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2/4/89

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SR/H--801

- 1 - W. C. *Kay* - H. Worthington
2 - J. C. Woodhouse - N. F. Spraggins
3 - D. F. Babcock
4 - V. R. Thayer - J. E. Evans
5 - K. G. Jones - W. J. O'Leary
6 - A. Pocalyko - R. R. Herries
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March 25, 1955

MEMORANDUM TO FILE

FROM: R. R. HERRIES

This document consists of 4 pages

No. 1 of 14 series, Series A

**Trip Report
BATTELLE MEMORIAL INSTITUTE
March 22-23, 1955**

W. J. O'Leary and R. R. Herries visited BMI to discuss the results of subcontract research on both the natural uranium and the enriched uranium extended surface fuel element programs.

SUMMARY

1. Nickel-plated uranium corrosion samples, 1" dia. X 0.180" thick, press-clad with 30-mil aluminum at both 10 and 15 thousand psi, show improved corrosion resistance over samples press-clad at 6 thousand psi with the same time-temperature conditions.
2. Design of equipment for the internal cladding of uranium tubes is progressing. The basic tools will be applicable to several variations of the proposed method of "inverse die sinking".
3. Analyses of double and triple melted Horizons' electrolytic thorium show a significant increase of H₂ and O₂, upon remelting with a corresponding increase in the hardness of the metal.

Classification Cancelled/Changed

TO **UNCLASSIFIED**

By Authority of

1. *S. M. R.* ADD 1/23/89
Name Title Date
2. *C. J. Banick* AED CO 2/4/89
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MASTER

DISCUSSION

Uranium

Outgassing Nickel-plated Uranium

A discussion was held at BMI to clarify a proposed program to study the effects of outgassing upon the corrosion resistance of nickel-plated uranium. Opinions were expressed as to the optimum pressing conditions and sample size which would give reproducible results, yet would be sensitive to the effects of entrapped moisture, plating solution, hydrated oxides, and hydride formations. In order to establish a satisfactory test, BMI will send a letter to Wilmington with their proposed approach to the problem, as agreed upon by those BMI personnel concerned with the work.

Corrosion

Corrosion testing of the series of "high-pressure" samples at BMI is nearing completion. These nickel-plated uranium cores, 1" in dia. X 0.180" thick, were press-clad 30-mil aluminum at 510°C using 6, 10, and 15 thousand psi. The bonded assemblies were pinch-welded around the edges and pinholed with a 15-mil drill for testing in boiling distilled water.

The specimens pressed at 6000 psi to serve as a basis for evaluating the corrosion behavior of the other samples failed between 21 and 35 days without undercutting. Those samples pressed at 10,000 psi failed between 35 and 45 days, while the group pressed at 15,000 psi is exhibiting a similar behavior; to date 5 of these samples have failed between 28 and 38 days. The failures were not of the undercutting type, since the pimples which formed at the pinholes grew slowly in diameter until they reached the edge of the uranium core from which corrosion spread rapidly over the opposite surface of the sample. The limiting factors under these conditions are the size of the samples and the rate of growth of the pimples.

It was concluded that the higher bonding pressures (10 and 15 thousand psi) produced more uniform pressures over the relatively rough metal surfaces; this resulted in more continuous bonds and better corrosion resistance than was obtained with 6 thousand psi.

The "half-dollar" size samples used for this test were the first specimens to give fairly uniform results when pressed at any given set of time-temperature conditions.

Uranium-Aluminum Alloy

Plans which are now being made for an investigation of the uranium-aluminum alloy system at BMI will be directed primarily toward a determination of the controls necessary to produce homogeneous castings in the range 14% to 18% uranium. Castings of the dimensions of SRL co-extrusion billets will be melted and poured in air as a matter of convenience. Data from these melts will aid SRL in evaluating air melting versus vacuum melting procedures for uranium-aluminum alloys.

Arrangements are being made to obtain the billet radiographic device from NMI to help in evaluating the homogeneity of the castings.

Concurrently with the work on homogeneous alloys, BMI will obtain cooling curves for alloys in the range 16% to 40% uranium as an accurate determination of the liquidus line above and below the peritectic point as well as a determination of the composition of the peritectic point.

Internal Cladding of Tubes

Preliminary designs for equipment to clad the internal surfaces of uranium tubes with aluminum were presented by BMI. One basic arrangement will require only slight modification for the investigation of several variations of the proposed "inverse die sinking" process. Sections of nickel-plated steel tubing, 1' to 2' in length, will be used for the early cladding work.

Thorium

Consolidation of Thorium

Fairly complete chemical analyses have been received from samples of as-received and of consumable electrode arc-melted Horizons' thorium at BMI. The impurity content of this metal, from the second lot received at BMI, was somewhat higher than was that of the first lot. The following table gives a comparison of metal in the as-received condition to metal that has been melted one, two, or three times.

**Analysis of Arc-Melted Horizons' Thorium
(Second Lot)**

<u>Impurity</u>	<u>As- Received</u>	<u>Once Melted</u>	<u>Double Melted</u>	<u>Triple Melted</u>
H ₂	89-98	18-30	-	29
Cl ₂	1000	60-400	30	30
C	400	400-500	300	200
HCl insolubles	.67 w/o	4.15-4.6 w/o	4.3 w/o	4.2 w/o
Na	278	25-35	34	<50
O ₂ (vacuum fusion)	3200-3300	3200-3300	-	5000
N ₂	20	50-60	40	50
<u>Hardness (Vickers)</u>	-	50	85.4	85

NOTE: All values in ppm except HCl insolubles.

Although remelting decreased the porosity in the metal, the O₂ content and the hardness increased. The Vickers hardness value of 50 for the virgin melted metal may be low due to the spongy nature of the ingot; however, the values of 85 for the remelted metal correspond to an increase of 1700 ppm O₂ in the remelted ingots. This increase in O₂ content after the first melt is attributed to (1) pickup during welding of electrodes and (2) oxidation of the extremely porous surface exposed when the original ingots were scalped.

Remelts of metal from the first lot of Horizons' thorium had previously shown a greater increase of impurity content than did remelts from this second lot. The H₂ content rose from <10 to 60 ppm while the Cl went from <60 to 90 ppm. An increase in O₂ of 3000 to 4700 ppm was believed to be due to the excessive welding necessary to piece electrodes together for remelting.

Inclusions found in the cast thorium were examined by diffraction methods and found to contain mostly thoria with small amounts of sodium present. Spectrographic analyses verify 10-350 ppm sodium and an equal amount of Ca.

DATE

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10/14/94

END