Priority Subjects — **Development of a Supply/Demand Infrastructure for Next-Generation Electric Power**

Improvement of Utilization Technology for Low-Grade Energy Resources

Background and Objective

As one of the carbon dioxide emission reduction measures for coal-fired power plants, co-combustion of biomass has been promoted in Japan, but the mixing ratio of biomass remains at a few percent due to the difficulty of biomass pulverizing compared to coal. In this project, we aim to develop a carbonization technology of biomass, the evaluation technology and standardization of carbonized biomass fuel used in coal-fired power plants. These are useful to improve the mixing ratio of biomass in co-combustion and to reduce the carbon dioxide emissions from coal-fired power plants.

Main results

1 Development of carbonization technology and estimation technology

Carbonized biomass fuel for commercial use is required to have a stable fuel property, such as heating value, fixed carbon, and fuel ratio*1. The property of carbonized biomass varies according to the carbonizer operation conditions such as feed rate of raw biomass, carbonization temperature and residence time. To maintain the property stably, continuous measurements must be made of the carbonized biomass and the measured values must be fed back into the carbonizer operation conditions. Carbonization tests were carried out on woody biomass using a demonstration scale carbonization test facility. The test results showed the property of carbonized biomass fuel (higher heating value, etc.) had correlation with the yield*2 of carbonized biomass*3 (Fig. 1) (M14012). The yield of carbonized biomass, which is calculated from the feed rate of raw biomass and the production rate of carbonized biomass, was found to be an effective operational index of carbonization process. The test results also showed the hue angle*4 of carbonized biomass had correlation with the heating value of carbonized biomass (Fig. 2) [1]. Because the hue angle also had correlation with the fixed carbon and fuel ratio of carbonized biomass, the colorimetry was found to be a convenient method for estimation of carbonized biomass property.

2 Co-combustion characteristic of coal and carbonized biomass

Assuming the use of carbonized woody biomass at a high mixing ratio in a coal-fired power plant, co-combustion tests of coal and carbonized biomass where mixing ratios were set at 10% and 30% in calorific value were carried out by a single-burner combustion test facility. The temperature distribution in the furnace showed little difference between the coal mono-combustion and co-combustion of coal with the carbonized biomass (Fig. 3). However, the combustion rate*5 increased as the mixing ratio of carbonized biomass increased (Fig. 4).

3 Grindability evaluation of coal and carbonized biomass pellets

The reduction of transportation cost and storage space is expected by increasing the bulk density of carbonized biomass. Pelletizing of the carbonized biomass could increase the bulk density by up to four times. The grindability of a mixture of coal and carbonized biomass (mixing ratios were 5% and 10% in calorific value) was tested in a roller mill test facility. The grinding power of the mixture and the particle size of the product were equivalent to those of coal by pelletizing carbonized biomass.

*1 The ratio of fixed carbon to volatile matter.
*2 The ratio of production rate of carbonized biomass to feed rate of raw biomass in dry basis.
*3 Study commissioned by the Ministry of Economy, Trade and Industry.
*4 A measure of color phase which is a color component (color phase, saturation and brightness).
*5 The ratio of the burned combustible content to the combustible content in fed fuel.

[1] M. Taki et al., Proc. of the 10th Conference on Biomass Science, pp.11-12, 2014.

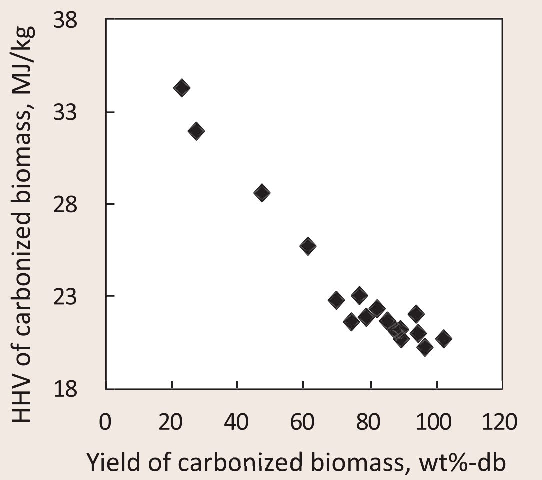

Fig. 1: Relationship between higher heating value (HHV) and yield of carbonized biomass

HHV of carbonized biomass showed a correlation with yield regardless of operation conditions in carbonization such as feed rate of raw biomass and carbonization temperature.

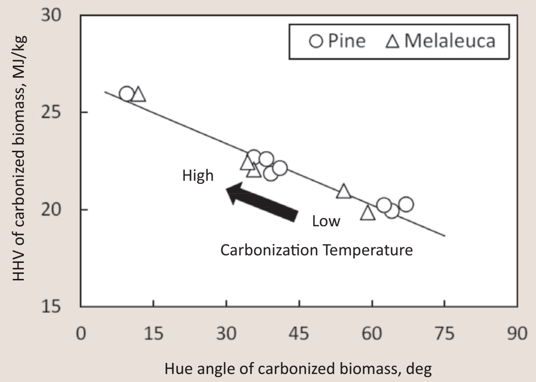

Fig. 2: Relationship between higher heating value and hue angle of carbonized biomass

The hue angle of carbonized biomass showed a correlation with HHV. HHV of carbonized biomass is easily estimated from the hue angle of pulverized carbonized biomass which is readily measurable by a color-difference meter.

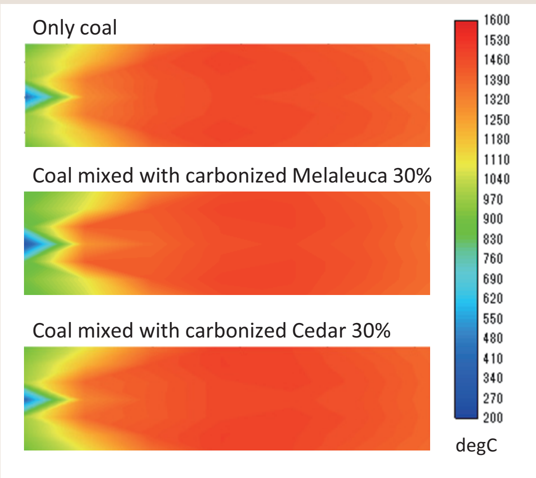

Fig. 3: Gas temperature distribution in co-combustion of coal and carbonized biomass

The figure shows gas temperature distribution in the combustion furnace in a cross-section containing the central axis of the burner. There was little impact from co-combustion of carbonized biomass.

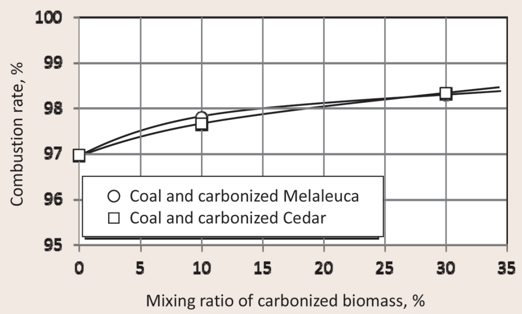

Fig. 4: Relationship between combustion rate and mixing ratio of carbonized biomass

Combustion rate was increased as mixing ratio of carbonized biomass increased, due to the ash content and fuel ratio of carbonized biomass being lower than that of coal.

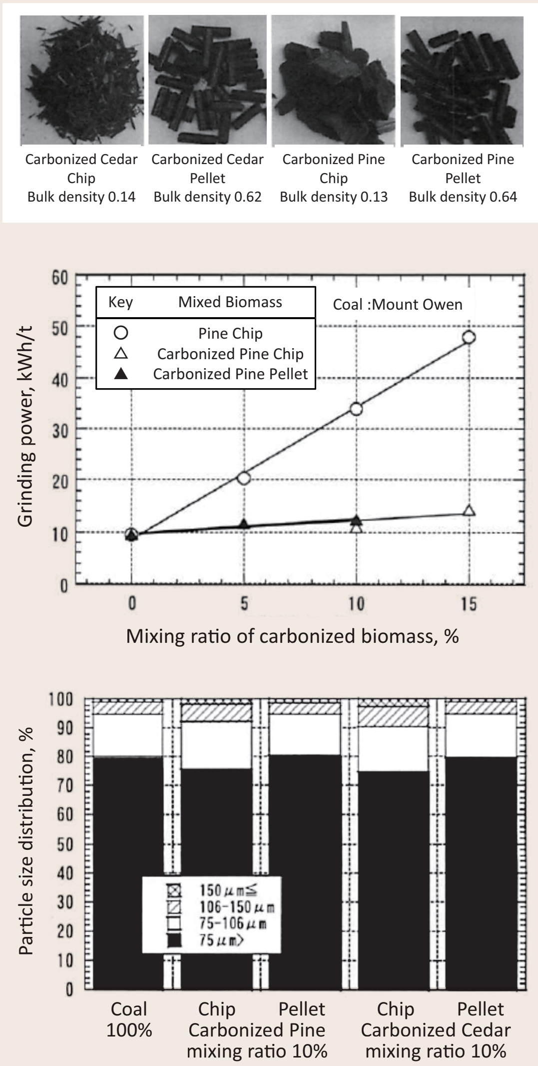

Fig. 5: Grindability of mixture of coal and carbonized biomass pellets

Grindability of carbonized biomass was equivalent to that of coal by pelletizing carbonized biomass.