Accurate and efficient, multiscale simulations of Newtonian of non-Newtonian free-surface flows

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ABSTRACT

The purpose of this presentation is to outline the main features of a new numerical method for the simulation of complex, Newtonian and non-Newtonian free-surface flows.

The method makes use of a Particle Level Set (PLS) approach along with Adaptive Mesh Refinement (AMR) techniques to retrieve, accurately and efficiently, the fluid interface at each time step as the zero isocontour of a level set function. The convective terms are dealt with by means of a semi-Lagrangian formulation of the Navier-Stokes equations within a Finite Element framework, leveraging isotropic as well as anisotropic AMR techniques developed via error estimation to produce spatially-adapted "optimal" triangulations.

Multiscale simulations of non-Newtonian flows are realized through the kinetic modelling of ensembles of dumbbells scattered over the domain, their internal configurations providing the extra-stress tensor representing the viscoelastic contribution to the Newtonian solvent.

The capabilities of the method are illustrated in a series of 2D simulations of free-surface flows, showing surface tension and purely non-Newtonian effects.