ECO REFRACTORY SOLUTIONS INC.

DMI Refractory Gold Process

Q: Why are some gold ores termed refractory?

A: A refractory gold ore is one in which the gold is not amenable to recovery by conventional cyanide methods without pre-treatment.

The two major causes of refractoriness in gold ores are ultra-fine gold particles or solid solution in the matrix of sulfide minerals and the presence of carbonaceous materials. The refractory nature can also result from either silica or sulfide encapsulation of the gold. The presence of arsenic, usually as arsenopypite with encased gold, can also cause a problem because it must be converted into a form suited for environmentally safe disposal.
There are often additional, non-refractory effects that may reduce or inhibit gold recovery. These include preg-robbing carbon and cyanicides which may remove the dissolved gold or consume cyanide.
Ores are said to be double refractory if the refractory properties are caused by both the presence of sulfides and carbonaceous matter.

Q: Why is there an increasing interest in refractory gold?

A: As new discoveries fail to keep up with the rate of depletion of conventional gold deposits, interest has heightened in previously discovered refractory gold ores which have remained undeveloped.

Between 1994 and 2009 world gold production increased by 40% from 1,677 to 2,350 tonnes but gold produced from refractory ores increased by more than 165% from 94 to over 250 tonnes, now representing above 10% of all production.

This 10% of world production has been at a high cost as methods for the recovery of refractory gold are capital-intensive, generally have high operating costs and in many cases increasing gold recovery may result in damage to the environment.

Q: Can these refractory properties be mitigated?

A: In refractory ores gold particles are in solution in the sulphide minerals and pretreatment is necessary to decompose the mineral structure to liberate gold for subsequent recovery. Carbonaceous matter, typically naturally occurring graphite, acts as a preg-robber* during cyanidation and therefore has to be eliminated or passivated before gold dissolution.

The pretreatment processes presently used on refractory ores include roasting, chlorination, pressure oxidation (autoclaving), ultrafine grinding/atmospheric oxidation (Albion Process) and bacterial oxidation.

*Preg-robbing: where the gold-cyanide complex is adsorbed on the naturally occurring carbon with the gold dissolved from the host rock being re-deposited onto the native carbon surface and lost from solution and remaining with the gangue.

Q: What is the DMI Refractory Gold Process?

A: A hydrometallurgical process designed to pre-treat gold ores and concentrates that exhibit refractory properties in order that conventional cyanidation techniques can be subsequently applied to extract a higher proportion of the gold in an environmentally friendly manner.

Q: What are the key elements of the DMI Process?

A: The DMI process was developed from earlier R&D work conducted on arsenic-bearing gold concentrates in the development of cupric-chrome arsenate (CCA) wood preservatives - an industry where the principals of DMI were a major force.

In the DMI refractory gold process the ground refractory ore or concentrate is reacted with chemicals under controlled conditions at atmospheric pressure. The leaching time is typically short compared to alternative processes. The chemicals in the leaching stage result in the oxidation of the sulfides to soluble sulfates and the solubilization of most of the iron, all of

the arsenic, antimony and bismuth leading to the liberation of the gold. Carbonaceous matter is similarly oxidized or otherwise treated.

After a solid/liquid separation step the leach residue is subjected to filtration and washing stages. The neutralized leach residue can then be treated by conventional cyanide techniques and significantly improved gold extraction rates are then the norm.

The leach solution is separately processed to reconstitute a concentrated acid for recycle to the leach process. The dissolved metals are treated to form stable compounds such as ferric arsenate that can be safely stored or co-deposited with non-acid generating tailings in an environmentally acceptable state.

DMI and its associated companies hold several patents on the required technologies and possess a wide range of experience and trade secrets related to the processes described.

Q: Are there examples of this technology in current use?

A: There are no examples of the DMI refractory gold process currently in operation. However similar DMI technology has been used in several industrial plants in the U.S. covering a range of applications.

Q: What are the principal advantages of the DMI process ?

A: The DMI process is conducted at atmospheric pressure and only a moderate temperature and inexpensive equipment is required compared to the high pressure of autoclaving or the high temperatures of roasting.

The ore or concentrate typically does not require extremely fine grinding as is practiced in the Isamill grinding stage, part of the Albion Process.

The chemicals used in the leaching process are reconstituted and recycled resulting in an extremely low level of make-up requirements.

Capital and operating costs of the DMI process in conjunction with high gold recoveries are projected to offer a superior return for most projects compared to the application of alternative processes.

The DMI process results in the dissolution of iron and other sulfides to form sulfates and arsenates which are neutralized and precipitated in long term stable forms, reducing or eliminating the risks and possible costs associated with potential acid mine drainage from these wastes.