

Superior and Sustainable Metals Production

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The Intec Zinc Process (IZP)

1. Technology Description

The Intec Zinc Process is a patented hydrometallurgical process for the production of high purity zinc metal and associated by-products from metallurgically complex sulphide concentrates.

The process is based on the same chemistry as the Intec Copper Process, producing high purity zinc from a purified chloride-bromide electrolyte of slightly different composition to that of the Intec Copper Process. During electrowinning, the same mixed halide species BrCl_2^- (Halex™), that is integral to the Intec Copper Process, is generated in solution at the anode and exhibits powerful leaching characteristics capable of directly leaching the sulphide concentrate feed. The need to roast the concentrate prior to leaching, as is practised in the conventional Roast/Leach/Electrowin (RLE) process, is thus eliminated whilst a range of by-products (notably lead, copper and precious metals) can be extracted in the simple, single-stage leach.

With the exception of the single-stage leach, the Intec Zinc Process resembles in concept the hydrometallurgical processes employed in the sulphate medium for the treatment of the calcine product from roasting. In particular, the purification step in the Intec Zinc Process relies heavily on cementation, whilst zinc is electrowon in the form of plate.

Description of the Intec Zinc Process

The Intec Zinc Process consists of the three consecutive circuits of leaching, purification and electrowinning, and is shown in the simplified flow diagram presented in Figure 1. The leach circuit is of single stage configuration with a series of reactors to which concentrate and lixiviant are fed. Purification consists of cementation and precipitation by pH adjustment. Electrowinning employs an electrolytic cell very similar in design to that of the Intec Copper Process, but differs in that a conventional plate cathode is produced.

Zinc metal is electrowon from purified electrolyte, which has a composition of 100 gpl zinc, 50 gpl sodium chloride (common salt, NaCl), 50gpl calcium chloride (CaCl_2) and 110 gpl sodium bromide (NaBr). All other constituents, which include 'equilibrium' levels of many other elements (manganese, magnesium, etc.), are regarded as impurities. Through the passage of an electric current at a density of 500 A/m² of electrode area, high purity zinc is formed on the negatively charged cathode. The feed electrolyte zinc tenor is depleted from 100 gpl to 50 gpl, which is the steady state concentration of the cell.

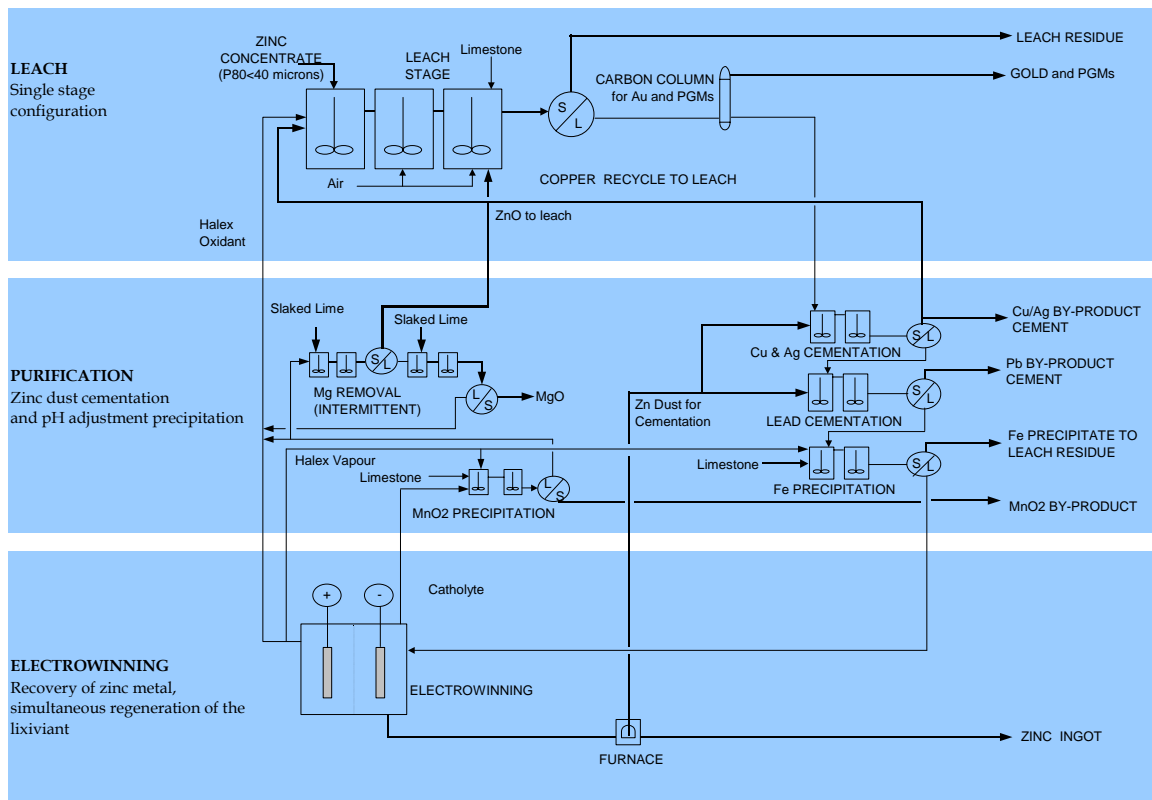


Figure 1 - The Intec Zinc Process Simplified Flow Diagram

The Lixiviant

The spent catholyte continuously permeates through a woven cloth membrane to the positively charged electrode (anode). In a totally chloride medium, the anode reaction is the oxidation of chloride ion to form chlorine gas. However, because of the presence of both chloride (Cl⁻) and bromide (Br⁻) in solution, there is a preferential formation of the halogen species BrCl₂⁻ (referred to by its generic name of Halex™). Halex can be considered as a chlorine molecule held in solution by a bromide ion.

This electrolyte is now a very powerful lixiviant at an oxidising potential (Eh) of 1,000 mV (vs Ag/AgCl). It is this lixiviant that is used for the leaching of the zinc concentrate feed.

Leaching and Purification

Finely ground zinc concentrate (P80 of 40 microns) and lixiviant are fed to the single stage leach, which operates at a temperature of 85°C and atmospheric pressure. Reaction initially proceeds without air sparging (aeration) until all hallex oxidant (BrCl₂⁻) is consumed. Significant iron dissolution occurs in this initial reaction step and aeration is subsequently initiated to precipitate iron into the leach residue as haematite. Recycled copper cement from the first stage purification is added to the aeration leach to enhance both oxygen uptake and metal extraction. When leaching is complete, limestone is added to reject any residual iron remaining in solution.

Finally the leach residue is separated from the zinc-rich liquor by filtration and washed before disposal to landfill.

The zinc-rich liquor is first passed through a series of columns containing activated carbon, onto which precious metals are adsorbed. From the columns, the liquor is purified via a cementation reaction with zinc dust reagent which is produced on-site from molten zinc. This is a two-stage operation with copper and silver predominantly removed in the first stage. In the second stage, excess zinc dust is added to remove remaining impurities such as cadmium, lead, nickel, cobalt, thallium, etc.

To the now relatively pure liquor, a small amount of cell anolyte is added until an Eh of 700mV is achieved. This ensures any remaining iron is oxidised to the ferric (Fe³⁺) oxidation state. The subsequent addition of ground limestone to raise the pH to 4.5 precipitates most remaining impurities (eg. bismuth, iron, indium, etc.). These precipitates are removed by filtration and are either discarded or reprocessed to recover economic by-products such as indium. The few impurities that remain do not contaminate the zinc product during electrowinning and are removed in either the manganese or magnesium purification circuits. These circuits treat spent catholyte from electrowinning using limestone and hallex in the manganese circuit and slaked lime in the magnesium circuit.

The purified zinc-rich liquor is electrolysed as described earlier, to produce high purity zinc metal

and to regenerate the lixiviant for recycle to the leach. Zinc product is washed and dried prior to melting in a furnace and conversion to ingot for sale.

2. Economic Advantages

The most compelling advantage of the Intec Zinc Process is its economic superiority over the conventional RLE technology used throughout the world for the production of zinc metal, as shown in Figures 2 and 3. The estimates contained in these figures have been generated from an internal Intec database. The estimates are to an accuracy of $\pm 30\%$ and have been determined based on the following key assumptions:

- a plant capacity of 200,000 tpa-Zn
- the treatment of a 50% Zn concentrate feed; and
- a power cost of 5US¢/kWh.

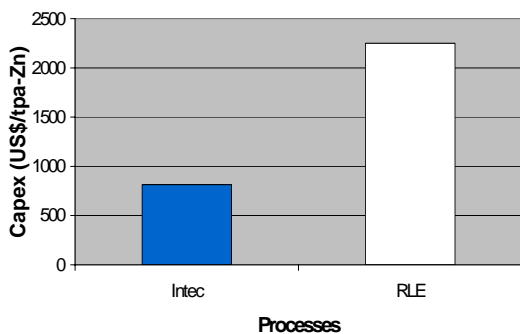


Figure 2 - Comparison of capital costs at 200,000tpa-Zn plant capacity.

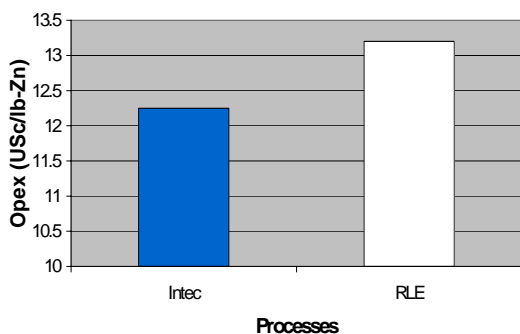


Figure 3 - Comparison of operating costs at 200,000tpa-Zn plant capacity.

The significant capital cost advantage of the Intec Zinc Process is principally due to the elimination of the roasting step. For example, Korea Zinc's 170,000tpa-Zn refinery in Townsville, Queensland was completed at a cost of approximately US\$425 million in 1999. This corresponds to US\$2,500 per annual tonne of capacity.

In addition, the economics of the Intec Zinc Process remain robust at plant capacities significantly lower than that required for RLE operations. Therefore,

the potential to locate metal production at the mine site is greatly enhanced. However, as the cost of electrical energy constitutes about 70% of the operating cost of the Intec Zinc Process (at a unit cost of 5US¢/kWh), plant location will be influenced by, among other factors, the trade-off between energy costs and concentrate transportation costs. Figures 4 and 5 detail capital and operating cost estimates for a range of Intec Zinc Process plant capacities.

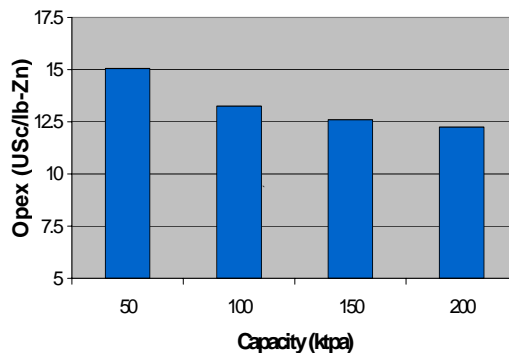


Figure 4 - Effect of plant size on the operating cost of the Intec Zinc Process.

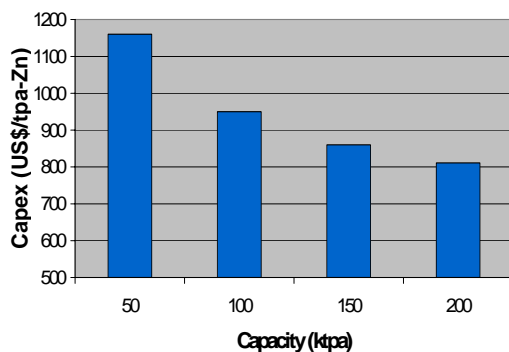


Figure 5 - Effect of plant size on the capital cost of the Intec Zinc Process.

3. Environmental Advantages

The Intec Zinc Process is inherently environmentally sustainable because it is based on a non-toxic brine lixiviant.

No Liquid Effluent

Heat is provided by the exothermic leach reactions coupled with the addition of air to the leach. This results in the evaporation of water which maintains the water balance neutral, so that no liquid effluent is generated.

Benign Gaseous Emissions

Only benign gases in the form of spent air and water vapour are produced.

This is in stark contrast to conventional roasting where large quantities of sulphur dioxide (SO₂) and

other noxious substances such as mercury are generated in off-gases. The capture of these substances is never complete and thus contamination of the surrounding environment at least to some degree is an unavoidable consequence.

Stable Solids Residue

An extremely important feature of the Intec Zinc Process is that all impurities including mercury and arsenic are either recovered as saleable by-products or stabilised in solid form for disposal.

The residue generated by the leach process consists of gangue minerals, plus chemically generated elemental sulphur and haematite. The electrolyte composition inhibits the formation of jarosite.

If commercially desirable, the sulphur can be separated from the residue, whilst the haematite, a stable iron oxide, is known to stabilise heavy metals.

Arsenic from the concentrate feed is stabilised in the residue as ferro-arsenate.

The residue produced is similar to that generated by the Intec Copper Process, which proved suitable for landfill. Operations at the Intec Copper demonstration plant saw all of the residues pass the NSW EPA's TCLP test for solid wastes, with the majority passing inert waste classification.

Lower Energy Consumption

The elimination of the roasting step is the main contribution to lower energy consumption in the Intec Zinc Process when compared with RLE.

A further advantage of the Intec Zinc Process is the higher metal recoveries for zinc and by-products by comparison with an RLE operation. The higher recoveries result in reduced energy consumption per unit of zinc equivalent produced.

For both the Intec Zinc Process and RLE, electrowinning is the most energy intensive process component. Electrowinning at 500A/m² in the Intec halide medium consumes 3,000kWh/t-Zn compared to 3,250kWh/t-Zn in the conventional sulphate medium.

4. Intec Zinc Process Development

Because about 85% of plant equipment is common to both Intec's copper and zinc technologies, the latter received a very substantial impetus from the successful operation of the Intec Copper demonstration plant.

Bench scale testwork and the operation of a prototype zinc electrowinning cell were then successfully undertaken at Intec's laboratories. A locked-cycle batch-processing zinc pilot plant was then designed, constructed, commissioned and successfully operated.

Nonetheless, because the Intec Zinc Process has not been trialled continuously at demonstration plant scale, the Directors consider that it will be necessary to do so prior to commercial application.

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