

Stability of Colloidal Bentonite Particles in Aqueous Systems

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Deep geological repositories are one of the preferred alternatives for the safe disposal of a high-level radioactive waste in many countries. The repository consists on a multi-barrier system. Bentonite is considered to be a suitable material as one of the barriers mainly because of its swelling and sorption capacity and low hydraulic permeability. However many experiments have shown that during bentonite-water interaction colloids may be formed (Missana *et al.*, 2011; Arcos *et al.*, 2003). For safety assessment is essential to study the stability of these colloids, because stable and mobile colloids may cause increased migration of radionuclides, compromise the functionality of the bentonite barrier.

The objective of this study was to investigate the stability of bentonite colloids during the interaction of bentonite with water under different conditions. Classical sedimentation tests are an easy method for studying the colloidal stability.

The laboratory tests were performed using Czech Sabelil bentonite, which is Na-activated type of bentonite. The suspension of bentonite and deionized water with S:L = 1:180 was prepared in glass cylinder and was sampled at regular intervals from the level of the selected reference point. The concentration of sedimented colloidal particles in the suspension and their time evolution was measured. There were studied the effect of bentonite saturation time, the concentration of electrolyte (NaCl) and type of the electrolyte (KCl, CaCl₂, MgCl₂) on the stability of colloidal particles. The research was carried out at room temperature and the sedimentation of particles was measured at an interval of 1 week to 5 months.

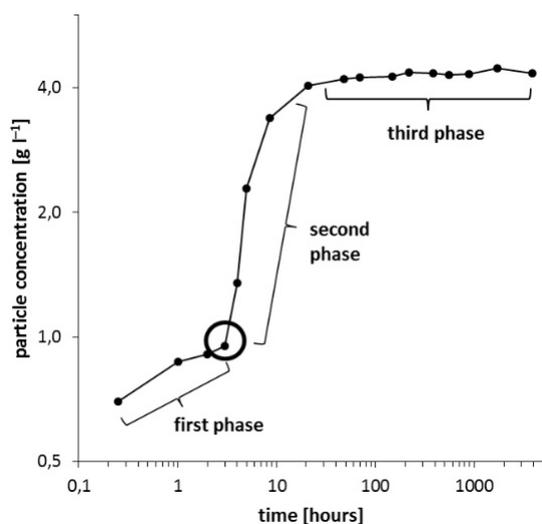


Fig. 1: Particle concentration as a function of time with indicated phases of sedimentation. The circle shows the beginning of the second phase. Both axes have a logarithmic scale.

The experimental results demonstrate that sedimentation of bentonite particles occurs in three phases and all phases are influenced by the bentonite saturation time, by the concentration of NaCl and by the type of the electrolyte. The most significant point on the all curves is

the beginning of the second phase, which corresponds to the rapidly increasing concentration of sedimented particles (Fig. 1). For this reason, the effect of different conditions on the stability of particles is the most evident at this point.

Adding NaCl causes the second phase to come earlier compared to simple sedimentation – the higher the concentration of NaCl, the sooner the second phase begins. The stability of bentonite particles decreases with increasing concentration of NaCl (Fig. 2).

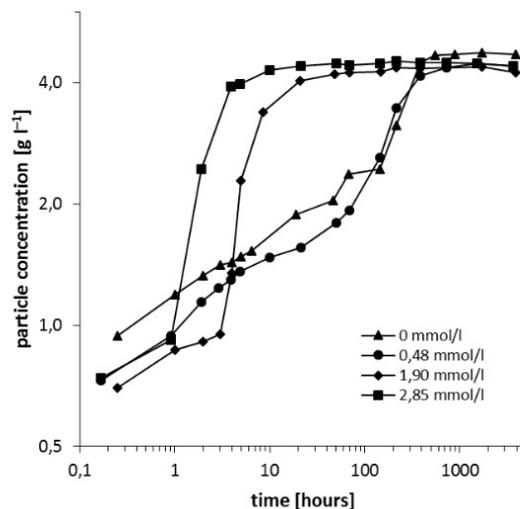


Fig. 2: Particle concentration as a function of time in experiment with the increasing concentration of NaCl. Each curve represents different concentration of NaCl. Both axes have a logarithmic scale.

In the case of bentonite saturation time, experiments were performed in two series – as simple sedimentation with no additives and with the addition of the same concentration of NaCl. In the series with added NaCl, the start of the second phase is directly proportional to the bentonite saturation time, but inversely proportional to the bentonite saturation time for simple sedimentation. In the case of the simple sedimentation, the stability of particles decreases with increasing saturation time and in experiments with added NaCl decreases with decreasing saturation time. The stability of colloidal particles is also influenced by the type of electrolyte. Adding of KCl and MgCl₂ causes the decrease of the colloidal stability.

During sedimentation of bentonite colloids several layers in suspension were formed. The granulometric analyses have shown that the layers have significantly different particle size and concentration. Over time the layers are moved downward by gravity and it was found that the beginning of the second phase is related to the transition of one of the concentration boundary between two layers through sampling point level.

Arcos D., Bruno J., Karnland O. (2003): Appl Clay Sci, 23: 219-228. Missana T., Alonso U., Albarran N., García-Gutiérrez M., Cormenzana J.-L. (2011): Phys Chem Earth, 36: 1607-1615.