6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

A Study on Binary Collision of GNF Droplets Using a Conservative Level-Set Method

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Keywords: *Multiphase flows, non-Newtonian droplets collision, Conservative Level-set*

In this paper, the collision of Generalized Newtonian Fluid (GNF) droplets in a gaseous environment is numerically studied. The droplet collision phenomena is of relevance to many natural and industrial applications, including raindrop and cloud formation, spray coating, combustion and ink-jet printing. In many of these applications, the droplets exhibit non-Newtonian behavior, which could be captured employing shear-thickening and shear-thinning models. Although it is of great importance, to the best of our knowledge, only a few numerical works have been done in this field.

Carreau-Yasuda (CY) model is used to replicate the shear-thinning behavior of the fluid.A second-order Adam-Bashforth scheme is used to discretize momentum equation. Conservative level-set method [1] on a finite volume structure is used to capture the interface. The method is validated against available experimental data on collision of Newtonian droplets, and benchmark numerical data on collision of non-Newtonian droplets. Good agreement is seen in all the cases. Our simulations mainly focus on the extreme cases in which collision of the droplets is followed by immediate coalescence. For these cases, persistence of the lamella film is crucial on the outcome of the collision. Resolving this lamella film usually requires very fine mesh sizes or Adaptive-mesh-refinement techniques which both can be computationally expensive. In this study a novel lamella stabilization approach is used to overcome this problem with no extra computational cost. For the cases where the output of the collision is bouncing or retarded coalescence, a ghost-node method is used to control the gas film rupture between the droplets.

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