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CONTENTS

Flotation

Flotation of Copper Oxide Ores: A Review from Laboratory Testing to Industrial Practise
Graeme Sheldon, AMML, Pty Ltd, Australia

The Froth Flotation of Nickel Sulphide Ore Using PAX and Its Mixtures with DTC and DTP
Walter Amos Ngobeni, Gregory Hangone & Daniel Ikhu-Omoregbe, Cape Peninsula University of Technology, South Africa

Cobalt Recovery

Not just another Cobalt Resource Review of Cobalt Processing Routes and the Value of Testwork
Rogan Roulstone, MDM Engineering, South Africa

The Hydrometallurgy and Activities Around Copper and Cobalt Recovery in the African Copperbelt
Christoph Pawlick & Marian Lidall, Mintek, South Africa

Equipment & Materials

The Next generation of Pump Technology in PAL Plants
Heinz Naegel & Stefan Willems, presented by Rudolf Gänsl, FELUWA Pumpen GmbH, Germany

Numerical Design Tools Optimize Agitators, Vessels and Internals to Ensure Safe and Economic Plant Operation
Wolfgang Keller, Jochen Jung, Nicole Rohn & Marc Stadtaus EKATO RMT, Germany

Mortars for Acid Resistant Brick Linings in Hydrometallurgical Applications
Kevin Brooks, Koch Knight LLC, USA, presented by Mark Martin, Koch Australia

Hydroprocessing of Sulphides Forum

Key Note Address, Hydroprocessing of Sulphides: Where Are We and Where Are We Going?
David Dreisinger, University of British Colombia, Canada

Bacterial Leaching at Elevated pH Using BioHeap™ Technology
Jason Fewings & Shawn Seet, Western Areas NL, Australia

High Temperature Heap Leaching of Ni, Cu & Co and Platinum, Group Metals from South African Platreef Concentrates Coated on Gravel
Jacques Eksteen, Curtin University, Australia, Jochen Petersen, University of Cape Town; Steven Bradshaw & Guven Akdogan, University of Stellenbosch, South Africa

Bulk Nickel-Copper Concentrates: A Comparison of Two Hydrometallurgical Processing Options
David Jones, Teck Resources Limited/CESL Limited, Canada

The Application and Economic Consideration of NSC Pressure Oxidation to Combined Copper Molybdenum Concentrates
Corby Anderson, Colorado School of Mines, Todd Fayram, Continental Metallurgical Services & Larry Twidwell, Montana Tech, USA

Developments In The Treatment Of Copper-Arsenic Concentrates
Ken Baxter & Iman Ghanad, SNC-Lavalin, Australia & David Dixon, University of British Columbia, Canada

Application of Mixed Chloride Technology for the Recovery of TiO_2 and Base Metals
Vaikuntam Lakshmanan, Ram Sridhar & Raja Roy, Process Research Ortech Inc., Canada

Development of a Versatile HCl-Leach Based Metal Extraction Technology Stack
Dieter Vogl, Christian Haidinger, Benedikt Nowak & Herbert Weissenbaeck, SMS Siemag Process Technologies GmbH, Germany

Kell Hydrometallurgical Process for Extraction of Platinum Group and Base Metals from Flotation Concentrates - An Update
Keith Liddell, Lifezone Ltd, Switzerland & Mike Adams, Mutis Liber Pty Ltd, Australia

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PROCESSING OF LATERITES

COMPARISON OF VARIOUS METHODS FOR CALCULATING CASH COSTS - FOCUS ON NICKEL INDUSTRY

By

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ABSTRACT

This paper has been prepared to help clarify the term “cash costs” and “unit cash costs (costs on a per mass basis)” which often appears in material associated with developing and promoting investment in mining ventures and mineral commodities.

In a strict accounting sense the term cash costs has a specific meaning as it refers to the cost of transactions when using cash, credit or cheques. This paper is not referring to this definition or subject.

In the mining industry, in an effort to quantify the costs associated with a mining venture, the term unit cash costs (often simply stated as the cash costs) are often cited as one of the indices to monitor and rank a specific venture’s performance against others. To be able to accurately carry out such an analysis requires a uniform approach and lots of data both from the producers and the smelters and refineries who take all play a part in transforming a mineral in the ground to a form that is useful to an end user, such as stainless steel producer, nickel plater, alloy manufacturer as is the case when referring to nickel.

The paper has a focus on the nickel industry although should apply to other industries such as the copper, lead and zinc. The paper is not concerned with comparing one operation against another, rather it outlines and discusses the methods used to make this comparison. It is arguable that the nickel industry brings complications compared to say the copper industry, in that there are a variety of “finished products”, such as FeNi, nickel salts and pure nickel metal.

As highlighted in this paper there are no standard internationally agreed methods used to calculate a cash cost curve, so care must be taken to examine the underlying assumptions when comparing cost curves.

While the author originally set out to make a case for greater standardization in defining the term cash costs and the associated cash cost curves, the author is now of the opinion that this may not be possible due to the sensitivity of reporting commercial terms.

There is no doubt that the use of the term cash costs will endure as it has become an often used measure of company operating performance as well as for analysts comparing industry trends.

NICKEL LATERITE AND THE THREE MINERAL ACIDS

By

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ABSTRACT

Recent literature reports laterite processes based on sulphate, chloride and nitrate chemistry. This paper presents a study of the mass/energy balances associated with processing limonite and saprolite via each of these three different routes, based on information published for each route. The mass/energy balances are analyzed and the variable operating costs potentially associated with each are calculated from the reagent and utility consumptions predicted by the mass/energy balances. The calculated reagent/utility costs are compared and discussed.

PRECIPITATION OF BASE METALS USING MgO

By

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ABSTRACT

The utilisation of MgO as a precipitant for base metals has increased significantly over the past 5 years, due to the relatively high grade base metal product that can be achieved when compared to lime. However, most base metal operations have found that the Mg content in the final product could be as high as 10-20% m/m Mg. This has major cost implications for an on-site refinery or for the sale and transport of an intermediate base metal hydroxide product. Reasons for the elevated Mg grades were identified as mode of reagent addition, precipitation temperature, ageing effects of MgO, as well as the grind size of the MgO. A suitable process route has been designed that improves the grade of the final mixed base metal hydroxide product by minimising the Mg content of the final product. A robust method for the determination of MgO reactivity within a typical base metal precipitation circuit is also discussed.

DEVELOPMENTS AND TRENDS IN HYDROMETALLURGICAL PROCESSING OF NICKEL LATERITES

By

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ABSTRACT

To date the only nickel laterite acid leaching plants constructed have been based around high pressure acid leaching (HPAL) technology and the only other nickel laterite hydrometallurgical plants constructed have employed the Caron process. Several downstream recovery routes have been employed, including mixed sulphide precipitation (MSP), mixed hydroxide precipitation (MHP) and direct solvent extraction (DSX), with commercial products ranging from intermediates (MSP/MHP) to nickel oxide, nickel briquettes and nickel cathodes. Over the last decade considerable effort has been expended on the development of atmospheric and low pressure leaching processes (heap leaching and agitated tank leaching), as well as integrated flowsheets that re-generate the lixiviant and produce value-adding by-products. Much progress has been made towards the development of alternative downstream recovery processes, particularly in the field of DSX.

This paper examines trends and new developments in hydrometallurgical processing of nickel laterite ores. Block flowsheets for the established and developmental processes are presented and the relative merits of each flowsheet are discussed.

CONTINUED DEVELOPMENTS IN CARBON FRIENDLY NICKEL PROCESSING: BETTER PROJECT RETURNS WITH REDUCED CARBON EMISSIONS

By

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Presenter and Corresponding Author

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ABSTRACT

Simulus Engineers were awarded an AusIndustry grant in 2010 to co-fund the development of a novel process for the production of nickel metal from laterite ores. The Carbon Friendly Nickel Production (CFNP) process, involves membrane technology to recover sulphuric acid and reductive calcination to regenerate reactive magnesia from waste process liquor. The CFNP process is anticipated to reduce CO_2 emissions by over 60% from a base case conventional atmospheric leach / neutralisation / mixed hydroxide process (MHP) flowsheet. This is achieved through lower process emissions by avoiding or significantly reducing the need for limestone and lime neutralisation of residual free acid, and reduced emissions from the transportation of reagents. The CFNP flowsheet can be applied to any sulphuric acid leach technology: PAL, atmospheric, or heap leach.

Operating costs are estimated to be 25 to 48% lower than the conventional flowsheet depending on the flowsheet scenario chosen. Capital costs are similar to the conventional atmospheric leach flowsheet, but can be 29% lower, or 24% higher, depending on the scenario. The optimum scenario will depend on the ore body, project location and business strategy of any company seeking to implement the technology.

Simulus Engineers will be operating a demonstration plant to showcase the new process in late 2012, in conjunction with further testwork to optimise leach, iron removal, manganese removal and magnesia recovery process parameters.

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LATERITE PROJECTS

SCANDIUM BREATHES NEW LIFE INTO OLD GREENVALE NICKEL MINE

By

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ABSTRACT

Metallica Minerals Ltd (ASX:MLM) is planning to install a high-pressure acid leach (HPAL) operation at its tri-metal flagship NORNICO project. The mineral resources of which are primarily located between the townships of Mt Garnet and Greenvale in North Queensland. Metallica's initial development focus is in NORNICO's southern area which includes the remaining nickel-cobalt laterite resources at the Greenvale Nickel Mine site and the scandium-cobalt rich nickel resources at the Lucknow deposit near the Greenvale township. The project also encompasses the Bell Creek nickel-cobalt resource (32km south of Mt Garnet), the Minnamoolka nickel resources (30km south of Bell Creek) and the cobalt-scandium-rich Kokomo nickel resource (55km north of Greenvale).

Although historically the Greenvale Nickel mine has yielded around 40Mt @ 1.56% Ni and 0.12% Co, there remains for the NORNICO project, in the 200km long belt, a combined JORC nickel-cobalt Resource of 50.3Mt @ 0.81% Ni and 0.09% Co. In addition the project contains a combined scandium resource of 16.8Mt @ 130g/t Sc. It is the latter, along with novel, proprietary process technology capable of recovering high purity scandium oxide, that will enable Metallica to breathe new life into the historic Greenvale nickel mine and adjacent ore bodies. The intent is to process 750,000tpa of combined nickel-cobalt-scandium laterite ores for at least 20 years, increasing the scandium production in step with the increasing scandium demand anticipated once this reliable, long term supply becomes available to key customers.

This presentation will provide an update of the project status and an overview of the environmental, metallurgical and engineering work currently in progress to expedite the project and, subject to a Feasibility Study, meet Metallica's planned development schedule through to process plant commissioning in late 2015.

RECOVERY OF NICKEL AND COBALT FROM THE WEDA BAY LATERITIC DEPOSIT (HALMAHERA, INDONESIA) USING AN ATMOSPHERIC LEACHING PROCESS

By

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ABSTRACT

The Weda Bay Nickel Project comprises the establishment of mining, hydrometallurgical processing and support infrastructure facilities in the Bay of Weda on Halmahera Island in East Indonesia where PT Weda Bay Nickel (WBN) holds the rights to develop a major nickel-cobalt laterite resource under a Contract of Work (COW) with the Government of Indonesia.

The process has been specifically design to accommodate the specificity of the ore resources: high saprolite ratio, difficulties and low interest to separate the different lithological horizons (limonite, earthy or rocky saprolite), high level of serpentinization.

The custom made atmospheric leaching approach and the retained solution processing have been retained to accommodate the resources specificities, to take into account the business model objectives, the site conditions and the stringent objectives for health, safety and environment.

The paper describes the main features of the retained process and the key drivers behind the retained options.

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PROCESS TECHNOLOGY

ADVANCED CONTROLS FOR HEAP LEACH DRUM AGGLOMERATION

By

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ABSTRACT

Recent work has shown that the quality of the agglomerates, produced for heap leaching, are an integral part of ensuring fast kinetics for the recovery of the target metal values. The moisture content is the critical parameter that produces a tighter agglomerate size distribution. However too high a moisture content can cause materials handling issues, as the agglomerates become too sticky. With even higher moisture contents the agglomerate structure collapses as the solids enter the plastic state.

The other key variable to faster leach kinetics is the addition of the correct amount of acid to the agglomeration process. The acid addition rate is a function of the main gangue acid consuming minerals. These can be characterised by their marker elements that relate directly to the gangue mineralogy. Acid addition rate is not normally changed very often; and over or under use is common.

Existing controls on agglomerate quality are basic with acid and moisture added on a mass ratio to the feed solids. These are adjusted periodically (every few hours or days) based on manual empirical test such as the squeeze and drop-shatter tests. Short term changes in ore characteristics are not considered due to the lack of real time agglomerate quality measurement.

By making use of existing on-line instrumentation, the quality of agglomerates can be improved significantly: with control of acid addition based on marker element analysis, and moisture addition based on the physical attributes of the resultant agglomerates. All of this instrumentation is commercially available and can be added to the existing controls to provide the benefits of improved leach kinetics and acid consumption management. Specific instruments and control algorithms are described along with methods of incorporation in the plant.

TOPSØE WET GAS SULFURIC ACID (WSA) TECHNOLOGY – A FEASIBLE WAY TO HANDLE SO_2 GASES

By

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ABSTRACT

This paper describes the Topsøe WSA technology which was developed and commercialized during the early 1980s. The technology has, in practice, proven to be viable in treating SO_2 bearing off-gases from non-ferrous operations ever since Topsøe commissioned the first WSA plant to treat molybdenum sulfide roaster off-gas in 1986. The WSA technology has demonstrated its superiority when it comes to total lifetime cost, taking not only the low investment cost, but also the attractive operating income into consideration.

The WSA technology is well suited for production of concentrated sulfuric acid of commercial quality from the sulfur dioxide (SO_2) gas that inevitably emerges from the metallurgical processes. Some of the features that make the WSA technology attractive for this application are:

- High SO_2 conversion rates (>99%)
- High energy efficiency leading to a low autothermal point (~ 3% SO_2)
- No need for gas cooling and drying to produce concentrated sulfuric acid
- No production of waste
- Very low cooling water consumption

This paper will describe the WSA process principles and also highlight features that make this process attractive for handling SO_2 gases.

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ELECTROWINNING

NOVEL DSA® ANODE FOR ELECTROWINNING OF NON-FERROUS METALS

By

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ABSTRACT

The result of extensive research into fundamental mixed metal oxide catalyst morphology has produced a next generation all titanium DSA® anode. This new DSA® anode, patent pending, is tailored for electrowinning of non-ferrous metals (copper, nickel, cobalt, zinc) by means of this new coating technology, already utilised in the chlor-alkali world. These DSA® anodes are characterised by a hanger bar with vertical distributor bars, having primary titanium mesh attached by weldments. The active mesh is provided with noble-metal electrocatalytic coatings, consisting of iridium and/or ruthenium oxides, obtained by thermal decomposition of precursor solutions applied to the titanium substrates. The catalytic activity of state-of-the-art DSA® anodes is improved by about 80 mV by controlling the crystallite size of the noble-metals without decreasing the decomposition temperature. It is known that below a certain value (typically 400°C) the stability of these oxides, and associated lifetime, is seriously compromised. A highly active DSA® anode, consisting of a quasi-amorphous phase, is obtained at high temperature (above 450°C), therefore not compromising lifetime performance. Through optimisation of these design parameters, the manufacture of these novel anodes was identified. DSA® anodes performance advantages include: lead-free 'green' all titanium anodes, true lead-free cathode quality, energy savings of 0.3 to 0.55 V can be realized depending on the EW application when compared to industry standard lead-alloy anodes, sustainability designed into long-life recoatable anode structures, increase plant cathode output through increased current density operations, eliminate need for cobalt sulphate addition required for lead anodes, improved plant on-stream production, no sludge generated or removed, and improved current distribution producing smooth high efficiency cathode.

DEVELOPMENTS IN NICKEL ELECTROWINNING CELLHOUSE DESIGN

By

[1]Tim Robinson, [2]Frank Crundwell, [2]Masatsugu Morimitsu,
[3]Lauri Palmu & [4]Torjus Akre

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Introduction

- Base metal electrownning design and technology development can be classified into three broad categories:
  - Increasing productivity
  - Energy reduction and efficiency
  - Acid mist reduction
- Ni EW focus is on acid mist reduction and elimination
- But energy reduction and improving productivity and capital cost reduction is important

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IX/SX

USE OF MOLECULAR RECOGNITION TECHNOLOGY TO ACHIEVE HIGH PURITY COBALT, NICKEL, AND COPPER

By

Neil E. Izatt, Ronald L. Bruening & Steven R. Izatt

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ABSTRACT

Modern technology requires ultra-pure cobalt, nickel, and copper for use in products that are critical to the economy. Impurities in these metals can result in serious impairment of downstream metal products through structural weakness or failure, lowered performance levels, diminished longevity, and increased danger of fire or explosion. Thus, a large economic incentive exists to produce these metals in highly purified form either from primary sources, waste streams, or recycling. IBC's Molecular Recognition Technology (MRT) process offers proven procedures, presently used commercially, for removing impurities from refining streams containing these metals. The MRT process is described with examples of its use together with a description of the technical and environmental advantages it offers to the metal refinery.

ELUTION STRATEGIES FOR RECOVERY OF NICKEL AND COBALT FROM LATERITE TAILS THROUGH SCAVENGING RESIN-IN-PULP

By

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ABSTRACT

The loss of residual nickel and cobalt to tailings streams represents a large inefficiency in many existing laterite operations. The majority of these losses can be avoided through treatment of tailings with scavenging resin-in-pulp. The resin produced through such circuits is loaded with a high proportion of impurity metals, complicating downstream processing. Selective elution of resin to recover nickel and cobalt preferentially over impurity metals can be carried out with multistage acid stripping or single stage ammoniacal stripping. Each option allows different methods for production of saleable material to reclaim value metal that would have otherwise been lost.

HYDROMETALLURGICAL NICKEL LATERITE PROCESSING: A REVIEW OF CURRENT SX FLOWSHEETS AND INDUSTRY TRENDS

By

Adam Fischmann, Shane Wiggett, Troy Bednarski, Violina Cocalia and Cyril Bourget

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ABSTRACT

The state of the art of nickel and cobalt solvent extraction in the nickel laterite industry is assessed, covering the reagents in commercial use (organophosphorus reagents, carboxylic acids, chelating oximes and amines), research developments and chemical fundamentals that result in the different approach taken with each of the reagent types.

RECOVERY OF COPPER FROM STRONG CHLORIDE SOLUTIONS BY SOLVENT EXTRACTION

By

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ABSTRACT

A new mixed solvent extraction system consisting of LIX 63, LIX 860 and TBP was developed to extract and transfer copper from strong chloride solutions to sulphate solutions for conventional electrowinning. Copper is separated from other base metals such as iron, nickel, zinc, etc. in extraction. The co-extracted impurities are removed with reasonably strong chloride solution by scrubbing. The chloride in the impurity-removed organic solution is scrubbed with weak chloride solution. Copper is readily stripped from the scrubbed organic solution to generate copper electrolyte containing very small amount of chloride (36 mg/L) and iron (5 mg/L) suitable for electrowinning. Further research work is required to optimise the organic system and the iron and chloride scrubbing steps.

Based on the new mixed solvent extraction system, a conceptual process flowsheet has been proposed with the advantages of:

- Copper can be transferred from chloride to sulphate solution with one solvent extraction circuit.
- No expensive base is required for copper extraction and transfer to sulphate solution for electrowinning.
- Iron, other base metals and chloride can be scrubbed from the loaded organic solution.
- Copper can be readily stripped to recycle the organic solution and generate suitable electrolyte for electrowinning.

CHUQUICAMATA RETROFIT AND FRANKE - RECENT CU SOLVENT EXTRACTION PROJECTS IMPLEMENTED BY OUTOTEC

By

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ABSTRACT

Development of Outotec VSF® technology dates back to the 1970's, the first commercial application being Kokkola Mo SX Plant in Finland (1977). Zaldívar in Chile was the first Cu SX plant to utilize the technology (1995), which has gone through several versions and incremental improvements from the first projects to the most recent. The latest projects are retrofit project of Chuquicamata Oxide Plant Train A (start-up in 2008), Franke Cu SX-EW (2009), Assarel Cu SX-EW (2010), Tia María Cu SX-EW (start-up date unknown), Caserones Cu SX-EW (2012), a confidential U SX project (2012) and a confidential Co/Ni SX project (after 2015).

The objective of this paper is to discuss the experiences of the Chuquicamata and Franke projects and specifically the results of technological improvements implemented in them. The Chuquicamata retrofit project was the first of its kind executed by Outotec, with incorporation of VSF technology in an existing, operative solvent extraction train to increase its PLS processing capacity. Downtime required for the installation of VSF equipment was minimized by incorporation of by-pass pipelines to the separate stages and installing the VSF equipment stage by stage, keeping the train in operation during the whole intervention sequence. In the Franke Project, a new concept of combined Washing stage and Loaded Organic tank was utilized for the first time, providing approximately 15% CAPEX reduction for the SX plant. Additionally, Outotec® Reverse settler design was utilised in order to further optimize the plant layout in terms of operational ergonomics.

CENTRIFUGATION SOLUTION FOR CRUD TREATMENT IN HYDOMETALLURGY PROCESSES

By

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ABSTRACT

In the hydrometal process, the presence of the so-called “crud” is a constant challenge in solvent extraction. Crud is a stable emulsion which forms along the interface between the aqueous and organic phase. The spread is influenced by the following parameters: first, wind blows the dust and impurities into the open sedimentation tanks. Second, the undissolved solids such as sand transported in the PLS cause problems in conjunction with incorrect agitator design.

The crud fraction can decisively impact the efficiency of the hydrometal extraction because the phase interface can constitute a large fraction and the sedimentation tanks cannot react flexibly to it. In the downstream process of the series-connected sedimentation tanks, they are thus all contaminated with crud. At the same time, the necessary mass transport is significantly impeded at the phase boundary between organic phase and aqueous phase due to the crud formation.

The transfer of the organic phase into the electrolysis cell can result in a “burnout” of the cathode. The carry-over of this electrolyte into the extraction can cause problems with the pH regulation. The carry-over of the organic components into the raffinate also leads to contamination of the leaching circuit.

The continuous treatment of the crud with a 3-phase decanter centrifuge is extremely effective in combating this. This technology splits all three phases from each other and they are consequently continuously separated. All subsequent process steps exhibit a stable, uniform effectiveness. The main advantage for the user is that fluctuations in the process are eliminated and the organic phase can be recirculated back to extraction. The recycling of the solvent alone justifies the investment in less than 6 months as examples from South Africa and Chile show.

To operate solvent recovery in daily operation fully automated online at the optimum limit, the decanter centrifuge is equipped with a concentration-dependent pond adjustment called DControl®. By this means, the users can be guaranteed the maximum possible solvent recovery and minimise the solvent costs in this process step. This system is presented in detail in this paper.

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FLOTATION

FLOTATION OF OXIDE COPPER ORES: A REVIEW FROM LABORATORY TESTING TO INDUSTRIAL PRACTICE

By

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ABSTRACT

Flotation has been used for many years as a method for recovering and upgrading oxide copper minerals into mineral concentrates. The traditional approach has been based on sulphidisation of the oxide copper minerals surfaces followed by collector to render these surfaces hydrophobic. Sulphidisation processes usually are very effective and efficient at laboratory scale, however are more problematic at industrial scale leading to inferior plant performance compared to laboratory performance. In more recent times, the use of hydroxamate collectors has been demonstrated to be effective at both laboratory and industrial scale for oxide copper mineral flotation, and commercial quantities of hydroxamates are now available for commercial use.

(Note: Author unable to attend the Conference)

THE FROTH FLOTATION OF NICKEL SULPHIDE ORE USING PAX AND ITS MIXTURES WITH DTC AND DTP

By

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ABSTRACT

Froth flotation is a method used to separate the desired mineral particles from the associated gangue mineral based on the differences in their hydrophobicity. It is used to treat nickel sulphide ores containing pyrrhotite, pentlandite and magnesium oxide. The Collectors are the reagents used in the froth flotation to impart the hydrophobicity to the desired mineral.

Potassium amyl xanthate (PAX) is one of the preferred collectors used in froth flotation of nickel sulphide ores. The xanthate collectors are sensitive to pH and their selectivity in treating complex ores is questionable. With deteriorating nickel sulphide ore reserves more selective collectors have to be used in the extraction of nickel. The dithiophosphates are believed to be more selective than xanthates but cost more.

The addition of a second collector in the froth flotation system improves surface coverage which is promoted by the collector co-adsorption. The synergistic effects or linear summation of constituents' adsorption characteristics may improve the overall flotation performance with regard to recovery and grade.

PAX was mixed with either sodium di-methyl dithiocarbamate (di-C_1-DTC) or sodium di-ethyl dithiophosphate (di-C_2-DTP) to investigate whether there were any improvements in recoveries and grades compared to pure xanthate collectors. The following mixtures were tested in this work

90% PAX and 10% di-C_1-DTC; 90% PAX and 10% di-C_2-DTP; 70% PAX and 30% di-C_1-DTC; and 70% PAX and 30% di-C_2-DTP

This study showed that the mixture 90% PAX and 10% di-C_1-DTC yielded higher nickel recovery and nickel grade than the pure PAX. It was not beneficial to use both mixtures of PAX with di-C_2-DTP. The nickel recoveries and nickel grades obtained with the use of these mixtures were lower than those obtained with pure PAX.

(Note: Author unable to attend the Conference)

ALTA 2012
NICKEL/COBALT/COPPER

COBALT RECOVERY

NOT JUST ANOTHER COBALT RESOURCE- REVIEW OF COBALT PROCESSING AND THE VALUE OF TEST WORK.

By

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ABSTRACT

As a member of an engineering and procurement company our primary function is to assist our clients with detail engineering and costing of the ore process plant. The process of arriving at the final design often but not always follows the following steps:

A scoping study
A pre-feasibility study
A feasibility study
And finally a bankable study

Each step has been honed over the years/months to produce a more accurate level of engineering and along with that a more detailed costing, culminating in an overall financial model that either indicates the need to build a process plant.

More often than not one of the criteria for an EPCM selection is the amount of in-house expertise or experience from consultants with the applicable commodity.

Why test work? Surely similar ores bodies should exhibit similar characteristics.

It can be debated that the cost of test work is a long and often tedious process, further made arduous by overloaded and understaffed laboratories.

So is test work over rated can you get away with none or at least very little? Secondly what is the lost opportunity cost? Thirdly and more importantly is whose money am I spending? And what are the conditions attached.

This paper attempts to compare two process plants, one built with little or no test work and one with a large amount of test work- not yet built.

THE HYDROMETALLURGY AND ACTIVITIES AROUND COPPER AND COBALT RECOVERY IN THE AFRICAN COPPERBELT

By

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ABSTRACT

The Copperbelt in Central Africa, which includes Zambia and the Democratic Republic of Congo (DRC), are well-known mineral-rich mining areas. Interest in the Copperbelt has resurged in recent years, primarily due to the upturn in international commodity prices and major projects have been commissioned or expanded in the Copperbelt over the past 5 years. Generally, projects in these areas produce copper metal as primary product, with an intermediate cobalt precipitate or cobalt metal as a by-product.

Hydrometallurgical processing forms an integral part of the recovery and purification of copper and cobalt. The conventional hydrometallurgical approach for treating ores in this region involves a sulphuric acid leach circuit in a loop with Cu solvent extraction and Cu electrowinning. In order to recover and purify cobalt, a copper raffinate bleed stream is typically taken from which impurities are removed and the cobalt is upgraded in multiple unit operations. The complexity of the downstream purification of cobalt is dependent on the type and purity of cobalt product that is to be produced, and the value that could be realised for the specific product.

Macro-economic factors such as the social and political environment, resource size, value metal grades, local infrastructure, environmental aspects, and certain other risks are critical considerations for process selection and financial investment. Some of these aspects are discussed hand-in-hand with the metallurgical processing options for projects in the Copperbelt.

ALTA 2012
NICKEL/COBALT/COPPER

EQUIPMENT & MATERIALS

THE NEXT GENERATION OF PUMP TECHNOLOGY IN PAL PLANTS

By

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Presenter

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ABSTRACT

PAL plants require the use of special pump equipment, not only for Autoclave feeding but also for acid supply, thickeners, choke water, seal water make-up and transportation such as slurry pumping from the mine to the plant and tailings transport from the plant to the reservoir.

The pumps for these applications have a common key characteristic: They have to ensure efficient and reliable operation under the most arduous of operating conditions. For this reason, selection of the most suitable pump technology and construction materials is most vital.

The MULTISAFE double hose-diaphragm pump is the best suited pump type for these applications. The fluid is linearly conveyed through the double hose-diaphragm and does not get in contact with the pump head housing. Two hose-diaphragms provide a double hermetic sealing from the hydraulic drive end.

Latest ball valve technology and the respected material selection ensure long life time, fastest valve change (Quick Change System) and lowest spare part costs.

Covering a range from 1m³/h up to 1000m³/h and pressures up to 400bar, various MULTISAFE gear and pump head combinations provide the best fit for all applications. The new single-acting quintuplex MULTISAFE (QGK) reciprocating pumps are able to reduce the kinematic irregularity down to just 5.1% (vs. 23.0% for that of single-acting three cylinder pumps) even without a pulsation dampener.

The MULTISAFE pumps provide the highest energy efficiency of all types of diaphragm pumps and help to reduce the energy costs tremendously.

NUMERICAL DESIGN TOOLS OPTIMIZE AGITATORS, VESSELS AND INTERNALS TO ENSURE SAFE AND ECONOMIC PLANT OPERATION

By

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ABSTRACT

The Increase in profitability is a common 'must' for production processes. In minerals processing this can be observed with production plant sizes being constantly increased and the requirement of higher plant availabilities. In hydrometallurgical plants agitated tanks are for example employed for atmospheric leach, neutralization etc. applications. Requirements in these applications can be very complex since quite often multiple phases have to be processed. This might require agitator designs with an increased level of power input leading to high dynamic loads on the vessel itself and all vessel internals such as feed pipes. These have to be considered with regard to safe operation to avoid resonance problems etc.

Although the classical methods of process and mechanical engineering are still indispensable new numerical methods are well established to design these complex agitated systems.

This paper presents examples of applications where numerical analysis has benefits. One example shows the importance of the educt feed positions required to generate a homogeneous product in a continuously operated reactor, another process oriented example illustrates the loads imposed on internal parts in a large vessel.

MORTARS FOR ACID RESISTANT BRICK LININGS IN HYDROMETALLURICAL APPLICATIONS

By

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ABSTRACT

The application of hydrometallurgy in the recovery of nickel, copper gold and other metals continues to grow. Acid brick linings have been proven to provide economical and reliable service in acid leach vessels, pressure oxidation autoclaves, pressure let down vessels, and other related equipment. Careful attention must be given to all of the components including the mortar selection and application to achieve a reliable lining system. An understanding of the properties and limitations of the mortar as well as the process conditions will allow for the selection of the best mortars to provide a reliable lining.

ALTA 2012
NICKEL/COBALT/COPPER

HYDROPROCESSING OF SULPHIDES FORUM

ALTA NICKEL-COBALT-COPPER 2012
KEY NOTE ADDRESS
HYDROPROCESSING OF SULPHIDES - WHERE ARE WE AND WHERE ARE WE HEADING?

By

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The University of British Columbia

UBC Vancouver

- 5 Affiliated Teaching Hospitals
- 12 Faculties; 2,181 FT Faculty
- 36,630 undergraduate students
- 8,680 graduate students
- 402 hectare campus

UBC Okanagan

- 7 Faculties; 275 FT Faculty
- 5,071 undergraduate students
- 325 graduate students

BACTERIAL LEACHING AT ELEVATED pH USING BIOHEAP™ TECHNOLOGY

By

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ABSTRACT

Many low grade nickel sulphide ores are hosted in gangue containing high levels of magnesium silicates, which consequently consume a large amount of sulphuric acid in conventional bacterial leaching scenarios where solution pH's below 2 are required. BioHeap has developed a saline tolerant bacterial culture using patented methods, that is capable of operating at elevated pH's at levels where ferric iron precipitates out of solution. Operating at elevated pH has the dual advantage of significantly reducing the acid consumption and reducing limestone demand for iron disposal.

Further work is planned to critically compare the performance of the high pH culture against cultures operating at conventional pH and to expand the range of cultures that are capable of operating at high pH.

BULK NICKEL-COPPER CONCENTRATES A COMPARISON OF TWO HYDROMETALLURGICAL PROCESSING OPTIONS

By

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Outline

Background

- Concept of Mine-to-Metal
- CESL Technology
- Nickel Resources
- Bulk Ni-Cu concentrates

Case Study

Conclusions

THE APPLICATION AND ECONOMIC CONSIDERATION OF NSC PRESSURE OXIDATION TO COMBINED COPPER MOLYBDENUM CONCENTRATES

By

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ABSTRACT

The need for copper and molybdenum continues to grow as does the need for clean efficient metallurgical technologies capable of treating mixed metal concentrates. Currently, the use of hydrometallurgical pressure oxidation for copper concentrate treatment is growing. Furthermore, with limited molybdenum roasting capacity, stringent industrial molybdenum concentrate roaster feed specifications, poor rhenium recoveries, and the inherent environmental issues associated with pyrometallurgical treatments, hydrometallurgical options are also now being pursued for molybdenum concentrates. Moreover, given the inherent grade, recovery and cost inefficiencies in the differential flotation process normally employed for molybdenum concentrates produced as a by-product of copper mining, there is a growing need to directly treat combined bulk copper and molybdenum concentrates. This minimizes molybdenum concentrate roasting limitations, specifications and requirements, while allowing simplification of increased efficiency of and cost reductions in upstream mineral processing circuits now producing separate copper and molybdenum concentrates by differential flotation. It would also allow more direct and efficient recovery of rhenium. Finally, hydrometallurgical technology will also reduce the need for costly final molybdenum concentrate impurity treatment circuits, thereby allowing for lower grade mixed metal molybdenum concentrates to be treated directly for a greater metal value realization. In summary, industrial nitrogen species catalyzed (i.e. NSC) hydrometallurgical pressure oxidation has many advantages over conventional pressure oxidation systems and offers a tangible process route to treat mixed bulk concentrates. This updated study illustrates the fundamental concepts, confirmatory testing, application, proposed design and associated cost estimates for the development and industrial implementation of this proven mode of hydrometallurgical processing as applied to copper, molybdenum, rhenium concentrates.

DEVELOPMENTS IN THE TREATMENT OF COPPER-ARSENIC CONCENTRATES

By

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ABSTRACT

Treatment of copper-arsenic concentrates has in the past presented technical difficulties both in achieving acceptable copper leach recoveries and fixing the arsenic in an environmentally acceptable form. Arsenic grades in copper concentrate in excess of 0.5% As are difficult to ship globally and to place with smelters. A hydrometallurgical alternative to smelting is presented which provides high copper recoveries and stabilises the arsenic as scorodite in the residues.

Ongoing testwork on the Galvanox™ process at the University of British Columbia (UBC) has identified an alternative catalyst suited to leaching copper-arsenic minerals and subsequent piloting has confirmed its utility.

A modified Galvanox™ flowsheet comprising an atmospheric leach circuit followed by solid/liquid separation and copper SX/EW has been developed based on this work where activated carbon is used to catalyse copper-arsenic minerals and pyrite oxidation is used to heat the reactors and provide iron to precipitate the arsenic leached as scorodite. The autoclave required in the typical Galvanox™ circuit is not required for this circuit configuration.

Capital and operating costs for this flowsheet have been developed.

APPLICATION OF MIXED CHLORIDE TECHNOLOGY FOR THE RECOVERY OF TIO_2 AND BASE METALS

By

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ABSTRACT

Increasingly attention is being paid to the efficiency of separation steps, as it leads to improved product recovery and environmental compliance. An understanding of aqueous chemistry is very important for this purpose. The paper will discuss the use of chloride technology to recover Ni, Co and TiO_2 from a variety of feed materials. The flowsheets developed are efficient and environmentally friendly.

DEVELOPMENT OF A VERSATILE HCL-LEACH BASED METAL EXTRACTION TECHNOLOGY STACK

By

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ABSTRACT

In this paper, hydrometallurgical process steps for separating metals from iron bearing brines, which could be suitable for processing complex ores, are presented. These process steps include pyrohydrolysis, vacuum evaporation, autoclave oxidation, selective ferric chloride hydrolysis, and selective metal chloride crystallization.

For the separation of nickel and cobalt from iron, experiments concerning the hydrolysis of ferric chloride are performed. It can be shown that produced hematite contains only traces of nickel and cobalt. In another set of experiments, nickel chloride and cobalt chloride are selectively precipitated from a ferric chloride solution by increasing the free hydrogen chloride concentration in the solution.

Based on the experiments performed, an exemplary flow sheet for processing a representative nickel laterite ore is presented. Based on the assumptions made, for an iron-to-nickel-ratio of 20:1, approx. 510 MJ of caloric energy are necessary for delivering 1 kg nickel (as nickel chloride dihydrate).

Challenges and risks of introducing new chloride hydromet processes are discussed in this paper; reference is also made to some experience gained while building the first large scale hydrolytic distillation facility for ferrous chloride at a customer in Alabama, USA.

KELL HYDROMETALLURGICAL PROCESS FOR EXTRACTION OF PLATINUM GROUP AND BASE METALS FROM FLOTATION CONCENTRATES – AN UPDATE

By

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ABSTRACT

The Kell Process has been developed for extraction of platinum group metals (PGM) and base metals from sulfide flotation concentrates. The process has been successfully tested on several different sulfide flotation concentrates, including those from the UG2 chromitite horizon, the Platreef mafic/ultramafic layer and the Lake Superior mid-continent rift. It has been shown to provide high (>95 per cent) and selective extraction efficiencies for the key valuable metals, i.e. Pt, Pd, Rh, Au, Ni, Co, Cu.

The Kell Process consists of several commercially proven unit operations. S, Ni, Co and Cu are first selectively removed by use of a pressure oxidation step during which the dissolution of PGM is minimized. The residue from pressure oxidation is subjected to a thermal treatment to ensure efficient PGM recovery by subsequent chlorination. All the core steps are very similar to well proven conventional unit operations in common use, as are the subsequent metal recovery steps to provide marketable end products. Typical metallurgical responses of flotation concentrates from UG2 and Platreef to the Kell Process are provided and key outcomes of an energy comparison study with smelting are summarized in this paper.

Kell presents a potentially substantial improvement in PGM and base metal concentrate processing technology, in terms of economics via much reduced power costs, ease of processing, and various environmental benefits. It allows for the treatment of high-chromium low-grade 'dirty' concentrates, such as secondary concentrates from the platinum industry's 'mill-float-mill-float' (MF2) flotation circuits and concentrates from retreatment of tailings. It allows greater concentrate mass pulls, higher tolerance to gangue intergrowths in concentrates and its use can provide substantial increases in overall PGM recovery. Its adoption would be a step change in the platinum industry, and given the commercially proven unit operations embodied in the Kell Process, at much reduced risk compared with other more experimental technologies. Since the initial process development work significant improvements and refinements have been introduced as a result of further comprehensive testing, engineering and process modelling. Pilot-scale testing and engineering study work is in progress for several mining operations and proposed projects.