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Selective separation of cesium contaminated clays from pristine clays by flotation

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Abstract

The ongoing boom of industrialization is conflicted by concerns regarding increased levels of environmental contamination, in particular the uncontrolled release of heavy metal ions and radionuclides into soils and groundwater systems. The extent of contamination can be substantial, hence ways to remediate and reduce the volume of waste for further treatment and ultimate disposal are highly desired. In the current study, flotation has been considered as an engineering solution to rapidly separate cesium contaminated clays from low-level contaminated and pristine clays. Cesium (Cs^+) sorption by montmorillonite clay particles was considered over a range of ionic concentrations (0.01 to 500 mM), showing a multistage sorption isotherm that can be interpreted using a two-site model, which considers both interlayer ion-exchange and specific ion sorption on the clay basal planes at higher cesium concentrations. Assessment by X-ray photoelectron spectroscopy (XPS) and zeta potential confirmed the increased surface contamination with increasing Cs^+ concentration, with the surface enrichment sufficiently altering the surface chemistry of the contaminated clays for them to favourably interact with the flotation collector, ethylhexadecyldimethyl-ammonium-bromide (EDAB). Within a critical concentration range of EDAB, the cesium contaminated clays were separated from pristine clays using flotation, with recovery efficiencies of ~75% for the contaminated clays, compared to less than 25% for the pristine clays. When contaminated and pristine clays were blended, separation by flotation once again demonstrated excellent selectivity for the contaminated clays. The current study highlights the potential for flotation to rapidly treat contaminated clay rich soils and significantly reduce the volume of contaminated solids for further treatment or ultimate disposal.

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