The effect of portland cement for solidification of soils contaminated by mine tailings containing heavy metals

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Portland cement (PC) was used to solidify the lead-zinc mine tailings contaminated soils (CS) in this work. The soils were heavily polluted by heavy metals with lead (up to 19592 mg/kg), zinc (up to 647 mg/kg), Cd (up to 14.65 mg/kg) and Cu (up to 287 mg/kg). Solidified/stabilized (s/s) forms with a range of cement contents, 40–90 wt%, were evaluated to determine the optimal binder content. Unconfined compression strength test (UCS), Chinese solid waste-extraction procedure for leaching toxicity - Horizontal vibration method, toxicity characteristic leaching procedures (TCLP) were used for physical and chemical characterization of the s/s forms. The procedure of Tessier et al. (1979) was used to separate S/S forms Pb, Zn, Cd, Cu into different fractions. The results show that addition of 50% cement was enough for the s/s forms to satisfy the MU10 requirements (0.10 MPa). Under the 50% addition, the content of the water-exchangeable fraction of Pb reduced from 2.25% to 0.2%, the carbonate-bound fraction and organic-bound fraction reduced by about half, while the Fe-Mn oxide-bound fraction was more than doubled. The residual fraction decreased 8% on the contrary. For Zn, except for the carbonate-bound fraction increased slightly, the features of other items were same as that of Pb. For Cd, the water-exchangeable fraction was reduced largely, the residual fraction and Fe-Mn oxide-bound fraction increased 2-3%. For Cu, A distinct feature is the organic-bound fraction reduced with the reduction in consumption of cement, at the same time, the residual fraction increased corresponding. Leaching test results indicate that the leaching contents of Pb^{2+} of the six specimens are quite different at low pH value (<4.2). The TCLP leaching content gradually increase with the decrease of the ratio of PC to CS. The addition of 60% cement remarkably reduced the leachability of Pb^{2+} in S/S forms in the vicinity of the neutral range. However, the leaching rate can reach to 0.70% at the pH1.4. The discussions were made for determination of optimal binder content and for evaluation of the environmental dangers of the S/S forms.