
Effects of Temperature on the Sorption of Lanthanides by Montmorillonite

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Abstract: The diffusion of exchanged Yb, Ho, and Eu from interlayer positions in montmorillonite was studied using infrared spectroscopy (IR), X-ray powder diffraction, and cation-exchange measurements. Dehydration of exchanged montmorillonite between 100° and 280° C caused the ions to diffuse into the hexagonal rings of surface oxygens. Subsequent migration into vacant octahedral sites was small regardless of the radius of the cation. Considerable ion fixation in excess of the cation-exchange capacity of the clay was observed at 20° C in both water and a 1:1 water:95% ethanol mixture. Evidence for hydrolysis as a possible mechanism for cation fixation was obtained by observing frequency shifts for deuterated hydroxyl groups using IR spectroscopy. A major IR band centered at 2680 cm⁻¹ was observed for all three lanthanide-exchanged montmorillonites studied and assigned to the OH-stretching frequency of a lanthanide hydroxide. This band intensified on heating at 300° C for 1 hr. An IR band between 690 and 710 cm⁻¹ also was observed for all three lanthanide-exchanged montmorillonites and was assigned to a lanthanide-hydroxyl deformation mode. No hydrolysis was observed for Na-montmorillonite, as expected from the very low hydration energy of Na⁺.

Key Words: Adsorption • Cation exchange • Hydrolysis • Infrared spectroscopy • Lanthanides • Montmorillonite • X-ray powder diffraction

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