International Master 2 Atmospheric Sciences: Research Training 2020-2021

Laboratory: PC2A

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

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

The future of combustion engines is dependent on significant reduction in pollutant emissions, as well as improvement in fuel efficiency and substantial reduction in fuel consumption. Controlled initiation of the combustion is a crucial step towards these goals, 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, 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 this work, the panel of diagnostics associated to the burner will be extended to flow-field characterization optical techniques, as well as techniques dedicated to the detection of unstable species, such as VUV photoionization mass spectrometry.

Keywords: Combustion, kinetics, pollutant reduction.