講演番号	368

The Issues in microalgae biofuel production and efforts to solve them

- (2nd Report) A Study on the Production of Gasoline Alternative Fuels , Maximization of CO_2 Reduction Efficiency , Improvement of Lipid Productivity -

Shinichiro Maeda[1)] Takehisa Koroki[1)] Kumiko Okazaki[2)] Tomokazu Kurita[2)]
Masako Iwai[4)] Hiroyuki Ohta[3)4)] Yoshitaka Nishiyama[5)] Takashi Yamamoto[2)] Atsushi Sakamoto[2)]
Hiroyuki Yamashita[1)]

1) Mazda Motor Corporation, 3-1 Shinchi, Fuchu-cho, Aki-gun, Hiroshima 730-8670, Japan. (E-mail: maeda.shin@mazda.co.jp)
2) Division of Integrated Sciences for Life, Graduate School of Integrated Sciences for Life, Hiroshima University,1-3-1 Kagamiyama, Higashi-Hiroshima, Hiroshima 739-8526, Japan.
3) School of Life Science and Technology, Institute of Science Tokyo, 4259-B-65 Nagatsuta-cho, Midori-ku, Yokohama, Kanagawa 226-8501,Japan.
4) Phytolipid Technologies Co. Ltd., 4259-3 Nagatsutacho, Midori Ward, Yokohama City, Kanagawa PrefectureTokyo Institute of Technology Yokohama Venture Plaza W402 226-8510, Japan.
5) Department of Biochemistry and Molecular Biology, Graduate School of Science and Engineering, Saitama University, 255 Shimo-Okubo, Sakura-ku, Saitama 338-8570, Japan.

KEY WORDS: **recyclable energy/renewableenergy, fuel/alternative fuel, energy manufacturing, algae biofuel (D2)**

Toward the carbon neutrality of automobiles, Mazda has adopted a “Multi-Solution Strategy,” which deploys powertrain technologies—including internal combustion engines and electrification—in an optimal manner tailored to specific applications, thereby addressing substantial CO_2 reduction. Among these solutions, bio-liquid fuels for internal combustion engines represent one of the most practical and promising options. In particular, biofuels produced from microalgae, which do not compete with food resources and offer high areal productivity, are regarded as one of the most viable candidates.In our previous report, we presented the significance, challenges toward widespread adoption, and research strategy for the social implementation of microalgae-derived biofuels that we have been pursuing. In this paper, we report on (i) the feasibility of producing gasoline substitute fuels from microalgal lipids, (ii) the maximization of CO_2 reduction, and (iii) initiatives to improve lipid production efficiency.

When producing automotive biofuels from microalgal lipids, diesel substitute fuels are typically targeted due to the carbon chain length of algal lipids. In contrast, gasoline substitute fuels are generally considered to be a combination of bioethanol and synthetic fuels. Since bioethanol blending is subject to an upper limit, it is necessary to increase the blending ratio of synthetic fuels; however, synthetic fuels inherently require a large amount of renewable electricity, which constitutes a fundamental challenge. If gasoline substitute fuels can be produced directly from microalgal lipids, they could compensate for the shortage of synthetic fuels and contribute to the carbon neutrality of automobiles. Accordingly, we investigated the feasibility of producing gasoline substitute fuels from microalgal lipids. As a result, it was found that diesel and gasoline substitute fuels can be selectively produced by controlling the reaction temperature during the isomerization process within the fuel production pathway (Fig.1).

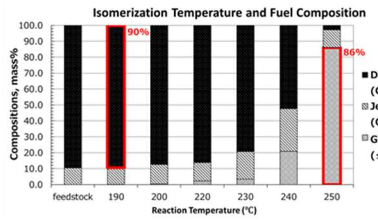

Fig.1 Isomerization Results

Microalgal biofuels are required to achieve a high CO_2 reduction rate. Using a process model developed by Mazda, we examined approaches to maximize CO_2 reduction. The results indicate that a CO_2 reduction rate of up to 90% relative to fossil fuels can be achieved through the utilization of waste materials and waste energy, together with the progressive carbon neutralization of electricity and hydrogen (Fig.2).

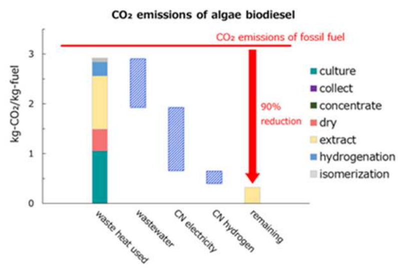

Fig.2 Estimated CO_2

A major challenge for microalgal biofuels is cost. In our previous report, we demonstrated that improving lipid production efficiency is a key pathway to addressing this issue. Therefore, to enhance lipid production efficiency, we conducted cultivation experiments under high-intensity light, fully leveraging the characteristic logarithmic growth of microalgae. As a result, we achieved a lipid productivity of 0.73 g/L/day, which exceeds the typical value for Nannochloropsis by more than 25 times. However, the use of high-power artificial lighting leads to a deterioration in energy efficiency. Based on experimental results, we have identified regions of high photosynthetic quantum yield (Fig.3). Going forward, we will advance the development of cultivation systems that simultaneously realize maximum energy efficiency and scalability, utilizing model-based technologies.

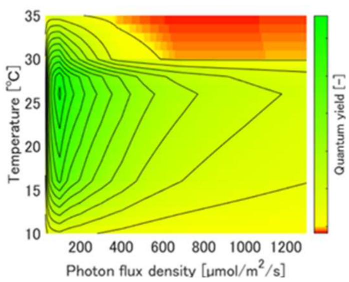

Fig.3 Photosynthetic Efficiency Map