Measurements in flames at elevated pressure and Reynolds number: a few challenges but many opportunities

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Lieu : Amphithéâtre V - Bâtiment Eiffel - CentraleSupélec

Date : jeudi 27 février 2020 - 11h

A large proportion of industrial combustion devices for propulsion and energy operates at elevated pressure and Reynolds number. This is needed to achieve high energy density and efficiency. Improving such devices requires to conduct experiments in laboratory-scale flames at practically relevant operating conditions, namely elevated pressure and Reynolds number. This motivated the creation of the high-pressure combustion laboratory (HPCL) at KAUST in Saudi Arabia. Such experiments are technically challenging and expensive but the ability to vary pressure creates opportunities. This additional degree of freedom opens new territories for parametric studies and can lead to new understanding of flames. In addition, accessing higher pressures unlocks the potential of advanced laser diagnostics such as Raman/Rayleigh imaging or non-linear four wave mixing techniques that all benefit from higher number densities. During this presentation, I will detail some of these opportunities using experiments conducted in the HPCL at KAUST with turbulent jet flames for pressures up to 12 bar and bulk Reynolds numbers up to ~100,000. Specifically, I will show how these experiments led to new understanding of the stabilisation mechanisms of turbulent flames and permitted the first ever simultaneous single-shot imaging of all major species and OH mole fractions and temperature in hydrogen flames.

Thibault GUIBERTI is a research scientist in the Clean Combustion Research Center (CCRC) at the King Abdullah University of Science and Technology (KAUST) in Saudi Arabia. His research interests include measurements in flames at practically relevant operating conditions, the development of laser diagnostics for reactive flows, and the promotion of carbon-free fuels such as hydrogen and ammonia. He received his PhD in 2015 from Ecole CentraleSupélec. Before joining KAUST, he did a one-year post-doc at the University of Sydney, Australia.