Lower limit of weak flame in a heated channel

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Abstract

Stationary and non-stationary flame responses in a heated meso-scale channel were investigated both experimentally and computationally. Special attention was paid to flame stabilities, particularly the existence of lower limit of weak flame regime. Previous microcombustion methodology with an external heat source to form stationary temperature gradient in the channel wall was employed. Normal stable flames at high and low velocity regimes, and non-stationary dynamic flames (FREI) at moderate velocity regime were confirmed experimentally. In addition to them, the lower limit of weak flame regime was experimentally identified for the first time. Measured temperature increase in such weak flame was found to be approaching to nearly zero degree. It was found that the flame temperature at the lower limit of the weak flame regime corresponds to ignition temperature of the employed mixture. One-dimensional computations with detailed chemistry and transport properties exhibited ε-shaped curve which has additional lowest velocity regime with previous S-shaped curve. Computational results comprehensively support and interpret the present experimental results indicating that the lower limit of weak flame regime is induced by the weakened reaction due to less frequent molecular collisions by diffusive mass dissipation at extremely low velocity regime.

Keywords

Weak flame, Combustion with heat recirculation,

Limit of mild combustion, Mass dissipation limit