Expanding Sulphide Use for Metal Recovery from Mine Water

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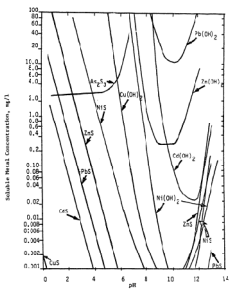
Introduction: Sulphide Precipitation - Current Practise

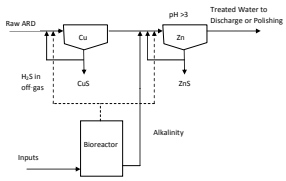
- Effective metal removal
- High reagent and handling costs
- Limited current use:
  - Difficult metals (e.g. Cd removal)
  - High value (e.g. Ni recovery)
  - Specialized hydromet uses (e.g. Ni-Co separation)
- Increasing operating experience
  - Separation of metals
  - Solid-liquid separation



Kemetco Research - Biometals Process

- Developing a new approach to biogenic sulphide generation
  - Low cost reagents
  - Operating efficiencies
  - Product/by-product values
  - Stage 2 laboratory development underway
  - Patenting in process
- Objective: Very low net-cost reagent sulphide
  - Expanding scope of feasible applications
- Testing for old and new applications
  - Individual metal recovery from ARD
  - Sequential recovery from complex drainage
  - New hydrometallurgical applications
- First site pilots in planning stage

Sulphide Treatment Flowsheet 1



- Weak ARD with high flow
- Cu, Zn and Cd main contaminants of concern

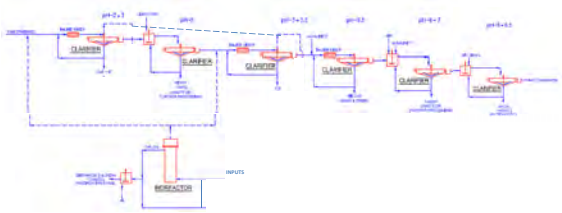
Flowsheet 1 – Laboratory Results

Sample	Flow (m^3/day)	pH	Cu (mg/L)	Zn (mg/L)	Co (mg/L)	Ni (mg/L)	Cd (mg/L)	Al (mg/L)	Fe (mg/L)	Mn (mg/L)
Flowsheet 1 Feed	12,000	4.3	14.3	17.8	<0.1	<0.1	0.09	13.3	0.4	3.65

Stage	pH	Reagents Added	Bio-alkalinity (g/l)	Cu (%)	Zn (%)	Cd (%)	Al (%)
Feed	4.3	-	-	0	0	0	0
Copper Recovery	3.7	H_2S	-	98	0	56	0
Zinc Recovery	4.0	H_2S/alk.	3.7	100	98	100	5
pH Adjustment	6.2	alkalinity	70.4	100	100	100	98

- Eliminates lime use and minimizes waste sludge generation
  - Biological alkalinity sufficient for pH control
- Metal products off-set other operating costs
  - Cu product up to 56% Cu produced in lab work
  - Product value of $700/day net of process inputs

Sulphide Treatment Flowsheet 2



- Highly acidic ARD with high metal loading
- High levels of low-value metals in addition to Cu, Zn and minor Ni, Co
- Significant ferric component and high sulphate

Flowsheet 2 – Laboratory Results

Sample	Flow (m^3/day)	pH	Cu (mg/L)	Zn (mg/L)	Co (mg/L)	Ni (mg/L)	Cd (mg/L)	Al (mg/L)	Fe (mg/L)	Mn (mg/L)
Sample B – High Strength	2,500	2.7	67	181	4.65	9.68	1.37	950	872	184

Stage	pH	Reagent Added	Addition (g/l)	Cu (%)	Zn (%)	Co (%)	Ni (%)	Cd (%)	Al (%)	Fe (%)	Mn (%)
Feed	2.5	-	-	0	0	0	0	0	0	0	0
Copper Recovery	2.3	H_2S	-	100	0	0	0	100	0	0	0
Al/$CaSO_4$ Removal	4.9	$CaCO_3$	5.1	100	8	0	0	100	98	0	1
Zinc Recovery	3.2	H_2S	-	100	97	0	0	100	97	10	1
Ni-Co Recovery	4.6	$CaCO_3$/ H_2S	0.3	100	100	100	100	100	98	4	4
Fe Removal	7.2	$CaCO_3$	1.9	100	100	100	100	100	100	100	21
Final Treatment	8.1	Bio. Alkal.	75	100	100	100	100	100	100	100	98

- Can replace lime with cheaper limestone
  - All metals removed at low pH except Mn ($MnCO_3$ @ pH 8)
- Reagent savings plus substantial metal product revenue
  - Cu and Zn products to 45% Cu and 60% Zn produced in lab work
  - Net reagent savings and product revenues >$3000/day projected

Conclusions

Sequential multi-product sulphide precipitation flowsheets are now technically feasible:

- High grade metal products
- Reduced waste sludge volumes
- Improved water treatment
- Potential for reagent cost savings

With very low cost sulphide generated on site, new applications are possible:

- Advanced multi-stage treatment of ARD
- Metal recovery from heap leaching and other hydrometallurgical processes
- Metal extraction and recovery from solid wastes

Initial test results and economic analyses justify further development

- Patenting initiated
- Site pilot projects under development

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