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Controlling colloid transport through porous media via local gradients of solute concentration

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Diffusiophoresis [1, 2] referring to the colloidal particle migration triggered by gradients of local salt concentration, has been established in the recent years as an efficient particle manipulation tool in relatively simple microfluidic setups such as plane channels [3], dead-end pores [4], Y-shaped channels [5], vertical diverging pores [6], etc. Owing to the fact that the particle velocities depend logarithmically on the solute concentration gradients, small variations in the concentration fields can result in significantly large diffusiophoretic particle motion [2]. However, despite the recent investigations hardly anything is known about its effects in the field of flow and transport in porous media. Spatial heterogeneities and complex fluid-phase distributions are quite ubiquitously found across spatial scales ranging from pore-scale to field-scale. These have a strong impact on the flow and transport of dissolved solutes through porous media giving rise to rich heterogeneous solute landscapes that provide local gradients of solute concentration, a prerequisite for diffusiophoretic motion. Following this motivation, we perform pore-scale simulations to understand the effects of diffusiophoresis at pore-scale in partially saturated media for varying degrees of fluid saturation and quantify their impact on the macroscopic particle transport. We envision that by exploiting the heterogeneous solute landscapes, particle motion can be controlled in an efficient manner. Depending on the sign of the diffusiophoretic mobility, determined by the size and surface charge of the colloidal particle, localized particle entrapment or removal can be achieved systematically. Our results that are pioneer in the field of diffusiophoretic transport through porous media, will pave the way to attaining controlled particle manipulation through porous media.

Participation

In-Person

References

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