

Droplet breakup analysis under turbulent conditions

C. Deberne^a, V. Chéron^{a,b} and J. C. Brändle de Motta^a

Since Hinze's and Kolmogorov's seminal works in the 50s, the droplet secondary breakup phenomenon due to turbulence has been subject to many studies. Secondary Breakup Models are built on the competition between the inertial forces responsible of the disruptive effects of the drop and the interfacial forces responsible of the restoring effects/ droplet-turbulence interaction. The different authors have based their models on the global statistics of a spray.

This communication analyzes the temporal evolution of thousands of individual droplets. Each spherical droplet is computed in a tri-periodic domain using the interface-resolved Direct Numerical Simulations solver ARCHER¹. The surrounding fluid is a turbulent sustained flow. The Weber number based on the velocity fluctuations ($We = \rho u'R/\sigma$) is set for all the simulations to 0.45. The density and viscosity ratios between the two-phases are fixed to unity. Different initial flow conditions are applied varying the turbulent realization. The simulations are performed until the drop breakage, which occurs after several capillary times (see Figure 1 for an example of the database). This methodology circumvents other phenomena (shear, coalescence, etc.) and enables the detailed analysis of the breakup mechanism.

In this communication, numerous morphological and physical parameters, such as the local Weber number suggested by Perlekar², are employed to predict an eventual breakup under turbulent conditions. A statistical analysis is carried out and the accuracy of the proposed criteria is evaluated by means of some indicators such as the F-score. The goal is to determine which parameters are the most reliable for the study of drop rupture.

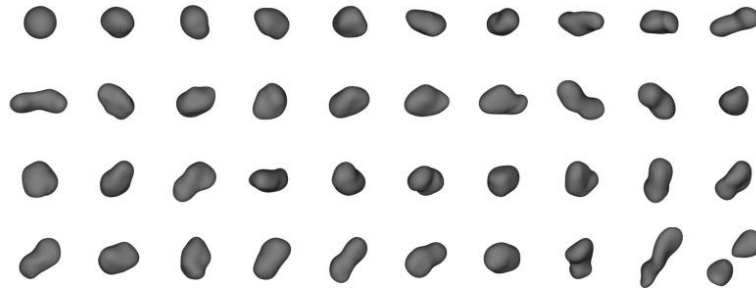


Figure 1: Temporal shape evolution of an individual droplet induced by turbulence. The time step between two snapshots is $\Delta t \approx 1.1 t_c$, where $t_c = (\rho R^3/\sigma)^{1/2}$.

^a UMR6614-CORIA, Rouen Normandie Université/INSA Rouen Normandie, 76801, France.

^b Lehrstuhl für Mechanische Verfahrenstechnik, Otto-von-Guericke-Universität Magdeburg, Universitätsplatz 2, 39106 Magdeburg, Germany.

¹ Chéron et al., *29th Conference on Liquid Atomization and Spray Systems* (2019).

² Perlekar et al., *Phys. Fluids* **24**, 065101 (2012).