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PRODUCTION TEST IP-614-A:
IRRADIATION OF THORIUM TARGET ELEMENTS

By

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PRODUCTION TEST IP-614-A
IRRADIATION OF THORIUM TARGET ELEMENTS

INTRODUCTION

Limited irradiations of thorium target elements have been conducted at HAP0 during the past ten years but large-scale irradiations have not been attempted. An obstacle encountered in thorium irradiation programs has been the formation of U-232, which is undesirable because of intense gamma radiation. Further study of the problem indicates that by employing certain restrictions during irradiation of the thorium a relatively "clean", free of U-232, product U-233 may be obtained.

OBJECTIVES

The objectives of this production test are to: (1) irradiate small quantities of metallic thorium elements to confirm physics predictions; (2) provide small quantities of irradiated thorium for laboratory evaluation of problems associated with chemical processing of the irradiated metallic thorium; and (3) provide preliminary information for study of large-scale irradiations of thorium at HAP0.

TEST SUMMARY

Three metallic thorium target elements of known concentrations of Th-230 will be irradiated in an F-Reactor central zone process tube. The exposure period will last about 60 days. Nonpoisonous spline flux traverses will be taken in the four adjacent process tubes as well as in the tube containing the thorium elements. The four adjacent process tubes will contain numbered charges of natural uranium fuel elements. All elements and targets will require special pick-up after discharge. The target elements will be shipped to Hanford Laboratories for processing after discharge.

BASIS AND JUSTIFICATION

A Research and Development program for the production of several kilograms of "clean" U-233 at HAP0 has been submitted to the AEC. To support this program and to provide small quantities of U-233 for laboratory analysis, thorium target elements must be irradiated.

Although the physics calculations for this irradiation program¹ were based on large quantities of target material in a unique lattice loading, irradiation of the three target elements under the proposed conditions will provide information to permit preliminary evaluation for larger-scale irradiations. Results obtained from this test will be interpreted as being preliminary in nature and not necessarily representative of what could be expected in an irradiation under conditions calculated as optimum for this material.

¹Lang, L. W., R. H. Meichle, and R. Nilson. Production of U-233 and Program Proposal, HW-76847, March 21, 1963. (██████)

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TEST DETAILS

1. Reactor

This test will be conducted in F Reactor, the choice of reactors based only upon scheduled outages.

2. Target Elements

a. Geometry

The elements used in this test will be solid elements 6.23 inches long with an outside diameter of 1.42 inches.

b. Fabrication

The metallic thorium elements will be fabricated according to the "C" Process for unbonded target elements² and shall meet all fabrication and quality specifications in effect at the time of assembly. Aluminum components will be 8001-F alloy.

Samples of each thorium piece will be obtained before canning. Identity of the samples with the particular parent pieces must be maintained and each thorium target element will be stamped to permit this identification of the pieces upon discharge following the irradiation.

The samples obtained from the cores will be submitted to Analytical Laboratories, Hanford Laboratories, for isotopic analysis.

c. Pre-Irradiation Measurements and Tests

No measurements or tests other than the normal quality tests and measurements are required for these pieces.

3. Fuel Elements

Four columns of OIIN normal production fuel elements are required by this test. The elements of these columns will be identified as to position within the fuel columns by means of numbers stamped on the base end of the element.

4. Irradiation

a. Location

The thorium elements will be charged into a process tube within the area enclosed by tube rows 34 and 38 and by tube columns 66 and 81, and at least

²Quality Control Standards, Fuel Element Manufacturing Processes, HW-50377.
October 14, 1957. ()

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three lattice units from major flux perturbations; i.e., graphite stringers. The actual location will be selected by the test authors with the concurrence of the assigned Process Engineer and Pile Physicist. The natural uranium fuel columns authorized by this test are to be charged into the four tubes adjacent to this tube.

b. Tube Flow

To give the desired flow rate, approximately equal to normal central flows, 20 solid aluminum spacers, 8 inches long with an outside diameter of 1.43 inches, will be charged into the tube containing the thorium elements. Ten of the solid aluminum pieces will be placed upstream and ten placed immediately downstream of the target elements.

c. Downstream Dummy

The normal downstream dummy pattern will be charged to permit spacing the target elements in the middle, front-to-rear, of the process tube.

d. Heat Generation

Heat generation versus exposure curves for the thorium elements appear in Figure 1. At the end of the exposure period of 60 days, heat generation in the target elements will be about 3 kw/ft.

e. Charging

The target elements are to be hand-charged; the four adjacent OIIIN columns may be machine-charged providing the column position of all pieces is known. This charging will be monitored by a representative of Research and Engineering. This test authorizes discharge of up to five columns of sub-goal elements to permit charging of test material.

All five tubes used for test material are to be equipped with spline caps and the associated upstream aluminum perforated dummies. The thorium elements will be approximately centered, front-to-rear, in the process tube.

f. Exposure

The target elements of this test are to be irradiated in a flux of about 3×10^{13} nv for a period of approximately 60 days.

The OIIIN fuel elements that are in the adjacent columns will be discharged during the same outage as the target elements. No fuel exposure beyond normal goal exposures are authorized by this test.

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g. Flux Measurements

Flux measurements on the tubes of this test are to be obtained by nonpoisonous spline techniques at equilibrium power level a minimum of two times during the irradiation. These measurements will be monitored by a member of Research and Engineering. No poison splines may be inserted into any of the tubes covered by this test.

h. Data

Daily flow and temperature data for the tubes of this test will be recorded on data sheets provided by the test authors.

4. Discharge

The thorium pieces are to be specially picked-up and stored in a separate bucket until shipping instructions are received.

The four natural uranium fuel columns of this test are to be discharged at the same outage and specially picked-up. All four columns may be combined in one bucket.

5. Hazards

No new or unusual hazards are associated with this production test.

6. General

a. Schedule

The thorium pieces are canned and ready for irradiation. Charging of the elements authorized by this test will take place at the first outage of the F Reactor following approval of the test.

b. Duration

The irradiation portion of the test will last approximately 60 days. All authorization by this test will be terminated by July 1, 1964.

c. Post-Irradiation Examination

The thorium target elements will require post-irradiation analysis; this work will be performed by Hanford Laboratories.

The natural uranium fuel elements will require only post-irradiation gamma radiation intensity measurements. These measurements may be performed in the Technical Viewing Facility, 105-F, by representatives of Research and Engineering. Results of these measurements will be transmitted to the test authors.

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d. Costs

Estimate of outage time required for this test, including both charging and special pick-up work - 3 hours. All outage time costs as a direct result of this test may be charged to cost code XXXX-5R23-XXX.71.

e. Operating Limits

Operating limits specified for OIIIN fuel elements will be applicable to all of the columns of this test. The actual limits will be specified by Process Technology Subsection, Research and Engineering.

RESPONSIBILITIES

Research and Engineering Section

Process Technology Subsection will be responsible for providing assistance in pre-shutdown scheduling, in charging elements of this test, in selection of process tubes, for specification of operating limits, and for gamma intensity measurements as required.

Pile Physics Subsection will be responsible for making any necessary reactivity changes required, and for taking nonpoisonous spline flux traverses.

Process and Reactor Development Subsection will be responsible for over-all coordination of the test, for technical assistance, and for analysis of the test results.'

Manufacturing Section

F-Reactor Operation will be responsible for operational safety and production continuity, for charging the test material, for collection of the necessary test data, and for discharge and special pick-up of the test material.

Production Scheduling will be responsible for maintaining accurate records and for scheduling discharge of the test columns.

Production Fuels Section will be responsible for canning, finishing, and testing all of the test elements.

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FIGURE 1
RATIO OF POWER IN THORIUM TO SURROUNDING E-COLUMN
VERSUS
IRRADIATION TIME

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