Characteristics of microjet methane diffusion flames

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Abstract

Characteristics of microjet methane diffusion flames stabilized on top of the vertically oriented, stainless-steel tubes with an inner diameter ranging from 186 to 778 μm are investigated experimentally, theoretically, and numerically. Of particular interest are the flame shape, flame length, and quenching limit, as they may be related to the minimum size and power of the devices in which such flames would be used for future micro power generation. Experimental measurements of the flame shape, flame length, and quenching velocity are compared with theoretical predictions as well as detailed numerical simulations. Comparisons of the theoretical predictions with measured results show that only Roper's model can satisfactorily predict the flame height and quenching velocity of microjet methane flames. Detailed numerical simulations, using skeletal chemical kinetic mechanism, of the flames stabilized at the tip of d = 186, 324, and 529 μm tubes are performed to investigate the flame structures and the effects of burner materials on the standoff distance near extinction limit. The computed flame shape and flame length for the d = 186 μm flame are in excellent agreement with experimental results. Numerical predictions of the flame structures strongly suggest that the flame burns in a diffusion mode near the extinction limit. The calculated OH mass fraction isopleths indicate that different tube materials have a minor effect on the standoff distance, but influence the quenching gap between the flame and the tube.

Keyword：Microjet flames; Flame characteristics; Extinction limit; Theoretical prediction; Numerical simulation