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Uranium-REE Conference

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ALTA 2013

25 May - 1 June

Perth, Western Australia

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PROCEEDINGS OF ALTA 2013 URANIUM-REE SESSIONS

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ALTA Metallurgical Services Publications

ALTA Metallurgical Services was established by metallurgical consultant Alan Taylor in Melbourne, Australia in 1985, to serve the worldwide mining, minerals and metallurgical industries.

Conferences: ALTA convenes international technical conferences, trade exhibitions and technical short-courses. The event is held annually in Perth, Australia. The event comprises three conferences over five days: Nickel-Cobalt-Copper, Uranium-REE and Gold. ALTA conferences and exhibitions have become established as major events on the international industry calendar.

Publications: Sales of proceedings and manuals from ALTA Conferences, Seminars and Short Courses.

Short Courses: Technical Short Courses are presented by Alan Taylor, Managing Director and Conference Convener.

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	2010 Uranium
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	1998 Nickel-Cobalt Forum
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ALTA SHORT COURSES	SX and its Application to Copper, Uranium and Nickel-Cobalt
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	Treatment of Nickel-Cobalt Laterites
	Uranium Ore Treatment
	A-Z of Copper Ore Leaching
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	Copper Oxide Ore Heap Leaching Testwork and Scale-Up

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Uranium-REE Proceedings

Keynote Address

ION EXCHANGE TECHNOLOGY
A NEW POLYMER FOR RESIN-IN-PULP TECHNOLOGY

By

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Project Development

LETLHAKANE URANIUM PROJECT

By

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A-CAP Resources Ltd, Australia/Botswana
David Cairns, Consultant, Australia
Alan Taylor, ALTA Metallurgical Services, Australia
Grenvil Dunn, Orway Mineral Consultants, Australia
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Highlights

Advanced Uranium Development Project – Scoping Study Completed

- Total resource of 350 million lb U_3O_8
- Includes 90 million lb U_3O_8 higher grade resource at 284ppm U_3O_8
- Significant initial production *(3Mlbs pa)* with Long Mine Life *(+20 years)*
- Low risk mining method – ore body is shallow, soft and flat
- Low capital cost with high recoveries (up to 77%) averaging 71.5%
- Mid range, predictable forward operating cost
- Well established infrastructure in Botswana, a stable and mining friendly country
- Assets includes major new coal deposits

RESOURCES REGULATION UNDER HARMONISED LEGISLATION

By

Simon Ridge
Department of Mines and Petroleum, WA, Australia

Presenter and Corresponding

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What were the drivers for change?

- Multiple reviews culminating in the Kenner Report April 2009: 119 recommendations
- A burgeoning resources sector with $109 billion in project commitments and growing
- A series of fatal and serious events in the resources sector
- A strong minister willing to act

REVIEW & ENHANCEMENT OF ENVIRONMENTAL REGULATIONS APPLYING TO URANIUM IN WA

By

Daniel Endacott

Department of Mines and Petroleum, WA, Australia

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Outline

- Overview of Uranium in WA
- Regulatory framework in WA
- Review of Regulations for Uranium mining
- Reforming Environmental Regulation
- Key focus areas for Uranium assessments

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Process Technology

CURRENT CHALLENGES WITH THE PROCESSING OF URANIUM ORES

By

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ABSTRACT

Australia has the potential to be the world's top uranium producer however development of new uranium projects has slowed throughout the world.

The crisis at the Fukushima nuclear plant in Japan after the tsunami killed off the world's appetite for nuclear energy and with it the price for yellowcake – making it so low that most projects other than Insitu Leach (ISL) are not viable. A number of projects are on hold waiting for the uranium price to improve.

This paper addresses the three options of uranium mining and its associated processing options including their long term sustainability in the current climate considering political implications of mining uranium ores.

RECENT ADVANCES IN ION EXCHANGE TECHNOLOGIES FOR URANIUM RECOVERY

By

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Selected References for Lewatit® in Mining Industry

Country/Region	Application	Resin
Macedonia	Copper recovery	TP 207
South Africa	Copper removal from nickel/cobalt concentrate	TP 207
Canada	Purification of a cobalt electrolyte (copper & zinc removal)	TP 207 & VP OC 1026
APAC	Copper, zinc & cobalt removal from a nickel concentrate	M+ TP 207 & M+ MP 64
China	Copper from waste water	TP 207
Zambia	Cobalt removal from waste water	TP 207
Canada	Nickel & cobalt removal from ground water	TP 207
Canada	Ground water remediation (nickel removal)	TP 207
Australia	Nickel recovery	TP 208
South Africa	Zinc removal from a nickel/cobalt electrolyte	VP OC 1026

HEAP LEACH HEIGHT AND RECOVERY ESTIMATES FROM COLUMN LEACH TEST RESULTS

By

[1]T Apelt, [1]K Forrester, [1]M Short and [2]L Stefan

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Presenter

Michael Short

ABSTRACT

Macusani Yellowcake Incorporated (MYI) is investigating the exploitation of its properties on the Macusani Plateau in south-eastern Peru. GBM Minerals Engineering Consultants Limited (GBM) has been engaged by MYI to assist with the completion of NI 43-101 compliant studies. In the current Preliminary Economic Assessment (PEA), a dynamic on/off heap leach pad has been designed to extract uranium from the fast-leaching ore, processing the ore at 12.1 Mt/y at a U_3O_8 grade of 212 ppm.

This paper describes a method used to determine the optimum heap height and corresponding recovery. The design base case is described with reference to column test work results. To address design challenges and scale-up issues, this paper also describes a relationship between leach extraction and grade, a leach extraction model, the recovery discounting applied, the financial parameters used, and the calculation sequence.

The results include relationships for leach recovery, lost revenue and pad cost by heap height. For this study, the optimum heap height is 7 m, the corresponding leach recovery is 88% and the heap cycle rate is 2.4 cycles per year.

DEVELOPMENT OF A PROCESS PROXY TO DETERMINE THE LEACHABILITY OF URANIUM ORE SAMPLES

By

Nicole L. Turner, Laura L. Kuhar and David J. Robinson

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ABSTRACT

Fully monitored, time consuming and costly conventional industry batch tests are often used to determine the leachability of uranium ore samples. The aim of this study was to develop a small-scale, affordable and relatively rapid process proxy that could be used as an alternative leach proxy for application to a large number of samples. Three experimental leach test protocols termed mild, moderate and aggressive leaches, were applied to eleven ore samples with varying uranium concentrations and deportment, gangue metal concentrations and acid consumption to assess their uranium leaching performance. Previous studies on uranium leaching identified acid concentration, oxidation reduction potential (usually by varying ferric to ferrous ratio) and temperature as the three main parameters that affect uranium dissolution. Experimental leach conditions were therefore modified by changing these three parameters with kinetic sampling conducted on all samples. Results from over 60 small-scale leach tests on the eleven samples correlated well with data from the conventional industry batch laboratory tests. The leaches developed would allow one to assess the “easily” (mild test) and “less easily” (aggressive test) leached uranium as well as the “unleachable” fraction (by difference between total uranium and aggressive leach results) and could be conducted within four hours, using a tenth of the sample mass required for the conventional industry batch tests. These tests would be useful in a number of applications, such as process design and optimisation and characterisation of the leachability of samples in an ore deposit.

THE KVANEFJELD PROCESS

By

DGI Krebs and D Furfaro

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ABSTRACT

Greenland Minerals and Energy Ltd ('GMEL' or 'the Company') is a mineral exploration and development company operating in southern Greenland. The Company is primarily focused on advancing the 100% owned Kvanefjeld multi-element project (both light and heavy rare earth elements, uranium, and zinc) through the feasibility and permitting phase and into mine development. Through a rigorous technical program an optimum flowsheet was identified and developed. The flowsheet consists of flotation to produce a mineral concentrate and then atmospheric sulphuric acid leaching of the concentrate. This paper describes the hydrometallurgical treatment of the Kvanefjeld Mineral concentrate. During the hydrometallurgical treatment the secular equilibrium of the naturally occurring radioactive materials is disturbed. The deportment of these radioactive elements is described along with removal methods to prevent contamination of the rare earth intermediate product.

URANIUM OVERVIEW: PRECIPITATION TO CONVERTER

By

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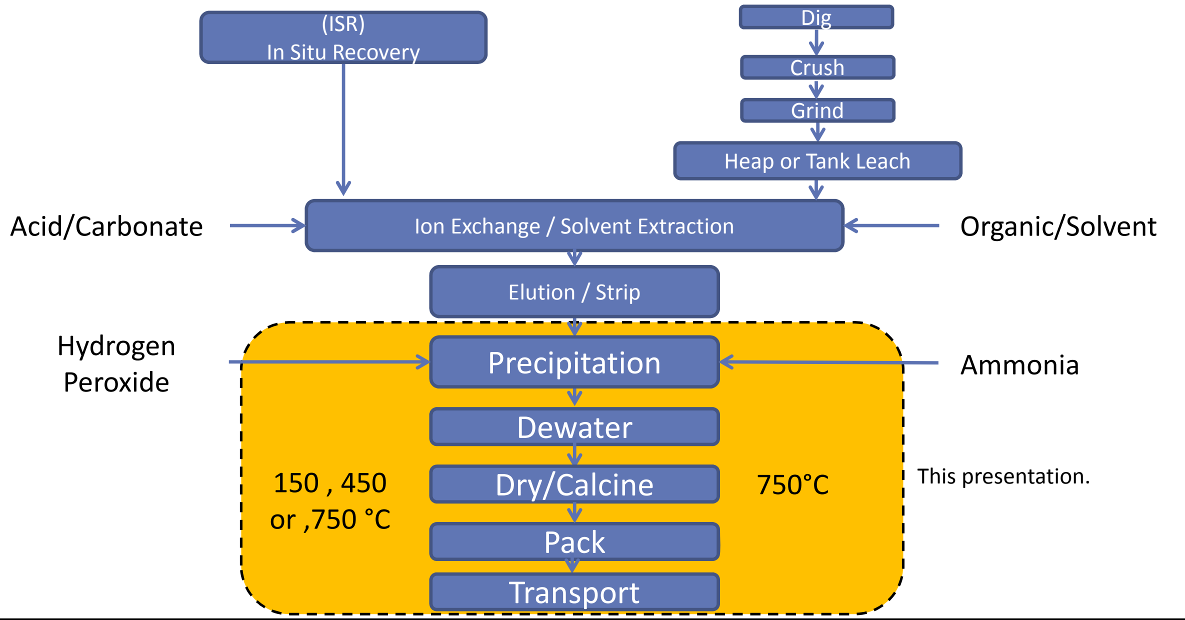
Uranium Process Flowsheet



URANIUM PROCESS SIMULATION

By

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About Us

- Established in 2007
- Extensive experience in uranium as well as nickel, cobalt, copper and PGMs.
- Established as a specialist provider of simulation services in the field of Hydrometallurgy
- Capability also covers process development, testwork management and scoping/ prefeasibility studies.
- Extensive experience in the development of novel processes

REMEDIATION OF ENVIRONMENTAL IMPACT OF ACIDIC DAM OF MINES THROUGH MEMBRANE PROCESS

By

[1]Renato Ramos, [1]Osmar Cunha, [2]Fabio Rodrigues; [2]Walter Scassiotti; [2]Mauricio Ribeiro; [3]Peter Aerts

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Presenter

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ABSTRACT

Today there are legislations and regulations concerning mining and mined land reclamation in most countries to prevent or minimize damage to mined lands. To conform with these regulations, the mining industry has developed and continues to develop pollution control measures and treatment strategies until some self regenerative treatment system with minimum maintenance and viable economics, replaces conventional treatment system. This paper details an industrial scale application using Nanofiltration membranes where Acid Mine Drainage from waste rock piles dam in a uranium mine (Brazilian Nuclear Industries, INB) located in Caldas, Brazil, has been treated in order to adequate a permeate water stream according the local legislation.

The Poços de Caldas mining site is located in the Minas Gerais state, in the southern region of Brazil. The mine was intended to produce 500t U_3O_8/year and 275t/year of calcium molybdate as a by-product and after 15 years (1982–1997) of operation, the uranium mining and milling operations have ceased. The operations gave rise to two main sources of contaminants to the environment; the waste rock piles (WRP) and the tailing dam. The aim of the application has been to remove $MnSO_4$ from an acid mine drainage water. Currently INB faces a process of site clean-up and it must to adequate manganese content of the dam according the local legislation (CONAMA 430/11) that limits to < 1 mg/L for environmental disposal. This study is referencing the use of Nanofiltration membranes for contaminant removal.

The 6 month large scale study concluded that the nanofiltration membranes had a great performance and 1) it was able to reduce sulfate, manganese and fluorine and to generate a permeate flow according the local regulatory for disposal in the environment or reuse. 2) It was proven that a correct operational action and a proper pre-treatment design can extend the lifetime of the membranes in tough waters as ARD. 3) Furthermore, an optimal anti scaling alternative was found for this particular water in the site. 4) From an economic perspective, the study shows that nanofiltration has a lower footprint and presents a lower OPEX alternative in terms of chemical consumption than physical chemical treatment.

This full scale study shows that ARD waters with high contamination can be treated with tailored nanofiltration membranes and optimized operational control and that nanofiltration is ready as a technology to be implemented in large scale in the mining reclamation of even more challenging waters.

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Rare Earth Elements

RECOVERY OF RARE EARTH ELEMENTS FROM COMPLEX AND LOW GRADE DEPOSITS

By

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ABSTRACT

Rare earth elements (REE) have gained prominence over the last few years due to concerns over a sustainable supply to meet the growing global demand. A number of REE deposits have been studied over the past 5 years, and most of these deposits are of relatively low grade. One of the most complex aspects of the recovery of REE from low grade ores is that almost every ore is different and requires a specific metallurgical process to optimise its potential value.

The generation of a REE concentrate that would be suitable as refinery feed from low grade and complex REE ores can be divided roughly into three processing stages, namely physical beneficiation, 'cracking' to reject REE precipitants such as fluorides and phosphates, and leaching of REE. In some cases, hydrometallurgical purification of the leach liquor might also be required to generate a product suitable as refinery feed. The selection of the metallurgical treatment options is initially based on a detailed understanding of the ore mineralogy and the chemical composition of the ore.

This paper describes the testwork conducted on complex ore samples of different mineralisations. The correlation between the ore composition and the metallurgical response for different treatment options is illustrated. Concurrently the technical criteria for the selection of viable process flow sheets are discussed which facilitate the generation of a suitable refinery feed whilst maximising the REE recovery.

CHALLENGES IN RARE EARTH PROCESSING

By

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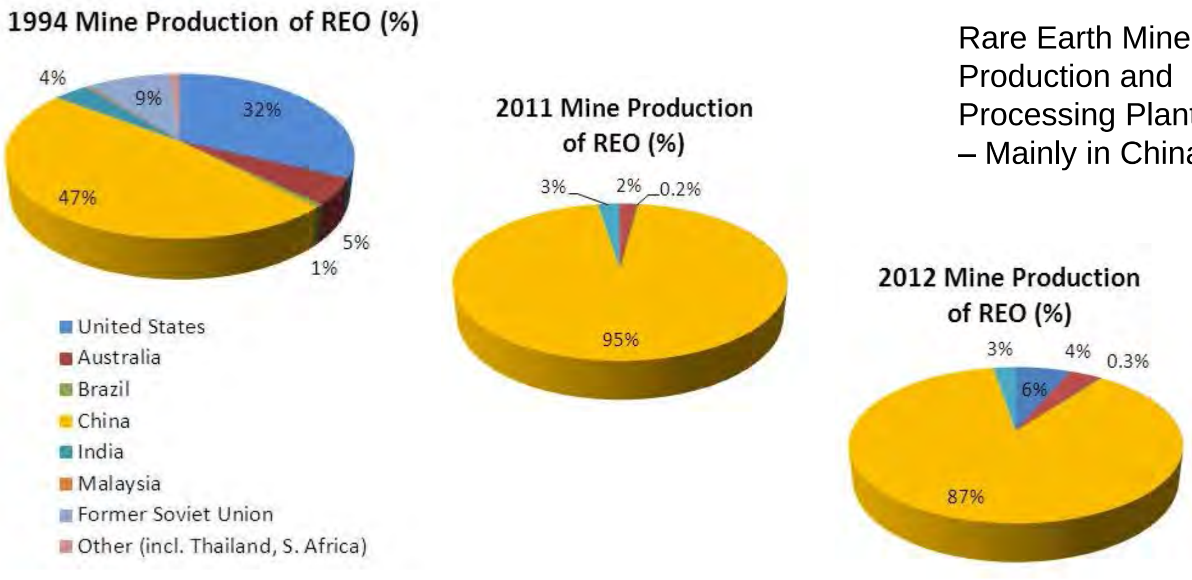
Rare Earth Mine Production and Processing Plants – Mainly in China



Rare Earth Mine Production

CENTRALIZED RARE EARTHS PROCESSING – CHALLENGES AND BENEFITS

By

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ABSTRACT

Processing and refining of rare earth elements are of pronounced interest in the world outside China. This was sparked mainly by concerns about reliability of supply since these elements have been declared strategic in both the USA and Europe. Two new non-Chines refineries, Molycorp (Mountain Pass, USA) and Lynas (Malaysia), due to come into full production in the near future, aim to address these concerns in the short to medium term. Depending on the world REE demand development, it is possible that additional capacity may be required in the longer term. The Molycorp and Lynas refineries are fed from world class deposits guaranteeing sufficient supply to feed these refineries at production capacities to render an independent refinery viable. However, smaller REE deposits or projects will in all likelihood not be able to attract the capital investment to build and operate refineries of sufficient size to make them economically viable. This spawned the concept of centralized refineries, which would treat and refine intermediate rare earth element products or concentrates from different producers. However, location and size of the current projects, costs of chemicals, environmental legislation and transportation costs might make even the production of a REE chemical concentrate on site by a producer challenging. The concept of centralized REE processing facility which will include cracking/leaching, purification and REE refinery is explored as an enabler to the development of these smaller deposits.

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SX

URANIUM RECOVERY FROM ALKALINE LEACH SOLUTION USING IONIC LIQUID CYPHOS 1L 101

By

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ABSTRACT

Solvent extraction technology has been widely used for metal recovery from leach solutions. However, until now, no suitable extractant has been found for uranium recovery from its alkaline leach solutions. In this paper, Cyphos 1L 101 (Cyphos 101), an ionic liquid of quaternary phosphonium, was studied for uranium recovery and separation from vanadium in alkaline leach solutions. It was found that high uranium extraction of more than 90% was obtained in the pH range of 10-12. In this pH range, the uranium extraction was much higher than that of vanadium. The extraction of uranium increased while that of vanadium decreased with increasing pH, indicating that increase in pH improved the separation of uranium from vanadium. The separation factor of uranium over vanadium reached 500-600 in the pH range of 11.5-12. Co-extracted vanadium could be scrubbed by NaOH solution at pH about 12. Uranium was stripped from the loaded Cyphos 101 by 0.5 M H_2SO_4. Chloride effect on the extraction of uranium and vanadium was studied. It was found that chloride significantly deteriorated the extraction of uranium and vanadium. Strict control of chloride concentration at a low level is required when Cyphos 101 is used for uranium extraction in alkaline solutions. Third phase could form if aliphatic diluent such as Shellsol D70 is used. Using long chain alcohol as the phase modifier or using aromatic diluents like Shellsol A150 as diluent could eliminate the third phase effectively.

CRITICAL ASPECTS FOR CONSIDERATION IN THE DESIGN OF A URANIUM SX CIRCUIT

By

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ABSTRACT

Solvent extraction is a well established processing route for producing uranium. Solvent extraction is a regular inclusion in designs of new uranium projects. Optimising the design of uranium solvent extraction plants results in significant capital cost savings, which can aid project viability. As such, it is important to understand the fundamental and critical aspects for consideration in the design of uranium SX circuits.

This paper highlights key decisions that need to be made for each uranium circuit and the basis for those decisions. A comprehensive test work campaign provides valuable information in the design of an SX circuit. It is important that a number of design considerations are included in the testwork program to ensure optimisation of the final testwork design. This additional information can be used to significantly reduce the number and size of mixer settlers reducing the capital cost of the plant and to minimise entrainment, significantly reducing operating costs.

Critical design aspects of a general SX circuit are discussed; particularly common problems with conventional mixer settler design and corresponding improvements to these designs. Finally the benefit of customised solvent extraction technology utilising CFD modelling is shown to illustrate how modelling the dispersion flow through the settler can identify improvements that enable high flux rates and even flow. This can be used in new settler design and to debottleneck existing operations to gain extra throughput with the same settler configuration.

+30Y KNOW-HOW: ANGLOGOLD ASHANTI'S SUP SX REPLACEMENT PROJECT

By

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Areas where experience has been implemented into the design

- Process configuration
- Fire prevention
- Fire protection
- Materials of construction
- Crud removal
- Modular design of mixer settlers & piping
- Maintenance accessibility
- Operating accessibility

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ION EXCHANGE RESINS FOR URANIUM RECOVERY: THE DURABILITY QUESTION EXPLORED

By
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ABSTRACT

The recovery of valuable metals from solutions and slurries can be greatly improved by using ion exchange resins. Resins found application in the uranium industry, the precious metal industry, e.g. gold and the PGM's, and the base metal industry, e.g. copper, nickel and cobalt. The use of the resin-in-pulp (RIP) process improves overall metal recoveries from slurries, especially in the case of ores with poor filterability where the difficult and expensive solid-liquid separation step can be eliminated.

RIP technology allows the exploitation of low-grade pulps and tailings which may have been previously considered as economically unattractive. An added benefit of the RIP process is a reduction in the negative environmental effect of entrained metal in solid waste residues.

The loss of resin and the associated cost is an important consideration of a RIP project. Projects with low-grade pulps are especially sensitive to resin loss. Resin degradation occurs as a result of the harsh physical environment (abrasive pulps, pumping, screening and agitation) as well as osmotic shock due to the constantly varying chemical environment (extraction under mildly acidic conditions, elution under strongly acidic conditions).

It is not practical or economically feasible to evaluate the resin loss of each project in a large-scale continuous plant. For this reason, various accelerated laboratory-scale durability tests and demonstration plants have been developed to evaluate the relative durability of different resins. This paper investigates the various tests that are currently available and comments on their applicability.

THE ROLE OF CHEATING RESINS IN URANIUM PROCESSING

By

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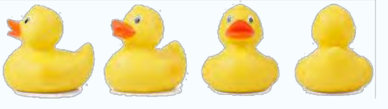
Getting our ducks in a row!!



- Forewarned is forearmed – what can we learn from the literature
- Chelating functionalities
- The example of IDA (iminodiacetic acid)
- Phosphonic acid resins
    - Aminophosphonic acid functionality
    - Mixed sulfonic/phosphonic functionality
- Conclusions
- Here we are now! – Which way forward!

OVERVIEW

IMPACT OF IMPURITIES ON PERFORMANCE OF STRONG-BASE RESIN FOR RECOVERY OF URANIUM FROM SULPHURIC ACID LEACH LIQUORS

By

Tresha Udayar, Volha Yahorava, Marthie Kotze

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ABSTRACT

Ion exchange is generally used for the recovery of uranium from relatively low grade sulphuric acid leach liquors, as a more cost effective processing route to direct solvent extraction. The eluate or strip liquor produced from the loaded ion exchange resin is then purified via solvent extraction prior to the precipitation of ammonium di-uranate. Hence, any impurities such as chloride, nitrates, phosphates, silica, molybdenum, vanadium, zirconium or iron, that were in the ion exchange eluate have to be bled or scrubbed from the solvent extraction circuit. Scrubbing of these impurities in the solvent extraction circuit can be costly, and might be handled more cost-effectively by scrubbing the ion exchange resin prior to stripping. Direct precipitation of uranium, from an ion exchange eluate might be economically attractive if the acid is recovered from the eluate and the uranium is upgraded prior to precipitation using nano-filtration. Previously, direct uranium precipitation from ion exchange eluates was not an option due to the high costs for acid and neutralisation but with the use of nano-filtration, this could be feasible. However, the impurities loaded onto the strong-base resin would still have to be managed in order to ensure that the final uranium product achieves the specifications. This paper describes the options available for the removal of impurities that could deport to the final uranium product.

POWER OF CIX FOR HYDRO-METALLURGY

By

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CCIX
Concentrate, Separate & Purify
One Unit Operation

Lower Capex, Lower Opex,

2