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Deterministic displacement of particles and oil droplets in a cross-flow microsieve module

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Abstract

Our investigation aims to apply Deterministic Lateral Displacement (DLD) to separate (deformable) particles or droplets from dispersions on industrial scale. DLD is a promising technique because it can separate particles *smaller* than the pores. Previous work shows how to manipulate the critical particle diameter in a sieve-based lateral displacement system by modifying the hydrodynamics. In this study, we apply this fundamental understanding of the DLD separation principle to deterministically displace particles in a cross-flow microsieve module. First, two-dimensional simulations of the fluid dynamics in this cross-flow module were performed to investigate the hydrodynamic conditions required for particle displacement. Next, these simulations were compared with the flow fields visualized in the experimental setup. In addition, high speed recordings confirmed deterministic displacement of particles and oil droplets over the microsieve surface. Last, the systems performance was evaluated by measuring the transmission of rigid PMMA particles and deformable hexadecane droplets and the particle size distribution for different operation conditions. These results clearly demonstrate that the DLD principle can be effectively applied in a cross-flow microsieve module. With this, the application of this microfluidic separation principle to separate particles or droplets (1 to 20 micrometer) from dispersions on industrial scale has become realistic.

Key words: Oil-water separation, Cross-flow microfiltration, Microsieve, Microfluidics, Deterministic lateral displacement