
Interactions of Citric Acid and Synthetic Hydroxy-Aluminum Montmorillonite

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Abstract: Hydroxy-Al-montmorillonite was prepared by mixing Na-Wyoming montmorillonite with $\text{Al}(\text{OH})_{2.5}$ polycations and aging the mixture for 10 days. The reactions of this complex with citric acid at millimolar concentrations were investigated at different pHs for a 4-hr reaction time. The citrate sorption data, X-ray powder diffraction patterns of the montmorillonite adsorbent, and solubility products for $\text{Al}(\text{OH})_3$, estimated after computer speciation of the aqueous solution phase, suggested two reaction mechanisms, depending on pH. At $4 < \text{pH} < 5.5$, the complex was stable, and only external hydroxy-Al polycations could react with citrate, yielding a sorption envelope characteristic of an acid having a low pK_a . At higher pH, and particularly at $\text{pH} > 7$, the interlayer Al-polymers became accessible to the ligand and desorbed quickly from the montmorillonite basal planes to form a new, external, X-ray-amorphous solid phase with citrate. This reaction produced a large second peak in the sorption envelopes near pH 8, which was controlled by the increasingly negative surface charge at high pH and by the initial concentration of citric acid. This ligand accelerated, i.e., favored kinetically, the dissociation of adsorbed hydroxy-Al polymers from moutmorillonite at $\text{pH} > 7$.

Key Words: Adsorption • Citric acid • Hydroxy-Al • Montmorillonite • X-ray powder diffraction

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