Advanced Test Reactor In-canal Ultrasonic Scanner: Experiment Design and Initial Results on Irradiated Plates


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AFIP Experiment Objectives

*Evaluate performance of ‘full size’ plate type nuclear fuels
Fuel Performance Properties

- Fuel Swelling

- Delamination

- Overall Dimensional Stability

![Fuel Swelling Images]

![Delamination Images]

![Overall Dimensional Stability Images]

Mini-plate test data

**Fission density (10^{21} \text{ f/cm}^3)**

- RERTR-5 (dispersion-0Si)
- RERTR-4 (dispersion-0Si)
- Open symbols: literature data [7-9]
- RERTR-6 (dispersion 2<Si)
- RERTR-7 (dispersion 2<Si)
- RERTR-6 (monolithic)
- RERTR-7 (monolithic)
- RERTR-8 (Monolithic-Boron)

INL Idaho National Laboratory

NNSA National Nuclear Security Administration
Advanced Test Reactor
AFIP Experiment Hardware

Planar View

(2) plate frames

(4) flux wire monitors

ram-rod

ram

(4) flux wire monitors

(2) plate frames

top removed

ram-rod
AFIP-2 Experiment

- Two friction bonded full size monolithic fuel plates
  - Si interface
  - Zr diffusion barrier
- Currently under irradiation
  - Peak surface heat flux ~350 W/cm²
  - Target burnup ~70%
- Plates subjected to ultrasonic scanning between cycles (reflection and transmission)
Irradiation Conditions

AFIP-2 Power History

Surface Heat Flux (W/cm²)

Node

AFIP-2 Burnup

Burnup (%)

Node
In-canal Ultrasonic Scanner

Through Transmission

Pulse/Echo

Receiver

Transmitter

Plate

Transmitter/Receiver

Delamination and Voids

Thickness and Distortion
Dimensional Stability - Distortion

1st

2nd

3rd
Dimensional Stability - Swelling
Voids and/or Delaminations

Pre-irradiation

35 Days of Irradiation

77 Days of Irradiation

133 Days of Irradiation

Formation of small defects
Summary

• Irradiation hardware (AFIP) was developed to investigate the performance of plate-type fuels

• Experiment can be disassembled and reassembled in the ATR canal

• The experiment is examined by ultrasonic scanning between cycles to measure various dimensional properties including thickness, distortion, and interface stability