§13. Practical Research on Radiation Education (2)

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Introduction

Operation of the International Thermonuclear Experimental Reactor (ITER) has paved the way for the development of prototype reactors and subsequent commercial reactors. However, problems with fusion reactors are the handling of tritium and the disposal of containment vessel walls that have been activated by neutrons. Since the Fukushima Daiichi Nuclear Power Plant accident, the handling of radioactive materials has come under close scrutiny. Greater efforts to address concerns are needed in order to make additional nuclear fusion reactors a reality. This study is related to that issue. This study developed instructional materials to enhance radiation education in schools and it used those materials to educate students, as reported here.

Development of instructional materials

The devised instructional materials were as follows.

A. Fig. 1 shows instructional materials for elementary and middle school students. The materials teach students about Penetration, which is one of the properties of radiation. The materials also teach about Shielding, which is one of the three principles of protection from radiation exposure. A radiation source (a lantern mantle) is affixed in a suitable place within a cardboard box, and students use a GM survey meter or an environmental radiation monitor (Radi from Horiba) to identify where the radiation source is located. In an experiment regarding Shielding, students place shielding materials such as a sheet of acrylic, aluminum, or lead in front of the location they previously identified and they use the Radi monitor to measure changes in the dose rate.

B. A radiation source was fabricated for an experiment regarding the three principles of protection from radiation exposure. The experiment is intended for high school and college students. Lantern mantles are packed into a clear polystyrene box (50*50*26 mm, M-1 model from Mizuhokasei Co., Ltd.) that is then tightly sealed. In an experiment regarding Distance, the radiation source is placed on graph paper and the Radi monitor is placed close to the radiation source. The dose rate at a distance of 0 mm is measured and then the dose rate is measured at varying distances (10 mm-200 mm). Naturally, students will determine the background dose rate before starting the experiment. Fig. 2 shows the results.

In an experiment regarding Shielding, the Radi monitor was placed 20 mm away from the radiation source as shown in Fig. 3. Shielding material with a thickness of 2 mm was placed between the radiation source and the Radi monitor, where it was held in place with clips. The dose rate was then measured. The dose rate was measured as sheets of the shielding material were added to a thickness of 10 mm. Fig. 4 shows the results.

Fig. 1 Scanning of the location on the radiation source.

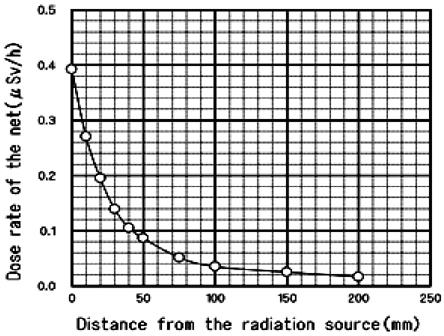

Fig. 2 Dependence of the dose rate on distance from the radiation source.

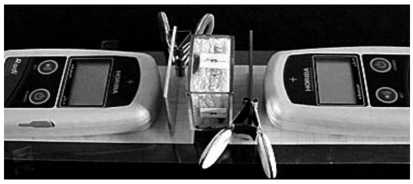

Fig. 3. Experiment of shielding.

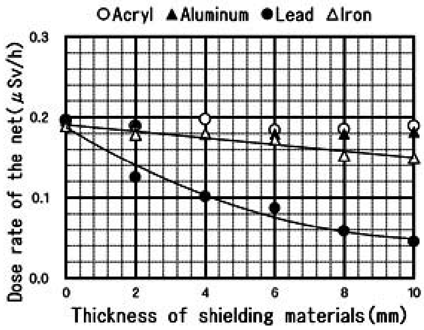

Fig. 4 Dependence of the dose rate on shielding thickness.

Note: Lantern mantles containing thorium are not currently manufactured. Teachers may need to look for stocks of these lantern mantles.

Radiation education provided in 2014

(1) Science Week, science and mathematics course, Kinkowan Senior High School (a designated “super science high school”)

(2) Course for Teaching Certificate Renewal, The World of Radiation: Fundamentals and Practice, elementary and middle school science and technology teachers

(3) The World of Radiation, Kagoshima University Common Education.