

# Study on coal blending scheme of formed coke made from anthracite blending with coal

Yonghua Ji<sup>1,a</sup>, Bingke Qin<sup>1,b</sup>

<sup>1</sup> School of Chemistry and materials Engineering, Liupanshui Normal University, Liupanshui, China

<sup>a</sup>haizhigong@126.com, <sup>b</sup>qinbingke@126.com

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**Abstract.** Gas coal, 1/3 coking coal, anthracite and lean coal are used to blend coal, asphalt is used as binder, coal blending scheme is formulated according to the requirements for each index of coal blending. The best scheme of coal blending is: 35% of the lean coal is combined with 30% 1/3 coking coal, 20% gas coal, 5% anthracite and 10% bitumen. Under this scheme, the various indexes of the formed coke are: the ash content is 11.91%, the sulfur content is 0.41%, the volatile matter content is 1.47%, the crushing strength is 98.93%, the wear-resistant strength is 1.07%, the compressive strength is 10.83MPa, which is accord with the national metallurgical coke grade one standard.

## Introduction

With the rapid development of the iron and steel industry in China, the capacity of coke is increasing. Although the coal resources are rich in China, the coking coal resources are relatively few. The main coking coal resources are short and the price rises and then increases, making the coking cost increase greatly[1,2]. In this severe case, only by expanding the range of coking coal, reducing its cost and improving the quality of coke, we can effectively solve the scarcity of coking coal, we can also make use of our country's advantages in other coal resources to broaden the types of coking coal, thus saving high quality coking coal and realizing the sustainable development of coking industry[3,4,5]. Anthracite has the characteristics of low volatilization. It can reduce cracks and improve the mechanical strength of coke.

Formed coke is based on pulverized coal as the main raw material, obtained after forming and carbonizing, compared with the traditional coke, the briquetted coke not only has the advantages of low cost and easy to process, but also can realize the sustainable development of coke industry. There are two forming processes in the process of forming coke, hot pressing and cold pressing, raw material coal must be pretreated before hot pressing process. After hot pressing, briquette is carbonized and heated to form coke. The cold pressing process is not used to preheat the raw coal, which is divided into two methods, without adhesive and binder. The process of cold pressing process is relatively simple, and it can use some non bonded coal. the cold pressing process with binder is used in this paper.

In this paper, gas coal, 1/3 coking coal, anthracite and lean coal are used as blending coal, asphalt is used as binder, first, coal blending scheme is formulated, then coal blending is pressed and formed by cold pressing process., then briquette is made into formed coke, finally, the best coal blending scheme is obtained through the detection of coke quality.

## Experiment

**Experimental materials and analysis.** The coal samples used in the experiment are gas coal, 1/3 coking coal, anthracite and lean coal, and the binder is asphalt. First, the raw materials are dried to air dry state, then crushing and screening and coal quality analysis, the particle size composition of raw coal is analyzed, the four kinds of coal have more fine particle size and smaller average grain size, in the process of coking, most of the coarse-grained part is an inactive part, which expands in the process of coking, thus becomes the center of coke crack and is not conducive to the quality of coke, but increasing the suitable fine grain content will increase the strength of coke. According to the principle that most of coal is less than 3mm, combined with the particle size analysis of the four kinds of coal used in this experiment, the selection of grain size for each kind of coal is less than 1mm.

The results of coal quality analysis are shown in Table 1.

Table 1. The results of raw materials industry analysis

Raw material	Water content $M_{ad}(\%)$	ash content $A_d(\%)$	Volatile matter content $V_{daf}(\%)$	Fixed carbon $FC_{daf}(\%)$	sulfur content $S_{t,d}(\%)$	Caking index G
1/3coking coal	1.54	11.14	28.96	71.04	0.31	91.39
gas coal	1.07	14.66	29.76	70.24	0.04	86.34
lean coal	3.13	11.85	13.99	86.01	0.46	63.50
anthracite	2.57	16.67	9.71	90.29	0.35	0
asphalt	0.56	5.82	37.93	62.87	0.79	97.98

**Coal blending scheme.** According to the analysis results of raw coal quality and the requirements for various indexes of coal blending, 12 schemes of coal blending are designed, as shown in Table 2.

Table 2. Coal blending scheme

Sequence number	Coal blending ratio(%)				
	1/3 coking coal	lean coal	gas coal	anthracite	asphalt
1	20	30	35	5	10
2	25	35	26	6	8
3	30	25	31	8	6
4	35	20	30	10	5
5	30	20	35	5	10
6	25	25	35	6	9
7	20	30	30	8	12
8	25	35	20	10	10
9	30	35	20	5	10
10	26	35	25	6	8
11	30	26	30	8	6
12	25	25	35	10	5

**Forming.** All kinds of raw coal and binder which are less than 1mm are added into the beaker in accordance with the corresponding quality of each mass 50g according to the ratio of coal blending in Table 2. 10% of the water is added (the water quality is not within the quality of

briquettes). After mixing, it is loaded into the molding mold, formed on the compression resistant test machine with 15MPa pressure, cylindrical briquettes of  $\Phi 50\text{mm} \times 20\text{mm}$  was obtained.

**Preparation of formed coke.** A square iron box is prepared, a certain thickness of sand is laid under the iron box, the briquettes are placed in the box, the sand is putted into the box until the briquette is covered. After the sealing, the briquettes are put into the resistance furnace, the heating rate of  $4^\circ\text{C}/\text{min}$  is heated to  $900^\circ\text{C}$ , constant temperature 3h. Then the power is shut down and the muffle furnace naturally cool to  $700^\circ\text{C}$ , remove the iron box, cool it to room temperature, remove the coke, clean it with a brush, and put it in a sealed bag.

## Results and analysis

Industrial analysis of coke was carried out, total sulfur content, mechanical strength and compressive strength were determined, the results are shown in Table 3.

Table 3. Quality inspection of formed coke

Sequence number	Ash $A_d(\%)$	volatile matter content $V_{daf}(\%)$	crushing strength $M_{25}(\%)$	abrasive resistance $M_{10}(\%)$	sulfur content $S_{t,d}(\%)$	compressive strength (Mpa)
1	12.00	1.45	99.30	0.70	0.34	9.47
2	11.95	1.53	99.07	0.93	0.37	6.98
3	12.33	1.77	98.33	1.67	0.34	7.35
4	12.46	1.64	98.50	1.50	0.43	5.87
5	11.93	1.59	99.35	0.65	0.34	7.46
6	12.26	1.55	99.39	0.61	0.32	11.37
7	11.82	1.37	99.11	0.89	0.37	8.76
8	11.78	1.35	99.39	0.61	0.41	9.02
9	11.51	1.47	98.93	1.07	0.41	10.83
10	11.91	1.50	99.18	0.82	0.38	9.69
11	12.31	1.56	99.19	0.81	0.35	8.50
12	12.67	1.66	99.32	0.68	0.41	10.90

The above scheme is analyzed according to the national quality standard for metallurgical coke:

Sulfur content, crushing strength and wear resistance, the coke formed under the 12 schemes has reached the national standard;

Volatile matter content: the volatile components of the coke obtained under the 12 schemes are all less than 1.8%, all within the national standard;

Ash: The coke formed in the scheme 3, 4, 6, 11 and 12 belongs to the national two grade metallurgical coke, the coke formed by other schemes belongs to metallurgical coke at the national level.

From the above analysis, we can see that the coke produced by the scheme 1,2,5,7,8,9,10 has reached the standard of metallurgical coke at the national level, compressive strength is used as an auxiliary index for evaluating the quality of metallurgical coke in the experiment, all of the above indexes reach the national level metallurgical coke program, and the compressive strength of the coke formed by Plan 9 is the largest, therefore, the best coal blending plan is determined as the plan 9.

## Conclusions

The best coal blending scheme for preparing coke from anthracite blended with other coals is 30% of 1/3 coking coal, 35% of lean coal, 20% of gas coal and 10% of bitumen were mixed with 5% anthracite.

Under the best coal blending scheme, the briquetted coke has reached the national level metallurgical coke standard, the indexes are: ash 11.51%, volatile matter content 1.47%, sulfur content 0.41%, crushing strength 98.93%, wear-resisting strength 1.07%, compressive strength 10.83Mpa.

Coking in coal blending, anthracite can be properly matched, which can reduce cracks and increase the mechanical strength of coke.

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## References

- [1] Shengchun Wang, Dexiang Zhang and Yinghua Liang: Coal Conversion. Vol 34. 92-96 (2011).
- [2] Ru Xiang, Gaifeng Xue and Lizhi Zhan, et al: Iron and Steel. Vol 648. 21-25 (2013).
- [3] K Bratek, I Geruspiasecka and W Brate: Earth & Planetary Science Letters. Vol 186. 57-73 (2004).
- [4] Yu. V. Stepanov, N. K. Popova and L. A. Makhortova: Coke and chemistry. Vol 10. 1-6 (2005).
- [5] Rongsun Zhu, Tingfeng Yi and Huawei Xu, et al: Coal Conversion. Vol 35. 46-50 (2012).