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# REUSE OF ACTIVATED ALUMINA



By

John E. Hobensack

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# REUSE OF ACTIVATED ALUMINA

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## ABSTRACT

Activated alumina is used as a trapping media to remove trace quantities of $UF_6$ from process vent streams. The current uranium recovery method employs concentrated nitric acid which destroys the alumina pellets and forms a sludge which is a storage and disposal problem. A recently developed technique using a distilled water rinse followed by three dilute acid rinses removes on average 97% of the uranium, and leaves the pellets intact with crush strength and surface area values comparable with new material. Trapping tests confirm the effectiveness of the recycled alumina as $UF_6$ trapping media.

## INTRODUCTION

The uranium hexafluoride ($UF_6$) process gas in the Portsmouth Gaseous Diffusion cascade contains low molecular weight gases or "lights", chiefly nitrogen or air which must be removed to maintain cascade operations. Several processes and/or operations are involved in separating the light gas impurities which are eventually drawn by an air-jet ejector through banks of activated alumina or sodium fluoride traps to reduce the residual uranium content prior to discharge to the atmosphere.

The chemical traps are used at several process vents to assure radioactive discharges are maintained as low as reasonably achievable. Several monitoring systems determine the need for trap changeout, and include space recorders, continuous vent samplers, trap breakthrough gamma monitors and grab samples.

The sodium fluoride traps are capable of in-place regeneration through multiple cycles of use, while activated alumina is a one-time use trapping agent. Exposure of the activated alumina to process vent streams eventually renders the alumina ineffective as a trapping agent because of uranium loading-and/or irreversible conversion to a less effective trapping form due to the presence of corrosive gases. The alumina in this state is considered "spent" and, unlike the sodium fluoride, there is no in-place process available for facile regeneration and reuse. Currently the spent alumina is either stored or processed for uranium recovery. Mounting costs of storage associated with accumulation of spent alumina and the uncertainty of ultimate disposal prompted feasibility studies for reuse of the alumina. These two handling methods are not appropriate for either waste minimization goals or cost effective handling of the alumina waste. In reprocessing, the alumina is currently treated with 3N $HNO_3$ which effectively removes the uranium, but also destroys the physical integrity of the alumina pellets. Disposal costs of the resultant sludge are about one dollar/pound a year for storage and \$60/ft$^3$ for burial. New material costs are about \$0.80/lb with current usage ranging from 12,000 to 15,000 lbs/year. The reuse of 50% of the annually consumed alumina would result in direct annual savings of about \$70,000. Reclamation of used material currently stored, but untreated, could eliminate new material purchases for several years.

## EXPERIMENTAL

The tests consisted of; (1) evaluating simple aqueous based leaching procedures to remove the bulk of the uranium from the spent alumina, (2) evaluating the physical properties of recovered alumina, and (3) performing $UF_6$ trapping tests with the recovered alumina from several trap sources.

Leaching Tests -- The uranium concentration on the spent alumina varies widely depending on the trap location. The alumina also varies with respect to the ($AlF_3$) aluminum fluoride content which can range from 0 to a high percent $AlF_3$. Samples of spent alumina utilized in this study contained .2544 grams U/grams and .0003 grams U/grams, and were selected as being representative of high and low values typically encountered. For initial tests, fifty (50) gram quantities of spent alumina containing little or no $AlF_3$ (this source represents more than half of the alumina waste) were subjected to various reagents and concentrations with an attempt to minimize waste solution generation and retain compatibility with current recovery methods. Each 50 gram sample of material was placed in a 500ml beaker and covered with 200ml of reagent. It was found that 80% to 85% of the uranium could be removed using distilled water. Uranium concentration in the solution reaches a maximum in about one hour. Subsequent uranium removal is enhanced by the use of dilute (0.3N) $HNO_3$. Three (3) tests using the initial distilled water wash followed by three consecutive $HNO_3$ treatments gave a total U removal of 95.3%, 98.8% and 96.9%. Following the leaching tests, the material was air-dried at 200°F to remove excess moisture.

Leaching tests were also conducted on spent alumina which was partially converted to aluminum fluoride ($AlF_3$) as a result of exposure to reactive fluorinating gases and contained considerably lower uranium loading. Material with two different levels of $AlF_3$ were evaluated, namely, 2.4% and 80% $AlF_3$. For this type of spent alumina, the initial distilled water treatment was found to be ineffective, however, two (2) 0.3 N $HNO_3$ treatments reduced U content to background or non-detectable levels.

In all tests pellet integrity of the spent alumina was essentially preserved in the leaching process.

Physical Properties and Trapping Efficiency of Recovered Alumina - The crush strength and surface area of the recycled alumina pellets and new alumina pellets, are compared in Table 1. To test the trapping effectiveness of the recycled alumina, 530 grams were prepared using the distilled water/nitric acid rinse procedure described above. The recycled material was introduced into 3" OD x 18" traps, and $UF_6$ was passed through the trap at 8.1g per hour at 2 psia. Tests were also performed comparing the performance of the regenerated alumina as a function of the $AlF_3$ content as shown in Table 2.

Table 1 Physical Properties

| | New Alumina | Recycled Alumina |
|---|---|---|
| Crush Strength | 300 $lbs/in^2$ | 750 $lbs/in^2$ |
| Surface Area | 274 $m^2/gm$ | 200 $m^2/gm$ |

*$AlF_3$ component is absent as determined by x-ray diffraction.

Table 2 Comparative Uranium Loading After Regeneration

| Spent Material % $AlF_3$* | U-Content (%) after Trap Test |
|---|---|
| 0 | 13.1 |
| 2.4 | 5.6 |
| 80 | 2.9 |

*Determined by x-ray diffraction.

## CONCLUSIONS

With a large percentage of the alumina used on plantsite being potentially recyclable, the dilute nitric acid leaching method has the possibility of reducing the inventory of stored contaminated waste, reducing new material purchases, and allowing uranium recovery using available material and technology.