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PRODUCTION TEST IP-734, HAFO 302, HIGH TEMPERATURE CAPSULES IN THE KW SHORT TUBE SERIES II

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PRODUCTION TEST IP-734, HAPO 300

HIGH CORE TEMPERATURE CAPSULES IN THE KW SNOUT FACILITY, SERIES II

J. H. Cox

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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PRODUCTION TEST IP-734, HAPO 309
HIGH CORE TEMPERATURE CAPSULES IN THE KW SNOUT FACILITY, SERIES II

OBJECTIVE

The objective of this production test is to continue a program started under Production Test IP-690*; the major change is an increase in sample enrichment. The higher enrichment is required to increase the portion of the fuel element core which is molten.

This test will provide 1) data to correlate maximum fuel temperature with post-irradiation microstructure, and 2) data that are required to study the kinetics of fuel redistribution during the time interval between insertion of the capsule, into a constant, established neutron flux, and the time at which a steady state equilibrium structure is reached.

BASIS AND JUSTIFICATION

This information will permit calculation of high temperature heat transfer coefficients and their variation during initial stages of irradiation. A quantitative understanding of fuel relocation and the time required to reach equilibrium are needed for optimum design of ultra-high temperature fuel elements.

REACTOR AND FACILITIES REQUIRED

KW Reactor, Snout Facility

DESCRIPTION OF CAPSULE

A drawing of the capsule is shown in Figure 1. The fuel is 1.0 per cent enriched UO_2 pellets containing 1.75 w/o tungsten shot. Maximum fuel loading will be 4.670 kg of UO_2 per capsule. The fuel pellets are clad in stainless steel. The stainless steel elements are placed in aluminum bar stock drilled out from both ends. The capsule is attached to a twenty-foot aluminum tube which is used as a "handle" for charge-discharge of the capsule.

DETAILS OF IRRADIATION

Capsule Instrumentation

None

Method

The Snout facility is a tube-in-tube arrangement. Each tube has independent coolant flow from the X-level crossheader and has reverse flow capability.

*HW-82698, Production Test IP-690, HAPO 309, High Core Temperature Capsules in the KW Snout Facility, J. H. Cox, August 4, 1964

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GENERAL NOTES

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Method (continued)

The capsule is inserted into the bore water lock; the ball valve connecting the water lock and the bore tube is opened, and flow is verified using the control room Panellit gauge. The bore flow is then placed in the reactor No. 1 Safety Circuit and the capsule is slowly pushed into the flat flux zone of the reactor.

After the capsule has received the required exposure, it is withdrawn to the water lock. The bore tube is removed from the No. 1 Safety Circuit. After a 24-hour decay period, the ball valve is closed and the capsule is withdrawn from the water lock into a cask train located in front of the Snout facility. The capsule is cut from the aluminum tube, utilizing the Snout guillotine, and pushed into a shipping cask. The aluminum tube is then cut up and buried.

Number of Capsules to be Irradiated and Length of Exposure

This production test authorizes the irradiation of twenty (20) capsules for periods of five minutes to sixty hours each.

Reactivity Loss

Negligible

Reactor Shutdown Time Required

None

Conditions for Reactor Shutdown

If a rupture is indicated, the capsule will be discharged within two hours. The fuel pellets are sintered; as a result, very little corrosion would take place if a rupture were to occur. The capsule would be removed from the active flux, allowed to cool for 24 hours, and then discharged. The reactor would not be shut down for a rupture.

The bore flow is in the reactor No. 1 Safety Circuit. If a loss of flow were to occur, the reactor will be scrammed. ~~Maximum and minimum~~ Panellit base pressures are listed in the Operating Conditions section.

Operating Conditions (See Figure 2)

Normal Flow	27 gpm
Scram Flow	20 gpm
Maximum High Base	258 psig
Minimum Low Base	52 psig

Thermal Hydraulics

Capsule Power*	58 KW Total 77 KW/ft (Maximum)
Maximum Surface Heat Flux	3.72×10^5 BTU/hr-ft ²

*RL-REA-N-1, Personal Notes, M. H. Montgomery

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Pressure

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Thermal Hydraulics (continued)

Normal Flow

Surface Temperature of Capsule
Tube Pressure
Saturation Temperature

= 27 gpm
= 196 F
= 50 psig
= 295 F

Scram Flow

Surface Temperature of Capsule
Tube Pressure
Saturation Temperature

= 20 gpm
= 269 F
= 40 psig
= 287 F

TEST MONITORING

The Snout bore and annulus tubes are equipped with Panellit gauges. The annulus gauge activates a control room annunciator on low flow; on a low annulus flow, the test will be discharged. The bore gauge is in the No. 1 Safety Circuit.

The Snout bore effluent is continuously monitored for radioactivity level; if a rupture is indicated, the capsule will be discharged.

HAZARDS

A conservative irradiation analysis has shown that the sample cladding should not melt on complete inlet plugging of the bore tube; this analysis assumes that the annulus flow remains normal and that the reactor scrams on loss of bore flow.

If the aluminum wall and stainless steel walls were to fail, the UO_2 would come in contact with the process water. However, because the UO_2 pellets are sintered, the corrosion rate in process water is very low. If a rupture becomes evident, the capsule will be withdrawn from the flux, allowed to cool, and then discharged.

J H Cox

J. H. Cox
Test Engineering
Research and Engineering

JH Cox:mkc

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RESPONSIBILITY

Irradiation Testing

Irradiation Testing will be responsible for:

1. Capsule integrity
2. Operating the facility according to Irradiation Testing Unit's Operating Procedure 2.1 except that the ball valve is left open for 24 hours to cool the capsule in the water lock after irradiation.
3. Charge-discharge and shipment of the capsule.

Approved *M. Ferguson*

KW Processing

KW Processing will be responsible for:

1. Setting Panellit trips and monitoring irradiations as specified in KW Processing D.O.P. 3.3.5, Revision 1, July, 1964.

Approved *D. P. Thacker*

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