

Study on the Hg content of coal in Dahebian coal mine

Yonghua Ji^{1,a}, Bingke Qin^{1,2,b}, Peng Chen^{1,c}, Shuai Li^{1,d}

¹ School of Chemistry and materials Engineering, Liupanshui Normal University, Liupanshui, China

² College of Materials and Metallurgy, Guizhou University, Guiyang, China

^ahaizhigong@126.com, ^bqinbingke@126.com, ^ckr2012@126.com, ^djyh129217@163.com.

Keywords: Hg; coal; Nitrification; Atomic fluorescence spectrophotometer

Abstract. This study first analyzed the phase composition of Dahebian coal mine by XRD, then do the experiment of screening, float and sink test, following the Hg content of coal was determined by atomic fluorescence spectrophotometer, and the regularities of distribution of Hg was studied. The results showed that the Hg content of the coal increased with the ash, density increasing, which indicated that Hg had a certain inorganic affinity. There is a significant correlation between Hg content and average density, when the density exceeded 1.8g/cm³, the maximum Hg content reached to be 0.97 ppm. At the same time the maximum sulfur and ash also measured respectively, it is 0.46% and 56.32%.

Introduction

There are two sources of Hg in atmospheric environment, one is natural source, and the other is artificial source. Natural sources include wind-blown sand, raise dust, volcanic activity, mineral release, forest fire, biological causes and so on. Artificial sources include mining, smelting, processing, transportation, waste incineration, energy utilization and so on. Among them, Hg in the atmosphere is a large part of anthropogenic activities, and the Hg released by coal combustion accounts for a large portion of Hg released by human activities [1-3].

China is the world's first coal power energy structure, coal accounted for more than 60%, in the foreseeable future decades, coal dominated energy structure will not change in China, coal will continue to be a major component of China's primary energy supply in the future [4]. Moreover, China's coal combustion technology is generally backward, low proportion of coal sorting rate, most of the steam coal without sorting. The mercury content of coal in China is extremely uneven, mainly concentrated in the range of 0.1~0.4μg/g. The Hg content of coal is relatively rich, and the Hg content in different plants is very different. Therefore, the Hg content of coal formed by different coal forming plants is different, the highest Hg content in Chinese coal is mainly distributed in Guizhou. In addition, Guizhou is China's major coal producing province, in recent years, Guizhou's annual coal combustion up to 8 million tons, and did not take any measures or clean flue gas emissions, therefore, human activities in Guizhou province to quantity of atmospheric Hg emissions is also very alarming, accounting for about 12% of global anthropogenic emissions of Hg.

The consensus of researchers at home and abroad is that pyrite of coal is the main carrier of Hg, especially in epigenetic pyrite, and the distribution of Hg in pyrite is uneven. In addition, the sulfide or selenide minerals of coal (such as sphalerite) may also contain Hg [5, 6].

In this paper, the determination of Hg content in coal by using advanced instruments, the distribution mechanism of Hg in Liupanshui area Dahebian coal mine was researched through screening and float-sink test; it can provide theoretical basis and technical support for resource utilization of high Hg content coal.

Experiment

The coal samples collected from Liupanshui Dahebian coal mine. First, the coal samples were dried to air-dried state, and then according to the grain size > 50, 50 ~ 25, 25 ~ 13, 13 ~ 6, 6 ~ 3, 3 ~ 1, 1 ~ 0.5, <0.5mm screened into eight parts. Next, the coal samples of each particle size were crushed, divided,

sample prepared, and screening into -0.2mm and -0.074mm. The coal samples of each particle size are measured of moisture content, ash content and total sulfur.

When did float-sink test of selected coal samples, the heavy-fluid is mixed liquor of zinc chloride and water. The coal samples divided into seven density level according to <1.3 , $1.3\sim1.4$, $1.4\sim1.5$, $1.5\sim1.6$, $1.6\sim1.7$, $1.7\sim1.8$, $>1.8\text{g/cm}^3$. Each of the density grade coal samples obtained after the float-sink test was crushed, divided, sample prepared, and screening into -0.2mm and -0.074mm, Then the moisture, ash, total sulfur and Hg content of each density class of coal samples were determined.

Accurately weighing coal samples which is below 200 mesh of each size grade, density level $0.1 \pm 0.0001\text{g}$, putted into the group which has been numbered digestion bottle, added 50% of aqua regia 10ml, shock heated 1h in the 95°C thermostat water bath. After added 50% of aqua regia 20ml, 1h after removed the bottle to stand still cooling down to room temperature, then added 1% of potassium permanganate solution 40ml, putted back to 95°C thermostat water bath, heated to digestion until the solution was completely clarified, the solution was determined by filtration and constant volume. The Hg content was determined by AFS-9700 dual channel atomic fluorescence spectrometer.

Results and discussion

Raw coal XRD analysis. Figure 1 is the test pattern of the raw coal by XRD. According to the patterns, the scanning step was 0.05, scanning angle range was $5^\circ \sim 65^\circ$. The analysis of the material phase showed that the raw coal in Dahebian coal mine contained quartz, kaolin, common pyrite, and so on minerals.

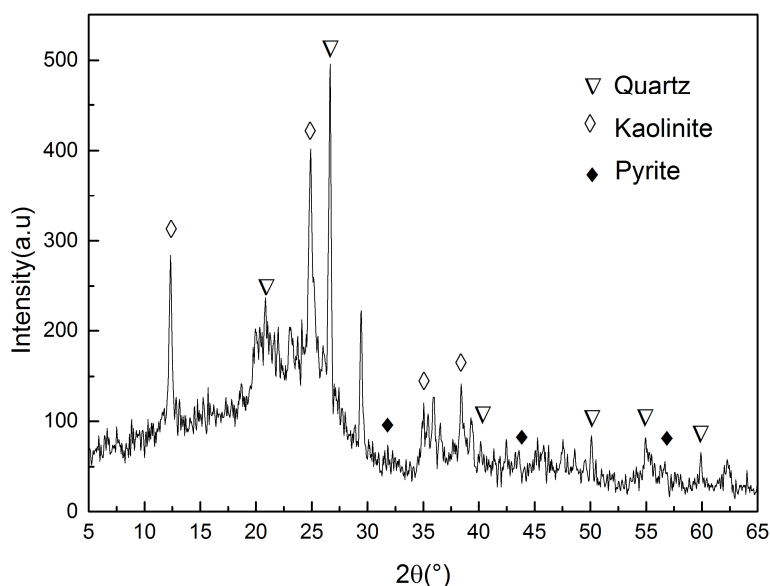


Fig.1 XRD patterns of raw coal in Dahebian coal mine

Analysis of Hg content, ash content and total sulfur in different granular coal. Table 1 is the test results of ash, sulfur and Hg content of different grades raw coal in Dahebian coal mine, from the test data we can see the Hg content increased with the increase of ash in coal on the whole. When the size of coal is above 50mm, the maximum Hg content is 0.96ppm, at the same time the ash and total sulfur also reached the maximum, respectively is 39.03% and 0.43%. In different size grades of raw coal, Hg content and ash showed a certain correlation, which indicated that Hg had a certain inorganic affinity.

Analysis of Hg content, Ash and total sulfur in different density level coal. The results of ash, sulfur and Hg content of the density of coal in Dahebian coal mine are shown in Table.2. From the test datas can be seen, with the increase in the density of raw coal, ash, total sulfur and Hg content has also increased, when the density is over 1.8g/cm^3 , the maximum Hg content was obtained 0.97 ppm. At the

same time the total sulfur and ash also measured the maximum, respectively is 0.46% and 56.32%. ash and Hg content showed a certain correlation.

Table1. Ash content, total sulfur and Hg content in different size grades in Dahebian coal mine

| Size grade (mm) | ash A_d (%) | sulfur $S_{t,ad}$ (%) | Hg content (ppm) |
|-----------------|---------------|-----------------------|------------------|
| +50 | 39.03 | 0.43 | 0.96 |
| 50~25 | 30.57 | 0.38 | 0.83 |
| 25~13 | 29.77 | 0.28 | 0.76 |
| 13~6 | 27.30 | 0.21 | 0.62 |
| 6~3 | 32.78 | 0.27 | 0.55 |
| 3~1 | 24.36 | 0.26 | 0.51 |
| 1~0.5 | 25.72 | 0.26 | 0.43 |
| -0.5 | 28.12 | 0.27 | 0.45 |

Table 2. Test result of ash, sulfur and Hg content in each density level

| Density ($g \cdot cm^{-3}$) | Ash A_d (%) | Sulfur $S_{t,ad}$ (%) | Hg content (ppm) |
|-------------------------------|---------------|-----------------------|------------------|
| -1.3 | 6.16 | 0.22 | 0.44 |
| 1.3~1.4 | 16.91 | 0.28 | 0.53 |
| 1.4~1.5 | 20.74 | 0.30 | 0.61 |
| 1.5~1.6 | 26.24 | 0.31 | 0.72 |
| 1.6~1.7 | 25.80 | 0.35 | 0.81 |
| 1.7~1.8 | 48.05 | 0.40 | 0.85 |
| +1.8 | 56.32 | 0.46 | 0.97 |

Fig.2 showed the relationship between the average density and Hg content of Dahebian coal. It can be seen from the figure that there is a significant correlation between Hg content and average density, the fitting model value of R^2 was 0.9966, and between fitting model and actual data shown a good correlation.

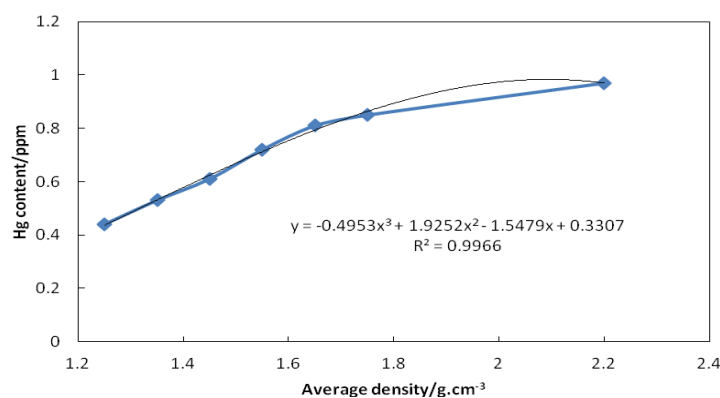


Fig.2 The relationship between the average density and Hg content of the coal

Comprehensive analysis the test results of Hg content, ash and sulfur of different size grade and different density in Dahebian coal mine, the Hg content increased with the increase of ash in coal on the whole, with the increase of density of raw coal, ash, total sulfur and Hg content has also increased. there is a significant correlation between Hg content and average density.

Conclusions

Based on the analysis of XRD spectra of raw coal in Dahebian coal mine, the raw coal contained quartz, common pyrite, kaolin and so on minerals. As a whole, the Hg content increases with the ash increasing, which indicates that Hg has a certain inorganic affinity. The Hg content of the coal is proportional to the density and size of Dahebian coal. When the size grade of raw coal is above 50mm, the maximum ash and sulfur respectively is 39.03% and 0.43%, and the maximum Hg content is 0.96ppm. There is a significant correlation between Hg content and average density, when the density is greater than 1.8g/cm^3 , the maximum mercury content is 0.97 ppm. At the same time the sulfur and ash also measured the maximum, respectively is 0.46% and 56.32%.

Acknowledgements

This work was financially supported by the Guizhou provincial science and technology department joint fund (Qiankehe LKLS [2013] 18); Guizhou provincial department of education fund (Qianjiaohe Talent team zi [2015] 69); Key Supported Discipline of Guizhou Province (Qian Xuewei He Zi ZDXK[2016]24); Guizhou provincial department of education foundation ([2014] 46).

References

- [1] Junying Zhang, Deyi Ren, Dewei Xu, et al: Chinese Journal of Environmental Engineering Vol(1993), P:101-105. In Chinese.
- [2] D.J.Swaine: Coal PreP Vol19(1998),P:177~193.
- [3] Liugen Zheng, Guijian Liu, Cuicui Qi, et al: Journal of University of Science and Technology of China Vol(2007), P:953-963. In Chinese.
- [4] Xiaohan Zhang, Niven Winchester, Xiliang Zhang, et al: Energy Policy Vol.110 (2017), P: 644-652.
- [5] Wei Li, Hongfu Liu, Xiaoxia Song: International Journal of Coal Geology Vol. 144-145 (2015), P: 138-152.
- [6] Xu Ping, Zhang Bi, Zeng Xiaobo, et al: International Journal of Coal Geology Vol. 170 (2017), P: 14-18.