Experimental test of a liquid-moderator-based neutron spectrometer for low energy neutrons

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Recently, accelerator-based neutron sources (ABNS) are being developed for BNCT instead of nuclear reactors. Generally, the neutron energy spectrum in the irradiation field formed by an ABNS is strongly dependent on the design of the ABNS. Since the dose is highly depending on the neutron energy spectrum, it is very important to measure the neutron spectrum in the treatment room to determine the patient dose correctly. To solve this issue, we developed a new neutron spectrometer for a wide dynamic energy range, from thermal to fast neutron energy regions, especially including epithermal neutron mainly used in BNCT. In the past study, we confirmed the capability of this spectrometer for mono-energetic and fast neutron fields. In this study, we have tested the performance of this device to measure a continuous neutron spectrum having thermal and epithermal neutrons.

In this study, two kinds of continuous energy neutron field were used for irradiation to verify the capability for thermal and epithermal neutron fields, and experiments were carried out at OKTAVIAN facility in Osaka University. The first one is a neutron field designed using a ^{241}Am-Be neutron source and neutron moderator, which consists of lead and polyethylene to form a thermal neutron field. The other consists of the above thermal neutron field covered with a cadmium sheet to shield thermal neutrons, in order to form an epi-thermal field. Measured neutron spectrum for each neutron field was compared with the calculated neutron spectrum by MCNP-5, and the capability of this spectrometer was verified from these results.

As a result, the measured neutron spectra in the thermal neutron field fairly agreed with the calculated neutron spectra. In the epithermal field, measured results roughly agreed, however, a little bit overestimated above 1 keV. The measured results in the fast region were generally larger than the calculated values by the factor of 2 – 5. The overestimations above 1 keV would be caused by the buildup owing to penetrating neutrons passing through the neutron collimator and neutron shield.

In conclusion, we confirmed the capability of liquid-moderator-based neutron spectrometer to measure the continuous energy neutron spectrum in thermal and epithermal region. In future, we will explore the possibility to measure the angle and energy differential neutron spectrum using OKTAVIAN. We also plan to confirm the capability to measure the neutron spectrum of real BNCT irradiation field.