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GRANULARITY COLLOCATION OF SINGLE COAL ON COMPREHENSIVE COMBUSTION OF BLENDS

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The combustion of anthracite and bituminite blends with different bituminite particle size was investigated with thermogravimetric analysis (TGA). It is indicated in the results that the increase of bituminite particle size may influence the pyrolysis of blends and consequently the decomposition of blends moved to higher temperature zones with the increase of bituminite particle size. However, the negative influence of specific area is not that significant to some bituminite and anthracite mixtures, the comprehensive combustion behavior of blends was stable when particle size of some bituminie PC was increased from 0,074 mm to 0,150 mm.

Key words: blast furnace; pulverized coal; combustion; TGA

INTRODUCTION

The only source of oxygen in blast furnace is the blast from the tuyere, therefore the gas atmosphere in blast furnace (BF) is basically the mixture of CO_2 and CO as well the inert N_2 from blast [1]. Simultaneously, pulverized coal (PC) are injected from the tuyeres and blown into the raceway of BF by the blast. The time of PC in the raceway is as short as about 0.004 s due to the high flow velocity of blast [2]. Hence, the combustion of injected PC in BF has to proceed efficiently, otherwise the unburnt PC will be blow away into the burden column by the subsequent blast. The unburnt blend is not only a waste of fuel but also a threat for the gas and liquid permeability of burden column, which deteriorates the flow of CO and simultaneously the gas reduction of ores [3, 4]. Therefore, lump coals were usually pulverized below 0,074 mm in order to derive larger specific areas of PC, namely an ideal kinetic condition for the combustion of blends.

Currently, anthrancite and bituminite are pulverized and blended for BF injection to achieve ideal indexes in both calorific value and combustion property of blends [5]. The pulverization and sieving of anthrancite and bituminite was carried after blending, consequently the size of anthrancite and bituminite particles are populated in same size zones. Due to the lower reaction temperature and high combustion rate of bituminite [6, 7], it is possibly to be exhausted at the early combustion stage of blends. As a result, the combustion-supporting effect of bituminite in blend becomes invalid and subsequently leads to the independent combustion of anthrancite and bituminite [8]. The increase in granularity of bituminite will decrease its specific area and retard the activity in combustion reaction, consequently slow down the consumption of bituminite and extend its assistance to the combustion of anthrancite [9, 10]. However, few studies have been noticed to be related to this field.

The effect of granularity collocation between bituminite and anthrancite in blend on its combustion behavior was investigated in this study. The combustion behavior of samples with different combination of granularity was tested with thermogravimetric analysis.

EXPERIMENTAL

Samples and preparation

Two anthrancite and three bituminite samples applied for actual BF pulverized coal injection were selected to investigated the influence of bituminite granularity on the comprehensive combustion behavior of blends. The proximate and ultimate analyses of PC samples are shown in Table 1. Anthrancite and bituminite samples were dried and sieved into different granularity levels and subsequently mixed into blends, the detailed parameters of granularity composition and mass fraction are shown in Table 2. Consequently, 24 blends with 20 % volatile content and various granularities were obtained.

Thermogravimetric tests of blends

Combustion characteristic of single PC and co-combustion behavior of blends were investigated by utilizing a HCT-4 thermogravimetric analyzer. In a typical run, about 17,5 mg sample was loaded and temperature was raised from ambient temperature to 900 °C at heat-

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Table 1 **Proximate analysis and ultimate analyses of CP sample / %**

Sample	Proximate analysis				Ultimate analysis				
	FC_d	V_d	A_d		C_d	H_d	N_d	O_d	S_d
A	77,89	10,33	11,78		80,42	2,96	0,72	4,33	0,217
B	81,48	8,77	9,75		81,83	3,07	1,05	3,56	0,833
C	58,17	37,24	4,59		75,02	4,69	0,85	17,42	0,213
D	55,21	35,20	9,59		68,80	4,11	0,78	17,13	0,330
E	51,00	33,85	15,15		64,58	4,08	0,90	16,89	0,388

FC, fixed carbon; V, volatile; A, ash; d, dried;

Table 2 **Granularity and mass fraction of anthrancite and bituminite in blends**

Sample	Granularity / mm				Mass fraction / %			
AC1	A	0,074	C	< 0,074	A	64,05	C	35,95
AC2			C	0,074 ~ 0,150				
AC3			C	0,150 ~ 0,270				
AC4			C	0,270 ~ 0,550				
BC1	B	0,074	C	< 0,074	B	60,54	C	39,46
BC2			C	0,074 ~ 0,150				
BC3			C	0,150 ~ 0,270				
BC4			C	0,270 ~ 0,550				
AD1	A	0,074	D	< 0,074	A	61,15	D	38,85
AD2			D	0,074 ~ 0,150				
AD3			D	0,150 ~ 0,270				
AD4			D	0,270 ~ 0,550				
BD1	B	0,074	D	< 0,074	B	57,50	D	42,50
BD2			D	0,074 ~ 0,150				
BD3			D	0,150 ~ 0,270				
BD4			D	0,270 ~ 0,550				
AE1	A	0,074	E	< 0,074	A	58,85	D	41,15
AE2			E	0,074 ~ 0,150				
AE3			E	0,150 ~ 0,270				
AE4			E	0,270 ~ 0,550				
BE1	B	0,074	E	< 0,074	B	55,21	D	44,79
BE2			E	0,074 ~ 0,150				
BE3			E	0,150 ~ 0,270				
BE4			E	0,270 ~ 0,550				

ing rate of 20 °C/min in air atmosphere with a flow rate of 100 mL/min.

RESULTS AND DISCUSSION

Combustion characteristics of single PC

Combustion characteristics of single PC samples were shown in Figure 1. It can be seen that the initial reaction temperature of bituminite are lower than that of anthracite and consequently the burn out temperatures of bitunimite were also lower. Though the initial pyrolysis temperature of B PC was as low as bituminite and its reaction rate was also close to bituminite, its reaction rate was sharply decreased at later pyrolysis stage. As a result, a two stages combustion process was observed on the Differential thermal gravity curve of B PC, while the peak in high temperature can be recognized as the combustion of coal char. Meanwhile, the maximum reaction rate of bituminite was achieved under the temperature of 500 °C, while that of anthracite samples was above 600 °C.

Combustion characteristics of blends with different particle size

Combustion characteristics of blend samples are shown in Figure 2. It is indicated that the increase in particle size of bituminite has a significant influence on the comprehensive combustion behavior of AC, BE, AD and BD samples. The reaction rate of these blends under low temperatures was sharply decreased with the increase of bituminite particle size from 0,074 mm to 0,150 mm, which was regarded as the decomposition of volatile in PC. Besides, the effect of further increment in particle size was not that significant, while the weight loss rate of these blends in high temperatures was also close. However, no significant variation in combustion property of AE and BE blends was noticed when the particle size of sample E was increase from 0,074 mm to 0,150 mm. Though a slight decrease in pyrolysis rate of blends was observed under 500 °C, the DTG value of AE and BE blends were higher than that of 0,074 mm bituminite blend samples. Therefore, the increase in

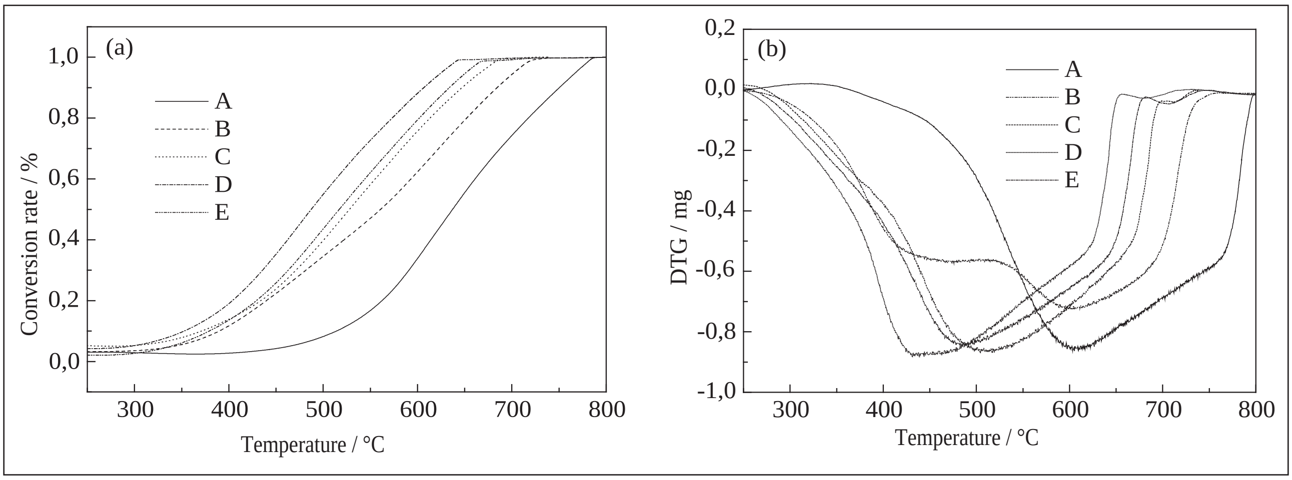

Figure 1 TG curves (a) and DTG curves (b) of PC samples

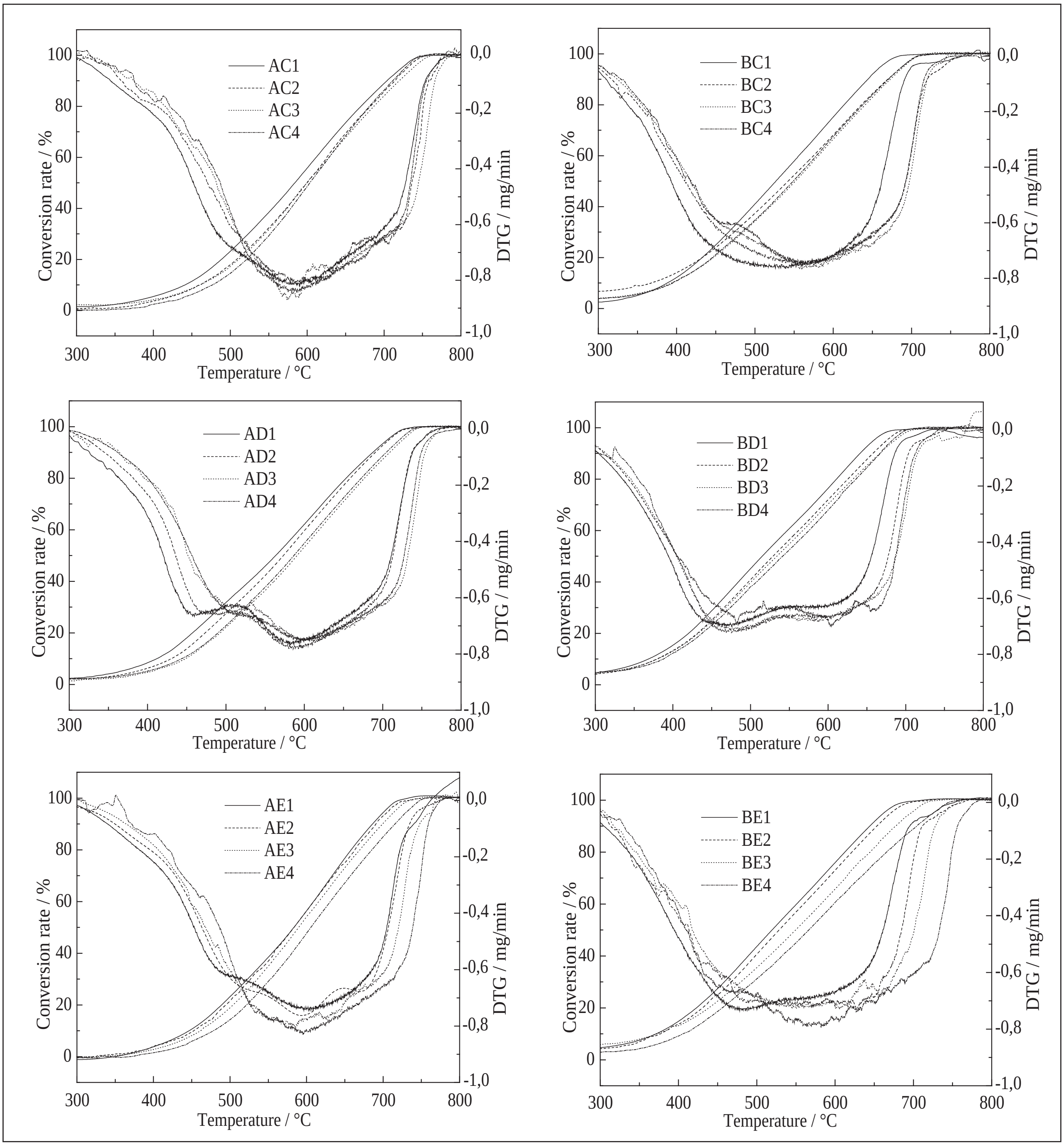

Figure 2 Co-combustion behavior of blends

particle size of E PC in blends did not lead to dramatic variation in comprehensive combustion behavior of AE or BE blends. The combustion behavior of AE blends were stable when particle size of E PC increased from 0,074 mm to 0,270 mm, which indicated that a proper increase in particle size of certain bituminite in blend may decrease the cost in pulverization process of coal and simultaneously will not cause negative influence on the combustion of blends.

CONCLUSION

The increase in particle size of bituminite PC in blends may lead to negative effect on pyrolysis process of blends under 500 °C to some extent, which was possibly attributed to the decrease in specific area of granular samples and namely the kinetic reaction condition. Consequently, the pyrolysis of blends with large particle size tended to take place in higher temperature zones, while the maximum combustion rate of blends with different bituminite particle size above 550 °C was very adjacent.

The increase of bituminite particle size in a certain range may not significantly affect the comprehensive combustion behavior of blends. Though the pyrolysis rate of blends occurred slightly slower, the combustion rate of coal char was slightly higher when the variation in particle size of bituminite was not that dramatic. Hence, the consumption of electric in pulverization of coal can be partly decreased by amplying the size of bituminite.

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Note: The responsible translator for language English is doctor W.L. Zhan - Univerisity of Science and Technology Liaoning, China.