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PRODUCTION TEST IP-560-A

HALF-PLANT LOW DICHROMATE - LOW pH WATER TREATMENT
AT C REACTOR

Classification Cancelled and Changed
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February 18, 1963

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HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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PRODUCTION TEST IP-560-A
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OBJECTIVE

The objective of this test is to determine the corrosion effects resulting from reducing the amount of sodium dichromate corrosion inhibitor added to process water from 1.8 to 1.0 ppm at a process water pH of 6.6.

JUSTIFICATION

Sodium dichromate at a feed rate of 240.2 ppm had been used for many years as an aluminum corrosion inhibitor. On September 26, 1960, C Reactor began a half-plant test⁽¹⁾ using pH 7.0 process water containing 1.8 ppm sodium dichromate on one side and 1.0 ppm sodium dichromate on the other. An interim evaluation⁽²⁾ after nine months of operation tentatively concluded that the reduced dichromate had not affected uniform or pitting corrosion of either the aluminum fuel jackets or the process tubes. The report recommended: 1) continuation of the half-plant test until final evaluation was completed, and 2) a reduction in sodium dichromate addition to 1.0 ppm at all reactors (excluding C) maintaining a process water pH of 7.0. The dichromate feed rate was reduced to 1.0 ppm at B, H, and F Reactors on July 1, 1961⁽³⁾ and at D and DR Reactors on December 16, 1961⁽⁴⁾. Neither subsequent C Reactor test data nor the use of 1.0 ppm dichromate at these reactors for well over a year has produced any evidence that the lower dichromate concentration is not providing adequate aluminum corrosion inhibition.

However, the question of the adequacy of inhibition of 1.0 ppm dichromate in pH 6.6 coolant has not yet been demonstrated. Coupon data⁽⁵⁾ from the KE Reactor single-pass tubes has indicated that under low dichromate (1.0 ppm) - low pH (6.6) conditions aluminum corrosion rates are higher than under high dichromate (1.8 ppm) - low pH (6.6) conditions. The data also indicate that the effect is more pronounced on Alloy 1100 (tube material) than on Alloy X8001 (fuel jacket material). Inasmuch as: (1) the savings accrued by using reduced dichromate would offset the increased costs of acid to provide the 6.6 pH coolant (demonstrated to be beneficial to aluminum corrosion at the K Plants), and (2) coupon

- (1) HW-65189, "Reduction of the Amount of Dichromate Added to Reactor Cooling Water, Production Test IP-321-A," E. J. Nesselson, May 11, 1960.
- (2) HW-69985, "Reduction of the Amount of Dichromate Added to Reactor Cooling Water Interim Report, Production Test IP-321-A," E. J. Nesselson, June 19, 1961.
- (3) HW-70295, "Process Improvement Transition Authorization IP-17-AI, Reduction of the Amount of Dichromate Added to Process Water," E. J. Nesselson and R. D. Shimer, July 14, 1961.
- (4) HW-70295 SUPA, "Supplement A to Process Improvement Transition Authorization IP-17-AI, Reduction of the Amount of Dichromate Added to Process Water," R. D. Shimer and F. W. VanWormer, January 23, 1962.
- (5) Letter, "Aluminum Corrosion in Low pH - Low Dichromate Water," R. B. Richman to M. A. Clinton, January 2, 1963.

data are difficult to extrapolate to actual process conditions, a half-plant test appears mandatory to define the aluminum corrosion effects of using low dichromate feed rates at 6.6 pH.

TEST DETAILS

1. Location

The test will be conducted at C Reactor.

2. Process Water

a. Reactor Operation

During reactor operation, the C Area process water will be maintained as follows:

	<u>Control Side</u>	<u>Test Side</u>
pH	6.6±0.1	6.6±0.1
Dichromate Feed Rate, ppm	2.0±0.2	1.0±0.1
Alum Feed Rate, ppm	18	18

b. Reactor Shutdowns

During shutdowns, the process water to both sides of the reactor may be 1.0 ppm dichromate and pH 7.0. However, the test conditions will be restored at least two hours prior to startup.

c. Water Plant Operation

When acid addition is made downstream of the water plant filters, the water plant will operate to produce pH 7.0±0.1 water during the initial phase of the test. After effluent activity effects are established (three to four months), it may prove desirable to operate the water plant at as high a pH possible consistent with 18 ppm alum.

3. Corrosion Monitoring

a. Aluminum

(1) Installation and Removal of New Process Tubes

Eight ribbed aluminum tubes will be installed at 105-C. Four will be on the test side, and four will be on the control side. One tube from each side will be removed at four to six month intervals.

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(2) Probologging

One hundred existing tubes (50 from each side) will be probologged at the start of the test and every other time fuel is discharged therefrom for the duration of the test.

(3) Fuel Elements

Fuel element corrosion will be monitored both by visual examination and by weight loss measurement. Four groups of 20 tubes, ten from each side, will be selected from those scheduled for normal goal discharge on the following basis:

- (a) One group prior to or as soon as possible after the change to pH 6.6.
- (b) One group every two months after the reduction in pH. The second of these will consist of numbered, weighed and measured fuel elements.

The tubes to be used will be selected by the Process Engineer with the concurrence of the test author. The ten charges from one side may be mixed and combined in pickup buckets. The fuel representing one side will not be mixed with fuel representing the other. All the fuel will be sent to the 105-C Metal Examination Facility for postirradiation examination. It is important that the identification of fuel source be maintained in the transfer.

(4) Coupons

Coupon holders shown in Print No. SK-1-23211 may be included in the downstream dummy pattern. The number and location of the coupon holders will be selected by the test author with the concurrence of C Processing Operation.

b. Carbon Steel

Weighed metal specimens and/or Corrosometer probes will be installed as required to detect and define the extent of carbon steel corrosion.

4. Fuel Charge and Exposure

Normally fuel charges will consist of the standard number of pieces. Mixers may be used in all charges except those in the eight new tubes which will be scheduled for early removal for ex-reactor examination. The absence of mixers in these tubes will increase tube corrosion rates and differences in rate can thus be detected sooner. If necessary, appropriate adjustments will be made in the no-mixer charges to insure conformance to the boiling limit standard (Process Standard A-021).

All fuel charges will run to the variable goal limit except those in the no-mixer tubes. These will run to 80 per cent of goal.

5. Start and Duration of Test

Operation at low pH will start as soon as possible after the approval of the test. The test will terminate one year after test initiation.

6. Operating Data Required

- a. Outlet temperature of the eight corrosion monitor tubes - daily (during operation).
- b. Panellit and crossheader pressures of the eight corrosion monitor tubes - weekly.
- c. Frequency of purging.
- d. Daily average pH and dichromate concentrations to each side of the reactor.

COSTS

1. Tube probologging: Three minutes per tube each time 100 tubes are probologged - 20 hours total.
2. Tube replacement: Three hours per tube when each of eight tubes is replaced - 24 hours total.
3. Charge-discharge: Four groups of 20 columns with no segregation except between reactor sides - 16 hours total.
4. Chemicals: The incremental acid cost of 6.6 pH vice 7.0 pH is estimated at \$40,000 per year.
5. Acid addition facilities: It is estimated that \$4,000 will be required to provide the acid addition facilities.
6. Test financing: All outage time and monetary expenditures will be absorbed by B-C Reactor Operation.

HAZARDS

There is a possibility that downstream acid addition may cause filming in the process tubes. Panellit gauge monitoring will detect this in time to permit purging or other corrective action.

RESPONSIBILITIES

Research and Engineering Section

Process and Reactor Development Subsection will be responsible for:

1. Coordination of effort, making process recommendations and supplying data sheets.
2. Analysis of corrosion data.
3. Termination of the test and issuance of final report.

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Process Technology Subsection will be responsible for:

1. Assistance in the selection of fuel charges for examination.
2. Specifying operating limits for the no-mixer tubes.

Testing Subsection will be responsible for:

1. Probologging of process tubes.
2. Postirradiation examination of fuel elements.
3. Postirradiation examination of process tubes.

Manufacturing Section

B-C Reactor Operation

B-C Power Operation will be responsible for:

1. Providing process water as specified.
2. Recording pH data as required.

C Processing Operation will be responsible for:

1. Operational safety and production continuity.
2. Recording operating data as required.
3. Charge-discharge of corrosion monitoring fuel.
4. Scheduling probologging.
5. Installation, removal, and special handling of specified process tubes.

Process and Reactor Development Subsection
Research and Engineering Section

RG Geier:nmd

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