Valve solutions for copper leaching, solvent extraction and electrowinning

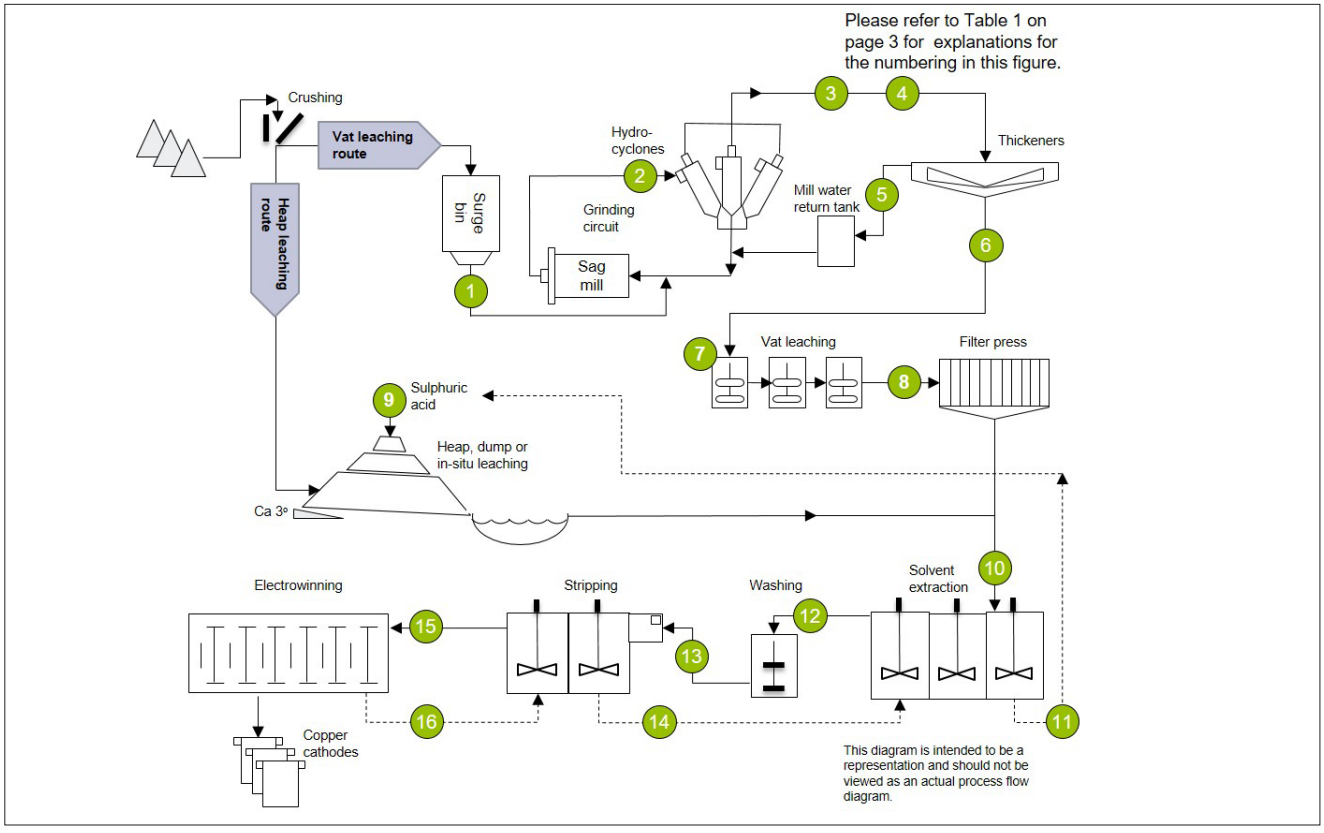

Fig. 1. implified flow diagram of copper leaching, solvent extraction and electrowinning process.

Process overview

The leaching, solvent extraction and electrowinning (LX-SX-EW) process is a widely used method for the production of copper from low-grade oxidized ore. Although copper is the most common metal to be processed by LX-SX-EW, the process can be used to extract, purify and concentrate other metals, such as nickel, cobalt and zinc.

The target of this process is to concentrate an aqueous copper solution from a few g/l to around 40–50 g/l, as well as to purify the solution from chloride, ferrous, manganese and other impurities, which may cause problems in the downstream electrowinning process.

There are six different methods for leaching: heap, dump, in-situ, agitation, autoclave and vat. In vat leaching, the process starts with crushing, grinding and a separation circuit followed by thickening. The slurry then enters vat leaching tanks and moves to solvent extraction through dewatering. Heap leaching, which is one of the most common leaching methods, starts with sprinkling a low concentration of sulfuric acid and water solution on a stockpile (leach pad) of low-grade ore. The liquid percolates through the stockpile and dissolves copper minerals, producing a copper-rich liquid called a pregnant leach solution (PLS) with around 60% concentration. The PLS flows to a collection reservoir and on to a solvent extraction plant, where the copper is transferred from the mildly acidic aqueous leach solution to an organic solution. The remaining leach solution, called raffinate, is replenished and returned to the leach pad for reuse.

After the extraction stage, the copper-loaded extractant is fed to the stripping unit, where the copper is transferred from the organic solution to a strongly acidic aqueous electrolyte solution. This is followed by the final stage, electrowinning, where the metal is recovered from the acidic solution by being deposited onto cathode plates. In this step, an electric current is passed through a bath of the extracted material. This causes the copper to deposit onto metal plates, resulting in a pure form of the metal. Then, the copper can be removed from the plates, moved to the next processing phase and finally to sale. A simplified flow diagram, including vat and heap leaching routes, is shown in Figure 1.

Valve applications

Valves play an important role in the LX-SX-EW process, ensuring that various liquid flows are kept within optimum levels. Due to the demanding requirements of some of the valve installations and the acidity of the LX-SX-EW process, correct valve selections can make a big difference to a plant's overall profitability. The following sections highlight selected valve applications in this process.

Valves for the pregnant leach solution

The pregnant leach solution is the output product of leaching. It forms as sulfuric acid percolates through the ore pile, while the copper content of the ore is introduced in the aqueous solution. At some sites, drainage systems move the solution to the next processing stage using gravity, while other sites use pumps.

Butterfly and ball valves are good choices for PLS flow control. Chloride sometimes poses a challenge in the PLS feed, in which case, valve material selection is an important factor to be considered. For instance, Hastelloy steel is a typical choice, as it exhibits very high resistance against corrosion.

Valves for the raffinate feed

Raffinate is a mild solution of sulfuric acid with a pH typically between 1.2–2.0. When selecting valves for this application, many valve characteristics, such as size and pressure class, are typically straightforward. Still, there are other factors that may need proper evaluation to ensure the best possible outcome. In addition to material selection, the right body and seat designs ensure that the valves operate at their peak performance.

Valves for the rich electrolyte solution

In the stripping stage of the process, the copper in the organic solution transfers to an aqueous solution, resulting in a rich electrolyte solution. This solution is fed to the electrowinning stage through piping. Pipe sizes vary from site to site and can be up to DN1000 or even larger. Since pressures are typically in the lower range 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 that are suitable for the LX-SX-EW application. Our superb know-how in flow control, combined with the customer's knowledge of the process, is a winning combination to ensure a plant's success.

Valves

In the copper LX-SX-EW process, valves must reliably isolate process flow where and when needed, particularly in the event of an emergency. Valve stem seals must prevent hazardous emissions from leaking into the atmosphere. In addition, the structural integrity of valve body castings must be maintained without fail. Human and environmental safety, process uptime and productivity, product quality and return on investment all depend on it.

With superior tightness, Neles butterfly valves operate in both 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 LX-SX-EW sites.

Neles butterfly valve

In addition to butterfly valves, we supply copper processing plants with a wide range of flow control solutions, including ball, globe, pinch and knife gate valves, to name a few. Knife gate valves provide a non-turbulent flow path and a low fluid friction loss. Globe valves are the most suitable option for especially demanding control applications, for example sulfuric acid feed, where they control the pH of various liquid flows in copper processing plants. With over a century of experience in the minerals processing industry, we are proud to continue using our expertise to help our customers succeed in their business.

Neles ball valve

Table 1 provides an excellent starting point to select valves for the copper LX-SX-EW process. The numbering used in the table refers to Figure 1.

Table 1. Typical valve types by application in copper 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, pinch, sleeved plug and knife gate valves
5	Thickening overflow	High-performance butterfly, resilient seated butterfly and knife gate valves
6	Thickening underflow	Pinch and knife gate valves
7	Vat leaching tanks	Process ball and butterfly valves
8	Mechanical filter press	High-performance butterfly, process ball and pinch valves
9	Sulphuric acid sprinkling	Butterfly valves
10	Pregnant leach solution (PLS)	Butterfly and ball valves
11	Raffinate	Butterfly and ball valves
12	Washing	Butterfly, ball and knife gate valves
13	Organic solution	Butterfly, knife gate and ball valves
14	Barren organic solution	Butterfly, knife gate and ball valves
15	Rich electrolyte	Butterfly valves
16	Spent electrolyte	Butterfly, knife gate and ball valves

Benefits

- Improved process control, with increased product yield and profit
- Forerunner in material technology for valve body materials
- Lasting valve designs, even under high-cycle service, reducing maintenance costs
- Minimized unexpected shutdowns
- Rotary designs and emission-certified valves minimize fugitive emissions
- Extensive portfolio of safety valves and equipment with third-party compliance certifications ensure plant safety

Valmet Flow Control Oy
Vanha Porvoontie 229, 01380 Vantaa, Finland.
Tel. +358 10 417 5000.
www.valmet.com/flowcontrol