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ELEMENT CLADDING FILM AND RADIOACTIVITY STUDIES

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PRODUCTION REACTOR PROCESS TUBE, DUMMY, AND FUEL
ELEMENT CLADDING FILM AND RADIOACTIVITY STUDIES

L. D. Perrigo

**HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON**

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PRODUCTION REACTOR PROCESS TUBE, DUMMY, AND FUEL
ELEMENT CLADDING FILM AND RADIOACTIVITY STUDIES

INTRODUCTION

During the normal operation of reactors ionic, particulate and colloidal substances in the coolant are activated as they pass through the neutron flux. The parent substances for the activated materials come from several sources: transient corrosion products from the coolant system piping and fuel element cladding, coolant additives and coolant impurities. Previous studies have shown that a major portion of these substances do not simply pass through the neutron flux field but undergo complex sorption phenomena that result in effluent radio-nuclide levels considerably in excess of what would be expected from activation on a once-through basis.

This report is being written to outline studies that will provide activity inventory data that will aid in defining radionuclide retention reactions in reactor coolant systems.

OBJECTIVES

The detailed objectives of this comprehensive program are:

1. To obtain corrosion data on process tubes.
2. To obtain corrosion data on fuel element claddings.
3. To determine the radionuclide inventories in aluminum process tube films as a function of tube length.
4. To determine the crystalline structure of films throughout the aluminum process tube.
5. To determine the material composition of films on aluminum process tubes and fuel element claddings.
6. To determine the radionuclide inventory on the films on columns of fuel elements.

PROCESS TUBE STUDIES

Since the greatest accumulations of radionuclides are assumed to be retained in the films on central reactor zone tubes, the initial phases of this study will be concentrated upon obtaining information on these tubes. After the radionuclide inventories in these tubes are reasonably well defined work will be started to determine total reactor inventories. This will require the use of fringe zone tubes.

Both short and long half-life radionuclides are of interest in this inventory study. Tube removal from the reactor and specimen handling and processing will take significant amounts of time. Time is critical. If the short half-life species are to be determined, close liaison will be necessary with reactor operations and the Component Testing Unit, IPD, who will use the same aluminum tubes for corrosion measurements.

Tube removal from the existing production reactors entails splitting the tube during removal. Tubes used for this study should be pushed in such a manner that segments of increasing length are cut at the rear face during the shearing operation. As soon as tube removal is completed, all segments should be gathered in the basin viewing facility. Here individual segments will be placed in a hand shearing apparatus that will be used to obtain 1" x 4" specimens. Shearing is to be used in this operation because it has been found to cause the least damage to aluminum oxide films and surface deposits. The in-reactor location of each specimen will be known from the following: the relative length of the tube segment compared with all other segments and 1" x 4" specimens will be removed from the center of each segment. Specimens will be taken from both top and bottom segments of each tube, the latter between the tube ribs.

Each 1" x 4" specimen will be divided into 1" x 1" coupons. After suitable identification these pieces will be loaded into a cask and transported to the 242-B Building, 200-E Area, for processing. Specimens from each tube segment will be processed as follows:

The iodine - methanol solution dissolves the aluminum metal, leaving the aluminum oxide. Experience has shown that the iodine - methanol solution also dissolves the reddish - brown coatings that are frequently found on the corrosion product films on production reactor tubes. Aluminum dissolution requires 12-16 hours. This means that there will be no opportunity to measure short half-life species in these samples.

Strong acid solutions are used for defilming. They react quite rapidly with both the reddish - brown coating and the aluminum oxide corrosion product films. If there are no long delays in the tube pushing operation, samples obtained in this fashion can be analyzed for short half-life species. Measured volumes of acid will be used so that it will be possible to determine the concentrations of various radioactive species per unit area.

By use of these two complementary techniques (defilming and film separation), radionuclide concentrations, corrosion, film composition and film identity should be established.

Standard techniques involving the use of pulse height energy analyzers and chemical separation, where necessary, will be used by the Redox Analytical Operation to determine radionuclide concentrations. Infrared, emission spectrography, and standard wet chemical methods will be used by the Physical Analysis and Chemical Analysis to determine film composition and identity. Corrosion will be determined by coupon weight differences.

FUEL ELEMENT CLADDING STUDIES

Radionuclides are retained in the films on the cladding of fuel elements. A certain amount of activity is also found on the aluminum dummies that hold the fuel element charge in position.

To determine the amount of various radioactive species in the cladding films and on the aluminum dummies, standard fuel elements will be charged in a central zone tube in the KE reactor. The fuel elements will remain in the reactor for a standard irradiation period. At the end of the irradiation period, the fuels and accompanying dummies will be pushed and removed by tray to minimize damage to surface deposits. Both fuel elements and dummies will be stored in a separate storage box. After cooling from 5 to 8 days, eight fuel pieces and four in-flux dummies will be loaded in a Hanford J-type cask and transported to the Radiometallurgy Group, 327 Bldg., 300 Area, for defilming. Fuel pieces for descaling will be selected so that film inventories for the varying conditions in the process tube can be determined.

A concentrated acid solution will be used for defilming the fuel element cladding. Defilming in given volumes of solution will be done immediately after the fuel elements and the dummies arrive at the 300 Area facility. Liquid sample studies will involve the following service organizations:

- a. Radiological Analysis Unit.
- b. Chemical Analysis Unit.
- c. Physical Analysis Unit.

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Charge-discharge instructions are covered in PT-IP-485-A, Fuel Element Film Formation Studies, HW-72383. Provisions have been made in this process test to charge the same tube three times consecutively so as to be certain that the necessary information can be obtained. Subsequent phases of this study will involve making fuel element charges to determine the kinetics of the activity and elemental buildups in the cladding and dummy films.

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