§8. Work Study of Radiation Measurements Using Radiation Sources Fabricated from Chemical Fertilizer

Kawano, T.

Many materials contain naturally occurring radioisotopes such as ^{40}K, ^{232}Th, and ^{238}U and are often used to demonstrate natural radiation and radioisotopes existing around us. One of those materials is chemical fertilizer containing potassium sulfate, which contains naturally occurring potassium-40 radioisotopes. In the present study, such chemical fertilizers were used to fabricate radiation sources for educational use.

Thus fabricated radiation sources were not legal radioisotopes and not governed by radiation laws because they were simply pressed and formed from usual chemical fertilizers. Consequently, chemical fertilizer radiation sources can be used anywhere although legal radiation sources must be handled at radiation facilities in accordance with radiation laws.

The fabricated radiation sources were applied to experience-based radiation education courses held in the home for the first time. In the course, four radiation measurements were conducted. One measurement was performed to evaluate background radiation and the other three were performed to assess the dependence of radiation counts on time, distance, and shielding thickness. The courses were held three times, and three married couples participated. Students took this study were general public who were women in their 20s and 50s, and men in their 30s, 40s and 60s in work study of radiation measurement. As a result, it was determined that the experience-based radiation education course using the radiation sources fabricated from chemical fertilizer could be safely and easily practiced, and the chemical fertilizer radiation sources were very useful not only for finding out about the existence of natural radiation and radioisotopes but also for understanding the characteristics of radiation, the intensity of which depends on time, distance, and shielding (radiation protection principles).

Three married couples (six participants) took this education. The typical results they obtained are plotted in Fig. 1, where the horizontal and vertical axes are respectively the distances and 1-min integrated net counts. Six signs are used to represent data measured by the six participants and vary depending on the participant. The extent of scattering was about 15% or less in the relative standard deviation for distances shorter than 3 cm. This increased for longer distances. On the whole, the initial steep decrease in the 1-min integrated net counts was drastic as the distance from the source ranged closer. This steep decrease was followed by a slow decrease as the distance increased.

Three curves are also drawn in Fig. 1. The solid curve represents an inverse square function $Y = A/(a+X)^2$ (A = 3000, a = 3) for reference. Here, X and Y correspond to the

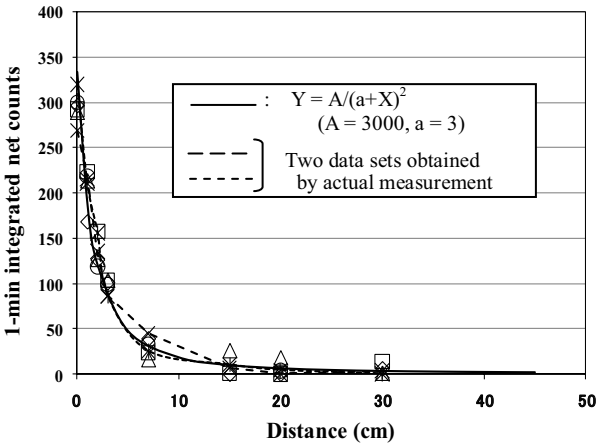

Fig. 1 Dependence of radiation count rates on distance.

distance and the 1-min integrated net counts. The physical meaning of constant *"a"* is the effective depth from the detector surface to the point where radiation is detected. The 1-min integrated net counts obtained by the six participants are around the curve of the inverse square function. Two dashed curves are drawn by connecting and smoothing data obtained by two random participants, respectively. The two curves show that participants could draw curves similar to the solid curve by connecting their own data although their data were scattered somewhat depending on the participant. Consequently, individual participants could understand that the intensity of radiation decreased according to the inverse-square law on the basis of their own obtained data. Similarly, they could understand the other two characteristics of radiation (the linearity between radiation count and elapsed time and the exponential relationship between the effectiveness of radiation shielding and its thickness) on the basis of their own measured data.

It was concluded that chemical fertilizer radiation sources are convenient educational tools for the teaching of radiation. By using chemical fertilizer radiation sources, radiation education in the home could be conducted without needing to worry about radiation related laws, and this experience-based radiation education will be conducted at all common places not only in the home but also in school classrooms, houses with children, and community halls where legal radiation sources cannot be handled.