ADDING VALUE TO LIX / SX / EW OPERATIONS BY RECOVERING COPPER FROM BLEED, RAFFINATE AND OTHER PLANT STREAMS

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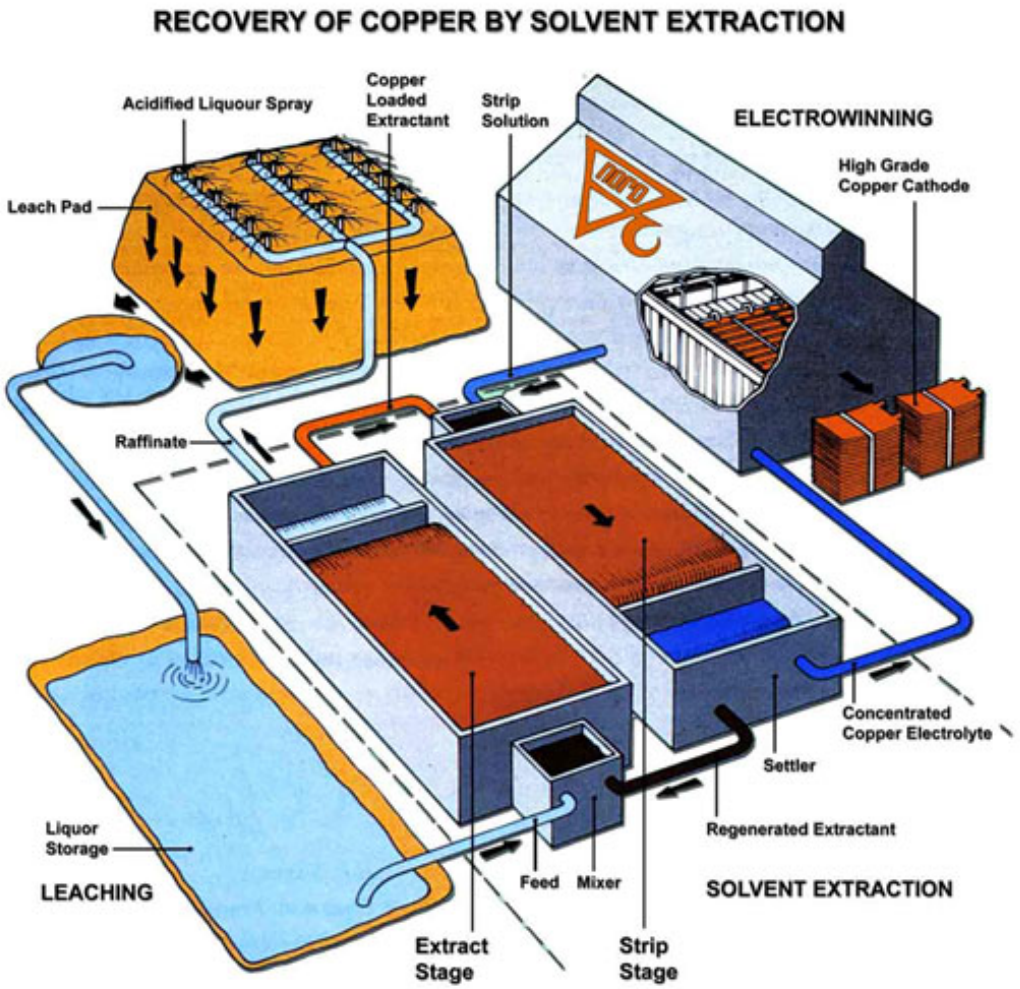
copper lix sx ew

Copper Leaching / SX / EW



Contaminant Buildup in Copper EW Electrolyte

Contaminants

Contaminant	Typical range	Potential Problems at Higher Concentrations
Cl	10 – 50 ppm	Cathode Stripping Problems
Fe	1-3 g/L	Current Efficiency loss (2% to 3% per g/L of Fe)
Mn	10 – 500 ppm	Faster degradation of Lead Anodes

contaminants

Quantity of EW Bleed needed to stabilize contaminants

Bleed Amount (as % of total annual Cu production)	Number of Plants	% of Total
0 to 0.2%	6	20
0.2 to 0.4%	6	20
0.4 to 1%	6	20
1 to 2%	4	13.3
2 to 3%	3	10
3 to 4%	3	10
Over 4%	2	6.7
Total	30	100

Contaminants

Reasons for Bleeding EW Electrolyte

Contaminant	Number of Plants	% of Total
Fe	7	35
Fe + Cl	1	5
Fe + Mn	4	20
Cl	4	20
Cl + Mn	3	15
Mn	1	5
Total	20	100

recycling

Bleed is recycled into Lix SX EW circuit to avoid loss of copper in the bleed

Destination of Bleed

Destination	Number of Plants	% of Total
E1	9	41
PLS	2	9
SX Wash	4	18
Raffinate	7	32
Total	22	100

recycling

Disadvantages of Recycling Bleed

Raffinate pond: Increased copper concentration in raffinate decreases leaching power of raffinate, resulting in lower copper recovery from the heap.

Extraction stage: Copper and acid concentrations are increased. Recovery in the SX stage is reduced. Compensated by increasing extractant concentration, resulting in increased carryover and loss of organic.

SX wash stage: Acid concentration increased and copper loss occurs similar to stripping stage.

PLS pond: Copper concentration to SX stage is increased, higher extractant needed, causing increased organic carryover and loss.

alternative

Alternative to Recycling Bleed

- **Electrowin most of the Copper from the Bleed**

- **Send Resulting Low Copper, High Acid solution to Leach (Raffinate)**

bleed electrowinning

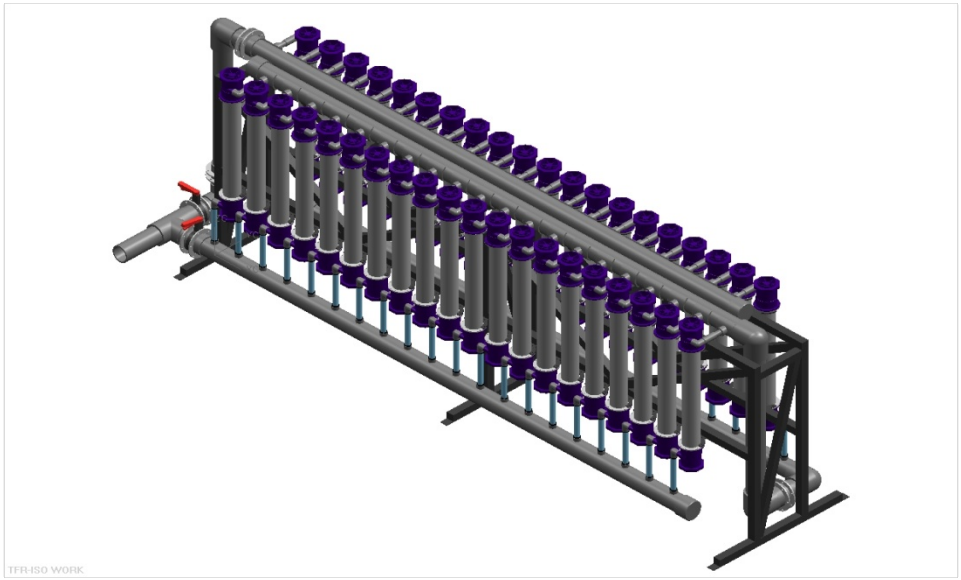
Electrowinning Copper from Bleed

- **Copper concentration usually reduced from 42 grams/liter to around 25 grams per liter in traditional EW tankhouse**

- **How much more can copper concentration be reduced and still produce high quality copper?**

bleed electrowinning

Electrowinning of Bleed using EMEW Cells



	Tankhouse Plating	EMEW
Open to Atmosphere	Yes	No
Flowrate	0.2 - 0.4 m3/Hr/m2	12 - 18 m3/Hr/m2
Concentration Range	45 - 25 g/L	45 - 2 g/L

bleed electrowinning

Electrowinning of Bleed using EMEW Cells

- **Codelco Radomiro Tomic**
- **ENAMI Salado**
- **Collahuasi Oxides**

bleed electrowinning

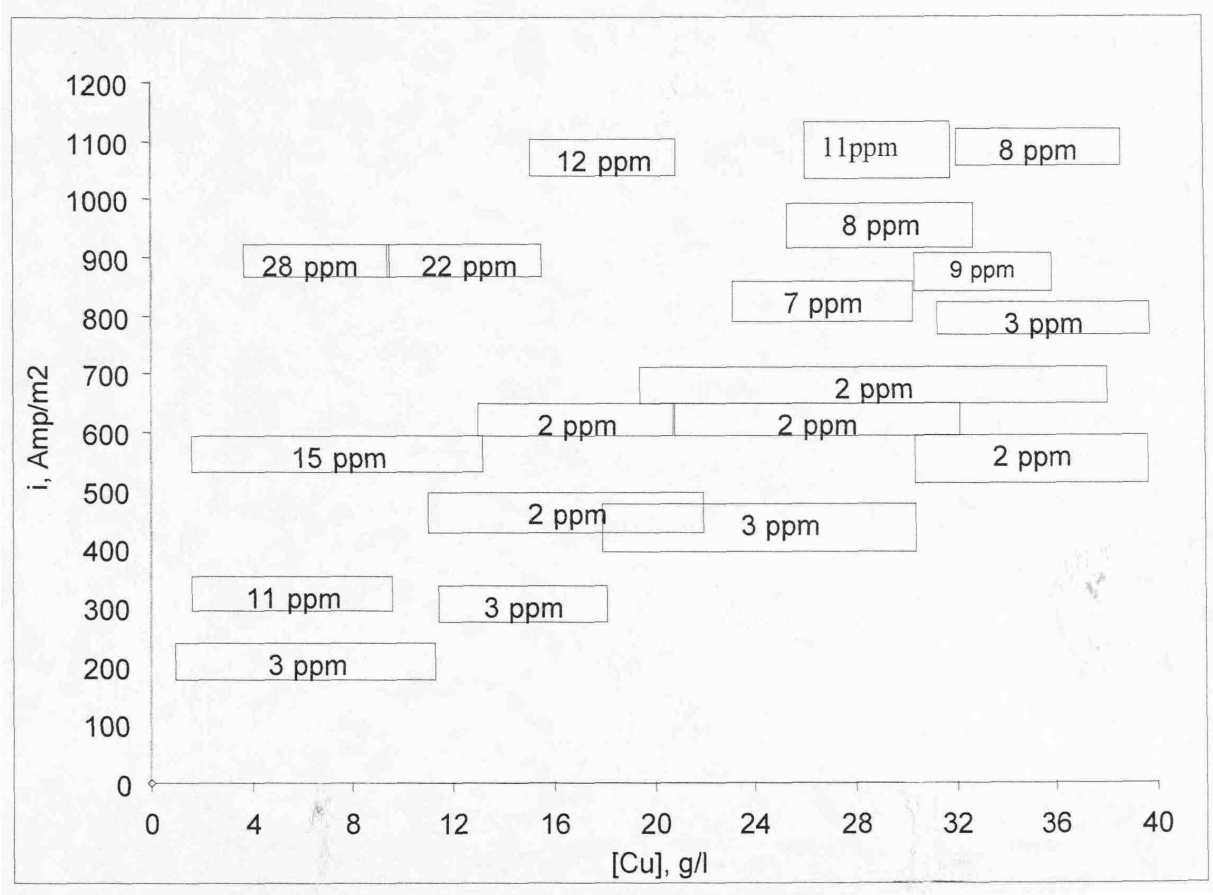
Codelco Radomiro Tomic

Run	Cu ini	Cu end	Volts	Dens	Effic	g/T
	g/l	g/l		A/m2	%	S
1	39	29	2.4	559	91	2
	29	18.8	2.4	417	91	3
	18.8	11.4	2.2	282	86	3
	11.4	0.8	2	188	81	3
2	38.9	30.6	3.7	891	88	9
3	40.4	32	3.3	825	87	3
	32	24	2.8	614	88	2
	24	13.5	2.8	605	89	2
	13.5	1.9	2.7	528	98	15
4	37.2	19.6	2.7	664	84	2
5	31.4	28.6	4.7	1130	89	7
	28.4	22.5	3.9	850	93	7
	22.6	10.2	2.7	460	93	2
	9.7	1.9	2.4	303	89	11
6	38.4	32.3	3.8	1100	80	8

Codelco Radomiro Tomic

bleed electrowinning

Sulphur Concentration (ppm) in Cathodes from EMEW Cells



bleed electrowinning

Enami Salado

Run	Current	Concentration		Voltage	Current	S
	Density	Cu gpl	Cu gpl	Volts	Efficiency	
	(amp/m2)	Initial	Final		%	g/T
1	450	33	18.2	2.4	94	8
	350	18.2	7	2.2	94	4
2	580	35.3	14.8	2.6	92	5
	300	14.8	3	2.2	93	5
3	700	34.2	22	2.8	97	1
4	600	39.1	22.3	2.6	94	2
	350	22.3	3.71	2.25	91	2
5	800	42.78	28.13	2.9	95	2

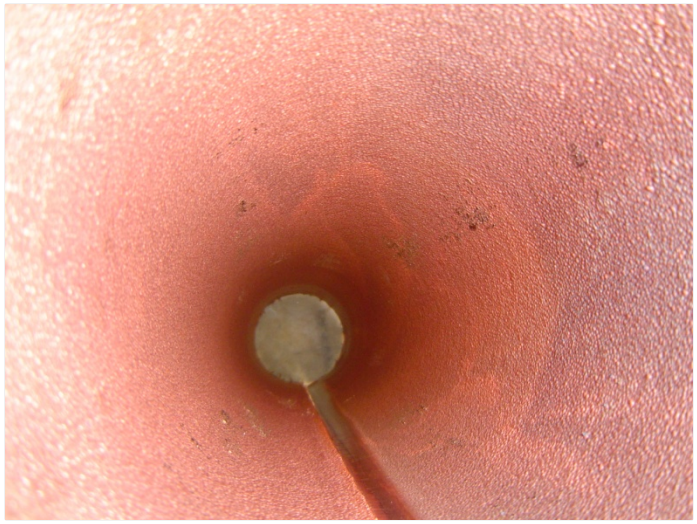
bleed electrowinning

Collahuasi Oxides

Run	1	2
Current Density, Amp/m^2	400	300
Initial Copper, gpl	33.1	13.1
Final Copper, gpl	13.1	3.6
Voltage ,V	2.6	2.4
Initial Acid, gpl	199	241
Final Acid, gpl	241	255
Current Efficiency, %	96	93
Sulphur in Cathodes, ppm	4	5

conclusions

Conclusions



- Copper concentration in Bleed stream can be reduced to at least 3 g/L, while maintaning high Copper purity
- Acid consumption reduced
- Expansion of SX/EW capacity without modifying SX
- Possible drop of up to 300 ppm in Raffinate Cu concentration – will be evaluated at Enami Salado
- Increased stability of plant – Impurities effectively out

raffinate

Raffinate Electrowinning - Collahuasi

Parameter	Concentration
Cu	1.46 gpl
H2SO4	20 gpl
Fe+ 2	16 gpl
Fe+ 3	2 gpl
Total Fe	18 gpl

Run Number	1	2	3	4	5
C. Density, Amp/m2	600	600	600	600	600
Initial Copper, gpl	1.46	0.5	0.34	0.23	0.17
Final Copper, gpl	0.5	0.34	0.23	0.17	0.13
Voltage, V	3.7	3.9	3.9	3.8	3.8
Run time, Hr.	8	5	15	16	28

- Initial Current Efficiency ca. 25%

raffinate

Product from Raffinate Electrowinning

effluent

Effluent Electrowinning - Collahuasi (EW cell cleaning, electrolyte spills, and other streams from the SX plant)

Parameter	Concentration
Cu	21.7 gpl
H2SO4	110 gpl

Run	1	2
Current Density, Ampere /m2	400	300
Initial Cu Concentration, gpl	21.7	13.6
Final Cu Concentration, gpl	13.6	4
Sulphur content, ppm	5	7
Voltage, V	2.7	2.4
Current Efficiency, %	94	90
Energy Use, KWh/Kg Cu	2.4	2.3

effluent

Effluent Electrowinning - Collahuasi (EW cell cleaning, electrolyte spills, and other streams from the SX plant)

acknowledgements

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