Low Frequency Conductivity Dispersion in Clay-Water-Electrolyte Systems

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Abstract: The electrical conductivity of a colloid-water-electrolyte system increases with the frequency of the applied alternating electric current. The phenomenon is referred to as conductivity dispersion. This paper reports on the effects of electrolyte type, electrolyte concentration, and water content on the dispersion characteristics of kaolinite, illite, and silty clay soils, with emphasis on the mechanisms governing the dispersion phenomenon. It was observed that magnitude of conductivity dispersion increases with a reduction in water content, electrolyte concentration, and cation-exchange capacity of the clay. The type of ions influence the electrical dispersion through their size and mobility. Frequency effect increases as the hydrated radius of the counterions associated with the clay surface increases. Conductivity dispersion is explained primarily in terms of counterion/co-ion ratio in the diffuse double layer. Increase in the ratio of counterions to co-ions is an indication of a larger contribution to conduction by counterions than by co-ions, which in turn results in a larger frequency effect. Although diffusion coupling has an important role in the electrical dispersion characteristics of clay—water—electrolyte systems, other coupling phenomena, particularly electro-osmotic coupling, plays a significant part.

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