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Wilmington, Delaware

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MEMORANDUM TO FILE

FROM: R. R. HERRIES

July 22, 1955
Classification Canceled/Changed
TO UNCLASSIFIED

By Authority of

Trip Report Worthington ADD 1/27/83
BATTELLE MEMORIAL INSTITUTE Name Title Date
July 12-13, 1955 C. J. Banick AED CO 7/6/89
Name Title Date

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

SUMMARY

1. It has been determined that the use of a poor quality uranium for cores was responsible for non-reproducibility in several series of corrosion samples. A better quality core material will be used for future studies of the effects of outgassing on the corrosion resistance of nickel-plated uranium.
2. Tools for extrusion cladding experiments at BMI are expected to be ready for use in early August.
3. Five nickel-plated steel tubes were internally clad with aluminum by "hot drawing". Although diffusion zones were formed, the weak bond was parted on cooling due to the differences in the thermal expansion of aluminum and steel.
4. Varying degrees and patterns of segregation have been found in uranium-aluminum castings which were cooled through the liquidus-solidus region at different rates. Equipment changes will be made to provide a wider range of cooling rates.

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Reviewing
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C. J. Banick, AED Class Officer

MASTER

DISCUSSION

Outgassing of Nickel-Plated Uranium

Corrosion samples of nickel-plated uranium which had been press-clad with aluminum and tested in boiling distilled water were examined metallographically. It was found that in many cases a poor quality metal had been used for the uranium cores. The cores, in the form of discs cut from 1-inch uranium rod, contained a large number of stringers parallel to the axis of the original rod and intersecting the flat surfaces of the cores.

When the cores were plated by the SRL nickel-plating procedure, the hot nitric etch and the severe anodic etch attacked the slag in the stringers, leaving pits which were not bridged over by the nickel-plate. These areas provided convenient paths for corrosion when the samples were pinhole corrosion-tested. With the less severe etch used in the BMI procedure, the slag remained in the stringers and was covered by the nickel-plate. These findings tend to explain the differences in corrosion resistance experienced from one series of samples to another.

Studies will be resumed with better quality metal to determine the effects of outgassing on the corrosion resistance of nickel-plated uranium. BMI has been requested to use samples cut from rolled plate, since the stringers in plate would lie parallel to the core surfaces and would not be attacked by the acid prior to electroplating. In this case, either the BMI or the SRL plating procedure should be satisfactory. Results from these studies will be checked by the use of 3" X 5" X 0.180" samples.

Extrusion Cladding

Machining of tools by Moczik for extrusion cladding experiments at BMI is expected to be completed early in August.

Internal Cladding of Tubes

Five nickel-plated steel tubes were internally clad with aluminum at BMI by the "hot draw" process. Per cent reduction of the draws varied from 18% to 50%; for two of the three runs the ID of the tube and the plug were lubricated with Aquadag. Bond strengths of the clad tubes varied from areas of non-bond to areas of very weak bond. Photomicrographs showed that in many cases a diffusion zone was formed, but the weak bond was parted on cooling due to the difference in thermal expansion of the steel and the aluminum.

The aluminum billets (4" to 7" in length) were placed in 1-foot steel tubes. These were brought to temperature, 900°F to 925°F, in the heated container. The plug was drawn through the assembly at a speed of 1"/min. When no lubricant was used for the heavier reductions, the excess aluminum was simply sheared off; however, lubrication of the billet and the plug caused this aluminum to flow along the tube, thus increasing the clad length. Lubrication also decreased the excessive pick-up of aluminum on the plug.

Uranium-Aluminum Alloy

Billets of 16% uranium-in-aluminum alloy have been cast under varying conditions in order that the effects of the rate of solidification on segregation of the alloy might be studied.

Six billets which had previously been cast through a pouring chamber and into a preheated graphite mold were radiographed. By preheating the mold to different temperatures the cooling rate of the castings was varied from 40 F°/min. to 120 F°/min. Segregation in the castings appeared on radiographs as the typical "cloudy" pattern for castings which are slow-cooled. Secondary pipe and surface defects were also present.

Castings have also been poured into a steel mold preheated so that the metal remains molten until the cooling water rises around the OD, thus providing a uniform directional solidification. For the first castings the mold was preheated to 1100°F and 1300°F. The castings cooled at a rate of about 30 F°/min., producing an odd "feathery" structure of uranium-aluminum compound.

The mold wall was then made thinner to provide a faster chill. Castings poured into the mold, preheated to 1050°F and 1200°F, exhibited a grainlike segregation pattern which was fairly uniform on a macro-scale throughout the entire casting. Surfaces were very good and the castings were sound. The castings will be sampled for chemical analysis.

An accurate determination of the uranium-aluminum constitution diagram in the range 16% to 30% uranium is being conducted at BMI. The solidus was previously established at 640°C and the peritectic temperature was located at 729°C - 732°C by means of a differential thermocouple technique. However, another means must be employed to locate the liquidus line at the higher temperatures.

DATE

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10/13/94

END