The Effect of Regulators on Flotation Desulfurization of High-sulfur Bauxites

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Abstract

Flotation of Chinese high sulfur bauxites for the purposes of desulfurization is more difficult than conventional sulfide flotation in that the finely disseminated sulfide content of these bauxites can lead to significant bubble inclusions and low separation efficiency. Acidification of high sulfur bauxite also makes desulfurizing flotation more difficult. This study systematically investigated different regulators on the flotation desulfurization effect. The results indicate that the regulator can have a great impact on separation efficiency and therefore the desulfurization result. A new regulator (WG) could improve the concentrate recovery rate by 10 % and significantly increase desulfurization efficiency. It was shown to play a promotional role in desulfurization by flotation, and has wide applicability.

Keywords: high-sulfur bauxite, desulfurization, regulator.

1. Introduction

According to the statistics, the high-sulfur bauxite resource exceeds 800 million tons in China [1]. Because the sulfur contained in these bauxites severely disrupt alumina production [2], this resource has not yet been exploited and utilized on a large scale. The research on processing high-sulfur bauxites to date has mainly focused on the main methods of roasting [3, 4, 5] and wet oxidation. The oxidizing agents used in the wet oxidation process are various, including gases such as air [6], oxygen [7] and ozone [8], and solid oxidizing agents such as chlorinated lime, sodium nitrate, etc. Precipitation agents such as lime [9] and barium salts [10] have also been studied. These desulfurization methods can reduce the harmful effects of sulfur in bauxite with a low content, but it cannot eliminate the difficulties and costs for bauxites with high sulfur. Despite all of this work, there are presently no instances of large-scale industrial application of these processing options. Flotation desulfurization [11] can remove the sulfur from the bauxite before entering the alumina refining process and negatively impacting the efficiency and economics of producing alumina from high-sulfur bauxite.

Pyrite is the main sulfide mineral in high-sulfur bauxite [12], which is easily floated by collectors such as xanthate, while aluminum minerals are not easily floated by this collector. Consequently, the separation between pyrite and aluminum minerals should be easily achieved using xanthate or similar collectors. However, the process is not so straightforward, flotation desulfurization of high-sulfur bauxites has its challenges.

High-sulfur bauxite is difficult to handle in flotation. Desulfurization by flotation requires that the crystal surfaces of pyrite are exposed by grinding. Pyrite liberation generally requires fine grinding, particularly where pyrite is present as small grains. Achieving liberation can easily lead to excessive grinding, including of clay of minerals, which may have negative effects on flotation and desulfurization efficiency. Metal sulfide ores on the other hand tend to be brittle, requiring less grinding for liberation.

Average sulfur content of high sulfur bauxites are as low as 1 – 3 %, and the fine grain size of its sulfur minerals results in difficult liberation and separation, while metal sulfide ores generally have higher sulfur content, and its coarse grain size is more easy to liberate and sort.

Acidification of high-sulfur bauxite mainly results from oxidation and acidification of pyrite surfaces. This oxidation-acidification is inevitable in ores with sulfide after exposure to air, and under the influence of temperature, moisture and microbial action. This acidification can disrupt the absorption of the flotation agent on pyrite and decrease the efficiency of mineral floatation. Among the metal sulfide minerals, pyrite is easily oxidized and acidified. Oxidative inhibition of pyrite minerals improves the flotation of the target minerals.

Flotation desulfurization in acid conditions conventionally use copper sulfate or sodium sulfide as activator, xanthate as collector and oil 2 as foaming agent. Production experience shows that this agent regime generally used for sulfide minerals cannot achieve the required desulfurization efficiency for acidified high-sulfur bauxite.

Regulators [13] can change the interaction between collecting agents and ores as well as the floatation properties of pulp, and enhance the selectivity of minerals [14, 15]. In this study, acidified high-sulfur bauxite was used as the research material, where different adjustment agents were tested to eliminate the influence of ions in pulp generated from acidified high-sulfur bauxite. These ions harm flotation, and eliminating their influence improves the separation efficiency.

2. Experimental

2.1. Test sample ores

The acidified high-sulfur bauxite used in this test came from bauxite mines in Henan province (1#), Zunyi province (2#), Gongyi Henan province (3#) and Changtong Henan province (4#). The main chemical compositions of these bauxite ores are shown in Table 1, while their mineral phase analysis is shown in Table 2.

The bauxite was ground to 78 % ± 2 % < 0.075 mm, with a 30 % pulp density. Measured with a pH meter, the pH value of the untreated slurries are listed in Table 3.

Table 1. Chemical composition of Experimental Bauxites (%)*.

Chemical composition	Al_2O_3	SiO_2	Fe_2O_3	TiO_2	K_2O	Na_2O	CaO	MgO	S
Ore 1#	64.48	8.30	6.06	2.79	1.21	0.018	0.56	0.34	2.32
Ore 2#	65.61	7.97	6.19	2.88	1.22	0.04	0.13	0.14	0.86
Ore 3#	59.61	19.22	2.54	2.51	0.39	0.01	0.27	0.21	1.18
Ore 4#	47.58	11.56	11.39	2.30	2.18	0.023	2.57	0.79	6.83

*X-fluorescence analysis.

Table 2. Mineral phase analysis of experimental Bauxites (%)*.

Ore	Diaspore	Pyrophyllite	Kaolinite	Chlorite	Illite	Quartz	Pyrite
1#	68.5	/	4.5	/	11.5	1.0	3.9
2#	69.0	/	4.5	3.0	11.5	/	3.0
3#	59.0	19.0	9.0	1.6	4.0	1.0	2.0

		Total	100	1.23	100.00
Ore 4#	0	Concentrate	68.47	0.94	9.70
		Sulfur tailings	31.53	19.01	90.30
		Total	100	6.64	100
	1500	Concentrate	71.37	0.62	6.47
		Sulfur tailings	28.63	22.35	93.53
		Total	100	6.84	100

Test results in Table 4 show that for bauxites with different sulfur content and different degrees of acidification, WG can obviously improve the separation efficiency of flotation desulfurization. Consequently, future studies should focus in detail on the optimization of flotation indices and improving the mechanism of WG on the separation. The flotation test results obviously show that WG is an effective regulator for flotation desulfurization and can not only improve inhibition of pyrite caused by acidification of ores, but also solves adverse effects on flotation, such as ore sliming, a common characteristic of oxidized ores. WG appears to have wide applicability for high-sulfur bauxite based on its impact on all of the bauxites tested.

4. Conclusion

Flotation desulfurization of high-sulfur bauxites could be the most economical and effective method for the treatment these bauxites. The special properties of high-sulfur bauxites make flotation experience from other sulfide ores difficult to apply to industrial flotation desulfurization of these materials. The application of a suitable regulator is essential to achieve efficient flotation separation. Research shows that the novel regulator WG can not only improve inhibition of pyrite caused by acidification of ores, but also solve adverse effects on flotation, such as ore sliming. Sulfur content of aluminum concentrates can be reduced significantly, and meeting the requirement for sulfur content of ores for the production of aluminium oxide. It can increase aluminum concentrate yield by 10 %, and moreover, WG has wide applicability to different kinds of high-sulfur bauxites.

5. References

1. Lv Xi-xing, Gu Yuan-xin, A new desulfurization agent – earthy graphite. L*ight Metals*,1992(11):21-23.
2. Peng Xin, Jin Li-ye, Development and application of bauxite containing high sulfur . *Light Metals*, 2010(11):14-17.
3. Qi Li-kuan, Low-grade and high-sulfur bauxite processing method. *Light metals*, 1995,(1)14-16.
4. Zhang Feng-lin, Wang Ke-qing, Deng Hai-xia, et al. Present sitution and progress of study oon desulphurization of high sulphur bauxite. *Shanxi Science and Technology*,2011,26（1）:94-95.
5. Hu Xiao-lian, Chen Wen-mi, Xie Qiao-ling, Roasting desulfurization of high sulfur bauxite with calcium oxide.*Light Metals*,2010(1):9-14.
6. Lan Jun, Wu Xian-xi. Research advance of desulfurization in production of alumina with bauxite. *Applied Chemical Industry*,2008(4):446-448.

7. Hu Xiao-lian, Chen Wen-mi, Desulfurization from sodium aluminate solution by wet oxidation. *Journal of Central South University (Science and Technology)*,2011,42(10):2911-2916.
8. Lan Jun, Wu Xian-xi, Xie Yuan-cheng, Ma Li, Liu Bin-bin, Research of desulfurization in the course of disposing of high grade bauxite containing sulfur. *Applied Chemical Industry*, 2008, 37(8):886-890.
9. He Pu-rui, Che Rong, Tian Zhong-liang, He Run-de. The wet desulfurization technical study from industry sodium aluminate solution. *Hydrometallurgy*, 2001, 20(4):186-190.
10. Wang Peng, Wei De-zhou. Desulfuration technique research of high-sulfur bauxite. *Metal Mine,* 2012(1):108-123.
11. Zhang Nian-bing, Bai Chen-guang, Li Zhi-ying, et al. Research on existence of sulfur mineral in high sulfur bauxite and the desulfurization efficiency. *Journal of Chinese Electron Microscopy Society*, 2009,28(3):229-234.
12. Sun Wei, Zhang Ying, Qin Wu-lin, et al. Activated flotation of pyrite once depressed by lime. *Journal of Central South University (Science and Technology)*, 2010,41(3):813-818.
13. Zhang Jing-sheng, Que Xuan-lan. *Reagents of Mine*. *Beijing: Metallurgical Industry Press*, 2008:623.
14. Zhu Jian-guang, *Flotation reagents. Beijing: Metallurgical Industry Press*,1993.
15. Hu Yue-hua, Chen Xiang-qing, Wang Yu-hua. Influence of phosphates on diaspore and kaolinite flotation.*The Chinese Journal of Nonferrous Meta*ls,2003(2)222-227.
16. Zhang Guo-fan, Theory and technology of Floatation of Bauxite Desilicate.*Changsha: Central South University*,2001,9.
17. Li Chang-kai, Sun Wei, Zhang Gang, et al. An experimental study on the effects of regulatiors on desulfurization of high-sulfur bauxite . *Nonferrous Metals (Extractive Metallurgy)*, 2011(1):56-5