Short Note

Simple and Quick Measurement of Neutron Flux Distribution by Using an Optical Fiber with Scintillator


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A very simple and quick measurement of thermal neutron flux distribution was demonstrated in Kyoto University Critical Assembly (KUCA) in the measurement time of only 10 min with position resolution of about 1 mm by using a plastic fiber whose end was painted with scintillator.

It is important to obtain the accurate information on neutron flux distribution in critical assembly or research reactor in the fields of reactor physics and some neutron applicational researches. Such informations are desired to obtain as quickly as possible in experimental work or preferably with real time measurement. Presently the distribution measurement is usually done with gold wire activation method(1), which generally takes several hours for irradiation, cooling, cutting the wire into pieces and radiation measurement. Fission chambers(2), aeroball systems(3) etc. are also used, although their position resolutions are poor.

The authors tried to utilize an optical plastic fiber with 2 mm diameter and 2 m length whose end was painted with a mixture of ZnS(Ag) scintillator, LiF and adhesive paste in an weight ratio of about 1:1:2 having a thickness of about 0.3 mm and the other end was viewed with a small photomultiplier.

Figure 1 shows the configuration of the critical assembly with narrow measuring holes A and B. The fiber was inserted into the holes and moved with a speed of 2.5 mm/s by a stepping motor and the output count was recorded in a multi-scaler.

Figure 2 (a) shows neutron flux distributions obtained with the fiber method in 10 min measurement and with a conventional gold wire activation method in about 5 h in the hole A which was situated in the polythene moderator with the nearest distance of 2.5 cm from the fuel-polythene boundary. The flux distributions were normalized at around d = 30~50 cm where neutrons were almost thermalized. Comparing the both curves, we can find a small difference that the relative in-
tensity at the center obtained by gold wire method is slightly larger than that by fiber method, which was probably caused by the resonance absorption in gold for 4.9 eV neutrons existing abundantly due to the less moderation of fast neutrons from the fuel. In the hole B situated at the boundary between the fuel and the moderator as shown in Fig. 2(b), the distributions show less intensity at the center compared with those in Fig. 2(a), which means far less moderation of fast neutrons near the fuel.

The proposed method can be applied for the measurement of fast neutrons by the replacement of LiF with threshold materials such as $^{238}$U or simply by the measurement of recoil protons under the elimination of LiF. It will be able to reduce the diameter of the fiber down to 1 mm and also the measurement time to 2 or 3 min.

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REFERENCES