Integral Test of Xenon Cross Section for Application to Failed Fuel Detection and Location by Tagging Method in Fast Reactor

ITO Chikara[a], MAEDA Shigetaka[a], HATTORI Kazuhiro[a] and HARANO Hideki[b]

[a] *O-arai Engineering Center, Japan Nuclear Cycle Development Institute,*

4002 Narita, Oarai, Ibaraki 311-1393 JAPAN

E-mail: ito@oec.jnc.go.jp

[b] *National Metrology Institute of Japan, National Institute of Advanced Industrial Science and Technology,*

AIST Tsukuba Central 2, Tsukuba, Ibaraki 305-8568 JAPAN

Artificially blended xenon and krypton gas (tag gas) is used for failed fuel detection and location (FFDL) at the prototype fast breeder reactor MONJU. Tag gases with unique isotopic ratios were enclosed in each MONJU fuel cladding tube and will be measured by means of mass spectrometry in the event of fuel failure. Identification of failed fuel needs the correction of tag gas isotopic ratios for burn-up changes. The calculation accuracy of varying xenon isotopic ratios was evaluated by an irradiation test of xenon tag gas samples.

The experiment was carried out using pressurized steel capsules of an on-line creep rupture experiment in the experimental fast reactor JOYO. The irradiation test capsules were internally pressurized by helium and contained unique blend ratios of stable xenon tag gases. The cover gas containing released tag gas, which was diluted to isotopic ratios of 10^0 - 10^2 ppb, was analyzed by means of laser resonance ionization mass spectrometry. The 5 kinds of tag gas samples were irradiated with total neutron fluences of 1.6 - 4.8 x 10^{26} n/m^2. Largest changes of the isotopic ratios were a 6 % decrease of ^{124}Xe and a 13 % increase of ^{130}Xe by burn in or out with the neutron fluence of 4.8 x 10^{26} n/m^2

The isotopic ratios of xenon tag gases after irradiation were calculated using the ORIGEN2 code. The neutron cross sections of xenon nuclides were based on the JENDL-3.3 library. These cross sections were collapsed into one group using the neutron spectra of JOYO evaluated by means of the multiple foil activation method. Figure 1 compares the measured xenon isotopic ratios (E) and calculated values (C). The C/E values ranged from 0.92 to 1.10. The differences between calculation and measurement were considered to be mainly due to the measurement error (3 %) and the uncertainty of xenon nuclide cross sections.

The present accuracies of the calculated xenon isotopic ratios for FFDL by the tagging method in liquid metal cooled fast reactors were confirmed.

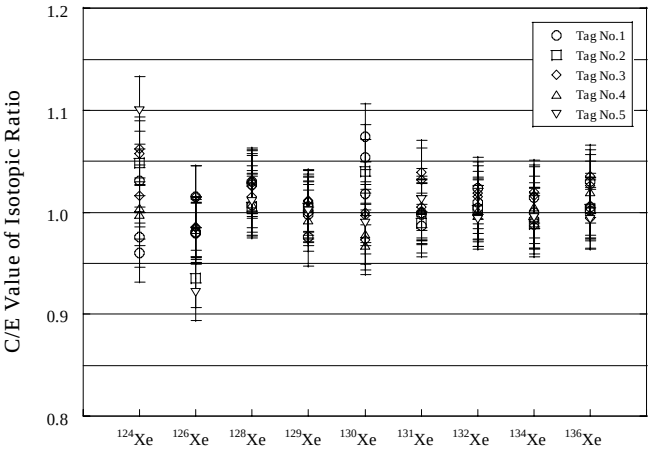

Fig. 1 Comparison of calculated and experimental values of xenon tag gas isotopic ratios after irradiation