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TITLE

PRODUCTION TEST IP-243-A-6-FP
EVALUATION OF X-8001 ALLOY ALUMINUM COMPONENTS FABRICATED FROM CAST BLANKS

AUTHOR

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PRODUCTION TEST IP-243-A-6-FP
EVALUATION OF X-8001 ALLOY ALUMINUM COMPONENTS
FABRICATED FROM CAST BLANKS

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OBJECTIVE

The objective of this test is to determine, through comparative irradiation testing, the relative qualities of X-8001 aluminum alloy components fabricated by impact extrusion of wrought and cast blanks.

SUMMARY OF TEST

This test shall involve:

a) Monitored irradiation of six charges of alternated cast and wrought blank, X-8001 aluminum alloy clad I & E enriched (0.94% U-235) elements (OIIE) to evaluate relative corrosion resistance, and resistance to "groove pitting" attack; and

b) Lot monitored irradiation of the gross performance of up to 240 charges of cast blank clad enriched I & E fuel elements to attempt to evaluate the gross performance of this material.

BASIS AND JUSTIFICATION

This test is designed to accomplish two primary objectives, i.e., 1) to attempt to verify ex-reactor corrosion data which indicated improved corrosion resistance of cast blank X-8001 alloy material compared with wrought blank, and b) to attempt to verify the resistance to "groove pitting" type of corrosion attack previously observed on M-388 components. Ex-reactor tests of cast blank M-388 alloy in autoclaves using water as the corrosive media up to 360° C, and in flow loops up to 120° C have indicated that the corrosion resistance of the cast blank material is equivalent to, and probably superior to the corrosion resistance of wrought blank material. Metallographic examination of this material indicated a more uniform nickel dispersion in the aluminum as a probable explanation of this performance.

The sporadic occurrence of severe "groove pitting" has seriously challenged the use of X-8001 nickel aluminum alloy as a fuel element cladding material. Although the actual cause of the groove pitting has not been determined, non-uniform dispersion of the nickel in the alloy is suspected. The cause of the non-uniform nickel dispersion or segregation has been located and virtually eliminated by removal of additional aluminum (scalping) from the ingots prior to fabrication of the components.

An alternative to this expensive scalping has been found by Hunter-Douglas Aluminum Company, which involves individually casting the blanks for impact extrusion. Metallographic examination of the components fabricated in this manner indicated that more complete dispersion of the nickel was achieved and segregation was notably absent. If reactor performance of this material is satisfactory, it will indicate that no new problems have been introduced and confirm that dispersion reduces groove pitting. Hunter-Douglas will then be certified as an alternate vendor for X-8001 alloy components and further performance data may then become a basis for process changes at the primary vendor, Aluminum Company of America.

Enriched fuel (0.947% U-235) will be utilized to achieve the higher heat fluxes and fuel surface temperature necessary to produce "groove" and "uniform" type corrosion to establish a difference.

[redacted]

TEST DETAILS

a) Fuel Elements

All elements utilized in this test shall be fabricated within all process standards for normal production OIIE fuel elements and shall pass all normal quality control tests. Aluminum components for the test material shall be fabricated by Hunter-Douglas utilizing the cast blank process.

b) Monitor Columns

1) All fuel elements in the six monitor columns shall have pre-exposure measurements of weight, diameter and warp recorded prior to shipment to the reactor.

2) The six monitor columns shall be charged, in order, with piece number one downstream into process channels required for normal enrichment requirements (except fringe compensation) at the discretion of the Operational Physicist and with the concurrence of the author. Charge makeup shall be identical to that utilized in other columns of OIIE in that reactor.

3) During irradiation, daily temperature and weekly flow data shall be obtained on data sheets provided. Two of the six columns shall be exposed to a goal exposure of 500 MWD/T, the remaining four are to be exposed to a nominal goal exposure of 800 MWD/T.

4) After exposure to the specified goal, each column shall be kept separate from the normal enriched metal discharged, i.e., separate buckets, and shall be shipped to the 105-C MEF* for post irradiation examination and measurements.

5) Post irradiation measurements of weight loss, dimension instability, relative gamma activity shall be obtained and all elements shall be visually examined.

c) Lot Charging

1) Up to five tons per quarter of the normal OIIE requirements of the same reactor chosen for the pilot loading (roughly 40% of total) will be fabricated in components made from cast blanks. No controls other than lot-charge identification are required for this material.

2) Irradiation shall be to normal OIIE goal exposures in effect.

3) No special handling of this material after discharge, other than normal, will be required.

d) Reactor

H Reactor was chosen for this test since it is the only older reactor which utilizes sufficient enriched fuel to accomplish this test within a reasonable length of time, and since H Reactor is the one which has shown the most tendancy to exhibit groove type pitting attack on M-388 or X-8001 alloy components.

* MEF - Metal Examination Facility

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e) Hazards

Since these elements are equivalent metalographically to normal production OIIE material, and since they must pass all normal fuel standards, rupture risk from this test is slight. If, however, two ruptures are sustained in this material the remainder may be discharged, and no further charging performed pending rupture examination, at the discretion of the Manager, H Processing Operation.

f) Outage Time Requirements

Since this test involves enriched fuel elements which require special charge-discharge procedures sufficient for this test, very slight outage costs should be incurred.

The lot charging portion of the test should require no outage time losses.

RESPONSIBILITIES

Fuels Preparation Department

Manufacturing Operation

The Manufacturing Operation shall be responsible for canning all pieces by the "F" Process, for normal quality control, and for pre-irradiation measurements and marking.

Engineering Operation

The Engineering Operation shall be responsible for liaison in the 300 Area portion of this test and for providing technical assistance.

Irradiation Processing Department

Research and Engineering Operation

Process Technology Operation shall be responsible for assistance in scheduling, choice of test channels, assistance in charging of the test, and for forwarding of operating data to the author.

Process and Reactor Development Operation shall be responsible for coordination of the test, data analysis, and reporting of irradiation experience.

Component Testing Operation shall be responsible for obtaining post-irradiation examination data.

H-Reactor Operation

H-Processing Operation will be responsible for planning, scheduling, the operational safety and production continuity of the reactor, and for collection of routine operating data for the test.

R E Hall
Reactor Fuels Unit
Process and Reactor Development
IRRADIATION PROCESSING DEPARTMENT

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