

## ELECTROCHEMICAL REDUCTION OF URANIUM OXIDE FUEL IN A MOLTEN LiCl/Li<sub>2</sub>O SYSTEM

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### ABSTRACT

Argonne National Laboratory (ANL) has developed and demonstrated an electrometallurgical technology which can separate uranium, fission products, and transuranic elements from spent metal fuels. The process has been described in numerous publications [1][2][3][4]. As an extension of this technology, ANL has more recently initiated development of a molten-salt-based electrochemical technique that is capable of separating uranium, fission products, and transuranic elements from spent light water reactor (LWR) fuel. Unlike spent metal fuels, this spent commercial fuel is comprised of oxides. This technology is of great significance in management of spent nuclear fuels since the Department of Energy (DOE) currently has approximately 40,000 MTHM of spent oxide fuel in its inventory with an annual growth rate of 2,000 MTHM [5].

This article reports the experimental results of electrochemical reduction of uranium oxide fuel in a bench-scale apparatus at ANL-West. The experiments were performed in a molten LiCl/Li<sub>2</sub>O electrolyte at 650 °C under an argon atmosphere in a hot cell. The anode was a straight platinum wire or a platinum wire wound in a coil. The cathode was a perforated stainless steel basket loaded with approximately 50 grams of UO<sub>2</sub> particles. A sectional view of the apparatus is shown in Fig. 1. During the electrochemical reduction process, the uranium oxide was reduced to uranium metal and retained in the cathode basket and oxygen ions were oxidized at the anode.

The purpose for the bench-scale experiments was to understand the mechanisms of predominant reactions at the anode and cathode. Cyclic voltammetry and Chronopotentiometry were used to explore the process limitations and to investigate the kinetic parameters of the electrode reactions. Depleted uranium oxide was used to determine the current efficiency and rate-limiting step for the entire process. A surrogate LWR fuel was also tested to assess fission product distributions and their impact on the electrode processes prior to initiating electrochemical reduction experiments with spent LWR oxide fuels.

### References:

1. J. J. Laidler, et al., "Development of Pyroprocessing Technology" *Progress in Nuclear Energy*, Vol. 31 Number 1/2, 1997.
2. R. W. Benedict and H. F. McFarlane, "EBR-II Spent Fuel Treatment Demonstration Project Status", *Radwaste Magazine*, Vol. 5, Number 4, page 23, July 1998.
3. K. M. Goff, et al., "Electrometallurgical Treatment Demonstration at ANL-West" *Proceedings of the Embedded Topical Meeting*

*DOE Spent Nuclear Fuel and Fissile Material Management*, ANS June 4-8, 2000.

4. *Electrometallurgical Techniques for DOE Spent Fuel Treatment: Final Report*, National Research Council, National Academy Press, Washington, DC (2000).
5. E. J. Karell, et al., "Separation of Actinides from LWR Spent Fuel Using Molten-Salt-Based Electrochemical Processes," *Nuclear Technology*, Vol. 136, Dec. 2001, pp. 342-353.

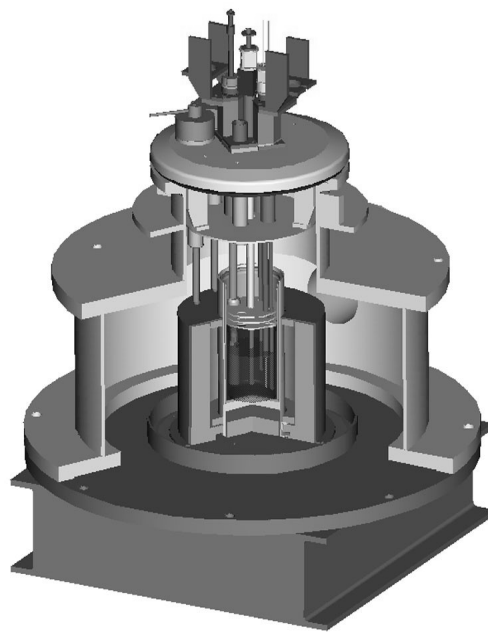


Fig. 1 Sectional view of the Apparatus for Bench-scale Electrochemical Reduction of UO<sub>2</sub>