ALTA Short Course

Copper SX/EW Basic Principles and Detailed Plant Design

May 2020

ALTA Metallurgical Services, Melbourne, Australia

www.altamet.com.au

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Presented by

Alan Taylor

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This practically oriented course has been put together over many years and is both a valuable introduction for newcomers and a useful refresher for old hands.

Course Presenter

Alan Taylor, Metallurgical Consultant and Managing Director, ALTA Metallurgical Services

Alan has 40+ years' experience in the metallurgical, mineral and chemical processing industries in Australasia, New Zealand, North and South America, Africa, Asia and Europe. Alan draws from his extensive first-hand experience with major engineering firms and as an independent consultant focussing on project development. He has worked on a wide variety of projects from the late 1960s - a period which has seen the introduction of many new technical developments. Detailed experience

Course Outline

Key SX functions	Simplified flowsheet Simplistic chemistry & implications Applications History
Reasons for growth	
Alternative processes	Precipitation of cement copper with scrap iron Direct electrowinning Copper powder production Copper oxide production Cuprous chloride precipitation Precipitation of copper sulphide with H2S or sodium sulphide Replacement of SX by ion exchange (IX) Replacement of EW by copper sulphate production
Organic liquids in SX	Extractants Modifiers Diluents Organic stability Organic selectivity
Typical flowsheets	SX EW Ancillary facilities: – Crud treatment – Solutions holding tank – Reagent facilities Variations in SX circuits: – Series-parallel Split circuit
SX contractors	Mixer-Settlers: – Types used for commercial copper SX – Types used for commercial non-copper SX – Types piloted for copper SX Column contactors Centrifugal contactors

Course Outline (continued)	
SX ancillary facilities	SX crud Clay treatment of organic Electrolyte clean-up Loaded organic clean-up Raffinate clean-up
EW cells	Principle of operation Alternative designs Anodes and cathodes
EW materials handling	Harvesting Washing and stripping Sampling, weighing, and banding
EW ancillary facilities	Rectiformers Acid mist control Iron control
Plant arrangement and layout	Key considerations Various SX arrangements Various EW arrangements
SX fire protection	Industry experience Causes Fire prevention measures Fire protection systems Fire containment and risk reduction system
Materials of construction	SX area EW area
Testwork	Overall test program strategy Leach solution samples SX test procedures
Scale-up and design criteria	Recommended guidelines for scale-up Typical design criteria
Plant operation	Operating characteristics Personnel Instrumentation/controls Sampling/analytical
Performance and risk	
Industry trends	
Example plant design review (course notes only)	Plant design criteria Basic process design calculations Mixer-settler design EW cell design Tank and pond design Other equipment design Plant arrangement Engineering notes Equipment list Design sketches

RANCHERS BLUEBIRD, ARIZONA, 1965
FIRST COMMERCIAL COPPER SX-EW OPERATION

Notes:

1. It was based on heap leaching of oxide ore.
2. The SX mix boxes were all located at the same end of the settlers.
3. Pump-mix impellers were not used and Inter-stage transfer was by pumping.
4. Copper was deposited on copper staring sheets in EW.

ORGANIC SELECTIVITY

- The only significant element extracted by oxime copper extractants is ferric iron.
- Copper-iron ratio of 500-2500 (under ideal conditions) depending on the particular extractant.
- Actual chemical transfer is affected by the Cu:Fe ratio in the aqueous feed solution.
- There is an additional transfer of both ferrous and ferric by physical entrainment with the organic. This is a particular problem for the loaded organic, as iron reduces current efficiency in EW.
- Other undesirable impurities which can be entrained in loaded organic include chloride, manganese and nitrate.
- Chloride can also be transferred from the leach solution by entrainment to EW which has a very tight specification of 30 ppm Cl maximum.

Notes:

Effect of entrained impurities:

1. If the chloride level in the EW electrolyte exceeds about 30 ppm it tends to attack stainless steel cathode blanks causing difficulty in stripping the copper from the blanks. (However, it should be noted that a low threshold chloride level of about 10 ppm is required as a surface smoothing agent.)
2. If manganese is transferred into the electrolyte circuit it can lead to permanganate formation which can severely degrade the SX organic in the strip circuit. This has happened to a number of operations during commissioning. If manganese is expected to be present, it is advisable to start with a minimum initial buffer of about 0.5 g/L iron and monitor the Eh which should be less than 600 mv, then maintain a ferrous iron/manganese ratio of 8-10/1in the electrolyte when in operation (Ref: Anglo American Chile paper, ALTA 2011).
3. It has been found that a minimum of 1 g/l of total iron is usually necessary to prevent high Eh levels in the electrolyte. At Chuquicamata, Chile, the total iron in electrolyte is 0.4-0.5 g/l to maintain high current efficiencies in the cellhouse. Because of this low level of total iron, a very high solution Eh of 900 mV is generated compared with 400 mV normally. The Eh is reduced by contacting the spent electrolyte with copper scrap in a reduction tower. This reduces the manganese to Mn^{2+} and renders it benign to the SX organic (Ref: MMS paper, ALTA 2010).
4. Cytec Solvay has introduced ACORGA OR formulations for SX solutions having high ORP (Ref: Cytec paper, ALTA 2011).
5. Nitrate in solution can lead to severe attack on the organic – see next slide.