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Dewatering and consolidation of clay slurries

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Dewatering, which is the process of separating (colloidal) suspended particles from a solvent (usually water), is used in many engineering applications (sanitary engineering, dredging engineering...). Key questions associated with dewatering in the context of the reuse of dredged sediment are (1) what is the process kinetics, (2) how can these processes be optimized and (3) can the dewatered sludge be reused and for which application? Dewatering and consolidation are functions of the suspended particles' size and type, and their solvent-mediated interaction. In this presentation, some examples will be given about the dewatering of suspensions and slurries as found in engineering applications [1]. The presentation will focus on the behaviour of mineral clay suspensions (kaolinite, montmorillonite, illite) composed of particles of different particle sizes [2-5]. We will show that, depending on the particle size distribution and solvent properties, the system is either undergoing a slow sedimentation dominated by thermodynamic forces or a rapid sedimentation dominated by gravity. The sedimentation is followed in time using NMR and inferential image analysis, and the particles are characterized by size, density and electrokinetic charge. We show that the time evolution of the sedimentation behaviour can be modelled using an advection-diffusion equation. The advective term is a function of gravity, whereas the diffusion term represents either a hard-sphere repulsion or an effective stress, depending on whether thermodynamic forces dominate the system [6-8].
For a mixture of different clays, the settling and consolidation behaviour is shown to be significantly affected by the type of colloidal particles in the system, even in a small amount. For instance, the settling of a kaolinite and montmorillonite suspension with a kaolinite to montmorillonite ratio of less than 0.1 (in weight) will be dominated by the strong electrostatic repulsive forces generated by the montmorillonite particles.
These interactions are not yet implemented in traditional civil engineering consolidation models based on effective stress concepts. Nonetheless, as we will discuss, their presence dramatically affects the answers to the questions (1-3) cited above.

Participation

In-Person

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