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SPECIAL PLUTONIUM RECYCLE AT PUREX

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This document consists of
5 pages.

SPECIAL PLUTONIUM RECYCLE AT PUREX

- Reference: (1) HW-56913, Secret, "Process Specifications for Critical Mass Control - Purex Plant (Revision No. 2)", July 30, 1958, E. R. Irish.
- (2) HW-73420, Unclassified, "Supplement - Process Specifications for Critical Mass Control - Purex Plant", April 19, 1962, B. F. Judson.
- (3) HW-56933, Secret, "Process Specifications for Operational Control - Purex Plant (Revision No. 1)", November 17, 1958, E. R. Irish.

A. Introduction

The critical-mass incident at Recuplex has necessitated resumption of reworking Task I supernatants through the Purex process. The supernatants contain relatively small quantities of plutonium and will be shipped as treated nitric acid solutions in PR cans. Current plans are to introduce the solutions into the Purex process at the normal rework position, the HAF Make-up Tank E6. The following memo summarizes the anticipated character of supernatant recycle material, outlines process control requirements and recommends procedures for assuring critical mass control within the limits of the current process control specifications.

B. Discussion1. General Bases

The Task I supernatant recycle is anticipated to consist of 2 - 3 M HNO_3 solutions treated with KMnO_4 and NaNO_2 to destroy excess oxalate and MnO_2 respectively. Plutonium concentrations will normally be low, in the order of 0.5 g/l.

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Purex process requirements for Z-Plant recycle are aimed at the control of composition of the material and the maintenance of critical mass controls. Composition requirements for Purex recycle are not unusual, being based on the process chemistry of the Purex process and intended to avoid chemical processing problems. Requirements for critical mass control are also basically the same as currently in effect. However, changes in shipping and handling methods have required reconsideration of the area of critical mass control. Therefore, most of the following discussion deals with critical mass control. Process control recommendations presented in Part D, below, cover both composition and critical mass requirements.

According to Z-Plant data, the volume of recycle generated will be large enough to impose a handling problem at Purex. Thus, at the Purex Plant, the processing system should be aimed at a maximum processing rate, compatible with process and safety requirements. The maximum rate will be attained by simultaneous recycle in the PR Room, via TK-L11 to TK-E6, and in the Sample Gallery, direct to TK-E6. Discussion and recommendations in this letter provide for such simultaneous recycle, providing that PR cans (not RC cans) are used for transporting the recycle material. The latter limitation results primarily from the fact that current critical mass specifications do not allow RC cans in the PR Room.

The basic control of the amount of recycle in a TK-E6 HAF batch is the limitation on the amount of plutonium per ton of uranium present. The process specifications for critical-mass control limit the amount of plutonium in Tank E6 to 1500 g/T (Ref. 1). The process specifications for operational control limit the plutonium content of Tank E6 to 950 to 1450 g/T depending upon 3WB stream concentrations (Ref. 3). Purex Plant practice has generally aimed at 1000 g/T to avoid control complications at downstream process points. Assuming uranium from the reactors to be irradiated to no greater than 700 g/T, allowable Pu recycle to TK-E6 is 300 g/T. For the normal 6.8-ton batch in TK-E6, the total allowable recycle per batch is slightly in excess of 2000 grams.

2. Sampling

The fact that present plans specify recycle solutions to be shipped in PR cans imposes a special problem of control at the Purex Plant because of the possibility of inadvertent substitution of a can containing product for a can containing recycle. The plutonium content of the recycle shipments will be stated on the basis of Z-Plant analytical data. This data can be most conveniently used for accountability purposes. For control of the amount of plutonium added to TK-E6, however, the recycle solutions should be monitored a second time, just prior to the transfer, to guard against errors.

At the Sample Gallery recycle station, where no sampling facilities exist, the use of a neutron monitor to check each can scheduled for recycle is proposed. Recent experiments with a neutron monitor for this purpose have demonstrated the practicability of this proposal. While the background of experience in the use of this instrument is presently insufficient to attempt accurate concentration measurements, it can be used for conservatively stated "less than" values, with confidence.

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In the PR Room, monitoring of the Pu content of the recycle solutions can be accomplished in the TK-L9 Sampler Tank. The use of a neutron monitor in the PR Room is not advisable because the physical layout of this area might permit bypassing the monitor and the background neutron level could interfere with measurements. In addition, actual TK-L9 measurements will permit convenient coordination of Z-Plant recycle rework with some rework of dilute Purex solutions, e.g., sumps.

3. Administrative Control

Insuring no more than 1000 grams of Pu per ton of U in any HAF batch in TK-E6 while adding recycle via two separate transfer routes will require special attention to administrative control. A system involving the tally of each individual can, with communication between the PR room and the Sample Gallery during the make-up of each HAF batch in TK-E6, is likely to be cumbersome and subject to errors to the point of being impractical. Instead, a practical system would be based on a specified arbitrary limit on the number of cans of recycle to be added from each recycle station, per batch of HAF. For example, limits of 10 cans of recycle per HAF batch could be specified for each recycle station (Sample Gallery and PR Room). This would amount to a total of 20 cans per HAF batch or about 60 cans per day, a somewhat optimistic rate according to most estimates. At the same time, the total grams of Pu normally involved would be very small, approximately 4 grams per can, according to Z-Plant estimates. In the Sample Gallery, a neutron monitor could be used effectively to insure no "overloaded" cans. In the PR Room, two five-can batches could be sampled in TK-L9, with each batch transferred to TK-L11 after sampling.

C. Proposed Operating Plan

On the basis of the discussion presented above, a typical and practical operating plan for handling recycle from Z Plant is summarized below. This plan may be considered an initial proposal, to be modified as necessary on the basis of further developments, operating demands, and experience. The plan assumes 20 cans of recycle per HAF batch (10 cans to be added from each station) and an allowable 2000 grams of Pu to be added to each HAF batch. Thus, each can could safely contain 100 g. of Pu.

In the Sample Gallery, each can would be checked using the neutron monitor, with the monitor located to avoid background interference. A safety factor of two in the use of the neutron monitor is proposed; in the present example, then, an operating limit of 50 grams per can would be used. The neutron monitor would be calibrated at least daily against a standard can containing 8 liters and a total of 50 grams of Pu. With completion of the transfer of a 6.8 ton batch of metal solution to TK-E6, the transfer of the recycle solutions could commence immediately. Ten cans, containing only 20 gallons of solution, could be added and tallied, with the tally turned in to the Shift Supervisor.

In the PR Room, meanwhile, a group of 10 cans could be processed independently. In this case, also, an operating limit of only 50 grams per can is suggested since experience has shown occasions of an L11 batch being held up in the L11-to-E6 transfer route. Two groups of 5 cans each would be transferred into TK-L9 for sampling and then immediately transferred to TK-L11. Transfer from TK-L11 to TK-E6, however, would be scheduled when

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the analytical results were available and when permitted by the HAF make-up in TK-E6. This scheduling is no different from current practice.

The rework of dilute Purex Pu wastes (e.g., sumps) could be coordinated with this plan in normal practice. By restricting the amount of Pu in TK-L11 to 500 grams, any PR Room rework source, or sources, totalling no more than this amount could be substituted for the Z-Plant recycle solution.

D. Recommendations

On the basis of the discussion presented above, the following Purex Plant process controls are recommended for the processing of supernatant recycle solutions received from Z Plant in PR cans.

1. The total amount of plutonium in the HAF Make-up Tank E6 should be limited to 1000 grams per ton of uranium.
2. Administrative controls should be set up to insure that the Processing Operation be notified in the event of any irradiated uranium containing Pu above a specified normal limit, say 700 g/T.
3. Within the limit of Item 1, above, recycle may be added to TK-E6 simultaneously from the Sample Gallery load-in station and from the PR Room load-in station, provided the following additional requirements are met:
 - (a) The amount of plutonium in the recycle added must be measured at the Purex Plant, with the recycle operation directly following the measurement.
 - (b) Appropriate factors of safety must be applied to the Pu recycle measurements. For a neutron-monitor measurement, a safety factor of two should be applied. Also, for a PR Room measurement (for L11 to E6 transfer) a safety factor of two should be applied.
 - (c) The amount of Pu to be recycled from each station may be proportioned generally according to operating convenience. However, the amounts should be specified as constant, standard-operating-practice values; they should not be varied on a batch-to-batch basis.
 - (d) The amount of Pu to be recycled should be based on the amount of uranium in a standard-size HAF batch. Recycle additions should be made only during the time when the full standard-size batch is in TK-E6.
4. Recycle of Purex Pu solutions from the PR Room may be included with Z-Plant supernate recycle provided the mass limit used for supernate recycle is not exceeded. In the event that recycle of a greater amount of Pu becomes necessary (such as a PR can containing product), the Z-Plant recycle operation should be temporarily suspended.
5. The recycle supernate should meet the following composition requirements:
 - (a) The recycle should not contain solids.
 - (b) The recycle should not contain free oxalate or permanganate ions.

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- (c) Excess sodium nitrite and nitric acid are acceptable providing the concentrations are known and reasonably constant.
- (d) The recycle should contain no oils, greases, or other "cruds".
- (e) Any substances not specifically mentioned above should not be included in recycle solutions without prior verification by Purex Technology.

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