International Master 2 Atmospheric Sciences: Research Training 2020-2021

Laboratory: PC2A

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Eventually,

CaPPA Work Package: WP1. From gas phase to aerosols

On the influence of hydrogen on the low-temperature combustion kinetics of biofuels

Considering the environmental costs of manufacturing, running and disposing of electric vehicles, the opportunity to use internal combustion engines fueled with hydrogen is much more realistic than expecting a nearly immediate global uptake of electric vehicles. Governments are putting strategic plans in motion to decrease primary energy use, take carbon out of fuels and facilitate modal shifts. Taking a prominent place in these strategic plans is hydrogen as a future energy carrier. A number of manufacturers are now leasing demonstration vehicles to consumers using hydrogen-fueled internal combustion engines. This dual-fuel application shows a decrease of NO_x, smoke, CO and unburnt hydrocarbons emissions.

However, fundamental studies on the hydrogen process affecting the low temperature combustion kinetics of carbon fuels are scarce, especially with oxygenated fuels produced from biomass. Low temperature combustion kinetics are initiated by the interaction of fuel-originated primary radicals and molecular oxygen, leading to an increase of the reactivity in the temperature range 650-800 K. It affects the operation of internal combustion engines, and ultimately their efficiency and pollutant emissions.

A global parameter is widely used for the characterization of a fuel: the ignition delay time (IDT). It describes the time required for a fuel/air mixture to ignite under known conditions of temperature and pressure. The study of the IDT allows the formulation of fuels and the optimization of fuel/air equivalence ratio required for an optimal performance of an engine.

During this internship, we propose the measurement of the IDT of different fuels mixed with H_2 depending on the chemical nature of the fuel – alkane, alkene, alcohol or ketone – to cover the potential chemicals that could be found in fossil fuels or biofuels. The facility used at PC2A is a rapid compression machine. This facility compresses the fuel / air mixture within 45 ms to pressures up to 25 bar heating the mixture to temperatures of 600 and 900 K. It is a temperature range allowing the study of the low-temperature kinetics of combustion. The analysis of results will make it possible to draw a trend in the interaction of chemical functions with H_2.

Key words: Hydrogen, biofuels, ignition delay times, pollutants, combustion