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INTERIM REPORT IV, PRODUCTION TEST IP-549-A
HALF-PLANT LOW ALUM FEED WATER TREATMENT
AT F REACTOR

AUTHOR

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INTERIM REPORT IV, PRODUCTION TEST IP-549-A
HALF-PLANT LOW ALUM FEED WATER TREATMENT
AT F REACTOR

By

R. G. Geier
Process and Reactor Development Subsection
Research and Engineering Section

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RICHLAND, WASHINGTON

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INTRODUCTION

A half-plant low alum water treatment test⁽¹⁾ began at F Reactor on January 16, 1963. The test, which had been prompted by the analysis of ledge corrosion attack on fuel elements⁽²⁾, will demonstrate whether or not high alum feed is responsible for increasing the frequency of ledge and groove⁽³⁾ corrosion attack on fuel element surfaces. The effect will be evaluated by comparing visual examination results obtained from normal production fuel irradiated in process water treated with two different alum feed rates. Three 20 column fuel discharges, ten from each side of the reactor, have been taken during the test as follows:

1. One discharge prior to the start of the test⁽⁴⁾.
2. One discharge such that the test side was exposed to coolant treated with both high and low alum feed⁽⁵⁾.
3. One discharge under test conditions⁽⁶⁾.

This report presents the results from the second discharge under test conditions.

SUMMARY

The visual fuel element examination data from 673 F Reactor elements, 320 from the near side and 353 from the far side, which had been charged on March 29, 1963 and discharged on June 19, 1963, gave the following results:

1. The over-all frequency of primary ledge corrosion was 12 per cent (21 per cent on the near side and three per cent on the far side).
2. The over-all frequency of primary groove corrosion was 0.7 per cent (1.6 per cent on the near side and none on the far side).

This is the first instance since the start of the test that a difference in the frequencies of localized corrosion was apparent between the two sides of the reactor. The high incidence of ledge corrosion on the near side (high alum) indicates that an alum effect may occur when other, presently unidentified, variables have combined to produce the proper threshold environment.

DISCUSSION

A. Water Treatment

In order to determine whether high alum feed in the water treatment process was responsible for an increased frequency in the types of localized corrosion described as groove and ledge, the following half-plant test conditions were established at F Reactor on January 16.

	<u>Control Side</u> <u>(Near)</u>	<u>Test Side</u> <u>(Far)</u>
pH	7.0	7.0
Dichromate, ppm	1.0	1.0
Alum, ppm	18	6

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The actual alum feed rate used on the test side from the inception of the test to the end of June is shown in Figure 1. On numerous occasions it was necessary to increase the feed rate above 6 ppm to produce coolant of acceptable quality. During the irradiation period of the fuel discussed in this report (March 29-June 19), the alum feed rate to the test side averaged 10 ppm. Such a feed rate is considered satisfactorily below 18 ppm to demonstrate alum effects, if any.

B. Fuel Element Characteristics

Twenty columns of fuel elements, ten from each side of the reactor, which had been charged during the outage of March 29, 1963, were discharged during the outage of June 19, 1963. The average irradiation conditions are shown in the following table.

	Control Side (Near)	Test Side (Far)
Exposure, Mwd/t	659	642
Tube Power, Kw	1140	1110
Tube Inlet Temperature, °C	10	10
Tube Outlet Temperature, °C	101	99
Tube Flow, gpm	47.6	47.5
Calendar Days in Reactor	80	80
Operating Days	69	69
Tube Age, Months	15	13
Fuel Charge (with water mixer)	31 pc OIIIN	31 pc OIIIN
High Alum Feed Coolant	69	0
Low Alum Feed Coolant	0	69

As has been the case with previous fuel discharges made during the production test, conditions on each side of the reactor were essentially identical.

For comparative purposes, the average irradiation conditions for all the fuel discharges made under the production test are given below.

	Pretest Fuel	First Test	Second Test	Present
Exposure, Mwd/t	565	940	645	650
Tube Power, Kw	1125	1140	1160	1125
Tube Outlet Temperature, °C	102.5	98	98.5	100
Tube Inlet Temperature, °C	14	7	7	10
Tube Flow, gpm	48.2	47.6	47.8	47.6
Tube Age, Months	9	11.5	12.5	14
Fuel Charge	32	31 + WM	31 + WM	31 + WM

While the first test fuel can be distinguished by its high exposure and the pre-test fuel by the absence of water mixers, in general the irradiation variables have been held quite constant.

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C. Visual Fuel Element Examination

1. Definitions

Visual fuel element examination identifies the serious type of corrosion attack as well as recognizing the presence of secondary effects. While a fuel element may exhibit several types of corrosion (pitting, uniform, ledge or groove), only primary and secondary are reported, according to the following definitions:

Primary - Type of corrosion considered most detrimental to fuel survival.

Secondary - Type of corrosion, although less important than primary, which may be a potential cause of future corrosion problems.

2. Results

Analysis of the visual examination data from 673 fuel elements, 320 from the near side and 353 from the far side, produced the results shown below.

Localized Corrosion Frequency

	<u>Per Cent of Pieces</u>		
	<u>Near</u>	<u>Far</u>	<u>Over-all</u>
Primary Ledge	20.6	3.1	11.5
Secondary Ledge	1.2	0.0	0.6
Primary Groove	1.6	0.0	0.7
Secondary Groove	0.6	0.0	0.3
Severe*	0.0	1.1	0.6

* Corrosion judged to be greater than ten mils deep.

The results from previous fuel discharges made prior to and under the production test are as follows:

Localized Corrosion Frequency

	<u>Per Cent of Pieces</u>			
	<u>PT-216</u>	<u>Pretest</u>	<u>First</u>	<u>Second</u>
	<u>Data</u>	<u>Over-all</u>	<u>Test</u>	<u>Test</u>
	<u>Over-all</u>		<u>Over-all</u>	<u>Over-all</u>
Primary Ledge	10.5	15.7	8.0	1.4
Secondary Ledge	4.5	4.3	1.2	0.0
Primary Groove	6.2	8.4	0.5	0.2
Secondary Groove	3.6	8.4	1.9	0.2
Severe*	4	9	2.5	1.9

* Corrosion judged to be greater than ten mils deep.

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It should be pointed out that in none of the previous data had there been a significant difference between the two sides of the reactor. Thus, it had been postulated that if high alum feed rates in the water treatment process contributed to an increased frequency of ledge or groove corrosion, the effect must be secondary to the effect of at least one other variable. In all probability several other variables may be involved.

The 20 per cent incidence of ledge corrosion on the near side (high alum) in the present fuel as compared to only three per cent incidence on the far side (low alum) indicates that the unidentified variables have changed sufficiently in the direction of increased corrosivity to permit an alum effect to be recognized. Also of significance is the continued absence of groove corrosion. This tends to substantiate the theory that an environment more corrosive than that required to produce ledge corrosion is necessary to produce groove corrosion.

In addition to identifying the most predominant types of corrosion, visual fuel element examination also delineates the location of the primary corrosion. The corrosion location data from the fuel discharges made under the production test have been analyzed, and the results are as follows:

Location of Groove and Ledge Corrosion

	<u>Pretest</u>	<u>Per Cent of Pieces</u>		<u>Present</u>
		<u>First</u> <u>Test</u>	<u>Second</u> <u>Test</u>	
Bottom	28	69	100	76
Side	13	8	0	1
Top	48	21	0	4
Scattered	11	2	0	19

It is of interest to note that with the exception of the pretest fuel the groove and ledge corrosion occurred predominantly at the bottom. In the pretest fuel the groove and ledge corrosion occurred predominantly at the top. Since the pretest fuel had been charged without water mixers, it can be presumed that the mixers were responsible for the shift in location.

D. Effluent Activity

The average concentrations of P^{32} and As^{76} in the F Area effluent from January 16 to May 31 are shown below.

	<u>P^{32}</u> <u>pc/ml</u>	<u>As^{76}</u> <u>pc/ml</u>
Test Side	11.7	134
Control Side	9.0	74
Old Reactor Average	7.1	77

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The results continue to show the test side P^{32} concentration to be 30 per cent above the control side. Similarly, the As^{76} concentration in the test side effluent is about double the control side concentration. Such results are typical of what might be expected from using low alum feed. Inasmuch as the results have been quite consistent for several months, differentiation between reactor sides was terminated on May 31.

E. Future Work

At startup after the June 19 outage, the coolant pH was lowered to 6.6 and the sodium dichromate feed rate was increased to 1.8 ppm. In order to determine whether there is an alum effect at pH 6.6 as well as to continue monitoring the status of ledge and groove corrosion, the present production test will be continued for one year.

A supplement authorizing such action is circulating for approval.

Process and Reactor Development
Research and Engineering Section
IRRADIATION PROCESSING DEPARTMENT

RG Geier:nmd

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FIGURE 1

ALUM FEED RATE - TEST HALF OF F REACTOR

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