

**PROCEEDINGS**

# **Uranium-REE Conference**

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**9<sup>th</sup> Annual Uranium Event**

**ALTA 2013**

**25 May - 1 June**

**Perth, Western Australia**

Melbourne, Australia

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# PROCEEDINGS OF ALTA 2013 URANIUM-REE SESSIONS

30-31 May 2013

Perth, Australia

ISBN: 978-0-9871262-7-6

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**Keynote Address**

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

By

Areski Rezkallah, Dow Chemical, France

Presenter and Corresponding Author

**Areski Rezkallah**



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# Project Development



## LETLHAKANE URANIUM PROJECT

By

Paul Woolrich, Paul Callender, Brent Laws, Paul Thompson  
A-CAP Resources Ltd, Australia/Botswana  
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Alan Taylor, ALTA Metallurgical Services, Australia  
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**RESOURCES REGULATION UNDER  
HARMONISED LEGISLATION**

By

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Presenter and Corresponding  
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**REVIEW & ENHANCEMENT OF ENVIRONMENTAL  
REGULATIONS APPLYING TO URANIUM IN WA**

By

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**Daniel Endacott**



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# Process Technology

# **CURRENT CHALLENGES WITH THE PROCESSING OF URANIUM ORES**

By

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Presenter and Corresponding Author

**Damian Connelly**

## **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

Stefan Neufeind  
LANXESS, Germany

Presenter and Corresponding Author

**Stefan Neufeind**

# HEAP LEACH HEIGHT AND RECOVERY ESTIMATES FROM COLUMN LEACH TEST RESULTS

By

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Corresponding Author

**Thomas Apelt**

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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Presenter and Corresponding Author

**Nicole Turner**

## **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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Presenter and Corresponding Author

**Damien Krebs**

### **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

Glen Jobling

Adelaide Control Engineering Pty Ltd, Australia

Presenter and Corresponding Author

**Glen Jobling**

# **URANIUM PROCESS SIMULATION**

By

John Vagenas  
Elemental Engineering, Australia

Presenter and Corresponding Author

**John Vagenas**

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

By

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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<sub>3</sub>O<sub>8</sub>/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<sub>4</sub> 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

Christoph Pawlik

MINTEK, South Africa

Presenter and Corresponding Author

**Christoph Pawlik**

## 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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Presenter and Corresponding Author

**Karin Soldenhoff**

# **CENTRALIZED RARE EARTHS PROCESSING – CHALLENGES AND BENEFITS**

By

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Presenter and Corresponding Author

**Volha Yahorava**

## **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-Chinese 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

Zhaowu Zhu, Yoko Pranolo and Chu Yong Cheng

CSIRO Process Science and Engineering /  
CSIRO Minerals Down Under National Research Flagship, Australia,

Presenter and Corresponding Author

**Zhaowu Zhu**

## 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<sub>2</sub>SO<sub>4</sub>. 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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Hatch Associates Pty Ltd, Australia

Presenter and Corresponding Author

**Scott Poulter**

## **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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**Alan Miller**

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**Uranium IX Forum**

# **ION EXCHANGE RESINS FOR URANIUM RECOVERY: THE DURABILITY QUESTION EXPLORED**

By  
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Purolite, South Africa

Presenter and Corresponding Author

**Johanna van Deventer**

## **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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Australia

Presenter and Corresponding Author

**Mark Ogden**

# **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

Mintek, South Africa

Presenter and Corresponding Author

**Volha Yahorava**

## **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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