

pH/ORP measurement

Cyanide leaching process



Mining – cyanide leaching process

Measurement made easy

Mining
cyanide leaching process

Introduction

Leaching involves the dissolution of a mineral from a solid (ore). The process contacts the ore with a solution containing reagents that dissolve the required mineral (and often some non-required materials). Various methods – carbon adsorption, precipitation, solvent extraction and electrowinning – concentrate the target mineral and remove it from solution.

Heap leaching

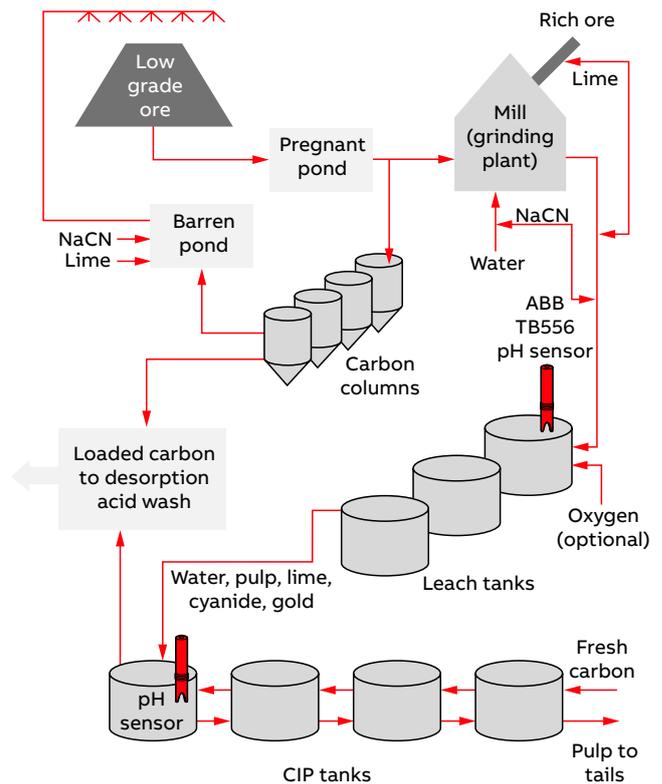
Heap leaching applies often to low-grade ore. The processing plant stacks the ore in a heap on an impermeable liner. Stacking is often preceded by a crushing step to increase the surface area of the ore and permeability of the heap. A sprinkler system above the heap then applies a leaching solution. The solution percolates through the heap, dissolving the target mineral as it migrates in and out of the ore. Heap leaching may take months.

The leachate (known as the 'pregnant' solution) collects at the bottom of the heap through a series of ditches and ponds. A process plant then removes the mineral from the pregnant solution and returns the now 'barren' solution to a pond to be recycled to the heap.

Some plants monitor pH further upstream of flotation in the mill circuit. A typical mill circuit installation point is in the cyclone overflow. Plants often mount the pH sensor in the flotation basin or the overflow line. Mounting in the overflow has the advantage of not totally submersing the back of the sensor, providing overflow depth remains constant. Care must be taken to ensure that the sensor is mounted deep enough to contact liquid rather than the top froth, that has a high percentage of air. Most sensors have a submersible design with a rigid mounting.

Leach tanks

Leaching ore in vessels is more expensive than heap leaching but is often more economical for richer grades of ore (high percentage of target mineral). Typically, the leaching solution is introduced during a crushing and milling operation that grinds the ore to a fine powder. The resulting slurry of powdered ore and leaching solution flows to a series of leach tanks to provide sufficient time for the leaching action to take place.



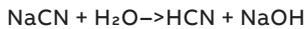
Cyanide leaching – gold processing

Cyanide leaching is most common in processing gold (and silver) ores. Cyanide dissolves gold from its host rock providing the ore exists as an oxide and is not bound closely. Low-grade ore contains gold in the form of microscopic particles and is processed via heap leaching. If gold is present in a larger and more concentrated state, the ore is ground finely and leached in a tank. A gold/cyanide complex forms as the gold dissolves from the rock or pulp (finely ground ore), according to the equation:



The control of pH in a cyanide leach solution is critical from both safety and cost perspectives. The process adds cyanide to a solution in the form of sodium cyanide (NaCN).

Decreased pH values favor the following reaction:



The result is the formation of hydrogen cyanide gas that is lethal in a concentrated state.

The reaction also has an economic concern. It generates a high consumption of cyanide as it releases into the atmosphere, never to be recovered. Sodium cyanide is a relatively costly reagent. To control costs and maintain worker safety, most operations try to keep process acidity in the 11 to 12 pH range.

Plants commonly use lime as the reagent for pH control. In a heap leach operation, the plant adds lime either to the crushed ore or into the barren solution pond. Continuous pH control is neither common nor necessary for heap leach operations. Adjustments are usually made on a batch basis at the barren pond.

In a milling operation, the plant usually measures pH in the leach tanks. As mill feed varies, so does the pH of the slurry. Adjustments of pH with lime are made to ensure optimum use of cyanide. Plants now also commonly inject oxygen into the leach tanks to help accelerate the leaching process. Since oxygen is a key component in the above reaction, it increases gold recovery for a given residence time in the leach tanks.

Usually, leach tanks are large and contain only cyanide solution and pulp. This slurry then flows into several carbon in pulp (CIP) tanks containing granulated carbon particles. The carbon captures the dissolved precious metal in solution through a mass transfer process known as adsorption. The carbon moves counter-current to the pulp flow so that the new carbon contacts with the lowest concentration of gold-bearing solution in the final CIP tank. The plant removes the loaded carbon at the first CIP tank and transfers it to the stripping plant (desorption) for further processing.

A common point for lime addition is at the fine-ore feed to the mill. If ore pH varies considerably, control may be more difficult. To maintain tighter control, pH sensors may be located in the mill stream or further lime additions can take place at a point closer to the leach tanks.

The ABB solution – TB556 for pH measurement

Cyanide leaching is a difficult process. The process liquid is in an abrasive slurry that can damage the glass electrode. The use of lime reagents can cause hard calcium scale problems. Hydraulic cleaners have been used successfully to combat scaling and particle accumulation – the periodic jet of fluid prevents a build-up of pulp or scale. Another problem is the very nature of the fluid. Cyanide is a strong oxidizer that makes this a very reactive solution. The reference electrolyte and reference element are subject to chemical contamination and lose stability much more rapidly than in a more neutral solution. The TB556 with TEFLON® Next Step liquid junctions are recommended for this service. If abrasion is a problem, a flat glass measuring electrode may reduce the replacement frequency.

The pH sensor in any mineral processing slurry should be mounted so that there is sufficient velocity past the sensor to minimize lime scale and material buildup. However, a compromise should be attempted so that abrasion to the sensor glass and body are reduced. A good mounting location is at an overflow weir or a transfer point in the leach or CIP tanks.



Figure 1 ABB TB556 pH Sensor



Figure 2 ABB TB556 pH Sensor with hydraulic cleaner

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