Industrial Trials of a Belt Filter for Filtration of Strong Evaporated Liquor at RUSAL Krasnoturyinsk

Dmitry Ovsyuchenko[1], Igor Chetyrkin[2], Elena Mitrofanova[3], Sergey Ordon[4], Maksim Pechenkin[5], Andrey Panov[6], Aleksey Perestoronin[7]
1. Industry Segment Manager, RUSAL ETC, St. Petersburg, Russia
2. Director of Technology and Technical Development Department of Alumina Production
3. Technology Manager, RUSAL ETC, Krasnoturyinsk, Russia
4. Deputy General Director for Alumina Production and Ecology
5. Director of Technical Development Department of Refineries,
6. Director R&D Alumina,
7. Senior Researcher, RUSAL ETC, St. Petersburg, Russia.
Corresponding Author: Dmitriy.Ovsyuchenko@rusal.com

Abstract

Alumina production at RUSAL Krasnoturyinsk includes the precipitation of sodium carbonate in the course of spent liquor evaporation which is then separated from the strong evaporated liquor and sent for bauxite sintering. Due to its fine particle size and polydispersity, these sodium carbonate crystals settle and filter poorly (filter cake moisture is as high as 30 %) causing increased caustic alkali and alumina recycling to sintering resulting in additional losses. Incomplete precipitate separation from evaporated liquor also causes accumulation of carbonate in production liquors reducing performance of the evaporation train and leading to decreased evaporated liquor caustic concentration, followed by further accumulation of sodium carbonate. Consequently, improved sodium carbonate removal from RUSAL Krasnoturyinsk process liquors is an urgent problem, especially in view of a planned increase in alumina production capacity. This paper reports on a solution enabling increased carbonate removal efficiency from RUSAL Krasnoturyinsk evaporated liquors. The results of industrial trials of the filtration of strong evaporated liquors on an experimental belt vacuum filter LON-1.8 are presented. In the course of belt filtration of evaporated liquor, humidity of filter cake was decreased by 8.5 % compared to the drum vacuum filters BOU-20 that are used now, and demonstrated the advantage of using belt vacuum filters in the flowsheet of RUSAL Krasnoturyinsk.

Keywords: filtration, slurry, high carbonate bauxite processing, sodium carbonate removal.

1. Introduction

At RUSAL Krasnoturyinsk alumina is mainly produced from North Urals bauxites that are characterized by high content of carbonate (~ 5 – 7 wt. % CO_2) and sulfur compounds (~ 0.7 - 0.8 wt. % S). These impurities cause accumulation of sodium carbonate and sulfate in recycled production liquors that reduce the liquor impurity removal efficiency of the evaporation train.

The main indicator for the removal efficiency of these impurities from liquors is the evaporation level, indicated by $Na_2O_{caustic}$ concentration in the evaporated liquor. Increased carbonate in the liquor fed to evaporation reduces evaporation efficiency due to increased scale on the heating surfaces of evaporation trains; the same effect occurs with increasing liquor sulfate. The resulting loss of heat transfer leads to a decreased evaporation level and degrades carbonate and sulfate removal from the liquor. This causes further accumulation of carbonate in the recycled liquors and a vicious circle of declining impurity removal efficiency. Incomplete removal of crystallized material from the liquor causes the generation of fine precipitated particles that settle poorly in the settling tanks and then impair filtration of sodium carbonate crystals at drum vacuum filters. Filter cake moistures of up to and above 30 %, and Na_2O and Al_2O_3 content increases to 15 – 16 wt. %

and 8 - 10 wt. %, respectively. Consequently, a significant amount of sodium carbonate in the sintering feed is replaced with caustic soda leading to a decrease in the sintering causticization rate, and an increase in the amount of caustic added to the process to balance the refinery alkali losses. Very often the evaporation and soda removal area cannot process the whole flow of spent liquor from the precipitation area mostly because of unsatisfactory processing properties of sodium carbonate and sulfate separated from the evaporated liquors [1].

Thus, sometimes, the existing evaporation capacity for removal soda and sulfates from the liquors is not sufficient even for current alumina production capacity at RUSAL Krasnoturyinsk. In view of a planned production capacity increase, the soda removal area requires an upgrade to improve its operating efficiency.

Presently at RUSAL Krasnoturyinsk sodium carbonate is separated using thickeners for preliminary thickening of precipitated solids in the evaporated liquor from the evaporation trains followed by thickener underflow filtration on drum vacuum filters BOU-20. Use of the thickeners and drum vacuum filters stems from low sodium carbonate solids content in the evaporated slurry from the evaporation trains (70 - 100 gpl) and the fine particle size of the precipitate.

In 2017 RUSAL ETC's laboratory in Saint Petersburg analyzed the properties of carbonate-sulfate precipitates from the Bayer process spent liquor from RUSAL Krasnoturyinsk. Averaged results of some of the tests are indicated below. Chemical composition of the evaporated liquor is specified in Table 1. Analysis of the precipitate indicates a mixture of sodium carbonate and sulfate, aluminium oxide and sodium oxalate [2].

Table 1. Chemical composition of the evaporated liquor.

Na_2O_{total} g/L	$Na_2O_{caustic}$ g/L	$Na_2O_{carb.}$ g/L	Al_2O_3 g/L	SO_3 g/L	$\alpha_{caustic}$	Υ g/cm^3
310.2	281.3	28.9	154.0	10.1	3.0	1.42

The precipitate was examined by microscope, which showed that the precipitate is rolled roughly rounded particles of 20 – 100 μm, with an average size of 50 – 60 μm [1]. Fine particle size and low solids content of the evaporated liquor cause poor settling and filtration properties of the precipitate.

One of the options to improve the separation efficiency of carbonates, sulfates, and organics from evaporated liquors at RUSAL Krasnoturyinsk is implementation of new advanced filtration equipment, e.g. belt vacuum filter (Figure 1).

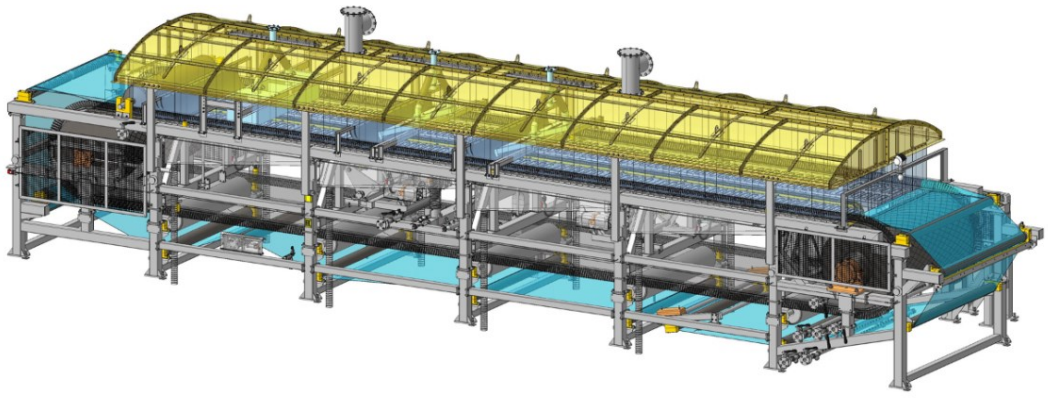

Figure 1. 3D model of a belt filter.

Based on the test results, the belt filter filtrate solids content amounted to 7.2 g/L, or 52 % less than the filtrate solids content from a reference filter BOU-20 (15.1 g/L), and 44 % less than the overflow from the settling tank (13.5 g/L).

Pilot tests proved that implementation of the belt filter to remove precipitated soda salts from recycled liquors is much more effective than the current process used at RUSAL Krasnoturyinsk in terms of both cake moisture and filtrate quality. This technology appears to be a promising option to enhance the capacity of the evaporation area to remove carbonate and sulfates from the liquors. Currently work on front-end engineering design of a new area for "red" soda removal using belt vacuum filters at RUSAL Krasnoturyinsk is in progress.

6. References

1. A.V. Perestoronin, G.V. Tokarev, M.N. Pechenkin, E.N. Mitrofanova "Study of crystal growth of recycled soda at Bogoslovsk Refinery". // Aluminum of Siberia – 2017, Book of papers, Krasnoyarsk, 2017, pp. 71-77.
2. Perestoronin A.V. Soda crystallization from aluminate process liquors: thesis for a Candidate Degree in Technology: 05.17.01 / A.V. Perestoronin – Saint Petersburg, 2016. – p. 176.
3. Report on "Improvement of effectiveness of soda removal from recycled liquors of "RUSAL Krasnoturyinsk": R&D report / "RUSAL ETC" LLC, Saint Petersburg, 2019 - p. 23.