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Numerical simulations of thermoacoustic waves in transcritical fluids employing the spectral difference approach CARLO SCALO, MARIO TINDARO MIGLIORINO, JEAN-BAPTISTE CHAPELIER, Purdue University — We investigate the stability properties of thermoacoustically unstable planar waves in transcritical fluids via high-fidelity Navier-Stokes simulations based on a Spectral Difference (SD) discretization coupled with the Peng-Robinson equation of state and Chungs method for the fluid transport properties. A canonical thermoacoustically unstable standing-wave resonator filled with supercritical CO2 kept in pseudoboiling conditions in the stack is considered. Real fluid effects near the critical point are shown to boost thermoacoustic energy production, as also confirmed by companion eigenvalue analysis supporting the closure of the acoustic energy budgets. A kink in the eigenmode shape is observed at the location of pseudo phase change, consistent with the abrupt change in base impedance. The current study demonstrates a transformative approach to thermoacoustic energy generation, exploiting otherwise unwanted fluid dynamics instabilities commonly observed in aeronautical applications employing transcritical fluids.

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