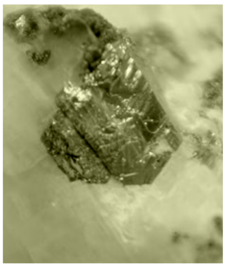
Cycad PROCESS
Simulation software
for the Metallurgical industry

More from ore

29
Cu
Copper
63,546 u
[Ar] $3d^{10}4s^1$

SURMOUNTING PRODUCTION PRESSURES IN COPPER SX EW



Production pressure vs operating challenges

As production pressures mount, metallurgical plants are often pushed beyond their design capacities. Physical separation plants, like crushing and milling circuits are ‘push’ plants, the more you push through, the better. However, hydrometallurgical plants do not respond in the same way – they are pull plants: operating conditions need to be correct from the product end. So, production pressures can be disastrous for a hydrometallurgical plant (*Figure 1*).

On the African Copperbelt, this is particularly true, as management requires more and more from equipment and staff.

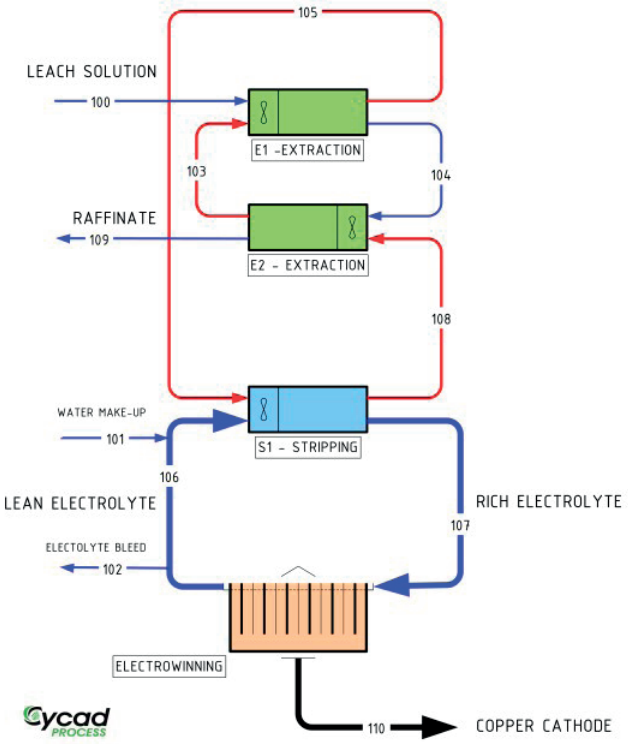
One way in which production pressure manifests itself is through impurities in the electrowinning circuit. The quality of the cathode produced in copper SX EW circuits is critically dependent on the quality of the solutions provided. And that is determined by the upfront processing steps – leaching, solid-liquid separation, and solvent extraction. Solvent extraction is a very effective barrier to impurities, but they can still make their way through to the EW circuit by:

- extraction of the metal by the solvent (mainly iron and manganese)
- aqueous entrainment through the SX mixer settlers (mainly calcium, silica, chloride)
- make-up water in EW (chlorides)

Monitoring bleed for purer cathode and equipment

If impurities do penetrate through SX into EW, they can build up – their concentrations can increase in the electrolyte because the electrowinning solutions are in a closed circuit. Such impurities must be removed by bleeding electrolyte from the lean electrolyte.

***Figure 1**:*
A solvent extraction – electrowinning circuit.

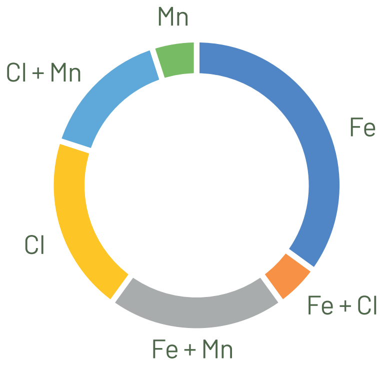


Because the type of impurities varies widely, the reason for bleeding varies (Figure 2a). The bleed volume is not disposed of but is added back to the circuit either prior to extraction (E1 or raffinate) or prior to stripping (wash) (Figure 2b).

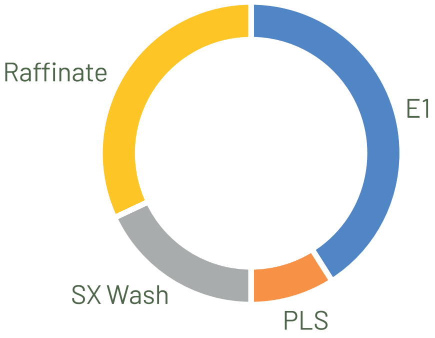
If the bleed volume is not monitored and controlled properly, the build-up of impurities can affect the quality of the copper cathode, the anode, or other pieces of equipment, like the electrolyte filters.

***Figure 2**:*
Reasons for and destinations of the EW bleed

2a ■ Reasons for EW bleed



2b ■ Destination of EW Bleed



Simulation saves money

Less Impurities => More Profit

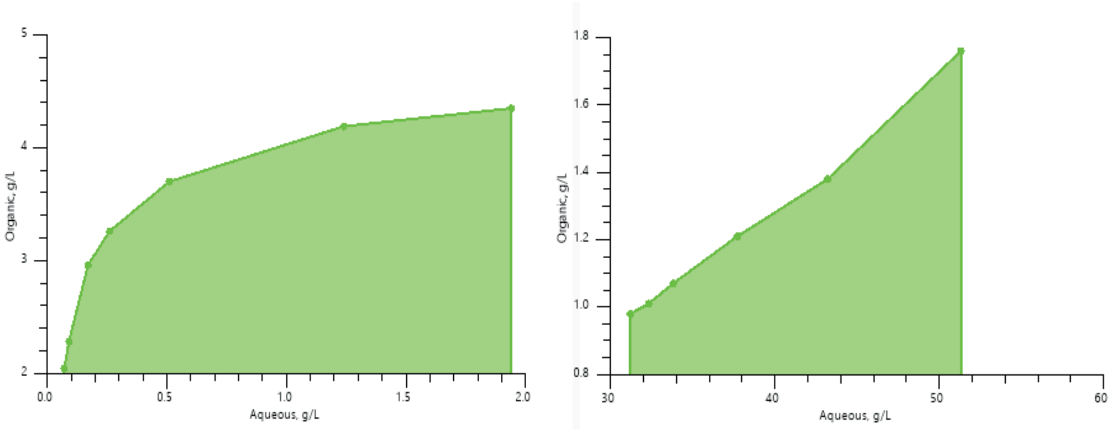
For example:
If 10% of the cathodes are rejected because of impurities that can be controlled the understanding generated by this modelling is worth 10% x 50 ktpa x $500, that is, $2.5 million per year:

- if the off-spec discount is $500 per ton of copper
    - for a 50,000 ton per annum operation.

Using Cycad Process® to understand bleed variables

How much to bleed depends on the mechanism of impurity breakthrough. Consultants used Cycad Process® (www.cycadprocess.com) to model the extraction of copper and iron by the solvent (Figure 3). Following the standard circuit design, the bleed volume was controlled to maintain the iron at 1.5 g/L in the lean electrolyte.

Figure 3:
Copper extraction and stripping isotherms from Cycad Process®.



Keeping calcium and silica impurities in check

On the African Copperbelt, leach solutions and process waters are saturated in calcium. However, these elements are frequently not considered in monitoring the EW circuit. (Figure 2).

If the leach solution is saturated in calcium, the concentration of calcium in the electrolyte will increase as the aqueous entrainment in SX extraction increases (which, of course, increases as the production of copper through SX increases). The saturation level in the electrolyte solutions is about 1.5 g/l $CaSO_4$, or 450 ppm Ca (see Dutrizac, Hydromet, 92, 2008, 54). The solubility might be even lower if silica is also approaching saturation in the electrolyte because a silica-gypsum precipitate might form.

At several sites, gypsum and silica have been observed on the anodes (see Figure 4). Gypsum will clog the piping and the electrolyte filters (see Figure 5), and because it expands on precipitation, the shell of the electrolyte filters can even buckle.

Another source of impurities is the water used in EW. If process water is used, rather than demin water, the build-up of calcium is dominated by this mechanism (Figure 6). This might seem obvious to some, but our engineers have seen this scenario at some operations. Of course, bleeding will not remove this calcium, because it is in the make-up water! This underlies the importance of understanding the source of impurities, and the mechanism of controlling them.

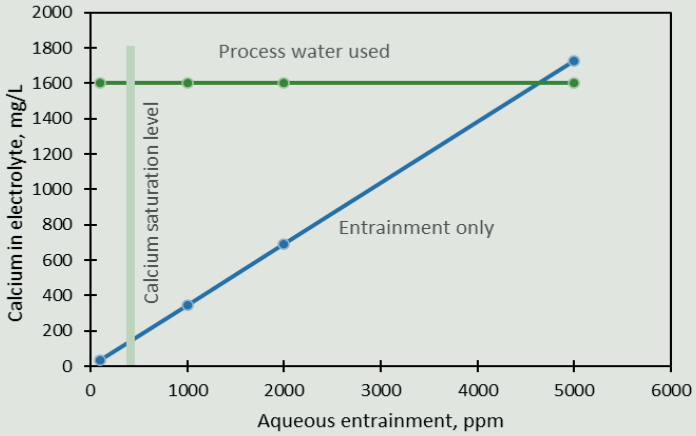
Decrease cathode rejects by controlling impurities

Electrolyte impurities invariably manifest themselves in cathode purity – and maintaining production of highly pure LME grade cathodes has an immediate implication on the operation's financial bottom-line, because off-spec cathodes are discounted heavily. If 10% of the cathodes are rejected because of impurities that can be controlled, the understanding generated by this modelling is worth 10% x 50 ktpa x $500, that is, $2.5 million per year if the off-spec discount is $500 per ton of copper for a 50,000 ton per annum operation.

Figure 4: *Gypsum formation on the lead anodes – the needle like crystal structure of selenite.*

Figure 5: *Choked electrolyte filter due to a gypsum-silica precipitate.*

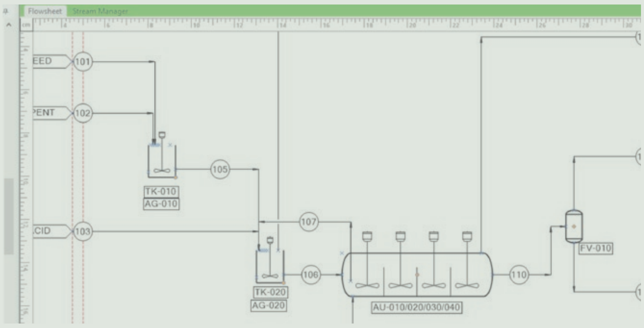
Figure 6: *Calculated values of calcium in the EW electrolyte for two sources of impurity.*

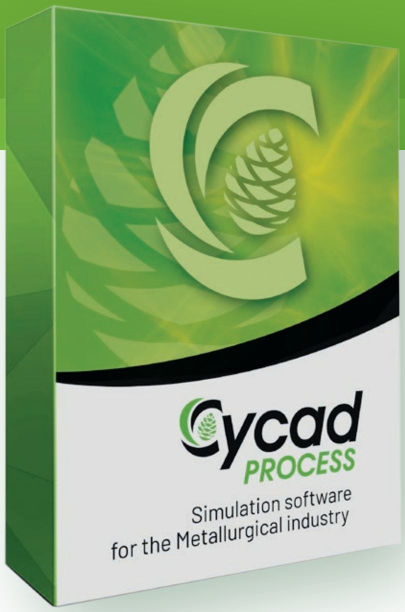


How was Cycad Process® used here?

Cycad Process was used to:

- build a model of the circuit
    - with extraction and stripping isotherms
        - for both copper and iron
- The impact of aqueous entrainment and impurities in the make-up were then:
    - investigated in different scenarios.





What is Cycad Process®?

- Cycad Process® is a **software product for modelling of metallurgical operations** – sophisticated models of unit operations are combined into a model of the process operation, allowing the user to design or optimize their operations.
- The outputs are the mass and energy balances for the plant, presented as **reports and process flow diagrams**.
- Cycad Process® has been used to **design plants and find solutions to metallurgical challenges** for the last 20 years.
- Our clients include leaders in **copper, gold, cobalt, lithium, vanadium, nickel, and the platinum group metals**.

Visit us on www.cycadprocess.com

To find out how Cycad Process can help you contact us at:

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