MODELING AND COMPREHENSIVE ASSESSMENT OF LARGE-SCALE OIL PRODUCTION SYSTEM FOR *BOTRYOCOCCUS*

Hiroaki Ide

Key Words: Botryococcus, Energy, Energy balance, Modeling, Large-scale cultivation, Energy payback time

1. INTRODUCTION

The large-scale oil production system using hydrocarbon-producing microalgae, *Botryococcus* spp., is expected as a new energy production system depending basically on photosynthesis. However, the comprehensive assessment of the system has not been evaluated sufficiently yet. The objects of this study are to establish an estimation model for the system to calculate the energy-balance and energy pay back time (EPT), and to evaluate the system as an energy production system.

2. MODELING AND CALCULATION

At first for the assessment, the system was divided into five major processes (1: strain maintenance in an incubator, 2: preculture for large-scale cultivation, 3: large-scale cultivation, 4: harvesting, and 5: liquefaction or solidification of algal biomass). It was presumed that the system was constructed at the side of a thermal power plant using LNG as its fuel, its waste gas was used for CO_2 source for the algal cultivation and the size of a large-scale culture pond was 19 ha. The energy consumption at each process was calculated using basic units reported in elsewhere. The flux of culture media and algal cell concentration were also calculated using basic units in several reports. The amount of total energy consumption was the sum of those energy consumptions. The amount of total energy production was defined as the energy of the liquefied or solidified algal biomass as a fuel. EPT was calculated based on the energy balance as well as the consumption energy for the system construction. The daily expected amount of fuel which could be stably supplied from the system through a year was calculated based on the fuel productivity and the daily variation of weather. Calculation procedures were shown in Fig. 1.

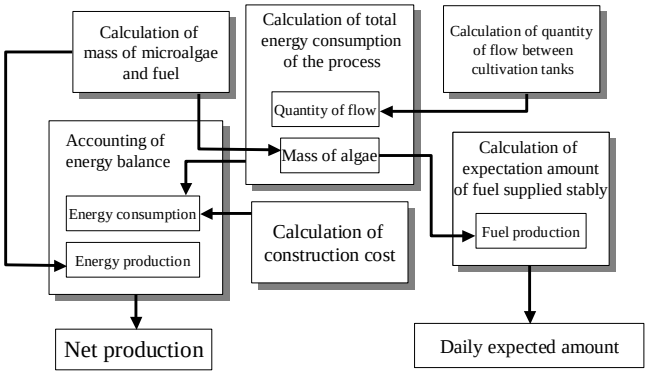

Fig. 1 Calculation procedures

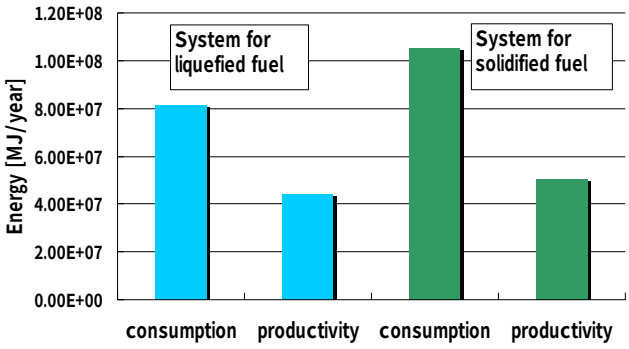

Fig. 2 Total energy consumption and productivity

3. RESULT

The calculated amounts of total energy consumption and productivity by the system were shown in Fig. 2. In the both case of liquefied and solidified fuels as its final products, the energy productivity was higher than the consumption, the total net production was 3.7×10^7 MJ and 5.4×10^7 MJ in a year, and EPT was calculated as 0.42 year and 0.29 year, respectively. EPT could be decreased to 0.36 year (liquefied fuel) and 0.23 year (solidified fuel), respectively, by the employment of seawater or stock media for precooling the waste gas and of waste heat from the power plant for the liquefaction or solidification process. In the case of liquefied fuels as the final products, annual mass productivity was 1.77×10^6 kg/year, and the daily expected amount was calculated as 4.4×10^3 kg/day.

4. CONCLUSION

This system can work as an energy production system because of its positive balance even under the consideration of total process. This system is also expected to be useful since this can supply a certain amount of fuel everyday through a year.