GRAVITY EFFECTS ON SUPPRESSION OF CUP-BURNER FLAMES

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The goal of the present investigation is to: (1) understand the physical and chemical processes of fire suppression in various gravity and O_2 levels; (2) provide rigorous testing of numerical models, which include detailed combustion-suppression chemistry and radiation sub-models; and (3) provide basic research results useful for advances in space fire safety technology, including new fire-extinguishing agents and approaches. The experiments involve both 1*g* laboratory testing and low-*g* testing (in drop towers and the KC-135 aircraft). The numerical modeling uses a time-dependent direct numerical simulation with full chemistry for simulating either the low-*g* or 1*g* flames, and interpreting the effect of gravity on the extinction process with and without a variety of agents (of types that act both physically and chemically). The configuration selected is a cup burner (a co-flow diffusion flame with a 2.8 cm diameter fuel source, either a liquid pool or a low-velocity gas jet, inside an 8.5 cm diameter chimney with oxidizer flowing at ~10 cm/s).

The combustion and extinction characteristics of the cup burner, including the extinction conditions, flame shape, time-dependent flame tip and base locations, and flicker frequency, have been measured for various fuels, including methanol, methane, heptane, and trioxane. The variation of the liquid or solid fuel mass loss rate with addition of inhibitor have also been measured. The fundamental kinetic work necessary for other parts of the project have been determined. Numerical simulations have been performed to investigate the flame structure of methane-air flames with an agent added (CO_2, CF_3H, or $Fe(CO)_5$). The computation has revealed that the suppression of cup-burner flames occurs via a blowoff process (in which the flame base drifts downstream) rather than the global extinction phenomenon typical of counterflow diffusion flames and that, in 0*g*, the radiative heat loss is a predominant factor in flame tip opening and suppression phenomena.

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