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CAMPAIGN REWORK
OF Z-PLANT MATERIAL AT PUREX

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CAMPAIGN REWORK
OF Z-PLANT MATERIAL AT PUREX

By

B. F. Judson and J. B. Kendall

Purex Process Engineering
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December 26, 1963

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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December 26, 1963

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CAMPAIGN REWORK
OF Z-PLANT MATERIAL AT PUREX

Introduction and Summary

The Purex Plant has been requested to process Z-Plant MR and EPT solutions containing about 200 kilograms of plutonium in order to alleviate processing problems at Z-Plant and to reduce the inventory of MR and EPT rework. Campaign recycle of uranium through the main plant is recommended as an economical and effective means of reworking large quantities of Z-Plant plutonium solutions. The following memorandum outlines process alternates and costs for reworking the solutions and itemizes specific recommendations for process and critical mass control.

Z-Plant Rework Solutions

The Z-Plant plutonium solutions that are scheduled for campaign rework through the Purex Plant are commonly called EPT and MR Rework. The EPT solution is the product from their Plutonium Ion Exchange unit. This solution is about 30 - 60 grams per liter of plutonium in a 0.7 to 1.3 M HNO_3 medium. EPT solutions may also contain a trace of resin fines. The MR rework solution is the product of plutonium scrap dissolutions. The MR solution will vary from 40 to 150 grams of plutonium per liter in a highly corrosive 10 to 15 M HNO_3 , 0.1 to 0.3 M F, and 0.1 to 0.3 M Al media. In addition, the MR rework solution may contain an alloy agent that is 1.0 weight per cent of the plutonium. Some of the MR rework solution may contain an appreciable quantity of post-precipitated aluminum nitrate crystals. The solutions normally do not contain organic phases, plutonium solids, or other materials that are deleterious to the Purex process, although some insoluble plutonium and other substances have been noted.

Process Alternates and Costs

Plutonium process rates in the Purex Plant are presently limited by the XCP Concentrator capacity to about 25 kilograms per day. Although critical mass specifications permit a plutonium concentration of 1500 grams per ton of uranium in the First Decontamination Cycle, experience has shown that the feed (EAF) to the system must be generally limited to about 1000 g/T because of normal backcycle plutonium via the LBSU and 3WB streams and because process upsets can quickly increase the plutonium recycle via the 3WB stream to the First Decontamination Cycle. On the basis of 1000 g/T and a dissolver solution of 600 g/T, the maximum rework rate is 400 g/T. Since the maximum plutonium processing rate is 25 kilograms per day, the maximum rate of plutonium rework is 10 kilograms and occurs when the uranium processing rate is 25 tons per day of dissolver feed. Increasing the processing rate of dissolver solution beyond 25 tons of uranium per day requires a reduction in the rate of plutonium rework since the grams of plutonium per ton of uranium must be reduced to prevent exceeding the 25 kilograms per day limit of the XCP Concentrator.

Reworking plutonium at a rate beyond 10 kilograms per day requires either the recycle of "cold" uranium or an increase in the grams of plutonium per ton of

*to keep
work at plant*

The recycle of "cold" uranium increases the cost of reworking plutonium since the First Decontamination Cycle costs of processing the "cold" uranium must be charged completely to the plutonium product. "Cold" uranium that does not meet final product specifications and requires rework can be used as the uranium recycle but this method of uranium recycle does not change the plutonium processing costs because the off-specification uranium processing costs are not changed. In other words, the uranium still requires processing through the Second Uranium Cycle and this is all it required initially. On the other hand, since the uranium and plutonium costs are not increased by recycling "cold" off-specification uranium product, there is no reason not to recycle off-specification uranium unless the plant process routings required are expensive.

Based on 1000 g/T per ton of "cold" uranium and assuming the uranium is not processed through the Second Uranium Cycle, the essential material costs for reworking plutonium is about \$90 per kilogram. Overall rework rates are limited to somewhat less than 25 Kg/day by can handling rates as discussed below.

An alternate method of reworking plutonium is direct addition to the Plutonium Ion Exchange and processing only enough "cold" uranium through the plant for critical mass control of the plutonium recycled via the 3WB stream. The essential material costs associated with reworking plutonium in this manner would be reduced. However, because reworking MR plutonium in N-Cell requires plutonium valence and other feed adjustment steps in very limited facilities, the rate of plutonium rework is less than 6 Kg/day, which is undesirably low for the large rework campaign planned.

Plutonium rework solutions can be added to process streams in the Purex Plant from either the PR Room or the RC Recycle Hood. The RC Recycle Hood adds the plutonium rework solutions only to TK-E6 (HAF), while the PR Room can add the plutonium rework solutions to either TK-N1 (XAF) or TK-E6 (HAF). Addition from the PR Room to TK-N1 (XAF) is rarely used because of the time consuming and complicated feed adjusted requirements before Plutonium Ion Exchange processing.

The E-Cell Sump critical mass control specifications limits the plutonium concentration to 75 grams per liter⁽¹⁾. For this reason, plutonium rework solutions greater than 75 grams per liter shall not be added to TK-E6 from either the RC Recycle Hood or the PR Room. However, since the TK-L11 to TK-E6 transfer jet dilutes the L11 solution about three-fold, plutonium at concentrations of up to 225 grams per liter can be transferred from TK-L11.

(1) HW-71625 (Secret), "Process Specifications for Critical Mass Control - Purex Plant (Revision No. 3)", B. F. Judson and G. C. Oberg, October 15, 1962.

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Rework additions through the sample gallery Load-in Station should enter TK-E6 directly from the product transfer can. The RC Recycle Storage Tank in the sample gallery is limited to a plutonium mass of 650 grams, corresponding to a maximum plutonium concentration of 13 grams per liter and thus is not suitable for rework operations.

The critical mass control specifications require that both TK-E6 agitators are operating before plutonium rework solutions are added. The TK-L11 to TK-E6 transfer jet is interlocked with the agitators to prevent transfers when the TK-E6 agitators are not operating. Administrative controls, however, are required for transfers from the sample gallery Load-in Station to TK-E6.

In addition, the critical mass control specifications requires that no plutonium rework solution shall be added unless TK-E6 is at least half full and the TK-E6 acidity is at least 0.4 M.

Can Load-In Rates

The maximum processing rate for plutonium in Purex is limited to 25 kilograms per day by the XCP Concentrator. The overall rate of reworking plutonium, however, may be limited to a lower value by can handling limitations in the rework load-in facilities. It is estimated that the RC Recycle Hood can handle about 40 cans per day, and the PR Room can handle from 9 to 15 cans per day depending on the rate of plutonium load-out requirements. However, the PR Room can probably only handle 6 cans per day, if the rework solution is treated for processing in the Plutonium Ion Exchange unit. Based on these maximum number of cans, the maximum normal load-in rates from the RC Recycle Hood to TK-E6, from the PR Room to TK-E6, and from the PR Room to TK-N1 are about 20, 9 to 15, and 6 Kgs of plutonium per day. Since many of the cans will not be as concentrated as desired, the maximum rework rates probably cannot be routinely achieved.

However, the Purex Plant should be able to attain a total rework rate via TK-E6 approaching the Purex Plant processing limit by loading in plutonium from both the PR Room and the RC Recycle Hood. Since the load-in rate via the PR Room is only 9 to 15 kilograms per day, the RC Recycle Hood load-in rate must be 10 to 16 kilograms to attain the maximum Purex plutonium processing rate. This means that at least half and preferably seventy per cent of the plutonium rework should be in solutions less than 75 grams per liter to use the RC Recycle load-in station effectively and thus attain the maximum rate of plutonium rework. A verbal agreement has been reached with Z-Plant to dilute the MR rework to less than 75 grams per liter as soon as sufficient PR cans are available. Sufficient cans should be available soon after the Purex Plant starts the plutonium rework campaign.

Since it is desirable to operate at the maximum of 1000 g/T to minimize essential material cuts, and since operation of the Purex Plant at a plutonium processing rate of 25 kilograms per day is sensitive to process upsets and critical mass control problems, an initial uranium processing rate of 20 tons per day is recommended. After the load-in procedures and process conditions are established, an increase in the uranium processing rate to 25 tons per day may be warranted. On the basis of 20 tons of uranium per day and a 1000 g/T plutonium concentration, a 200 kilogram campaign will require 10 days of plant operation.

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The Z-Plant dissolvers have a capacity of about 15 kilograms per day. Since the quantity of plutonium already in solution is in excess of 50 kilograms, the Purex Plant processing rate should not be limited by the Z-Plant dissolvers during the 200 kilogram campaign.

Process Recommendations

The following recommendations are suggested for processing Z-Plant MR and EP-1 solutions while recycling plutonium-free uranium (items marked with an asterisk are required by Critical Mass Control Specifications(1):

A. Rework Via the RC Recycle Hood

1. No rework solutions greater than 75 grams per liter shall be added to TK-E6 via the RC Recycle Hood.* Plutonium solids with a particle size greater than 40 microns shall not be introduced into the Purex Plant.*
2. Rework solutions should be added directly to TK-E6 through a <40 micron filter. The RC Recycle Storage Tank should be blanked-off to prevent uncontrolled additions.*
3. No PR cans containing more than 600 grams will be added to TK-E6 from the RC Recycle Hood. Each PR can will be checked with the neutron monitor to verify the quantity of plutonium is less than 600 grams.
4. Each PR can should be thoroughly flushed with a dilute nitric solution. Before filling with Purex plutonium product, the can should also be inspected to assure that an appreciable quantity of solids is not present. If solids are present, the can should be returned to Z-Plant for additional flushing.
5. As part of the campaign's special administrative controls, a light and/or alarm system should be provided at the RC Recycle Hood to assure that plutonium solutions are not added to TK-E6 without TK-E6 agitators operating. Operation of TK-E6 agitators is required by Ref. 1.

B. Rework Via the FR Room

1. Rework solutions greater than 75 grams per liter shall be added via the FR Room. Plutonium solids with a particle size greater than 40 microns shall not be introduced into the Purex Plant.*
2. The rework solution should be transferred from the PR can to TK-L9/L10 through a less than 40 micron filter to prevent plugging FR Room lines and valves.
3. The rework solution should be diluted with a nitric acid solution. The nitric acid solution for dilution must be $\geq 2.0 \text{ M HNO}_3$ in TK-L9/L10 to prevent exceeding 225 grams per liter.* The dilution should also assure that the acidity of the final solution will be $\leq 10 \text{ M HNO}_3$ to prevent precipitation of aluminum nitrate.

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4. Each PR can should be thoroughly flushed with a dilute nitric solution. Before loading with Purex plutonium product, the can should also be inspected to assure that an appreciable quantity of solids is not present. If solids are present, the can should be returned to Z-Plant for additional flushing.
5. Only one plutonium storage tank, L9 or L10, should be used for handling rework. In addition, the tank should be isolated by installation of appropriate line blanks to prevent a violation of critical mass control or contamination of the Purex plutonium product.
6. TK-L11 should not contain more than 5000 grams of plutonium.
7. The L11 to E6 pump should operate for several minutes after closing the suction valve on the L11 to E6 jet in order to flush the L11 to E6 line.

C. TK-E6 Plutonium and Nitric Concentration and Volume

1. Plutonium should not be added to TK-E6 unless the TK-E6 solution is greater than 0.5 M HNO_3 , thereby avoiding plutonium polymer formation.* The control of TK-E6 acidity may be based on acid analysis of TK-K1 or P2 area rework solutions.
2. TK-E6 must be at least half full before the addition of any plutonium rework solution.*
3. The initial plutonium butt to TK-E6 should be limited to 750 grams per ton of uranium and should be made from only one station to guard against double batching. Each batch of TK-E6 after butting with plutonium should be sampled for rush Pu, HNO_3 and Sp.G. analyses.
4. The TK-E6 plutonium concentration should be limited to a maximum 1000 grams per ton and should be increased from the 750 g/T only after a plutonium analysis of the initial TK-E6 plutonium butt. The second butt of TK-E6 should be made only from the RC Recycle Hood.

D. Other Processing Recommendations

1. One gallon of 2.4 M aluminum nitrate should be added for each FR can of MR rework solution upstream of the IWW Concentrator. Aluminum additions are not required for EPT solutions.
2. The recycle uranium route should be TK-E6 to TK-D5 to TK-H1 to provide adequate lag storage of feed solution.
3. P-Tank rework uranium should not be added via TK-K6 to prevent contamination of uranium product.
4. The Second Uranium Cycle should not be operated unless the P-Tank uranium rework is being processed. This is required to minimize essential material costs.

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5. Uranium recycled from TK-K1 to TK-E6 should be screened to prevent TK-K1 solids from being added to other processing vessels.
6. The 2DF-Fe line should be blanked during TK-K1 uranium cycle. Any TK-K1 recycle solution containing ferrous sulfamate should be destroyed with sodium nitrite. The recommended concentration of excess sodium nitrite is 0.01 M.
7. During recycle of TK-K1 uranium, the 2DF-HNO₃ flow should be shut off. This nitric acid loss to the 3WB should be made up by the addition of Purex recovered acid to TK-J1.
8. The HA Column saturation should be reduced during the rework campaign. Commensurate with decontamination and waste loss performance. However, the saturation should be maintained at a reasonable level to prevent a large increase in the HAP nitrite concentration.

Draft procedures and line routings prepared during the rework study are available for your use. We would be happy to be of any further assistance.

J B Kendall

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