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Development of Low Cyclic Fatigue Test Technique for irradiated Cladding Tube in Hot Laboratory

KAERI's R&D group had produced a lot of low cycle fatigue data for an un-irradiated fuel cladding tube using a cyclic pressurization device. However, the infrastructures and fatigue test techniques, which can produce the fatigue data on the irradiated fuel cladding tube, are still worse off in Korea. Therefore, the objectives of this study are to develop low cycle fatigue test techniques for irradiated fuel cladding tube, as well as produce a stress-life curve of the irradiated cladding tube under the cyclic pressurization.

The cyclic pressurization fatigue test machine was newly developed and installed in hot laboratory at KAERI' s post irradiation examination facility. Non-flammable silicone oil was used as a medium to exert an internal pressure on the cladding tube. The hydraulic cylinder moves up and down to apply a cyclic pressure to the cladding specimen so that the pressure of the cladding can be controlled within the range of 0 to 100 MPa, and the resultant hoop stress ranges up to 780 MPa. The loading frequency can be controlled in a range of 0.5 to 2 Hz with a sawtooth and sinusoidal waveform.

Radiation shielding system that surround the irradiated cladding specimen and the electric furnace was installed to protect the tester and minimize the radiation exposure from the spent fuel cladding specimens. Based on the shielding calculation results produced by the MCNP5 code system, the shielding material is determined to be rectangular shaped pure lead with a 50 mm thickness. In addition, the lead structure is covered with a 5 mm thick stainless steel casing.

To exert an internal pressure inside the irradiated cladding tube specimen, it is essential to remove the spent fuel pellet from the fuel rod. So defueling machine which can remove the spent fuel pellet from 300 mm long irradiated cladding tube specimen was developed.

In Addition, remote handling fitting fastening apparatus was equipped in hot cell. This apparatus was designed to fasten the high pressure fitting to defueled cladding tube specimen remotely using manipulator. The fatigue test specimen clamped with high pressure fitting guaranteed the non-leakage performance during cyclic pressurization.

Using these developed test systems, fatigue behavior data of the un-irradiated advanced Zircaloy cladding tube w/ and w/o hydrogen have been produced from this study. In addition, the preliminary fatigue test for an irradiated advanced Zircaloy cladding tube was also carried out successively.

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