SEDIMENTATION OF TWO COAXIALLY, CHARGED, SPHERICAL PARTICLES IN ELECTROLYTE SOLUTIONS

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ABSTRACT
Particle separation by centrifugation of several charged rigid spheres within an electrolyte solution involves complex hydrodynamic and electrodynamic interactions, leading to distinct behaviours compared to isolated particles under the same conditions. This phenomenon finds applications in various fields, such as assessing the stability of colloidal suspensions in pharmaceutical and cosmetic products.

Previous studies have primarily focused on isolated particle sedimentation in Newtonian and viscoelastic electrolytes [1],[2], revealing that when a charged particle is submerged in an electrolyte solution, an electric double layer (EDL) is formed. The translation of the particle induces deformation of the EDL, generating an electric force opposing motion and thereby reducing the settling velocity. To explore the dynamics of this intricate system when the deformed EDLs of two particles interact, we conducted a computational study on the sedimentation of two equal-sized coaxial, charged, spherical, rigid particles initially separated by a distance h_o within a viscoelastic, electrolyte solution. Assuming axial symmetry, we solved the momentum and mass balance equations, Poisson's equation for the electric field, and species conservation equations for the ions using our in-house finite element algorithm [3].

The Giesekus model was employed to describe the rheological behaviour of the viscoelastic electrolyte [4]. A comprehensive parametric analysis was performed by varying the initial separation distance, surface potential, and electrolyte concentrations. We investigated the rate at which the particles approached each other and compared results with cases where electrokinetic phenomena were absent.

Our observations indicate that increasing the surface potential leads to decreased velocities due to heightened electric force, with more pronounced EDL interaction. Notably, the electric field effect appears stronger for the trailing particle. For small initial separation distances, intensified EDL interaction results in initial repulsion. Additionally, elasticity gives rise to a birefringent strand behind the trailing particle.

KEYWORDS: Sedimentation, Electric Double layer, Viscoelasticity, Electrolyte, Particle interaction

REFERENCES

[1] Keller, F., Feist, M., Nirschl, H., & Dörfler, W. (2010). *J. Coll. Interf. Sci.* 344(1): 228-236.
[2] Kouni, E., Moschopoulos, P., Dimakopoulos, Y., & Tsamopoulos, J. (2023). *Langmuir*, 39(45), 16006-16022.
[3] Varchanis, S., Syrakos, A., Dimakopoulos, Y., & Tsamopoulos, J. (2019*). J. NonNewton Fluid Mech.,* 267:78-97.
[4] Varchanis, S., Dimakopoulos, Y., Wagner, C., & Tsamopoulos, J. (2018). *Soft Matter*. 14(21): 4238-4251.

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