Experimental analysis of supercritical CO$_2$ assisted atomization
SHADI SHARIATNIA, DORRIN JARRAHBASHI, Texas AM University — Dissolution of supercritical fluids in liquids introduces gas bubbles upon depressurization due to injection and the expansion and burst of these bubbles facilitate the atomization. We experimentally study the atomization behavior of water with dissolved CO$_2$ above its critical pressure and temperature injected into ambient condition. To elucidate the effects of gas solubility, interfacial tension and injection parameters on the promotion of dissolved supercritical fluid atomization, we repeat the experiments with injection of water and dissolved N$_2$. High-speed imaging and laser diffraction are used to understand the effects of flow parameters: injection pressure, temperature, gas-to-liquid ratio and axial distance from the injector on jet breakup and droplet sizes. The CO$_2$ atomized droplets are smaller and distributed over a narrow span compared to that of N$_2$. Two combined phenomena explain the enhanced atomization of water-CO$_2$: the solubility of N$_2$ in water above its supercritical condition is substantially lower than CO$_2$ and the interfacial tension of CO$_2$-water is much lower compared to N$_2$-water at the same condition. A novel predictive model of droplet sizes is developed for a wide range of flow conditions.