Volume Control at CBA's Alumina Refinery

Thiago Franco
Process Engineer
Companhia Brasileira de Alumínio, Alumínio, Brazil
Corresponding author: thiago.franco@cba.com.br

Abstract

Plant volume control is a challenge for all alumina refineries because it involves complex mass and energy balances with numerous variables and conflicting goals. The competition between these goals may be seen in such daily examples as deciding between maximizing tank levels for increased production and the risk of overflowing with the associated safety hazards and unnecessary cleaning expenses. Other examples include increasing water return with red mud filtration for better caustic recovery, but higher costs in water evaporation. Bayer process refineries have large numbers of equipment and tanks through which caustic liquor flows and many parameters vary dynamically. Therefore, it is necessary to have well-established control limits, plant volume parameters and targets to allow daily routines of caustic cleaning and maintenance. This paper presents the developments at Companhia Brasileira de Alumínio's (CBA) alumina refinery, regarding the tools provided to teams allowing them to make important decisions about volume control and the management system created for weekly and annual planning.

Keywords: Water Balance, Process Simulation, Plant Volume Control.

1. Introduction

The volume control of a hydrometallurgical process is a required routine operational activity done in industries that use large quantities (sometimes in excess of millions of liters) of liquids (typically acidic or caustic) for the chemical solubilization of ores. Increasing the levels in the tanks often means increasing the production. This is the goal of all company owners. On the other hand, working with high tank inventories elevates the risk of overflows or spillages, which is a hazard to employees. In addition to the safety risks, there will be an increase in the expenses associated with cleaning up the factory area and the introduction of water to the process. This is one example of conflicts between operational targets and volume control. In this case, activities must be managed to meet the targets of performance indicators that interact with each other, while avoiding safety risks to assets and people. Tank levels and stocked volume management is so important that many factories dedicate process engineers to that specific control application, or even a whole team to this coordination.

2. Main activities

Good volume control comprises of, but are not limited to, the following:

a. Daily water balance: mass and energy balances of the process liquor. To have an accurate volume control, it is necessary to have well-defined control limits and also know their material inlets and outlets. This enables the creation of mass and energy balances that indicate the tendency of tank levels in the process.
b. Daily solids balance: mass balance of the solid phase materials. The focal point during inventory is to manage variations in large tanks such as settlers, washers and precipitators.
c. Volume transfers between tanks in and out of operation. This is used to avoid spills, to generate new chemical cleaning solutions for out of service tanks, or to fill empty vessels with spent liquor or send caustic solutions to operational tanks.

d. Investigations to identify unexplainable flow inlets or outlets (e.g. erroneous flowmeters, measurement inaccuracies or pipe spillages)
e. Management of the return and isolation of tanks in the process: this requires short-term and long-term planning.

3. Main goals

For good management of these activities, the main goals must be taken into account, as follows:

a. Manage tank levels in operation to avoid accumulation or depletion of inventory:
   a.1 Overflowing tanks generate unwanted costs with floor cleaning, increased evaporation and increase safety risks to employees.
   a.2 Empty tanks don't make production, therefore they don't generate profit.
b. Enable **chemical cleaning** of out of operation tanks within a planned schedule.
c. Enable **routine** operation and maintenance.
d. Enable **non-routine** maintenance.
e. Manage red mud and hydrate wash water flows to **minimize caustic losses**;
f. Find the balance between **wash water** flow in decanters for maximum **circuit efficiency** while minimizing **alumina losses** by precipitation.
g. Maintain **maximum temperature** in **security filtration** to obtain high filtration velocities;
h. **Minimize steam consumption** in forced evaporation units.
i. Maintain a **constant caustic concentration** to manage the stability of the whole process.
j. Adapt to **special conditions**. For instance, fine seed storage, bauxite quality variations, calciner shutdown and others.

4. CBA Volume Control Management

Considering the goals and needed activities for the desired volume control management, in July 2019, CBA started to develop a program with people, management and technical tools to improve and optimize the process. In the past, there were many decentralized activities with little or no connection between each other. The new program organized these into a formal structure with connected activities, formal responsibilities and with a process engineer responsible for managing the structure and activities.

To support the new structure, many tools were created to help the decision-making process. The most important ones are covered in the next section.

5. Tools

5.1 Volume balance

A good volume balance program comprises of mass and energy balances of all processes from ore introduction to the calcined alumina, taking into consideration all entry and exit material flows.

The result is indicative trends of accumulation, stability or volume reduction in tank levels. This is illustrated in the example shown in Figures 1 and 2.

5.6.3 Weekly Plan

Weekly, a multidisciplinary team for volume control gathers to schedule activities for the upcoming week and tackle deviations from the previous schedule. The monthly and annual planning are used as a guide during this process. Resources will be analyzed and distributed according to their respective availability.

6. Conclusions

The improvement in volume control management at CBA's alumina refinery brought numerous benefits. The main benefits can be seen below:

a. Better integration and coordination of activities amongst the different teams.
b. Creation of new tools to increase agility when making decisions, planning and scheduling routine activities.
c. Support to control process parameters such as Netwash in mud filters and in hydrate filters, among others.
d. Reduction of tank overflows and spillage events.
e. Reduction in waste liquor discharge to the tailings dam due to volume accumulation in the process tanks.

In 2019, the financial damage associated with liquor discharged was of 2.67 million USD. With the aid of the tools and systems presented in this paper, in 2020, an estimated gain of 200 000 USD could be attributed to the reduction of waste liquor discharged, a gain of 300 000 USD could be attributed to the reduction of specific caustic consumption in the process and a further gain of 400 000 USD to the reduction of live steam consumption in the evaporation unit.

References

1. L. Martin and S. Howard, Alumina Refinery Wastewater Management: When Zero Discharge Just Isn't Feasible, *Light Metals* (2011)