A two-scale model for two-phase flows including geometric variables

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Two-phase flows of liquid and gaseous phases play an important role in several natural processes and engineering systems, such as hybrid rockets engines, atomization of liquid jets, and spray combustion. According to the geometrical configuration of the interface, two-phase flows can exhibit different behaviours. We present here a two-scale model [4] which provides a unified description of separated-disperse phases, so as to naturally take into account the multi-scale nature of atomization phenomena. The model is derived by means of the Stationary Action Principle (SAP) [2, 4, 5], so as to retrieve good mathematical properties, such as hyperbolicity or entropic structure. The two-scale model is enriched with geometrical information from the interface, such as interfacial area density and curvatures, so that the large scale that describes the bulk fluid is well resolved, whereas the small scale, represented by (possibly non spherical) droplets or bubbles of different size forming a polydisperse spray, is modelled employing suitable geometric variables and the Geometric Method Of Moments [4]. In particular, for what concerns the interfacial area density, we present a derivation of an evolution equation through the SAP [5], so as to obtain a dynamic relation in a general variational framework. This novel approach is significantly different with respect to those already available in the literature and we compare this equation with those which are typically either postulated or derived by means of empirical considerations, showing how to retrieve well known relations in the literature as limiting cases or submodels.
The transfer of mass between the two scales is performed computing the local mean curvature and it is triggered when this value is above a certain threshold [3, 4]. A number of test cases on classical benchmarks will be presented to assess the validity of the model. The implementation is carried out in the framework of Samurai [1], which allows adaptive simulations.

Références

[1] *https://hpc-math-samurai.readthedocs.io/en/latest/*.

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