Experimental study of the maximum upstream location of premixed CH₄/air and CH₄/O₂-He flames with repetitive extinction and ignition in a quartz micro flow reactor

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1. Goal of the study
   - Growing need to improve knowledge in the field of small-scale combustion and take advantage of high energy density of fuel [1] in different applications such as portable device [2], micro-satellite thrusters [3], heat sources [4].
   - Previous studies have been done with fuel/air mixtures. Combustion of a CH₄/O₂ mixture with different diluents can improve the understanding of flame behaviour in micro-scale reactor by changing physical properties of the environment. Hence, to be able to point out physico-chemical properties that play an important role in micro-scale combustion.

2. Experimental set-up
   - Cylindrical quartz tube heated by 3 hydrogen/oxygen blowtorchs.
   - The temperature profile on the outer side is measured by an infrared camera A655sc.
   - A spectroscopic EMCCD camera ProEM 1600 and a Phantom v1611 camera coupled with a High-Speed IRO intensifier with a CH² band-pass filter (208PFL_430) is used to detect the flame positions.
   - CH₄/diluent mixture is supplied in a reactor with an internal diameter smaller than the quenching distance. (Quenching distance of CH₄/air is 2.50 mm)

3. Flame with Repetitive Extinction and Ignition (FREI)
   - The ignition in FREI occurs at the hot wall temperature region near blowtorches. Then the flame front propagates upstream toward fresh gases, reaching a maximum upstream location, until it is finally quenched downstream in colder wall region.

4. Diluent Influence on FREI
   - Compositions of diluents used in this study in molar fraction
   - Laminar burning velocity and adiabatic flame temperature of a stoichiometric mixture CH₄/He

5. Conclusions
   - Difference between turning point and extinction point increases with the inlet mixture velocity
   - A new method is used to establish a correlation between turning point and its location
   - Mass diffusivity of the CH₄ and thermal conductivity seems to play a significant role
   - There no simple relations between fluid properties and FREI behavior

Acknowledgements
Authors thank the Ministry of Research on Higher Education (MESRI) for a PhD grant. Support from the CAPRYSSES project (ANR-11-LABX-006-01) funded by ANR through the PIA (Programme d’Investissement d’Avenir) is gratefully acknowledged.