Study on Influencing Factors of Precipitation Ratio

Shao Shuai
Engineer
Zhengzhou Non-ferrous Metals Research Institute Ltd of CHALCO, Henan, China
Corresponding author: zyy_shsh@rilm.com.cn

Abstract

Seeded precipitation of sodium aluminate solution was a key procedure in the Bayer process to produce alumina. This process exposed vital impacts not only on the quality and yield, but also on the technical and economic indexes of the alumina. The precipitation ratio of sodium aluminate solution was one of the main economic and technical indices of alumina production process. To improve the precipitation ratio, the relationship between green liquor α_k, green liquor Na_2O_K, green liquor Na_2O_C, precipitation temperature, precipitation solids content, precipitation time and precipitation ratio were studied in this paper. The optimum precipitation ratio was obtained by determining the appropriate precipitation system.

Keywords: Green liquor, Precipitation, Precipitation ratio, Influencing factors.

1. Introduction

The relationship between the seed decomposition ratio of the Bayer process and the cycle efficiency, total capacity and alumina production cost, this relationship was one of the most important economic and technical indicators of alumina production process to improve the precipitation ratio [1].

The process of precipitation by the Bayer method refers to the process of adding seed in supersaturated sodium aluminate solution, cooling down and continuously stirring to decompose and precipitate aluminum hydroxide. Due to the relatively large interfacial tension between sodium aluminate solution and aluminum hydroxide crystal, the precipitation process provides a low surface energy, resulting in the difficulty of spontaneous nucleation of aluminum hydroxide. Therefore, it was necessary to add a certain mass of seeds to overcome the interfacial tension between sodium aluminate solution and aluminum hydroxide crystals, so that aluminum hydroxide crystals could be precipitated [2].

To increase the rate of precipitation and crystallization for the aluminum hydroxide, the sodium aluminate solution required a large supersaturation, such as lower precipitation temperature, lower green liquor Na_2O_K (Na_2O caustic) and molar ratio of Na_2O_K to Al_2O_3 (α_k). At the same time, it was necessary to add a certain amount of highly active seeds in sodium aluminate solution, such as a high precipitation solids content. In addition, the longer precipitation time and the lower impurity content of solution were also conducive to improving the precipitation ratio [3].

Because the precipitation process of sodium aluminate solution was more complicated and there were many process parameters associated with the precipitation ratio, it was necessary to study the precipitation system of specific alumina production enterprises to determine the best process parameters and improve the precipitation ratio [4].

2. Test Materials and Test Methods

2.1 Test Materials

The green liquor and seeds were taken from the alumina production site. During the condition test, the composition of the solution was adjusted with analytical pure sodium carbonate and sodium hydroxide reagents. The chemical component in green liquor from an alumina refinery was shown in Table 1.

Table 1. Chemical component in green liquor, g/L.

Composition	Na_2O_T (total)	Al_2O_3	Na_2O_K	α_k	Na_2O_C/Na_2O_T
Content	199.5	180.3	160.0	1.46	0.20

The chemical component of impurities for seed was shown in Table 2.

Table 2. Component of aluminum hydroxide seed, %.

Composition	SiO_2	Fe_2O_3	Na_2O
Content	0.015	0.013	0.24

2.2 Test Methods

After preheating at the initial precipitation temperature, a certain amount of alumina hydroxide seed was added and ran under the established precipitation temperature system. After a certain period, samples were collected and analyzed for the composition of the solution. The correlations between the change of its composition and adjustments made were investigated. After a certain period, the precipitation slurry was separated from liquid and solid. The components of Na_2O_T, Al_2O_3, Na_2O_K were analyzed, and the precipitation ratio was calculated. Table 3 showed the variation range of influence that needed to be investigated in this precipitation test [5].

Table 3. Experimental matrix.

Serial number	Influence	variation range
1	green liquor Na_2O_K	155–170 g/L
2	initial precipitation temperature	58–63 °C
3	precipitation solids content	650–800 g/L
4	green liquor α_k	1.44–1.55
5	green liquor Na_2O_C (carbonate)	23–43 g/L
6	precipitation time	40–55 h

3. Test Results and Discussion

3.1 Influence of Green Liquor Na_2O_K on Precipitation Ratio

Under the conditions of α_k (1.46), Na_2O_C/Na_2O_T (0.20), precipitation solids content (750 g/L), precipitation temperature (initial temperature 60 °C to final temperature 48 °C). When the green liquor Na_2O_K (hereinafter Nk) was 155 g/L, 160 g/L, 165 g/L and 170 g/L respectively, the effects of different green liquor Na_2O_K on the decomposition ratio were investigated. The test results were shown in Figure 1.

At the same time, it could be concluded that reducing green liquor Na_2O_K and Na_2O_C was the most effective means to improve the precipitation ratio.

5. References

1. Xie Yanli, Sodium aluminate dissolved liquid crystal species precipitation, *Beijing: Metallurgical Industry Press*, 2003, 36 - 57.
2. Zhao Qingjie, Yang Qiaofang and Yan Weizhen, Study on improving the ratio of precipitation by Bayer method, *Light Metals*, 2000, 20 - 21.
3. Xie Yanli, Li Shangming, and Bi Shiwen, Study on enhanced precipitation process of sodium aluminate liquid crystal, *Light Metals*, 2000, 18 - 19, 24.
4. Feng YanLei, Analysis of influencing factors and measures of agglomeration in precipitation process, *Shandong Chemical Industry*, Vol. 50, No. 21, (2021), 107 - 108.
5. Ren Zhen, Experimental study on increasing the rate of precipitation, *World Nonferrous Metals*, Vol. 8, (2018), 224 - 225.