Refractory Gold Treatment

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 reason is gold locked in sulphide, and most frequently pyrite. Another contributor to refractory behaviour is arsenic and antimony, which affects recoveries 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 solutions.

Once a 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 to improve the level of liberation. If fine grinding does not improve liberation, some form of sulphide oxidation to liberate the gold would be required. This can be accomplished by pressure oxidation (POX) in an autoclave or innovative solutions such as Albion Process™, a combination of ultrafine grinding and oxidative leaching at atmospheric pressure. Roasting – either the well-established simple dead roasting to convert pyrite to hematite while oxidizing any carbon present, or two-stage roasting to firstly remove arsenic by partial roasting followed by dead roasting can also be used in the treatment of refractory ores. Flotation can also be performed at XPS to concentrate the gold bearing minerals in advance of pre-treatment and cyanidation.

Since XPS has expertise in fine grinding, pressure hydrometallurgy and pyrometallurgy, all these skills have been bundled into a "one-stop-shop".

Here a client can receive:

- a diagnostic leach test to determine the cause of a particular ore's refractoriness;
- a comprehensive review of solutions;
- a recommendation as to which of the alternatives best suits the project needs;
- 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.

The key to curing the headache is proper diagnosis of the cause. XPS recommends QEMSCAN mineralogy, Electron Microprobe Analysis (EPMA), Laser Ablation (LA-ICP-MS) which will define the proportion of free vs refractive gold along with liberation and association data. The mineralogical data supports Diagnostic Leach results that clearly identify where the gold is in the ore by systematically destroying key minerals, followed by cyanide leaching of the residue until all of the gold has been recovered

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", 4" or 12" 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. The 12" roaster can run at 100-150 kg/hr for larger pilot tests! All roasters are fully instrumented with thermocouples, pressure measurements, and gas analyzers to ensure reliable data capture.

The Albion Process™

The Albion setup at XPS consists of an M4 IsaMill to efficiently produce the ultrafine ground ore or concentrate, followed by leaching in an agitated tank at atmospheric pressure. Fifteen kilograms of feed is required for determining the signature plot in the IsaMill, but a single Albion leach test can be carried out on as little as 1 kg of ground material. Typically, more sample is required to do a full process design. XPS works closely with Glencore Technology (GT), the inventors of

Albion Process™ to ensure their experience in testing and scale up is included in the program.

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.

Cyanidation

Having 'neutralized' the deleterious elements by roasting, pressure oxidation, or Albion leaching, the residue from the pre-treatment stage is leached in a cyanide solution and voila... the gold is recovered!

Contact Gregg Hill at gregg.hill@xps.ca for discussion on treatment of your refractory gold for maximum recovery.

PROCESS GAS ANALYSIS

One of the most revealing process streams in any smelting or processing plant is the off-gas.

GAS IS A DYNAMIC PHASE WITH VERY SHORT RESIDENCE TIMES WHEN COMPARED TO THE CONDENSED PHASES. A CHANGE IN A FEED OR CALCINE COMPOSITION MAY TAKE HOURS OR DAYS TO APPEAR IN THE ASSOCIATED SLAG AND METAL STREAMS, WHILE THE CHANGE IN THE GAS STREAM WILL OCCUR IN SECONDS OR MINUTES.

This advanced knowledge of process changes provides valuable time for corrective action. However, many smelters and process plants find that the benefits of gas analysis are outweighed by the burden of onerous maintenance and frequent calibration costs, and choose to let analytical equipment become defunct.

XPS has recently acquired experience with tunable diode lasers for gas analysis. The laser systems can be configured in either an extractive system, where sample is pulled out of the process, or as an in-situ installation, where the laser is mounted across the duct to measure the process stream itself. In-situ applications are very low maintenance with high sensitivities and zero lag. Calibration of the analytical setup is maintained by splitting the laser and continuously passing a portion of the beam (normally 5-10%) through a sealed calibration cell of known concentration.

During plant trials and audits, measuring process gas at various locations can yield invaluable information. For these applications, a portable gas analysis rig suitable to the harsh environment of a smelter is preferable to in-situ analysis.

XPS is pleased to announce that custom analytical rigs can be tailored and built to meet any need. Units are industrial rack-mounts with IP68 dust and water ingress ratings and support simultaneous analysis of 3 to 5 gases. Provisions for crane lifting and integral fork-lift channels ensure they are plant friendly and robust.

For more information on this technology or applications, contact Graeme Goodall at graeme.goodall@xps.ca