Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Manipulating gas-assisted atomization by inlet gas turbulence

DELIN JIANG, YUE LING, Baylor University, DANIEL FUSTER, STEPHANE ZALESKI, Sorbonne Universite, GRETAR TRYGGVASON, Johns Hopkins University — In an airblast atomization process, the destabilization and breakup of a liquid jet is assisted by a co-flowing high speed gas stream. Recent experiments and simulations show that the inlet gas turbulence has a strong impact on the interfacial instability development near the nozzle exit and also the liquid breakup downstream. In this study we will systematically investigate the effect of inlet gas turbulence on the interfacial instability and spray formation through high-fidelity simulation. The gas-liquid interface is resolved by a momentum-conserving volume-of-fluid method. A digital filter approach is used to generate temporally and spatially correlated velocity fluctuations at the gas inlet. The dominant frequency and spatial growth rate of the mixing layer are observed to increase significantly with the inlet gas turbulence intensity. The dominant frequency predicted by simulations are in a good agreement with the experimental data. Spatial-temporal viscous linear instability analysis is also conducted using the eddy-viscosity model. The simulation results also reveal the change of dominant breakup mechanism when gas inlet turbulence is present.

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Date submitted: 31 Jul 2019 Electronic form version 1.4