Secondary Breakup of Non-Newtonian Liquid Drops

C. López-Rivera* and P. E. Sojka
Maurice J. Zucrow Laboratories
Department of Mechanical Engineering
Purdue University
West Lafayette, IN 47907-2014 USA

Abstract

The secondary breakup of non-Newtonian liquid drops was investigated experimentally to determine breakup morphology and initial breakup time. Xanthan gum-water solutions with concentrations ranging from 0.05 to 0.25% by weight were formed into drops and injected into a high speed air stream. Drop morphology was captured using a high-speed (6688 fps) imaging system. Breakup times were determined from these images. Bag and multimode breakup regime boundaries for non-Newtonian drops were found to occur at Weber numbers close to those reported for Newtonian liquids. In contrast, sheet-thinning breakup was observed at Weber number values smaller than for Newtonian drops. In contrast to Newtonian results, significant bag growth and stretching was observed prior to breakup. In addition, after breakup not only were drops found, but also ligaments. As expected, an increase in Weber number lead to more violent breakup. Dimensionless initial breakup times were independent of Weber number and approximately 60% higher than those of Newtonian drops under the same conditions. Finally, increases in Ohnesorge number were observed to produce increases in initial breakup time. Based on data illustrating the effects of variations in liquid rheology on drop morphology and breakup times, we conclude that the behavior of even low concentration non-Newtonian liquids deviates from that reported for Newtonian liquids.

Key words: secondary breakup, atomization, non-Newtonian, drop, spray

*lopez0@purdue.edu