

Uranium-REE Keynote

URANIUM IX – Past, Present and Future

By

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ABSTRACT

Ion exchange has played an important role in nuclear power generation. The development of resins in particular, was spurred by the challenges posed by the recovery of uranium from leach liquors on the one hand and the purification of water used for reactor cooling on the other.

The application of ion exchange resins for the separation, concentration and purification of uranium leach liquors is the subject of this paper. Major developments of this technology, which has come in waves in response to the fluctuating prices and demand for uranium, are highlighted.

The first wave of uranium mining activity occurred in the nineteen fifties, underpinned by military applications and interest in nuclear power. These plants used strong base polystyrene-divinylbenzene gel resins in fixed bed systems with nitrate based elution.

The uptake and construction of new nuclear power plants in the sixties was slower than projected and a decline in uranium demand ensued. This was reversed by the oil crisis in the seventies which brought about increased uranium production and a series of innovations to the uranium hydrometallurgical flowsheet, including the coupled IX/SX Bufflex/Eluex processes using sulfate elution and the adoption of fluidized continuous ion exchange to treat unclarified liquors.

Two decades of sustained low uranium prices, reduced demand and draw down of military inventories, resulted in virtually no new uranium developments. Second generation plants which commenced operation in the eighties treating higher grade ores, tended to use solvent extraction as the preferred separation technology. Ion exchange has maintained its relevance with technologies such as resin-in-pulp and in-situ recovery processes that are applied to lower grade deposits. Ion exchange has been adopted by three of the most recently built tank leaching operations, Langer Heinrich, Kayelekera and Husab, and continues to be used in all operating ISR projects in the USA, Kazakhstan and Australia.

Looking to future innovations, this paper discusses the potential of ion exchange to address particular challenges and niche areas in uranium processing such as:

- The use of resins with functionalities other than conventional strong base, for recovery of uranium from saline and phosphoric acid liquors;
- The use of ion exchange to facilitate reagent re-cycle;
- Improvements in elution to target more concentrated eluates; and
- Coupling ion exchange with other technologies.

Keywords: ion exchange, uranium, strong base resins

THE DEVELOPMENT OF A GEOMETALLURGICAL URANIUM LEACHING MODEL AS A PREDICTIVE TOOL FOR LEACH OPTIMISATION

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ABSTRACT

The uranium/copper deposit at Olympic Dam has complex mineralogy. Although the uranium can be categorised into three main minerals - uraninite, coffinite and brannerite - these definitions each encompass a broad spectrum of compositions and textures. Also, these minerals are found within diverse ore-types with varying gangue mineralogy, each with different degrees of uranium mineral liberation. This diversity means that the optimum leaching conditions can be significantly different for ores from different parts of the deposit. Consequently, the Olympic Dam geometallurgical program involves large batch leaching programs on the major ore-types which make up the stopes scheduled for production in the near future, allowing optimisation of the leach process in terms of acid addition, oxidant addition and temperature. However, these batch leach programs are slow and costly. To overcome this, a model of the uranium leaching process has been developed which predicts the leach response to changes in pH, ORP and temperature, thus providing the required information in a fast and inexpensive manner.

The model does not rely on the measurement of uranium mineral contents by XRD or SEM, but defines four forms of uranium each with different leaching behaviour. These are not specific to any uranium mineral and their characteristics are derived from nearly two thousand data points from previous laboratory leach programs. The proportions of these forms of uranium in a new ore are determined from the ores measured response during a specially designed standard leach. This approach provides a solution to the problem which arises when a particular uranium mineral exhibits different leaching rates depending on its degree of alteration and liberation. Validation trials have shown that the predictions are sufficiently accurate for the model to be trialled as part of the production planning system at Olympic Dam.

Keywords: Uranium Leaching, Modelling, Olympic Dam, Geometallurgy

LITHIUM HYDROXIDE PRODUCTION – PROCESSING REVIEW, TECHNOLOGY DEVELOPMENT AND FUTURE OPPORTUNITIES

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ABSTRACT

Integral to the production of cathode materials and electrolytes for Lithium Ion Batteries (LIB) is the availability of suitable lithium chemical concentrates. The most commonly referred to concentrates include lithium carbonate (Li_2CO_3 , LC) and hydroxide mono hydrate ($\text{LiOH}\cdot\text{H}_2\text{O}$, LH). Although chloride, sulfate and phosphates are employed to varying degrees, each of these can be easily accessed using either LC or LH and the appropriate inorganic acid.

Industrial production of LH has historically been conducted in a number of ways including: 1) Direct α -spodumene conversion with slaked lime; 2) LC reaction with slaked lime and rejection of CaCO_3 ; and 3) Causticisation of Li_2SO_4 and rejection of Glauber salt. The latter is the preferred method for LH production from spodumene mineral concentrate and is that which will be employed by Tianqi, Albermarle and SQM/Kidman for the refineries under construction or planned for Western Australia.

The success of these methods in producing high purity LH suitable for LIB manufacture varies considerably. This is in part to the ability to purify the Li-containing feed adequately prior to LH crystallization, as well as the amount of impurities introduced with the reagents required in the different methods. Although LH crystallization and refining (re-crystallisation) offers significant scope to cope with such introduced impurities, eventually a bleed of LH, either back up-stream or away from the process completely, to manage those impurities is required and can be a key issue for certain impurities.

Emerging alternative LH production technologies involve electrolysis and/or electrodialysis of highly purified LiCl or Li_2SO_4 solutions. The details of processes developed by Nemaska Lithium, POSCO and Neometals' are slowly coming into the public domain, but for most part there is little data on the impact of impurities, membrane life, membrane fouling and power consumption, and how this compares to more conventional LH production.

In this presentation, we intend to provide an overview of LH production methods, highlight the significant challenges that one needs to understand and overcome in order to produce LH suitable for LIB production, and demonstrate the importance of the emerging electrochemical-based technologies.

Keywords: Lithium, Lithium Hydroxide, Process Development, Process Review