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Proper Orthogonal Decomposition Analysis of Turbulent Cryogenic Liquid Jet Injection Under Transcritical Conditions DORRIN JARRAHBASHI, SALAR TAGHIZADEH, Texas A&M University, TEXAS A&M UNIVERSITY TEAM — Liquid-rocket and high-pressure diesel engines operate at pressures and temperatures that exceed the critical pressure and temperature of the liquid fuels during injection. The turbulent flow features and turbulent fluctuations are impacted by the transition from subcritical to supercritical conditions that in turn affect the turbulent mixing between the fuel and oxidizer in the combustor. LES and the proper orthogonal decomposition (POD) algorithm are employed to study the turbulent flow and dominant unstable flow modes at transcritical and supercritical conditions for cryogenic nitrogen jet injected into a warm nitrogen environment. The effects of the transition from transcritical to supercritical conditions on mixing layer behavior are demonstrated. Real-gas thermodynamic properties at supercritical conditions are considered via implementing the cubic Peng–Robinson equation of state and Chung's method for obtaining fluid transport properties. The results show that the presence of large density gradients in the mixing layer at transcritical conditions smear out the turbulent coherent structures in the radial direction and turbulence shows anisotropic behavior near the mixing layer that retards the overall mixing process.

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