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Particle Migration in Channel Flow of an Elastoviscoplastic Fluid

Rashid Shaik*

Associate Professor, University of Milan, Italy

Abstract

We study the dynamics of a neutrally buoyant rigid sphere carried by an elastoviscoplastic fluid during a pressure-driven channel flow numerically. The yielding to flow is marked by the yield stress which splits the flow into two main regions: the core unyielded region and two sheared yielded regions on the brink of the walls. The particles which are initially within the plug region are observed to translate with an equivalent velocity because the plug with none rotation/migration. Keeping the Reynolds number fixed, we study the effect of elasticity (Weissenberg number) and plasticity (Bingham number) of the fluid on the particle migration inside the sheared regions. within the viscoelastic limit, within the range of studied parameters (low elasticity), inertia is dominant and therefore the refore the particle finds its equilibrium position between the centreline and the wall. An equivalent happens within the viscoplastic limit, yet the yield surface plays the role of centreline. However, the mixture of elasticity and plasticity of the suspending fluid (elastoviscoplasticity) trigger particle-focusing: within the elastoviscoplastic flow, for a particular range of Weissenberg numbers isolated particles migrate all the thanks to the centreline by getting into the core plug region. This behaviour suggests a particle-focusing process for inertial regimes which wasn't previously found during a viscoelastic or viscoplastic carrying fluid.Transporting suspension of particles during a yield-stress fluid may be a crucial problem to be understood thanks to intrinsic complexities from the carrying fluid rheology to the particle dynamics. a brief list of applications may include, but isn't limited to, construction and oil & gas industries. Efforts of Segré & Silberber and other scholars uncovered the behaviour of particles suspended during a Newtonian fluid Poiseuille flow from theoretical frameworks that extensively revealed features of this problem at the low Reynolds number limit, to experimental validations/extensions, Further studies uncovered the features of the matter in non-cylindrical conduits and migration of deformable and non-spherical particles.

***Address for Correspondence:** Rashid Shaik, Associate Professor, University of Milan, Italy, E-mail: rashid786@gmail.com*

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