

---

# Rheology of Na-Rich Montmorillonite Suspension as Affected by Electrolyte Concentration and Shear Rate

Hadar Heller and Rami Keren

Institute of Soil, Water and Environmental Sciences, The Volcani Center, Agriculture Research Organization (ARO), P.O. Box 6, Bet Dagan 50250, Israel

E-mail of corresponding author: [rkeren@volcani.agri.gov.il](mailto:rkeren@volcani.agri.gov.il)

**Abstract:** Rheological measurements were used to evaluate the particle-particle associations of Na-rich montmorillonite in suspensions, under various electrolyte concentrations. A 2% free electrolyte clay suspension showed pseudoplastic flow behavior and had a high apparent viscosity, attributed at low shear rates to the high volume fraction of the suspended clay platelets, the flexibility of the platelets, and the presence of edge-to-edge association. The breaking of edge-to-edge associations and the progressive orientation of the individual platelets in the direction of flow contribute to the reduction in viscosity with increasing shear rate.

The compression of the diffuse double layer at a NaCl concentration of  $10 \text{ mEq L}^{-1}$  contributes to the free movement of the individual platelets, even at low shear rates. The flow behavior changed from pseudoplastic to plastic at an NaCl concentration of  $100 \text{ mEq L}^{-1}$ . At this electrolyte concentration, face-to-face associations of specific junction points at certain areas of the planar surface are probably occurring.

The apparent viscosity of the clay suspension for the two particle-size ranges ( $<2$  and  $<0.02 \mu\text{m}$ ) at all shear rates converged to a minimum value of  $4.5 \text{ mPa s}$  at NaCl concentrations of  $10\text{--}20 \text{ mEq L}^{-1}$ . On both sides of the minimum, the lower the shear rate, the greater the slope. The apparent viscosity of a 2% suspension of Na-rich montmorillonite  $<0.02 \mu\text{m}$  particles, however, was significantly greater than that observed for a suspension of  $<2 \mu\text{m}$  particles. This high apparent viscosity is attributed to the increase in edge surface area and the number of clay particles in a unit volume.

We suggest that edge-to-edge association between Na-rich montmorillonite platelets prevails when the NaCl concentration is below the electrolyte critical concentration, for which the apparent viscosity of the suspension is at its minimum value, whereas face-to-face association prevails at NaCl concentrations above this critical value.

**Key Words:** Clay-particle Interaction • Clay-suspension Viscosity • Na-rich Montmorillonite

*Clays and Clay Minerals*; August 2001 v. 49; no. 4; p. 286-291; DOI: [10.1346/CCMN.2001.0490402](https://doi.org/10.1346/CCMN.2001.0490402)

© 2001, The Clay Minerals Society

Clay Minerals Society ([www.clays.org](http://www.clays.org))

---