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HU-ACE NEWS LETTER

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Activities of the Core

Apr. 16-17, 2021	At the "International Symposium Optical Diagnostics of Combustion Systems" held on-line, Professer Nishida gave a guest lecture "Optical Measurement of Fuel Spray -Fuel Air Mixture Formation and Wall-Impinging Spray Fuel Film Formation"
Apr. 19, 2021	The 58th HU-ACE Steering Committee Meeting
Apr. 21, 2021	The 93rd Hiroshima University Biomass Evening Seminar (co-organized)
Apr. 23, 2021	The 55th Mechanical System Engineering Seminar (in Japanese, co-organized)

New Head of HU-ACE was Appointed.

Head of this core, Prof. Keiya Nishida, retired from professorship at Hiroshima University in March, 2021. Thus, we had to ask for approval of the core's continuation and exchange of its head. Approval by the university was delayed until August, but now the continuation of the Advanced Core of Energetics, Hiroshima University (HU-ACE) with Prof. Yukihiko Matsumura as its new head has been officially approved. We will continue to develop the Hiroshima Scenario, information sharing on energy, and interdisciplinary collaborative research on energy and the environment, and thus, we would like to ask for your continued support going forward. Prof. Nishida will continue to participate in the organization of this core, collaborative projects, etc. Now that continuation of the core is officially approved, we are pleased to announce that the news letter reporting our activitiesy in April, 2021 is here. We apologize for the delayed delivery, due to waiting for the official approval.

Prof. Keiya Nishida

New head Prof. Yukihiko Matsumura

Issued by Advanced Core for Energetics, Hiroshima University
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Research Topics No. 24

Seeing is believing

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Research fields: Engineering/Mechanical Engineering/Fluid Engineering
Keywords: Fuel Spray/ Liquid Atomization/ Internal Combustion Engine/ Diesel Combustion/ Laser Diagnostics/ Simulation

Abstract

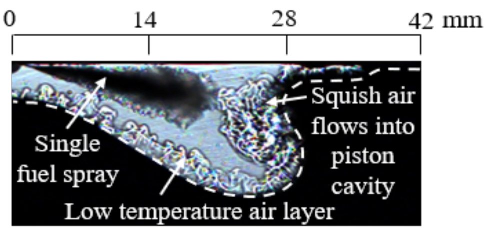
The combustion chamber of a Diesel engine is a space enclosed by the cylinder head, cylinder liner, and piston top surfaces. Defining the combustion chamber shape is an essential design process of the engine combustion system, which greatly influences the exhaust gas emissions, especially soot, and the thermal efficiency. Since the cylinder head surface is flat, the cylinder liner is cylindrical, and their shapes cannot be changed, the shape of the top of the piston is the design parameter that defines the combustion chamber shape.

The top of the piston is carved with a cavity in the center, which is filled with air during the compression process, then the “squish” flow is created in the vertical plane of the combustion chamber (including the cylinder axis). Beside the airflow, the fuel sprays, injected radially from the injection nozzle at the center of the cylinder head, impinge on the piston cavity side wall and flow along the cavity wall. However, the phenomena of the squish flow and the impinging spray had not been confirmed with experimental observation, and these were just our predictions.

We at the Mechanical Power and Motor Systems Laboratory built the special experimental apparatus, in collaboration with Mazda Motor Corporation, to observe the phenomena in the piston cavity from the cylinder lateral side. With this apparatus, visual measurements were made of the in-cylinder airflow, fuel spray development in the piston cavity, and subsequent combustion and soot formation processes [(1)].

The new finding is that the low temperature air squish flow from the clearance space, between the piston side and cylinder liner (piston top land), into the piston cavity appears near the top dead center in the compression and expansion strokes (Fig.1). Another finding is that the fuel spray and flame penetrate along the cavity wall in the direction of the cavity bottom and cylinder head (Fig.2). We concluded that the roles of the piston cavity are (I) to concentrate the in-cylinder air to the central area of the cylinder where the fuel sprays are located and (II) to guide the fuel spray to the cavity bottom after the wall impingement to increase air utilization along the cavity bottom. These conclusions could be obtained through the visual study, which teaches us that “seeing is believing”.

(1) Fan, et al., International Journal of Engine Research, DOI:10.1177/1468087421993062 (2020).



-2.2ms ATDC

Fig.1 The piston cavity of the right half from the cylinder center is shown. The squish flow is created by squeezing the space between piston top and cylinder head. The low temperature air flows from the top land space. The fuel spray develops toward the cavity side wall.

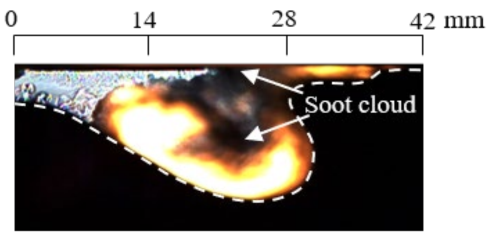


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Fig.2 The fuel spray, after the impingement on the cavity side wall, develops in the direction of the cavity bottom and the cylinder head. After the ignition, luminous flames appear and the black soot cloud is formed in the low temperature air side (not along the cavity wall).