Advanced Core for Energetics, Hiroshima University Vol. 36

HU-ACE NEWS LETTER

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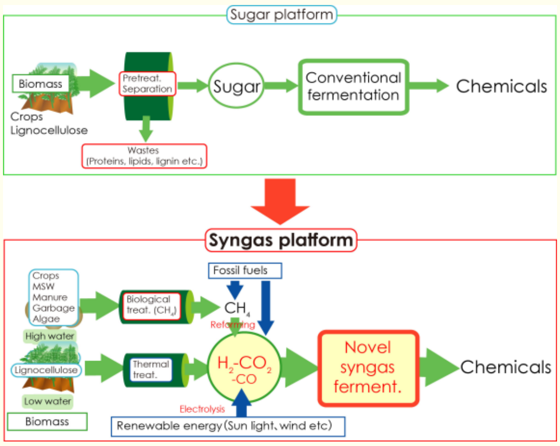
Activities of the Core

Dec.1,2019	Nishida, Head of HU-ACE attended the 3rd Low-Speed Marine Engine Technology Development Conference held in Shanghai, China and gave an invited talk.
Dec.16,2019	The 80th Hiroshima University Biomass Evening Seminar (co-organization)
Dec.19,2019	The 40th HU-ACE Steering Committee Meeting

Making bulk chemicals from renewable energy and resources by utilizing microorganisms

To realize a low-carbon society, it is effective to develop a recycling-based production processes that use renewable energy such as biomass, sunlight, and wind power in an integrated manner. In our laboratory, under the support from JST JST-Mirai Program, we are developing various strains of *Moorella thermoacetica* (thermophilic homoacetic acid bacteria) to produce bulk chemicals from synthetic gas (CO-H_2) and H_2 and CO_2 as raw materials using genetic engineering. In particular, we are proceeding with the development of bacteria strains producing C2 to C4 compounds, which are difficult to produce by sole chemical synthesis.

By using the bulk chemical-producing bacteria obtained in this research will enable CO_2 (carbon) -recycled bulk chemical production from synthetic gas obtained by biomass gasification and renewable hydrogen as energy sources in the future. I expect that it will contribute significantly to the realization of a low carbon society.



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Research Topics No. 13

Renewable fuels renovate automotive engines

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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 including global warming. For this purpose, some of the automobiles will be replaced by electric cars while the high energy-density liquid fuels such as gasoline and diesel oils are going to be produced from renewable energy source. These liquid fuels should not need to mimic those derived from fossil oil. If fuels more appropriate for automotive engines can be provided, the engine performance will increase and results in depletion of carbon dioxide emission. Then, what is the appropriate fuels? We do not have clear answer to this question.

Methods for research

To answer this question, researches are undertaken as joint projects among researchers of automotive company, oil company, and universities. In these, my role is, by elucidation of reaction mechanisms of combustion, to answer *why this fuel is good*. Combustion is 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.

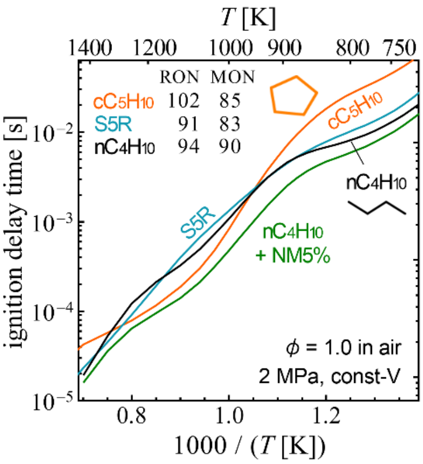

Fig. 1. Temperature-variation of ignition delay times (IDT).

Results

The thermal efficiency of gasoline engine 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 condition to reduce the cooling loss by lowering the combustion temperature. However, under such lean conditions, it is found that the better performance is reached by fuels with shorter IDTs at high (>1000 K) temperature such as orange and green curves of model fuels. In order to elucidate this, numerical simulations were performed and shown in Fig. 2. Flame propagation in engines are need to be fast and firm but these are deteriorated under lean condition. The right turning point of each curve in Fig. 2 shows the resistance against the extinction. The fuels with shorter ignition delay time in Fig. 1 tend to show stronger resistance.

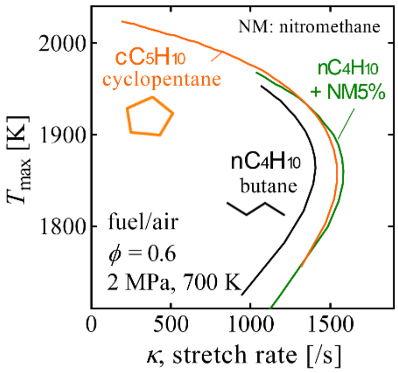

Fig. 2. Extinction stretch rate.

References

[1] Akira Miyoshi, On the Relation between the Extinction Flame Stretch and SI Combustion Characteristics of Fuels, 57th Symp. (Jpn.) Combust., E132, Sapporo, Nov. 11–22, 2019.