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THE BEHAVIOR OF MICROGRAVITY SPREADING FLAMES IN NARROW SPACES

Abstract

The fire properties of solid materials are of critical importance for spacecraft fire safety. Although a practical fire could start and spread in a constrained space, most previous experiments on microgravity flame spread have been performed in open areas, and our knowledge of flame behavior in this geometry is rather limited. In this study, drop-tower experiments and numerical computations are conducted to investigate the characteristics of opposed-flow flames spreading over thin solids in narrow tunnels. The flow tunnels have different half-heights in a range of 0.5 - 3 cm, while the velocity of the air flow is fixed at 5 cm/s. Thin Whatman filter is used as the sample paper. The flame spread is recorded by two digital video cameras and the flame temperature is determined by the RGB colorimetric method. It is showed that the flow tunnel height has significant influence on the flame behaviors. With half tunnel heights greater than 1.5 cm, decreasing tunnel height increases the flame spread rate. This is opposite to the flame spread trend in the narrower tunnel regime, i.e. flame spread rate decreases with decreasing tunnel height. Thus, the flame spread rate curve is non-monotonic with respect to tunnel height. The flame length and the flame temperature also depend on tunnel height, and the maximum values are obtained with a half-height of about 1.5 cm. The computation analyses indicate that a finite size tunnel can affect the spreading flames by restricting the thermal expansion and introducing additional heat loss to tunnel walls. The very small tunnel can also put a limit on flame spread by decreasing the oxygen supply into the flame.