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AEC RESEARCH AND DEVELOPMENT REPORT

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REDUCTION OF REAR FACE Zn^{65} ACTIVITY

INTRODUCTION

As outlet water temperatures have been raised, an increase in the Zn^{65} activity has been evidenced in most reactor discharge areas.* Because of the long half life of Zn^{65} (250 days) there is a resulting high rate of personnel burnout during the entire duration of a reactor outage. There would be a considerable economic advantage in finding a practical method of reducing this rear face activity and consequently reducing the outage time and labor costs.

Two methods have been considered to reduce the rear face activity. The first involves the use of a solids purge to scour out the activity, and the second employs the use of a chromic acid purge to put the activity into solution.

SUMMARY

Solids purging is found to be ineffective in reducing rear face activity levels. A chromic acid purge conducted at 60 C for 1/2 hour can be expected to reduce the Zn^{65} activity level about five fold without injuring the reactor or causing any harmful after effects.

*This is attributed to increased corrosion of the 1% Zn-Al alloy process tubes.

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EXPERIMENTAL RESULTSSolids Purge

Since the Zn^{65} originates in the reactor, all of the rear face Zn^{65} activity must be deposited in some sort of surface film in the piping. If this film can be removed, the activity should drop significantly.

The use of a solids purge to remove this film was investigated at F Pile prior to the January 17, 1955 shutdown. Forty hours before shutdown the pile was purged for 1/2 hour at a solids concentration of 25 ppm. Four hours before shutdown another purge was conducted for a duration of 1-1/2 hours at 20 ppm. No reduction in rear face radiation levels were detected after either purge.

Chromic Acid Purge

Ten per cent chromic acid solution at about 60 C can be used quite effectively to completely remove corrosion product from aluminum in about 1/2 hour. This solution is innocuous toward all of the reactor structural materials except copper alloys, and will not cause any harmful after effects such as accelerated corrosion rates.⁽¹⁾ The two main questions that remain to be answered are:

1. Will the chromic acid be effective in the reduction of activity on stainless steel and aluminum surfaces?
2. Will the activity in solution redeposit in other parts of the system?

Two rear pigtaills and nozzles were removed from F Pile, and cleaned for 18 hours in a cold (20 C) 10 per cent chromic acid solution.* The radiation levels (taken with a CP) were 20 mr/hr β and γ and 10 mr/hr γ before cleaning and half of that after cleaning. Another rear nozzle and pigtail assembly was obtained from H Pile and cleaned at 60 C for 1/2 hour. Table I gives the readings on the two components before and after cleaning

TABLE I
RESULTS OF CHROMIC ACID DECONTAMINATION**

	Nozzle Base	Nozzle Side	Pigtail
Before Cleaning	2500 mr/hr (β and γ) 50 mr/hr (γ)	1300 mr/hr (β and γ) 50 mr/hr (γ)	130 mr/hr (β and γ) 15 mr/hr (γ)
After Cleaning	210 mr/hr (β and γ) 7 mr/hr (γ)	60 mr/hr (β and γ) 7 mr/hr (γ)	30 mr/hr (β and γ) ~1 mr/hr (γ)

(1) de Halas, D. R., "Final Report, PT 105-516-E, Corrosion Product Removal From Pile Process Tubes," HW-29334, 9-14-53.

* The 10% chromic acid solution that is used for all of these tests is actually made up by mixing 15% $Na_2Cr_2O_7 \cdot 2H_2O$ and about 6% H_2SO_4 . pH = 0.3.

** All readings corrected for background.

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The cold solution that was used to clean the nozzles and pigtails was also used to clean 80 feet of discharged process tubing. A sample of this solution, reading 150 mr/hr gamma at the surface, was obtained and used to test for the possibility of activity transfer. Stainless steel, rusty carbon steel, and aluminum samples were placed in the solution and heated to 60 C for 1/2 hour. Immediately after removal from the solution the carbon steel sample read 35 mrep/hr with no gamma; the stainless steel read 20 mrep/hr with no gamma; and the aluminum was only slightly above background. After a one minute rinse in running water the stainless steel sample reduced to 2 mrep/hr and the rusted carbon steel to 20 mrep/hr.

There was no visible evidence of any of the rust on the carbon steel sample being dissolved during the cleaning.

DISCUSSION OF DATA

The water velocity in the rear face piping and fittings is evidently insufficient to allow any effective scouring activity by a solids purge. Raising the solids concentrations might somewhat improve the effectiveness of a purge, but the maximum concentration that can pass through a 32 mesh screen is only about 50 ppm.

The chromic acid is evidently quite effective in removing activity from both stainless steel and aluminum. If it is assumed that the gamma activity is primarily Zn^{65} , a greater than five fold reduction in rear face activity could be expected by a 1/2 hour flush at 60 C. (2)

Any activity that redeposits on clean surfaces can be removed by a few minutes flush with water. If the solution comes in contact with rusty surfaces the results of flushing are not as rapid, but prolonged washing will most likely remove most of the activity.

CONCLUSIONS

Solids purging can be expected to be quite ineffective in reducing rear face activity when used in practical concentrations.

If chromic acid is used as a cleaning solution the rear face Zn^{65} activity can most likely be reduced more than five fold. No redeposition of activity is likely except possibly in very dirty or rusty sections of pipe.

D.R. de Halas

File Coolant Studies
File Technology Section
ENGINEERING DEPARTMENT

R.H. Gay DRH

Reactor Operation Engineering
Process Sub-Section
REACTOR SECTION

DR de Halas:RH Gay:dh

(2) Greene, M.C., "High Radiation Levels at the Discharge Faces of the Reactors," HW-34311, 1-4-55. Greene reports that 80-90% of the gamma activity results from Zn^{65} .

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APPENDIX

SUMMARY OF POSSIBLE EVENTS CONNECTED WITH CLEANING
A PILE WITH CHROMIC ACID

A list is given below of the possible things that may happen when a pile is cleaned with chromic acid. Conditions are assumed to be: 15 per cent sodium dichromate, pH = 0.3; temperature = 60 C, cleaning time one-half hour.

ACTIONCONSEQUENCE

Acid in contact with tubes and slugs.	Negligible removal of aluminum - no harmful after effects on corrosion.
Acid in contact with brass, copper or zinc.	Will dissolve copper and brass. Most likely harmful to zinc. Contact must be avoided.
Acid in contact with rubber or cranite (gaskets).	No effect on rubber. No effect ever noted (or expected) on cranite.
Acid in contact with stainless steel.	No effect
Acid in contact with black iron.	Very slow attack. May free some loose rust particles. Might cause trouble with screen plugging.
Personnel contact with acid.	Must be avoided - treat as strong acid.
Acid leak into graphite.	No reaction with graphite. Loss of 5 gallons estimated to be equivalent to reactivity loss of 1 Pb-Cd dummy.
Acid leaks between gunbarrel and tube.	Heat will concentrate acid. Tube will most likely be somewhat attacked - not serious.
Acid contacts ruptured slug.	Activity will increase. Most likely not much percentage-wise. Pu introduced in solution. No swelling of slug expected.
Front and rear face leaks during cleaning.	Bad from standpoint of personnel contact or contact with copper lines. Leaked acid should be washed off as soon as possible after cleaning.
Temperature rises 10 or 20 C (over 60 C) during cleaning.	Most likely no effect at 10 C rise. 20 C rise may well start attack on aluminum - should be avoided

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Temperature drops 10 or 20 C (below 60 C) during cleaning.

Half required amount of acid added
pH = 0.6

Contaminated acid in front face and valve pit piping during cleaning.

Twice required amount of acid added.
pH = 0.0

Contaminated acid leaks out of system.

Cleaning time shortened or lengthened.

CONSEQUENCE

10 C drop will somewhat slow cleaning.
20 C drop will prolong effective cleaning to about 2 hours.

Cleaning may be ineffective. pH best if kept below 0.4.

Radiation levels will most likely be high during cleaning. All activity is expected to flush out with water. Activity holdup may possibly occur in sludge deposits or badly rusted sections of pipe.

Attack accelerated. Amount not known but situation should be avoided. pH should be kept greater than 0.2.

Should clean easily from metal surfaces. Spills on concrete may be difficult to clean up.

Any time between 20 minutes and one hour at temperature will most likely be effective and safe. Cleaning time must be adjusted for temperature.

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