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C-25, Metallurgy
and Ceramics

SCNC-313

QUARTERLY TECHNICAL PROGRESS REPORT

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AEC RESEARCH AND DEVELOPMENT REPORT

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I. LOW COST CERAMIC FUEL ELEMENTS BY ISOSTATIC PRESSING

(J. Fugardi)

This project expired at the end of the quarterly period. A final report summarizing all experimental work and results is presently in publication. It is expected that distribution will be made within approximately one month.

II. URANIUM DIOXIDE FUEL ELEMENTS (Y. Cavallaro, J. P. Mathern, and R. M. Powers)

This project expired at the end of the quarterly period. A final report summarizing all experimental work and results is presently in publication. It is expected that distribution will be made within approximately one month.

III. IRRADIATION OF ISOSTATICALLY PRESSED OXIDE SAMPLES

(S. D. Strauss)

Objective: Determination of the behavior of stainless steel-clad, isostatically pressed UO_2 samples relative to that of standard, pelletized UO_2, under prolonged neutron irradiation.

A. Preparation of Irradiation Samples

Progress on sample fabrication was slowed during this quarter due to the appearance of an aluminum impurity in the 19% enriched UO_2 produced by Spencer Chemical Corporation. The oxide was originally obtained by conversion and downgrading of highly enriched uranium metal which had been procured by Sylcor from Davison Chemical Corporation. After reprocessing the contaminated uranium dioxide an emission spectrographic analysis showed the following impurities, in parts per million (Table I).

The aluminum has apparently been removed, and the material is now considered reactor grade oxide.

Further delay in sample preparation resulted from a review of the design with regard to the creation of stresses induced in the steel cladding by fission gases released into the oxide melt zone. The pressure to be generated by fission product gases merits particular consideration in this program, since the isostatic pressing process precludes the presence of

TABLE I

	Fused UO_2	Ceramic UO_2
Silver	0.1	0.1
Aluminum	5	5
Boron	0.3	0.2
Cadmium	<1	<1
Chromium	<5	<5
Copper	0.6	0.4
Iron	84	40
Magnesium	2	3
Manganese	<3	<3
Molybdenum	<1	<1
Nickel	<5	<5
Phosphorus	<20	<20
Lead	<3	<3
Silicon	22	38
Tin	<3	<3
Vanadium	<10	<10
Zinc	<10	<10
Antimony	<20	<20
Cobalt	<3	<3
	<198	<171

void space in which the gases could otherwise accumulate. The design review was based on the following considerations in the 20,000 MWD/ton samples.

1. Molten zone diameter of 0.030 inches.

2. Kr and Xe produced at the rate of 0.24 atoms per fission.

3. Gas released at the rate of 100% at temperatures above 2900°F, zero elsewhere due to small diffusion coefficient in non-molten region.[1]

4. Void space of 5 v/o in 95% dense UO_2, all of which is available to fission product gas.

These result in a calculated release of 52% of the gas atoms generated in a sample, after 20,000 MWD/ton irradiation. Assuming an average gas temperature of 1000°C, an internal pressure of approximately 5800 psi could be anticipated, resulting in a calculated hoop stress of 77,000 psi in the cladding. In view of this extreme result, it was decided to incorporate a porous spacer plug above the oxide in each sample to provide additional void space for the fission gases. A 1/4 inch alumina plug with 50% porosity was selected for this purpose. Inclusion of the plug is to be accomplished by tamping alumina powder above the oxide before closure, followed by isostatic pressing of the entire assembly. Such a plug should reduce the internal sample pressure to 1400 psi and the cladding hoop stress to approximately 19,000 psi. This should be adequate to prevent rupture of the cladding.[2]

The powder selected is Norton Grade RR, 60 mesh, electrically fused crystalline alumina. This has been ordered and received, and trial isostatic pressing runs with normal or depleted UO_2 are scheduled for August, 1960.

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1 Based on findings reported by Eichenberg, et al, WAPD-183, "Effects of Irradiation on Bulk UO_2" (October, 1957).

2 ASTM Tables of Data on Chemical Compositions, Physical and Mechanical Properties of Wrought Corrosion-Resisting and Heat Resisting Chromium and Chromium-Nickel Steels (December, 1942)-Figure 13 gives 68,000 psi as tensile strength of type 304 stainless steel at 800°F.

B. Work Plan for Next Quarter

The isostatic pressing process will be developed for samples incorporating alumina powder, and the steel-clad irradiation samples will be completed in the next quarterly period. It will also be necessary to reschedule insertion of the capsules in the testing reactor during this time.

IV. IRRADIATION OF URANIUM-YTTRIUM ALLOYS (S. D. Strauss)

Objective: Determination of the characteristics and dimensional stability of two uranium-yttrium alloys under neutron irradiation at high temperatures.

A. Capsule Design and Fabrication

Following the receipt of two heaters to replace those which failed near the end of the preceding quarter, the calibration capsule was successfully reassembled and is ready to produce the necessary calibration information over the desired temperature range.

All subcontract work on the capsule phase of the program was temporarily halted by NDA on April 25, 1960. This action was taken since Sylcor had not yet approved the terms of the contract. Approval had been delayed pending joint resolution, by Sylcor and Phillips Petroleum, of the problems of indemnification and waiver of consequential damages, should these arise in the event of a reactor incident. These questions have been partially resolved, and Sylcor has indicated to NDA its willingness to approve the subcontract as it is presently constituted.

B. Work Plan for Next Quarter

The irradiation samples will be delivered to NDA for encapsulation upon completion of contract negotiations and resumption of work by NDA. Completion of the calibration test and reschedule of capsule insertion in the testing reactor are planned for the next quarterly period.

V. HIGH TEMPERATURE CLADDING FOR UO_2 (J. Fugardi)

This project expired at the end of the quarterly period. A final report summarizing all experimental work and results is presently in publication. It is expected that distribution will be made within approximately one month.

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