High Throughput Electrorefining of Uranium in Pyro-reprocessing

Background

In the electrorefining step of pyro-reprocessing, the spent metallic fuel is dissolved anodically and actinide elements are recovered on cathodes. An enhancement of processing rate of uranium in this step is important because uranium occupies 70-80% in the spent nuclear fuel. We had focused on collecting uranium on a mandrel type solid cathode. However, this method was found to be unsuitable for adapting to a practical plant because of low collecting ratio and low processing rate.

Objectives

A laboratory scale high throughput electrorefining apparatus will be fabricated. And the performance of this apparatus will be checked by some parametric experiments using uranium.

Principal Results

1. A high throughput electrorefining apparatus was fabricated (Fig.1). This apparatus employs anode-cathode module type electrode unit, which consists of a cylindrical cathode and a rotating anode located in the center of the cathode. The anode is equipped with anode baskets that hold anode uranium and also has blades that scrape uranium deposit growing on the inner surface of cathode. The scraped uranium is collected on a mesh basket placed beneath the electrode unit. Though basic concept of this apparatus was proposed by Argonne National Laboratory, USA, some original ideas of CRIEPI, such as slanting blade, were adopted.
2. The performance of the apparatus was shown as follows by experiments using up to 500g of uranium under several operational conditions, such as anode rotation rate, concentration of uranium in the salt phase, and shape of the blades.
   - Processing rate of uranium of 22.9g-U/hour/litter was achieved. This value corresponds to processing 10kg of uranium in 18 hours by an electrode unit. And this value also corresponds to more than twice of the result obtained using a conventional electrode (Fig.2).
   - Termination of anode rotation due to interference with cathode deposit was controlled by use of perpendicularly quartered slanting blades.
   - Electrorefining was continued until anode uranium with claddings was completely dissolved at high processing rate, by adopting reverse rotation of anode and reverse current electrolysis during the electrorefining. The result of this experiment is shown in Figs.3- (a) and 3-(b).
   - The design data necessary for fabricating engineering scale electrorefining apparatus was obtained by the aforementioned results.

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Future Developments

Engineering scale electrorefining tests using up to 10kg of uranium will start in 2004 by use of an engineering scale high throughput electrorefining apparatus, which was fabricated in 2003.

Main Researcher: Koichi Uozumi,
Research Scientist, Advanced Nuclear Fuel Cycle Sector, Nuclear Technology Research Laboratory

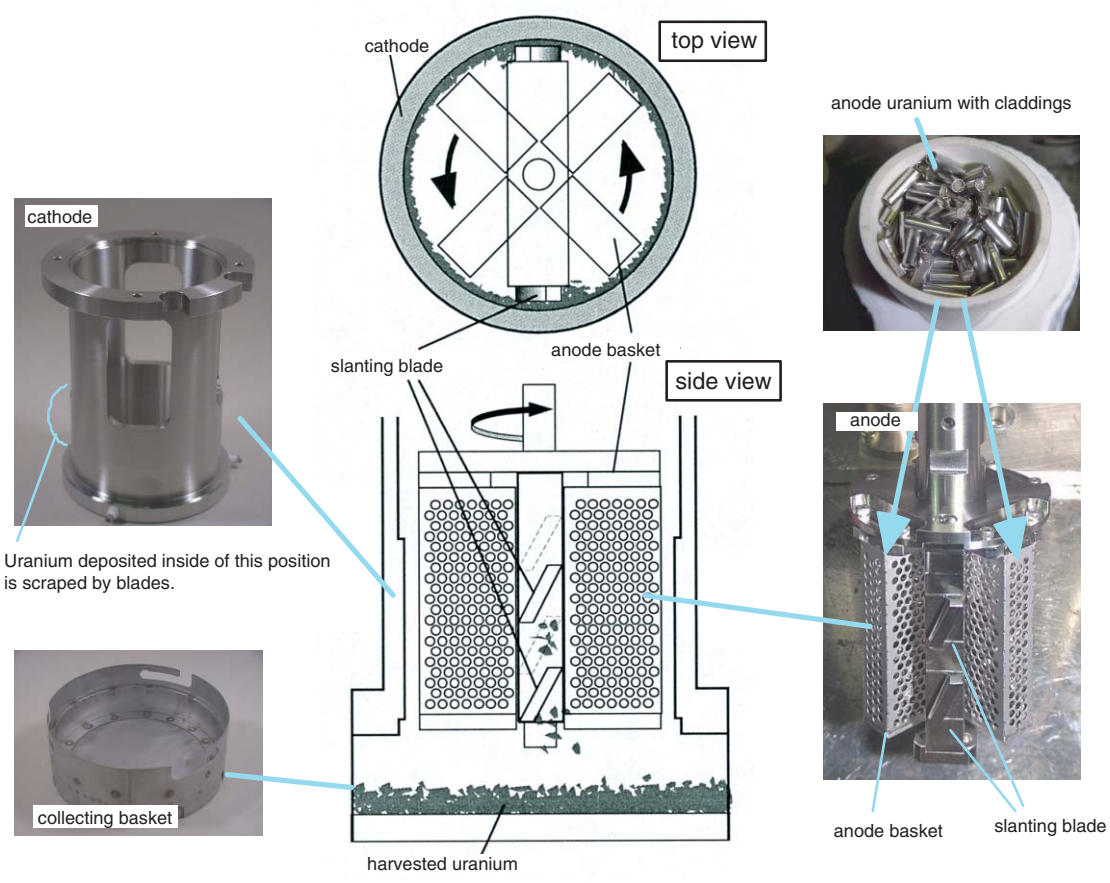

Fig.1 High throughput electrorefining apparatus

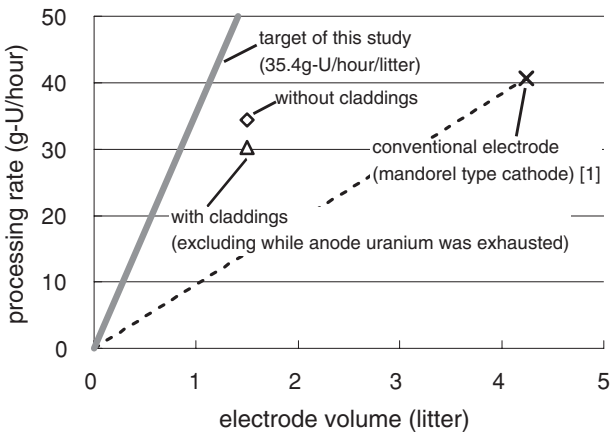

Fig.2 Processing rate of uranium using high throughput electrorefining apparatus
[1] T. Koyama at al, J. Nucl. Mater., 34 (1997) 384.

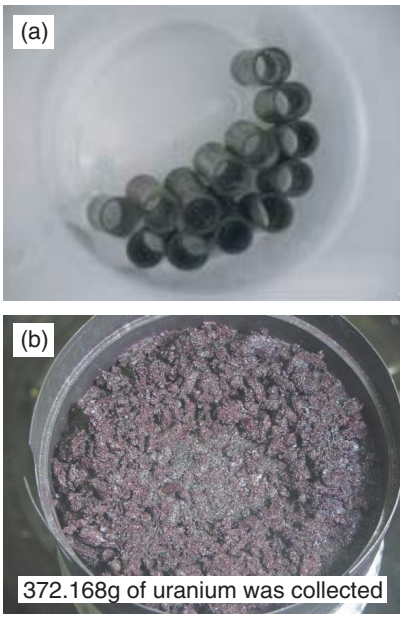

Fig.3 Result of experiment processing 510g of uranium with clad
(a) Claddings left in anode basket
(b) Uranium on collecting basket