

Thermodynamic Parameters on the Sorption of Phosphate Ions by Montmorillonite

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ABSTRACT

The sorption of phosphate by montmorillonite at 10, 30, and 50°C was investigated aiming to mainly determine thermodynamic parameters for the formation of surface complexes in the adsorption of phosphate ions by montmorillonite. Data were collected by adsorption edge experiments investigating the effect of pH, adsorption isotherms enabling the effect of sorbate concentration, and acid-base titration calculating protons released or taken up by adsorption process. Data analysis was carried out using surface complexation model to fit the data collected in this study using the parameters obtained from previous study, as well as to calculate the values of ΔH and ΔS . Previous study reported that phosphate ions formed two outer-sphere surface complexes with active sites of montmorillonite through hydrogen bonding. In the first complex, $[(XH)^0 - H_2L^-]$, the phosphate was held to permanent-charge X^- sites on the tetrahedral siloxane faces, and the second complex, $[(SO^-(SOH))^- - [H_2L]^-]^2$ was formed through the interaction between the phosphate and variable charge surface hydroxyl groups at the edges of montmorillonite crystals and on the octahedral alumina faces. The values of ΔH for the first and second reactions are 39.756 and 3.765×10^{-7} kJ mol⁻¹ respectively. Since both reactions have positive enthalpy values, it can be concluded that the reactions are endothermic. Large energy for the first reaction is needed by X^- sites (permanent negatively charge sites of montmorillonite) to be partially desolvated, on which K^+ or other surface cations are replaced by H^+ ions in the surface protonated process, and are then ready to interact phosphate ions in the solution. Small values of ΔH for the second reactions indicates that hydrogen bonds formed by phosphate and SOH sites in the second reaction are easily broken out, and the phosphate can easily desorbed from the surface. The values of ΔS for the first and second reactions are 122.523 dan 2.393×10^{-2} J K⁻¹ mol⁻¹, which are greater than -10 kJ mol⁻¹ and indicates that the surface reactions occurs through dissociative mechanisms.

Keywords: *temperature, adsorption, extended constant capacitance surface complexation model (ECCM), enthalpy, reaction mechanisms.*