Valve solutions for lithium production from hard rock minerals

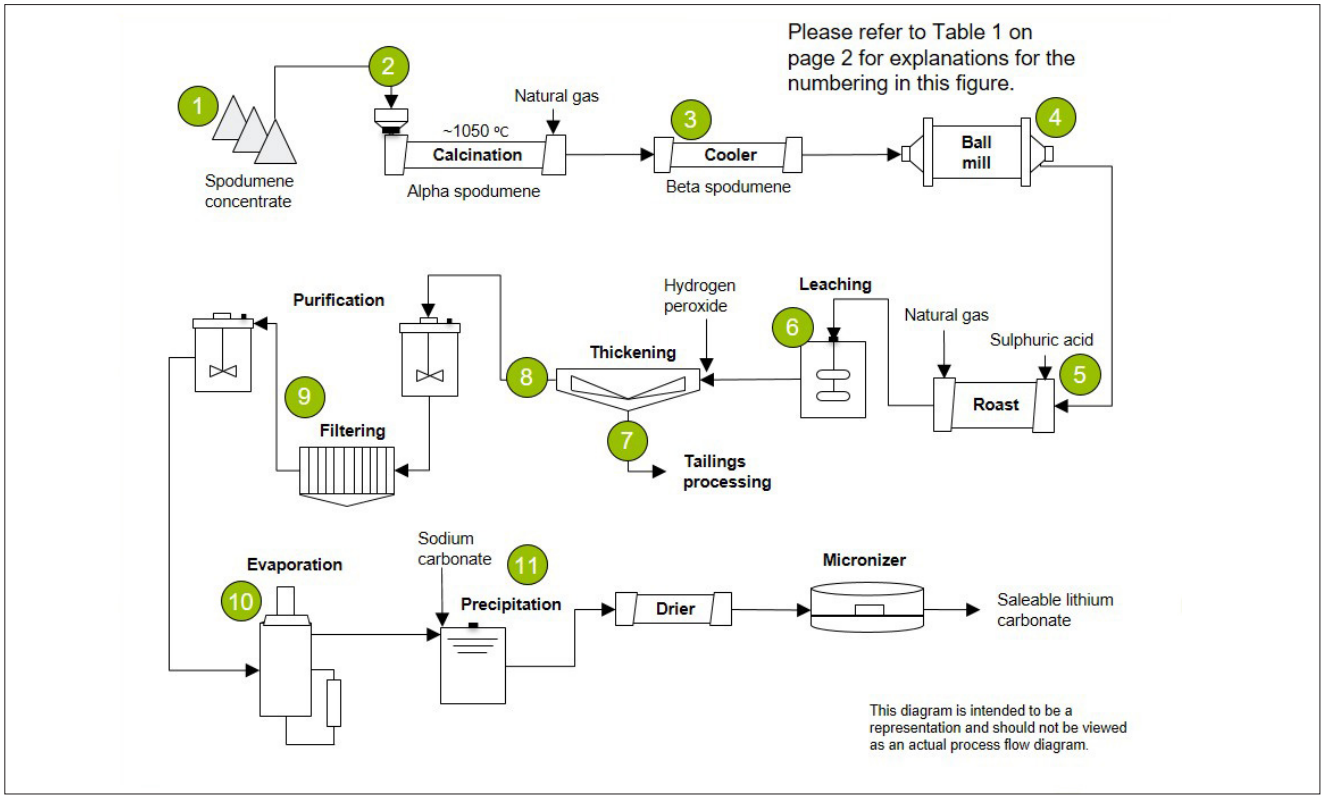

Fig. 1. Simplified flow diagram of Lithium carbonate production from spodumene concentrate.

Process overview

Lithium is mainly produced from two major sources – underground mineral ore and brine deposits. Most lithium extraction processes entail a form of mining to reach underground deposits of hard rock formations or brines before the processing takes place.

The process for extracting lithium from ore varies, based on the specific composition of the mineral deposit in question and the desired end product. Spodumene, with a theoretical Li2O content of 8%, is the most common commercially exploited lithium mineral and a typical raw material to be converted to lithium carbonate, lithium hydroxide or other desirable lithium compounds. In lithium carbonate production, the following processing steps are typically performed:

- Spodumene concentrate production
- Calcination
- Leaching
- Purification
- Precipitation
- Drying and micronizing

Before leaching the lithium slurry, it needs to be calcinated. Calcination is a process in which alpha-spodumene goes through a phase transformation into beta-spodumene at temperatures between 1,000 and 1,100 °C. The roasted product is then leached to extract lithium from beta-spodumene into a solution. The most common reagent for the leaching process is sulfuric acid, although soda ash and lime can also be utilized. The first step in the leaching process is to mix the spodumene with concentrated sulfuric acid and heat the mixture to 250 °C. In addition to lithium, also iron, magnesium, sodium and aluminum are leached. These metals need to be precipitated from the solution to produce a saleable technical grade of lithium carbonate. A simplified flow diagram of lithium carbonate production from spodumene concentrate is shown in Figure 1.

Valve applications

In lithium production, valves face challenges, such as high temperatures, abrasive particles and significantly high acidity levels. To ensure the efficiency and reliability of these valves, it is critical that they are selected by experts. The following paragraphs describe some of the most important valve installations within the lithium carbonate production process.

Valves for spodumene concentrate production

Flotation is one of the primary processing steps to produce spodumene concentrate. In typical flotation equipment, valves control the slurry feed and discharge, reagent addition and water flow. Knife gate valves are used extensively in this application. For more demanding valve installations, segment valves are a top choice. Due to the segment design, there are considerably fewer cavities in the valve compared to ball valves, for example. As fewer solid particles have a chance to settle within the valve's construction, the lifetime of these valves is longer.

Valves for the calcination process

The calcination of beta-spodumene into alpha-spodumene takes place in temperatures exceeding 1,000 °C. This needs to be considered in the design of all instrumentation, including valves. The natural gas feed for the calcination process can be controlled with different valve solutions, ball valves are among the most typical ones.

Valves for the leaching process

A leaching process takes place to extract lithium into a solution from the beta-spodumene. The presence of sulfuric acid in the leaching process poses challenges to the process control, which makes correct valve material selection essential. Valve selection is also affected by the temperature, typically ranging about 250 °C in this process.

Valves for filters

As particles get finer, the resistance against removing water increases. Dewatering can no longer be achieved by gravitation, but pressure must be used. A mechanical filter press is one option for the dewatering service. The machine contains several valves: pinch valves are typically used in the slurry inlet feed, other valves used for water and air service are often butterfly valves.

Neles solutions

We offer a wide range of valves, actuators and controllers suitable for the lithium processing. Our superb know-how in flow control, combined with the customer's expertise of the process, is a winning combination to ensure the plant's success.

Valves

We aim to solve the flow control challenges of lithium processing plants with our application experience and wide product offering for control, safety and on-off valve duty. A typical pressure rating in lithium production is ASME Class 150. Common materials include WCB or CF8M for valve bodies. Some of the more demanding valve installations require higher pressure ratings and more durable materials, such as Hastelloy. Table 1 lists different valve applications in the lithium carbonate production. It shows typical valve types in each of the various processing steps.

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

Nr.	Application	Typical Valve types
1	Spodumene flotation	Knifegate and segment valves
2	Calcination	Ball and butterfly valves
3	Cooler	Ball and butterfly valves
4	Ball mill discharge	Knife gate, pinch and diagraphm valves
5	Sulphuric acid feed	Butterfly and ball valves
6	Leaching	Process ball, sleeved plug and knife gate valves
7	Thickening underflow	Pinch and knife gate valves
8	Thickening overflow	Rubber-lined butterfly valves and knife gate valves
9	Purification and filtering	High performance butterfly, process ball and pinch valves
10	Evaporation	Butterfly, segment and ball valves
11	Precipitation	Butterfly and ball valves

For our customers in lithium production, we are dedicated to matching the application requirements with the most economical products. For example, spodumene concentrate producers use our Neles RE series V-port segment valves, which are economical, high-performance valves 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

With superior tightness, Neles butterfly valves operate both in control and shutoff applications. They provide long-lasting tight shutoff capability, excellent flow characteristics and long service life. Our butterfly valve portfolio covers a wide variety of trim materials and seat combinations, making it the perfect choice for many of the liquid flows at lithium production sites. For instance, in flotation solutions, we are true experts: In addition to supplying the complete set of flotation equipment, our portfolio includes industry-leading valve technology for flotation flow control.

Neles butterfly valve

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.

- 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.
- Arctic service compatibility: In extreme temperature conditions, the actuator can be equipped with a high-performance piston seal and steel materials, making it functional in temperatures as low as -55 °C (-67 °F).

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
- Predictive maintenance: With the help of the extensive diagnostics that the controllers provide
- Hazardous area certifications: Available for safe and flameproof applications

Benefits

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

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

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