ADVANCES IN THE COMBUSTION KINETICS OF SECOND-GENERATION BIOFUELS

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Abstract

The decline of the World's oil resources, unpredictable market prices, increasing demand for ground and air transportation fuels, and environmental concerns (i.e., global warming, emission of nitrogen oxides, particulates, polyaromatics, volatile organic compounds etc.) have recently made the production of 1st generation biofuels to reach record volumes . This can be interpreted as early transition to a high-efficiency and low-carbon energy scheme. Different renewable raw materials sources and technological routes to produce sustainable biofuels have been investigated, demonstrating the 1st generation biofuels obtained from edible sources have limited value. Conversely, second-generation biofuels produced from ligno-cellulose should better secure our energy future and create jobs in renewable energy industries. A range of ligno-cellulosic sources is available (i.e., straw, woody materials, vegetable waste).

Whereas biodiesel and ethanol are used worldwide for automotives, jet fuels reformulation has been investigated only recently in the US and in Europe. A variety of renewable fuels have been considered. Amongst them, synthetic kerosene obtained via a coal-to-liquid Fischer-Tropsch process has recently been certified. However, there are lots of difficulties for proposing valid combustion models for these fuels due to their unusual composition (e.g., high content of lightly branched paraffins). Furthermore, the FT-fuels composition varies with their origin, resulting in combustion modelling difficulties and need for advanced surrogates. Many other chemicals including furanics, terpenes, isoprenoids, algae-derived fuels, and fatty alcohols have been proposed. Until recently, for most of these compounds, the chemical kinetics of oxidation was unknown and needed to be investigated experimentally and theoretically to benefit of positive aspects of fuel reformulation and minimize drawbacks. New combustion-generated pollutants arising from the combustion of reformulated fuels, potentially dangerous to human beings must be identified and their mechanisms of formation assessed.

Recent experimental and kinetic modelling results for the combustion of synthetic fuels are presented. They concern synthetic jet fuels, oxygenated fuels, mixtures of biofuels with conventional fuels [1-4]. The kinetics of oxidation of these fuels was studied using jet-stirred reactors. The sensitization of fuels ignition was also investigated by combining homogeneous charge compressed ignition engines and kinetic modelling [5-7]. Finally, the impact of fuel reformulation on pollutants emissions was studied using sooting premixed flames and a Diesel engine[8-9].

Acknowledgements

The research leading to these results has received funding from the European Research Council under the European Community's Seventh Framework Programme (FP7/2007-2013) / ERC grant agreement n° 291049 − 2G-CSafe.

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