Pressurized Pyrolysis and Gasification of Chinese Typical Coal Samples

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This paper aims to understand the pyrolysis and gasification behavior of different Chinese coal samples at different pressures. First, the pyrolysis of four typical Chinese coals samples (Xiaolongtan brown coal, Shenfu bituminous coal, Pingzhai anthracite coal, and Heshan lean coal) were carried out using a pressurized thermogravimetric analyzer at ambient pressure and 3 MPa, respectively. The surface structure and elemental component of the resultant char were measured with an automated gas adsorption apparatus and element analyzer. It was observed that higher pressure suppressed the primary pyrolysis, while the secondary pyrolysis of coal particles was promoted. With respect to the resultant solid char, the carbon content increased while H content decreased; however, the pore structure varied greatly with increasing pressure for different coal samples. For Xiaolongtan brown coal (XLT) char, it decreased greatly, while it increased obviously for the other three char types. Then, the isothermal gasification behavior of solid char particles was investigated using an ambient thermal analyzer with CO_2 as the gasifying agent at 1000 °C. The gasification reactivity of solid char was decreased greatly with increasing pyrolysis pressure. However, the extent of change displayed a vital relation with the characteristics of the original coal sample.

1. Introduction

Coal gasification is a very complex process; it is consisted of the devolatilization of coal particles and the gasification of resultant char.[1] Furthermore, pyrolysis is the primary and essential step of coal combustion and gasification; it involves a set of complex reactions. The gasification reactivity of coal greatly depends on the reactivity of coal char obtained from coal pyrolysis.[2–4] The gasification reactivity of char is influenced by many factors, such as coal type, pressure, final temperature, residence time, etc.[5–10] Kajitani et al. and Ahn et al. found that the gasification was accelerated with increasing pressure and that surface reaction and diffusion of the internal gas phase are the two main factors controlling solid char gasification behavior.[11,12] System pressure showed great impact on the characteristics of the evolution of volatiles and resultant char swelling,[5,13] as such the physical and chemical structure of solid char changed greatly with variation in pyrolysis pressure, hence the gasification property was switched, which resulted in a change in the gasification reactivity of solid char.[14] Messenbock et al. pointed out that the combustion reactivity of solid char decreased gradually as the system pressure of coal pyrolysis and gasification increased.[15] However, the characteristics of the original coal displayed significant influence on the property of coal pyrolysis and char gasification but also affected the influence of operating conditions on the behavior of coal utilization.[2,16,17] It is essential to investigate the influence of coal properties on coal pyrolysis/gasification, especially the interaction between coal properties and operating conditions. However, this has been rarely reported. Mae et al.[17] studied the relationship of the yield of pyrolysis products with coal structure. It was observed that tar yield correlated well with the fraction of aliphatic carbon and the amount of hydrogen bonding determined from Fourier transform infrared (FT-IR) spectra. Xie et al.[18] investigated the formation of HCN and NH_3 from the pyrolysis of a serial of Australian and Chinese coals.

In the study, the pyrolysis property of four typical Chinese coal samples—Xiaolongtan brown coal, Shenfu bituminous coal, Pingzhai anthracite coal, and Heshan lean coal—was performed

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Table 1. Proximate and Ultimate Analyses of Coal Samples

	proximate analysis (wt %, ad)				ultimate analysis (wt %, ad)				
	M	V	A	FC	C	H	N	S	O
XLT	16.16	48.90	24.76	26.34	41.35	3.46	3.04	1.18	10.05
SF	10.19	31.62	5.84	52.35	68.84	5.06	0.91	0.28	8.88
PZ	2.83	9.42	6.82	80.93	78.38	3.29	0.99	2.34	5.35
HS	3.10	11.94	51.89	35.88	33.06	1.73	0.50	6.00	3.72

in a pressurized thermogravimetric analyzer at ambient pressure and 3 MPa, respectively. Then, the surface structure, chemical components, and chemical functional groups of the observed char particles was measured and the gasification reactivity was analyzed using ambient thermal analyzer. Simultaneously, the influence of the coal sample on the behavior of coal pyrolysis and char gasification was analyzed in depth.

2. Sample and Experimental Setup

2.1. Samples. To check the influence of coal type on coal pyrolysis and the interaction of coal type and pressure, four typical Chinese industrial coal samples with different ranks were involved. They are Xiaolongtan brown coal (XLT), ShenFu bituminous coal (SF), Pingzhai anthracite coal (PZ), and Heshan lean coal (HS). The original sample was ground and sieved with 100 mesh screen, i.e. the samples analyzed are less than 100 mesh. The result of the proximate and ultimate analyses of coal samples is listed in Table 1. It can be observed that the volatile content of XLT coal is quite high, whereas the content of fixed carbon is very low; PZ coal showed the highest fixed carbon content (~80%), while HS coal had the highest ash content, which covered more than half of the sample weight.

2.2. Experimental Apparatus and Method. *2.2.1. Pyrolysis of the Coal Sample.* The pyrolysis of four coal samples was carried out in a pressurized thermogravimetric analyzer (TG, Thermal Max 500, Thermal Cahn, USA). The experimental procedure is briefly elaborated as follows. The sample (~1 g) held by a quartz crucible was put in the furnace previously, and then, the system pressure was elevated to a selected value (0.1 and 3 MPa) slowly. After that, the gas flow rate of carrier gas was adjusted to 100 mL/min and kept constant for the whole trial. The sample was heated up to 1000 °C from an ambient temperature at 10 °C/min and maintained there for 10 min to make sure that the pyrolysis was complete. During the pyrolysis process, the system pressure was kept constant. After each trial, the furnace was cooled down quickly and solid residue was collected for further analysis.

2.2.2. Calculation of the Kinetic Parameters of Coal Pyrolysis. Knowledge of the coal devolatilization rate is of great importance as it exerts a marked effect on the overall gasification behavior.[19] The kinetics study of coal pyrolysis is necessary to achieve an efficient production of fuel gases, chemicals, and energy. Kinetics is also of utmost importance for the proper design of large-scale pyrolysis reactors. The kinetic parameters of coal pyrolysis under different pressure were calculated based on the following principles.[20]

$$\ln[F(\alpha)] = -(E/RT) + \ln(AR/\beta E) \tag{1}$$

$$F(\alpha) = -\ln(1-\alpha)/T^2 \quad n = 1 \tag{2}$$

$$F(\alpha) = \{1 - (1-\alpha)^{1-n}\}/(1-n)T^2 \quad n \neq 1 \; n = 0, 0.5, 1.5, 2, \ldots \tag{3}$$

where β is the heating rate, $\beta = dT/dt$ is the reaction time, and T is the corresponding temperature. The term α is the degree of conversion $\alpha = (W_0 - W)/(W_0 - W_\infty)$. W is the mass of solid sample at time t, and the subscripts 0 and ∞ refer to the initial and final residual amounts, respectively. Kinetic parameters E and A represent the activation energy and the pre-exponential factor respectively.

R is the general gas constant, and n is reaction order, which was assumed previously.

If the reaction order n is assumed to be correct, the plot of $\ln[F(101)] \sim -1/T$ should be a straight line, activation energy (E) can be obtained from the slope, and pre-exponential factor (A) can be obtained from the intercept. The correct mechanism was ascertained on the basis of best-fit criteria between the experiments and calculated results.

2.2.3. Physicochemical Analysis of Char. During the process of coal devolatilization, the particles underwent a serial complex chemical and morphological transformation, which caused the variance of the physicochemical structure of the resultant solid char.[13,21] The surface structure of different char batches was measured with Micromeritics Accelerated Surface Area and Porosity 2020 automated gas adsorption apparatus. The isothermal adsorption was carried out using liquid N_2 at 77 K. The specific surface area, pore size, and pore distribution were analyzed in detail. Moreover, the main organic elemental components (C, H, N, and S) of the solid char were analyzed with elemental analyzer Vario EL II CNHS/O (Germany).

2.2.4. Gasification of Solid Char. An isothermal gasification experiment of the observed char was performed with an ambient thermobalance (STA 409C, Netsch, Germany) in carbon dioxide at 1000 °C. About 20 mg of char obtained after the pyrolysis was charged into an alundum container, which was then placed on the thermal balance. As soon as the sample was heated to 1000 °C at 50 °C/min in a flow of high purity Ar (100 mL/min), the flow of Ar was switched to pure carbon dioxide (100 mL/min) and char gasification was initialized and maintained for 60 min to make sure the gasification of chars was complete.

With gasification proceeding, the weight of char particles decreased quickly. Takarada et al. pointed out that the reactivity exponent (R) can be used to analyze the gasification reactivity, and it was successfully used to investigate the gasification reactivity of 34 different coal samples quantitatively.[22]

$$K = \frac{2}{\tau_{0.5}} \tag{4}$$

where $\tau_{0.5}$ is the time (h) for the carbon conversion ratio to reach 50%. The initial time of gasification is counted as carrier gas Ar was switched to CO_2. The larger the R value, the higher the gasification reactivity of char particles. Here, it was used to display the gasification reactivity of solid char observed from coal pyrolysis under different conditions.

3. Result and Discussion

3.1. Pyrolysis of Coal Particles. The pyrolysis curves of the four typical coal samples are plotted in Figures 1 and 2. It can be observed that the pyrolysis of coal particles can be divided into three ranges. When temperature is lower than 300 °C, the moisture is removed, the drying process of the sample. It can be observed that XLT and SF showed higher moisture part, it is consistent with the result of proximate analysis. With a further increasing temperature (>300 °C), the primary pyrolysis took place with some gas products evolving out, such as CO_2, CO, light aliphatics, CH_4, H_2O, etc. It might be attributed to the cracking and reforming of weaker organic functional groups in coal particles; therefore, the weight of the coal sample decreased gradually, and a mass loss rate peak was displayed in DTG curves (300–700 °C). After that, another small peak showed up in DTG curves, which was mainly caused by the secondary cracking of coal particles, and gas products were mainly consisting of CO and H_2.[23]

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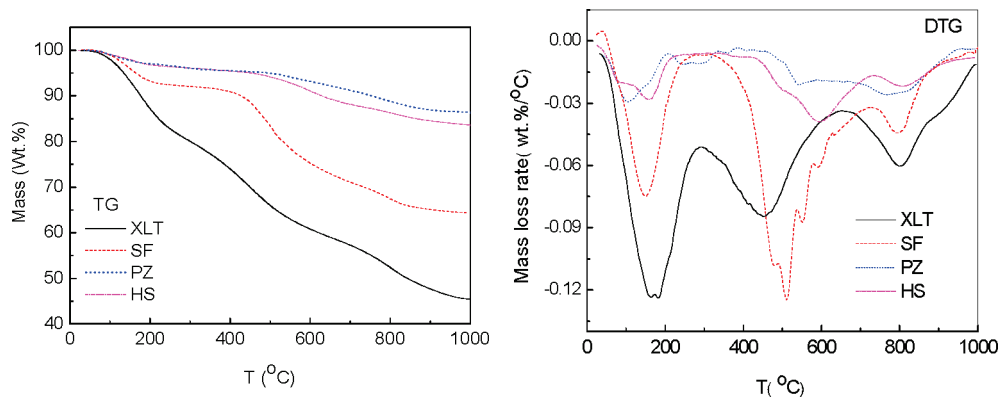(20) Rao, T. R.; Sharma, A. *Energy* **1998**, *23*, 973–978.

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Figure 1. Pyrolysis profiles of coal samples at ambient pressure.
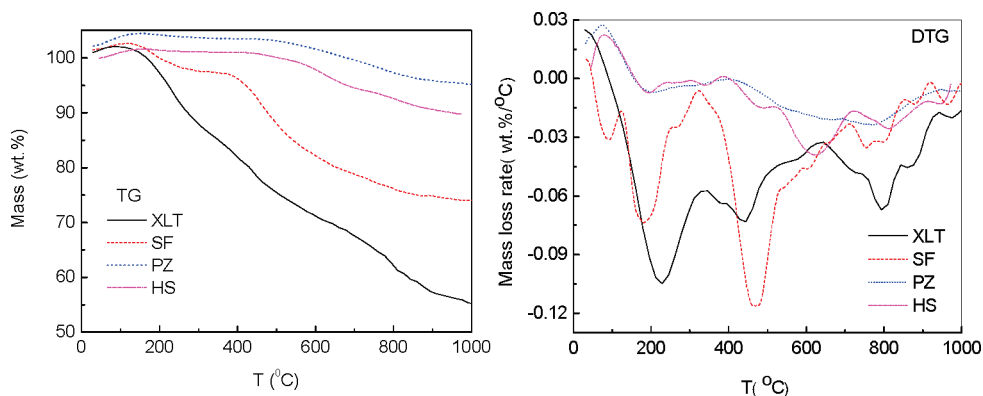

Figure 2. Pyrolysis profiles of coal samples pyrolysis at 3 MPa.

With regard to the different coal types, the initial temperature of volatile removal varied slightly. The volatiles of XLT brown coal and SF bituminous coal evolved out easily (∼300 °C) and achieved the maximum decomposition rate at 450 and 512 °C, respectively. Meanwhile, the rates of PZ anthracite coal and HS coal were quite slow, and the maximum evolution rate was shifted to a higher temperature (∼600 °C). The weight loss rate was very low, and the total weight loss just covered 10 wt % of the original coal particles. The maximum value of the primary pyrolysis of SF coal is 0.125% 1/°C, obviously higher than that of XLT coal, while the peak value of secondary pyrolysis is lower than that of XLT coal. This might be attributed to the difference existing in the interior structure of the two coals. The order of the pyrolysis rate of the four coal samples can be written as brown coal (XLT) ≫ bituminous (SF) > anthracite (PZ) > lean coal (HS).

In comparison with Figures 1 and 2, it can be observed that the devolatilization of the coal sample was shifted to higher temperatures (∼50 °C) and the mass loss rate of primary pyrolysis was reduced as well as the peak value, while the yield of char residue increased greatly (10%). Higher pressure suppressed the release of volatiles and blocked the thermal degradation of coal particles; however, the peak value of secondary pyrolysis increased greatly, especially for XLT brown coal. This might be attributed to the higher external pressure hindering the fast release of volatiles from the inside of the particle to the surface and extending the residence time of the gas product in the higher pressure reactor system. Hence, this promoted the thermal cracking of tar with more light gas products formed. But, no obvious change was shown for PZ and HS coal pyrolysis, which might be attributed to the lower volatile content they contained (see Table 1).

The kinetic parameters of the pyrolysis of four coal samples were calculated following eqs 1–3 with results listed in Table 2. As mentioned above, the pyrolysis of coal can be divided into the three main zones of moisture removal, primary pyrolysis, and secondary pyrolysis. Hence, with a change of pyrolysis temperature, the related mechanism might be different, so the kinetic parameters under different temperature ranges were analyzed separately. The lower and higher temperature ranges could be specified to the primary and secondary pyrolysis of the coal sample, respectively. From the table, it can be observed that the E value of the lower temperature range is much lower than that of the high temperature range. This indicated that the pyrolysis of the coal sample was quite easy, while the secondary cracking was much more difficult.

E_m is the weight mean activation energy calculated based on the mass loss and activation energy; it can be used to describe the overall kinetics of coal pyrolysis.[24] With increasing pressure, E_m showed a similar tendency to change, which increased with increasing pressure and the mass loss was decreased. This is consistent with the previous result that higher pressure hindered the decomposition of coal particles. From the table, it can be observed that the reaction order of XLT and SF is 2, while that of PZ and HS is 1, which might be related to the proximate components of coal samples, as XLT and SF coal had high volatile contents, whereas the PZ and HS coal samples showed very low volatiles and the pyrolysis is a little bit simple.

3.2. Physicochemical Characteristics of Solid Char. The parameters of the resultant solid char surface structure are listed in Table 3. As the sample was heated, volatiles evolved out and coal particles converted to char with a porous structure. The higher volatile content of the original coal and higher surface area of the resultant char showed. From Table 3, it can be observed that the surface area of XLT char is the largest and that it decreased greatly with increasing pyrolysis pressure.

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Table 2. Kinetic Parameters of the Pyrolysis of Various Coal Samples

sample	P (MPa)	temp (°C)	n	E (kJ/mol)	A (1/s)	CR[a]	mass loss (wt %)	E_m (kJ/mol)
XLT	0.1	220–410	2	3.34	0.0142	0.9659	12.01	
		410–790	2	10.86	0.189	0.9902	16.14	42.63
		790–1000	2	128.19	1.65E+06	0.9459	11.51	
	3	260–690	2	10.84	0.138	0.9861	23.08	56.23
		690–1000	2	139.56	6.7E+06	0.9101	12.57	
SF	0.1	430–540	2	44.15	7.06E+01	0.9927	10.12	
		540–760	2	30.82	7.25E+00	0.9989	10.7	54.73
		760–1000	2	126.62	1.84E+06	0.9958	4.92	
	3	390–540	2	62.64	1.88E+03	0.9973	11.71	
		540–740	2	33.94	1.30E+01	0.9993	7.29	60.22
		740–850	2	118.28	9.26E+05	0.9903	2.81	
HS	0.1	460–730	1	18.09	0.264	0.991	7.23	20.40
		730–1000	1	24.21	0.662	0.9954	4.37	
	3	440–1000	1	30.46	1.27	0.9634	10.84	30.46
PZ	0.1	490–700	1	10.79	0.0469	0.999	3.92	19.13
		700–910	1	26.85	0.815	0.9978	4.24	
	3	500–920	1	30.46	1.18	0.9681	8.51	30.46

[a] CR: the correlated coefficient.

Table 3. Surface Structure Parameters of Solid Chars

sample	XLT		SF		PZ		HS	
P (MPa)	0.1	3	0.1	3	0.1	3	0.1	3
S_{BET} (m²/g)	79.18	47.45	0.736	1.87	0.34	0.84	1.82	2.31
d_m (Å)	29.60	47.58	250.55	149.70	151.93	163.18	154.20	155.83

But, the char from other three coals showed contrary results, as it increased with varying pressure from ambient pressure to 3 MPa; furthermore, the increased ratio showed a consistent trend with the amount of volatile matters that the original samples contained. However, the mean diameter showed inverse relationship with surface area. The pore area distribution profiles of different char samples are plotted in Figure 3. It can be observed that the pore area of XLT char showed a different pattern from the other char samples. For XLT char, the area of fine pores (~20 Å is much higher than that of large pore. This indicated that there existed a large mount of fine pores in XLT char particles. For SF, PZ, and HS char samples, the area of pore size among 400–500 Å showed a great peak, as the mesopore (400–500 Å) took the main contribution to the total pore area of the observed char particles and pore size is mainly located at 400–500 Å. As pyrolysis pressure increased from ambient to 3 MPa, the incremental pore area of the fine pores range (<500 Å, Figure 3) increased greatly for all char samples. That is to say that more fine pores in the solid char residue were opened with increasing pyrolysis pressure. But, the pore area of large pores (>500 Å) showed different properties, as no obvious change was displayed for XLT and HS coal char, while it decreased for SF char but increased greatly for PZ char. It was known that higher pressure enhanced the secondary cracking of the volatiles and was favorable for the opening of more fine pores. On the other hand, a higher external pressure is a disadvantage for the release of volatile products. It might block the opening of large pores. The interaction of the two contrary contributions of higher pressure resulted in the various pore area distributions of different char particles. It could be concluded that the influence of pyrolysis pressure on the surface structure of the resultant char varies with the preliminary physicochemical property of the original coal sample. The mechanism of the influence of operating pressure on char structure will be investigated in depth in the future.

With the evolution of volatiles, the chemical compounds varied greatly as well as the physical surface structure. The ultimate analysis of the solid char was listed in Table 4; it can be observed that the content of carbon increased while the H content decreased with increaseing pressure from ambient pressure and 3 MPa. This might be attributed to the facts that higher pressure prolonged the residence of volatiles inside the particles and enhanced the thermal cracking; more light H-containing gas product was formed, hence the H content in solid char decreased at high pressure; and the graphitization extent of solid char was increased with increasing C content.

3.3. Characteristics of Char Gasification. The isothermal gasification behavior of the resultant char particles was investigated in an ambient thermal analyzer with CO_2 as the gasifying agent; the gasification profiles are plotted in Figures 4 and 5. The whole process consisted of a preheated range (postpyrolysis) and char gasification. In the former range, the sample was heated up quickly with some moisture and volatile residue evolving out. However, the time for preheating was very limited and the weight loss was insignificant. Once the furnace temperature reached the selected value (~1000 °C), the carrier gas Ar was switched to CO_2 and char gasification started promptly. The gasification was finished in a short time (~10 min) except for PZ char. From the DTG curve, it can be observed that the gasification of char derived from XLT and HS coal pyrolysis at ambient pressure was very fast. The DTG curve showed a sharp and narrow peak, and the maximum value of the mass loss rate is 18.3% and 13.7% 1/min for XLT and SF chars, respectively. However, the gasification of SF char is a little bit slow. It took about 20 min, and the peak shape of the DTG curve was wide and short. Different from other chars, the initial stage of PZ char gasification is very fast, the maximum mass loss rate reached 13.7% 1/min, and the mass loss covered about 30% of char weight in the first 4 min. After that, the gasification rate decreased greatly to ~1.23% 1/min and did not change until gasification ended. The weight loss amounted to 60% of the original char sample. The difference among the gasification behaviors might be related to the difference in the physico-chemical properties of the char and original coal particles. PZ coal displayed the characteristics of anthracite coal with a larger amount of fixed carbon (~80%). The specific surface area of the solid char from PZ pyrolysis is very limited (0.34 m²/g), and the physical structure is highly compact. It is difficult for gasifying agent CO_2 to reach the internal active surface of the
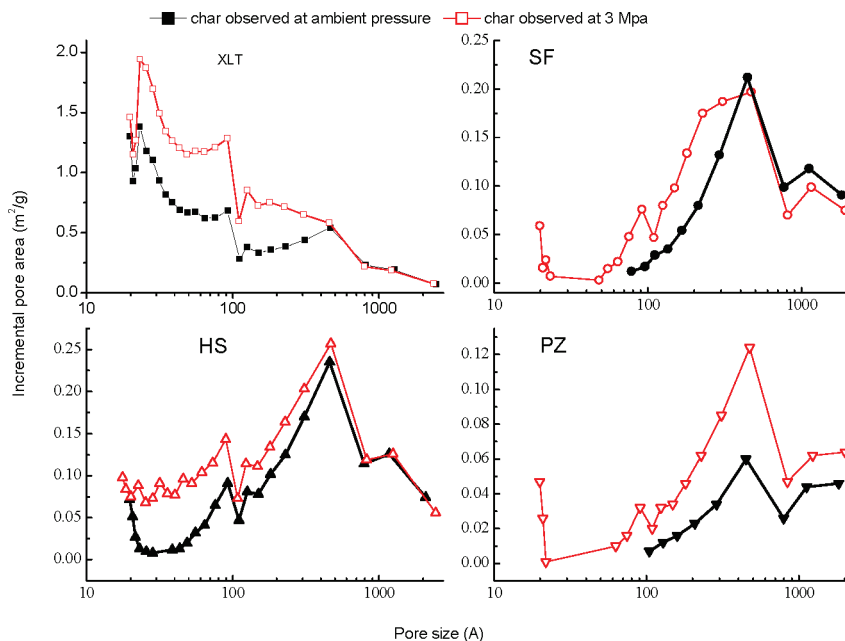
Figure 3. Profiles of the pore area distributions of char samples.

Table 4. Ultimate Analysis of Char Particles from Different Coals Pyrolysis

char sample	P (MPa)	C_d (wt %)	H_d (wt %)	N_d (wt %)	S_d (wt %)
XLT	0.1	47.89	0.535	0.691	6.131
	3	47.81	0.396	0.461	6.987
SF	0.1	79.71	0.483	0.707	0.527
	3	81.46	0.361	0.751	0.567
PZ	0.1	81.05	0.681	0.903	2.177
	3	82.27	0.803	0.801	2.17
HS	0.1	34.55	0.514	0.328	5.681
	3	35.29	0.329	0.384	5.268

solid char. SF char showed similar properties to PZ char. However, the fixed carbon content of XLT and HS is quite low (∼30–40%), the surface area of solid char is much higher, and the carbon structure is very loose; hence, it is favorable for the diffusing of gas phase and C−CO₂ shifting. consequently, the gasification rate is much faster than PZ and SF char.

With pyrolysis pressure increasing from ambient to 3 MPa, the gasification of the solid char was lowered, the maximum gasification rate was decreased greatly, especially for PZ and HS, and no obvious mass loss rate peak was observed.

The gasification reactivity was calculated using eq 4, the result is listed in Table 5. It can be observed that the order of gasification reactivity of the char samples from the pyrolysis of four coal samples at ambient pressure can be written as follows: XLT > HS > SF > PZ, i.e., the gasification reactivity of XLT brown coal is highest, that of HS lean char is a little bit lower, and the gasification reactivity of PZ anthracite coal char is the lowest. This is consistent with the experimental result (Figure 4). The difference among the gasification reactivity of the four chars might be attributed to thier physicochemical properteis, such as the molar ratio of C/H, functional groups, pore structure, etc. From Table 5, it can be observed that the higher the value of the molar ratio of C/H, the lower the char gasification reactivity. On the contrary, the gasification reactivity increased with the increasing specific surface area. Simulta-neously, ash composites in solid chars also display great influence on the gasification behavior, as some inorganic

compounds acted as catalysts during char gasification.[7,25] As operating parameters were kept the same for each trial, the physicochemical properties played the critical role in influencing the gasification behavior of difference chars.

As the pyrolysis pressure increased to 3 MPa, the gasification rate of XLT, HS, and PZ coal char decreased greatly; however, the value of K for SF char gasification increased greatly. The gasification mainly consisted of the reaction between carbon and CO_2. It is a heterogeneous gas–solid reaction, including gas diffusion and $C-CO_2$ chemical reaction. The surface property of the porous char displayed significant influence on the diffusion of gasify agent CO_2 and evolution of gas products, which is the key factor controlling the gasification rate for solid char isothermal gasification. However, the surface structure of the resultant solid char changed greatly with pyrolysis pressure, hence the gasification reactivity was varied obviously.[26] As the specific surface area of solid chars derived from SF, PZ, and HS pyrolyzed increased with increasing pyrolysis pressure, the gasification reactivity was increased. However, for XLT char, it decreased with the surface area shrinkage. On the other hand, the molecular structure of the resultant solid char, i.e. the degree of graphitization, also played a vital role in the gasification behavior of solid char. As mentioned above, higher pressure extended the residence of volatiles which is favorable for the secondary cracking; simultaneously, it enhanced the cracking and reforming of the organic functional groups in solid char. Accordingly, the amount of organic functional groups in char decreased (see Table 5, the molar ratio C/H increased greatly with increasing pyrolysis pressure) and resulted in an increase in the graphitization degree of the resultant char, and the gasification reactivity reduced as well. The interaction of the two main factors brought varying gasification characteristics of solid char while adjusting the pyrolysis operating conditions. When the coal sample pyrolyzed at 3 MPa, the gasification reactivity of the observed solid char can be summarized as follows: XLT > SF > HS > PZ. The gasification reactivity of XLT char was still kept the highest, the gasification reactivity

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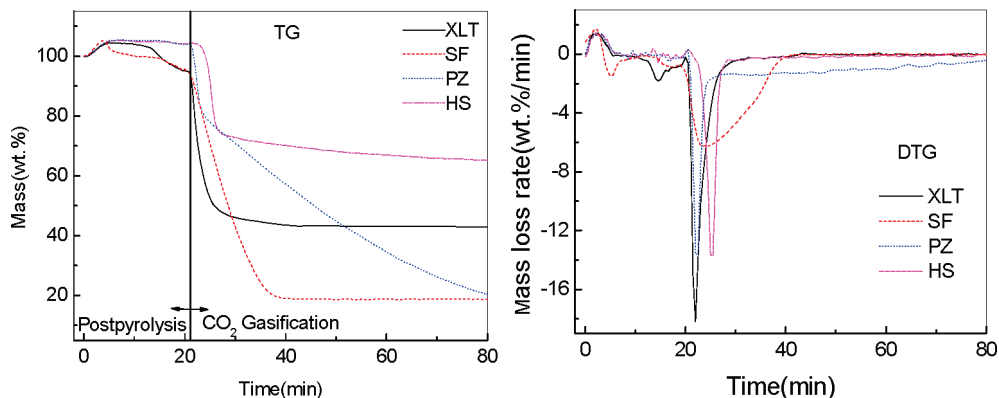
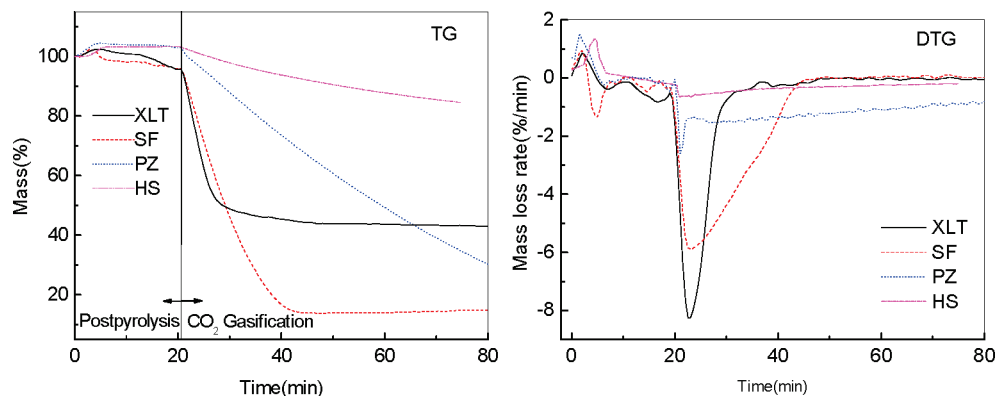**Figure 4.** Gasification curve of ambient char particles

Figure 5. Gasification curve of pressurized char particles

Table 5. Reactivity of Solid Char Gasification with CO_2

sample	XLT		SF		PZ		HS	
MPa	0.1	3	0.1	3	0.1	3	0.1	3
C/H (mol)	7.46	10.06	13.75	18.80	9.92	8.54	5.60	8.94
K (1/h)	9.12	7.92	1.74	3.90	3.84	1.14	5.46	1.36

of SF char was a little bit lower, and that of PZ char was very low. To catch the quantitative relation between the gasification properties and the physicochemical characteristics of the char, the investigation will be carried out in depth in the near future.

4. Conclusion

The pyrolysis of XLT, SF, HS, and PZ coal was performed with a pressurized thermogravimetric analyzer at ambient pressure and 3 MPa, and then, the physicochemical characteristics and gasification behavior of the resultant char were investigated in detail. It can be observed that pyrolysis pressure and coal type are significant for coal pyrolysis and char gasification. The main conclusion can be summarized as follows:

The pyrolysis of coal particles mainly consisted of the primary pyrolysis of coal samples (300–700 °C) and the secondary cracking of volatile and solid char (700–1000 °C). XLT coal decomposed easily, while PZ and HS coal samples were very difficult to pyrolyze due to the low volatile content. Higher pressure suppressed the release of volatiles and hindered the thermal degradation of coal samples; consequently, the yield of solid char residue increased, and the molar ratio of C to H increased greatly. From the viewpoint of the physical structure

of the resultant solid char, it can be observed that XLT char showed highest specific surface area and the surface area is mainly made up of fine pores (~20 Å). The specific surface area of other chars from SF, PZ, and HS coal samples is very limited, while mesopores (~400–500 Å) take the main roles. With pyrolysis pressure increasing, the pore area of fine pores (<500 Å) increased greatly, which indicated that more fine pores were formed. However, the specific surface showed a different tendency; it decreased for XLT char, while it increased for other samples.

With the physical structure and chemical composite varied, the gasification of solid char showed various properties. For char observed at ambient pressure, the gasification of XLT brown coal and HS lean coal char is very fast, the gasification of PZ coal char showed similar properties at the initial stage, and a sharp peak was observed on the mass loss rate profiles of the three char samples. However, the gasification of SF char is a little bit slow; it took quite a long reaction period. The gasification reactivity of XLT char decreased greatly while that of others increased slightly. This might be attributed the interaction of the variance of the surface structure and chemical components of char samples.