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Effects of pressure on thermodiffusively-unstable lean premixed hydrogen piloted jet flames

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This paper presents a DNS study of thermodiffusively-unstable lean premixed hydrogen piloted jet flames, focussing on the effects of pressure. The simulations were performed with the well-established DNS solver PeleLMeX [1, 2], and the Burke *et al.* chemical mechanism [3], with the Soret effect included following [4]. The premise of the study is to investigate how turbulence-flame interactions and the thermodiffusive response vary with pressure, in particular whether atmospheric studies can be generalised to high pressures with the appropriate normalisation. A reference atmospheric condition was taken from the Cambridge Bunsen flame [5, 6], where the jet diameter was 15 mm, with an inlet speed of 3.5 m/s, and a reactant equivalence ratio of $\phi = 0.3112$. Two trajectories were selected: firstly, increasing the pressure (up to 16 atm in factors of 2) with a fixed burner size and inlet speed; and secondly, increasing the pressure but normalising the burner diameter and inlet velocity to match the freely-propagating Karlovitz and Damköhler numbers. The trajectory with fixed burner geometry resulted in significant differences with increasing pressure, but is instead attributed to the increase in Karlovitz number; conversely, the trajectory with fixed dimensionless parameters resulted in flames with much more comparable thermodiffusive response, demonstrating that the appropriate nondimensionalisation mitigates the effects of pressure.

References

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