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PRODUCTION TEST IP-520-A
IN-REACTOR TESTING WITH COOLANT PREPARED
IN THE WATER TREATMENT PILOT PLANT

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July 16, 1962

PRODUCTION TEST IP-520-A
IN-REACTOR TESTING WITH COOLANT PREPARED
IN THE WATER TREATMENT PILOT PLANT

OBJECTIVE

The objectives of this test are: (1) to operate two single pass tubes in the 1706-KE in-reactor facility using water treated in the water treatment pilot plant, (2) to obtain samples of effluent water, and (3) to obtain corrosion measurements from weighed fuel, dummies, and coupons.

BASIS AND JUSTIFICATION

A goal of the Irradiation Processing Department is to develop processes to effect substantial reductions in the biologically significant radioisotopes occurring in reactor effluent. Research and development programs directed toward this end have demonstrated that the water treatment process strongly influences the effluent activity. As an example, the high alum feed process has reduced the discharge of some radioisotopes by factors of two to three when compared to prior years experience.

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A flexible water treatment pilot plant was constructed to enable more comprehensive investigation in this area. The initial studies in the pilot plant will be to optimize the alum flocculation process with regard to the removal of radioisotope parents. Subsequent studies will include the use of alternate flocculating agents and/or polyelectrolytes, different points of chemical addition, modified basin holdup time, and variations in filter rates and filter composition.

TEST DETAILS

A. Description of Facilities

The water treatment pilot plant located in KE Area will supply coolant via the 1706-KE pumps to two KE tubes. The pilot plant is a miniature K Area water plant capable of treating 150 gpm of water. It contains chemical makeup tanks, a flash mixer, a flocculator, a settling basin, filters and a clearwell. The installation is described in detail in the project proposal.⁽¹⁾ However, a simplified flow diagram is shown in Figure 1.

The two tubes to be supplied with coolant from the pilot plant are:

4355-KE (SP-3), a smooth-bore C reactor size Zr-2 tube.

4456-KE (SP-4), a standard K reactor aluminum tube.

B. Fuel Loading

Tube 4355-KE will be charged with 38 KIVNS fuel elements. Tube 4456-KE will be charged with 38 KIVN fuel elements.

C. Coolant

Water treated in the pilot plant will supply the two tubes both during normal operation and reactor shutdown.

In the initial phase of this test alum will be used as the flocculating agent and sulfuric acid for pH adjustment. The water will meet all applicable process standards except that the pH will be varied within the range of 6.0 to 7.5. Subsequent studies utilizing alternate flocculating agents and/or polyelectrolytes and/or chemical additions will be authorized by supplements to this production test.

D. Effluent Sampling

Effluent sampling from the two tubes will be required throughout the test. A detailed description of the sampling requirements will be provided in the outline of each segment of the test.

(1) "Project Proposal for Water Treatment Pilot Plant, 100 K Area - Project CGI-933," J. W. Ballowe.

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Previous experience has shown that erroneous results are obtained if the flow in the effluent sample lines is disturbed. To eliminate this possibility, the sample line will remain open and flowing for the duration of a study. The plastic line will be inserted into the drain funnel between sampling operations to avoid contaminating the sample room.

E. Test Duration

Approximately three months will be required for each segment of this test. It is estimated that eight to twelve test segments will be required to complete the study. In any event this test will terminate two years after issue date.

F. Decontamination

In the course of this test it may be necessary to decontaminate the tubes between segments of the study. Thus, four decontaminations per tube are authorized.

One of the following decontaminating agents will be supplied from the 1706-KE building and will enter the tubes in the 105-KE valve pit.

1. 0.3 M sulfuric acid - 0.1 M oxalic acid suitably inhibited
2. Turco 4306 C at 6 oz/gal

The decontaminating solution will be flushed through the tube at a rate of 5 gal/min for at least 45 but not more than 75 minutes at a temperature at least 45 C but not more than 60 C.

In order to insure that no decontaminating solution enters the graphite stack, the tube will be pressure tested prior to decontamination at a pressure twice that to be used or 50 psig whichever is greater.

Detailed procedures for the decontamination will be supplied by Coolant Testing Unit.

G. Probologging

The tubes will be probologged prior to the initial and after every second decontamination.

H. Premature Discharges

If necessary for the timely initiation of the test or for integration with other single pass tube studies, three premature discharges per tube are authorized.

I. Corrosion Tests

An important part of the evaluation of the water treatment processes to be tested throughout this study will be the corrosivity of the water. For this

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reason weighed fuel elements will be used and some of the downstream dummies will be coupon holders. The number, type, 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.

In addition to the in-reactor testing, ex-reactor testing will be carried out to determine the corrosivity of the water toward water plant components.

THERMAL HYDRAULICS

Thermal hydraulic considerations give rise to the operating criteria discussed below.

A. General

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 can be considered highly reliable. Process water is available to the system through inter-connecting lines, but it is excluded from the system by check valves. The check valves are held shut by maintaining the pressure in the 1706-KE supply system higher than the reactor process water pressures. When pump failure occurs, the pressure in the normal 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 back-up system to the 1706-KE pumps. It also protects the system from the remote chance that a line rupture occurs between the 1706-KE pumps and the process water intertie.

In order to insure protection, it is necessary to lock and tag open all stop valves on the process water lines upstream from the check valves.

B. Instability Limits

In order to insure safe and stable operation of the tubes, the provisions of Process Standard A-050 will be met for both high and low trip limits.

The use of crossheader pressure to detect upstream plugging is advantageous in that it is in excess of venturi throat pressure and is more sensitive to flow changes. Therefore, low trip limits will be monitored by a pressure signal obtained from the special inlet crossheader and by a pressure signal from the venturi throat. Low trip limits shall be calculated according to Process Standard A-020 (HW-46000 K). The tube outlet temperature must not exceed 130 C.

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These trip settings are valid for front header pressures greater than 325 psig and a differential between high and low pressure trips of less than 90 psi. All pressures are to be measured at a common elevation.

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 supplied by the process water system. Next, the pressure supplied by the process water system 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 2 which are based on a flow reduction of not more than 20 per cent before tube power decay commences.

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

HAZARDS

Since the tubes will be supplied with coolant by the 1706-KE pumps both during normal operation and during shutdown, the flow to the tubes will be valved down during shutdown (currently standard procedure) to avoid the consequences of inadvertent cap removal.

COST

A. Outage Time

Two hours for each decontamination of the two tubes. Two hours for each charge-discharge and special pickup of the metal from the two tubes.

B. Operator Time for Sampling

Operator time for sampling will be required in amounts depending on the specific sampling schedule chosen. Charges for sampling over and above that which can be carried out by the normal operating staff will be borne by Process and Reactor Development Operation.

C. Cost Code

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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.
5. Scheduling probologging of the tubes.

Research and Engineering Operation

Coolant Testing Unit will be responsible for:

1. Operation of the water treatment pilot plant.
2. Decontamination of the tubes.
3. Recording of operating data.

Process and Reactor Development Operation will be responsible for

1. Making process recommendations.
2. Issuing final report and termination of the test.

Hanford Laboratories Operation

Chemical Research and Development Operation

Radiological Chemistry Operation will be responsible for:

1. Selection of water treatment pilot plant operating conditions.
2. Delivery of effluent samples to the laboratory.
3. Obtaining analytical data.
4. Issuing technical reports.

Reactor and Fuels Research and Development Operation

Coolant Systems Development Operation will be responsible for:

1. Obtaining corrosion data.
2. Issuing technical reports.

Process and Reactor Development
Research and Engineering

RG Geier:nmd

FIGURE 1

PROCESS FLOW DIAGRAM
WATER TREATMENT PILOT PLANT

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FIGURE 2
BPA FAILURE LIMIT

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Maximum 1706-KE Tube Supply Pressure As Measured In The Pipe Tunnel - PSIG

Bottom-of-Riser Process Water Pressure - PSIG

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