A fully-resolved immersed boundary numerical method to simulate particle-laden viscoelastic flows

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Fluid-particle transport systems present a significant practical relevance, in several engineering applications, such as oil sands mining and polymer processing [1]. In several cases it is essential to consider that the fluid, in which the particles are dispersed, has underlying viscoelastic characteristics [2]. For this aim, a novel numerical algorithm was implemented on an open-source finite-volume viscoelastic fluid flow solver coupled with an immersed boundary method, by extending the open-source computational fluid dynamics library CFDEMcoupling [3]. The code is able to perform fully-resolved simulations, wherein all flow scales, associated with the particle motion, are resolved. Additionally, the formulation employed exploits the log-conformation tensor approach [4], to avoid high Weissenberg number issues. The accuracy of the algorithm was evaluated by studying several benchmark flows, namely: (i) the sedimentation of a sphere in a bounded domain; (ii) rotation of a sphere in simple shear flow; (iii) the cross-stream migration of a neutrally buoyant sphere in a steady Poiseuille flow. In each case, a comparison of the results obtained with the newly developed code with data reported in the literature [5, 6] is performed, in order to assess the code accuracy and robustness. Finally, the capability of the code to solve a physical challenging problem is illustrated by studying the interactions and flow-induced alignment of three spheres in a wall-bounded shear flow [7]. The role of the fluid rheology and finite gap size on both the approach rate and pathways of the solid particles are described.

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