7th Uranium Event

ALTA 2011 URANIUM CONFERENCE

MAY 26-27 2011
BURSWOOD CONVENTION CENTR
PERTH, AUSTRALIA

ALTA Metallurgical Services
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Australia

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LEACHING OF URANIUM MINERALS CHALLENGES AND RESEARCH OPPORTUNITIES

By

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Suresh K Bhargava

Introduction

- There may be a considerable opportunity for the Australian uranium mining / processing industry to expand substantially in the years ahead. To grab hold of and make the most of this opportunity however the industry like all others must ensure it continues to improve.

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PROJECT DEVELOPMENT

GEOMETALLURGY AND PROCESSING OF AUSTRALIA'S URANIUM DEPOSITS

By

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ABSTRACT

Key issues confronting the Australian uranium mining industry include: the prevalence of low grade ores; a lack of detailed chemical and mineralogical information for the various ore deposit types; the presence of refractory uranium-bearing minerals and high acid-consuming gangue minerals, and; complex processing flowsheets.

CSIRO has sought to address the problem of the lack of chemical and mineralogical information by initiating a characterisation project focusing on the generation of detailed chemical and mineralogical data from a range of Australian uranium deposits. These include examples from iron ore-copper-gold-uranium (IOCGU), metasomatite, surficial, unconformity-related, sandstone-hosted and vein-type uranium deposits. For representative samples from each deposit, the abundance and type of uranium minerals and associated gangue minerals were determined using a combination of techniques including X-ray fluorescence spectroscopy, X-ray diffraction, automated reflectance spectroscopy (HyLogging^{TM}) and high resolution electron probe microanalysis (EPMA).

Future work aims to use the insights gained through analysis of the chemistry and mineralogy of different ore types to assist industry in developing new and improved processing routes for these so-called 'challenging' uranium deposits.

URANIUM DEPORTMENT STUDIES: BEYOND THE ASSAY

By

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ABSTRACT

The nature and mode of occurrence of uranium minerals, as well as their associated gangue, control reagent consumption during leaching, the rate of uranium dissolution and uranium recoveries. Traditionally, mineralogy was used to resolve difficulties in metallurgical testwork programs; however this is no longer the case. Mineralogical investigations are now included in the early stages of exploration. Samples from new uranium prospects are often sent for mineralogical investigation as soon as the assays confirm grade. The uranium deportment study is adapted to obtain suitable information from exploration through to feasibility. In the early stages of exploration, qualitative or semi-quantitative mineralogical data is adequate; indicating whether or not a prospect contains high concentrations of refractory uranium minerals and/or deleterious gangue. During a feasibility study, quantitative mineralogical data, produced by modern automated techniques, can be used to guide the metallurgical testwork program. Characteristics such as uranium phase speciation, grain size distribution, mineral associations and degree of exposure are quantified. This makes it possible to determine optimal processing conditions more rapidly and cost effectively.

URANIUM PROJECT DEVELOPMENT ADOPTING THE RIGHT APPROACH

By

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- Uranium exists in a seemingly myriad of minerals (>150 known).
- Further complicated by different valencies.
- While there may be one or two dominant species, in a deposit, there are often a variety of minor minerals which need to be treated in order to achieve a high recovery.
- On top of this, uranium minerals occur in a wide variety of host rocks.

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SX/IX/REFINING

A REVIEW OF URANIUM SOLVENT EXTRACTION: ITS PRESENT STATUS AND FUTURE TRENDS

By

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ABSTRACT

The present status and future trends of uranium solvent extraction has been reviewed with particular focus on the amine extraction or AMEX process. Some problems commonly encountered in current industrial operations are reviewed including crud formation caused by soluble silica, tertiary amine degradation by oxidation, recovery of vanadium and molybdenum, thorium treatment and operation difficulties with high chloride concentrations. Possible solutions are described and commented in terms of industrial practice. Future research trends of uranium solvent extraction have been suggested.

SONOCHEMICAL ION EXCHANGE IN RIP SYSTEM

By

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ABSTRACT

Ultrasound has been proved to be a very useful tool in enhancing the reaction rates in a variety of reacting systems. It has successfully increased the conversion, improved the yield, changed the reaction pathway and/or initiated the reaction in biological, chemical and electrochemical systems. In addition, the use of ultrasound may enable operation at milder operating conditions (lower temperatures and pressures), eliminate the need for extra-costly solvents, reduce the number of synthesis steps while simultaneously increasing end yields, permit the use of lower purity reagents and solvents, and/or increase the activity of existing catalysts. On recent years, the study of ultrasonics and sonochemistry has expanded considerably in the field of hydrometallurgy. Especially, the application of sonication for leaching of lean grade uranium has attracted much intention. It has been reported that the collapse of the cavitation bubble near a surface produces an unsymmetrical inrush of fluid to fill the void with the result that a liquid jet is formed, targeted at the surfaces in a heterogeneous solid-liquid situations, which increase mass transfer to the surface by disruption of the interfacial boundary layers. It is understood that this effect could be effective in the enhancement of ionic exchange reaction for uranium separation. Lately, it was revealed that the use of ultrasound give rise to enhancement of ionic exchange rate. In this study, the effect of sonication on the ionic exchange reaction has been examined.

Lately, ionic exchange process becomes important for uranium separation and concentration. Especially, development of resin-in-pulp method to eliminate the filtration process for energy-saving makes the use of ionic exchange resin for uranium separation more important. The present work applied the sonication to the uranium extraction/separation with anionic exchange resin and studied the effect of sonication power on the adsorption/desorption rate and selectivity of uranium, and adsorption equilibrium of uranium on resin.

OPERATION OF A RESIN- IN-PULP (RIP) DEMONSTRATION PLANT FOR RECOVERING URANIUM FROM A SOUTH AFRICAN GOLD PULP

By

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ABSTRACT

Ion exchange using Resin-in-Pulp (RIP) technology is increasingly finding application in uranium recovery from acidic leach pulps, where it has been shown to offer considerable capital and operating cost savings over more traditional uranium flowsheets.

Bateman and Mintek have jointly developed the MetRIX^{TM} RIP technology, which offers continuous counter-current transfer of resin and pulp through the adsorption stages. This technology has been selected by a South African gold producer for a new uranium recovery facility that is currently being designed by Bateman.

A demonstration plant, at a scale of 1:150 to the planned production plant, was constructed by Bateman at the clients premises, along with fit-for-purpose uranium leach and tails neutralisation facilities, and has been operated by Mintek for a continuous period of 45 days.

This paper describes the successful demonstration program including a summary of the metallurgical performance and resin durability test results.

WHAT ARE THE OPTIONS FOR AN INTERGRATED IX PROCESS TO RECOVER URANIUM FROM SALINE AND HYPERSALINE LIQUORS

By

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ABSTRACT

In arid mining regions of Australia, there are significant economic and environmental drivers to utilise saline bore water as make-up water for use in uranium processing. Solvent extraction (SX) and ion exchange (IX) are the most common methods for uranium recovery from acidic leach solutions. Various studies have demonstrated the negative impact of chloride on both SX and IX processes which restricts current operating practice to < 5 g/L Cl. The focus of this paper is to discuss and propose options to broaden the operating range of chloride tolerance for IX processes beyond what is commonly practiced. ANSTO proposes two new IX processes: one to operate in saline liquors containing chloride ranging from (5-12 g/L Cl) and the second to operate in hypersaline liquors containing chloride concentrations > 15 g/L Cl.

1) The ANSTO IX process for saline liquors makes use of a weak base anion exchange resin. The process includes an uranium IX adsorption step, followed by sodium chloride elution. The eluate is treated by nanofiltration, allowing for recycle of permeate back to the elution circuit. The concentrate stream can be directly fed to a uranium precipitation circuit using hydrogen peroxide.

2) The ANSTO IX process for hypersaline liquors makes use of a chelating resin. The process includes an uranium IX adsorption step, followed by sulphuric acid elution. The eluate is treated by nanofiltration, allowing for recycle of permeate back to the elution circuit. The concentrate stream will require neutralisation and iron removal prior to uranium recovery.

INVESTIGATIONS INTO THE RECOVERY OF URANIUM FROM LIQUORS CONTAINING HIGH CHLORIDE CONCENTRATIONS FROM AN IX PERSPECTIVE (ABSTRACT ONLY)

By

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ABSTRACT

Solvent Extraction (SX) and Ion Exchange (IX) are the established technologies for the concentration of Uranium from impure leaching solutions. While the decision criterion between these techniques is based on the Uranium concentration (higher pro SX, lower pro IX), both technologies are equally challenged by the presence of competing species in solution. For many Uranium mining operations, the focal point is on the detrimental effect of chloride in the leaching liquors on the uptake efficiency of the recovery operation.

The paper presents a) studies on the mechanism of chloride influencing the uptake of the uranyl complexes, b) quantitative data on the effect of chloride in leaching solutions on the uptake of different resins, c) comments on state-of-the-art IX technology (SBA, WBA), and d) a new IX based approach for the recovery of Uranium from liquors containing high chloride concentrations. Data is shared that prove the suitability of this new methodology. It is believed that this approach will significantly increase the attractiveness of many Uranium deposits in Australia and elsewhere, either in operation or untouched so far.

THE CLEAN TEQ U-HISAL™ PROCESS: EXTRACTION OF URANIUM FROM ACIDIC SALINE ENVIRONMENTS

By

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ABSTRACT

The U-HiSAL™ process extracts uranium from acidic saline solutions.

The past few years has seen a renaissance in uranium mining as the demand for nuclear power has increased. New mines have been developed to meet this demand; however the scarcity of fresh water means many uranium mines are having to source saline or hyper-saline water for the processing plants. Use of saline water (greater than 3g/L Cl) significantly reduces the performance of conventional uranium ion exchange and solvent extraction processes.

Currently, large-scale desalination plants producing potable water are being considered to allow the use of conventional ion exchange and solvent extraction processes. These desalination plants have exceptionally high capital (>$20M) and high operating costs (>$1/$m^3$).

Clean TeQ has developed the U-HiSAL™ process for extraction of uranium in acidic saline environments. The U-HiSAL™ process extracts 99% uranium in acidic saline solutions and slurries containing in excess of 20g/L Cl without the requirement for potable water. The U-HiSAL™ process is easily integrated with commercially available product recovery systems. Existing and future uranium plants without access to high quality water have the potential to significantly reduce their capital and operating costs using the U-HiSAL™ process.

MODELLING APPROACH FOR A PRECIPITATION PROCESS – APPLICATION TO THE TETRAVALENT URANIUM OXALATE PRECIPITATION

By

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ABSTRACT

Oxalic precipitation is usually applied to process radioactive wastes or to recover actinides from a multicomponent solution. Precipitation reactions being highly sensitive to many operation parameters, the computer simulation appears to be a very effective tool to predict the evolutions of the system subjected to various operating conditions. This study focuses on the description of a modelling development for a precipitation operation. The modelling which combines both kinetic laws and hydrodynamics is applied to simulate the industrial process of the tetravalent uranium oxalate precipitation. The hydrodynamic model is based on the Large Eddy Simulation approach (LES). The objective is to show how the modelling can be supporting the process control.

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PROCESS PLANT DESIGN

DESIGNING URANIUM PLANTS

By

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ABSTRACT

A great variety of mining and hydrometallurgical process routes are available for the production of uranium concentrate. Designing a process for a particular ore requires a comprehensive comparison of the varying process routes so that the optimal economical and environmental option is selected, these two factors being equally important and critical to the success of uranium projects. To achieve the best process design an understanding of all the options is required.

This paper provides a review of the main milling options, acid and alkali leaching routes, and solution extraction methods currently employed in numerous plants worldwide. Common and novel processing routes are highlighted, and the unit operations and critical design parameters for each step in a typical uranium flow sheet are assessed.

In conclusion, a review of a number of current and prospective Australian uranium mines is presented to illustrate the influence of various ore types and their impact on the processing options selected.

ALTERNATIVE METHOD FOR DETERMINING YIELD STRESS OF A CALCRETE-HOSTED URANIUM ORE

By

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ABSTRACT

Slurry flow properties are critical in plant design and operation. The slurry shear yield stress is defined as the minimum force required to initiate slurry flow and is often used in the mining industry to define slurry characteristics in pumping and mixing, pipeline transport, disposal etc. One of the conventional well-known methods for shear yield stress determination is via a simple vane test. This test may be operator dependent, time-consuming and require large amounts of sample. The development of an alternative, more rapid method for determining the yield stress of a large number of samples of low mass would be advantageous.

The compressive yield stress is mostly used in the design and control of solid-liquid separation processes and not in slurry flow characterisation, but plots of compressive yield stress versus pulp density tend to follow the same trend for those of shear yield stress measurements. The compressive yield stress is determined by measuring the equilibrium sediment height after centrifuging a slurry sample at a series of different speeds.

Test work was conducted on samples from a calcrete-hosted uranium ore to determine whether the compressive yield stress measurements could be used as an alternative to shear yield stress measurements to obtain a relative indication of sample rheological behaviour. Test results showed good agreement. In terms of the sample mineralogy, quartz and dolomite appeared to have a positive effect on sample rheology while smectite affected sample yield stress deleteriously. The compressive centrifuge test may allow for more rapid yield stress determination on an increased number of smaller sample masses with reduced operator involvement.

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URANIUM ORE LEACHING PROCESSES FORUM

REVIEW OF URANIUM ORE LEACHING SYSTEMS

By

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ABSTRACT

This paper reviews and compares the various leaching systems which have been used to treat uranium ores including agitated tanks at atmospheric pressure, pressure autoclaves, heap and vat leaching, and In-situ leaching. It presents operating conditions, pros and cons, configuration, design aspects and materials of construction. Key references are included for more detailed follow-up.

PILOT PLANT SCALE UP OF URANIUM LEACH APPLICATIONS

By

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ABSTRACT

This paper reviews methods of scaling up fluid agitation systems from pilot scale to commercial plant design. It identifies the key factors to be taken into account, and presents some guidelines for carrying out a successful pilot plant program.

SONOCHEMICAL LEACHING OF LOW-GRADE URANIUM ORE

By

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ABSTRACT

Sonochemical leaching is a promising method to promote the leaching of uranium ore. It increased leaching rate of uranium by 46% up to 85% leaching of uranium. However, it also decreased liberated uranium at prolonged time and promoted MnO_2 consumption by side reaction. Therefore, optimum condition is required to reveal maximum sonication effect.