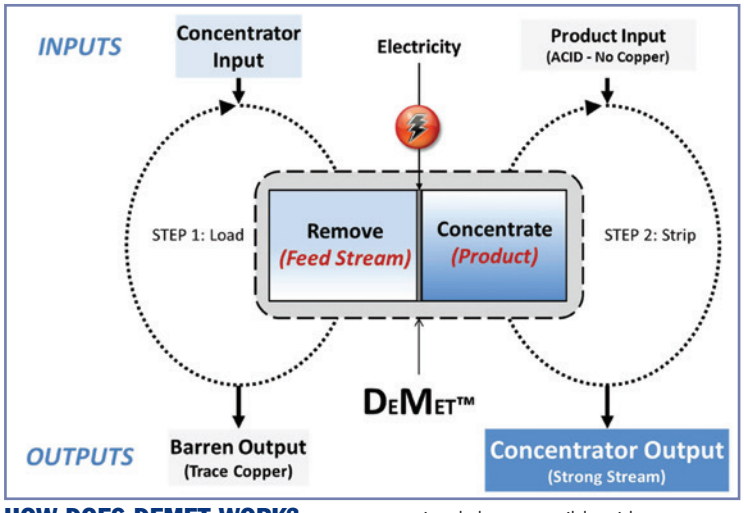
Accessing hidden revenues

Blue Planet Strategies introduces its new DEMET electrolytic technology for the recovery of residual metals to improve process profitability and performance

Leakage of valuable metals occurs often during metal production, formation and refining. Blue Planet Strategies (BPS) has developed DEMET (dynamic electrode metal effluent treatment), a new electrolytic technology, to release the hidden revenue locked up in this leakage and to help mitigate the associated environmental impacts.

Metal leakage can cost plants millions of dollars annually in unrealised production, process degradation and costly regulatory-driven treatments.

DEMET is electrically activated and can cost-effectively and selectively remove metals from leakage sources and recover them in a variety of useful forms – generating new revenues and providing a versatile platform for site-specific solutions. It can be used to electro-win target metals, generate cleaned and concentrated streams for recycling into other processes, or even create value-added metal salts.



The DEMET concentration process

HOW DOES DEMET WORK?

DEMET has been specifically designed to work with very weak solutions, while also retaining its benefits for higher-strength solutions. As a result, it affords new opportunities that have not previously been possible with conventional electro-winning (EW) treatment methods. It maintains high processing rates and efficiencies for practical use on low-concentration (weaker) streams that have not traditionally been viable for large-scale EW. When targeting direct metal creation for EW, DEMET can provide superior performance, and reduce problematic and contaminating side reactions compared with conventional EW employing sheet-like plating surfaces.

Additionally, DEMET's ability to create a strong (concentrated) product in either liquid (solution) or solid (crystal) form represents an industrial breakthrough.

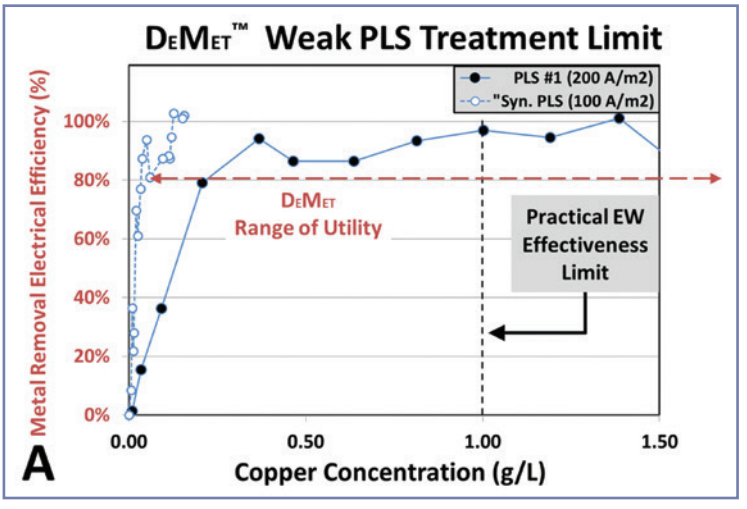
To accomplish concentration, the electrochemical DEMET process employs two steps:

- Step one (Load): Removes the metal from the target stream and deposits (electroplates) it onto a solid electrode substrate as in normal EW. This step controls the overall processing rate and range of utility (i.e. it determines how weak a solution DEMET can effectively be applied to).
- Step two (Strip): Releases the captured metal into a product stream. Recovered metal is separated from impurities during the loading process and can then be accumulated (concentrated) in the product stream to create a strong and clean product suitable for conventional solvent extraction (SX) and EW, or reuse in target processes as a regenerated and refreshed feed. ►

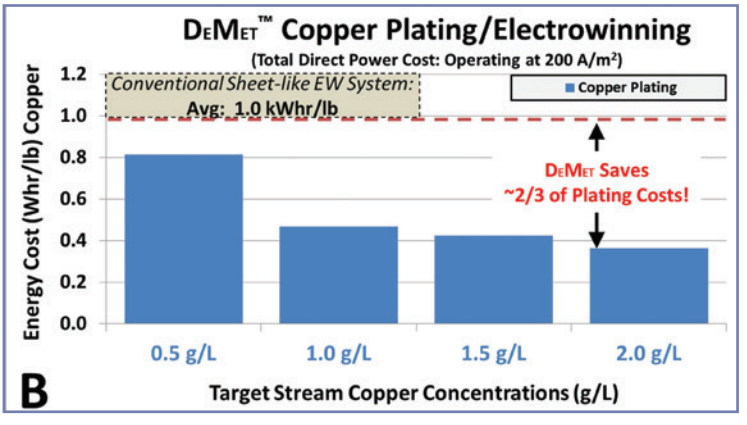
Prototype DEMET machinery

"Metal leakage can cost plants millions of dollars annually in unrealised production, process degradation and costly regulatory-driven treatments"

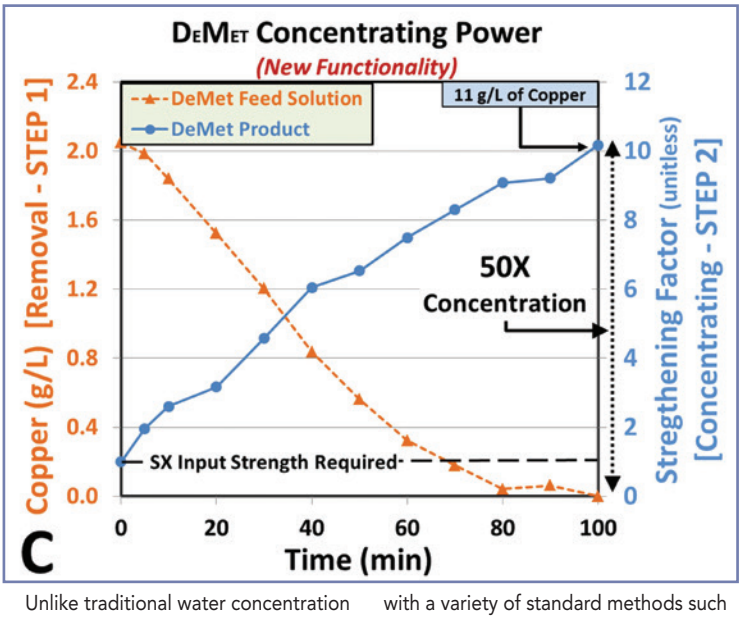
Graph A: results of DEMET copper removal from mine pregnant leach solution



Graph B: energy cost for removing copper with DEMET



Graph C: results of DEMET treatment of input containing between 2.0g/L and 0.05g/L copper



Unlike traditional water concentration methods of filtration (such as reverse osmosis), ion exchange, or SX, DEMET's direct use of electricity enables high concentration levels to be achieved for little cost premium over low concentration levels. Adjusting system operation can further strengthen the product and facilitate crystalline metal-salt recovery with a variety of standard methods such as using a crystalliser.

Copper provides a model target-metal, and its representative performance yields outstanding results in comparison with conventional EW for usual performance metrics (focusing on more difficult weak-stream treatment highlights treatment barriers).

DEMET capabilities

Applicable metals

- Antimony
- Cobalt
- Iron
- Palladium
- Tin
- Copper
- Gold
- Nickel
- Silver
- Zinc

Application areas

- Enable processing of weak PLS;
- Reclaim/recycle bleed and process streams;
- Cost-effectively recover tramp metals;
- Recover refinery and rod production residuals;
- Reclaim metals in smelter blown-down;
- Control target contaminants in process streams.

Products

- Metals
- Concentrated streams
- Crystalline metal salts

DEMET maintains performance down to 0.2g/L copper (at 200A/m²), where conventional sheet-like cathode systems generally require input solutions of at least 1.0g/L of copper to maintain any level of efficiency at practical processing rates, and inputs of ≤3.0g/L of copper to produce a good-quality product.

RESULTS: STEP ONE

Representative copper-removal results for DEMET treatment of an actual mine pregnant leach solution (PLS) are illustrated in graph A. The graph shows the solution strength range where DEMET functions at practical rates and removal of electrical efficiencies. Graph B shows the energy cost for removing the targeted copper and takes into account the cell potential changes with feed solution strength.

DEMET treatment at 200A/m² and cell potential of 1.0 volts direct current (Vdc) at 1.0g/L copper averaged 91% removal electrical efficiency from 1.7g/L to 0.2g/L copper, and required 0.42Wh/lb to plate 1lb (453g) of copper.

At 100A/m² the cell potential was 0.5Vdc (at 1.0g/L copper) with >80% electrical efficiency maintained to 0.05g/L copper. At 350A/m² (see graph C) the cell potential was 2.0Vdc (at 1.0g/L copper) and an average removal electrical efficiency of 73% was maintained from 1.8g/L to 0.3 g/L copper. Even better performance can be achieved for stronger-stream operations.

State-of-the-art EW systems using

DEMET innovations and advantages	
High-surface-area electrode	High operation rates, mantains high efficiency, uses less energy for process and lessens undesirable side reactions or degradation of additives
Dynamic eletrode	Resists problematic shorting during plating and enables continuous operation
Decoupled fluid/ electrode motions	Maintains process practicality over a wider range and enables new process functionality; reduces energy use
Split-chamber cell	Keeps electrode reaction products unmixed and allows separated fluid manipulation; uses less energy and avoids feric ion (Fe^{+3}) creation in treated solution

sheet-like electrodes typically require at least 1kWh/lb to plate copper and suffer severe performance degradation with weak solutions, limiting their practical use to streams containing ≥1.0g/L copper and ≥3.0 g/L copper when grade A copper sheet is desired.

Operating at 300A/m^2, DEMET removed the more challenging metal zinc to 0.5g/L at a 47% plating electrical efficiency from a solution of pH1.5; removal to 0.01g/L was achieved at a 12% plating efficiency.

"DEMET provides an improved and extremely versatile ability to practically, cost-effectively and selectively remove and reclaim a variety of metals"

RESULTS: STEP TWO

Graph C illustrates DEMET treatment of input containing between 2.0g/L and 0.05g/L copper, and shows that the DEMET product is strengthened at a consistent rate. The resulting product strength is not notably limited by the input stream strength, and product of up to 11g/L copper (up to 50 times stronger than the input) can be readily generated. Additional tailoring of the unit configuration and operation for specific conditions and needs can enable even greater strengthening.

DEMET offers several advantages over traditional (sheet-like electrode) electroplating techniques, and circumvents traditional limitations to extend the range and practicality of its use.

DEMET's design enables key process components to be controlled independently and manipulated as desired. This allows tailoring of the target product chemistry and system operation to best meet customer needs. The result is a greatly improved targeted process with the ability to generate a concentrated product that conventional cells cannot.

The closed system design prevents acid-mist generation and the uncontrolled release of any gases generated, and the ability to generate refreshed product suitable for automatic reintroduction to the source process can reduce labour costs. This is particularly relevant for the smaller systems typical of bleed and blown-down treatment where labour costs have a proportionally higher impact on the overall copper-generation cost.

DEMET employs a high-surface area, dynamic (moving) electrode to spread out typical reactions. The high surface area reduces degradation of organic additives, lessens problematic side reactions (such as hazardous hydrogen evolution or arsine gas), and the reaction area can be more than 10 times higher than a sheet-like unit, while its dynamic nature precludes problematic electrode shorting.

DEMET's split-cell design, new to the mining industry, maintains reaction separation and controls fluid circulation, which lowers the cell voltage by shrinking the gap maintained between cell electrodes and reduces energy consumption by as much as 50%.

It also eliminates ferrous to ferric oxidation in the stream being treated, and also provides the possibility of using the technology in reverse to efficiently generate additional ferric in the target stream (such as raffinate) to augment the leaching of sulphide ore. For example, where a conventional sheet-like electrolytic cell treating copper raffinate containing 13-16g/L of ferrous (Fe^{+2}) ions generated ferric ions (Fe^{+3}) at an estimated average electrical efficiency of 22%, DEMET technology was seen to convert ferrous ions between 0.5g/L and 1g/L (a more challenging condition) to the desired ferric ions at more than 80% efficiency at practical rates.

SUMMARY

DEMET provides an improved and extremely versatile ability to practically, cost-effectively and selectively remove and reclaim a variety of metals from both weak and strong streams in various forms.

It unlocks the possibility for new profits and hidden revenue imprisoned by metal leakage in bleed streams, recirculation and raffinate, drain-down, or blow-down streams at metal processing, smelting and refining operations, enabling the direct capture of residuals currently lost, control of impurities hampering target process performance (such as copper in a nickel leachate stream), or cleaning and regenerating streams for return to their bleed source.

Treated metals could be completely removed from the process circuit by either direct EW or transformation into metal salts, or recycled by being cleaned, concentrated and reintroduced into the target process.

DEMET's added ability to work with weak PLS can enable the augmentation of conventional SX/EW operations to allow more production from lower ore grades and potentially extend mine lives. The process overcomes key roadblocks to applying conventional EW to the noted processing and recovery applications, and may provide a powerful new tool for residual metal recovery.

DEMET offers an alternative to conventional EW treatment methods. It is gentler, and more efficient and practical at lower concentrations while using less energy (lower cell voltage and less required pumping).

It also brings new functionality; the ability to concentrate and generate higher-value metal salts. DEMET is extremely versatile and on-site pilot scoping can readily assess its performance against site-specific applications.

This truck-mounted portable test centre is used to pilot-test the DEMET process

BPS was founded by Dr Patrick James and leverages expertise in electrochemical system development to bring new electrolytic system advances to miners. Working closely with its partners in metal mining and processing, BPS tailors DEMET's treatment for site-specific integration opportunities to yield more profitable and sustainable operations. See www.bps09.com