NEW PLAYERS IN COPPER CONCENTRATES HYDROMET

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Some new players have joined the list of hydromet processes for copper sulphide concentrates. A key driving force is increasing industry concerns in the transporting and smelting of concentrates with high impurity levels, especially arsenic. This has led some to focus on removal of impurities rather than total hydromet processing.

Impurity Removal Processes

NONOX Process

The process utilises a combination of copper metathesis and hydrothermal leach mechanisms to remove or reduce impurities from copper sulphide concentrates while significantly upgrading the copper content. Chalcopyrite and bornite minerals are reacted with copper sulphate which displaces iron and produces chalcocite/digenite. Covellite also reacts to form chalcocite/digenite. The result is a copper in concentrate of 50-60% together with the gold. The iron passes into solution accompanied by other impurities such as cobalt, nickel, zinc, lead, bismuth, thorium and its daughter products, and uranium and its daughter products. The process can be carried out in sulphate or sulphate-chloride media. The latter is reported to be more suitable for the mobilisation of impurities[(1)] and is subject to patent application[(2)].

The upgrading process is carried out in an autoclave in a non-oxidative (NONOX) environment) at 180-220°C. The discharge slurry is filtered to separate upgraded concentrate from the spent leach solution which is neutralised for disposal. Consideration could be given to recovering potentially valuable impurities such as uranium. Copper sulphate solution is typically generated by treating a portion of the upgraded concentrate in a pressure-ox autoclave. The chalcocite/digenite is converted to copper sulphate and the gold reports to the residue. The discharge slurry is fed to the NONOX autoclave. Alternatively, copper sulphate could be produced by processing oxide ore or tailings by leach-SX-EW.

Oz Minerals are conducting a PFS for a NONOX type facility as part of their Carrapateena project in South Australia with a view to establishing a commercial operation in 2019[(3)]. Successful pilot and demonstration plant campaigns and smelter trial tests have been carried out. Incentives include significant freight savings, long term protection from penalties and competitive market advantage.

Toowong Process

The Towong Process is being developed by Core Resources, Brisbane, Australia. It is a patented alkaline leach process for the removal of arsenic, antimony and other penalty elements from copper, lead and nickel sulphide concentrates, and antimony from gold concentrates. The flowsheet consists of an atmospheric tank caustic leach followed by filtration and washing of the cleaned concentrate. The filtrate is treated in a pressure oxidation autoclave and any gold and antimony is precipitated, after which arsenic is precipitated from the solution in a disposable form. The final solution is concentrated by evaporation and recycled to leach.

The process was successfully piloted in small and larger facilities in 2011 and 2012 which achieved >90% arsenic removal from concentrates containing 1.1% As. Claimed advantages versus existing alkaline leaching technology include nil to low sodium sulphide addition, low polysulphides, low sulphate bleed, and low gold dissolution from the concentrate[4]. Further development work and engineering studies are envisaged progressing towards commercialisation assisted by a licenced early adopter of the process with a suitable project.

Total Leaching Processes

ROL Process

The FLSmidth® Rapid Oxidative Leach (ROL) Process is being developed by FLSmidth in USA. It utilises a series of stirred media reactors (SMRt) in tandem with conventional agitated leach tanks with ferric sulphate lixiviant and oxygen sparging at 80°C. Copper recovery of 97-99% is achieved in about six hours for chalcopyrite concentrates and 12 hours for enargite[5]. The inter-stage placement of the SMRt reactors, gives the advantages of mechano-chemical activation and surface cleaning with only a minimal addition to base-line processing costs. Leaching is followed by solid/liquid separation and SXEW for copper recovery. The patented process is said to cost effectively overcome the slow leach kinetics and poor copper recoveries commonly experienced with ferric sulphate leaching due to surface passivation issues. Tests indicate about 68% of the sulphur reports as elemental to the residue with the remainder as sulphate. Gold reports to the residue.

It was announced in February 2016[6] that a pilot plant facility is being built onsite at FLSmidth's Minerals division headquarters located in Salt Lake City. Also, they have signed a joint R&D agreement with BASF to expedite commercialisation. BASF will focus on innovative SX extractants with high degradation resistance and increased copper selectivity.

GlyLeach™ Process

The GlyLeach™ Process, under development at Curtin University, Australia, is an alkaline-based process utilising glycine, a non-toxic, non-corrosive, environmentally benign amino acid for leaching copper, gold and silver from primary copper sulphide concentrates as well as secondary sulphide, mixed and oxide ores. The flowsheet typically includes ultrafine grinding, pre-oxidation with oxygen, atmospheric tank leaching at <100°C, and solid liquid separation. Copper is recovered from the solution by SX/EW (or sulphide precipitation), followed by pH adjustment and precipitation of silicates/carbonates with lime, then gold recovery in carbon columns before recycling to leach[7].

Other than losses in leach residues, the glycine is recovered and recycled for leaching. Caustic make-up is added to pre-oxidation and glycine make-up to leach. Tests indicate that over 90% copper recovery can be achieved in 17 hours. Iron dissolution is insignificant in the pregnant leach solution. Iron in pyrite is unaffected, whereas iron in chalcopyrite is precipitated as a readily a filterable iron hydroxide. No elemental sulphur is formed. The process is particularly suitable for ores containing acid-consuming gangue, concentrates with high arsenic or halide contents and for copper-gold ores with significant sulfide mineralisation. Further optimisation work and improvement work is planned, leading to a pilot scale program. An exclusive license has been signed with Mining and Process Solutions, Perth, Australia.

While hydromet has yet to make a significant inroad into the dominance of smelting, the impurities issue may well open the door wider. Also, the lower cost and reduced risk of impurity removal processes may provide added incentive.

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For more information on hydromet processes for copper sulphide concentrates, see ALTA Short Course *A-Z of Copper Ore Leaching* available from Publications

MetBytes are metallurgical commentary and insights written by Alan Taylor who has 40+ years' experience in the metallurgical, mineral and chemical processing industries. He has worked in metallurgical consulting, project development, engineering/construction, plant operations, plant start-up and technology development. Projects and studies have involved copper, gold/silver, nickel/cobalt, uranium, base metals, phosphates and alumina.

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