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Numerical Study on Cryogenic Coflowing Jets under Transcritical Conditions HIROUMI TANI, Japan Aerospace Exploration Agency, SUSUMU TERAMOTO, KOJI OKAMOTO, University of Tokyo, NOBUHIRO YAMANISHI, Japan Aerospace Exploration Agency — A numerical and experimental study is presented on cryogenic coflowing jets under transcritical conditions for a better understanding of the propellant mixing in supercritical-pressure rocket engines. The major concerns are dominant flow structures in the mixing of cryogenic coflowing jets under transcritical conditions. Experimentally, in advance of detailed numerical simulations, cryogenic nitrogen/gaseous nitrogen coaxial jets were visualized by the backlighting photography technique. It was observed that a dense nitrogen core has a shear-layer instability near the injector exit and eventually breaks up into large lumps which dissolve and fade away downstream. In numerical simulations, LES technique was employed for more detailed discussion on the flow structures. LES of a cryogenic nitrogen/gaseous nitrogen coflowing plane jet was conducted with the same density and velocity ratios of inner/outer jets as the experiments. As observed in the experiments, the shear-layer instability in the inner mixing layers is predominant near the injector exit. After roll-up and paring, the shear-layer instability waves become large-scale vortices. They cause coherent vortex structures which become dominant in the downstream and break the dense core into lumps. Strouhal numbers of the shear-layer instability and the dense lump shedding in the numerical simulations were comparable to those measured in the experiments, respectively.

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