

Evaluation of hoop creep behaviors in long-term dry storage condition of pre-hydrided and high burn-up nuclear fuel cladding

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Related to the degradation of the mechanical properties of Zr-based nuclear fuel cladding tubes under long term dry storage condition, the mechanical tests which can simulate the degradation of the mechanical properties properly are needed. Especially, the degradation of the mechanical properties by creep mechanism seems to be dominant under long term dry storage condition. Accordingly, in this paper, ring creep tests were performed in order to evaluate the creep behaviors of high burn-up fuel cladding under a hoop loading condition in a hot cell.

The tests are performed with Zircaloy-4 fuel cladding whose burn-up is approximately ~60,000 MWd/tU in the temperature range from 350°C to 550°C. The tests are also performed with pre-hydrided Zircaloy-4 and ZIRLO up to 1,000 ppm.

First of all, the hoop loading grip for the ring creep test was designed in order that a constant curvature of the specimen was maintained during the creep deformation, and the graphite lubricant was used to minimize the friction between the outer surface of the die insert and the inner surface of the ring specimen. The specimen for the ring creep test was designed to limit the deformation within the gauge section and to maximize the uniformity of the strain distribution. It was confirmed that the mechanical properties under a hoop loading condition can be correctly evaluated by using this test technique.

In this paper, secondary creep rate with increasing hydrogen content are drawn, and then kinetic data such as pre-exponential factor and activation energy for creep process are also drawn. In addition, creep life are predicted by obtaining LMP(Larson-Miller parameter) correlation in the function of hydrogen content and applied stress to yield stress ratio.