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

Development of Upgrading Technology for Low-Grade Energy Resources

Background and Objective

The co-firing of biomass with coal is promoted as one of the CO_2 emissions reduction measures in coal-fired power plants. However, the mixing rate of biomass is limited to several percent, due to the increase in grinding power consumption as a result of the difficulty of biomass grinding with ordinary coal mill.
The use of brown coal is also attracting interest as a means of diversifying fuels for coal fired power plants, although it requires dewatering and control of spontaneous ignition.
This project aims to develop carbonization technology to improve the quality and grindability of biomass, and a dewatering technology that upgrades the quality of brown coal using the water-absorbing property of dimethyl ether (DME).

Main results

1 Development of carbonization technology for woody biomass

To increase the mixing rate of biomass in existing coal-fired power plants, we started development of a carbonization technology for woody biomass. The co-firing of carbonized biomass (char) at a 10cal% mixing rate in an actual coal-fired power plant will require several hundred tons of char per day. We set up an experimental facility for studying carbonization processes and selected the indirect heating rotary kiln[*1] as the carbonizer of the facility in terms of scale-up (Fig. 1). A test run of the facility using wood chip was carried out at a feed rate of 140kg/h and a carbonized temperature range between 300 and 600 degC, and the performance of the facility was confirmed (Fig. 2).

2 Grindability evaluation of carbonized woody biomass

The carbonized woody biomass shows various fuel properties depending on the carbonization temperature and the residence time. The mixed grinding test of the coal and carbonized woody biomass (char) was carried out by using a test roller mill. The grinding power for the mixture of coal and char at the carbonization rate[*2] of 58% became 10% higher than the typical value for coal (Fig. 3). However, volatile matter in the woody biomass was decreased, and the energy recovery rate of the woody biomass was decreased at higher carbonization ratio, it is important to optimize the carbonization rate in view of the energy balance.

3 Development of DME dewatering technology for brown coal

The technologies of dewatering and spontaneous ignition control are major issues in the expansion of brown coal usage and as such, we are developing an effective dewatering technology using DME. We clarified the relationship between the DME flow rate and the dewatering ratio (weight percent of removed moisture to the original moisture of brown coal) through a laboratory scale experiment. There was little difference in the dewatering ratio as a result of change to the DME flow rate. This means the required time of the dewatering processing can be reduced.

*1 There are direct heating and indirect heating processes for carbonization. The indirect heating carbonizer can easily control carbonization temperature, and yields the volatile gas and char separately. A carbonizer with the horizontal cylindrical vessel which rotates slowly and heats the raw material uniformly is called the rotary-kiln.
*2 The carbonization rate means the carbon content in fuel on dry ash free basis. In general, the carbon content is increased at higher carbonization temperatures.

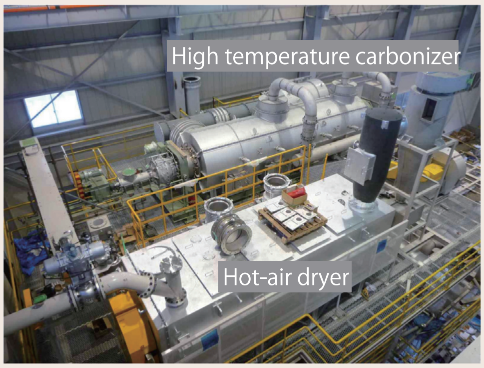


Fig. 1: Carbonization experimental facility

The hot air dryer has a biaxial stir, and the throughput is 300kg/h for the sewage sludge cake (moisture 80%). The inner cylinder of the carbonizer is made of nickel alloy, which has excellent heatproof and anti-corrosion properties, and enables carbonization at 650 degC.

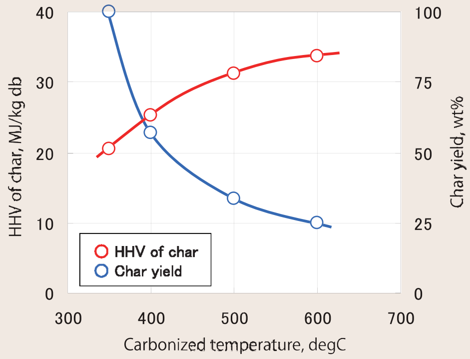


Fig. 2: Relationship between HHV of char, char yield and carbonization temperature

Carbonization of wood chip (moisture 50%, feed rate 140kg/h) showed that HHV of char improved with the rise of the carbonization temperature, and the char yield decreased. At 500℃, HHV of the char reached approximately 1.5 times that of the raw material, and the char yield lowered to approximately 1/3 of the raw material.

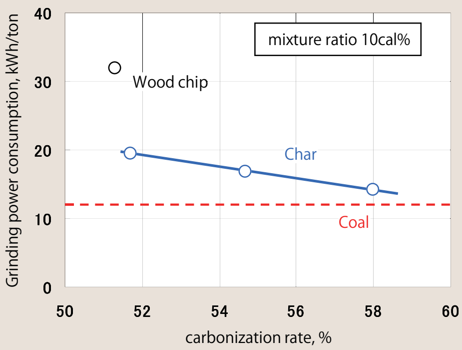
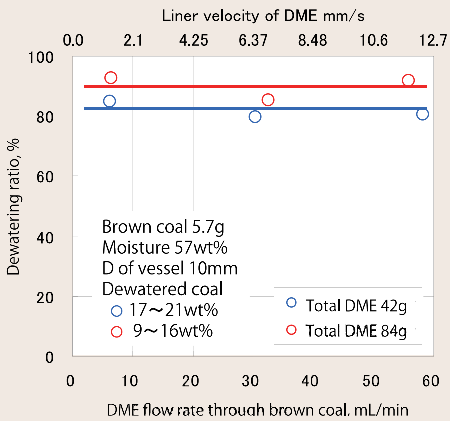


Fig. 3: Example of mixed grinding test result of coal and char

Char is mixed with coal by 10 cal%, and the grinding test was carried out in a test roller mill. The grinding power of wood chip mixture with coal became more than twice that of coal, and the grinding power of char decreased as the carbonization rate was raised.



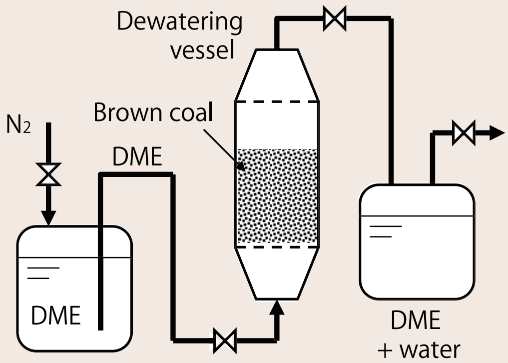


Fig. 4: Relationship between DME flow rate and dewatering ratio

There was little change in the dewatering ratio when the DME flow rate was increased and the contact time of the brown coal with DME was shortened. It was possible to dewater the brown coal when DME penetrated the brown coal layer at 10mm/s.