Understanding Mixing vs. Segregation: Migration of Suspensions in a Time-Periodic Lid Driven Cavity

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Abstract

In systems where both convective mixing and segregation due to constituent migration result from applied deformation, it is unclear whether a given process enhances mixing or segregation. This work simulates segregation of non-colloidal particle suspensions in a 2D time-periodic flow. Two different mixing protocols having alternating moving boundaries in a cavity known to generate chaotic advection while maintaining a constant energy input rate are applied to each suspension. A diffusive flux model (Phillips et al., *Phys. Fluids*, 1992) is used to capture the essence of shear-induced migration. In this system, fluid deformation drives both mixing and segregation where the local rheology is a function of particle volume fraction. The impact of migration strength, altered by varying the including particle size and bulk volume fraction, and topology, altered by breaking symmetry in the flow when varying the period length, are investigated. As a result of the complex interplay between the flow topology and shear migration, the concentration profile ranges from that representing the underlying topology to that of steady flow in a lid-driven cavity, and depends on the parameters mentioned above and the structure produced by the two mixing protocols. In this system, increasing the size of chaotic regions does not result in enhancing mixing. These results challenge conventional wisdom in designing small scale flows for mixing and separations in MEMS applications.

keywords: suspensions, flow, chaos, chaotic mixing, non-Newtonian, shear migration, normal stresses, Poincare map

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