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Activities of the Core

May. 10, 2022 — The 100th Hiroshima University Biomass Evening Seminar (co-organized).

May.25, 2022 — The 71th HU-ACE Seminar was held.

Development of Safety Technology for Hydrogen Fueled City Infrastructure.

HU-ACE is participating in the project "Development of Safety Technology for Hydrogen Fueled City Infrastructure" (2022-2026) funded by the Ministry of Science and ICT, which is a ministry of the Government of South Korea. This project aims to expand the hydrogen economy and achieve carbon neutrality by developing protection and safety systems for hydrogen urban infrastructure facilities, evaluating underground protection and material systems in consideration of hydrogen explosions or combustion, and developing safety facilities, operation systems, and blue hydrogen platforms in hydrogen infrastructure.

Hydrogen Fueled City Infrastructure

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Research Topics No.32

Renovation of engine combustion by carbon-neutral fuels

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Research fields: Combustion engineering/chemistry, Chemical kinetics
Keywords: Detailed kinetics of combustion, Engine combustion and fuel

Abstract

Background

Transition to renewable energy is inevitable for mitigation of climate change and global warming. To this end, some automobiles will be replaced by electric cars, while high energy-density liquid fuels such as gasoline and diesel oils will be produced from carbon-neutral energy sources. These liquid fuels should not need to mimic those derived from fossil fuels. If fuels more appropriate for automotive engines can be provided, then engine performance will increase, which will lead to a depletion of carbon dioxide emissions. In that case, what is the most appropriate fuels? The goal of our research is to answer this question.

Methods

To answer the question, research is underway in the form of joint projects, in which researchers of automotive companies, oil companies, and universities are working together. Within this research, my role is, by elucidation of reaction mechanisms of combustion, to answer *why this fuel is good*. Combustion is a chemical reaction consisting of a huge number of elementary processes. The mechanisms are constructed from the accumulated experimental and theoretical knowledge supplemented by quantum chemical or other calculations. Then, by numerically solving the system of ODEs of elementary reactions, combustion phenomena are reproduced and analyzed. Here, examples of such numerical calculations are shown.

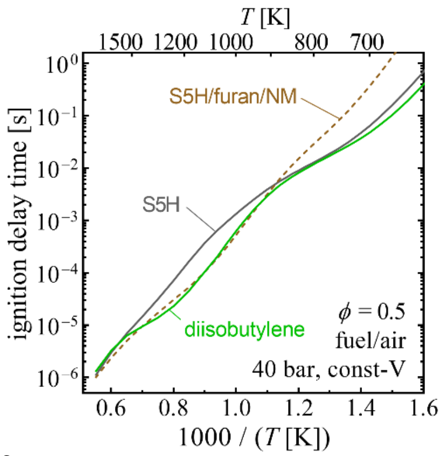

Fig. 1. Temperature-variation of ignition delay times (IDT).

Results

The thermal efficiency of gasoline engines is limited by the anomalous combustion called *knock* and fuels are regulated by the anti-knock property known as octane number. Figure 1 shows the temperature dependence of ignition delay times (IDTs) of several fuels. High octane-number fuels show larger IDTs at lower (<1000 K) temperatures. Recent research engines use fuel-lean conditions to reduce the cooling loss by lowering the combustion temperature. Under such lean conditions, it is found that better performance is reached by fuels with shorter IDTs at high (>1000 K) temperatures such as brown and green curves of model fuels. In order to elucidate other properties, numerical simulations were performed and are shown in Fig. 2. Flame propagation in engines need to be fast and firm but these are deteriorated under lean conditions. The right turning point of each curve in Fig. 2 shows the resistance against extinction. The fuels with smaller molecular weights tend to show stronger resistance in this example.

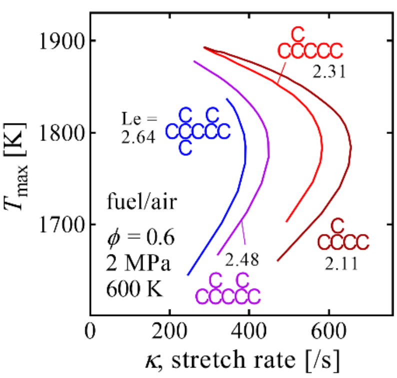

Fig. 2. Extinction stretch rate.

References

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