# Spatially Resolved Characteristics and Analytical Modeling of Elastic Non-Newtonian Secondary Breakup

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## Abstract

The secondary breakup of elastic non-Newtonian liquid drops will be investigated experimentally to determine fragment size and velocity distributions. Knowledge of these parameters will help with the design and/or optimization of many technical systems such as gas turbine combustors or film coating processes. To do this, Xanthan gum – water solutions of various concentrations ranging from 0.1% to 1.0% by weight are prepared and injected into a high speed air stream. Both PIV and LDA techniques have been employed to characterize the air stream velocity. The fragment size and velocity distributions of elastic liquid fragments resulting from secondary atomization will be characterized using a dual-PDA system (Dantec Dynamics GmbH, Germany). The fragment size and velocity distributions of the wake region of the fragmenting drop will be plotted against the Weber and Ohnesorge numbers to investigate how the two distributions change with respect to these parameters. The primary focus will be on the bag and bag and stamen (multimode) breakup regimes, with work extending to the sheet-thinning regime if fragment geometries allow. Previous work focusing on the resulting fragments on secondary breakup has mainly studied the fragment sizes, not velocities. Work by Villermaux and Bossa [3] was focused on the distribution of fragment sizes. The end result was a plot of drop size distribution versus initial drop diameter. Since Villermaux and Bossa [3] studied water droplets, the effects of liquid properties (density, surface tension, etc.) were not taken into account. Also, since the drops in this study fell due to gravity, the effects of varying air velocity were not studied. In the work of Gast [2], the focus was only on the breakup of the drop rim, even though the conditions were such that the drops were undergoing bag breakup. Again, water was the only solution used, and the drop diameter was the only variable changed. Gast [2] used time-lapse photography to determine if there was a relationship between initial drop diameter and torus diameter; his focus was mainly on torus geometry, not fragment properties. Most recently, the products of drop fragmentation have been studied by Bartz *et al*. [1]. We expect to produce plots of fragment size versus axial location that are similar to Bartz *et al*.'s [1] findings (as shown in Figure 1):

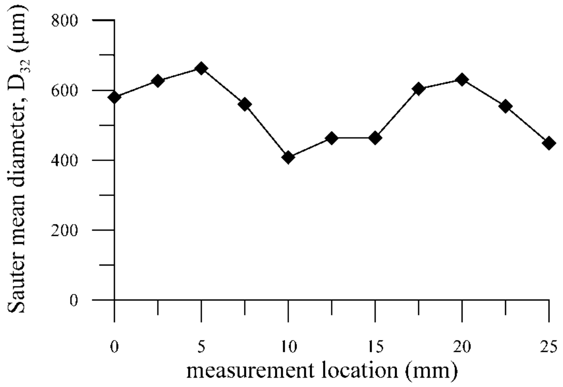


Figure 1: $D_{32}$ versus axial measurement location [1].

This work aims to extend the knowledge of drop fragment size and velocity distribution to the elastic non-Newtonian case. We will attempt to determine how these distributions vary with respect to important non-Newtonian fluid parameters (namely Weber and Ohnesorge number). By studying the bag and bag and stamen breakup regimes, we will cover a wide range of flow and distribution conditions.

***Keywords: non-Newtonian, secondary breakup, secondary atomization, liquid drops***

[1] Bartz, Frank-Oliver, *et al*. "Comparison of droplet breakup models for single droplet fragmentation under varying accelerations." *ILASS – Europe 2011, 24th European Conference on Liquid Atomization and Spray Systems, Estoril, Portugal*. September, 2011.
[2] Gast, Luis A. "Capillary Instability of a Liquid Ring." (Doctoral Dissertation). Rutgers The State University of New Jersey; 1991.
[3] Villermaux, E., and B. Bossa. "Single-drop fragmentation determines size distribution of raindrops." *Nature Physics*, **5**, p. 697 – 702, 2009.

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