AA19 - The Behaviour of Zinc in the Bayer Process

Dong-zhan Han [1,2], Er-wei Song [3], Xiao-tao Lu [4], Li-juan Qi [5], Zhong-lin Yin [6], Xiao-ge Guan [7] and Feng-jiang Zhou [8]
1. Doctor, School of Metallurgy and Environment, Central South University, Changsha, Hunan, China
2. Professor
3. Engineer
4. Engineer
5. Director
6. Chief Engineer
7. Engineer
8. Senior Engineer
Zhengzhou Non-ferrous Metals Research Institute Co. Ltd. of CHALCO, Zhengzhou, Henan, China
Corresponding author: zyy_hdz@rilm.com.cn

Abstract

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High zinc in metallurgical alumina has a negative impact on the current efficiency of aluminum electrolysis and the properties of aluminum metal and alloys. In this study, the behaviour of zinc in bauxite in the Bayer process was studied. The effects of digestion conditions on the extraction rates of zinc in digestion, and that of the caustic concentration on the precipitation rate of zinc in a seeded precipitation process were investigated. With the increase in leaching temperature, digestion time and lime addition, the digestion efficiency of zinc increased at first and then decreased. From the material balance, it can be seen that in digestion process, about two-thirds of the zinc in bauxite is extracted into the Bayer liquor, and the rest into red mud. At precipitation conditions where temperatures are between 60 °C and 48 °C, a precipitation time of 45 hours, first tank seed solids content of 800 g/L and caustic concentration (N_k) of 165~175 g/L (as Na_2O), 40～60 % of zinc in green liquor enters aluminum hydroxide product during seeded precipitation. Reducing the caustic concentration is conducive to the precipitation of zinc during seeded precipitation.

Keywords: Bauxite bearing-zinc, digestion, seeded precipitation.

1. Introduction

The zinc content in Guangxi bauxite is high (about 0.025 % as ZnO), and consequently the alumina produced in this region is relatively high in ZnO (>0.015 %), which seriously impacts product quality, and the competitiveness of these refineries. Although zinc provides some benefits in the Bayer precipitation process, such as contributing to the crystal growth rate and characteristics of the gibbsite crystal, its high concentration in product alumina will affect the current efficiency of aluminum electrolysis, purity of aluminum ingots and metal and alloy material properties. Suss et al points out that the current efficiency decreases by 0.13 % for every 0.01 % increase in zinc content, and the material properties of alloys are also affected. For example, aluminum profiles with high zinc content are more brittle and have poor ductility [3].
In this study, the behaviour of zinc in the Bayer process was investigated. The effects of digestion conditions on the extent of zinc extraction from bauxite, and the effect of the liquor caustic concentration on the precipitation of zinc during Bayer seeded precipitation were examined. Besides analyzing the test results, a material balance for zinc in different process areas of an alumina refinery was conducted, which could help clarify the distribution and behaviour of zinc though the process, and provide a mathematical basis for the control of zinc in alumina product.

2. Raw Materials and Methods

2.1 Raw Materials

2.1.1 Bauxite

The bauxite used in this test was provided by the Guangxi Branch of the Aluminum Corporation of China Limited. All the bauxite was crushed and ground to the particle size specification for the Guangxi Branch refinery. Following milling, it was homogenised, divided, bagged and sealed for use. The particle size of the bauxite sample is shown in Table 1.

Table1. Particle size distribution of test bauxite sample (%).

+60 mesh	-60~+100 mesh	-100~+230 mesh	-230 mesh
0.30	6.35	18.15	75.20

Following bauxite sample preparation, its chemical composition was analyzed. The chemical and phase composition of the high-zinc bauxite are shown in Tables 2 and 3 respectively. The X-ray diffraction pattern is shown in Figure 1.

Table 2. Chemical composition of test bauxite (%).

Al_2O_3	SiO_2	Fe_2O_3	TiO_2	K_2O	Na_2O	CaO	MgO	ZnO	A/S	LOI
52.48	4.96	23.00	2.98	0.12	0.055	0.45	0.15	0.014	10.58	14.21

Table 3. Mineral phase composition of test bauxite (%).

diaspore	gibbsite	goethite	hematite	illite	kaolinite	anatase	rutile	calcite	dolomite
54.5	3.0	20.8	5.0	2.0	9.0	2.6	0.4	0.7	0.3

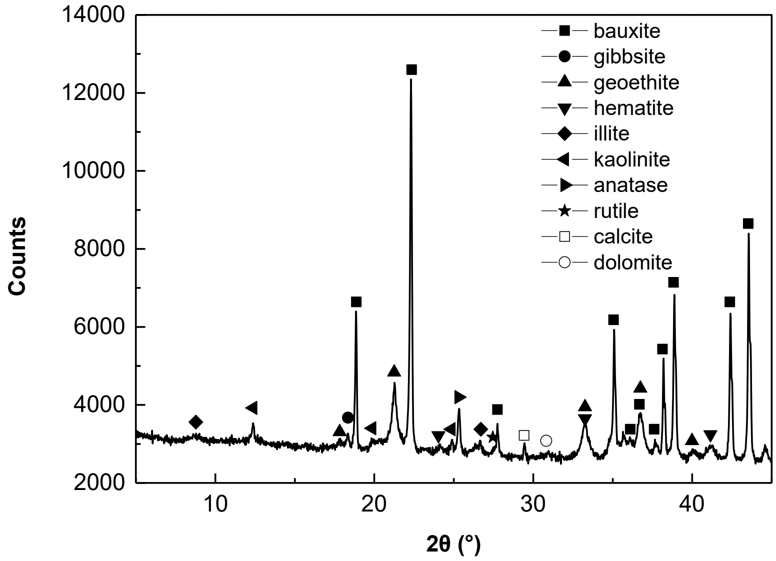

Figure 1. X-ray diffraction pattern of test bauxite.

5. References

1. B. Jiang, Study on zinc removal by sulfide in Bayer process, *[D] Changsha*: Central South University, 2006: 8-11.
2. X.Q. Zhang, J. H. Yang, Q.Y. Li et al, Behavior and elimination of zinc in alumina production, *Journal of Central South University of Technology: Natural Science Edition, 1999,* (6), 589-591.
3. A. Suss et al., Optimization of elemental sulfur utilization of zinc removal from Bayer cycle, *Proceedings of 10th Alumina Quality Workshop 2015*, pp. 383-388.
4. Y.C. Zhao, J.C. Jiang, X.X. Cao et al., Alkaline leaching thermodynamics of zinc hazardous wastes, *Nonferrous Metallurgy Design and Research, 2017*, 038 (005), 63-68.
5. Ram Sharma, Physico-chemical properties of calcium zincate, *Journal of the Electrochemical Society*, 1986, 133 (11), 2215.
6. D. E. Xu, Basic theory research on alkaline process of extracting Zn from zinc oxide ores, *Central South University*, 2011.