The Research of Technology for Combined Desulfurization of Refractory Ultra-High Sulfur Bauxite by Gravity Flotation

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Abstract

China is rich in high sulfur bauxite resources, and some ultra-high sulfur bauxites with sulfur content of more than 4 % have poor washability. It is difficult to obtain qualified aluminium oxide concentrate only by a single flotation process. In view of the difficult problems in the development and utilization of refractory ultra-high sulfur bauxite in Zunyi area, this paper introduces the gravity separation method into the bauxite beneficiation process and developed the process technology of "raw ore classification / desliming - primary slime acid flotation / desulfurization - coarse particle gravity flotation and combined desulfurization". This technology is used to treat refractory ultra-high sulfur bauxite with sulfur content of 7.12 %. Finally, an aluminium oxide concentrate with yield of 80.60 % and sulfur content of 0.40 % and a sulfur concentrate with yield of 19.40 % and sulfur content of 35.94 % were obtained. The successful development of this technology provides a practical technical prototype for the development and utilization of refractory ultra-high sulfur bauxite resources in China.

Keywords: Ultra high sulfur bauxite, Gravity floating combination, Primary slime, Secondary slime, Butyl xanthate.

1. Introduction

As a supplementary resource for alumina production, high sulfur Bauxite has been used in alumina production. Some high sulfur Bauxite with sulfur content less than 1 % enters alumina production in the form of ore blending. Some enterprises in Henan, Guizhou, Chongqing, and other regions use flotation method for desulfurization and then use it for alumina production. The research on the application of high sulfur Bauxite to produce alumina has made some progress, among which flotation desulfurization is an effective and industrialized method for the comprehensive utilization of high sulfur Bauxite [1-3]. Relevant investigations found that the ultra-high sulfur Bauxite resources in Zunyi and surrounding areas with sulfur content more than 4% exceeded 8 million tons, and the mined ores were seriously oxidized and acidified due to stacking conditions. Through a series of flotation desulfurization tests on it, it was found that the ore sample undergoes flotation desulfurization under acidic conditions, which severely corrodes the equipment; flotation desulfurization under alkaline conditions can only be conducted when the amount of sodium carbonate is more than 30kg/t - raw ore to adjust the pulp pH value to 8.0~9.0. Not only is the cost of flotation reagent high, but also when the amount of pH regulator is too large, the flotation foam will become sticky and have serious inclusions, and the flotation desulfurization separation index will become worse [4-6]. To develop and utilize refractory and ultra-high sulfur Bauxite resources and solve the environmental problems caused by ore acidification, it is necessary to accelerate the development and improve the comprehensive utilization technology of refractory and ultra-high sulfur Bauxite.

2. Research on the Properties of Ore

2.1 Analysis of Mineral Sample Properties

The test sample was taken from a high-sulfur bauxite mine in Zunyi. In order to determine the type, content and mineral composition of elements in the raw ore, multi-element analysis and phase analysis were carried out. The analysis results are shown in Table 1 and Table 2.

Table 1. Multi-element analysis results of raw ore (%).

Element	Al_2O_3	SiO_2	Fe_2O_3	TiO_2	K_2O	Na_2O	CaO	MgO	S	LOI
Content	52.86	11.91	12.17	2.24	2.32	0.058	0.20	0.26	7.29	16.80

Table 2. The original mineral phase analysis results (%).

Mineral	Diaspore	Illite	Chlorite	Pyrite	Anatase	Rutile
Content	50.00	23.50	6.00	14.00	1.80	0.40

As can be seen from Table 1, the Al_2O_3 content in the raw ore sample is 52.86 %, the SiO_2 content is 11.91 %, and the sulfur content in the ore is 7.29 %, which belongs to a typical ultra-high sulfur bauxite. It can be seen from Table 2 that the useful, for alumina extraction, mineral in the ore is mainly diaspore, the gangue minerals are mainly silicate minerals such as illite and chlorite, and the sulfur minerals are mainly in the form of pyrite.

2.2 Ore Sample Size

In order to understand the particle size characteristics and distribution of sulfur content of raw ore and provide a basis for the control of grinding particle size in the subsequent grinding process, the particle size screening analysis of ultra-high sulfur bauxite raw ore was carried out. The analysis results are shown in Table 3.

Table 3. Particle size screening analysis results of raw ore (%).

Particle size	Yield	S grade	S distribution rate
+5mm	24.01	9.86	31.12
-5～+3mm	8.70	8.89	10.16
-3～+1mm	13.26	10.28	17.90
-1～+0.15mm	19.34	9.82	24.95
-0.15～+0.074mm	10.91	6.50	9.32
-0.074～+0.037mm	2.65	5.88	2.04
-0.037～+0.023mm	1.06	4.83	0.67
-0.023mm	20.07	1.43	3.77
Total	100.00	7.61	100.00

[where: Yield expresses the % mass of each particle size, S grade the % of S in each particle size and S distribution rate the distribution of S over each particle size]

It can be seen from Table 3 that the +5 mm and -0.023 mm grain sizes account for the largest proportion in the raw ore, while the sulfur content generally shows a decreasing trend with the

in each process are combined, a comprehensive aluminum concentrate with a yield of 80.60 % and a sulfur content of 0.40 % and a comprehensive sulfur concentrate with a yield of 19.40 % and a sulfur content of 35.05 % can be obtained, and a good desulfurization index is obtained. The low sulfur content of aluminum concentrate can meet the raw material requirements of alumina production and realize the comprehensive utilization of ultra-high sulfur bauxite.

4. Conclusion

1. An ultra-high sulfur Bauxite raw ore in Zunyi contains 52.86 % Al_2O_3, 11.91 % SiO_2 and 7.29 % sulfur; The useful mineral is diaspore, and the main sulfur bearing mineral is Pyrite. The dissemination relationship between Pyrite and other minerals in the ore sample is complex, and the degree of ore acidification is serious, so it is difficult to select ultra-high sulfur Bauxite.

2. For refractory ultra-high sulfur Bauxite with a sulfur content of 7.29 %, comprehensive aluminum concentrate with a yield of 80.60 % and a sulfur content of 0.40 % and comprehensive sulfur concentrate with a sulfur content of 35.94 % can be obtained through the full process closed-circuit test of "raw ore grading desliming & gravity flotation combined desulfurization". The aluminum concentrate has a low sulfur content, which can meet the requirements of raw materials for alumina production and realize the comprehensive utilization of ultra-high sulfur Bauxite. The Sulfur concentrate can be used as a raw material for producing sulfuric acid.

3. The successful development of the key process technology of heavy flotation combined desulfurization of refractory ultrahigh sulfur Bauxite can not only solve the problem of comprehensive utilization of refractory ultrahigh sulfur Bauxite, alleviate the existing ore supply crisis of alumina enterprises, but also solve the environmental problems caused by acidification of ore storage yard, with good economic and environmental benefits.

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6. References

1. Yan Zheng, et al., Interaction between Synchronization Desulfurization and Desiliconization in High Sulfur Bauxite Reverse Flotation. *J. Metal Mine*, 2020, No.532(10):180-184.
2. Han Yue xin, et al. Current Situation of Bauxite Resource and Its Beneficiation Technology in China. *J. Conservation And Utilization Of Mineral Resources.*2019, 39(4):151-158.
3. Liu Xianmin. Experimental Study on Flotation Technique for Desulfurizing of High Sulfur Bauxite under the Coal Seam in Henan Province. *J. Multipurpose Utilization of Mineral Resources,* 2017(03):51-54.
4. Yang Zhuo, et al. Experiment on Reverse Flotation Desulfurization of a High Sulfur Bauxite from Guizhou. *J.Metal Mine*, 2018(02):89-93.
5. Wang Peng, Wei Dezhou. Desulfuration Technique Research of High-sulfur Bauxite. *J. Metal MinE*, 2012(01):108-110+123.
6. Shiyu Wang et al,. Research status and development trend of high-sulfur and high-silicon bauxite. *J. Light Metals*, 2018, 12:1-4.
7. Wang Dianzuo, Qiu Guanzhou, Hu Yuehua. Resources processing. *M.Beijing: Science Press,* 2011,132-135.
8. Hu Yuehua, Feng Qiming. Resource Processing Technology and Equipment. *M. Beijing: Science Press*, 2014,79-80.

9. Zhai Hongxin. Regression Model of Energy Consumption and Particle Size in Continuous Grinding of Ball Mills and Its Supercritical Speed Study. *J.Mining & Processing Equipment*,2006(01):47-49.
10. Liang Shuang, Lu Liang, and Zhang Xingrong, .Research progress of organic depressants in flotation of Pyrite. *J. China Mining*, 2020, 29 (S02): 4
11. Woods R. Electrochemical potential controling flotation. *J. Mineral Engineering*, 2003, 72(1/4):151-162.
12. Buswell A M, et al. The use of electrochemical measurements in the flotation of a platinum group minerals (PGM) bearing ore. *J. Mineral Engineering*, 2002, 15(6):395-404.