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August 6, 1965

MONTHLY RESEARCH AND DEVELOPMENT REPORT
IRRADIATION PROCESSING DEPARTMENT

By

T. W. Ambrose

JULY 1965

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RESEARCH AND DEVELOPMENTRESEARCH AND ENGINEERINGC-Overbore Bismuth Test

The bismuth charge was discharged after about 99 days of full power operation on July 6, 1965. The mixed charge (uranium alternated with bismuth pieces) will be ready for discharge after July 22.

Uranium Oxide Irradiations

Battelle-Northwest is fabricating two columns of oxide fuel elements for irradiation in a K Reactor to obtain preliminary oxide fuel design data applicable to the Hanford reactors. Poor canning yields have been experienced to date primarily because of problems in obtaining satisfactory final closures. These canning problems are expected to delay the irradiation test by about one month.

Plutonium-Aluminum Irradiations

An authorizing document was issued to permit the irradiation of a few plutonium-aluminum fuel elements in B Reactor. Initially, graphite temperature data will be obtained in a short-term irradiation of a single column containing two plutonium-aluminum fuel elements. Assuming satisfactory results from this column, two additional columns, each containing six elements, will be charged for irradiation for up to 18 months. The test is expected to begin during August.

Neptunium Enhancement Studies

Studies of various fuel management plans to enhance the production of neptunium from the Hanford reactors have been extended considering that the average Pu-238 cost from the incrementally-produced neptunium in all the Hanford reactors will not exceed \$270 per gram. Formerly the studies were performed assuming that the neptunium from the IPD reactors only must meet the \$270 limit. This modification would permit blending the KN and SN streams with 1.55 per cent U-235 material rather than with material having an assay of about 0.8 per cent U-235. The higher enrichment blend would significantly enhance the neptunium production by keeping more of the reactor produced U-236 in the production stream.

Plutonium-Aluminum, Thoria Supercell Measurements

A series of wet and dry k_{∞} and flux distribution measurements for plutonium-aluminum fuel and thoria in a 1:1 supercell arrangement was initiated in the PCTR. These tests, which should be completed by September, will provide information for evaluating nuclear safety characteristics of plutonium fuel and basic data for normalizing calculational models used in analyzing the physics of supercell loadings.

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Irradiated IPD fuel Examination, 105-C Facility

Examinations were completed on the fuel elements from 63 tubes requiring 6566 individual examinations.

<u>No. of Tubes</u>	<u>Production Test Material</u>	<u>Other Material</u>
25	IP-216, Evaluation of Performance of Normal Production I&E Fuel Elements	
20	IP-750, Evaluation of Raw Water as a Reactor Coolant	
3	IP-694, Depleted Uranium Irradiation - K Reactors	
1	IP-746, Polonium Production in the C Overbore Facility	
13		Visual examination of randomly discharged fuel elements for end unbond - B Reactor
1		Visual examination of regular production overbore fuel elements and supports

Photographs were taken of one ruptured fuel element from B Reactor and one from C Reactor.

Single-Pass Tube Facility Operation - 1706-KE

<u>Tube</u>	<u>PT</u>	<u>Water Supplied</u>	<u>Corrosion Inhibitors & Chemical Additions</u>	<u>pH</u>
SP-1 (2952)	604	Service	2.0 ppm dichromate	7.0*
SP-2 (3050)	604	Service	2.0 ppm dichromate	7.0*
SP-3 (4355)	520	WTFPP**	1.8 ppm dichromate	6.6**
SP-4 (4456)	520	WTFPP**	1.8 ppm dichromate	6.6**
SP-5 (4557)	604	Service	2.0 ppm sodium sulfite***	6.6
SP-6 (4863)	604	Service	2.0 ppm sodium sulfite	6.6
SP-7 (4963)	449	Process	10.0 ppm activated silica****	6.6
SP-8 (5063)	449	Process	10.0 ppm activated silica	6.6

* pH control changed from ammonium hydroxide to sodium hydroxide.

** Water Treatment Pilot Plant product. The flocculating agent was changed from aluminum sulfate to aluminum nitrate and supplied in sufficient quantity to maintain the zeta potential near zero. The pH control was changed from sulfuric acid to nitric acid addition.

*** Sodium nitrate addition was changed to sodium sulfite addition.

**** During the June outage the water source was changed to 1706-KE control and a different mixture of activated silica was started.

FACILITIES ENGINEERINGDose Rate Telemetry

The prototype dose rate telemetry system, fabricated by Tracerlab, Richmond, California, on Contract DDR-191, was received at HAPO early this month. Acceptance test data taken at Tracerlab, their reliability analysis, and the system operation and maintenance manuals have not been received. Off-reactor laboratory testing at HAPO has been initiated.

In-Core Flux Monitor

Due to higher priority work during reactor outages at KW, removal and shipment to Battelle-Northwest of the gamma-sensitive, stainless steel, in-core chambers now in the storage basin has not been accomplished. As soon as outage time permits, the chambers will be shipped to BNW for examination and evaluation.

Uncooled Horizontal Control Rods

The entire development program was reviewed during a visit to the Nuclear Materials and Propulsion Operation (NMPO) and all facets of the work are progressing satisfactorily.

Environmental testing of materials is approaching 7,000 hours out of a goal exposure of 10,000 hours. Inconel 600 is the favored sheath material at this point.

The articulated joint design is being tested in a simulated environment under load with various lubricants. Failure of the test fixture has delayed completion of this work.

A fabrication method of the rod by co-extrusion is nearing realization. From a cost and finished product viewpoint, the co-extruded rod element is superior to other methods of fabrication.

A dummy rod made from stainless steel is undergoing cyclic testing at the 189-D Laboratory in a mocked-up HCR channel.

The request for Classification Guide changes has met with favorable action by RLOO-AEC, and procurement will be on an unclassified basis for test and production rods.

PRODUCTION FUELS SECTIONThoria

Analyses on thoria received from Mallinckrodt Chemical Works show that the oxide has a high surface area and a low particle density, and that the compaction density is directly related to particle density. The surface area analyses of sixteen lots ranged from 0.95 to 6.00 m²/g with an average of 2.90 m²/g. The particle density ranged from 8.23 to 9.91 g/cc as determined with a mercury porosimeter at 3000 psig. The density achieved during compaction is dependent more upon particle density than particle size within the range of particle size distributions normally produced by MCW.

A ten-pound sample of thoria was received from NMPO (G.E. Evendale) for evaluation. The thoria was produced by mixing steam-denitrated thoria with an organic binder, extruding, firing at 300-1000 C, and sintering at 1600-1700 C. The oxide was in the form of 1/8 inch pellets. The preliminary analyses show the material to be of excellent quality. The dissolution was 96.1 per cent by the standard test, the LOI was less than 0.01 per cent, and the off-gas volume was 0.029 cc/g. The LOI and off-gas results are lower than the typical analyses of MCW oxide by a factor of approximately ten. The analyses were performed on the as-received pellets, and we may expect the LOI and off-gas to increase upon grinding.

Alternate Process

A run-to-rupture test comparing 0.95 w/o U-235 enriched HDS and AlSi-brazed fuel elements was charged into D Reactor under authority of Production Test IP-781 as described in document RL-REA-2020. Final preparation of the fuels included measurement of the closure integrity, using a recently developed ultrasonic tester, the UT-16, an experimental tester designed to nondestructively test for unbonded or poorly bonded areas of the cap-jacketing interface. Fuel elements were 100 per cent tested, with a bulk indicating < one per cent unbonded area, and the maximum at ~ five per cent unbonded area. In general, these results indicated a highly satisfactory closure.

Preparation of 1.25 enriched fuel elements for the K Reactor portion of the test included normal acceptance sampling and stamping identification numbers on the cores, and preparation of PWR's for both the AlSi and the HDS fuel element fabrication was initiated.

A "Hall-Effect" probe is being fabricated for evaluation as a device to measure nickel thickness on nickel-plated uranium which has been jacketed in aluminum. Work done elsewhere indicates that measurement of nickel thicknesses of 0.5 mils to $\pm$ 0.1 mils can be achieved through a 30-mil thick aluminum jacket. This device will be compared with the low-frequency

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eddy-current device, and the X-ray fluorescence technique as reported previously.

Plating studies included evaluation of the effects of increasing current density with ultrasonic agitation employed to aid in maintaining a high nickel ion concentration at the uranium cathode. Ultrasonic agitation of 40 KC was employed. Tests were run at five values of current density between ~ 60 and 1440 ASF (amperes/sq. ft.). Current efficiency did not appear to vary based on the photomicrographs of the nickel cross-section. Nickel plate porosity, as measured by a standard air-atmosphere heating test, was not consistently and reproducibly affected by current density, coupled with the ultrasonic bath agitation.

Manager, Research and Engineering

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