

Valve solutions for alumina production

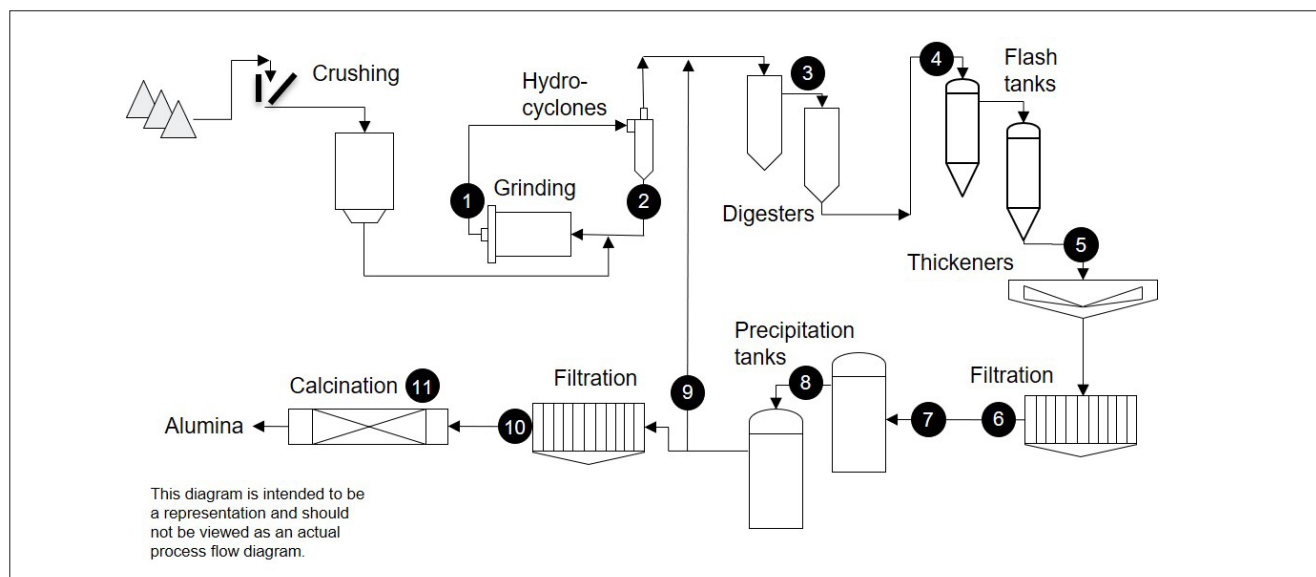


Fig. 1. Simplified flow diagram of alumina production.

Process overview

Most of the global aluminum production goes through two main processes. The Bayer process is the most popular process to refine bauxite into alumina. The Hall-Heroult process is used when refining alumina into aluminum. This report focuses on the Bayer process.

Figure 1 presents a simplified process diagram of the Bayer process. The processing steps are briefly described as follows:

- Crushing and grinding:** The primary crusher typically reduces the bauxite ore to less than 150 mm in diameter. The grinding mills grind it further down to less than 150 μm particle sizes.
- Desilication:** Bauxites sometimes contain clays, which are reactive in the process. The target of the desilication process step is to form and dispose a *desilication product* (DSP), which contains these unwanted clays. To achieve this, the milled bauxite is kept in agitated holding tanks at 90 $^{\circ}\text{C}$ for at least 8 hours. During this time, the DSP forms and is then removed from the slurry before the digestion stage.
- Digestion:** The slurry from the desilication tank is pumped into a train of digesters, where it is held for 10 to 30 minutes in a temperature range from 140 to 280 $^{\circ}\text{C}$. Holding times and temperatures depend on the specific ore type and chemistry. The digestion temperatures are above the boiling point of the caustic liquor, so the tanks are pressurized.
- Solid-liquid separation and filtration:** After digestion, the slurry is flashed down to atmospheric pressure and temperature, and the steam is collected. The slurry then enters the thickeners, followed by filtration.
- Precipitation:** The liquor exiting filtration is saturated with aluminum hydroxide. The target of the precipitation stage is to crystallize the aluminum hydroxide onto seed crystals in a controlled way. Seed crystals are fed to the first precipitator, providing an area for the crystals to grow. The tanks are typically about 30 meters high and 15 meters in diameter. The precipitation process is the slowest step of the Bayer cycle, taking over 24 hours. Due to the slowness of the process, each precipitation train typically includes 10 vessels, allowing enough buffer and enabling a continuous process.

- **Hydrate particle separation, washing and filtration:** Exiting the last precipitator, the hydrate particles are screened from the spent liquor, washed and filtered. The filter cake is transported to the final process step – calcination.
- **Calcination:** The aluminum hydroxide filter cake is heated to produce alumina, Al_2O_3 , which is the end product of the Bayer process.

Valve applications

In alumina production, valves face challenges, such as abrasive particles, a high tendency for material build-up and elevated temperatures. To ensure efficient and reliable flow control, the choice of valves and their seat type, along with material selection, play an important role. The following paragraphs describe typical valve applications in the alumina production process.

Valves for the desilication process

Scale build-up is one of the main issues faced by producers of alumina in the desilication process. This material build-up typically forms very hard deposits, which cannot be removed by the caustic soda present in the process. The desilication product, or DSP, is soluble in acids. Thus, the process equipment involved is regularly taken offline and rinsed with sulfuric acid. Scale build-up, acidity and abrasive particles must be considered when selecting valves for this application or when taking actions to improve their performance.

Valves for digester steam control

Digester steam control valves perform one of the most critical services at an alumina plant. Steam control is an aggressive environment in which accurate and stable control is essential. High pressure, noise and vibration are common characteristics, along with contaminated, high chloride-containing steam. Therefore, this application requires special valve materials and cavitation control.

Valves for flash tanks and heat recovery

After the digestion stage, the pressure is reduced over a series of flash tanks. Valuable heat energy can then be recovered from the flashed steam, improving plant efficiency. In this application, valves tend to be large in size. Typically, plants use butterfly valves to provide high performance with low lifetime costs.

Valves for solid-liquid separation and filters

At a typical alumina plant, solid-liquid separation techniques are applied in various processes. One of these is the mud washing stage in the tailings stream of the process. The volumes entering this stream depend on the bauxite quality but are huge in every plant. Thickeners and washers, such as in the countercurrent decantation process, are typically operated with knife gate and butterfly valves. Controlling the chemical feed, such as flocculant dosing, can be done with segmented ball valves, which provide excellent control characteristics.

Valves for precipitation

In the precipitation step, the hydrate is supersaturated, leading to a high tendency to precipitate from the solution in a less controlled way than desired. As a result, hydrate scale can form in the pipes, valves and other process equipment. In addition to the potential loss of yield, this may lead to inefficient operations of the valves and other process equipment. Correct valve selection and careful consideration of their seat design can have a considerable impact on improving the plant's performance.

Valves for spent liquor

Spent liquor, or weak caustic soda returning from the filtration and precipitation areas, needs to be concentrated before being recycled back into the digestion system. During this stage, low temperatures make metallurgy simple, so carbon steel materials can be used. However, during the evaporation stage of spent liquor and when leaving it, temperatures are high (above 150 °C), demanding uncommon materials like Monel. For this, valve sizes are typically large and pressures are low.

Valves for the calcination process

The final processing step at the alumina production plant, calcination, is a very important phase. It is not only because this is where quality control takes place, but also because this stage consumes a lot of energy, using up to 30% of the plant's total energy. The process is run above 1,000 °C, which also has implications for the design of all instrumentation, including the valves. The natural gas feed to the calcination process can be controlled using different valve solutions, with segment ball valves being among the most effective.

Neles solutions

We offer a wide range of valves, actuators and controllers suitable for the production of alumina. As customer success is our number one target, we can help you select the correct valve for each application. Our superb know-how in flow control, together with our customers' process expertise, is a winning combination to ensure peak plant performance.

Valves

We have a world-leading portfolio of products that are ideal for control, safety and on-off valve duties. Table 1 lists the different valve applications required for alumina production. It shows typical valve types in each of the various processing steps. Some of the more demanding valve installations require high pressure ratings. Ceramic valves can even be used, providing a considerably extended lifetime compared to other materials.

Table 1. Typical valve types by application in alumina production.

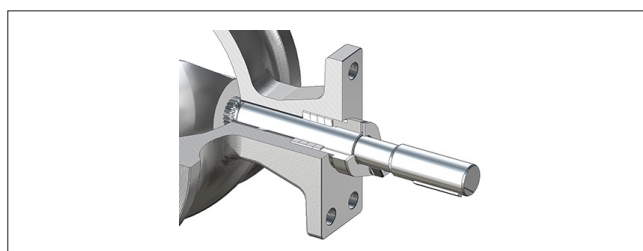
Nr.	Application	Typical valve types
1	Grinding	Knife gate & pinch valves
2	Cyclones	Knife gate & pinch valves
3	Digester tanks	Ball & globe valves, Q-trim for selected tags
4	Flash tanks & heat recovery	Butterfly & globe valves
5	Thickening	Knife gate & pinch valves
6 & 10	Filtration	Butterfly, segmented ball & ball valves
7	Pregnant liquor control	Butterfly valves
8	Precipitation tanks	High performance butterfly valves
9	Spent liquor & evaporation	High performance butterfly valves
11	Calcination	Segmented ball, butterfly valves

Our butterfly valves offer several features that are beneficial at an alumina production plant. For example, Neles' high-performance Wafer-Sphere™ Xtreme™ seat guarantees bi-directional shutoff even in the most demanding applications.



Neles high-performance butterfly valve

Our segmented ball valves have been designed with a unique bearing assembly, minimizing the ingress of the solids. This feature extends valve lifetime and improves reliability.



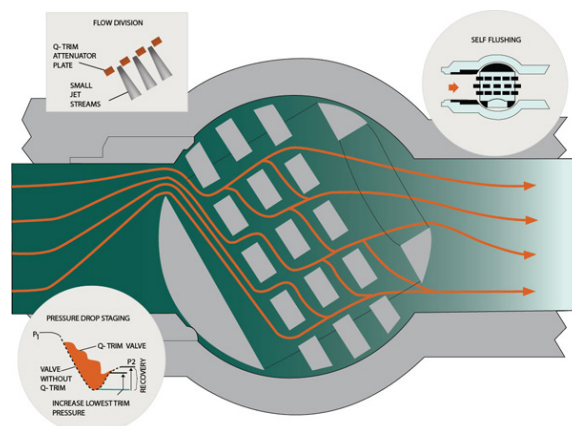
Neles bearings assembly with no cavities for solids buildup

Neles RE series V-port segment valves can be used in various locations within the plant to provide high-performance with a quarter-turn design. These valves are offered with a wide variety of trim options, from standard to low Cv trims, depending on the application. Standard units are equipped with either diaphragm or cylinder actuators as well as ND intelligent valve controllers for precise control, reliability and performance.



Neles segment valve, actuator and controller

Some applications at alumina plants call for cavitation control and noise attenuation. For over 25 years, Neles rotary valve Q-Trim™ design has proven optimum non-clogging noise attenuation, high capacity and rangeability, while keeping the valve dimensions, weight and cost at a reasonable level. The principle of the patented Q-Trim™ is a combination of the following elements: pressure staging, flow division, peak frequency shifting, self-cleaning and non-clogging features.



Neles Q-Trim for rotary valves

Actuators and valve controllers

Leading industrial companies have standardized Neles pneumatic piston-type, high-cycle cylinder actuator because of its robust design, which allows longer plant operating time with less maintenance. For alumina plants, one of the key requirements is that process equipment cannot contain any aluminum components. Our flow control portfolio fully complies with this requirement. Key characteristics of our actuators include:

- **Robust materials:** Standard anodized/chromed cylinder pipe, hard-chromed piston rod, corrosion-resistant construction and high-quality springs make the actuator's design robust and reliable.
- **Modular design:** Simplified maintenance and spare parts management are ensured with the actuator's modular construction.
- **High torque:** When closing the valve, the high-torque capability enables a smaller actuator to be used to achieve tight valve shutoff.
- **Predictive maintenance:** With the help of the extensive diagnostics that the controllers provide, plants have the possibility to optimize the maintenance of their equipment.
- **Hazardous area certifications:** Available for safe and flameproof applications.

Benefits

With decades of experience in the mining and minerals processing industry, we provide our customers with superior products, solutions and service.

Neles intelligent valve controllers offer maximum reliability in severe environmental conditions and provide extensive diagnostics for high-cycle on-off applications, guaranteeing users the availability of high-cycle valves.

- **Meet the process requirements:** Neles' valve controllers offer the option of setting the on-off valve stroking times and profiles according to the process needs.
- **Millions of cycles without maintenance:** Due to the advanced design of the controller's pneumatics, our controllers are maintenance-free for a long period of time.

- Improved process control to increase product yield and profit
- Maintenance planning capabilities to reach plant uptime targets
- Reliable and lasting valve operation
- Long-lasting valve designs, even for high-cycle service, reduce maintenance costs
- Minimized unexpected shutdowns
- Compliance with noise, emission and fire safety regulations set by local authorities

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