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Fundamental Study on the Devolatilization of the Pulverized Coal in N2 and CO2 conditions with Drop Tube Furnace

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1. Introduction

Pulverized coal combustion in CO2 condition is largely different from the one in N2 condition. This is because of the heat transfer characteristics of the coal particle in CO2 condition, CO2 gasification effect on coal particle, etc. In this study, fundamental investigation on the devolatilization of the pulverized coal in CO2 condition was experimentally conducted. Objectives of this study are as below.

- To measure and compare the devolatilization rate of the pulverized coal in N2 and CO2 conditions.
- To identify the conditions, under which the devolatilization rate is significantly different in N2 and O2 conditions.

2. Experimental

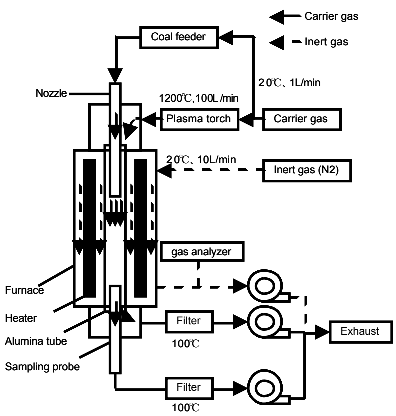

Figure 1. Schematic diagram of the drop tube furnace.

Figure 1 shows the schematic diagram of the drop tube furnace, which was used as an experimental apparatus in this study. A furnace is made of alumina tube and heated by the SiC heaters. The inner diameter of the furnace is 50 mm and the heating zone is 750mm. Coal is supplied from the feeder into the furnace and carried by the carrier gas. The carrier gas is either N2 or CO2 in this study. The coal particles released in the furnace are heated up by the radiative heat transfer from the furnace wall and the convective heat transfer from the carrier gas. Coal particles were finally sampled by the probe located downstream. The weight loss of the sampled particle due to the devolatilization was analyzed by the ash tracer method with thermo gravimetric analyzer. The residence time of the coal particle in the furnace is controlled by changing the position of the sampling probe. Table 1 shows the detail of the experimental condition. And table 2 shows the properties of the coal used in this study.

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Table 1 Experimental condition

Wall temperature (℃)	800, 1200, 1400, 1600
Residence time of the coal particle (s)	From 0.01 to 0.1
Carrier Gas	N_2 or CO_2
Coal particle diameter (μm)	32～53
Coal feeding rate (g/min)	0.3

Table 2 Properties of the coal

Property	**Weight percent of coal**
Moisture	8.0
Volatile matter	24.5
Fixed carbon	48.1
Ash	19.4

Weight percent of coal is as received base.

3. Summary of the results

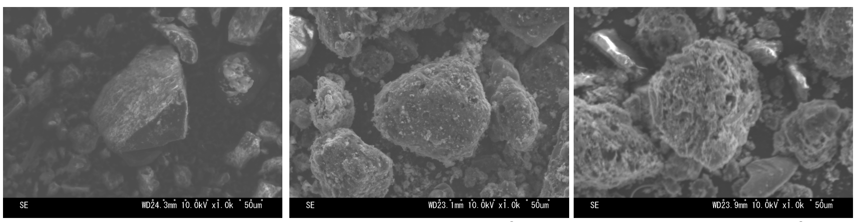
The summary of the results is mentioned as below.

- Devolatilization rate in CO_2 condition is higher than the one in N_2 condition at 1200℃.This may be because of the CO_2 gasification effect.
- Devolatilization rate in CO_2 condition is not largely different from the one in N_2 condition at 1600℃. This may be because of the increase in volatile matter in N_2 conditions due to the high coal particle heating rate.
- The conditions, where devolatilization rate is significantly different in N_2 and O_2 conditions, is around 1200℃ in particle temperature in this study. This condition can be where CO_2 gasification effect is large while particle heating rate is not enough high to increase the volatile matter.
- Although devolatilization rate in CO_2 condition is not largely different from the one in N_2 condition at 1600℃, the CO_2 gasification may have a large influence on the char structure, see Figure 2.

4. Appendix: Particle images

Figure 2 shows the particle images of the coal char after devolatilization.

- Either N_2 or CO_2 conditions, the edge of the char particle is rounded smoother than the one of the original coal be, due to the high temperature of the drop tube furnace wall.
- The surface of the char particle in CO_2 condition is rougher than that of the char particle in N_2. This may be because of the CO_2 gasification effect.



a) Original Coal **b) in N_2 at 1600℃** **c) in CO_2 at 1600℃**

Figure 2 Particle images by Scanning Electron Microscope.