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The uneven ash melting behavior of pulverized blended Chinese coals

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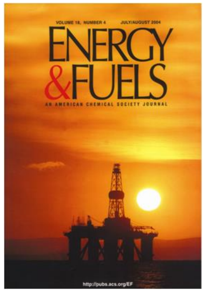
Related Papers



Determination of The Mineral Distribution In Pulverized Coal Using Densitometry And Laser Particle Sizing (2005)

The influence of included minerals on the intrinsic reactivity of chars prepared at 900 °C in a drop tube furnace and a muffle furnace (2009)

1. Introduction
2. Experimental
3. Results and discussion
4. Conclusions
5. Acknowledgement

1 Introduction


Beijing
CHINA
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Wuhan
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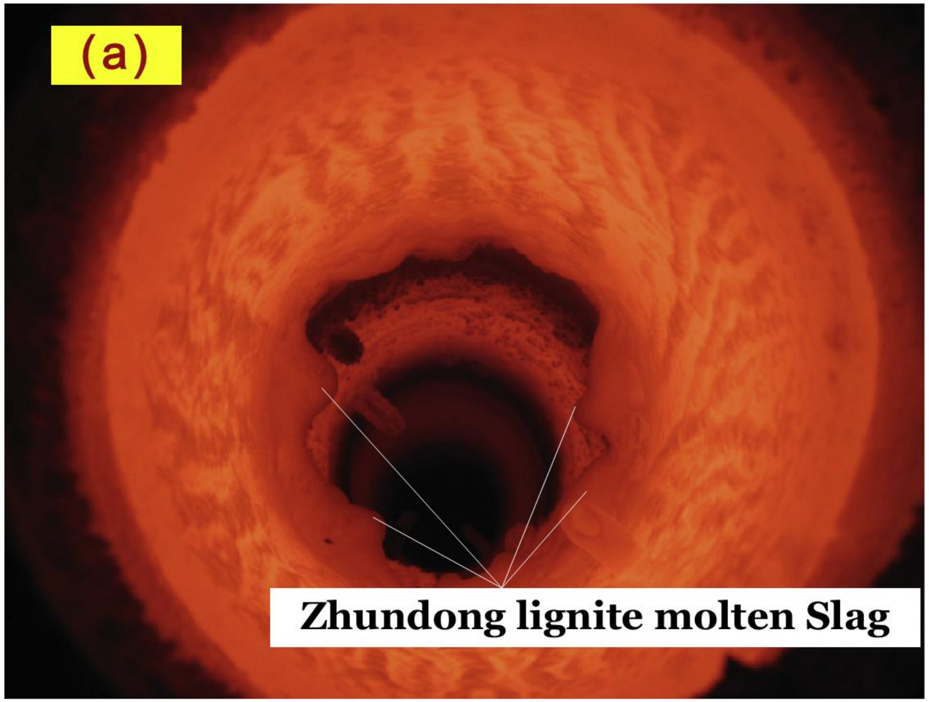
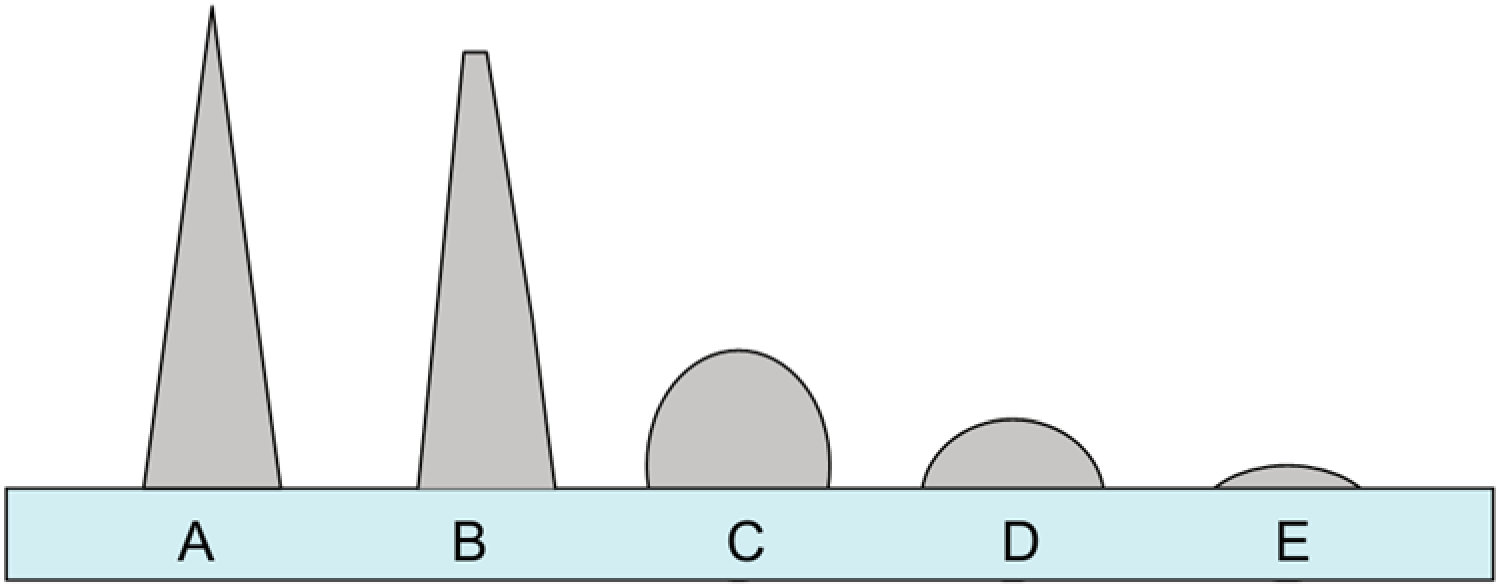
Guangzhou
Hainan



G. Li et al. / Fuel 143 (2015) 430–437 H. Tan et al/ Electric power 49(2016)167-171

Severe ash fouling and slagging problems both inside the furnace and in the convective pass were found when the Zhundong coal is fired in utility boilers.

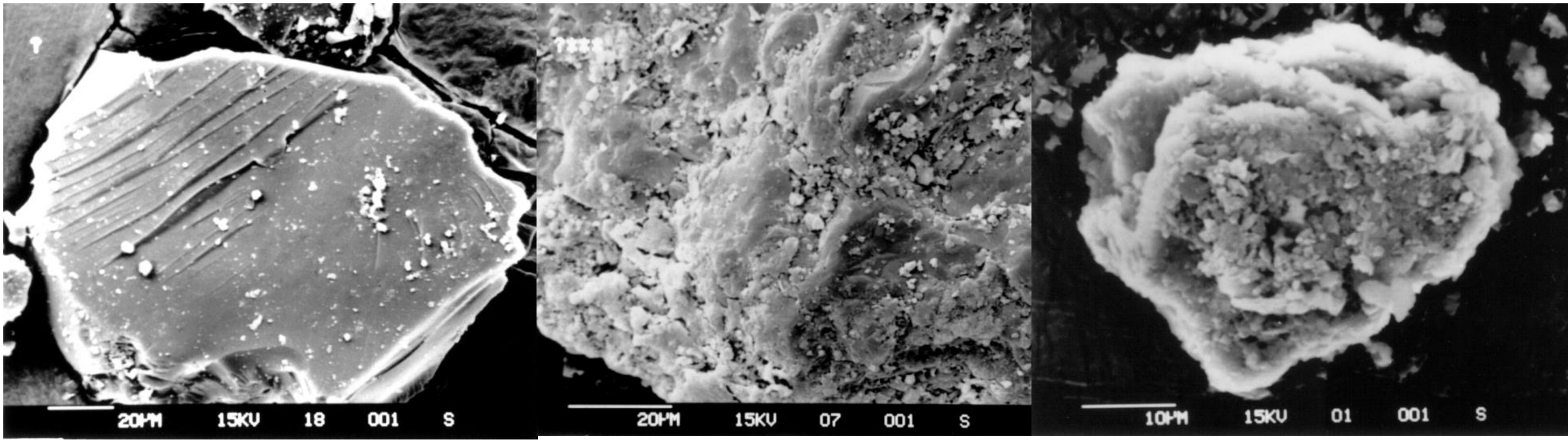
To mitigate the ash deposition of the Zhundong coal, coal blending is currently practiced in utility boilers.



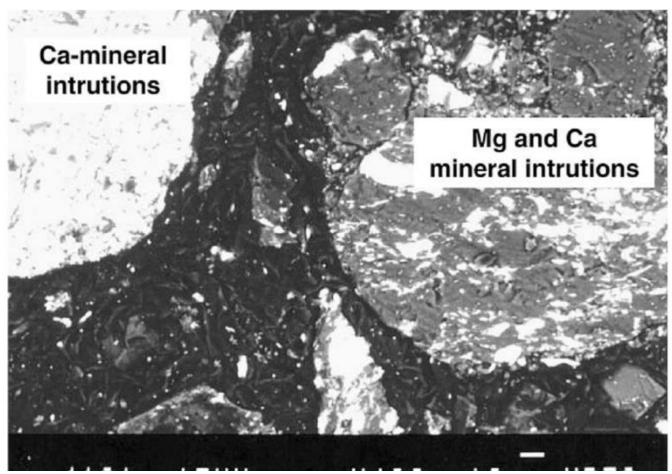
(A) Original cone before heating
(B) Initial deformation temperature where first rounding of cone tip is taking place (IDT)
(C) Softening or sphere temperature where the cone height = cone width (ST)
(D) Hemispherical temperature where cone height = ½ cone width (HT)
(E) Fluid or flow temperature where cone height = 1.6mm (FT)

The problem with AFT mainly results from that it is related to the bulk chemistry and fusion temperature of the ash.

Mineral matter is not evenly distributed in coal

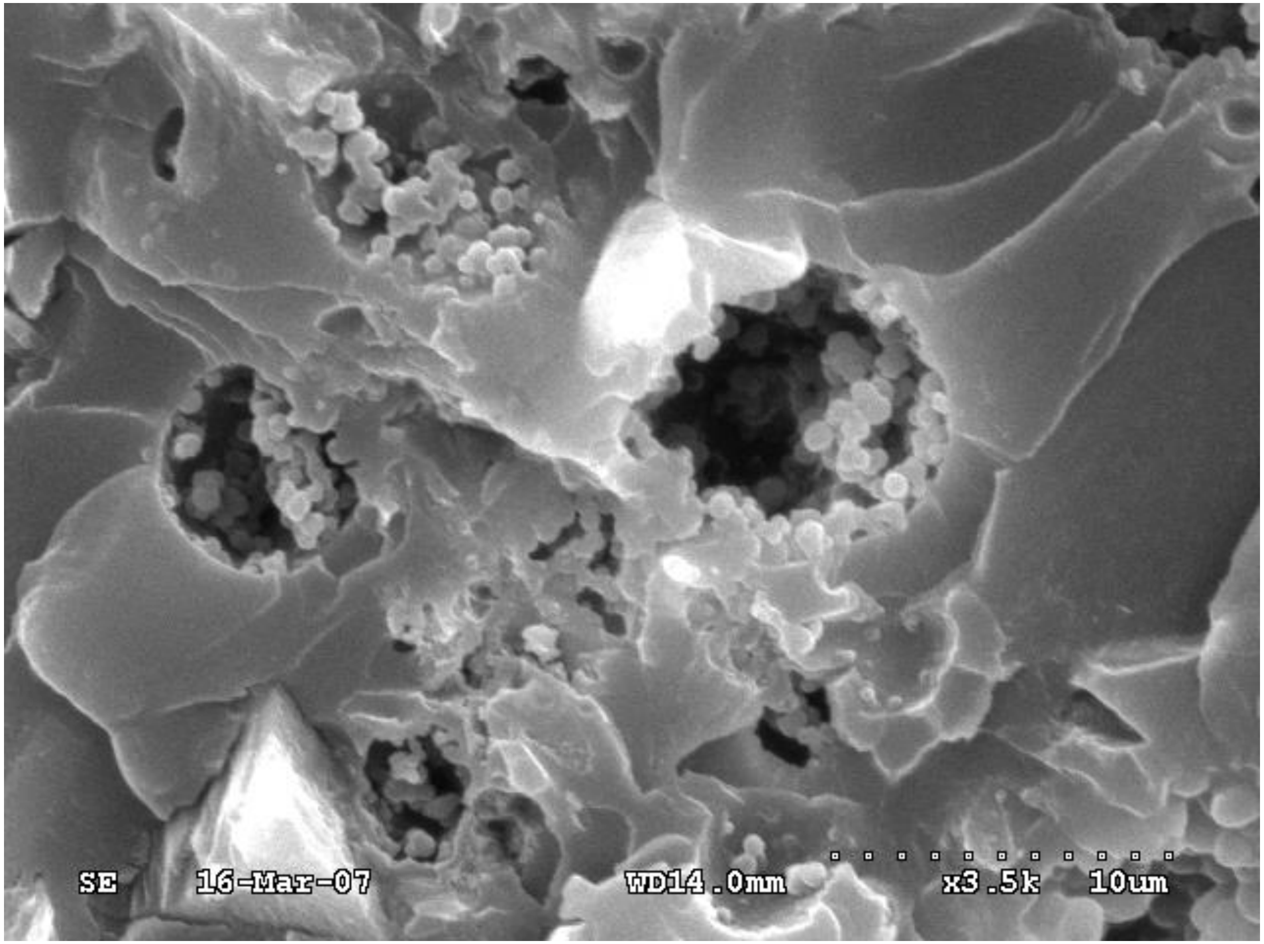


Float sink method H.Zhang et al/ J. Engineering Thermphysics 29(2008)1231-35



CCSEM method *J.C. Van Dyk et al./Fuel 88 (2009) 1057–1063*

Laumb, MTI).



A more clear look of included minerals in a char with SEM observation

Hong Zhang Fuel 88 (2009) 2303–2310

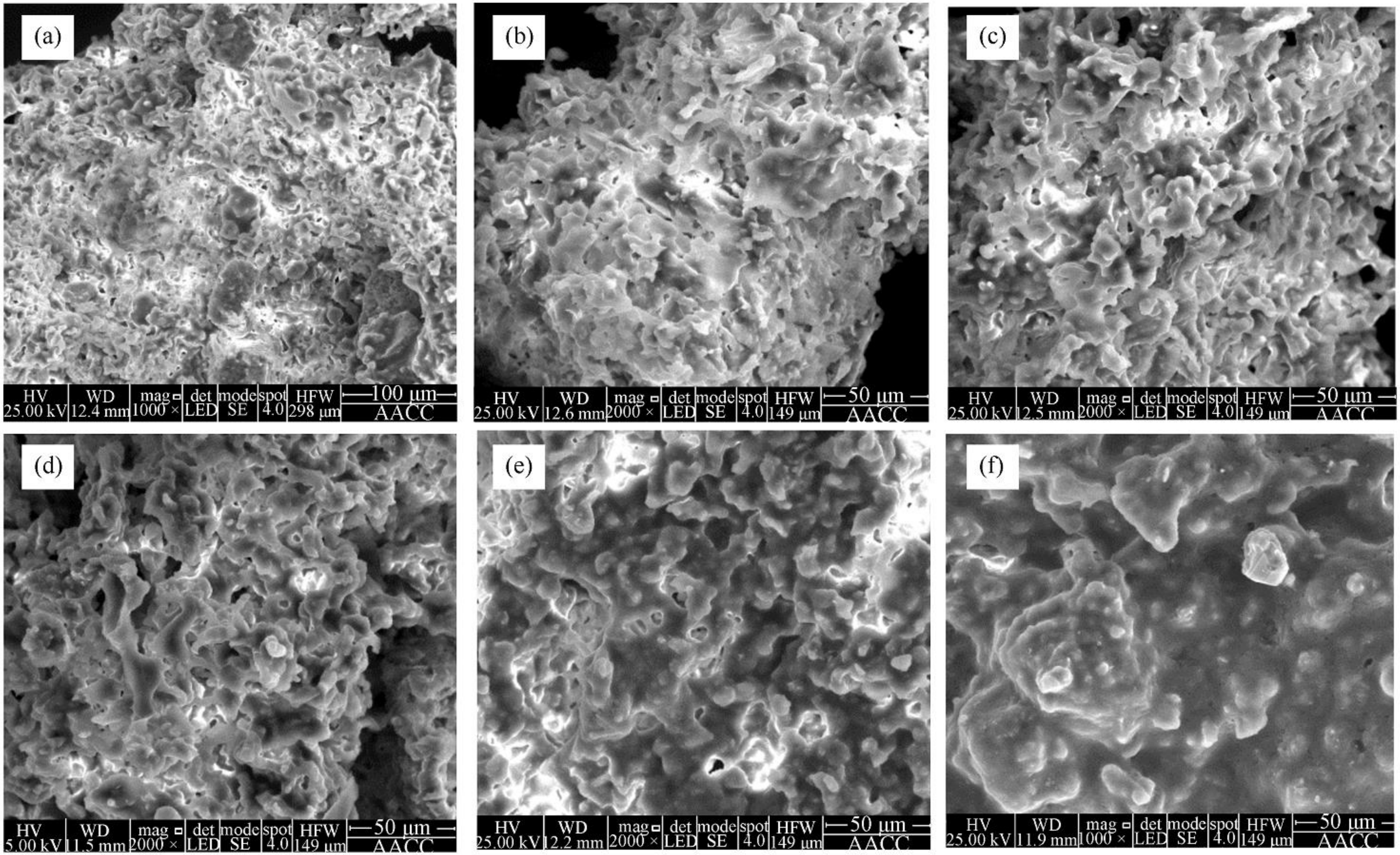
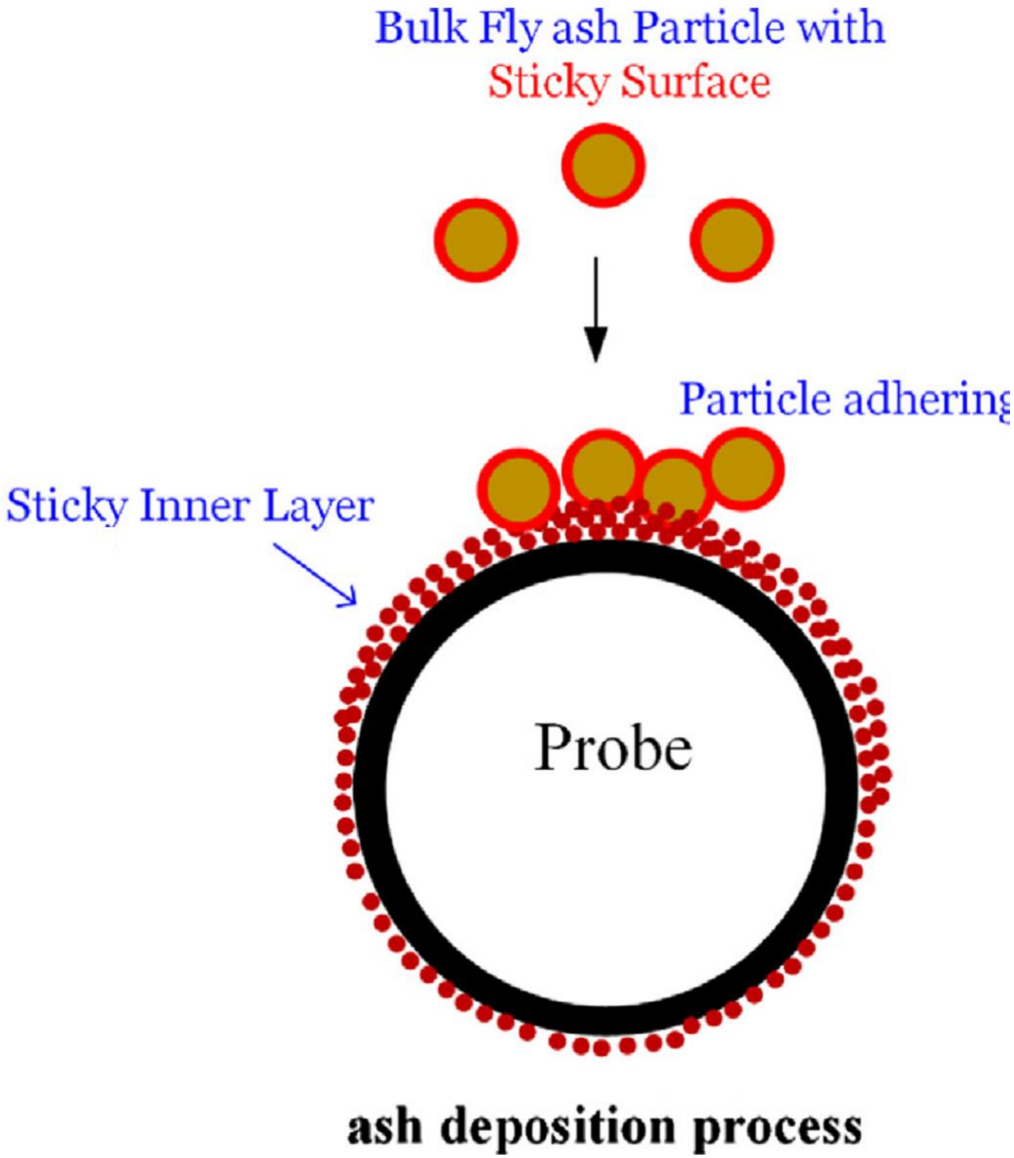


Figure 7 SEM pictures of pulverized Jincheng coal ashes and its density fractions under 1300 ℃

ZHANG Peng-qi J Chinese fuel chemistry 46(2017)1-7



The ash deposition rate is determined by a sum of the four independent rates, the inertial impaction, thermophoresis, condensation and chemical reaction.

M.U. Garba Fuel 113 (2013) 863–872

Gengda Li Fuel 143 (2015) 430–437

The present work as reported in this paper was aimed to study:

a) The uneven ash fusion characteristics of blended coals
b) The size distribution of the density fractions' ash of coal blends.

so as to predict ash deposition behavior of coal blend in boilers more accurately.

2 Experimental

Table1 Proximate analysis and ultimate analysis of Zhundong and Jincheng coals

Sample	Proximate analysis（wt, %）				Ultimate analysis（wt, %）				
	M_{ad}	A_{ad}	V_{ad}	FC_{ad}	C_{daf}	H_{daf}	N_{daf}	O_{daf} *	$S_{t,d}$
ZD	9.05	14.15	25.54	51.26	80.15	3.38	0.73	14.95	0.73
JC	3.66	16.91	6.31	73.12	88.60	3.24	1.11	3.94	3.11

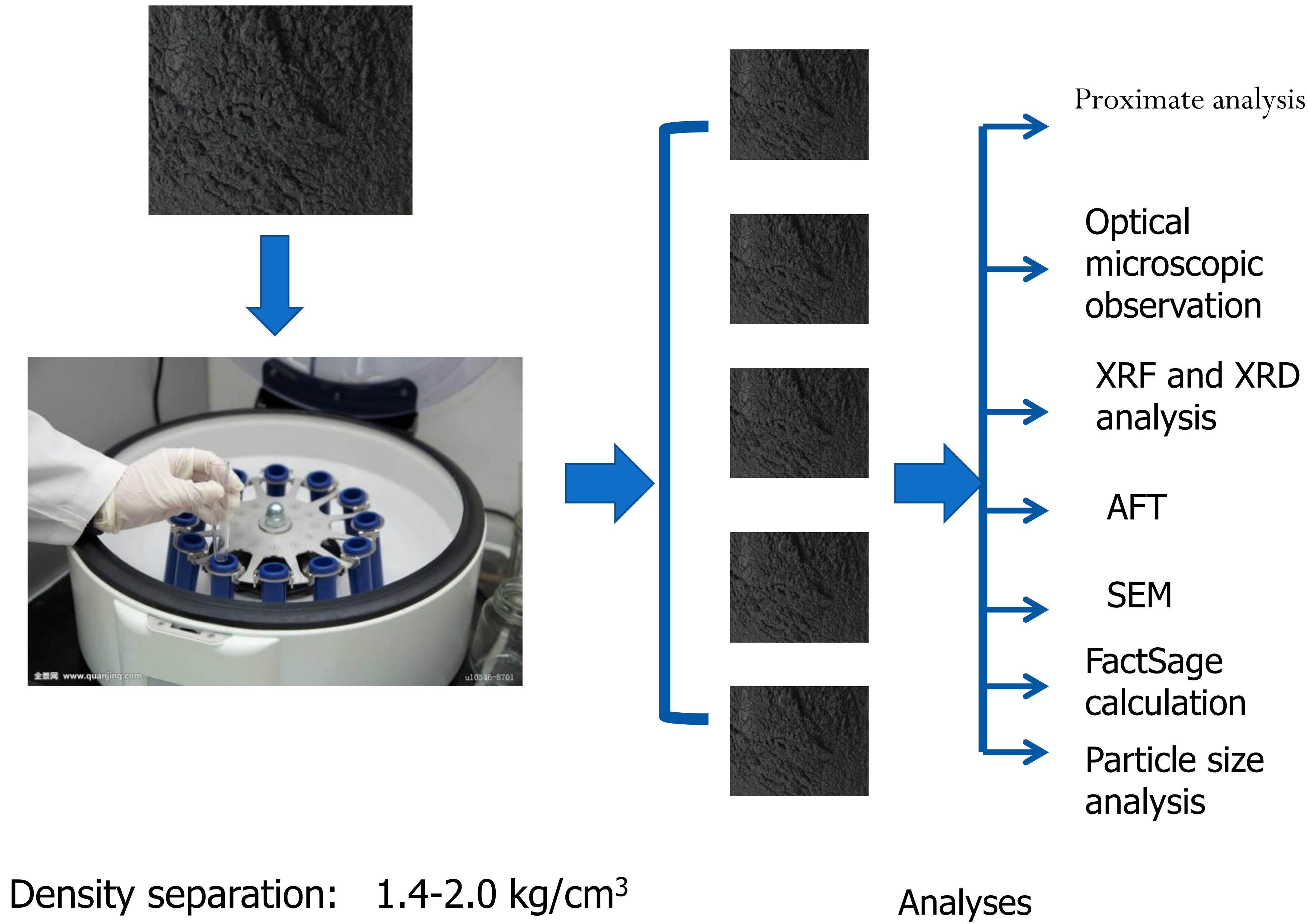
Table 2 Ash fusion temperatures of Zhundong and Jincheng coals

Sample	DT(°C)	ST(°C)	HT(°C)	FT(°C)
ZD	1140	1160	1170	1180
JC	1530	1550	1560	1580

Table 3 The chemical composition of Zhundong and Jincheng coal ashes

Sample	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	TiO_2	K_2O	Na_2O
ZD	52.19	12.54	7.08	11.21	3.62	5.88	0.66	1.46	4.07
JC	47.78	33.97	8.04	3.44	0.50	2.03	1.19	0.97	0.38

Blending and grinding procedure


Proximate analysis
Optical microscopic observation
XRF and XRD analysis
AFT
SEM
FactSage calculation
Particle size analysis
Density separation: 1.4-2.0 kg/cm3
Analyses

3 Results and discussion

3.1 Effect of blending ratio on the density composition of the Coal blends

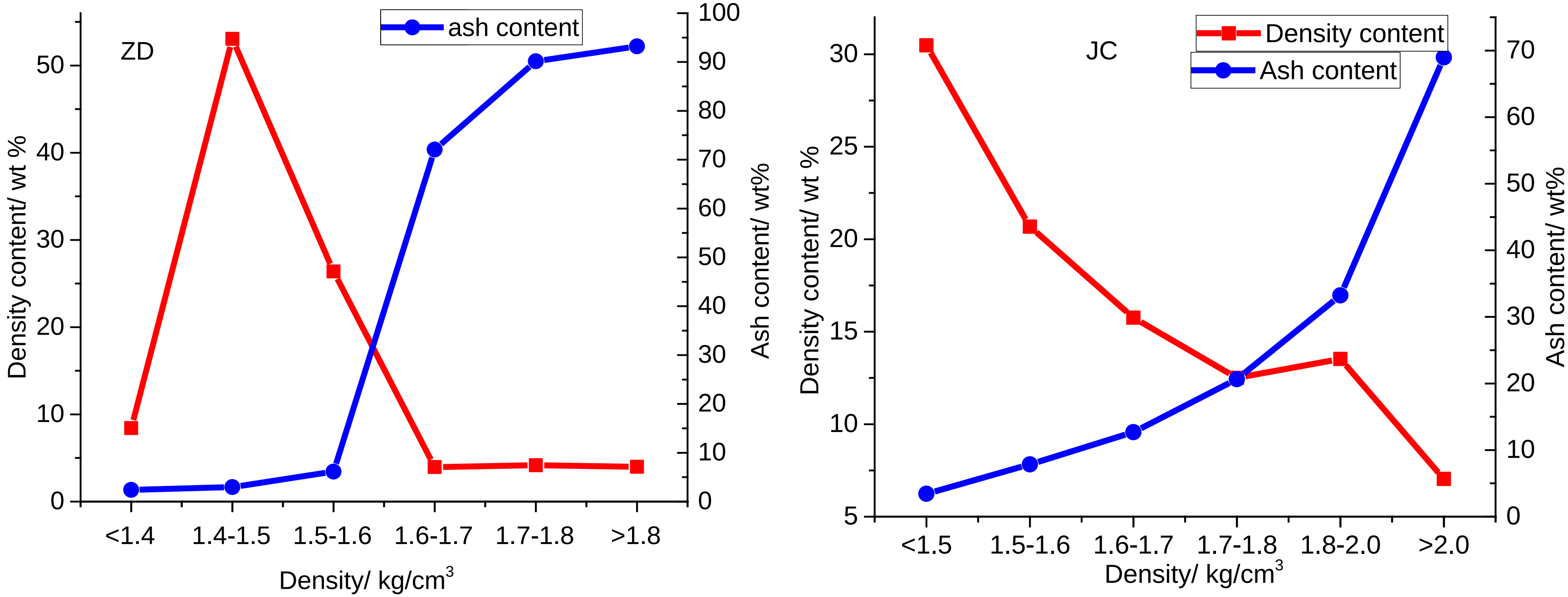
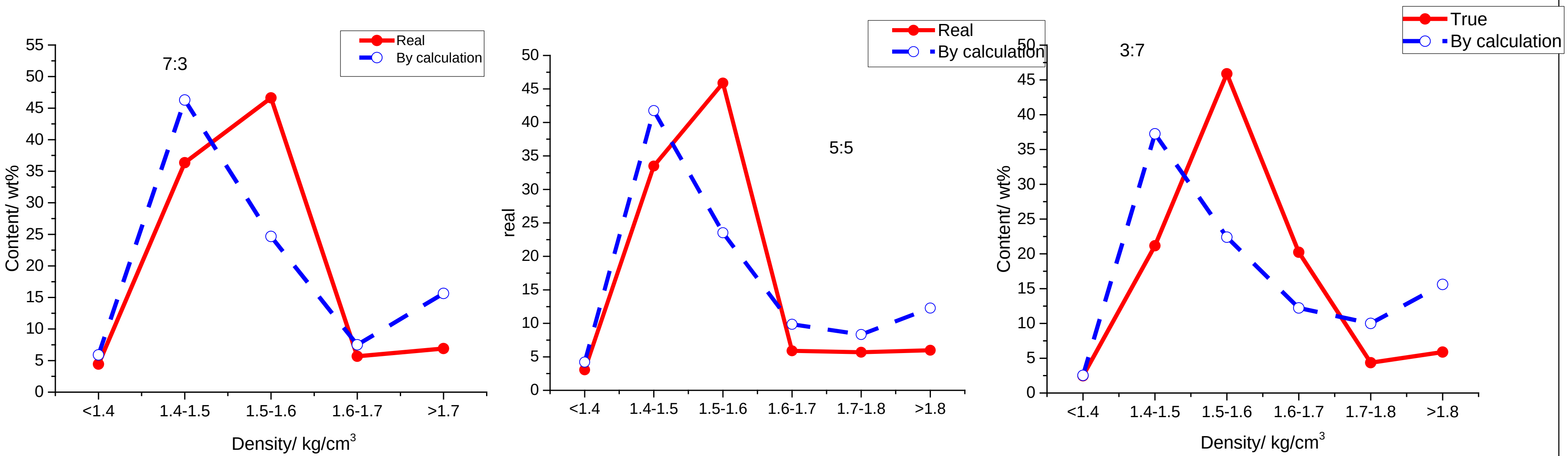
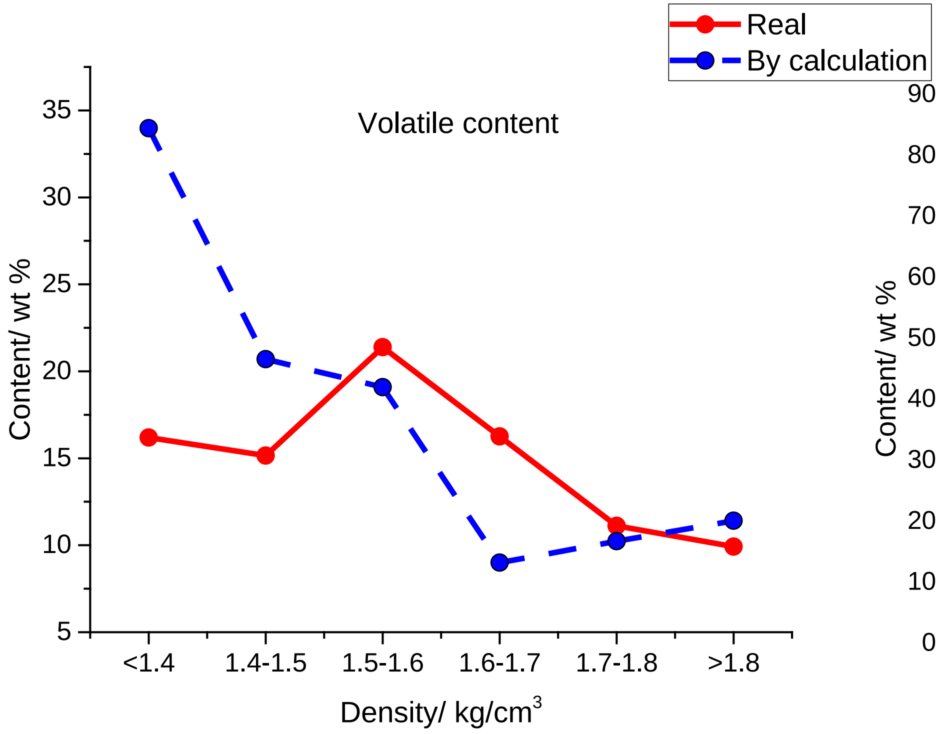


Fig.1 The density compositions and their ash contents of pulverized ZD and JC coals



B7030 B5050 B3070

Fig.2 The density compositions of the three blended coals and their calculated weight-averaged results



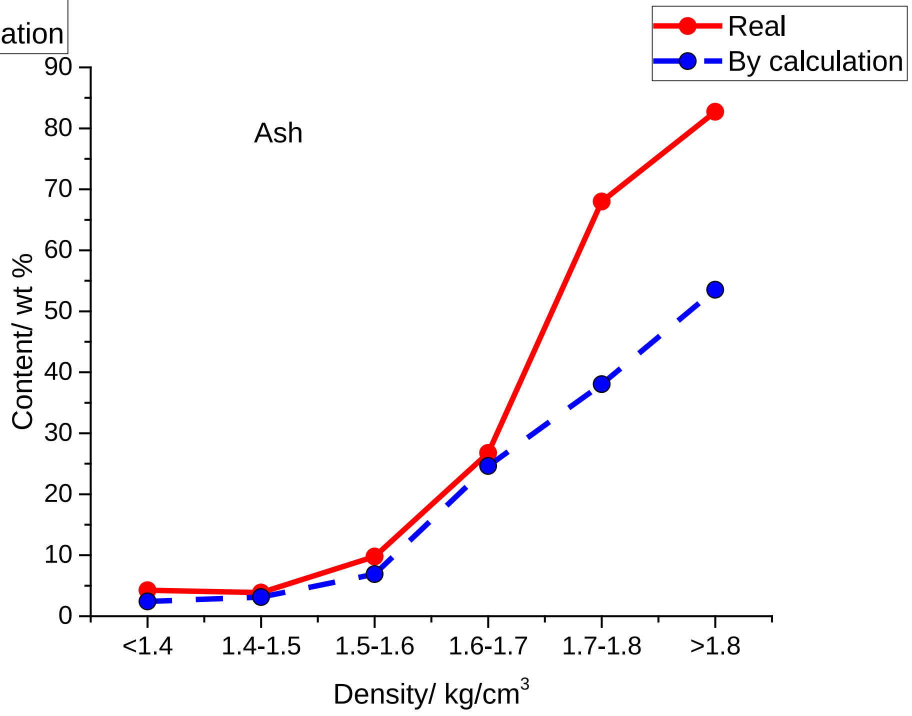
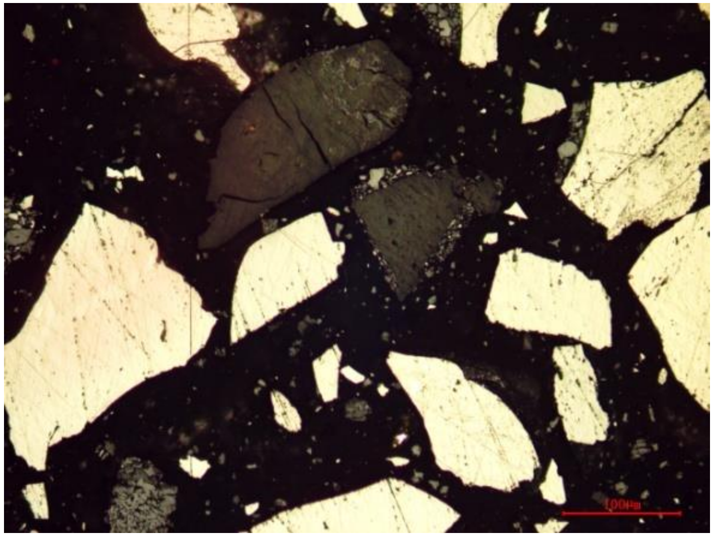


Fig.3 The change of proximate composition and their calculated weight-averaged results with density in the 50:50 blended coal



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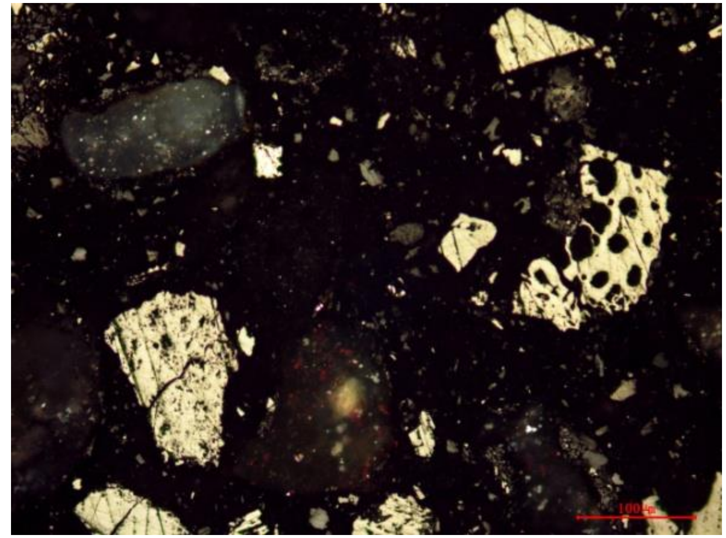
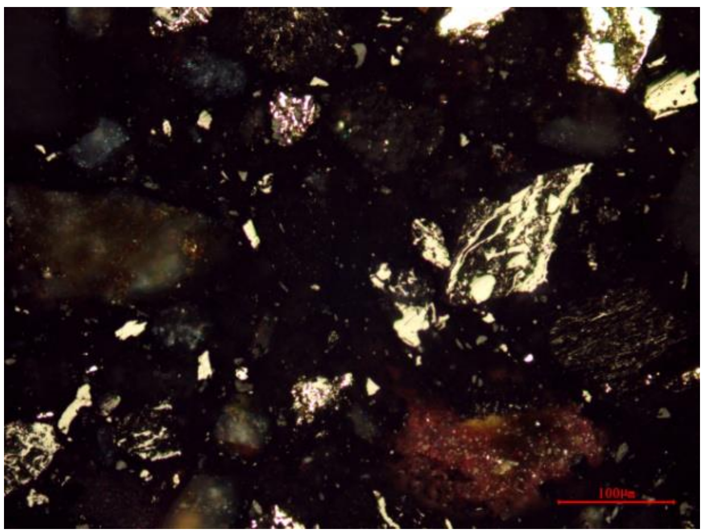
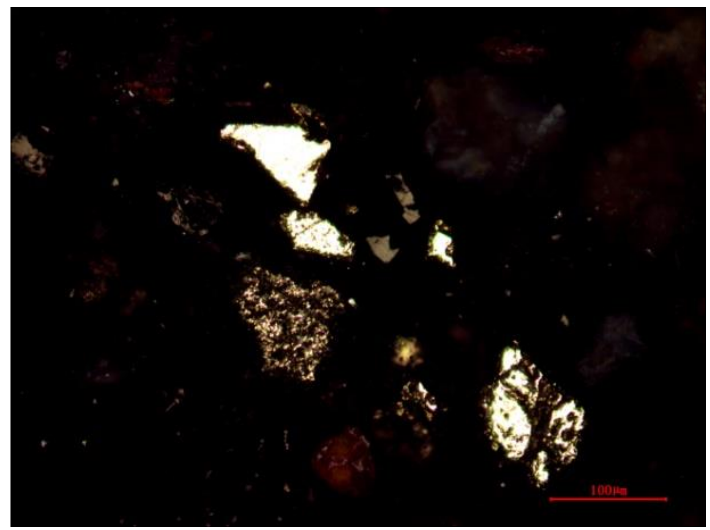


1.6-1.7



1.7-1.8



＞1.8

Fig.4 Optical microscopic observation of the density fractions of the 50:50 coal blend

Conclusion 1:

Grinding process has influence on the density composition of coal blends. The easy grinding component will be more thoroughly separated.

3.2 Effect of coal blending on the Chemical Composition and Mineral Composition of Blended Coals and their density fractions

Table 3 The chemical composition of their density fractions of ZD and JC

Sample	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	TiO_2	K_2O	Na_2O
ZD16	30.40	12.54	6.77	28.03	8.51	8.32	0.69	0.35	1.14
ZD1617	63.15	13.28	6.82	4.93	1.85	2.91	0.66	1.91	3.07
ZD17	64.79	12.93	7.36	3.54	1.60	2.82	0.67	1.94	3.55
JC16	48.94	37.53	4.58	3.29	0.65	0.64	1.34	0.96	0.43
JC1617	49.76	36.86	5.41	2.71	0.50	0.50	1.22	1.03	0.61
JC1720	50.68	34.99	5.41	2.96	0.53	0.65	1.16	1.12	0.50
JC20	45.81	25.78	17.28	4.25	0.42	3.51	1.03	0.82	0.44

Table 4 The chemical composition and their calculated weight-averaged results of their density fractions of coal blend B5050

Sample	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	TiO_2	K_2O	Na_2O
B16	42.98	27.50	5.61	10.66	3.10	3.19	1.02	1.01	2.94
B1617	55.38	24.12	7.77	4.46	1.19	2.19	0.92	1.37	1.72
B1718	57.81	20.84	7.41	4.08	1.08	2.72	0.84	1.48	1.79
B18	58.37	20.06	8.21	3.57	0.99	3.19	0.83	1.53	1.88

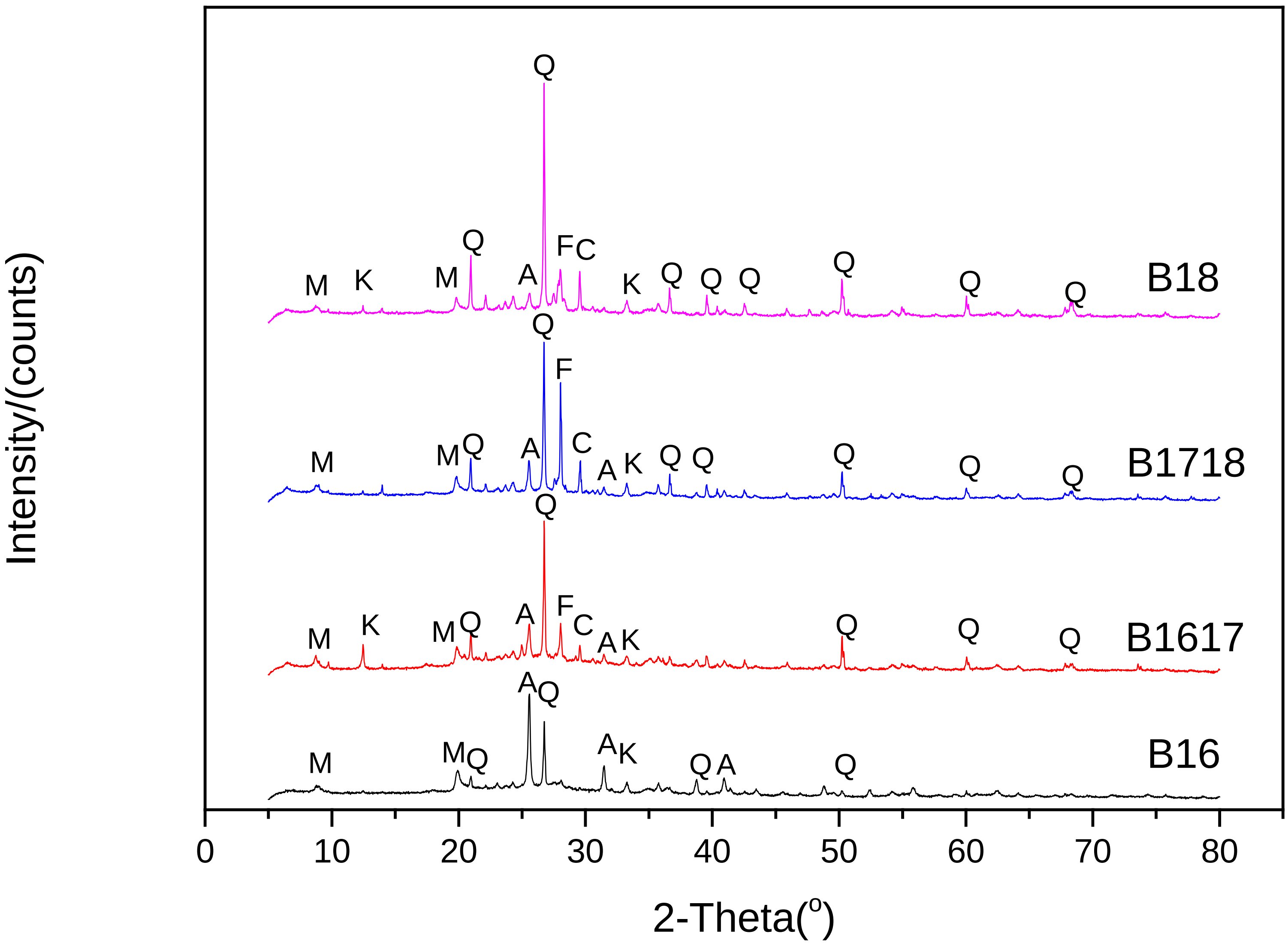


Figure 5 XRD Analysis of the density fractions of blended Coal
Q-Quartz； H-Hamite； A- Anhydrite； M- Muscovite
N- Feldspar； C- Calcite K- Kaolinite

Table 4 The chemical composition and their calculated weight-averaged results of their density fractions of coal blend B5050

Sample	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	TiO_2	K_2O	Na_2O
B16	42.98	27.50	5.61	10.66	3.10	3.19	1.02	1.01	2.94
$B16_{cal}$	38.56	23.54	5.81	17.14	5.05	4.94	0.81	0.62	0.83
B1617	55.38	24.12	7.77	4.46	1.19	2.19	0.92	1.37	1.72
$B1617_{cal}$	57.63	23.00	6.24	4.02	1.29	1.92	0.81	1.55	2.06
B1718	57.81	20.84	7.41	4.08	1.08	2.72	0.84	1.48	1.79
$B1718_{cal}$	59.04	21.91	6.57	3.30	1.16	1.94	0.85	1.61	2.31
B18	58.37	20.06	8.21	3.57	0.99	3.19	0.83	1.53	1.88
$B18_{cal}$	53.51	26.45	8.87	3.44	0.81	1.97	0.92	1.28	1.35

Conclusion 2:

The difference in chemical composition among different density fractions in the coal blend is greatly narrowed as compared with its parent coals.

3.3 The Ash Melting Behaviors of Blended Coal and its density fractions

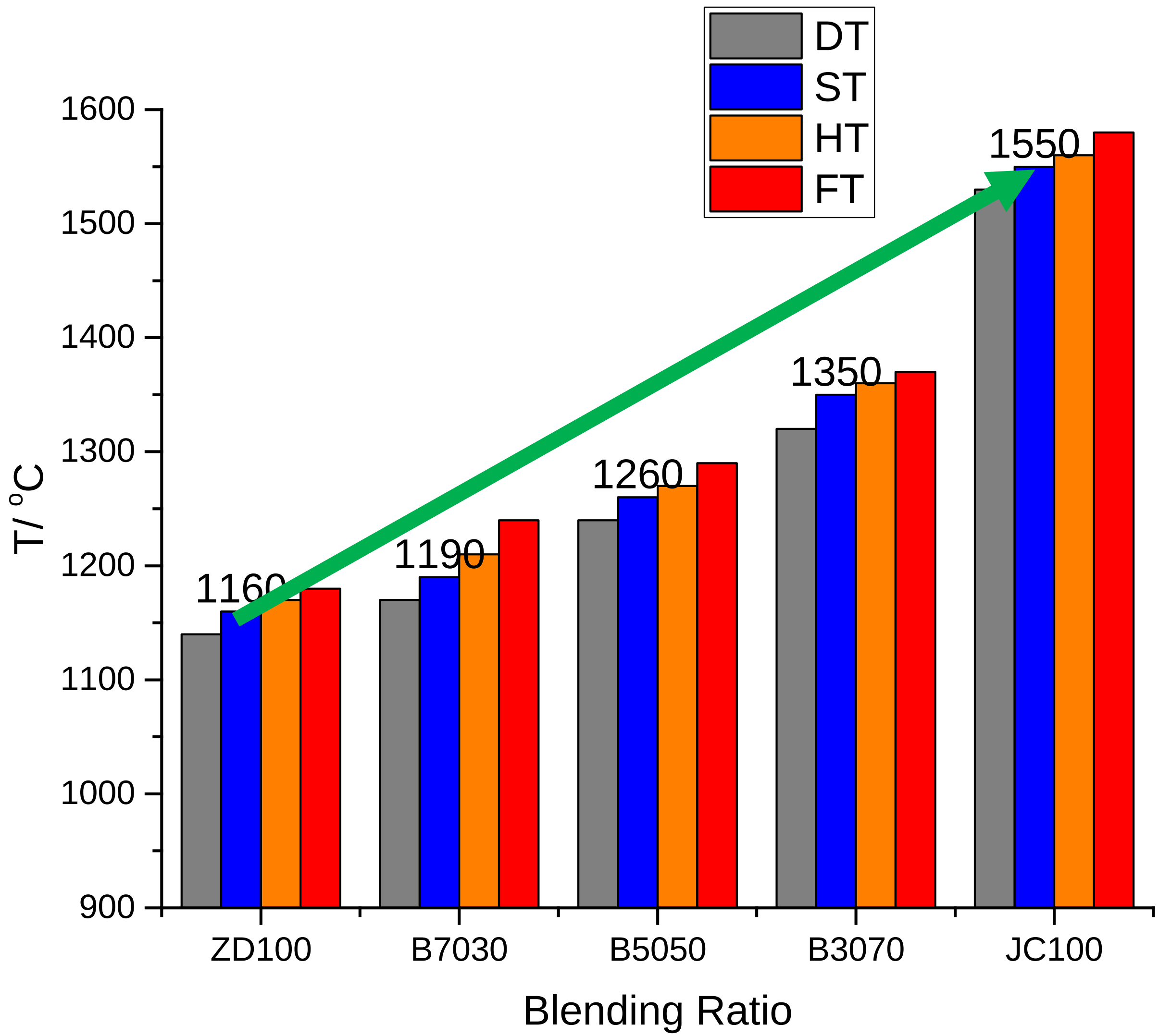


Fig.6 The influence of blending ratio on the AFTs of coal blends

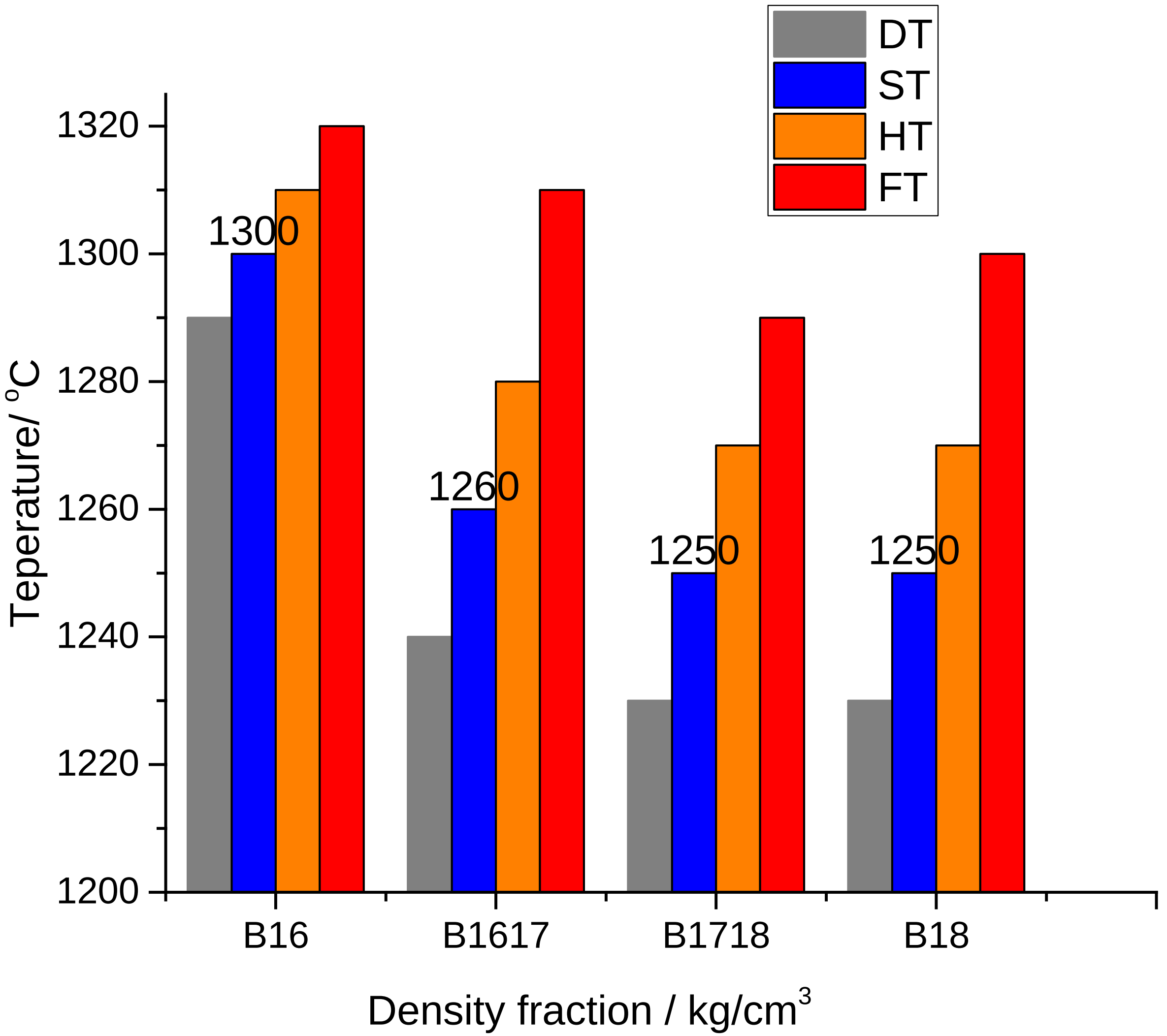
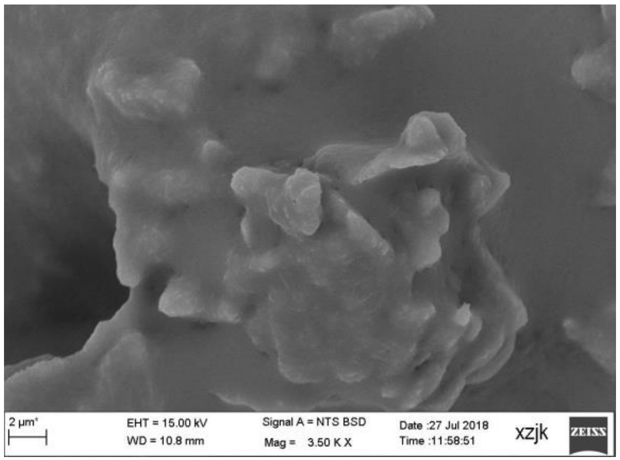


Figure7 The AFTs of the density fractions of blended coal B5050



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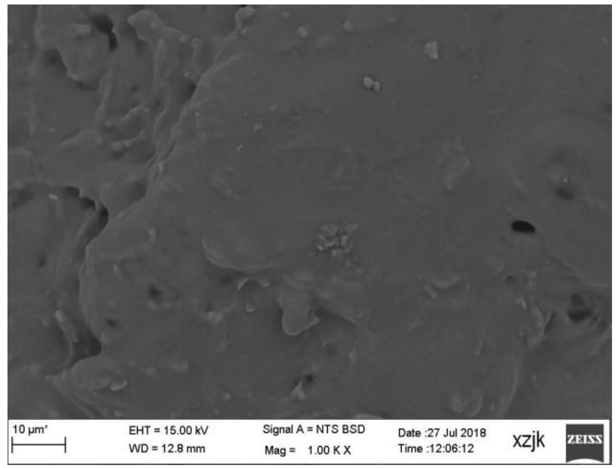

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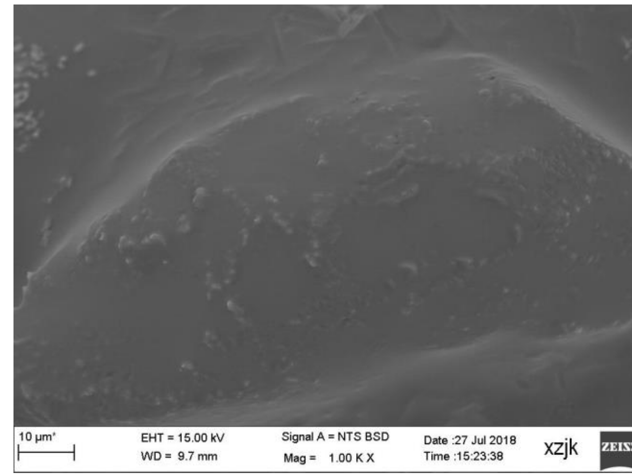


1.7-1.8

Fig.8 The SEM graphs of density fractions of coal blend B5050 under 1300^{o}C

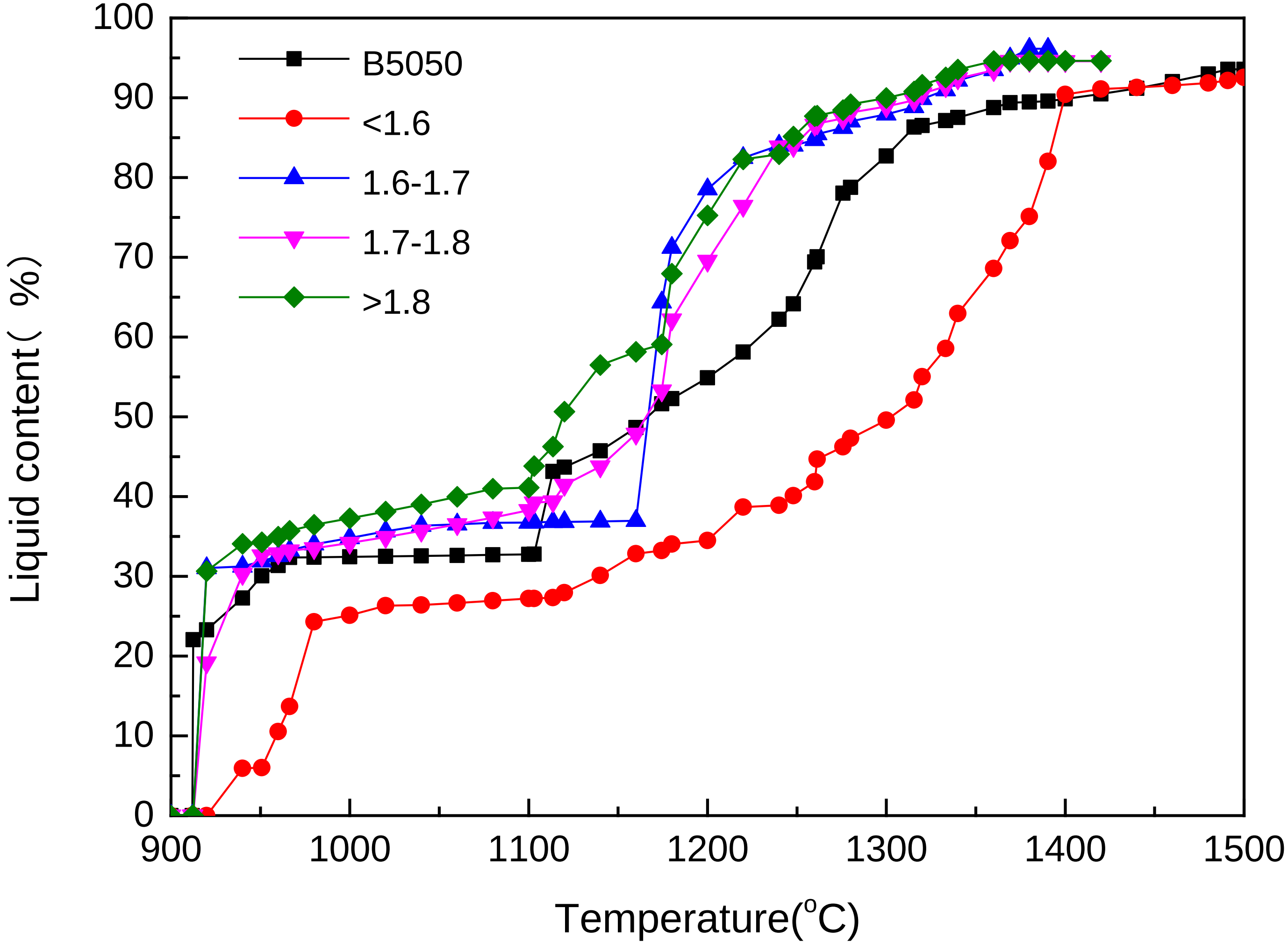
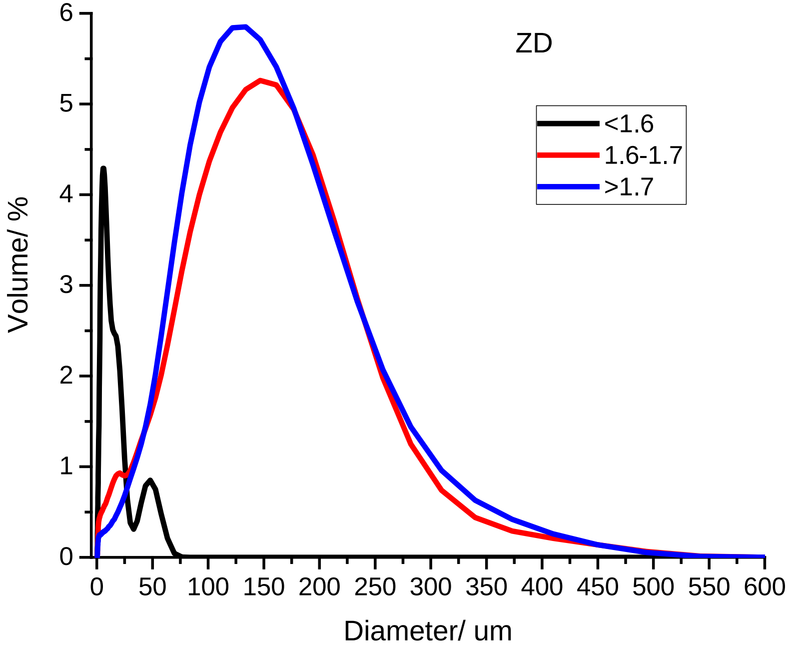


Fig.9 The liquid contents in the melt of the four density fractions of B5050 between 900°C and 1500°C

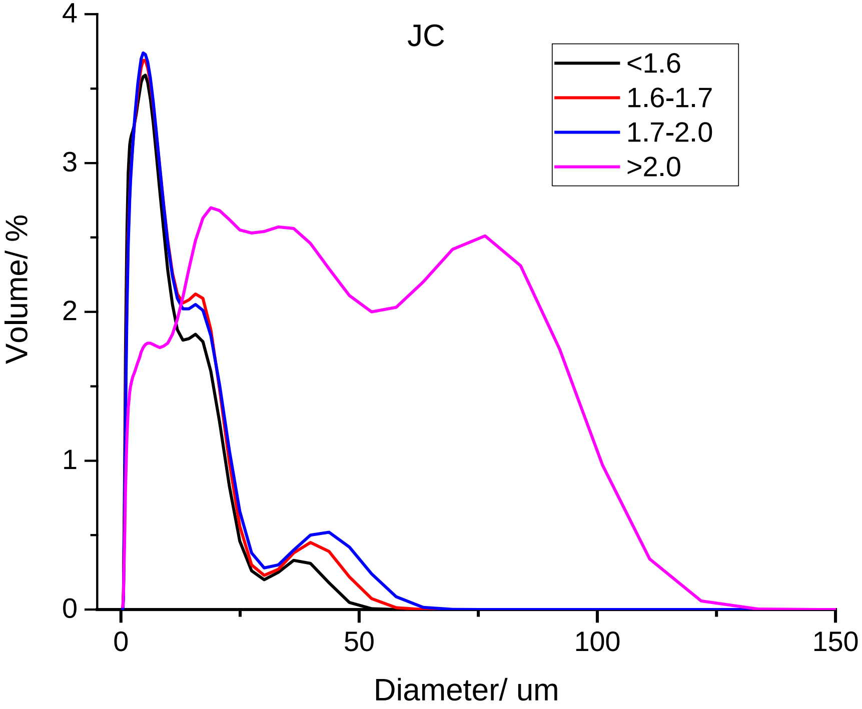
Conclusion 3:

An uneven ash melting behavior among different density fractions was observed for the blended coal.

3.4 The Size distributions of ash particles in different density fractions

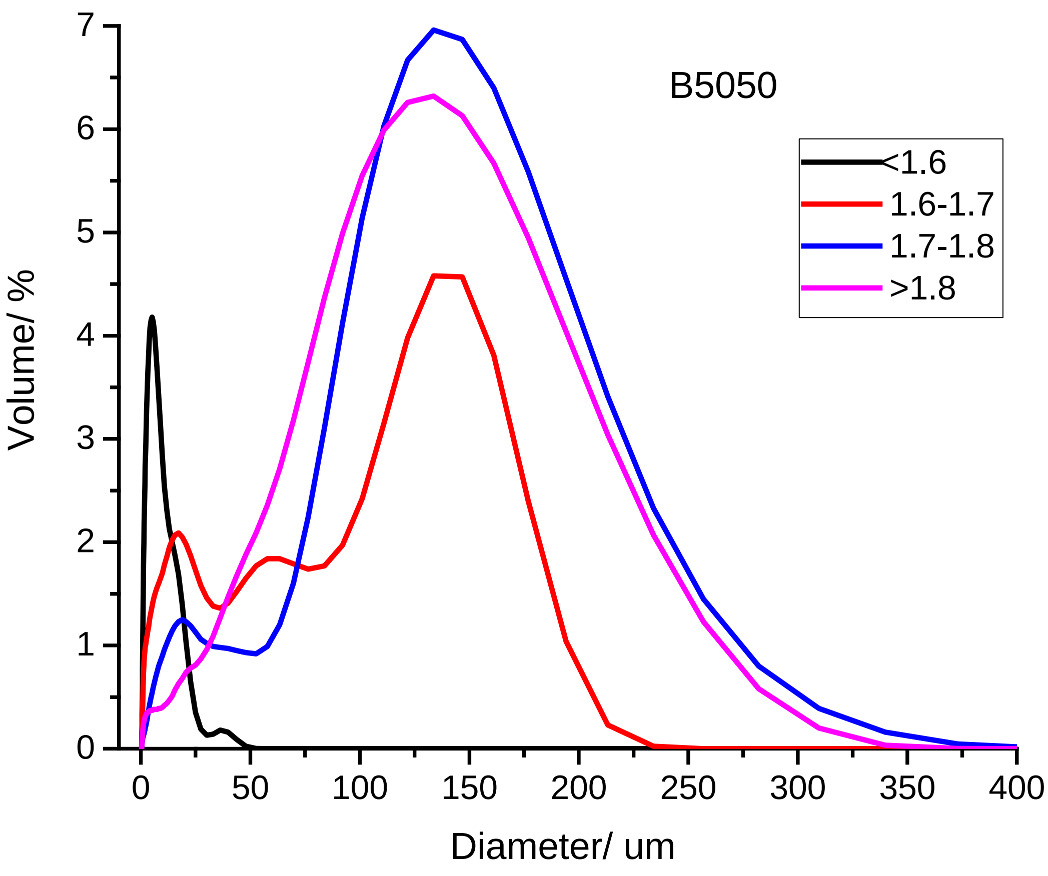


ZD



JC

The size distribution of coal ash of different density fractions in ZD and JC coal

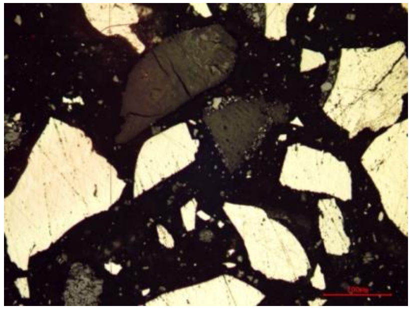
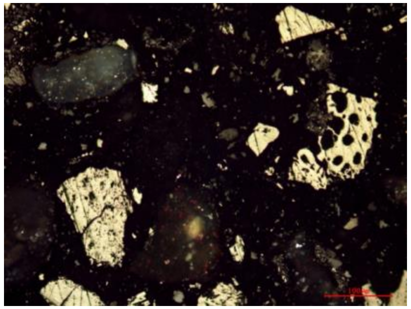
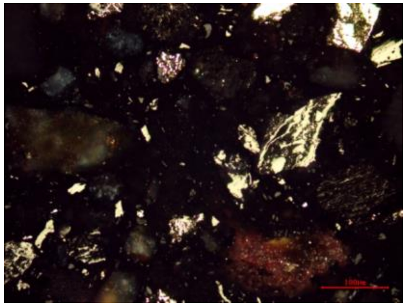
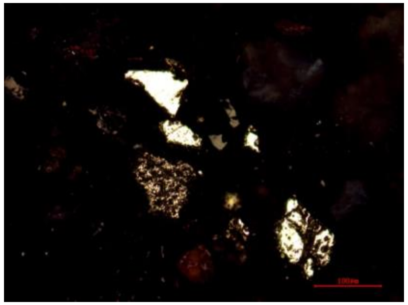


The size distribution of coal ash of different density fractions in coal blend B5050

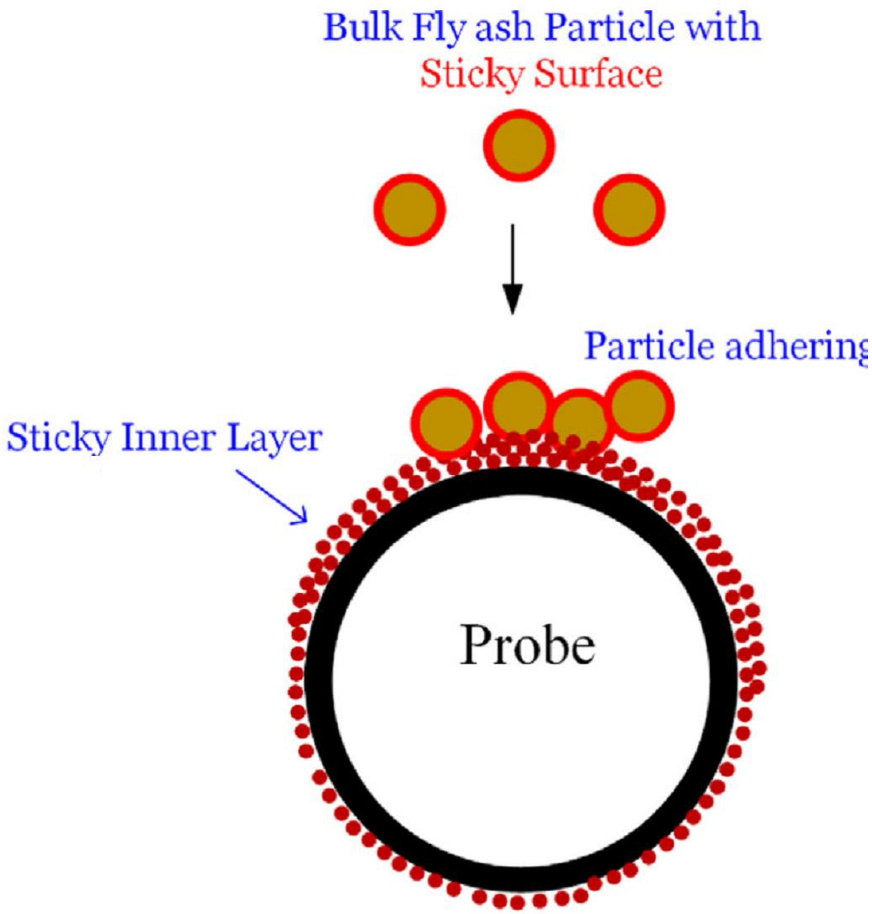
Conclusion 4:

Minerals in different state within raw coal evolve into ash in different size distribution. For the coal blend, ash from the two highest density fractions was much coarser than the other density fractions.

3.4 Discussions

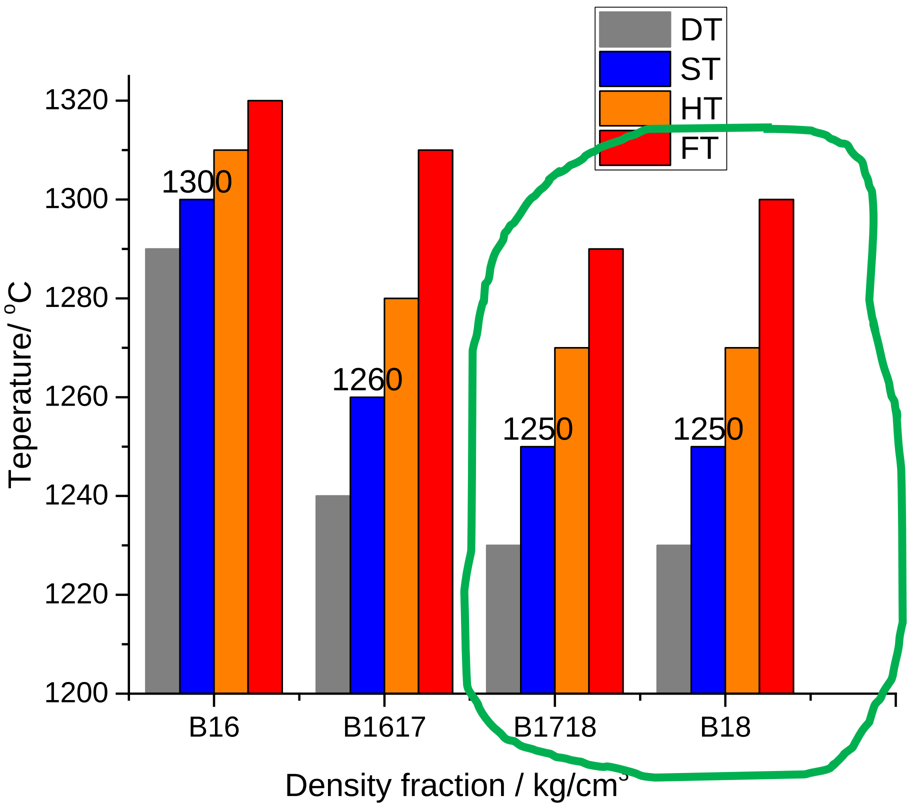





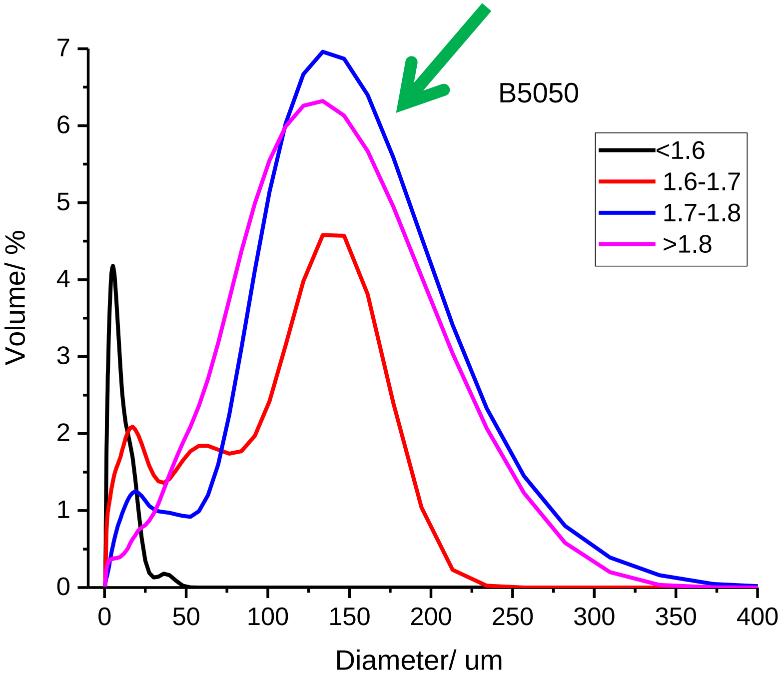
Pulverized blended coals are composed particles with different density. Which density fraction determines the melting behaviour of the whole coal in boilers?



ash deposition process

The ash deposition rate is determined by a sum of the four independent rates, the inertial impaction, thermophoresis, condensation and chemical reaction.





The two highest density fractions have low AFT and larger particle size of ash. They'll determine the whole slagging performance of the coal blend.

Conclusion 5:

The ash melting behavior of coal blend should be determined by the two highest density fractions, as they have low AFT and large ash particles.

4 Conclusions

① **Grinding process has influence on the density composition of coal blends.**

② The difference in chemical composition among different density fractions in the coal blend is greatly narrowed as compared with its parent coals.

③ **An uneven ash melting behavior among different density fractions was observed for the blended coal.**

④ For the coal blend, ash from the two highest density fractions was much coarser than the other density fractions.

⑤ **The ash melting behavior of coal blend should be determined by the two highest density fractions, as they have low AFT and large ash particles.**

5 ACKNOWLEDGEMENTS

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Thank you for your attention!

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