CO8-1 Development of Non-Destructive Methods Adapted for Integrity Test of Next Generation Nuclear Fuels at KURRI-LINAC

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INTRODUCTION: Fast reactor system with transuranium (TRU) fuels containing minor-actinides (MAs) is one of attractive options for the incineration of high-level radioactive wastes. In order to develop the integrity evaluation methods of the fuels for safety operation of the fast reactor system, the N-DeMAIN (Development of Non-destructive Methods Adapted for Integrity Test of Next Generation Nuclear Fuels) project has been started from 2014. In the project, the identification and quantification of nuclide in the fuels will be conducted by the neutron resonance transmission analysis (NRTA). Moreover, the determination of temperature distribution in the fuels based on the Doppler-broadening and neutron imaging are planned. KURRI-LINAC is used for the project because it is the only pulsed neutron facility where nuclear materials can be utilized in Japan. To achieve these purposes, The KURRI-LINAC neutron source should be improved and modified for the high quality neutron beam regarding neutron flux, time resolution and spatial resolution. Based on numerical analyses, the neutron source system, especially moderator, reflector and collimator, was newly designed and it was installed at KURRI-LINAC as shown in **Fig.1**. Then, the characteristic of the neutron source system was investigated.

Fig.1 New neutron source installed in KURRI-LINAC

EXPERIMENTS: Neutron spectrum was obtained by the Time-of-flight (TOF) method at 12 m beam line at KURRI-LINAC where the capture gamma-rays from ^{10}B and dummy samples were measured. The samples were set at the 135 degree with respect to the incident electron beam and 12.7 m distance from the target. Two BGO scintillators (2 in. diam. $\times$ 2 in. length) were used for measuring capture gamma-rays and arranged at 80 mm from the samples. The effective area of the detectors was covered by lead (50mm thick) for reducig background gamma-rays. The operating conditions of the accelerator were as follows: average beam current was 16.3 μA, frequency was 50 Hz and pulse width was 100 ns. The polyethylene was used as a moderator and its size was 15 cm square and 5 cm thick which was designed to increase the epi-thermal neutron flux. The collimator in the beam line was arranged in tapered shape using several polyethylene tubes containing boron which have 5, 10 and 15 cm hole, respectively. The size of outlet side of the neutron beam is 5 cm in diameter.

RESULTS: The measured TOF spectrum using ^{10}B and dummy samples is shown in **Fig. 2**. The horizontal axis is neutron energy and the vertical axis is neutron flux per unit of time, unit of area and unit of average beam current. The values over 10 eV are distorted by the gamma flash effect from the neutron source. It was found that the gamma shield to reduce the effect is important for the measurement of epi-thermal neutrons. From the results under 10 eV region, the neutron flux was 1.9×10^2 [n/cm^2/s] per 1 μA in average beam current. Note that the value of the neutron flux is slightly overestimated because the detection efficiency for 662 keV gamma-rays from ^{137}Cs standard source was used instead of that for 448 keV from ^{10}B capture gamma-rays. In the case of the maximum power of KURRI-LINAC which is 6 kW, it was found the maximum neutron flux can be obtained 3.8×10^4 [n/cm^2/s] at 12 m beam line with the present neutron source system.

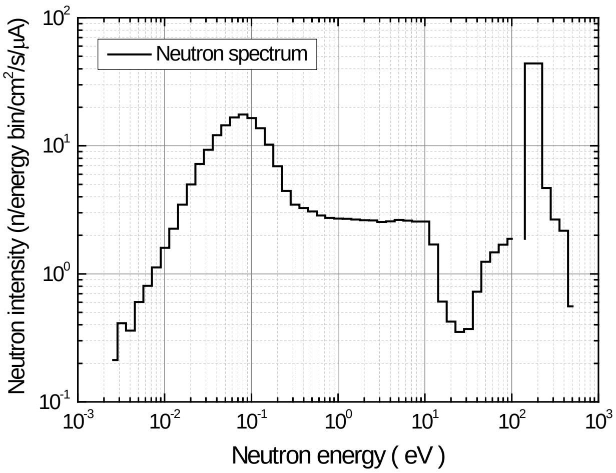

Fig.2 The result of TOF spectrum

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