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GOLD EXTRACTION FROM TAILINGS USING MODIFIED ISR TECHNOLOGY

By

Tim Graham

Atom Minerals, Australia

Presenter and Corresponding Author

Tim Graham

ABSTRACT

Over the last sixty years, In-Situ Recovery (ISR) of water-soluble compounds, including potash, halite, sodium sulphate and acid-soluble minerals, such as uranium and copper, have become low-cost and well-established mineral extraction processes. The key initiatives driving this development include continuous improvement of production processes, lower capital costs than competing technologies and reduced environmental footprints. Unfortunately, ISR can only be successfully applied within a narrow range of conditions, principally defined by the ore body's geophysical properties and chemical properties of both solvent and solute.

For ISR to function, ore needs to be sufficiently permeable to allow solvent mass transfer and solvation to occur, and an impermeable layer of material beneath the ore is required to prevent solution leakage. These conditions are present in some copper, uranium, potash and salt deposits, but are rare in gold ore bodies. Whilst the solvent used in extracting uranium, copper and salts is non-toxic but may be acidic, alkaline or neutral (e.g., water), gold generally requires sodium cyanide to achieve dissolution.

There are two key issues associated with cyanide lixiviants. Firstly, cyanide is almost universally used as the lixiviant of choice due to its effectiveness and comparatively low cost. However, cyanide and its derivatives, such as hydrogen cyanide gas (HCN), are extremely toxic and potentially lethal compounds, which are strictly regulated and controlled. Secondly, the process of recapturing cyanide for reuse is expensive and usually omitted in favour of detoxification after an adsorption process.

From an environmental standpoint, ISR processes using toxic solvents or lixiviants are generally prohibited due to the risks of leakage or percolation into a water table. From a commercial perspective, seepage of a loaded lixiviant represents permanently unrecoverable gold. Both issues highlight the essential properties of a "green" lixiviant: Non-toxicity and maximum recovery.

The development of various non-toxic or low toxicity lixiviants has been widely researched and reported over the last two decades with various levels of efficiency implied. However, the lack of adoption by the mainstream gold production industry indicates issues with either technical performance, cost or product knowledge dissemination. Whilst a lixiviant with a lower recovery than cyanide is likely to be commercially unacceptable, higher initial cost would be mitigated if a high percentage were able to be recovered and reused.

The non-toxic requirement of the proposed Modified ISR method is addressed by using an iodide-based lixiviant patented by Enviromental Technologies Inc. of Vancouver, Canada, which has shown promising gold recovery, leach kinetics and minimal losses.

The term "Modified ISR" refers to a specially designed modular plant being located and operated adjacent to a tailings resource, rather than in a genuine in situ configuration. The plant is designed to produce a clear pregnant leach solution (PLS), which is adsorbed onto selective ion-exchange resins (IXRs) and is therefore substantially different from conventional slurry leach or pulp circuits.

There are several benefits arising from a clear liquor system. Firstly, plant footprint is lower than similar capacity CIL or CIP circuits which require trains of agitated adsorption tanks. Secondly, clear liquor and IX resin beads are easily separated by a simple countercurrent flow and screening arrangement enabling barren solution to be returned to the leaching stage. Thirdly, the gold stripping elution process from loaded resin can be performed at ambient temperature and pressure. In addition, a filter press stage, which washes and captures lixiviant from wet solids, produces tailings that can be dry stacked rather than dumped wet into a TSF.

The overarching goal of Modified ISR is to create a non-toxic, flexible, efficient and sustainable solution, which is easily moved to multiple resources with minimal set up time, lower costs and reduced permitting.

Keywords: Non-toxic, Modified In Situ Recovery, hydrogen cyanide gas, lixiviant, iodide, clear liquor, Enviromental Technologies Inc., Pregnant Leach Solution, Ion Exchange Resins