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Superior and Sustainable Metals Production

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INTEC LATERITE PROCESS

PROCESS DESCRIPTION

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1.0 Introduction

The Intec Laterite Process (ILP) has been developed as a halide-based alternative for the recovery of nickel and associated by-products from lateritic deposits. The development of such deposits is generally by way of pressure acid leach (PAL) or high pressure acid leaching (HPAL).

The ILP uses the chloride medium, which is relatively novel when compared with the conventional sulphate medium for PAL and HPAL. The main advantage of the chloride medium is the ability to operate a leach at atmospheric pressure. This approach is the essence of the Atmospheric Acid Leach (AAL) (Jaguar Nickel), which relies on pyrohydrolysis to recover HCl for leaching and MgO for liquor purification.

Alternatively, the ILP is based on the input of H₂SO₄ for leaching and calcium based alkali for purification, which eliminates the need for pyrohydrolysis. The ILP process is thus not constrained in the types of halide salts that can be used. In this respect NaCl is a more cost effective source of chloride ion, whilst NaBr can be used to enhance the complexing of precious metals (Au, Ag, Pt, etc). Conditions in the ILP leach are conducive to haematite precipitation as practiced in the Intec Copper Process. In particular, the temperature is in the range of 95 to 105°C, pH 0-1, residence time >10hours, Eh is controlled at ~600mV (versus Ag/AgCl) by air addition and total chloride is in the range of 6 to 8M.

2.0 Process Flowsheet and Chemistry

The ILP consists of the two main circuits of leach and purification as shown in Figure 1.

Leach

The leach configuration and conditions depend on:

- the mineralogy of the lateritic material; and
- the relationship between acid consumption and metal extraction.

In Figure 1, a countercurrent two-stage leach is shown, which benefits H₂SO₄ consumption as compared to a single stage leach. The actual configuration used depends on the degree of this benefit as compared to the added complexity of the countercurrent arrangement.

The electrolyte for leaching depends on the mineralogy of the material, in particular the types and quantities of contained acid consumers. Firstly a minimum of 30g/l of CaCl₂ is maintained in the leach to suppress jarosite formation in turn optimising iron precipitation as haematite.

The preferred source of chloride is NaCl due to its low cost, but when the laterite contains high levels of Mg, then MgCl₂ is used to suppress Mg extraction in order to minimise H₂SO₄ demand. The actual H₂SO₄ demand is a compromise between its cost and the value of extracted metals.

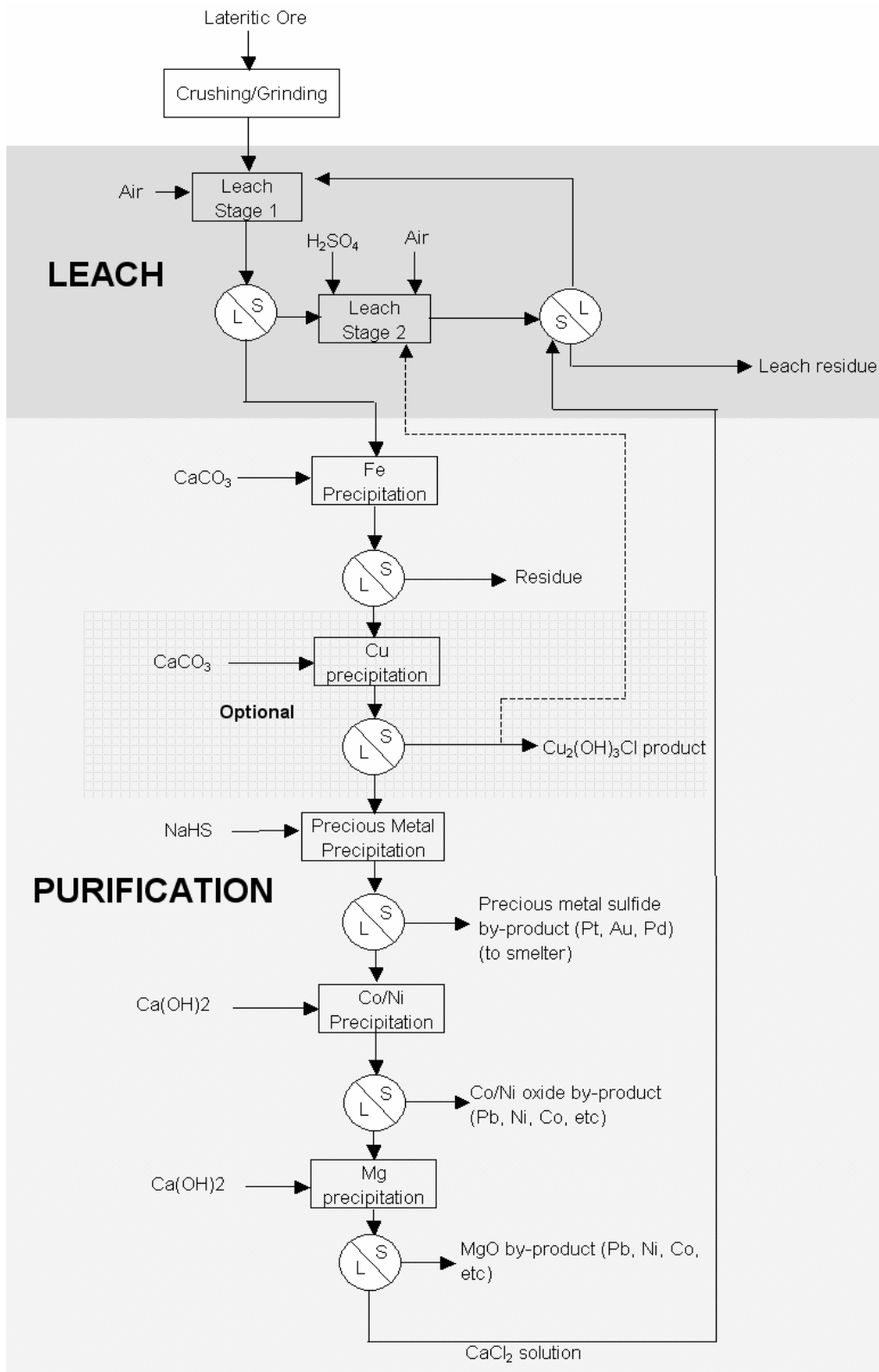
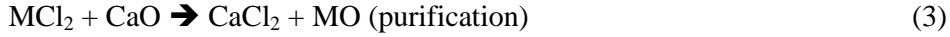
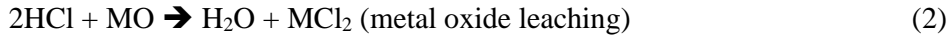
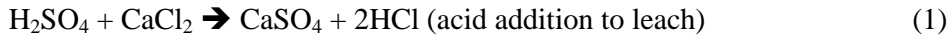


Figure 1: Block diagram of unit operations for the Intec Laterite Process.

The level of CaCl₂ in the incoming leach liquor is equivalent to the H₂SO₄ demand according to the following mechanism:



Thus the higher the overall metal leached the greater the background of CaCl₂, due to the increased addition of acid to the leach and alkali in purification.

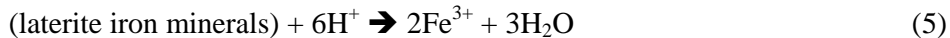
The option exists to add NaBr to the background electrolyte where high levels of precious metals exist in the feed. Bromide is a stronger complex than chloride in terms of its ability to stabilise the precious metal ions in solution.

An important aspect of the leach is to maximise the rejection of iron as haematite (Fe₂O₃). The formation of goethite (α-FeOOH) and akagenite (β-FeOOH) in the chloride medium is well understood, but over time the FeOOH undergoes dehydration to haematite according to the reaction:



In the Intec Copper Process haematite is the main form of iron oxide generated. This has been attributed to the high residence time at > 10 hours, the relatively high temperature at >85°C, the desiccating effect of the chloride medium and the availability of seed particles in a continuous leach.

Another important aspect of the process is to minimize the consumption of H₂SO₄ and consequently CaCO₄. This is achieved through the dehydration reaction (4) described above. Haematite (Fe₂O₃) is a significantly more stable form of iron oxide than goethite or the various forms found in laterite ores. The transformation of lateritic iron minerals through goethite to haematite has no net consumption of acid as shown by the reactions below:



Acid consumption can be very significantly reduced by this route, and consequently, process economics are significantly improved.

Air can be added to the leach if required to maximise iron precipitation by ensuring any reduced species such as FeO are oxidised to Fe₂O₃ as per the reaction:



The rate of air addition is controlled to maintain the Eh at ~600mV (versus Ag/AgCl). Further, there exists the possibility of adding copper into the electrolyte as the

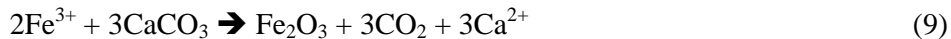
$\text{Cu}^+/\text{Cu}^{2+}$ oxidation couple is more effective than the $\text{Fe}^{2+}/\text{Fe}^{3+}$ couple in the uptake of oxygen.

The residue generated from the leach is firstly washed with brine from the purification circuit to displace valuable metal ions from the interstitial liquor. Subsequently a countercurrent washing regime is used to minimise wash water, which ultimately must be evaporated from the liquor through the input of heat.

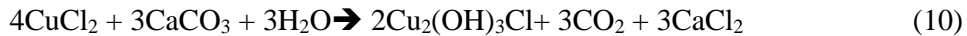
Purification

Purification in Figure 1 is based on precipitation with the calcium based alkalis of CaCO_3 and $\text{Ca}(\text{OH})_2$. An alternative to precipitation could be solvent extraction (or ion exchange) where the various metal cations are extracted in the process, replenishing the solution with acid (H^+). The choice of purification is a trade off between the cost of solvent extraction and its increased complexity versus the reduced acid demand and the possibly higher value of products generated.

In the alkali precipitation route iron is the first to be precipitated at pH 2 with the addition of limestone according to the reaction:



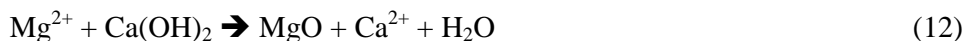
Subsequently, copper is precipitated at pH3 to 4 with the addition of limestone according to the reaction:



Precious metal extraction, where required, is via NaHS addition and is followed by precipitation of the remaining base metal ions with slaked lime addition according to the reaction:



In the final precipitation step magnesium is precipitated by slake lime addition according to the reaction:



The CaCl_2 rich liquor remaining is returned to the leach as the first washing step for the leach residue.