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Activities of the Core

Jul. 5-6, 2021	The 5th International Symposium on Fuels and Energy (ISFE2021)
Jul. 29, 2021	The 95th Hiroshima University Biomass Evening Seminar(co-organized)
Jul. 30, 2021	The 61st HU-ACE Steering Committee Meeting

The ISFE2021 was held successfully online.

The 5th International Symposium on Fuels and Energy (ISFE2021) hosted by the Advanced Core for Energetics, Hiroshima University (HU-ACE), which was initially planned in July at Higashi Hiroshima Arts & Culture Hall 'Kurara', was held online due to the outbreak of COVID-19. Although the numbers of attendees, presentations, and invited lecturers were lower than usual (48 participants, 35 general presentations, and 4 invited lecturers), it was a fruitful meeting in which we were able to provide a forum for a wide range of lectures, presentations, and discussions on the broad topic areas of fuel and energy thanks to the cooperation of all the attendees. The organizers deeply thank all attendees and collaborators, and hope to hold a successful face-to-face meeting in the next year.

ISFE2021(ZOOM) Holding scenery

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Research Topics

No. 25

Characterization of Diesel Sprays at Evaporating and Reacting Conditions

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Research fields: Fuel sprays, Combustion, Energy technology, Optical measurement techniques
Keywords: Diesel engine, Spray, Combustion, Optical diagnostics

Abstract

Background

The diesel engine is widely used for propulsion of trucks, ships, construction equipment, and cars. Even if today's engines are built on advanced technology, there is a need for further improvements in terms of higher efficiency, lower emissions, and operation on renewable fuels. The fuel injection process, in which pressurized fuel is injected into the cylinder through small holes forming sprays, is key to controlling the combustion.

Methods

Fuel sprays are investigated in a specially designed chamber with gas pressure and temperature similar to those inside a diesel engine. The chamber has large windows for optical characterization of the spray using laser light and cameras. The laser absorption and scattering (LAS) technique, originally developed for liquid and vapor phase spray measurements at Hiroshima University, was applied using high-speed video cameras. Further, OH molecules and soot were characterized by detecting luminescence, fluorescence, or absorption with additional cameras.

Results

Cavitation in the nozzle hole is expected to have an influence on the characteristics of the fuel spray and sprays from straight; cavitating, and convergent; non-cavitating, nozzle holes were compared [1]. It was found that sprays from straight holes were wider up to 20 mm downstream of the nozzle, but evaporation was at least as fast using conical nozzles indicating a good air entrainment and mixing. In studies of diesel spray flames, the soot formation and oxidation were characterized by imaging soot and OH distribution for sprays from nozzles with different diameters, different injection pressures, as well as for different blends with renewable fuels [2-4]. It was found that for smaller nozzle hole diameters and higher fuel injection pressures the amount of soot and the volume where soot is present decrease and the volume of the OH-rich flame increases, as shown in Fig. 1. Furthermore, renewable fuels containing oxygen form less soot due to both of the chemical composition and a longer time for air mixing in the spray before ignition. A process in the diesel engine, the spray and flame impinging on the piston, can be mimicked in the spray chamber [5]. It has been found that wave-like protrusions in the piston bowl can both increase efficiency and reduce particle emissions. Spray chamber studies in combination with modelling revealed that this is the result of the protrusions inducing faster detachment of the flame from the piston wall leading to faster oxidation.

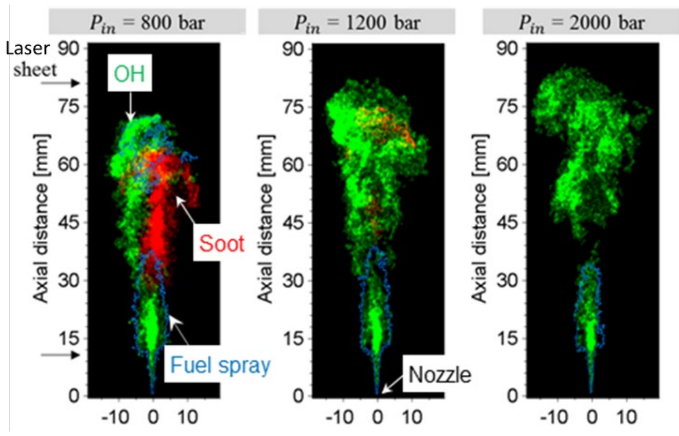

Fig. 1: Overlaid images from a diesel spray flame of OH fluorescence (green), soot concentration (red), and fluorescence from other species, e.g. aromatic molecules in the fuel (green inside blue border) [3].

References

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