

**Development of the  
Intec Nickel Process  
to  
treat low-grade  
Ni/Cu/Co/PGM concentrate**

**Frank Houllis, Process Development Manager  
Intec Ltd  
20 May 2003**

## **1. Intec Copper Process**

- **Operation of 350tpa demonstration plant**
- **Commercially available**
- **Difficult competitive environment**

## **2. Metallurgically Complex Base/Precious Metal Projects**

- **Tailored process approach**
- **Target optimal economic value**

## **1. Hydrometallurgy**

- **Low grade bulk concentrate**
- **Viability at smaller scale**

## **2. Mixed halide approach**

- **Leach (<105°C, 1 atm and air)**
- **Purification (precipitation/cementation)**
- **Electrowinning (halex™ soluble oxidant)**

## 1. Concentrate Characterisation

- **Mineralogy and elemental composition**

## 2. Process Flowsheet

- **Set criteria (literature review and past experience)**
- **Mathematical model (METSIM)**

## 3. Laboratory Validation

- **Equipment selection to define process parameters**
- **Iteration with flowsheet development**

## Low Grade Ni/Cu/Co/PGM Concentrate

Intec Group

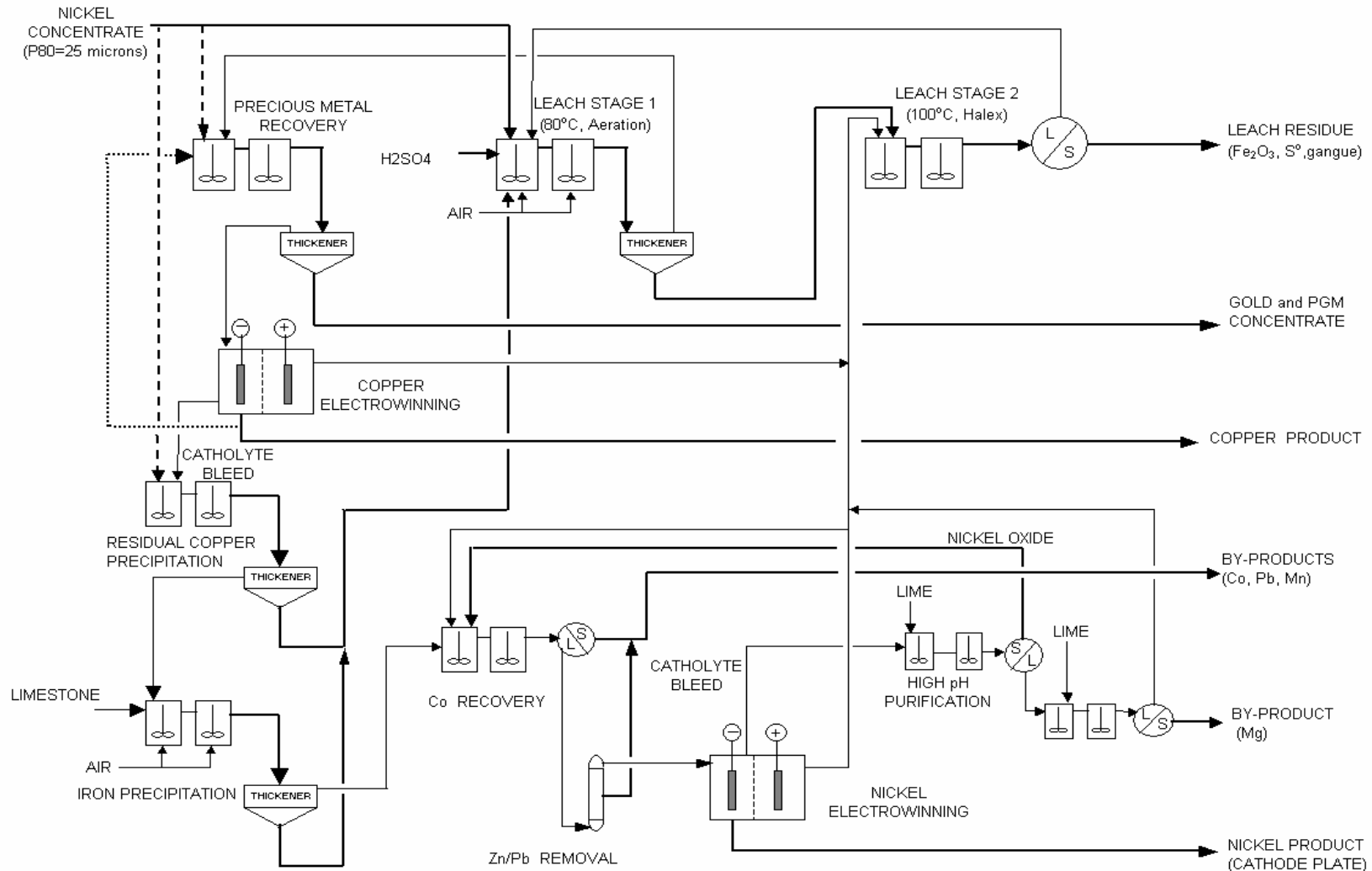
Element	%	Element	ppm
Ni	3.23	Co	1230
Cu	2.03	Au	0.76
Fe	27.6	Pt	3.97
S	17.4	Pd	3.93

Elemental Analysis of Concentrate

- Pentlandite and chalcopyrite
- One-third pyrrhotite

# Intec Nickel Process for treating low grade Ni/Cu/Co/PGM concentrate

Intec Group



## Two Stage Countercurrent Leach

- Mild Operating Conditions (85-100°C, 1 atm).
- Single pass leach for Ni, Cu, Co and PMs (Pt, Pd, Au).

## Purification (By-products)

- PMs (High grade sulfide intermediate ).
- Copper electrowinning (as dendrites 99.9% purity).
- Cu and Fe (precipitation products recycled to leach).
- Cobalt (precipitated as oxide product).
- Zn and Pb (ion exchange to recover oxide product)

## Nickel Electrowinning

- LME Grade A purity cathode plate.

# Experimental Results

## 2-Stage Countercurrent Atmospheric Leach

Intec Group

### Aeration Leach (Ni, Cu, Co)

- Pyrrhotite ( $\downarrow$  Eh), feed input to maintain 500mV Eh
- $O_2$  ( $\uparrow$  Eh) to regenerate  $Cu^+/Cu^{2+}$  &  $Fe^{2+}/Fe^{3+}$
- Mild temp. (80-85°C) and air ( $O_2$ ) at 1 atm. pressure

### Halex Leach (Pt, Pd, Au)

- Halex oxidant (Eh > 650mV), Temp. (100°C),
- $[Cl^-]$  increased during program

# Leach Parameters

Intec Group

## Aeration Leach

- 15 litre lab-scale test
- Retention time dominated by high pyrrhotite content
- Oxygen uptake at 28% at lab-scale

## Halex Leach

- 15 litre bench scale test
- 8h retention time
- Filtration rate 170 l/m<sup>2</sup>/h

## Leach Results

Intec Group

Element	% Metal Extraction
Au	87
Pt	54
Pd	86
Ni	98
Cu	99
Co	98

### Metal extractions achieved

- 89% of metal value extracted
- High base metal extraction
- <0.1ppm Au and <0.5ppm Pd in residue
- Pt extraction improved from 16% to 54% during program

## Precipitation of Intermediate PM Product

- Add copper ( $\downarrow$ Eh) and concentrate (S for precip.)
- $\text{Cu}^{2+} \rightarrow \text{Cu}^+$  for Cu EW
- 180ppm Intermediate PM product (Pt, Pd and Au)

## Cu Electrowinning

- 250 A/m<sup>2</sup>, 10g/l Cu in catholyte
- 97ppm Ni and 62ppm Fe
- Refining of Cu product required

## Precipitation of Cu

- Metathesis reaction
- $\text{FeS} + 2\text{Cu}^+ \rightarrow \text{Cu}_2\text{S} + \text{Fe}^{2+}$
- 21% Cu product recycled to aeration leach

## Precipitation of Fe

- Air to oxidise  $\text{Fe}^{2+} \rightarrow \text{Fe}^{3+}$
- Halex plus  $\text{CaCO}_3$  to  $\downarrow \text{Fe} < 0.5\text{g/l}$
- Iron precipitate recycled to halex leach

## Precipitation of Co

- Halex and  $\text{Ca}(\text{OH})_2$  to  $\downarrow\text{Co} < 5\text{ppm}$
- Solvent Extraction alternative
- 4% Co product

## Ion Exchange of Zn/Pb

- Literature
- Future program

# Ni Electrowinning

Intec Group

- 15g/l strip, 50g/l catholyte [Ni]
- 55°C, 300A/m<sup>2</sup>, plate product
- 2.3V cell voltage, 95% current efficiency
- Energy consumption 2250 kWh/t-Ni

Element	Bi	C	Co	Cu	Fe	Mn	Pb	S	Sb	Si	Zn
LME Spec. (ppm)	50	300	1500	200	200	50	<b>50</b>	100	50	10	<b>50</b>
Nickel cathode assay (ppm)	0.3	<100	45	143	90	<1	<b>65</b>	25	<1	<10	<b>615</b>

**Nickel cathode assay**

- Chemistry of main unit operations validated
- First pass at design data
- Areas requiring further work are platinum extraction and Pb & Zn department
- Scope for further optimisation

# Development Status

---

Intec Group

- Process concept developed
- Process viability demonstrated at lab scale
- 3 month program,
- cost < A\$100,000 (leveraged off 10yr ICP development)

# Preliminary Cost estimation

- Completed Experimental Program
- Metsim Mathematical Model
- Intec Copper plant feasibility study ( $\pm 15\%$ )
- North American labour rates
- H<sub>2</sub>SO<sub>4</sub> cost input: US\$120/t
- Power: 3.5 US¢/kWh
- 20% contingency

# Estimated Costs

---

Intec Group

- Operating Cost: US\$0.45/lb-Ni
- Capital Cost: US\$6500/tpa-Ni
- $\pm 35\%$
- Exclusive of by-product credits

- Concept for Intec Nickel Process has been developed
- Process refinement and optimisation required before pilot plant phase
- Attractive economics (no smelter, oxygen plant)
- Ability to treat low grade and complex feed (optimise recovery)

# Contact Intec Ltd

**Intec Group**

**Philip R. Wood**

*Managing Director and CEO*

Intec Ltd

Gordon Chiu Building, J01

Department of Chemical Engineering

Maze Crescent, University of Sydney

NSW 2006 AUSTRALIA

Tel: +61-2-9351-6741

Fax: +61-2-9351-7180

Email: [philip@intec.com.au](mailto:philip@intec.com.au)

Web: [www.intec.com.au](http://www.intec.com.au)

