Study on Dezincification Technology of Alumina Production from High Zinc Bauxite

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https://doi.org/10.71659/icsoba2024-aa009

Abstract

In this paper, a high zinc bauxite in Guangxi region of China was studied in the process of alumina production of zinc digestion performance and dezincification technology with sodium sulfide. The dezincification test of sodium sulfide in the process of digestion shows that the dezincification rate increases gradually with the increase of sodium sulfide content and digestion temperature. When the digestion temperature is 275 °C and the sodium sulfide content is 0.7 g/L, the dezincification rate can reach 74.36 %. In the process of dilution – postdesilication, sodium sulfide is added for dezincification, and the efficiency of dezincification is greatly increased. When the sodium sulfide content is 0.5 g/L, the dezincification rate can reach 90.23 %. Based on the experimental results, the technical suggestions of dezincification in alumina production were put forward.

Keywords: High zinc bauxite, Alumina, Sodium sulfide, Digestion.

1. Introduction

With the development of aluminum industry in China, the grade of bauxite decreases rapidly, and the impurity content in the ore increases obviously, and the impurity composition becomes more and more complex. In the alumina production by Bayer process, zinc impurities are mostly brought in by bauxite, and (ZnO) in ores in some areas reaches about 0.02 % [1]. Zinc exists in bauxite in the form of sphalerite (ZnS), smithsonite ($ZnCO_3$), hemimorphite ($Zn_4(OH)_2Si_2O_7 \cdot H_2O$), etc. [1]. During the digestion process, zinc-containing minerals react with NaOH and exist in sodium aluminate liquor in the form of sodium zincate, which is adsorbed by aluminum hydroxide in the subsequent seeded precipitation process and enters alumina products, resulting in low quality of alumina products and ultimately adversely affecting the electrolysis of alumina.

In the process of alumina production, the commonly used technologies are dithiocarbamate method, improved control filtration process, sodium sulfide method, high sulfur bauxite method and so on. Dithiocarbamate method uses the lone electron pair on the sulfur atom in the dithio-ammonium polar group to capture the cation, forming a stable cross-network of heavy metal ion chelates with Zn^{2+} [2], and heavy metal impurities were removed through precipitation method. This method is simple in operation and has obvious effect, but with the circulation of Bayer liquor in the production process, organic matter accumulation will be caused, which has a negative impact on production; The improved filtration process method uses Fe_2O_3 to adsorb various impurities in Bayer liquor [3,4], and uses the control filter device with tiny particle layer of Fe_2O_3 as the main part to remove zinc impurities, which has obvious dezincification effect. However, due to the periodic cleaning and replacement of the filter layer, it will increase the costs of the alumina plant. Both the sodium sulfide method and the high-sulfur bauxite method use S^{2-} to react with Zn^{2+} to generate a precipitation to achieve dezincification [5–8]. The dezincification effect needs to be further studied.

In this paper, the digestion performance of a high zinc bauxite was studied, and dezincification tests were carried out by adding sodium sulfide in the digestion process step of the Bayer process and the dilution process step of the digested slurry effluent. The influence of addition of different amounts of sodium sulfide and digestion temperature on the dezincification were analyzed, and suggestions of dezincification technology under different production conditions were put forward.

2. Test Raw Materials

2.1 Bauxite

The bauxite was obtained from an alumina plant in Guangxi, China. The main chemical composition of bauxite (%): Al_2O_3 52.54, SiO_2 4.92, Fe_2O_3 23.00, TiO_2 2.99, K_2O 0.14, Na_2O 0.07, CaO 0.49, MgO 0.18, ZnO 0.014. The main mineral composition (%): diaspore 54.6, gibbsite 3, goethite 20.8, hematite 5, illite 2, kaolinite 9, anatase 2.6, rutile 0.4, calcite 0.7, dolomite 0.3.

2.2 Liquor

The digestion liquor was obtained from an alumina plant in Guangxi, China. The chemical composition of the liquor was Na_2O_T 259.80 g/L, Al_2O_3 130.62 g/L, Na_2O_k 243.00 g/L, Zn 5.88 mg/L, α_k 3.06.

2.3 Lime

The lime used in the experiment was obtained from an alumina plant in Guangxi, China. The CaO content in lime is 84.44 % and the effective CaO content is 80.32 %.

2.4 Sodium Sulphide

Sodium sulphide is an analytical grade reagent from Tianjin Damao Chemical Reagent Factory in China, and the content of $Na_2S.9H_2O$ is not less than 98.0 %.

3. Test Methods

3.1 Bauxite Digestion Test

The bauxite digestion tests were carried out in a steel bomb digester heated by fused salt. The volume of the steel bomb digester is 130 mL According to the requirements of the ingredients, a portion of bauxite, digestion liquor, lime and sodium sulphide were added into the steel bomb, installed in the rotating steel bomb rack, at a predetermined temperature and immediately stirred. When the predetermined reaction time is reached, the reaction mix is cooled to a temperature of 80 °C in 15 to 30 minutes, the liquor is separated from the treated solid phase, and the chemical composition of the liquor is analysed. After washing and drying, the solid phase was analysed for chemical composition.

The digestion efficiency of total alumina (η_A) is calculated with A/S (the weight ratio of Al_2O_3 and SiO_2) in the bauxite and in the red mud according to the following formula:

$$\eta_A = \frac{(A/S)_B - (A/S)_R}{(A/S)_B} \times 100\% \qquad (1)$$

where:
$(A/S)_B$ - The weight ratio of Al_2O_3 and SiO_2 in the bauxite

5. Conclusion

(1) With the increase of lime content, the digestion rate of zinc increased first and then slightly decreased. When C/S was 1.2, the digestion rate of zinc was the highest, reaching 66.06 %. The influence of digestion temperature on the digestion of zinc is not obvious.

(2) When the sodium sulfide is added during digestion process to remove zinc, with the increase of the amount of sodium sulfide and the increase of the digestion temperature, the dezincification rate gradually increases. When the digestion temperature is 275 °C and the amount of sodium sulfide is 0.7 g/L, the dezincification rate can reach 74.36 %.

(3) When the sodium sulfide is added during dilution-postdesilication process to remove zinc, with the increase of sodium sulfide content, the dezincification rate gradually increases. When the sodium sulfide content is 0.5 g/L, the dezincification rate can reach 90.23 %, and the dezincification efficiency is significantly higher than that of the digestion process.

(4) For the case of high zinc content in alumina production system, sodium sulfide dezincification method can be used, but because sulfide has a great impact on alumina production, the amount of dezincification taken by adding sodium sulfide should not be excessive, and the addition point should be selected at the dilution-postdesilication process.

6. Reference

1. Zhang Qingxiang, Yang Jianhong, et al. Behavior and elimination of zinc in alumina production[J]. *Journal of Central South University of Technology*,1999,12:589-591
2. Shi Yingjie, Li Rongxing, Yu Xiaohua, et al. Application of dithiocarbamates in removing zinc from Bayer solution[J]. *Modern Chemical Industry*, 2017,6:72-75
3. R Yamada, T Harato, Y Furumi. Removal of iron Compound from the Bayer liquor[J]. *Light Metals*, 1974,3:713-722
4. John A.S. Green, Sergio A Loynaz. Method for removing ferrous iron from alkali metal aluminate liquor. US Patent,4083925[P].1978-04-11
5. Ren Lin, Liu Yongqing, Liu Yanling. Orthogonal test analysis for zinc removal in Bayer process by sodium sulfide[J]. *Light Metals*, 2018,8:25-26
6. Shi Yingjie, Li Rongxing, Yu Xiaohua, et al. Study on Zinc Removal by Sodium Sulfide in Bayer Alumina Production[J] *Journal of Kunming University of Technology: Natural Science Edition*, 2016,12:1-8
7. Liu Baowei, Hu Yubo, Chen Wenmi, Wu Haiwen, et al. A method for removing impurity zinc from industrial sodium aluminate solution [P]. China, CN101913631A.2010-08-09.
8. Chen Wenmi, Jiang Bing, Liu Hongzhao, et al. Removal of Zinc by adding Pyrite during the digestion Process of Bauxite[J]. *Light Metals*, 2006,10:21-24