Performance of immobilization materials against lead and arsenic contaminated soils

Juan Carlos Bobea Rivas

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1. INTRODUCTION

Stabilization and/or immobilization technique is effective for heavy metal contamination to reduce their solubility, mobility or toxicity through a chemical reaction. Chemical admixtures most commonly cement, lime, magnesium oxide, ferrous sulfate and others, have been widely used to stabilize contaminants in soils and wastes as well as to improve soils strength and durability. The aim of this study is to test the immobilization performance of various materials, such as Slag Cement, Magnesium Oxide (MgO), Ferrous Sulphate ($FeSO_4$) and Magical Fix (MFX) which is a novel stabilization material, and to understand the mechanism involved in the immobilization processes. MFX is a novel and proprietary immobilization material designed specifically to address heavy metals contamination issues, which utilizes a solid-phase chemical stabilization process to reduce the leachability of heavy metals.

2. EXPERIMENTAL METHODOLOGIES

Artificial contaminated soil with arsenic (As) and lead (Pb) were used in this study. The immobilization performance was evaluated through batch leaching tests following the Japanese Leaching Test, JLT-46. BCR sequential extraction tests were also conducted to fractionate the immobilized metals; acid soluble, reducible, oxidisable, or residual fractions. Besides, a series of column tests and sorption tests were also done to evaluate the immobilization performance for simulating actual application. Solid samples collected from the sorption test were analyzed using Scanning Electron Microscopy (SEM), Energy Dispersive Spectrometry (EDS) and X-Ray Diffraction (XRD) to estimate the immobilization mechanism by MFX.

3. RESULTS AND DISCUSSIONS

From the JLT-46 tests, the results showed that the immobilization of Pb and As is affected by initial concentration, amount of immobilization material added and contact time as shown in Figure 1. In the case of Pb, MFX compares favorably to cement. In addition, MFX and MgO have higher immobilization performance for As, but MFX maintained a lower pH than MgO and Cement. From BCR sequential extraction tests, it was determined that great amounts of heavy metals exist as acid soluble fractions in $FeSO_4$ addition case. A great amount of reducible fractions was also observed in $FeSO_4$ addition case, and for the oxidisable fractions it was observed that MFX, cement and MgO were predominant. In the hydroxide process, an alkaline lead hydroxide and an alkaline calcium arsenate is obtained after addition of MFX, as the hydroxides are insoluble, they precipitate (Figure 2).

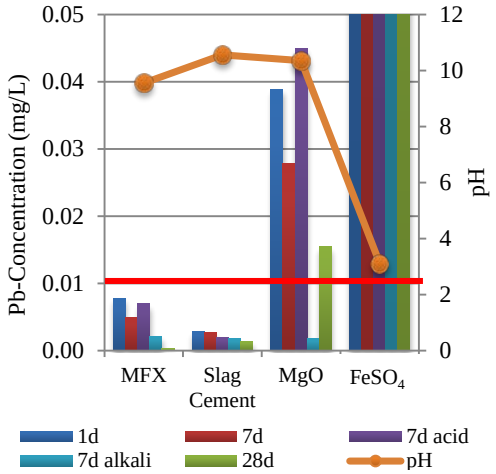

Figure 1. Result of batch leaching tests (Pb)

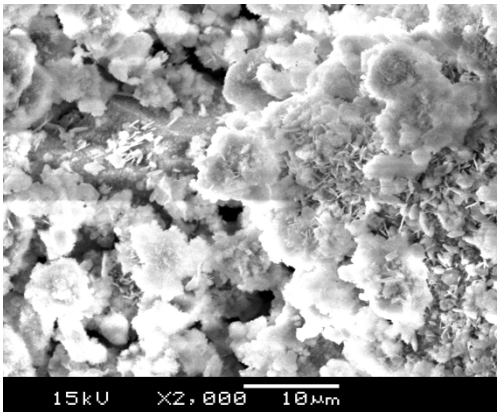

Figure 2. Result of SEM-EDS analysis (Pb)

4. CONLUSIONS

From experiments, MFX proved to be effective to immobilize both of As and Pb below the Japanese standard (0.01mg/L), and fractionation of immobilized metal was implemented for each materials addition. Besides, the possible mechanism of immobilization by MFX addition is precipitation, chemisorption and inclusion.