Advanced Core for Energetics, Hiroshima University Vol. 71

HU-ACE NEWS LETTER

Vol. 71
2022.11

Advanced Core for Energetics, Hiroshima University

Activities of the Core

Nov. 2, 2022	The 103th Hiroshima University Biomass Evening Seminar (co-organized).
Nov. 7, 2022	The 76th HU-ACE Steering Committee Meeting.
Nov. 18, 2022	Responding to the Japan Association of New Economy's "Inspection of Carbon Neutrality Initiatives"

The 1st Ground thermal energy seminar (110th ACE seminar) was held

The 1st Ground thermal energy seminar was held online on 25th Oct 2022. Prof. Katsunori Nagano of Hokkaido University, who is a leader of ground thermal energy utilization in Japan, gave us a lecture with the title “The world trends of ground thermal energy utilization and recent research in Hokkaido University to achieve further advancement and cost reduction”. The lecture gave suggestions for future improvement of ground thermal energy utilization to 50 participants in total. Prof. Nagano reported dynamic and active trends in foreign countries with three key points in the system design: 1) increase in the system size, 2) increase in the depth of a heat exchanger, and 3) increase in the density of heat supply. In particular, “the fifth-generation district heat supply system” allows heat supply with low temperatures compared to previous ones and may be a trend forward the worldwide spread of utilization of ground thermal energy. Prof. Nagano also introduced a NEDO research project focusing on standardization of a database and simulation tool.

Issued by Advanced Core for Energetics, Hiroshima University
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Research Topics

No. 37

Laser ignition of high-speed C_2H_4-O_2 gas flow

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Research fields: Engineering/Integrated engineering/Aerospace engineering
Keywords: Laser / Combustion / Detonation / Thermal spray

Abstract

Background

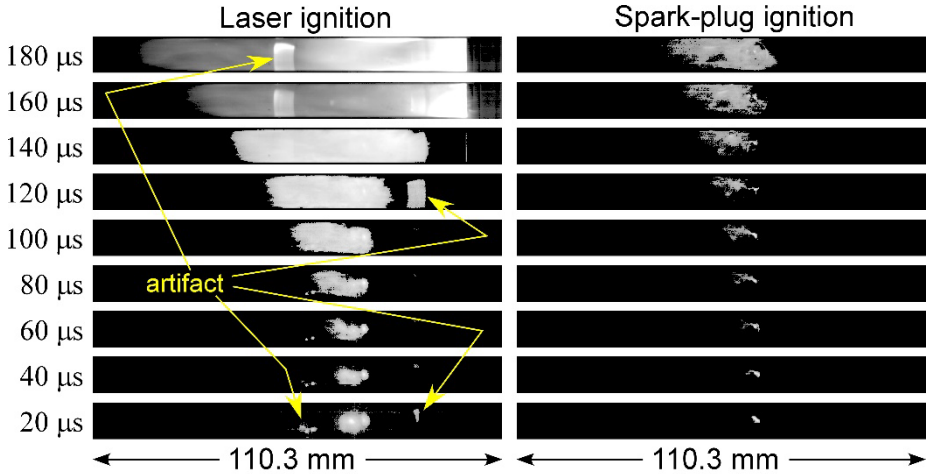
Spark-ignition engines are being developed toward lean-burn high-compression-ratio operations offering greater fuel economy but requiring durable high-energy ignition devices. Higher spark energy tends to decrease the life of the conventional spark plug. Recent advances in laser technology have made laser devices smaller and cheaper, and laser ignition a promising ignition technology. So far, we demonstrated that laser ignition is superior to spark-plug ignition when the flammable gas is quiescent [1]. This time, we show some results on the experiments in which high-speed flammable-gas flow is ignited by laser [2].

Methods

With a Nd:YAG laser of 10-ns pulse duration and a conventional spark plug of 2-ms discharge duration, we carried out ignition experiments on ethylene-oxygen gas mixtures. In both of the ignition methods, the deposited energy was fixed to be 24 mJ. The high-speed flow of an ethylene-oxygen gas mixture was created by the head-on collision between the high-speed gas flows of ethylene and oxygen at the inlet of the combustor. The average flow speed of the flammable gas was (1) 0 m/s, (2) 40-46 m/s, or (3) 82-114 m/s in the ignition experiments. The fuel equivalence ratio of the mixture was varied from 0.13 to 0.30. The cross section of the combustor was a square of 8.86 mm x 8.86 mm, and the combustor length was 170 mm. In the experiments, we observed self-emission images of the burning gas with a high-speed camera through a window of sapphire, and investigated the ignitability and flame propagation.

Results

The figure on the right shows the behavior of the burned-gas extension, where the time origin corresponds to the beginning of the ignition spark. In the case of the laser ignition, the initial flame kernel is very large, and accordingly, the subsequent extension of the burned-gas begins earlier. It is therefore expected that all of the flammable gas in a combustor burns out in a shorter time. The ignitabilities of both of the ignition methods were almost the same, but the laser ignition was slightly inferior near the lower ignitability limit.



Self-emission images
(Flow speed: 89 m/s [from right to left], Equivalence ratio: 0.205)

References

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