
Modeling Boron Adsorption on Kaolinite

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Abstract: Boron adsorption at constant ionic strength [0.09 ± 0.01 moles/liter of KClO_4 or $\text{Ca}(\text{ClO}_4)_2$] on 0.2– 2 μm clay fraction of pretreated kaolinite was modeled using both phenomenological equations and surface complexation reactions. Phenomenological equations were expressed as linear relationships between the distribution coefficient and adsorption density or equilibrium concentration. The normalized form of the isotherms allowed the distribution coefficient to be predicted over a wide range of adsorption densities or equilibrium concentrations and pH. The Langmuir isotherm revealed a weak two-part linear trend supported by a similar behavior of the van Bemmelen-Freundlich isotherm. Potential adsorption mechanisms were assessed from these isotherms. The bases for the inner-sphere (surface coordination) and outer-sphere (ion-pair) surface reactions were postulated, and equations were developed and incorporated into the generalized triple-layer surface-complexation model [TL(g)-SCM]. Boron adsorption was best modeled using the inner-sphere complexes. The results confirm that the generalized triple-layer surface-complexation model can provide information regarding plausible reactions at the substrate/aqueous interface. Intrinsic constants for postulated surface reactions were derived as fitting parameters over a range of pH and initial boron concentrations.

Key Words: Adsorption • Boron • Ion-pair • Ion-speciation • Kaolinite • Surface complexation • Triple-layer model

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