 15μm.[3)]

3. Results and Discussions

The results of remediation for PCBs contaminated soils using ultrasounic process are shown in **Fig. 2.** There is no big difference depending on the solid:liquid ratio, but methanol is more effective in removing PCBs than hexane. Methanol and hexane show a difference in the presence or absence of polarity. One of the reasons why methanol is so better than hexane is that the soil samples contain a large number of polar PCBs.

The alumina foil test was conducted as shown in **Fig. 3.** In the aluminum foil test, pits on the foil are created by the sonophysical effect generated by ultrasonic cavitation. It is confirmed that the sonophysical effect is significant reduction in the organic solvent than that of water. The physical effect of methanol is greater than that of hexane.

The values of calorimetric power are 11W, 10W, and 8W according to the methanol, hexane, and water, respectively, with solid:liquid ratio of

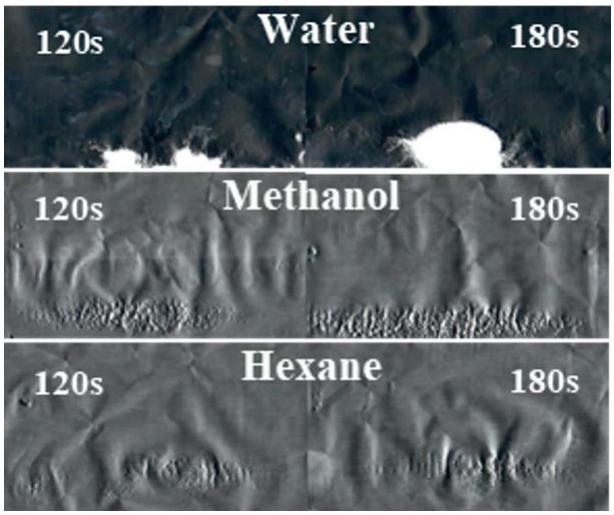

Fig. 3 The damaged aluminum foils caused by sonophysical effects for different solutions in the sonoreactor

1:10. In the solid:liquid ratio of 1:5, the values of calorimetric power are 6.6W, 5.1W, and 3.1W according to the same order with the ratio of 1:10. The values of organic solvents' calorimetric power are larger than the value of water's calorimetric power, but the difference is not significant.

Acknowledgment

This work was supported by National Research Foundation (NRF) of Korea (No. NRF-2021R1A2C1005470) and by the Korea Ministry of Environment (MOE) as "SEM (Subsurface Environment Management)" Program (project No. 2021002470001).

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