STABILITY OF HEAVY METALS (Cd, Pb and Zn) IN CONTAMINATED SOIL UPON TREATMENT WITH CALCINED CLAM SHELL

Mohammad Nazrul Islam, Xuan Phuc Nguyen, Young-Tae Jo, Yeon-Jae Jeong, Jeong-Hun Park

Department of Environmental and Energy Engineering, Chonnam National University, Gwangju 500-757, Republic of Korea

mnazrul09@yahoo.com

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Introduction

Mining is one of the most important sources of heavy metal contamination to the environment (Ok et al., 2011). Due to decreasing availability or demand, the abandoned mines have become a releasing source of heavy metals such as Cd, Pb, and Zn into nearby agricultural soils (Abd El-Azeem et al., 2013). Stabilization of metal(loid)s by addition of waste resources to the soil could be consider a potentially cost effective and reliable means of in situ remediation. Numerous amendments including liming and phosphate materials have been examined for reducing metal mobility and availability in the recent past years (Ahmad et al., 2012; Cao et al., 2003; Moon et al., 2013).

Liming materials which raise the soil pH have been commonly used to stabilize the heavy metals, such Pb and Zn. The aim of this study was to examine the effectiveness of reducing the leaching of heavy metals using calcined clam shell (CCS).

Methods

The contaminated soil was collected from a mine tailing located in Jecheon, Republic of Korea. The collected soil was air dried and passed through a #20 mesh (< 1 mm) to remove large particles and gravel. The soil taxonomy was sandy loam and the soil pH was 7.6. Based on Korean and other international standard, the soil was extremely contaminated by Cd (140 mg/kg), Pb (22,142 mg/kg) and Zn (51,675 mg/kg).

Waste clam shells were collected from a local market and were washed several times with hot water, then subsequently dried at 100 ºC for 72 h and ground to pass through 1-mm sieve. Portion of clam shell powders were calcined at 900 ºC for 4 h in a furnace. The prepared amendment was then mixed with 50 g of the air-dried contaminated soil in a sealed plastic container at 0% (control), 5, 10 and 15% by weight. The soil was incubated for 7 days, after which the air-dried treated soil samples were subjected to Korean Standard Leaching Test (KSLT). 10 g of each soil sample was reacted with 50 mL of 0.1 N HCl by shaking at 100 rpm for 1 h. The suspension was then analyzed for Cd, Pb and Zn concentration using ICP-OES (Perkin Elmer 5300 DV, USA). All batch experiments were performed triplicate, and an average values were reported.

Results and Discussion

It is well known that the soil pH is the main factor for soil chemical processes. It was noted that soil pH increased significantly from 7.6 in the control soil to 12.01, 12.16 and 12.25 in the treated soil with 5, 10 and 15% CCS, respectively. The increase in soil pH caused by additive can be explained by the presence of CaO as it was the dominant compound (96%) in the CCS. The treatment results obtained based on KSLT are presented in Figure 1. Even though a high concentration of each metal in leachate was observed in the control soil, the treatment with CCS was very effective in reducing the Cd, Pb and Zn leachability.

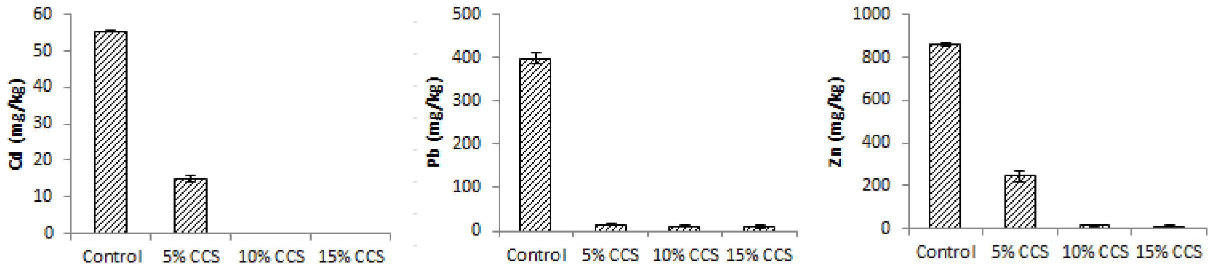

Figure 1. Heavy metal leaching upon CCS treatment after 7 days of curing.

The increased soil pH might be responsible for decreasing extractability of Cd as a result of its precipitation a carbonate or hydroxide. Additionally, the result of SEM-EDX indicated Pb associated with Al, Si and Ca in the soil amended with CCS (Figure 2), the formation of calcium-silicate-hydrate might be responsible for reducing Pb extractability.

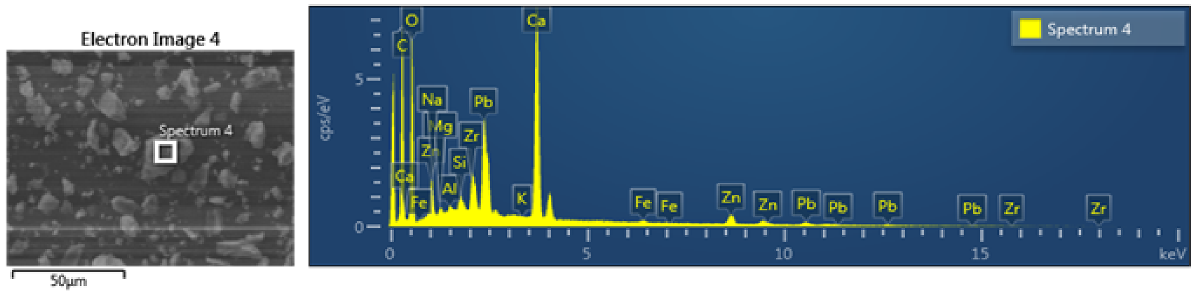

Figure 2. SEM-EDX analyses of the treated soil (15% CCS).

Conclusion

In this study, Cd, Pb and Zn contaminated soil was stabilized with CCS. The effectiveness of stabilization was evaluated by 0.1 N HCl extraction. The treatment results showed that each of metal leachability was significantly reduced (up to 97%) upon treatment. Overall, CCS proved in the immobilization of heavy metals in the contaminated soil, very likely due to its CaO content.

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