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January 21, 1955

MEMORANDUM TO FILE

FROM: R. R. HERRIES

R.R.H.

This document consists of 3 pages

Trip Report No. 7 of 13 Copies, Series A
BATTELLE MEMORIAL INSTITUTE
January 12, 1955

W. J. O'Leary and R. R. Herries visited BMI to review the progress of subcontract research on extended fuel elements.

SUMMARY

1. Three "pinhole" corrosion samples, bonded at ERL by fluid pressure, have been tested in boiling distilled water for 624 hours with no evidence of undercutting corrosion.
2. A series of 30 samples is being prepared to investigate the effect of higher bonding pressures on resistance to undercutting corrosion.
3. A 25-pound lot of Horizons' Thorium Contained/Charged and has been compacted in preparation for consumption in electrode arc melting.

DISCUSSION

By Authority of

Uranium

Mechanical Hot Die Pressing

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Since previous results indicate that present standard bonding conditions may be marginal in respect to corrosion resistance, a series of samples is being prepared to investigate the effects of higher bonding pressures on corrosion undercutting. Thirty 1" diameter X 0.180" thick uranium specimens were electroplated with 0.5 mil nickel and are being clad with 30-mil aluminum. The die has been revised to provide a pinch weld of 40-50% reduction on the circumference of the 1 1/2" diameter picture frame assembly. Ten samples will be

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press-clad at each of 3 pressures: 6, 10, and 15 thousand psi using the BMI standard temperature of 950°F (510°C) for 5 minutes. A pinhole of 15-mil diameter will be drilled into the uranium. To date, 6 samples have been press-clad.

Extrusion Cladding

Several unsuccessful attempts were made to extrusion-clad MTR-size steel cores with 30-mil ribbed aluminum sheath. Attempts to (1) provide a means of die alignment, (2) vary mandrel-to-die distance, and (3) mechanically push the core, produced only an extruded aluminum tube with the core acting as a mandrel. The high extrusion ratio (30:1), smaller die opening, and mandrel-tip geometry resulted in forces tending to grip the core surface between the mandrel tip and die, preventing movement of the plate. All of the cores were grit-blasted; one was both grit-blasted and nickel-plated.

For one extrusion of plasticene a conical die was used to increase the forward component of force on the core. Some improvement was noted over previous trials with flat-faced dies, in that only a slight pressure was required to start the core moving.

It was recommended by Du Pont personnel that this approach be abandoned, and that further work on extrusion cladding utilize the porthole extrusion technique with the core moving at right angles to the direction of ram movement to facilitate die alignment and maintenance. Preliminary investigations with plasticene should be carried out to show the feasibility of the method.

Corrosion

Three "pinhole" samples, bonded at ERL by fluid pressure methods, had on January 12 been on test for 624 hours with no evidence of undercutting corrosion. The 1" X 8" X 0.180" nickel-plated uranium cores, clad with 30-mil aluminum, were drilled with a 15-mil hole into the uranium and placed in boiling distilled water. After 9 to 11 days the samples began to pimple at the pinholes; within 26 days (624 hours) the pimples had grown to 1" diameter at their base. The absence of undercutting substantiates the theory that good bond continuity, as achieved in fluid pressure bonding, is necessary for corrosion resistance.

The ten samples nickel-coated at the Mound Laboratory, by the decomposition of nickel carbonyl, provided no conclusive results upon corrosion testing. After step-press cladding at 6000 psi and 510°C, the MTR-size uranium cores were pinholed with a 15-mil drill. Inspection prior to corrosion testing showed a number of blisters on four of the plates and a non-bond

on a fifth. After 24 hours on test three more samples showed non-bonds in areas not immediately adjacent to the "pinholes". No increase in thickness of the plates was found, although some of the non-bonds increased in area upon further exposure. After 1 to 2 days, definite undercutting occurred in two of the samples. Two more failed between 4 and 7 days. It is believed that the 4 to 5 weeks delay between nickel-coating and press-cladding seriously affected the bond quality. Electrographic tests at BMI did, however, prove the nickel layer applied by Mound to be far superior to electroplated deposits in regard to lack of porosity.

Thorium

Consolidation of Thorium

The shipment of 25 pounds of Horizons' thorium received from Nuclear Metals is being carefully analyzed, in order that any purification achieved in the arc melting may be followed. Results from the microscopic examination, screen analysis, and chemical analysis will be provided.

In preparation for consumable electrode arc melting, the metal was compacted at pressures up to 50 tons/sq.in. into 1" X 1" X 6" bars, two of which will be melted green and six sintered. Five of the sintered bars were held at 1250°C, in vacuum, for 15 minutes, and one was held for 90 minutes. Large volumes of gas were given off as ThH_2 and ThH_4 were decomposed. Losses averaged 20 grams per bar, part of which flaked off. The densities of the sintered bars were slightly below the 11 gm/cc values determined for the green compacts. Green strengths were good, though during welding the bars parted at interfaces caused by refilling the die in compacting. These bars were tack-welded back together. No problems were encountered with the sintered bars. Considerable outgassing was experienced when the first green electrode was charged into the vacuum furnace, so BMI considers it inadvisable to arc-melt unsintered electrodes.

Diffusion of Thorium into Aluminum

Alloys of approximately 0.5% thorium in aluminum have been prepared for use in diffusion studies. These alloys, which are below the limit of solid solubility, will serve as a base line for determining whether any diffusion of thorium into aluminum takes place beyond that limit which can be detected by metallography. The metal has been sampled for chemical analysis, extruded, and machined into cylinders for use in diffusion couples.

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10/20/94

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