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Significance of chamber pressure to complex multi-phase physics in jet engine fuel injection processes RAINER DAHMS, JOSEPH OEFELEIN, Sandia National Laboratories — Injection processes in jet engines at chamber pressures in excess of the thermodynamic critical pressure of the liquid fuel are not well understood. Under some conditions, a distinct two-phase interface may not exist anymore which eliminates the presence of classical spray atomization phenomena. A comprehensive model for jet engine fuel injections is derived to quantify the conditions under which the interfacial dynamics transition to diffusion-dominated mixing processes without surface tension. At certain conditions, the model shows two-phase interfaces with substantially increased thicknesses and distinctively reduced mean free paths in comparison to ambient pressure conditions. Then, the underlying assumptions of a distinct two-phase interface do not apply anymore and the interface along with its surface tension is shown to deteriorate as it broadens substantially. As a consequence of this physical complexity, the conceptual view of spray atomization and evaporation as an appropriate model for jet engine injection processes is, contrary to conventional wisdom, questionable at certain operating conditions. Instead, a Large Eddy Simulation using a dense-fluid approximation is applied which takes the complex thermo-physics of real-fluid behavior into account.

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