Improvement of Digested Slurry Post-Desilication Efficiency in the Flashing Circuit at Nikolaev Alumina Refinery

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Abstract

To ensure continuous production of G-00 grade alumina at Nikolaev alumina refinery (NGZ) alumina/silica mass ratio (μ_{Si} or A/S ratio) in the pregnant liquor shall be above 210. This limitation is associated with specifics of precipitation process at Nikolaev refinery. Many approaches to μ_{Si} control have been tested in the past: pre-desilication of thick raw slurry; addition of calcium containing additives to the digestion process; post-desilication of digested diluted slurry; seeding with fine fraction of bauxite residue rich in desilication product (DSP) into the raw slurry. These approaches have not delivered the required results as they caused hydrolysis, boehmite reversion, reduction in alumina production rate. The paper discusses the results of test simulation of post-desilication of Guinean bauxite digested slurry by addition of process water to the flashing circuit. Process parameters such as dilution conditions, residence time and temperatures have been determined. The test proved that the proposed solution will provide for increase of μ_{Si} value in the pregnant liquor by 15 - 20 units. Heat calculations showed that post-desilication in the flashing circuit at Nikolaev refinery reduces the specific heat consumption. Based on the obtained results the design data were defined for rearrangement of digestion trains at Nikolaev refinery to perform pilot testing.

Keywords: alumina/silica ratio (μ_{Si}), desilication in flashing circuit, desilication.

1. Introduction

Conditions of bauxite digestion should provide not only the maximum extraction of alumina from raw materials into pregnant liquor, but also the required rate of its desilication to obtain in precipitation aluminum hydroxide of high quality.

In the course of bauxite digestion silica passes into solution in the form of sodium silicate, and then precipitates with red mud as sodium hydroaluminosilicate (if the slurry does not contain Ca^{2+}).

Several flowsheets of aluminate liquor desilication are known in the industry:

- preliminary desilication (under atmospheric pressure, with prolonged residence time of raw slurry at a temperature of 95 - 105 ºC, using various ways of temperature maintenance, including heating through a wall and by live steam) – realized at NGZ;
- post-desilication (under atmospheric pressure, with prolonged residence time of diluted digested slurry at a temperature of 95 - 105 ºC, simultaneously with the process of deep desilication, a process of liquor decomposition occurs releasing aluminum hydroxide that

reduces alumina yield. Refineries operated with high A/C ratio of digested slurry does not use this method due to high losses of alumina) –realized at NGZ.

- feeding DSP seed into the process in the form nozean or cancrinite – requires production of the seed at high temperatures of kaolin processing [1];
- Sumitomo process [2]. The process is based on four key operations (1 - two stream heating and a tubular digestion system. Alumina is completely extracted from bauxite, and reactive silica passes into solution only by half; 2 - high rate settler: digested slurry is separated within several minutes under pressure to prevent further dissolution of silica contained in bauxite; 3 - high rate washers: red mud is rapidly washed by counterflow decantation; 4 – desilication of pregnant liquor under pressure) – the process requires great capital expenditures for implementation. This method is suitable for high silica gibbsite raw material and was realized only at several refineries.

The first two of the considered options of desilication process are realized at the site of NGZ, and the rest ones demand great capital expenditures. Equipment arrangement of the first two options is characterized by a significant amount of tank equipment, the third option - by a large number of pressure vessels.

Our proposal to improve desilication in the flashing (steam separation) circuit of bauxite slurry enables to carry out this process at higher temperatures which promotes more vigorous chemical reactions both in bauxite digestion, and in desilication of pregnant liquor

Unlike the Sumitomo process, the proposed option does not require separation of phases of digested slurry for desilication under pressure [3] that allows to minimize capital expenditures for modernization of the digestion train.

Intensification gives an opportunity to reduce residence time from 8 - 10 to 1 - 2 hours that in case of use live steam as a heat carrier results in dilution of aluminate liquor to a lesser extent.

Increase in desilication temperature of aluminate liquors facilitates reduction in equilibrium content of silica in the liquors and increase in μ_{Si} to 220 units that is much higher than at low-temperature desilication.

2. Experimental

A laboratory autoclave installation was assembled and prepared for investigations that allowed to feed and select samples directly in the course of an experiment.

The laboratory installation (Figure 1) comprises:

- an autoclave, volume 1 dm^3 (p. 1);
- a system for feeding of reagents (spent liquor, sweetening slurry, wash water, etc.) to the reaction zone (p. 2), including a pressure vessel of liquefied nitrogen with reducing gear and measure feeder;
- a system of slurry sampling from the reaction zone (p. 3);
- a system of water cooling of the autoclave to the set temperature (p. 4).

The laboratory autoclave installation simulated the processes taking place at the production site of the NGZ alumina plant on the basis of pre-desilication, digestion and post-desilication.

Figure 2 shows the Block flow diagram of testing in the laboratory:

- a – corresponding to the current alumina production process;
- b – proposed alumina production process.

The use of this approach allows to ensure continuous production of alumina by silica content at minimum capital expenditures.

6. References

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