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REDOX DISSOLVER TESTS

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Introduction

At the present time, production commitments require that each of the two dissolvers used at the Redox Plant be charged with 4.95 tons of irradiated metal every other day. After the aluminum jackets are removed from the slugs, the uranium is dissolved in three "cuts" of 1.65 tons each. Because meteorological conditions often limit the time when the radioactive dissolver off gases may be emitted without contamination of the surrounding area, the dissolving requirements are frequently too great to maintain the required dissolver charging schedule. Unless the dissolving time cycles (or the meteorological limitations) can be reduced to assure that charging every other day can be maintained, phase II rates cannot be met even after activation of the third (spare) dissolver.

As a means of reducing the dissolver time cycle and enabling the charging of each dissolver on alternate days throughout the year, a proposal was submitted that each dissolver charge be dissolved in two cuts of 2.475 tons each. This report presents the results of the plant test to determine the operational feasibility and relative merits of this proposal. Moreover, the information obtained may be used on a supplemental basis for the design of the Purex Plant dissolvers.

Summary

The test consisted of a series of four metal charges with two cuts for each charge. The charge sizes and cut sizes were varied so that the amount of metal dissolved was gradually increased from 1.925 tons to 2.475 tons per cut. (See Table I for nominal test conditions.)

The results of the test show that two-cut dissolutions of 4.95-ton dissolver charges would virtually assure that each dissolver could be charged every other day as scheduled. A reduction of 13 per cent in dissolving times and 9 per cent in overall dissolver time cycle is effected by the use of a two-cut dissolution compared with the present three-cut dissolution. The operation of the dissolver was essentially the same as with the smaller cuts. Adequate cooling capacity is available for controlling the reaction and maintaining vacuum. Dissolver off-gas equipment appears adequate for handling the increased maximum rate of gas evolution at the peak of reaction.

Recommendations

Based on the results of this test it is recommended that (a) the two-cut dissolution of a 4.95-ton charge be adopted immediately as standard procedure in the B-2 Dissolver; (b) the two-cut dissolution of a 4.95-ton charge be adopted as standard procedure in the A-2 Dissolver as soon as the silver reactor heater unit for this dissolver has been repaired or replaced.

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Experimental

Present plant dissolver operation consists of the following operations:

- (a) Charge 4.95 tons of uranium on top of ~ 1.5 tons of uranium heel in the dissolver.
- (b) Remove the aluminum slug jackets by digesting in hot caustic solution.
- (c) Dissolve the uranium with 60 per cent nitric acid in 3 cuts of 1.65 tons each, leaving ~ 1.5 ton heel.

The volume and liquid level considerations pertaining to the present 3-cut dissolution are presented in Table I. Some of the important operating characteristics of a 3-cut dissolution are summarized in Table II.

The test was initiated by removing the heel in the B-2 dissolver in order to establish the amount of metal present in the dissolver during the test. The dissolver was then charged with metal and the jackets were removed according to standard procedure. Two 3850-pound cuts (compared with the present standard 3300-pound cuts) were then dissolved according to standard procedure, except that a minimum of pot coil cooling water was used in the first cut to control the reaction. The test was continued by increasing the cut size to a final amount of 4950 pounds. The 4950-pound cut was confirmed by two additional cuts of the same size. Tables I and II present a summary of the test schedule and actual test operating characteristics, respectively. Comparison of these data with those for the standard 3-cut dissolution indicate that the increased reaction rates and volumes of the larger cuts are safely within the capacity of the dissolving equipment.

As indicated in Table III, the two-cut dissolution represents a time cycle reduction of approximately 3.3 hours per charge, which is a 13.2 per cent reduction based on dissolution time or 8.6 per cent based on the total dissolver time cycle. However, the actual time reduction is appreciably more when it is considered that frequently during the summer and occasionally during the winter, atmospheric dilution of dissolver off gases is limited. Under these conditions only 12 to 16 hours would be available for dissolving the last two cuts of each charge in order to meet the charging schedules. Since this is impossible, charging schedules would not be met and production would be hindered. Dissolution of each charge in two cuts would preclude the necessity of dissolving two cuts in a short period of time and therefore practically assure the maintenance of dissolver charging and production schedules.

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References

HW-25252, R. E. Tomlinson to File, 8-5-52; "Dissolver Production Tests".

HW-18700, Chemical Development Sub Unit, Separations Technology Unit,
7-10-51; "Redox Technical Manual", pp. 305-308.

HW-23745, R. E. Tomlinson to File, 3-10-52, "Redox Process - Potential
Process Modifications - Rough Draft".

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TABLE I
DISSOLVING TABLETS, VOLUMES AND LIQUID LEVELS

Rm No.	Cut No.	Lbs. U Heel	Lbs. U Charged	Lbs. U Total	Lbs. U Dissolved	Lbs. of 60% HNO ₃	Gals. of 60% HNO ₃ of U	Gals. Total	Liquid Level, in.	Freeboard in.
Standard Dissolution of Three 3300-Pound Cuts										
	1	3,000	9,900	12,900	3,300	8,100	720	70	790	39.5
	2	9,600	0	9,600	3,300	8,100	720	50	770	38.5
	3	6,300	0	6,300	3,300	8,100	720	30	750	39.0
Nominal Dissolver Test Schedule										
0	1									
	1	0	12,100	12,100	3,850	9,500	840	65	905	44.5
	2	8,250	0	8,250	3,850	9,500	840	40	880	46.0
	1	4,400	7,700	12,100	4,400	10,900	965	65	1,030	39.3
	2	7,700	0	7,700	4,400	10,900	965	35	1,000	40.5
	1	3,300	9,900	13,200	4,400	10,900	965	75	1,040	39.0
	2	8,800	0	8,800	4,950	12,200	1,080	45	1,125	35.0
	1	3,850	8,800	12,650	4,950	12,200	1,080	70	1,150	34.0
	2	7,700	0	7,700	4,950	12,200	1,080	35	1,115	35.5

TABLE II
OPERATING CHARACTERISTICS OF DISSOLVER

	Standard Dissolution of Three 3300-Pound Cuts			Dissolver Test					
	First Cut	Second Cut	Third Cut	First Charge		Second Charge		Third Charge	
				Cut 1 (3)	Cut 2	Cut 1	Cut 2	Cut 1	Cut 2
Dissolving Time, hours	6.6	6.9	8.8	8.8	9.7	9.9	10.9	9.9	9.9
Cooling Time, hours	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.5	0.5
Transfer Time, hours	0.4	0.4	0.4	0.4	0.3	0.4	0.3	0.6	0.3
Maximum Silver Reactor $\bar{c}_P$, in. water	16.5	16.0	15.0	19.4	18.2	19.0	19.7	18.0	15.8
Maximum Off-gas Rate to Silver Reactor, cfm (1)	270	260	250	300	290	295	310	260	280
Maximum Off-gas Filter $\bar{c}_P$, in. water	2.3	2.3	2.2	2.2	2.3	2.2	2.3	2.4	2.2
Maximum Reactor Heater Current, amps.	40	40	35	35	35	20	35	30	35
Minimum Silver Reactor Inlet Temp., °F.	355	360	365	360	366	360	366	375	350
Minimum Dissolver Pot Vacuum, in. water (2)	0	0	5	3.5	6.5	3.0	4.0	0	0.5
Maximum Dissolver Column $\bar{c}_P$, in. water (2)	20	20	15	20	11.2	20	8.0	20	12.0
Maximum Dissolver Off-gas Temp., °C.	40	39	36	36	33	35	33	36	34
Dissolver Tower Cooling Water Rate, GPM	80	80	80	100	100	100	100	100	100

(1) Based on calibration of silver reactor pressure drop and flow rate for air.

(2) These conditions occur at the peak of reaction, and are largely dependent upon the technique of the operator in charge.

(3) A total of 494 gallons of dissolver pot cooling water over a cooling period of 7 minutes was used to control the reaction at peak.

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TABLE III
COMPARISON OF TIME CYCLES BETWEEN
THREE-CUT DISSOLUTION AND TWO-CUT DISSOLUTION OF
4.95 TON CHARGES

	Time, in hours	
	3 Cuts(1)	2 Cuts(2)
Charge	4.5	4.5
Jacket Removal	7.2	7.2
Cool	0.6	0.6
Wash, Transfer	1.0	1.0
First Cut, Dissolve	6.6	9.3
Cool	0.5	0.5
Transfer	0.4	0.5
Second Cut, Dissolve	6.9	10.5
Cool	0.5	0.5
Transfer	0.4	0.6
Third Cut, Dissolve	8.8	---
Cool	0.5	---
Transfer	0.4	---
Total Cycle Time	38.3	35.0
Dissolving Cycle Time	25.0	21.7

(1) Determined from 14 charges.

(2) Estimated from results of this test.

Time Saving = $38.3 - 35.0 = 3.3$ hours/charge
 = 3.6% of total cycle
 = 13.2% of dissolving cycle.

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