RIGID PARTICLES SETTLING IN YIELD STRESS FLUIDS AND NONSMOOTH OPTIMIZATION

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ABSTRACT

A well-known characteristic of yield stress fluids is their ability to hold in suspension a particle of different density. This static flow limit is characterized by a critical ratio of the yield stress to buoyancy stress Y, such that there is no motion of the particle for $Y > Y_c$. Practically, it provides a zeroth order approximation to the carrying capacity of such fluids, the determination of which is useful in various applications.

Values of Y_c have traditionally been computed by iteratively calculating a steady Stokes flow and varying parameters until motion stops, which is computationally expensive. We focus instead on a direct formulation based on minimizing the plastic dissipation functional subject to a flow rate constraint, and involving only one (discontinuous) field.

For anti-plane shear flows such a formulation allows us to calculate Y_c analytically for some simple suspensions of single and multiple particles [2, 3], and enables deriving some analytical results on the corresponding discontinuous fields. Numerically, we use [1] a primal-dual formulation for 3D flows, where the primal problem is the dissipation minimization mentioned. Besides comparing favorably with results 3D axisymmetric particles computed through iterative methods, the direct approach also allows to obtain results for non-axisymmetric and non-convex 3D particles.

References

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