Methane–air flame stability under the various gravity conditions

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Flame stabilization under various gravitational conditions is critical for a wide range of applications. In laboratory experiments, a conical flame is most useful. Experimentally, the stability of an inverted conical plane-symmetrical premixed methane–air flame under normal and reversed gravity was investigated. The flow velocity was varied from 1 to 8 m/s, and the fuel equivalence ratio was varied from 0.8 to 1.4. Depending on the set of conditions, such a flame could be V-shaped (attached only to the stabilization rod) or M-shaped (attached both to the nozzle edge and the stabilization rod). Under normal and reversed gravity, the transition between two modes was studied. The hysteresis properties of the M–V and V–M transitions in normal gravity were reported, as well as their absence in reverse gravity. At the maximum burning velocity, the most unstable flames were observed under reversed gravity ($\phi \approx 1.1$). Under normal gravity, a reverse flow exists above the stabilizer at any velocity, and under reverse gravity, at high velocities (> 5 m/s). With increasing velocity, the longitudinal size of the vortex zone increased linearly in both cases. Gravity was found to play a significant role in the stability of rich flames.

This research was supported by The Ministry of Science and Higher Education of the Russian Federation (agreement No. 075-15-2020-806 dated 29.09.2020).