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

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Journal of Colloid and Interface Science
Vol. 194, Issue.1, 1997

Abstract: Nitrilotriacetic acid (NTA) is extensively used in different industries because of its excellent chelating properties. Introduction of NTA into the natural environment is a concern because of mobilization of heavy metal species that may be otherwise bound to natural particulate matter. The present study investigates the adsorption behavior of Pb(II) and NTA, both as individual species and as complex species onto titanium dioxide. This adsorption information is important in considering the TiO2-assisted photocatalytic treatment of these metal-organic complexes. Pb(II) shows a typical cationic type of adsorption behavior, whereas NTA demonstrates an anionic type of adsorption trend. Results from stoichiometric ternary systems show a gradual increase in Pb(II) adsorption and a decrease in NTA removal with an increase in pH. However, for the cases of Pb(II) > NTA, increased NTA adsorption as compared to pure NTA systems was noted even at higher pH. Model predictions employing MINTEQA2 software followed the experimental trends. Experimental and model results from ternary systems suggest adsorption of free Pb(II) and NTA, as well as ternary Ti-NTA-Pb(II) and Ti-O-Pb(II)-NTA2- species. The cationic-type complexation, i.e., Ti-O-Pb(II)-NTA2-, was essential for the successful NTA adsorption modeling, especially at higher pH and for Pb > NTA systems, where significant NTA adsorption was noted even at very high pH values. Most of the previous metal-ligand adsorption studies did not consider such a surface complexation. However, the present results indicate that any groundwater transport modeling of such pollutants will require the inclusion of cationic-type surface complexation, in addition to other surface species.