# Gas-assisted atomization and drying of concentrated suspensions of particles: role of the suspension rheology

**Topic:** experimental; turbulent two-phase flows; suspensions; data and image processing
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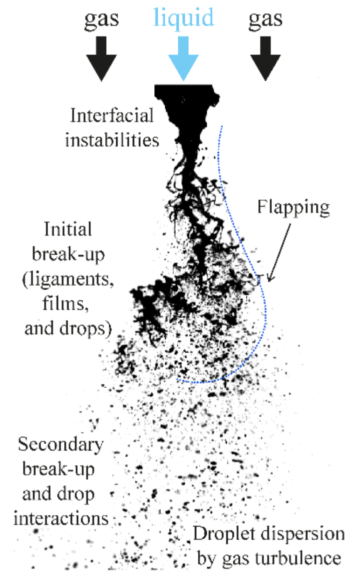


Context: Liquid atomization is ubiquitous in many processes in the manufacturing, food, pharmaceutical, agriculture, transportation, fire safety, and electronics industry to name a few. The liquid phase often bears highly viscous and/or non-Newtonian behaviors, whether present by nature (e. g. fuel) or added for their properties (in spray coating for instance). While the fragmentation of viscoelastic liquids received a fair amount of attention, only a few studies focus on the case of suspensions. Beyond their possible non-linear rheological properties with respect to shear (e. g. thinning or thickening), the suspensions' behaviors strongly depend on the particle volume fraction. Gas-assisted atomization, such as typically used for spray drying applications, presents a highly turbulent two-phase flow, inherently inhomogeneous and multiscale. This can easily be assumed to lead to strong local variations of the volume fraction, which could explain why the time-consuming and expensive trial-and-error approaches cannot yield successful models and predictions for process design and innovation. In particular, shear-induced migration of the particle, within the suspension, and increased evaporation due to a potentially dry and hot surrounding gas jet are two physical phenomena that can easily lead to large changes in the local particle volume fraction.

Project: The goal of this project is hence to investigate the underlying mechanisms of the fragmentation of a suspension by a gas flow. The combination of a canonical coaxial two-fluid atomizer and the use of model suspensions of well-controlled properties will be key in unveiling the controlling parameters of this multi-physics process. A multiscale experimental approach will be led, combining a set of available measurement techniques and the development of analysis tools. Different advances can be achieved through the following tasks:

- Implement and characterize a set of model suspensions with the desired properties (e. g. Newtonian, shear-thinning, shear-thickening, experiencing a visco-inertial transition)
- Conduct a base study of the effect of rheological behavior in the absence of gas flow
- Measure the dynamic of the liquid jet fragmentation by the fast gas flow in the near-field using high-speed imaging, in a wide range of liquid and gas Reynolds numbers
- Disentangle the effect of migration and evaporation on local particle volume fraction by varying the gas flow relative humidity and temperature
- Analyze the droplet size and spatiotemporal distribution using laser interferometry
- Test and develop new modeling approaches in agreement with the result obtained

Visualizations of the fragmentation process (water): https://www.youtube.com/watch?v=tAVFWx9VQeQ%2F

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