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RICHLAND, WASHINGTON

HANFORD ATOMI

PRODUCTION TEST 221-T-19
REDUCTION OF TIME CYCLE IN DISSOLVER SECTION

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DS Lewis 6/19/92
DJ Phicker 9/4/92
J.E. Savelly 9-4-92

W. C. Schmidt

T and U Plant Process Unit
Operations Technology Section
ENGINEERING DEPARTMENT

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HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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PRODUCTION TEST 221-T-19

I. Objective

To determine, by test, the feasibility of decreasing the time requirements to prepare the aluminum clad uranium slugs into uranyl nitrate solution suitable for the separation of plutonium from uranium in the extraction step.

II. Basis

Although the third dissolver (3-5-L) has been activated to increase the dissolving capacity of the Bismuth Phosphate Plant, additional capacity is needed. Since the majority of the time is consumed by the actual dissolving operation, new techniques for faster dissolving are needed.

At present the dissolvers are charged with 6600 pounds of eight inch aluminum jacketed uranium slugs. After jacket removal, the uranium is converted to 74.6 per cent uranyl nitrate - 0.4 M nitric acid solution by the reaction with 15,000 pounds of 60 per cent nitric acid. This solution concentration is controlled by dissolving uranium until the Sp.G. is 1.82 at the boiling point. Normally, two shots of 7500 pounds each of acid are required to dissolve the complete charge of uranium. The uranyl nitrate solution is diluted with water to lower the freezing point, and transferred to the 4-8 tank. At this point 2820 pounds of 93 per cent sulfuric acid is added for two reasons: (a) the sulfate ion associated with the acid is added to make the solution 0.5 M in the extraction step to prevent precipitation of uranyl phosphate; (b) the final hydrogen ion concentration, 1.0 M, required for optimum bismuth phosphate precipitation, during extraction, is partially realized through the addition of the sulfuric acid. The solution is then transferred to the 4-7 tank; thence to the 6-1 tank from where a batch size of 300 grams of plutonium is transferred to the 6-3 tank. Sodium nitrite is added in 6-3 to reduce the plutonium before transfer to the 7-1 or 8-1 tank. Dilution water is then added to make the solution 22 per cent uranyl nitrate by weight.

It is estimated that up to 30 per cent reduction in dissolution time cycle may be realized by halting the dissolution process at 4 M nitric acid instead of the usual 0.4 M concentration. Dissolution to a final dissolver sp.gr. of 1.68, at the boiling point, is expected to give ca. 57.8 per cent UNH and 4 M nitric acid. To attain the final solution concentration specifications of 1 M hydrogen ion, 0.5 M sulfate ion, and 22 weight per cent uranyl nitrate, after chemical additions and dilution, sodium sulfate is used vice sulfuric acid to supply the required sulfate ion. The final solution, before extraction precipitation, is higher than present 7-1 (8-1) solutions in sodium and nitrate ions, but laboratory data show no expected impairment of extraction efficiency due to this cause. See Figure I for proposed flow sheet.

III. Procedure

The procedure is presented in outline form to present the necessary changes. All steps which are in the present procedure and not mentioned below should be followed.

1. Dissolver

- a. Add 20,620 lbs. of 60 per cent nitric acid (10,310 lbs. per cut).
- b. Dissolve to a Sp. G. of 1.68. Expected boiling point will be 113 C.
- c. Add 2250 lbs. of water per cut for dilution water.
- d. Add 19.5 oz. of mercuric nitrate salt ($\text{Hg}(\text{NO}_3)_2 \cdot \text{H}_2\text{O}$) in 50 lbs. of water per cut.
- e. Add 1500 lbs. of water to dissolver after second cut has been sent to 4-8 to rinse dissolver. Transfer this rinse water to the dissolver solution in 4-8.

2. 4-8 Tank

- a. Eliminate addition of sulfuric acid.
- b. Jet directly on to Tank 4-7.

3. 4-7 Tank

- a. No additions. Transfer directly to 6-1 tank.

4. 6-1 Tank

- a. Sample and transfer calculated amount for maximum permissible batch size to 6-3 tank.

5. 6-3 Tank

- a. Eliminate addition of dilution water.
- b. Add 9300 lbs. of 20 per cent sodium sulfate (Na_2SO_4) solution as rapidly as possible with agitator running.

6. 7-1. 8-1 Tank

- a. Adjust total weight in precipitator tank with dilution water as prescribed in the present operating procedure.

This procedure as described above is based upon the best estimates of uranyl nitrate-nitric acid compositions and densities of dissolver solution as dissolving proceeds. Therefore, the amounts proposed in this outline in the flowsheet (Figure I) are tentative, only, and should be adjusted as needed to give an extraction solution of the proper concentrations (e.g. 22 per cent UNH , 1 M HNO_3 , 0.5 M Na_2SO_4 , 0.09 M NaNO_3 , 0.5 M H_3PO_4 in the precipitation tank). These adjustments can be made from the special 6-1 $\text{UNH} - \text{HNO}_3$ analysis requested.

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IV. Special Data

Dissolution times should be collected with an explanation of all delays not expected in routine dissolving procedure. Extraction waste losses will be needed, and can be obtained from the routine 7-3 WS, 8-3 WS sample. The 6-1 Tank will be sampled for routine TV analysis and for URE-H₂O₃ determination in the 222-S laboratories. Accountability procedures will not be affected.

V. Equipment and Process Chemicals

No new equipment will be required. Sulfuric acid will be eliminated and approximately 1860 pounds of sodium sulfate (Na₂SO₄) will be needed per dissolver charge.

VI. Responsibility

Run books for both sections of this test will be prepared by the Process Unit of the T-Plant Sub-Section, Separations Section. Procurement and summation of all data will be done by appropriate Separations Section personnel. Evaluation of test data will be a joint responsibility between the Process Unit, T-Plant Sub-Section, Separations Section and Separations Technology Section personnel.

VII. Estimated Completion

Completion of the test is anticipated after thirty chargings have been dissolved (approximately ten chargings in each dissolver).

VIII. Future Work

If the foregoing procedures yield satisfactory dissolving cycles, several variables are worthy of additional consideration and evaluation. Among these are: (a) adding sufficient nitric acid in the dissolver to have the final dissolver solution greater than the proposed 4.0 M hydrogen ion and adding sodium hydroxide in either the 6-3 Tank or 7-1, 8-1 Tank to reduce hydrogen ion concentration to 1.0 M in extraction, (b) starting with a higher concentration of acid in the dissolver than 60 per cent acid, (c) applying catalysts, e.g. phosphoric and sulfuric acid, to the uranium dissolution step.

W. C. Schmidt
W. C. Schmidt

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FIGURE I
Flowsheet for Na_2SO_4 Addition

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APPROVALS

O. F. Hill Manager, Plant Processes
O. F. Hill Separations Technology Section

12/16/54
Date

C. S. Tinsmith Superintendent, T Plant
C. S. Tinsmith Separations Section

12/17/54
Date

R. S. Bell Manager, Separations Section
R. S. Bell

12/14/54
Date

R. B. Richards Manager, Separations Technology
R. B. Richards

12/22/54
Date

J. E. Maider Manager, Manufacturing
J. E. Maider

12/27/54
Date

Date Issued 12/30/54

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