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NUMERICAL INVESTIGATION OF THREE DIMENSIONAL VISCOELASTIC FREE SURFACE FLOWS: IMPACTING DROP PROBLEM

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This work describes the numerical investigation of three dimensional viscoelastic free surface flows. In particular, using two different numerical methodologies, we have simulated a typical free-surface benchmark problem: the impact of a viscoelastic fluid droplet with a rigid boundary (see Figure 1). We intend that our results are useful both for testing numerical methods, and to promote the understanding of rheological behaviour of polymers in flows with industrial relevance.

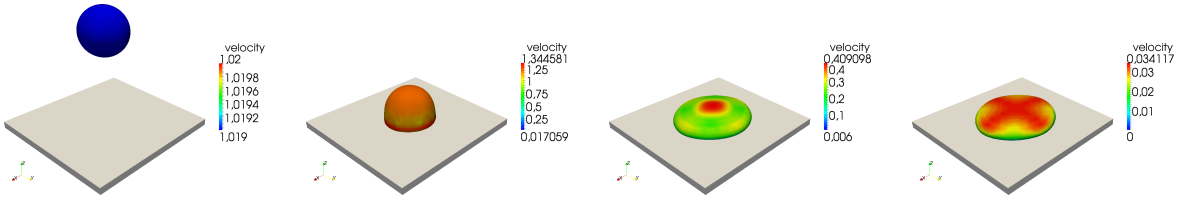

Figure 1: Illustration of the numerical simulation of the impacting drop problem.

The first numerical method used in this work was recently proposed by Figueiredo et al. [1] which was implemented in a viscoelastic flow solver developed in-house. In this methodology, a finite difference scheme is adopted combining the Marker-And-Cell (MAC) method and Front-Tracking strategy. In order to preserve mass conservation properties in transient viscoelastic fluid flows, we have modified the method in [1] including an improvement on the MAC discretization of the velocity boundary condition at free-surfaces.

The second methodology employed in this numerical investigation is the freely-available finite volume OpenFOAM software [2]. This open-source code is based in a collocated finite volume method, and two-phase flow calculations employ a variant of the Volume-of-Fluid (VoF) scheme, proposed in [4]. More details of the methodology are presented in [5].

In order to verify the codes, a comparison of numerical formulations for the drop impact problem is firstly performed for a Newtonian fluid. After this validation, we employ the Oldroyd-B model to assess the differences between the methodologies, and comparing our results with those presented in the literature [3]. Finally, a detailed study of the influence of the relevant rheological parameters of the non-linear viscoelastic models (Giesekus and XPP models) is reported, regarding the deformation and spreading of the viscoelastic fluid drop after impacting on a rigid surface.

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