Arrest vs. Collapse of Clay suspensions

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Natural clays are widely used as rheology modifiers for surface coatings, paints, and drilling fluids, due to their ability to form arrested states at low concentrations (about 2-3 wt%). Arrested suspensions of clay show high low-shear viscosities, high yield stress and shear thinning. This useful rheological response is based on the microscopic structural properties, originating from a highly anisotropic shape of clay particles, and the interparticle interactions. Recently it was shown that rheological behavior of clay suspensions can be significantly modified when small spherical colloids of the same charge are added to them. The mechanism behind this finding is not fully understood yet.

We present a study of arrested states formation in aqueous suspensions of pure hectorite clay and hectorite/silica sphere mixtures. Hectorite is a natural 2:1 smectite clay with relatively flexible lath-shaped particles. Its particles are negatively charged in aqueous solutions. Oscillatory rheological measurements were used to locate the appearance of the arrested states. We show the different states of hectorite suspensions, sol and gel, in a phase diagram spanned by the clay concentration and the ionic strength.

Silica spheres were added to the arrested hectorite suspensions to modify their phase behaviour and, consequently, rheology. Here two regimes were found. At higher clay concentrations mixed suspensions become more arrested than pure hectorite suspensions. They show larger yield stress and storage modulus. On the other hand, when silica spheres were added to the suspensions with lower clay concentrations they become more liquid-like and collapse. The latter behaviour is similar to the delayed sedimentation of weak polymer/colloid gels. We speculate what kind of structural rearrangements are behind the rheological changes in mixed clay/sphere suspensions.