Electrical Conductivity of Na/Ca-Montmorillonite Gels

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Abstract: The specific conductivity, κ_g, of Na ° Ca montmorillonite gels (0.02 and 0.04 g clay/cm^3) as a function of the specific conductivity of the interclay solution, κ_w, was measured. For low values of κ_w (<3 mmho/cm) the conductivity curves were convex with respect to κ_w; at higher values they were linear. The κ_w at which deviation from linearity began increased with increasing sodium content from 0.7 mmho/cm for the Ca-montmorillonite gel to 2.6 mmho/cm for Na-montmorillonite gel. The intercept of the linear portion of the conductivity curve increased and its slope decreased with increasing exchangeable sodium.

The experimental results were described by a conductance model comprised of two elements connected in parallel: an element consisting of the solid and solution phases connected in series, and another consisting of the solution phase. At low electrolyte concentrations, the first element accounts for the curvature of the κ_g-κ_w curve, whereas at high electrolyte concentrations, the second element dominates, and the curve is linear with a slope determined by a formation factor and an intercept determined by exchangeable cation mobility.

An adjustable parameter in the conductivity term for the first element, which accounts for the thickness of the clay particles, increased with exchangeable Na, and its numerical value indicated that the solid phase also includes the diffuse double layer. The mobility of the exchangeable cation relative to that in water increased from 4% for Ca to 41% for Na with the largest increase occurring between 20 and 40% exchangeable Na. Similar effects of exchangeable Na were evident on the axial ratio of the clay particles calculated from the slopes of the linear lines. These observations are consistent with an exchangeable-ion demixing model where the initial exchangeable Na is adsorbed on the external surfaces of the Ca-montmorillonite tactoids without affecting exchangeable ion mobility or tactoid size. Further additions of exchangeable Na result in Na adsorption on the internal surfaces of the tactoid and tactoid breakdown with a subsequent increase in both exchangeable ion mobility and the axial ratio of the clay particles.

Key Words: Cation mobility • Electrical conductivity • Electrolyte • Montmorillonite

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