International Master 2 Atmospheric Sciences: Research Training 2021-2022

Laboratory: PC2A

Supervisor: VANHOVE Guillaume

Tél : 03.20.43.44.85, E-mail: guillaume.vanhove@univ-lille.fr

Co-supervisor: PILLIER Laure

CaPPA Work Package: WP-1 From gas phase to aerosols

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. In all these cases, reproducible initiation of the combustion phase is sought, and multipoint or volumetric ignition being preferred. However, fuel ignition is highly dependent on the chemical kinetics associated with Low Temperature Combustion (LTC).

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 also true for next generation biofuels, whose oxidation pathways can be strongly different from “traditional” fossil fuels. To facilitate ignition of such fuels, ozone-seeding has been suggested as a practical and easy solution.

To investigate the potential of this technology, a burner dedicated to the study of stabilized cool flames has been designed and validated. The potential to perform detailed kinetic studies through a number of optical and analytical diagnostics has been demonstrated, including Planar Laser Induced Fluorescence (PLIF), chemiluminescence and gas chromatographic techniques. These data can be used to validate kinetic models of the LTC chemistry under these rarely investigated conditions.

As part of future work, the panel of diagnostics associated to the burner will be extended to VUV photoionization mass spectrometry/PhotoElectron PhotoIonization Mass Spectrometry, and preliminary flame stabilization tests, as well as characterization of flames in a similar configuration dedicated to this diagnostic, must be carried on.

Keywords: Combustion, kinetics, pollutant reduction.