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Spectral induced polarization of Na-montmorillonite dispersions

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Abstract

Montmorillonite (Mt) clays have a high specific surface area and surface charge, which confer them remarkable adsorption properties. Nevertheless, their electrochemical and aggregation behavior are not completely elucidated because of the complexity of their microstructural and interfacial properties. In this work, the conductive and dispersive properties of Na-Mt suspensions of weight fractions 0.5 to 5.2% were investigated for the first time using the spectral induced polarization method. A four-electrode system was used to reduce errors introduced by electrode polarization and contact resistances. Complex conductivity spectra in the low-frequency range of 0.1 Hz to 45 kHz were successfully described using a triple layer model of the basal surface of Mt and a complex conductivity model that considers conduction of the diffuse layer and polarization of the Stern layer. Aggregate size distributions were inferred from inverted relaxation time distributions. We found that the negative and permanent surface charge of the basal plane of Na-Mt controls its quadrature (imaginary) conductivity, which is not very sensitive to pH and salinity (NaCl) in the 100 Hz to 45 kHz frequency range. For lower frequencies, the sudden increase of the quadrature conductivity at the highest salinities was explained by considering coagulation of Na-Mt particles.

Keywords: Na-montmorillonite, dispersions, spectral induced polarization, conductivity, dielectric permittivity, basal plane, surface charge, Stern layer, diffuse layer.