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High fidelity simulation of transcritical injection MARIOS SOTERIOU, HUI GAO, XIAOYI LI, DUSTIN DAVIS, United Technologies Research Center — Transcritical injection of a multi-component fluid occurs in many practical applications such as diesel and rocket engines. In this type of injection a liquid fuel at a supercritical pressure but subcritical temperature, is introduced into an environment where conditions are supercritical. The convoluted physics of the transition from the subcritical to the supercritical state is linked to thermodynamic property variations and poses challenges to numerical simulation. For example, the temporary presence of surface tension implies that both the subcritical liquid-vapor interface and the transition boundary to supercritical fluid need to be captured. In this work, numerical simulation of a binary system of a subcritical liquid injecting into a supercritical, quiescent gaseous environment is performed. A coupled level set and volume of fluid method is adopted to capture the liquid-vapor interface, across which the continuity of mass and energy fluxes is preserved. The fluid state over the range of subcritical liquid to supercritical fluid is determined by incorporating the Peng-Robinson equation of state. To efficiently account for the sharp changes in properties near the liquid-vapor interface and the transition boundary to supercritical fluid, an adaptive mesh refinement technique is employed. Analysis of results focuses on the impact of vanishing surface tension as conditions transition from sub-critical to supercritical.

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