Valve solutions for copper concentrates production, smelting and electrolysis

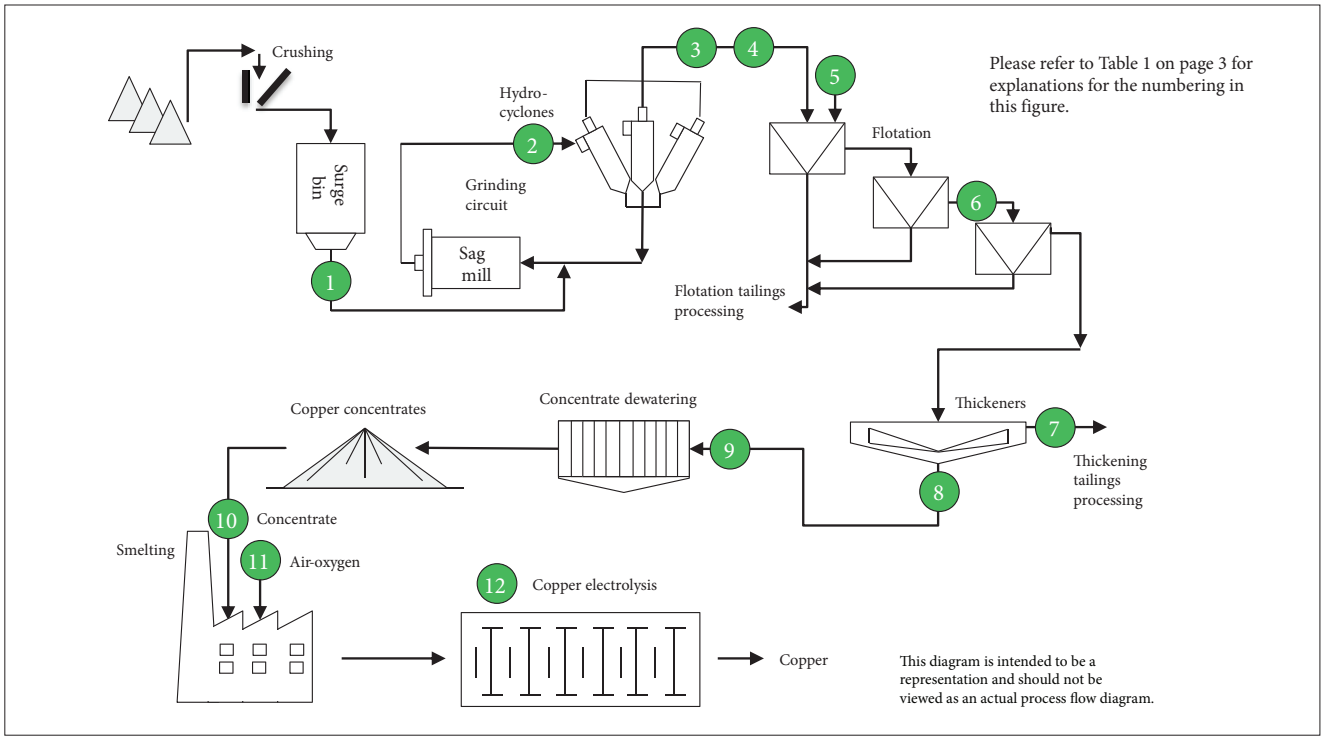

Fig. 1. Simplified flow diagram of copper concentrates production, smelting and electrolysis.

Process overview

The most common copper ore types, copper oxide and copper sulfide, undergo two different refining processes – hydrometallurgical and pyrometallurgical, respectively. By volume of global copper production, pyrometallurgy is the dominant processing method.

Each ore deposit is unique in its concentration and mineral composition. Therefore, the most economical plant flowsheet varies from site to site. Even though the unit processes might be site specific, the principles of processing sulfide ore remain the same. The refining starts with crushing and grinding. At some sites, this is followed by hydrocyclone separation. The slurry then moves to a flotation stage, where reagents are added to the feed. The reagents bind to the copper particles, making them hydrophobic. Air bubbles are generated in the bottom of the tank. As the bubbles rise to the surface, they take the copper-bearing minerals along with them. The copper-rich froth at the top of the tank is then skimmed off and taken to a thickening stage. Thickening is followed by dewatering, and the resulting copper concentrate typically contains around 30% copper.

This concentrate is then transported to a smelter, where high temperatures are used to further purify the copper concentrate. In the smelting furnace, the pyroprocessing begins, and the concentrate is converted into molten liquid with temperatures up to 1,200 °C (2,300 °F). The hot liquid is poured into a slag-settling furnace. The output product of this step is called copper matte, containing some 60% copper. Then this molten matte moves to the next furnace, called a converter, to have most of the remaining impurities burned off. The converter produces an output referred to as blister copper, now at 98% concentration. An anode smelter follows the converter. There, the purity is further increased by one percentage point, to 99%. Then the molten anode copper is poured into molds in an anode casting plant.

The copper anode slabs are refined in a final processing step referred to as electrolysis. These anode slabs are hung in a large tank full of electrolyte solution. Thin sheets of pure copper, cathodes, are hung between the anodes. When an electric current is applied, copper ions leave the anode, move through the solution and are plated on to the cathode. After about two weeks, the anodes have dissolved and the copper cathodes, weighing over 150 kg (350 pounds) contain 99.99% pure copper.

Valve applications

To isolate and control various process flows, copper processing plants turn to flow control experts. In the upstream process, valves regulate, for example, flotation and dewatering. In the downstream smelting and electrolysis process, the valves control, among others, gas, air and electrolyte solution flows.

Valves for the froth flotation

In typical flotation equipment, valves control the slurry feed and discharge, reagent addition and water flows. Knife gate valves are used extensively in this application. Another commonly used valve type is the rubber-lined butterfly valve. For the reagent feed and control, segment valves provide an excellent solution.

Valves for dewatering

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.

Valves for the smelting process

The smelting process is a complex, multi-stage process, involving high temperatures and molten liquids. The control of oxygen and air is one key to a reliable and efficient process. For these operations, valve materials need to be carefully selected. Cleanliness is of paramount importance, due to the inherent danger of oxygen reacting with any grease, oil or any other combustible material left in the piping system. The evaluation of valves for the oxygen application requires an understanding of metallurgy as well as valve geometries.

Valves for electrolysis

The electrolyte solution is fed to the tank through piping. As pressures are typically rather low in this application, butterfly valves are a good choice, providing the lowest total cost of ownership.

Neles solutions

We offer a wide range of valves, actuators and controllers suitable for the copper 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 copper processing plants with our application experience and wide product offering for control, safety and on-off valve duty. 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 copper 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

For the smelting operation's oxygen service, valves need to be fully compatible from the design and material point of view, and provide long-term tightness in continuous operation. Our trunnion-mounted ball valves will do the job. They have full metal-to-metal seats, ensuring safe and reliable long-term operation. Neles' material selection is based on international material codes for oxygen service. For decades, we have designed and manufactured high-pressure ball valves to provide customers with long, service-free valve operation, along with lasting internal and external valve tightness.

Trunnion-mounted ball valve with intelligent Neles SwitchGuard™ controller.

Table 1 lists valve applications in copper concentrates production and smelting. It also shows typical valve types used in each of the various processing steps. The numbering in the table refers to Figure 1.

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

Nr.	Application	Typical valve types
1	Surge bin	Gate, globe and diaphragm valves
2	Cyclones	Knife gate and butterfly valves
3	Pump isolation	Butterfly and knife gate valves
4	Slurry	Process ball, butterfly, pinch and knife gate valves
5	Flocculent addition	Butterfly, ball valves and knife gate valves
6	Flotation	Pinch and knife gate valves
7	Thickening overflow	High-performance butterfly, resilient seated butterfly and knife gate valves
8	Thickening underflow	Pinch and knife gate valves
9	Mechanical filter press	High-performance butterfly, process ball and pinch valves
10	Smelting	Butterfly and ball valves
11	Air-oxygen	Ball and butterfly valves
12	Electrolytic refining	Ball, butterfly and knife gate 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.

- **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.

- Configure to meet process demands – Neles' valve controllers offer the option of setting the on-off valve stroking times and profiles according to the process needs
- Operate millions of cycles without maintenance, due to the advanced design of the controller's pneumatics
- Practice predictive maintenance with the help of the extensive diagnostics that the controllers provide
- Comprehensive hazardous area certifications for safe and flameproof applications are available for all valve control instruments

Benefits

With decades of experience in the mining and minerals processing industry, we provide our 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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