DESIGN AND QUALIFICATION OF RESEARCH REACTOR NUCLEAR FUEL AND CONTROL ELEMENTS

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Fuel element qualifying program

Since the 80's IPEN has been producing and qualifying its own LEU (19,75% of 235-U) MTR fuels. Fuel element assemblies had been constructed with U3O8-Al dispersion fuel plates with densities of 1.9 gU/cm3 (from 1988 to 1996) and 2,3 gU/cm3 (from 1996 to 1999). Since September 1999 IPEN has been fabricating 3,0 gU/cm3 U3Si2-Al dispersion fuel. The strategy adopted by IPEN for qualification the own fuel elements was to conduct the fuel tests and fuel performance evaluations in pile, during reactor IEA-R1 operation. Fuel performance and nuclear fuel qualification require a post-irradiation analysis. IPEN has no hot cells to provide destructive analysis of the fuel. So non-destructive methods are utilized to evaluate irradiation performance of the IPEN fuel elements. The IPEN program for fuel element evaluation consistes of the following items: i) Monitoring the reactor power; time of operation; neutron flux calculation at the position of each fuel assembly; burn up calculation; inlet and outlet water temperature in core; water pH; water conductivity; chloride content in water; radiochemistry analysis of reactor water. ii) Periodic underwater visual inspection of fuel assemblies and eventual sipping tests for suspect fuel assembly. Irradiated fuel element assemblies have been periodically visually inspected by an underwater radiation resistant video camera, inside the IEA-R1 reactor pool, to verify its integrity and its general surfaces conditions. Regarding the qualification in-use of MTR fuel assemblies, by the end of august, 2004, the U3Si2-Al dispersion fuels have achieved in Reactor IEA-R1 an average burnup of 21.50%. The in pile irradiation of U3Si2-Al dispersion fuel will continue until the qualification be achieved for a burnup of 30%. To evaluate the fuel miniplate swelling during the irradiation time, a special equipment to perform underwater thickness measuring was projected by the fuel engineering group of IPEN. A Brazilian supplier constructed the mechanical parts and the electronic measurement instruments were acquired by IAEA. The mechanical parts and the electronic measuring components were received, assembled and tested. The equipment will be mounted in the Reactor IEA-R1 pool.

Analysis of fission products release behaviour in dispersion fuels (U3O8-Al e U3Si2-Al)

The release of fission products from nuclear fuel during and after irradiation is a phenomenon having important safety implications in all reactor systems. In order to measure the leakage rate of fission products during and after irradiation of MTR fuel elements under normal operation conditions, the fuel engineering group developed a new experimental device named CICON (Circuit for Nuclear Fuels Irradiation). This device consists of a sealed and non-pressurized capsule that enables the one by one irradiation of fuel miniplates that contain simulated cladding failures of known dimensions. The miniplate is cooled by natural convection, although the capsule has also a forced circulation loop to collect coolant water samples. The specific activity of fission products will be measured in the collected samples by means of gamma-ray spectroscopy. Using a microcomputer data acquisition system, the capsule is also instrumented to allow the continuous monitoring of neutron flux and average coolant temperature near the surface of the miniplate. A total of eight thermocouples will be employed to measure this temperature. The coolant temperature, the simulated failure dimensions and the achieved burnup will be correlated with the measured leakage rate of fission products, for both U3O8-Al and U3Si2-Al dispersion fuels, using a release-diffusion model. Neutronic calculations will be performed to determine the device position in the IEA-R1 core during irradiation.

Design and technical specification of Ag-In-Cd reactor control element

During 2002 the final fabrication drawings for the IEA-R1 Ag-In-Cd control rods were produced by the fuel enginnering group of IPEN. The control rods construction was performed totally in IPEN and succesfully tested in Reactor in 2003.