

Adsorption of Pb(II), EDTA, and Pb(II)-EDTA onto TiO₂

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Abstract: The adsorption of aqueous Pb(II), EDTA, and Pb(II)-EDTA complexes onto TiO₂ were studied at both stoichiometric and nonstoichiometric Pb(II)/EDTA concentrations. For Pb(II)-TiO₂ and EDTA-TiO₂, a typical cationic and anionic-type of adsorption was noted, respectively. For 10⁻³ and 10⁻⁴ M Pb(II)-EDTA systems, near-equal adsorption of Pb(II) and EDTA indicated that the complex adsorbs as a single species. Also, a ligand-type Pb(II)EDTA adsorption, i.e., decreasing adsorption with an increase in the pH, was noted. Systems with EDTA greater than Pb(II) showed near-zero lead removal; competitive adsorption of EDTA and Pb(II)-EDTA onto TiO₂ was suggested to cause this effect. For Pb(II) concentrations (5 x 10⁻⁴ and 10⁻³ M) higher than EDTA (10⁻⁴ M), significantly higher EDTA adsorption at high pH as compared to individual 10⁻⁴ M EDTA and 10⁻⁴ M Pb(II)EDTA systems was noted. Adsorption modeling was completed employing the geochemical speciation model MINTEQA2 employing the diffuse layer model. Inner-sphere complexation was considered to occur between Pb(II), EDTA, Pb(II)-EDTA, and the TiO₂ surface sites. Surface complexes used in the modeling included Ti-O-Pb⁺, Ti-EDTAH₂⁻, Ti-EDTA-Pb⁻, and Ti-O-Pb-EDTA₃⁻. The cationic-type complexation, Ti-O-Pb-EDTA₃⁻, was postulated to explain and model the anomalous EDTA adsorption as noted for Pb(II) > EDTA studies. Results from the present study show that the adsorption behavior in aqueous metal/EDTA systems will change with any variation in the contaminant concentration ratios.