

Experimental Study on Recleaning of Coking Coal's Middlings

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Abstract: With middlings of TBS underflow from Shanxi serving as sample, recleaning experimental study was conducted in order to improve the recovery of coke. Lab single-cell flotator was used as the main separation device. The ash content of sample was 17.84%, collecting agent dosage and pulp density were separately adjusted to obtain the optimal parameter after cracking to -0.5mm. The experiment results showed that the optimum condition was collecting agent dosage value at 600 g/t, pulp density at 50 g/L, which ensures obtaining clean coal of ash content at 9.89%, recovery at 85.91%. The experimental optimal parameter possessed some guidance for industrial processing.

Introduction

China has abundant coal resource and most are low-rank lignite, while gas coal, fat coal, coking coal, lean coal and anthracite coal that are used in metallurgy and chemical industries are scarce^[1], which is considered as "national treasure". Over the past 10 years, the production of domestic coking coal, fat coal and lean coal has no real growth and high-quality coking coal resources will face depletion crisis in the near future. In recent years, the annual output of raw coking coal was continuous more than 1.2 billion tons. By 2015, the total national demand for coking coal will add 180 million tons, while production of coking coal in Shanxi Province is expected to add 80 million tons and other provinces increment is limited, which will lead to around 100 million tons of gap between supply and demand in China^[2,3]. Therefore, the recleaning of coking coal middlings to recover high-quality coking coal is an important way to achieve efficient and clean utilization of coal resources. As one of the most efficient ways to separate fine coal^[4], flotation can be used in the research of recleaning coking coal middlings. In this paper, the feasibility of recleaning coking coal middlings from Shanxi Province through flotation was studied for providing the basic data of recleaning and upgrading.

Analysis of Coal Sample

Proximate analysis and Ultimate analysis

Proximate analysis and Ultimate analysis were carried out according to GB/T30732-2014 《Proximate analysis of coal》^[5] and GB/T476-2001 《Ultimate analysis of coal》^[6]. The results were shown in Table 1.

Table 1 Industrial Analysis and Elemental Analysis

Proximate analysis/%				Ultimate analysis/%				
M_{ad}	A_d	V_{ad}	FC_{ad}	C	H	N	S	O
0.69	17.84	18.33	63.14	72.72	3.87	1.46	2.06	19.89

Table 1 shows that the ash content of sample was 17.84% belonging to moderate and low ash coal, where there is space and feasibility of upgrading. The sample is scarce coking coal on the basis of Ultimate analysis data. Recleaning of coking coal middlings to recover high-quality coking coal is an important way to achieve efficient and clean utilization of coal resources.

Mineral Composition Analysis

X-ray diffraction is commonly used in analyzing mineral composition in coal [7]. Coal sample was cracked -0.045mm and X- ray diffraction analysis was conducted to obtain the results shown in Figure 1.

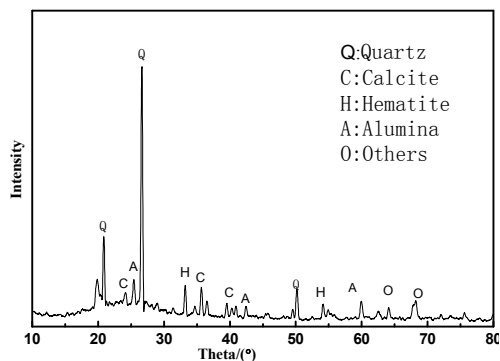


Fig. 1 X-ray diffraction patterns of coal sample

As shown in Figure1, this coal sample is mainly composed of quartz, calcite. Additionally, it also contains hematite, alumina, etc., but the content is low.

Experimental

Release evaluation

The sample was separated through flotation after cracking to -0.5mm. Composition of different floatability substance in sample can be obtained through release evaluation experiment and theoretical flotation index in laboratory is established. Experiment of release evaluation was conducted referring MT/T 144-1997 [8] standard. The test results were shown in Table 2 and the ash-yield curve was drawn according to the data in Table 2, as shown in Figure 2.

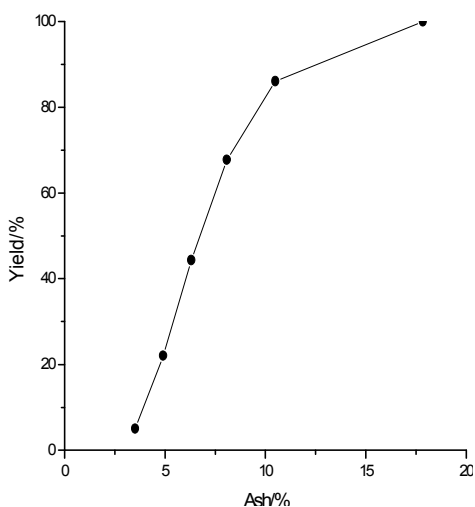


Fig.2 Curve of concentrate ash-yield

Table 2 Results of distribution releasing experiment

Product	Yield/%	Ash Content/%	Cumulative Yield/%	Average Ash Content/%
J	5.02	3.52	5.02	3.52
W5	17.04	5.32	22.06	4.91
W4	22.27	7.69	44.33	6.31
W3	23.42	11.45	67.75	8.08
W2	18.35	19.41	86.10	10.50
W1	13.90	63.34	100.00	17.84

As shown in Figure2, flotation concentrate with high yield could be received after one rough

selection and four beneficiation. The preliminary experiment can gain the clean coal with the ash of 10% and the yield of 85%. Therefore, it is feasible that low ash and high yield concentrate can be obtained from the sample by flotation technique.

Flotation Upgrading Research

Lab single-cell XFD-1.5L flotator was used as the main separation device, air flow rate and impeller speed were adjusted at $0.15 \text{ m}^3/\text{min}$ and $1800\text{r}/\text{min}$, separately. The optimum condition about reagent dosage and pulp density were explored in this paper.

Exploring experiment of reagent dosage

Kerosene and octanol were separately selected as collecting agent and frothing agent ratio at 4:1, pulp density at $40 \text{ g}/\text{L}$. Four groups exploring experiment concerning reagent dosage were conducted according to the above conditions, the results were shown in Table 3 and Figure 3.

Table 3 Experiment results of reagent dosage

Collector dosage/ $\text{g} \cdot \text{t}^{-1}$	Frother dosage/ $\text{g} \cdot \text{t}^{-1}$	Concentrate yield/%	Concentrate ash/%	Tailing yield/%	Tailing ash/%	Calculated feed ash/%
400	100	80.14	8.65	19.86	55.13	17.88
500	125	82.55	9.25	17.45	57.50	17.67
600	150	84.70	9.73	15.30	61.10	17.59
700	175	91.37	12.87	8.63	69.19	17.73

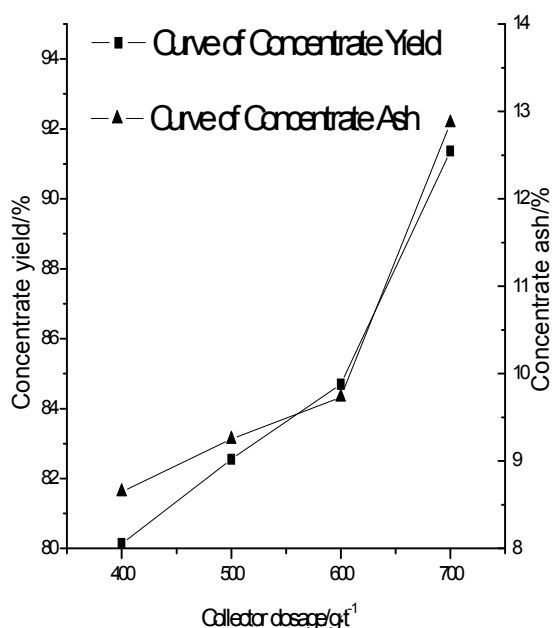


Fig.3 Curve of collector dosage--concentrate ash and yield

As shown in Table 3 and Figure 3, both concentrate yield and concentrate ash increased, while tailing yield decreased and tailing ash increased, accompanying with increment of reagent dosage. In order to get clean coal of ash content under 10%, the

experiment results showed that the optimum condition was collecting agent dosage value at $600 \text{ g}/\text{t}$, frothing agent dosage value at $150 \text{ g}/\text{t}$, which ensured obtaining clean coal of ash content at 9.73% , recovery at 84.70% .

Exploring experiment of pulp density

Pulp density is one of the important factors which has influence on the floatability and flotation effect of coal slime. If the pulp density is too low, it will affect the clean coal yield and reduce the processing amount of flotator. However, proper air flow will be prevented and concentrate will be

polluted by fine mud if the pulp density is too high^[9]. Exploring experiment of pulp density were carried out on condition that collecting agent dosage value at 600 g/t, frothing agent dosage value at 150 g/t, pulp density value at 40,50,60,70g/L, separately. The results were shown in Table 4 and Figure 4.

Table 4 Exploring experiment of pulp density

Pulp density/g·L ⁻¹	Concentrate yield/%	Concentrate ash/%	Tailing yield/%	Tailing ash/%	Calculated feed ash/%
40	84.70	9.73	15.30	61.10	17.59
50	85.91	9.89	14.09	61.91	17.22
60	87.96	11.27	12.04	62.85	17.48
70	88.23	11.40	11.77	64.33	17.63

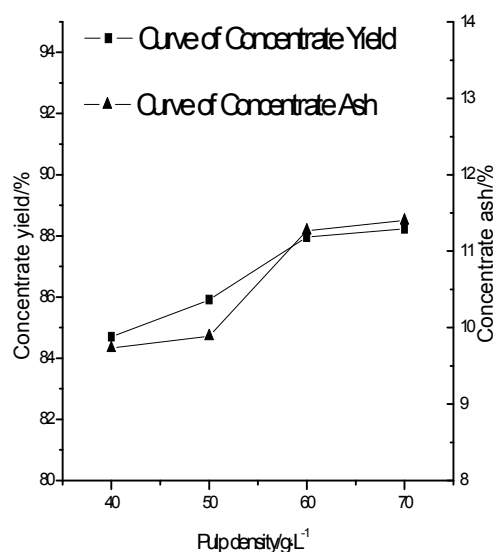


Fig.4 Curve of pulp density-concentrate ash and yield

As shown in Table 4 and Figure 4, both concentrate yield and concentrate ash increased with pulp density increasing. In order to get clean coal of ash content under 10%, the experiment results showed that the optimum condition was pulp density value at 50g/L, which ensured obtaining clean coal of ash content at 9.89%, recovery at 85.91%.

Conclusion

(1)The coking coal is scarce resource in China, it is predicted that there will be 100 million tons gap of supply and Demand every year. Therefore, the

recleaning of coking coal middlings to recover high-quality coking coal is an important way to achieve efficient and clean utilization of coal resources and possess good economic and social benefits.

(2)The exploring experiment results showed that the optimum condition was collecting agent dosage value at 600 g/t, pulp density at 50 g/L, which ensures obtaining clean coal of ash content at 9.89%, recovery at 85.91%.

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