Pozzolanic-based Stabilization/Solidification of Lead Contaminated Firing Range Soils

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Abstract

Pozzolanic stabilization/solidification (S/S) using cement, lime and other cementitious materials is considered the most cost-effective remediation method for heavy metal contaminated solid media. In this study, the effectiveness of pozzolanic (S/S) treatment of two firing range lead (Pb) contaminated soils was evaluated by toxicity characteristic leaching procedure (TCLP) tests. X-ray powder diffraction (XRPD), Scanning Electron Microscope (SEM) and Electron Microprobe Analysis (EMPA) spectroscopy were also employed to investigate Pb immobilization mechanisms for the treated soils. Portland cement, quicklime and fly ash cementitous (S/S) agents were added to immobilize lead (Pb) found in berm (backstop) soils from both sites. Pb leachability was found to be highly influenced by Pb speciation in the soils. Soil buffering capacity, metal oxide, hydroxides and clay content were also found to affect Pb leachability. XRPD and SEM analyses determined that Pb was primarily incorporated within clay, Fe-Mn oxides and aluminum hydroxides in the untreated Goldstone (Mojave Desert, California) firing range soil. The leaching results showed that pozzolanic treatment was effective for this soil. The optimum addition of quicklime and Portland cement was 7.5% by weight percentage. Pb leachability decreased with elapsed time after treatment due to the apparent interplay with the soils' buffering capacity. Pb appeared to be immobilized by microencapsulation in and/or sorption onto pozzolanic reaction products in the treated Goldstone soil. The pozzolanic reaction products observed were calcium silicate hydrate (C-S-H) gels and/or ettringite ([Ca3Al(OH)6]2(SO4)3.26H2O) during pozzolanic treatment. Since Goldstone soils were clayey soils, silicates and aluminums would release out by high alkalinity attack and form more pozzolanic products to enhance the immobilization efficiency Leaching test of Pb spiked synthesized CSH confirmed the high immobilization capability of pozzolanic products. Based on our studies, cementitou S/S treatment works for

clayey soils. Since pozzolanc products are unstable under acidic condition, investigation of long term effectiveness of cementitous S/S treated clayey soils are strong recommended to be performed, including the strength of the stabilized material and Pb leachability.