Efficiency and mechanism of lead stabilization in soil of lead-acid battery contaminated site with phosphorus-based materials

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Lead contaminated soils occurred at lead-acid battery manufacturing and recycling sites are of great concern. Bench-scale batch experiments of stabilization treatment were conducted using twelve materials and three phosphorus-based materials, KH$_2$PO$_4$ (KP), KH$_2$PO$_4$:oyster shell power = 1:1 (by mass ratio; KSP), and KH$_2$PO$_4$:sintered magnesia = 1:1(by mass ratio; KPM), were screened out for lead contaminated soil in an abandoned lead-acid battery factory site. The three materials had higher remediation efficiencies that led to a 92% reduction in leachable Pb and 12% reduction in bioaccessible Pb with the addition of 5% material, while the acid soluble fraction of lead decreased by 41–46%. The lead activity in the soil solution sharply decreased treated by three materials. Pb$_5$(PO$_4$)$_3$Cl was the primary mineral controlling lead solubility in soil treated by KP and KSP and lead activity was related to Pb$_5$(PO$_4$)$_3$OH and Pb$_5$(PO$_4$)$_3$Cl in soil amended with KPM.