The Radiation Levels for Household Goods Made in Korea

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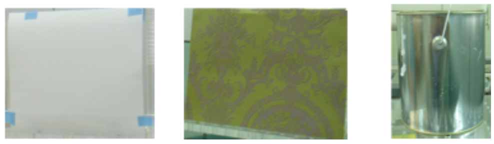
1. Introduction

The environmental radiation based on a natural and artificial radiation always exists in the environment. The natural radiation includes cosmic ray coming into the atmosphere from outer space, radiation emitted from the earth's crust or soil, radiation by the radon in the air and its progenies.[1] These natural radiation comes from various buildings like a house and an apartment, agricultural and stockbreeding products like rice and milk, and a body, etc.[1, 2] The artificial radiation emanates from a nuclear power plant, a radioisotope facility, a radioactive waste disposal site, a medical or research facility treating a radioactive material, a radiation generation device for an industry, TV, a microwave oven, appliances like a fluorescent clock, an airport security table, etc. Among the various kinds of radioactive nuclides that existed in the earth's crust at the time of the earth's formation about 4,000 million years ago, all the short half life nuclides decayed and the long half life nuclides remain amid the nuclides of a half life with more than 100 million years and their progenies now. In fact, the natural radiation level is determined by the nuclides of the Thorium series which have K-40 (half life 1.25 billion years), Th-232 (half life 14.5 billion years) as a parent nuclide, the nuclides of the uranium series which have U-238 (half life 4.5 billon years) as a parent nuclide, and the cosmic ray like photon and muon. These nuclides are distributed in the soil, sea water, construction material and body with different concentrations. Different radiation dose rates are presented in different regions due to the different concentrations of the radioactive minerals included at the materials. Actually, Brazil and India reveal a relatively high natural radiation level.[3, 4] In Korea, the radiation dose rate is normally between 0.05 uSv/hr and 0.3 uSv/h and rises to about 0.05 uSv/hr ~ 0.06 uSv/h due to a washout effect by rainfall. Especially, some regions show a radiation level of 0.57 uSv/h at a maximum. This experiment represents the measurements and estimations of the radiation level on daily commodities or goods, which are easily met in the living environment.

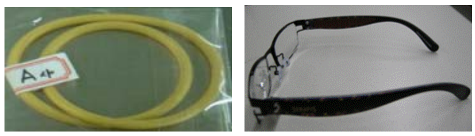
2. Methods and Results

One hundred sample items for a measurement were chosen out of the goods and materials which are used in a living space. First of all, a health band, a massage pack, and a natural clay bath were selected as a health assistant instrument. For the mat samples, the radiation dose rates for thirty nine kinds of samples such as a warming instrument, a stimulating instrument, a cauterizing instrument, a stone bed, a warm pad, a functional matrix, which are generally used in Korea, were measured before and after a heating where the temperature was increased to 60 degree in centigrade at a maximum. Also, thirty two kinds of construction materials like a functional floor material, paint, a closing material, a wall paper, a floor paper were measured. Ornaments like a necklace, an armlet, violet quartz, a sapphire, and glasses were measured. The office supplies covered a sheet of anion paper, packing paper, and tape. Clothing like nanoceramic T-shirt, film, glass, a TV monitor, shoes and charcoal were also measured. Fig. 1 displays the appearance of some samples.

(a) A health assistant instrument and a mat



(b) a wallpaper, a floor material and a paint



(c) An armlet and glasses

(d) A T-shirt, TV monitor and shoes

Fig. 1. The various kinds of the samples measured

The NaI scintillation gamma scanner was employed so that the effective dose rates could be displayed right after a measurement. The radiation dose rate was measured at the surface of the samples and at the distance of 0.1 m, 0.5 m, 1.0m from the surface where the measurement uncertainty was calculated by using k=2 corresponding to a confidence level of 95%. The background radiation level corresponded to the that of the laboratory room where the samples were measured and the values were between 0.12 uSv/h and 0.14 uSv/h. Table 1 shows the radiation dose rates for various kinds of the measured samples where a similar kind of the samples were classified as 11 groups. First of all, their range was between 0.095 uSv/h ～ 0.162 uSv/h where the film samples had a minimum value and the construction samples had a maximum value.

Table 1. The measurement results for the household goods made in Korea
(uSv/h)

Items	The radiation dose rate	Background
Health instruments	0.157 ± 0.0118	0.119±0.0639
Mats	0.153 ± 0.0185	0.127±0.0743
TV monitors	0.141 ± 0.0155	0.133±0.0244
Bottles	0.118 ± 0.0133	0.104±0.0244
Office supplies	0.130 ± 0.0137	0.130±0.0051
Construction materials	0.162 ± 0.0171	0.115±0.0474
Charcoals	0.130 ± 0.0111	0.131±0.0311
Ornaments or Accessories	0.134 ± 0.0153	0.116±0.0631
Glass	0.158 ± 0.0122	0.173±0.0244
Clothing	0.130 ± 0.0144	0.129±0.0222
Film	0.095 ± 0.0100	0.090±0.0200

In Fig. 2, the radiation dose rates for the measured samples were presented and they were understood not to be out of the ranges of the background levels. But, the construction material sample revealed a relatively high radiation dose rate. It was thought that it was because the construction material actually had most of the earth's crust or soil properties including radioactive minerals most. Taking into account the variation of the environmental radiation of the Korea, it was established that the radiation levels of all the samples were within the range of the natural radiation level.

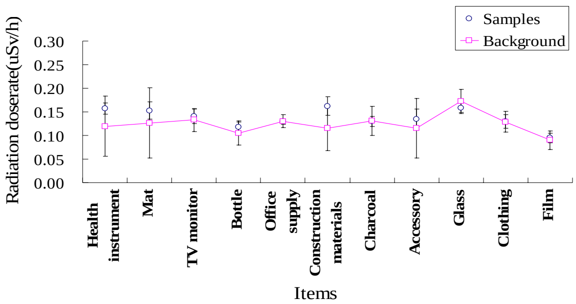


Fig. 2. The distribution of the radiation dose rate on the household goods made in Korea

In fact, for the estimation on the two averages with a finite number of samples, a statistical T-test was employed to determine whether there was a noticeable difference between the two groups, the average of the samples and background.[5] First of all, the distribution of the population groups for the two groups was assumed to be a normal distribution although the possibility of an asymmetry could be contained in the samples themselves. Two-tail test was accomplished to assess if the averages of the two population groups would be the same or not by using Equation (1) in the case of the same population variance and Equation (2) in the case of a different population variance.

$$T = \frac{x_1 - x_2}{s\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \qquad s^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{(n_1 - 1) + (n_2 - 1)}, \qquad (1)$$

$$T = \frac{x_1 - x_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \qquad (2)$$

where x_1, s_1, and n_1 denote the average, standard deviation and the number of samples for the research reactor site, and x_2, s_2 and n_2 for the comparison points, respectively. A significance level of 0.05, which corresponds to a confidence level of 95 %, was taken and the P-value from the T-test was compared with it. In the present analysis, the P-value was 0.158 where the value is about 3 times as high as 0.05, the present significance level. Therefore, the averages for the samples and background were not thought to have particular differences at least at a 95 % confidence level.

3. Conclusions

The radiation levels of the household goods made in Korea were similar to those of their background although the construction material sample revealed a relatively high radiation dose rate. A comparative estimation was carried out for the radiation level of the samples of the goods or commodities around a living environment and their background level. The present analyses showed that the P-value was much higher than the significance level at a 95 % confidence level. It was not thought that the radiation level of the household goods made in Korea was out of the range of their background level.

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