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Modeling primary break-up of turbulent liquid jets in cross-flow using detailed numerical simulations MADHUSUDAN PAI, Stanford University, OLIVIER DESJARDINS, University of Colorado, HEINZ PITSCH, Stanford University — Combustion efficiency and pollutant emissions from internal combustion engines and gas turbines are determined by the atomization of the liquid fuel. When injected into a quiescent or moving ambient gas, the liquid jet develops instabilities due to various causes (such as aerodynamic effects, pressure fluctuations and cavitation) which in turn lead to the primary break-up of the liquid jet. The ability to understand and accurately quantify these instabilities can provide avenues to model liquid primary break-up. Such statistics are accessible only in accurate numerical simulations of liquid jet break-up. A spectrally-refined interface (SRI) tracking method for interface transport coupled to an accurate and robust Navier-Stokes/Ghost-fluid method solver is employed to perform detailed numerical simulations of liquid-jets in cross-flow. For validation purposes, predictions from the numerical simulations for the liquid-column trajectory and liquid-jet penetration are compared with experimental datasets. Statistics of energy fluctuations due to turbulence and aerodynamic instabilities in the liquid jet, and the impact of these fluctuations on the shedding of ligaments and droplets from the surface of the liquid jet are quantified. Based on the results from the numerical simulations, a framework for modeling primary break-up of liquid jets is proposed.

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