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GENERAL ELECTRIC

HANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

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December 17, 1962

TITLE

PRODUCTION TEST IP-555-A
SODIUM SILICATE AS A CORROSION INHIBITOR

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HW-75915
Page 1

This document consists of
9 pages,

PRODUCTION TEST IP-555-A
SODIUM SILICATE AS A CORROSION INHIBITOR

By

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December 17, 1962

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RICHLAND, WASHINGTON

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By Authority of CG PR-2
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Verified By DK Hanson, 4-5-94

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HW-75915
Page 2

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HW-75915
Page 3

PRODUCTION TEST IP-555-A
SODIUM SILICATE AS A CORROSION INHIBITOR

OBJECTIVE

The objective of this test is to operate one of the 1706-KE single pass tubes using sodium silicate rather than sodium dichromate as the corrosion inhibitor and to monitor the radioisotope concentration in the effluent.

JUSTIFICATION

Single pass tube tests carried out under Production Test IP-484-A⁽¹⁾ have demonstrated that when sodium silicate is added to process water the concentrations of significant radioisotopes in the effluent are reduced by a factor of two.⁽²⁾ At the concentrations investigated, the use of sodium silicate as an additional additive to all Hanford process water would cost in the neighborhood of two million dollars per year. If, however, sodium silicate, an excellent corrosion inhibitor for certain applications, would also serve to replace sodium dichromate, it would provide the added benefits of eliminating Cr⁵¹ and hexavalent chromium from the effluent. While still not economically attractive, the use of sodium silicate would be less unpalatable.

The literature covering both in-reactor and ex-reactor testing of sodium dichromate from 0 to 2 ppm is voluminous. Generally, the conclusions have been that without sodium dichromate fuel ruptures and tube corrosion will increase markedly. It is unfortunate that the large share of both the ex-reactor and in-reactor data were obtained under reactor operating conditions and water treatment conditions which are no longer in effect. For example, data were obtained at pH 7.6 vice the present 7.0 or 6.6 and with ferrofloc treated water vice alum treated water.

In the proposed single tube test, tube corrosion will be of no consequence since a zirconium tube will be used. Since the historical data cannot be ignored, some increased rupture potential may be expected but it is expected to be minimal.

TEST DETAILS

A. Process Tube

The 1706-KE single pass facility contains six C-sized Zircaloy tubes (2952-KE, 3050-KE, 4355-KE, 4557-KE, 4863-KE, and 5063-KE). The test will be carried out in one of these tubes.

- (1) HW-72382, "Production Test IP-484-A Effluent Activity Studies in the 1706-KE In-Reactor Facility," by R. G. Geier, 1-22-62.
- (2) HW-75782, "Reduced Effluent Radionuclides by the Addition of Sodium Silicate to Process Water," R. W. Perkins and D. E. Robertson, 12-6-62.

DECLASSIFIED

HW-75915
Page 4

B. Fuel Element Loading

The tube will be charged with 38 KIVNS fuel elements. Exposure will be based on the variable goal limit normally used for production metal.

C. Coolant

The tube will be cooled with service water containing sodium silicate in concentrations up to 10 ppm silicon. The pH will be adjusted within the range of 6.6 - 7.5.

Sodium silicate will be added both during normal operation and during shutdown.

D. Effluent Sampling

Sampling the effluent from the tube will be required throughout the test. A detailed description of sampling requirements will be supplied by the test author.

E. Corrosion Studies

In order to determine corrosion effects weighed and measured fuel elements will be used as well as coupon holders in the downstream dummy pattern. The coupon holders will be as shown in Prints No. SK-1-23211 and H-1-33319.

The number and location of the coupon holders will be selected by Coolant Systems Development Operation, HLO, with the concurrence of Coolant Testing Unit and KE Processing Operation, IPD.

F. Duration of Test

This production test authorizes the irradiation of two fuel charges under the conditions described. In any event, the test will terminate one year after issuance.

G. Premature Discharge

If necessary for the timely initiation of the test, premature discharge of green metal from the tube is authorized.

THERMAL HYDRAULICS

Thermal hydraulic considerations gave rise to the operating criteria described below.

A. Process Water Backup

In case of failure of the 1706-KE pumps, the safety of the tubes depends on the process water backup system. The system is simple and is highly reliable. Process water is available to the system through interconnecting lines, but

DECLASSIFIED

HW-75915
Page 5

it is excluded by check valves during normal operation. The check valves are held shut by maintaining the pressure in the 1706-KE supply system higher than the process water pressure. When pump failure occurs, the pressure in the supply lines decays and the check valves open.

A second check valve is situated in the 1706-KE supply lines upstream from the point of process water intertie. This valve will prevent the flow of water from the backup system to the 1706-KE pumps. It also protects against the remote chance that a line rupture occurs between the 1706-KE pumps and the process water intertie.

B. Instability Limits

In order to insure safe and stable operation of the tube, instability limits shall be calculated according to the specifications in HW-75523.⁽³⁾

The use of crossheader pressure to detect upstream plugging is advantageous in that it is higher than the venturi throat pressure and thus is more sensitive to upstream flow stoppages. Therefore, the crossheader low trip setting must be set at least 50 psi above the venturi high trip setting.

C. BPA Outage Limits

In case of a BPA outage, the 1706-KE pumps trip out and the tubes are supplied with coolant from the process water system. In such an event, two critical periods exist. The first comes within a few seconds after the BPA outage. The flow to the tubes decays in two steps after the power decays. The supply pressure to the tubes drops immediately to that of the process water system. Next, the process water system pressure decays as the flywheel energy on the 190-KE pumps is used up.

In order to pass through the first critical period safely, it is necessary to insure that the total flow decay before the beginning of tube power decay is not excessive. Such protection is obtained by the limits shown in Figure 1 which are based on a flow reduction of not more than 30 per cent before tube power decay begins.

The second critical period occurs about 100-150 seconds after the outage. At this time, the coolant flow has decayed about 85 per cent and the tube power has decayed about 88 per cent. Both the flow and power will remain relatively constant at these values for a considerable period of time. It is desirable that the tube exit temperature not exceed the rear crossheader

(3) HW-75523, "Instability Limits for Smooth-Bore Process Tubes," by P. A. Carlson, 11-6-62.

DECLASSIFIED

HW-75915
Page 6

saturation temperature. A maximum tube temperature of 130 C has been specified under instability limits. Inasmuch as this is 9 C below rear crossheader saturation temperature, safe operation is assured.

HAZARDS

None other than the increased rupture potential discussed previously.

COSTS

A. Outage Time

One hour for each charge-discharge and special pickup.

B. Sampling

Operator time for sampling will be required in amounts depending on the sampling schedule chosen. Charges for sampling will be borne by Process and Reactor Development Operation.

C. Cost Code

XXXX-5R20-XXX.71

RESPONSIBILITIES

Irradiation Processing Department

KE-KW Reactor Operation

KE Processing Operation will be responsible for:

1. The operational safety of the reactor.
2. Production continuity.
3. Charge-discharge of the tubes.
4. Obtaining samples.

Research and Engineering Operation

Testing Operation

Coolant Testing Unit will be responsible for:

1. Operation of the 1706-KE equipment.
2. Recording of operating data.
3. Reactor safety and production continuity as they are affected by 1706-KE equipment operation.

DECLASSIFIED

HW-75915
Page 7

Component Testing Unit will be responsible for:

1. Post-irradiation fuel examination.

Process and Reactor Development Operation will be responsible for:

1. Making process recommendations.
2. Termination of the test and issuance of the final report.

Hanford Laboratories Operation

Chemical Research and Development Operation

Radiological Chemistry Operation will be responsible for:

1. Delivery of samples to the laboratory.
2. Analyzing effluent data and issuing technical reports.

Reactor and Fuels Research and Development Operation

Coolant Systems Development Operation will be responsible for:

1. Analyzing corrosion data and issuing technical reports.

MA Clinton

Process and Reactor Development
Research and Engineering

RG Geier

Process and Reactor Development
Research and Engineering

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FIGURE 1
BPA FAILURE LIMIT

HW-75915
Page 8

Maximum 1706-KE Tube Supply Pressure As Measured In The 105-KE Valve Pit - PSIG

Backup Process Water Pressure As Measured In The 105-KE Valve Pit - PSIG

DECLASSIFIED

HW-75915
Page 9

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