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Nucleation of Super-Critical Carbon Dioxide in a Venturi Nozzle DORRIN JARRAHBASHI, SANDEEP PIDAPARTI, DEVESH RANJAN, Georgia Institute of Technology — The supercritical carbon dioxide $(S-CO_2)$ Brayton cycle combines the primary advantages of the ideal Brayton and Rankine cycles by utilizing CO_2 above its critical pressure. In addition to single phase and small back work ratios, supercritical fluids offer other advantages, e.g. heat transfer augmentation and low specific volume. Pressure reduction at the entrance of the compressor may cause homogenous nucleation, vapor production, and collapse of bubbles due to operation near the saturation conditions. Transient behavior of the flow after nucleation may cause serious issues in operation of the cycle and affect the materials used in design. The flow of $S-CO_2$ through a venturi nozzle near the critical point has been studied. A transient compressible 3D Navier-Stokes solver, coupled with continuity, and energy equation has been used. Developed FIT libraries based on a piecewise biquintic spline interpolation of Helmholtz energy have been integrated with OpenFOAM to model S-CO₂ properties. The mass fraction of vapor created in the venturi has been calculated using homogeneous equilibrium model (HEM). The flow conditions that lead to nucleation have been investigated. The sensitivity of nucleation to the inlet pressure and temperature, flow rate, and venturi profile has been shown.

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