§4. Proposal for a Portable Directional Neutron Source Finder

Yamanishi, H.

Instruments that can specify the direction of a neutron source have been developed in various fields such as nuclear science, nuclear fusion, and space science. Such instruments can be applied to pointing out the location of neutron sources mingled in scrap metal, as an example. A portable directional neutron source finder based on a new principle is proposed in this study. The instrument is a very simple device that combines a polyethylene block (PE) and Li-6-enriched lithium glass scintillator (GS).

The instrument's configuration is shown in Fig. 1. Four sheets of GS having a thickness of 1 mm and being 10 cm square were arranged in a square around the PE cube. The directional response of the GS was calculated using the Monte Carlo calculation code MCNP, and its possible use as a directional neutron source finder was discussed. A neutron point source that releases monochrome energy neutrons was located 1 m distant from the center of the instrument and moved on the x-z plane. The incident energies were chosen to be from 10^{-8} to 1 MeV. The reaction rate of $^{6}Li\ (n, \alpha)\ ^{3}H$ was considered to be the response of the GS.

Figure 2 shows the variation in the response difference, in which the response of GS-L is subtracted from that of GS-R in regard to several neutron injection energies. The response difference decreases monotonically from 90 degrees to 0 degrees at any energy. The response difference decreases sharply from 20 degrees to 5 degrees at every energy level from 10^{-8} MeV to 10^{-1} MeV. The direction of the neutron source emitting low-energy neutrons is easily specified because the change in the response for low energy is large. At 1 MeV, the response differences are small as shown in Fig. 1, but they are still dependent on the angle of incidence. The configuration of the PE cube should be modified for application to fast neutrons.

The energy dependence is small at $\theta=0$, as it had a characteristic of a flux counter. Although the responses to monochrome neutrons were calculated in this study, this instrument can be applied to neutron sources having continuous energy. The response difference decreases monotonically to $\theta=0$ at any energy as shown in Fig. 2. If the energy spectrum of a neutron source does not change in terms of time, the response difference decreases monotonically, bringing the angle close to $\theta=0$. Therefore, the direction of the central axis of the instrument in which the response difference of the four GSs reaches a minimum indicates the direction of the neutron source.

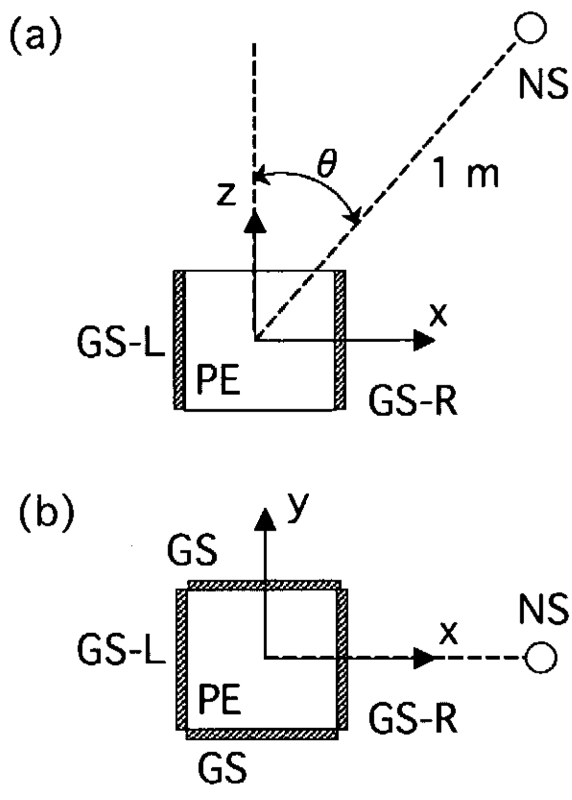

Fig. 1 Configuration of the instrument and calculation model
(a) Cross section of x-z plane
(b) Cross section of x-y plane
PE, polyethylene cube 10 cm per side;
GS, GS-R, GS-L,
lithium glass scintillator 10 cm × 10 cm × 1 mm;
NS, neutron source;
θ, angle of incidence

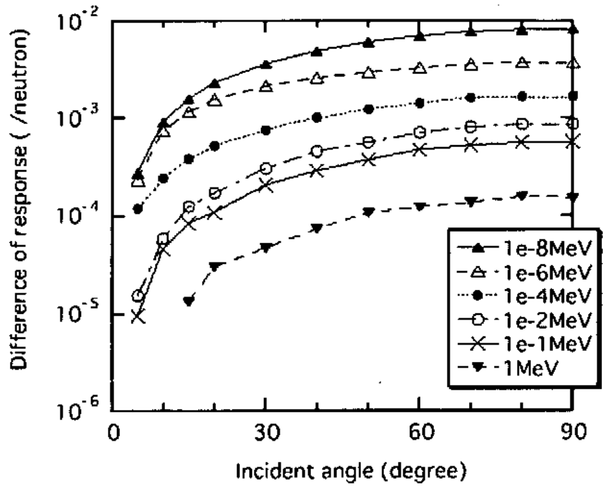

Fig. 2 Calculated count difference between GS-R and GS-L in regard to angle of incidence for several neutron energies.