Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Multi-scale characterization of the effect of gas swirl on two-fluid coaxial atomization. NATHANAEL MACHICOANE, PETER D. HUCK, University of Washington, TIMOTHY B. MORGAN, JULIE K. BOTHELL, Iowa State University, RODRIGO OSUNA-OROZCO, University of Washington, DANYU LI, THEODORE J. HEINDEL, Iowa State University, ALAN L. KASTENGREN, Argonne National Laboratory, ALBERTO ALISEDA, University of Washington —
This work aims at developing a better mechanistic understanding of the processes that control droplet formation and transport in coaxial two-fluid atomization. The goal is to experimentally develop spray control strategies and implement feedback control of the spray characteristics. We will present results on the impact of modulation of the swirl ratio (ratio of gas flow rate with tangential momentum to the total gas flow rate) on the physics of the atomization, from the formation of liquid ligaments close to the nozzle, to droplet size and spatiotemporal distributions in the mid-field. This parameter dominates the spray structure when it is above a critical value and its modulation in time has a non-linear effect on the spray dynamics that can be used to shape it towards a desired state (the control goal). Synchrotron X-ray measurements provide detailed information of the spray near-field, while time-resolved optical measurements of the spray structure, as well as the droplet size and velocity, are collected in the mid field. The response of the spray to the open-loop actuations is mapped from these measurements. This is used to develop reduced order model for feedback control and to validate assumptions used for computational, adjoint-based, control strategies.

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Date submitted: 26 Jul 2019 Electronic form version 1.4