

Treatment of Refractory Gold Ores

While the recovery of free milling gold by gravity and direct cyanidation is straightforward and well-established, refractory ores pose a very different challenge to producers.

The first challenge is determining the reason for the poor recovery by direct **cyanidation**, which can be caused by one or more contributors. The oldest and best understood is gold locked in sulphide, and most frequently pyrite. The second contributor to refractory behaviour is arsenic, which causes high refractoriness even at low concentrations. The presence of carbon in the ore is also a frequent cause of poor recovery, not because it makes the gold unresponsive to cyanidation but because it readily absorbs gold in solution and leads to “preg-robbing”. When these refractory contributors present themselves in combination, obtaining satisfactory gold recoveries can prove a real headache. Fortunately there are cures.



Key to curing the headache is proper diagnosis of the cause. XPS recommend QEMSCAN for feed characterisation. This analysis may be used in conjunction with a very systematic sequential leaching technique known as a “Diagnostic Leach” which clearly identifies where the gold is in the ore by systematically destroying key minerals, followed by cyanide leaching of the residue

Once the cause has been identified, there are a number of alternatives for treating the ore. Firstly, the gold can be made more amenable to cyanidation by ultra-fine milling, followed by a hot atmospheric leach – the Albion Process. A second solution is complete pressure oxidation (POX), which is effective for all conditions except carbon, but this can be expensive. The third method is roasting – either the well-established simple dead roasting to convert pyrite to hematite while oxidising any carbon present, or two-stage roasting to firstly remove arsenic by partial roasting followed by dead roasting.

Since XPS has expertise in fine grinding, pressure hydrometallurgy and pyrometallurgy, it should come as no surprise that these skills have been bundled into a “one-stop-shop” where a client can have the diagnostic leach performed to determine the cause of a particular ore’s refractoriness, followed by a review of the options and a recommendation as to which of the alternatives best suits the client’s needs followed by appropriate testing in XPS’s well equipped laboratories.

With our combined experience in mineral processing, pyrometallurgy, and hydrometallurgy, XPS is well suited for the detailed metallurgical testwork required for successful refractory gold processing.

FLUID BED ROASTING

Comparative testing of all three options can be carried out at bench scale at XPS using the facilities and expertise on hand. Roasting can be completed in either 2" or 4" diameter continuous fluid bed roasters, each equipped with a cyclone, afterburner for combustion of arsenic and/or sulphur vapour, condenser, and scrubber. Typically, 1-5 kg of feed is sufficient for preliminary comparative evaluation using the 2" roaster, while 20-50 kg can be sufficient for longer duration testing in the 4" roaster. Both roasters are fully instrumented with thermocouples, pressure measurements, and gas analyzers to ensure reliable data capture.



PRESSURE OXIDATION

Pressure oxidation tests are carried out in a stirred 2L Parr bench-scale autoclave, which typically handles charges of approximately 1 kg. The autoclave is constructed of titanium and can be operated with an optional glass liner. It is fully automated to measure and control the temperature and pressure within the autoclave and the gas flow into the autoclave. The process measurements are captured continuously to a PI server as for the roasters.



THE ALBION PROCESS

XPS has been engaged in metallurgical testing of ultrafine grinding for several years. We are currently in the process of installing and commissioning a bench-scale agitated leach tank to collect key metallurgical data for the evaluation of the Albion Process for a given ore or concentrate. The Albion setup at XPS comprises an M4 IsaMill to produce the ultrafinely ground ore or concentrate, followed by leaching in an agitated tank at atmospheric pressure. 15 kg of feed is required for determining the signature plot in the IsaMill, but a single Albion leach test can be carried out on 1 kg of ground material.



CYANIDATION

Having removed the deleterious elements by roasting, pressure, oxidation, or Albion

leaching, the residue from the pre-treatment stage is leached in a cyanide solution to leach out and recover the gold.

