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Flame Spread Behavior in Partial Gravity Fields —For Fire Safety Strategy on Lunar & Martian Environments—

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Abstract

A flame spread behavior under various partial gravity fields (from zero to normal gravity) in laboratory scale system has been investigated numerically to gain better understandings of fire behavior in Lunar or Martian environments. Two-dimensional, mass and heat transport with one-step finite rate reaction model are considered in the gas phase, whereas thermally-thin solid with two overall decomposition reactions are considered in the solid phase. Thermal interaction between the flame and surface leads continuous fuel supply into the gas phase and brings the flame spread behavior. Following four features are predicted depending on the imposed field gravity levels: 1) quasi-steady flame spread is observed under the condition considered, 2) flame spreads only one side (upstream) under extremely small gravity level, then additional downstream flame appears over certain gravity level, 3) flames start flicker over certain gravity level, 4) the spread rate shows maximum at certain gravity level where also shows maximum total heat release in the system. Gravity-induced flow correlation of spread rate follows a single curve, indicating that the instantaneous spread rate is essentially determined by the flow structure at the flame leading edge. It is suggested that severe fire retardant regulation and different fire safety strategy must be taken into account for the safety human activity on Lunar or Martian environments.