PostDoc position in PC2A (CNRS/Université de Lille, France)

Towards low-pollutant combustion technologies: Experimental studies of ozone-assisted combustion

Combustion-driven processes are still responsible for a large proportion of energy production and conversion worldwide. Thus major reductions in pollutant emissions and improvements in fuel efficiency should be sought, and can be reached by means of fuel-lean mixtures of renewable fuels. Controlled initiation of the combustion is however a crucial step towards widespread application of such conditions, with wide ranges of application including piston engines, constant volume combustors, gas turbines and aeronautic engines. However, fuel ignition is highly dependent on the chemical kinetics associated with Low Temperature Combustion (LTC) [1].

The chemical mechanisms relevant to LTC include the formation of unstable peroxides, the structure of which reflects the initial fuel. The reactivity of a fuel in this temperature regime is therefore highly constrained by its structure. This is a strong incentive towards the development of predictive models which must be validated with reliable data in this temperature regime and under rarely investigated fuel-lean conditions.

To this end, a burner dedicated to the study of stabilized cool flames has recently been designed and validated in PC2A [2-4]. The potential to perform detailed kinetic studies through a number of optical and analytical diagnostics, including Planar Laser Induced Fluorescence (PLIF), chemiluminescence, thermometry and gas chromatographic techniques, has been demonstrated. Moreover, the potential of Particle Imaging Velocimetry (PIV) techniques for the determination of cool flame propagation velocities has been established. This paves the way towards exciting upcoming experimental campaigns, which are planned in 2024 and to which the candidate will participate:

1- Among them, the panel of diagnostics associated to the burner will be extended to VUV photoionization mass spectrometry/PhotoElectron PhotoIonization Mass Spectrometry, in collaboration with the DESIRS beamline of Synchrotron SOLEIL, allowing the selective detection and quantification of elusive products, such as the hydroperoxides responsible for radical-chain branching.

2- Further development of the PIV technique towards determination of cool flame burning velocities for new fuels will be achieved in collaboration with CORIA and LMFL laboratories.

References

[1] F. Battin-Leclerc, Detailed Chemical Kinetic Models for the Low-Temperature Combustion of Hydrocarbons with Application to Gasoline and Diesel Fuel Surrogates. Prog. Energy Combust. Sci. 2008, 34, 440−498.
[2] K. De Ras, T. Panaget, Y. Fenard, J. Aerssens, L. Pillier, J. W. Thybaut, G. Vanhove, K. M. Van Geem, An experimental and kinetic modelling study on the low-temperature oxidation of oxymethylene ether-2 (OME-2) by means of stabilized cool flames, Combustion and Flame 253 (2023) 112792.
[3] T. Panaget, K. Potier, S. Batut, A. Lahccen, Y. Fenard, L. Pillier, G. Vanhove, How ozone affects the product distribution inside cool flames of diethyl ether, Proceedings of the Combustion Institute 39 (2023) 325-333.
[4] T. Panaget, N. Mokrani, S. Batut, A. Lahccen, Y. Fenard, L. Pillier and G. Vanhove, Insight into Ozone-Assisted Low-Temperature Combustion of Dimethyl Ether by Means of Stabilized Cool Flames, J. Phys. Chem. A 125 (2021) 9167−9179.

Keywords: Low Temperature Combustion, Kinetics, Pollutant reduction, bio- and e-fuels, optical and analytical diagnostics.

Academic Requirements: A PhD degree in the fields of Combustion Chemistry and/or Laser diagnostic techniques and a strong aspiration to perform experimental work are required.

Funding: CPER ECRIN (https://ecrin.cper-hautsdefrance.fr/)

Laboratory: PC2A

Supervisors: Guillaume VANHOVE, Laure PILLIER

Duration and starting date: 13 months, flexible start from October 2023 to January 2024.

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About PC2A (https://pc2a.univ-lille.fr/)

PC2A (Physico-Chimie des Processus de Combustion et de l'Atmosphère) is a joint laboratory of the CNRS and the University of Lille, in which transdisciplinary research has been performed for more than 60 years in the fields of combustion and atmospheric chemistry. Based on a strong interaction between experimental and modeling work, the researchers in PC2A crave at building better understanding of the science behind the challenges of the current society, such as clean and safe energy, and the mitigation of, and adaptation to climate change.