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Secondary Atomization: Drop Breakup in a Continuous Air Jet

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ABSTRACT

Understanding drop breakup will optimize aircraft engine performance, reduce agro-chemical overspray, and improve pharmaceutical tablet efficacy. Large fuel fragments in engines lead to lowered fuel economy and higher pollutant emissions, while small drops yield more agro-spray drift into surrounding residential and environmental zones. Better pharmaceutical tablets will improve drug uptake and patient comfort.

Engineers and scientists are currently unable to predict the number, size, and velocity of fragments formed during important drop breakup processes. Therefore, we are required to measure these quantities. We use digital inline holography (DIH) to record three-dimensional diameter and position data for fragments formed during multi-mode breakup. DIH provides 3D images at framing rates 300 times faster than in an IMAX theater. A laser is used as the light source and a high speed camera records the breakup events to video files. A MATLAB script is used to extract the diameters and positions of all fragments in the spray. The data is sorted into bins and histograms are produced which describe the probability of observing a fragment of any particular size and speed.

Results show size histograms with more than one peak, a finding in direct contradiction to the last 40 years of spray research. Multiple peaks are indicative of fragmentation processes that occur due to multiple breakup mechanisms, with the number of histogram peaks corresponding to the number of mechanisms (some combination of bag, rim, and/or stamen breakup modes). The histograms will be useful to those modeling sprays in gas turbine engines and industrial sprayers.

KEYWORDS

Energy/environmental, medicine/pharmaceutical, agricultural, sprays