Hot cell facility for Post-Irradiation Examination

Description

Post Irradiation Examination (PIE) facility at Radiometallurgy laboratory (RML) consist of seven concrete shielded and a few lead shielded alpha-beta-gamma hot cells designed to handle highly irradiated plutonium rich fuels. Figure 1 shows view of the hot cell facility. The concrete shielded hot cells have walls of 1200 mm thick made of high density concrete. The lead shielded cells have walls of 250 mm thick lead-antimony alloy. The concrete shielded cells are designed to handle irradiated material with radioactivity up to 3.7×10^7 GBq and lead cells up to 3.7×10^4 GBq of 1 MeV gamma radiation. The hot cells have a high purity nitrogen gas atmosphere to handle highly reactive mixed carbide fuel of FBTR. The nitrogen gas is recirculated, cooled and purified to control the temperature, moisture and oxygen. The hot cells are equipped with viewing and remote handling devices, alpha tight fuel transfer systems and state-of-art equipments/techniques covering a wide spectrum of non-destructive as well as destructive metallurgical examinations.

Inside reactor/Outside Reactor:

This is outside reactor facility and coupled with reactor.

Instrumentation:

PIE technique	Equipment used
Visual examination of FSAs and fuel pins	Periscope, magnifying glass, CCD camera, long distance microscope and telescope (Monocular viewing and photography is possible)
Profilometry and dismantling of FSAs	Indigenously developed 3 -axes profilometer with touch probe for dimensional measurements and dismantling of fuel sub-assemblies (accuracy $\pm$ 0.1mm) using laser system
Profilometry of fuel pins	Stepper motor controlled bench with LVDTs for measuring the diameter of fuel pins along their length with an accuracy of $\pm$ 5 micrometers
Neutron radiography of	Source of neutrons: KAMINI Reactor

irradiated objects	Flux: 10^6 n/cm^2/s at radiography site Indigenously developed rig is used for neutron radiography of fuel sub- assemblies and pins using dysprosium foils and converter screens
X-radiography of fuel pins	420 kV X-ray ceramic fine focus tube is used. Films, less sensitive to typical gamma spectrum of irradiated fuel pins are used. Special techniques to reduce fogging of film due to gamma irradiation.
Leak testing of fuel pins	Pressure chamber for pressurizing the suspect pin with 90:10 mixture of nitrogen and sulphur hexafluoride. Sniffing probe and detector which gives constant current from tritium source at no leak is used for characterizing the leak.
Eddy current testing of fuel pins	Indigenously developed encircling coils are used for eddy current testing on pins held vertically on a test bench.
Metallography	Indigenously developed fuel pin cutting machine, vacuum impregnation setup, automatic polishing systems, etching and replica preparation systems, Photomosaic and image analysis
Uniaxial tensile testing	Screw driven universal tensile test machine fitted with a resistance heating furnace
Density measurement (Swelling)	Archimedes principle. Weighing balance 0.01 mg resolution; Pycnometer 0.1 mg/cc resolution
Fission gas analysis	Puncturing and collection of fission gas. Analysis by gas chromatography
Burnup estimation	By radiochemical analysis
Fission Product Distribution	By Gamma Scanning

Transmission Electron Microscopy (TEM)	Disc specimen extraction from irradiated wrapper, Mechanical & electrolytic thinning, examination under Philips CM200 TEM with Energy Dispersive Spectrometer and DX4 Analyser (operating voltage of 120-200 kV)

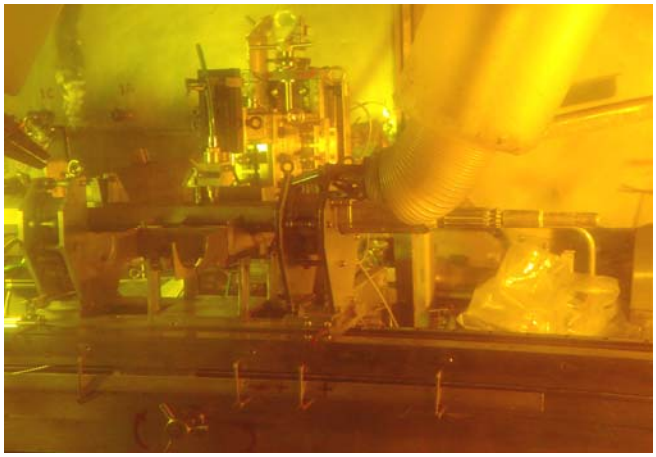
Current status and availability:

Presently the facility is being operated for post irradiation examination of FBTR fuel subassemblies. The facility is available.

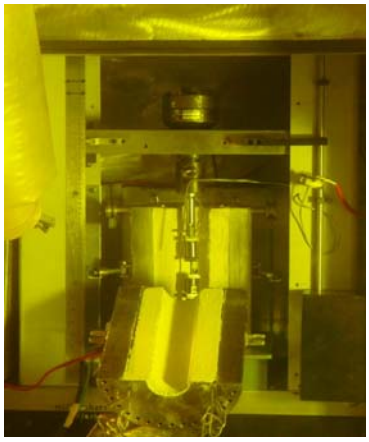
Uniqueness:

This facility has played important role in the extended burnup achievement of FBTR Mark-I carbide fuel.

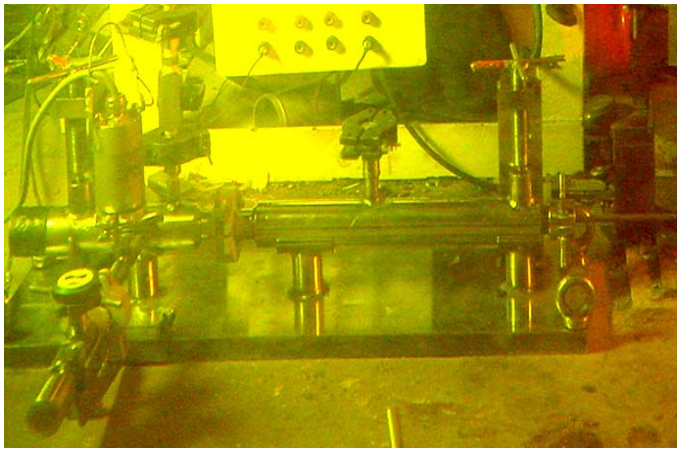
A view of the operating area of Hot cells



Remote dimensional measurement cum laser dismantling equipment



Remote Tensile testing machine



Fuel puncturing and fission g