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Radionuclide identification method using high sum ratio of a PVT detector spectrum

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1. Introduction

A polyvinyl toluene (PVT) plastic scintillation detector has been widely used for radiation portal monitors (RPMs) because of low cost and large volume size [1]. Although a PVT scintillation detector is very efficient to detect gamma-ray, it is difficult to identify man-made radionuclides using a PVT scintillation detector because of limited spectral capability. To overcome this difficulty of a PVT scintillation detector, several methods that can distinguish man-made radionuclides have been studied [2-7]. However, it might be difficult to use these methods when a radiation intensity is slightly higher than a background level. We have developed new radionuclide identification method that can be used even in very week radiation level. In this paper, radionuclide identification method using high sum ratio of a PVT detector spectrum and experimental results using various radiation sources are presented.

2. Methods and Results

In this section, it is described how the high sum ratio was obtained from a PVT detector spectrum, and some results using the developed method are shown and discussed. Fig. 1 shows the PVT detector spectra with various radiation sources including without sources, i.e. background radiation. The radiation intensity level was about 20% higher than the background level. The radiation intensity was controlled by the distance between the sources and the detector.

The size of the detector was 5cm (thick) x 30cm (wide) x 40cm (long), and the detector was shielded with lead of 1 cm thickness except detection window in order to reduce background level.

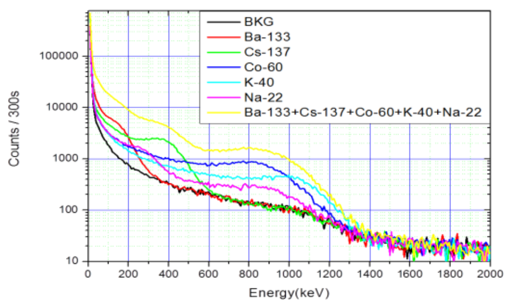

Fig. 1. The measured spectrum using a PVT detector

The high energy sum from the measured spectrum can be expressed by the following equation.

$$S_H(n_R) = \sum_{n=n_R+1}^{n_{max}} C(n) \qquad (1)$$

where, S_H is high energy sum, n_R is reference energy, n is the number of energy bin, C(n) is count intensity of n^{th} bin in the energy spectrum. The graph of the high energy sum from the measured spectrum is shown in Fig. 2. It is confirmed that the high energy sum graph with radiation source is higher than the background one and meets the high energy sum graph of background at certain energy point. This energy point is different in accordance with various radiation source materials. We can identify radionuclide using this energy point from the high energy sum graph.

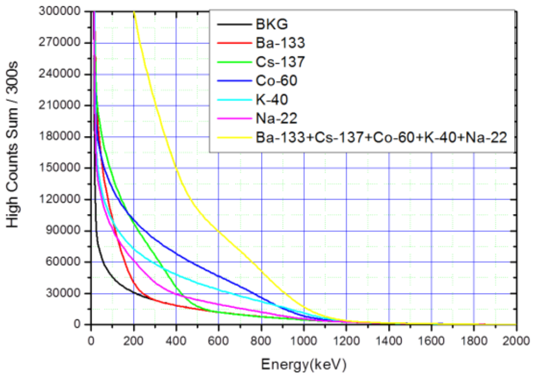

Fig. 2. The graph of high energy sum from the measured spectrum.

The high sum ratio is obtained when the high energy sum from the measured spectrum with radiation source is divided in the high energy sum from the background spectrum. The graph of the high sum ratio from the measured spectrum is shown in Fig. 3. Although we can identify radionuclide using the energy point from the high energy sum graph, it is confirmed that the high sum ratio graph is more suitable for identification of radionuclide.

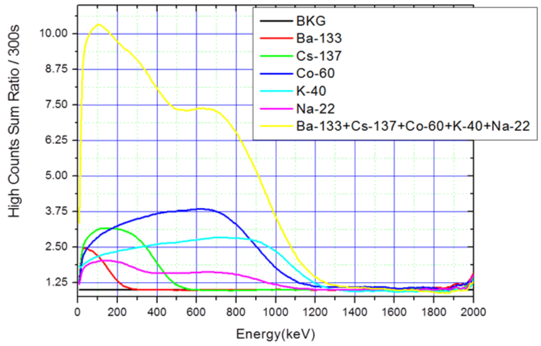

Fig. 3. The graph of high sum ratio from the measured spectrum

A Cs-137 source is taken as the case study to analyze the proposed method. The spectrum data was measured while varying the counting intensity. The counting intensity was changed from a minimum of 127cps to a maximum of 152cps by adjusting the distance between the detector and the radiation source. The measurement time was 300 seconds. When source intensity is slightly higher than background one, it is possible to distinguish a Cs-137 source as shown Fig. 4.

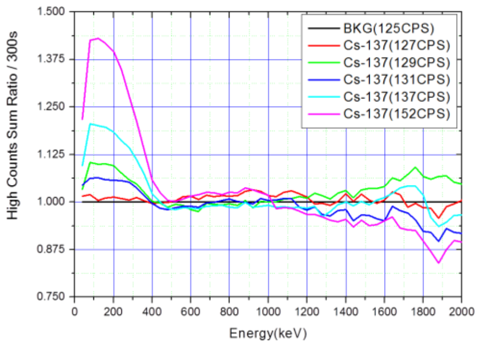

Fig. 4. The graph of high sum ratio from the measured spectrum in accordance with a Cs-137 source intensity

3. Conclusions

We have developed new method for identification of radionuclide using a PVT plastic scintillation detector, and this high sum ratio method has been applied to the measured spectrum from a PVT plastic scintillation detector. We have confirmed that the high sum ratio method is suitable for identification of radionuclide. This method is advantageous in that some radiation source with quite small intensity can be detectable. Therefore, it can be adapted for use in the radiation measurement of various applications, such cargo, radioactive waste, and food inspections.

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