The misconceptions on radiation and radioactivity

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Abstract

On 11 March 2011, the great earthquake has occurred in the East Japan and the tsunami attacked the Fukushima nuclear plant. All of Japanese citizens were exposed by much information of radiation and radioactivity with fear and disorders. They have not learned about radiation and radioactivity so well in school. Many misunderstandings or misconceptions were found in not only common citizens even the news media.

Keywords: Misconception, radiation, radioactivity, cloud chamber.

Resumen

El 11 de marzo de 2011, el gran terremoto ocurrido en Japón oriental y el tsunami atacó la planta nuclear de Fukushima. Todos los ciudadanos japoneses fueron expuestos a mucha cantidad de información sobre el miedo y trastornos de la radiación y la radiactividad. No han aprendido acerca de la radiación y la radioactividad tan bien en la escuela. Muchos malentendidos o ideas erróneas fueron encontrados no sólo en los ciudadanos comunes, sino incluso los medios de comunicación.

Palabras clave: Conceptos erróneos, radiación, radiactividad, cámara de niebla.

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I. INTRODUCTION

National curriculum is renewed by every decade in Japan. A small part of high school students study about radiation and radioactivity in the present curriculum of advanced physics. However, all of junior high school students become to learn about radiation in next curriculum from 2012. The majority of science teachers do not have experience to teach radiation.

Even on the critical case, it is the most they can tell enumeration of secondhand knowledge. It is importance to develop how teach radiation. It must be based on the general misunderstandings and misconceptions.

II. GENERAL MISUNDERSTANDINGS

Some misunderstandings have been found in students and people genarally. The typical one is fundamental. The Japanese word, "*Hosha-no*" means radioactivity, but many people believe that substance called "*Hosha-no*" is exist concretely. They cannot distinguish the "*Hosha-no*" from "*Hosha-sen*". "*Hosha-sen*" means radiation and especially "*Sen*" means a ray.

Japanese have usually nature worship in comparison with occidental. They often consider nature to be goodness and artifice to be wickedness. Students do not know natural radiation previously. As they study natural radiation and find the facts that radiation dose rate is lower on the grass than in a building, they misunderstand that nature is safe from radiation.

Even after studying about radioactivity, the students often get strange idea. You can see their misinterpretation about the half-life of radio-isotope for example. Radioactive substance become to 1/2, 1/4, 1/8…by each the own half-life. Many students think that the radioactive substance will never vanish like the Zeno's paradoxes.

III. MISRERDINGS ON THE MEDIA

Immediately after the accident, strange explanations have appeared one after another on Japanese public media. The one of them is confusion of dose rate with dose itself.

One of commentator in NHK (Japanese Broadcasting Corporation) have told 23μSv/h was safety measured at one city because the number of 23 was less than half of 50μSv, one time dose of X-ray inspection. He told it was danger to be exposed to radiation of dose rate over 100mSv/h for a moment. Newspaper articles proofread are better than the live broadcast. But the Websites are treasure houses of misunderstandings and false rumors.

As the United States government recommended evacuating from the area for American citizens who live within 50miles (80km) of the Fukushima Nuclear Power Plant, some people guessed that the number of 80km had a serious meaning. Typical rumor that plutonium would lead nuclear explosion was spread over the internet or the twitter.

About the half-life there is another misconception that the radio isotope with long half-life is more dangerous. In fact if the radio isotope with long half-life has same activity, it will be dangerous. But it just means that the amount of the radio isotope is much. You may attract that radioactivity is in inverse proportion to half-life. When the radioactive I-131 with 8days half-life was found at the water supply in Tokyo, one of celebrities who is the CEO of a telecommunications services has commentate that the government concealed the fact about I-129 with 15million years half-life. He declared that I-129 was terrible. But if the same amount of I-129 as 131was in water, I-129 would decay less than one time in the month.

TABLE I. Preliminary calculation of FP released to the environment in the early stage of Fukushima Dai-ichi accident (Bq) [1].

Nuclide	Half-life		Unit 1	Unit 2	Unit 3	Total
Xe-133	5.2	d	3.4×10^{18}	3.5×10^{18}	4.4×10^{18}	1.1×10^{19}
Cs-134	2.1	y	7.1×10^{14}	1.6×10^{16}	8.2×10^{14}	1.8×10^{16}
Cs-137	30	y	5.9×10^{14}	1.4×10^{16}	7.1×10^{14}	1.5×10^{16}
Sr-89	50.5	d	8.2×10^{13}	6.8×10^{14}	1.2×10^{15}	2.0×10^{15}
Sr-90	29.1	y	6.1×10^{12}	4.8×10^{13}	8.5×10^{13}	1.4×10^{14}
Ba-140	12.7	d	1.3×10^{14}	1.1×10^{15}	1.9×10^{15}	3.2×10^{15}
Te-127m	109	d	2.5×10^{14}	7.7×10^{14}	6.9×10^{13}	1.1×10^{15}
Te-129m	33.6	d	7.2×10^{14}	2.4×10^{15}	2.1×10^{14}	3.3×10^{15}
Te-131m	30	h	9.5×10^{13}	5.4×10^{10}	1.8×10^{12}	9.7×10^{13}
Te-132	78.2	h	7.4×10^{14}	4.2×10^{11}	1.4×10^{13}	7.6×10^{14}
Ru-103	39.3	d	2.5×10^{09}	1.8×10^{09}	3.2×10^{09}	7.5×10^{09}
Ru-106	368.2	d	7.4×10^{08}	5.1×10^{08}	8.9×10^{08}	2.1×10^{09}
Zr-95	64	d	4.6×10^{11}	1.6×10^{13}	2.2×10^{11}	1.7×10^{13}
Ce-141	32.5	d	4.6×10^{11}	1.7×10^{13}	2.2×10^{11}	1.8×10^{13}
Ce-144	284.3	d	3.1×10^{11}	1.1×10^{13}	1.4×10^{11}	1.1×10^{13}
Np-239	2.4	d	3.7×10^{12}	7.1×10^{13}	1.4×10^{12}	7.6×10^{13}
Pu-238	87.7	y	5.8×10^{08}	1.8×10^{10}	2.5×10^{08}	1.9×10^{10}
Pu-239	24065	y	8.6×10^{07}	3.1×10^{09}	4.0×10^{07}	3.2×10^{09}
Pu-240	6537	y	8.8×10^{07}	3.0×10^{09}	4.0×10^{07}	3.2×10^{09}
Pu-241	14.4	y	3.5×10^{10}	1.2×10^{12}	1.6×10^{10}	1.2×10^{12}
Y-91	58.5	d	3.1×10^{11}	2.7×10^{12}	4.4×10^{11}	3.4×10^{12}
Pr-143	13.6	d	3.6×10^{11}	3.2×10^{12}	5.2×10^{11}	4.1×10^{12}
Nd-147	11	d	1.5×10^{11}	1.3×10^{12}	2.2×10^{11}	1.6×10^{12}
Cm-242	162.8	d	1.1×10^{10}	7.7×10^{10}	1.4×10^{10}	1.0×10^{11}
I-131	8	d	1.2×10^{16}	1.4×10^{17}	7.0×10^{15}	1.6×10^{17}
I-132	2.3	h	4.5×10^{14}	9.6×10^{11}	1.8×10^{13}	4.7×10^{14}
I-133	20.8	h	6.5×10^{14}	1.4×10^{12}	2.6×10^{13}	6.8×10^{14}
I-135	6.6	h	6.1×10^{14}	1.3×10^{12}	2.4×10^{13}	6.3×10^{14}
Sb-127	3.9	d	1.7×10^{15}	4.2×10^{15}	4.5×10^{14}	6.4×10^{15}
Sb-129	4.3	h	1.6×10^{14}	8.9×10^{10}	3.0×10^{12}	1.6×10^{14}
Mo-99	66	h	8.1×10^{07}	1.0×10^{04}	6.7×10^{06}	8.8×10^{07}

About the belief of plutonium is a legend rather than misunderstanding. Pu-239 is alpha nuclide with 24thousand years half-life. It is made in the reactor by neutron capturing of U-238. And it is well-known for the material of nuclear fuel and bomb. As a result, it is feared extremely. It has certainly half-life of one to 10thousands and activity of 10thousand times of U-238. But at present, more volume of radio isotope with short half life and strong activity is leaking. However, plutonium is dangerous in ordinary times it is strange in the specified case that citizens regard plutonium as risky particularly.

IV. TOWARD COMPREHENSION

It is hard to understand the concept on life of decay for novices. Following equations is described on the textbooks.

$$\frac{dN}{dt} = -\lambda N, N = N_0 e^{-\lambda t} = N_0\left(\frac{1}{2}\right)^{\frac{t}{T}}$$

N: Number of nuclear, λ : Decay constant, *T*: Half-life.

Students want to memorize these equations without actuality. Decay is a probability phenomenon simply. If you watch only one nuclear of C-14 in a second, you may meet its decay in probability 1 in 2.6billion. In an hour, 1 in 72million. If you can continue to watch it for 5,730 years, you may meet its decay in probability 1 in 2. It means the half-life. In the beginning, if you have 2.6billion nuclears, you can observe their decay by each seconds. It means 1 becquerel. It is efective to learn in concrete example for novices.

It is more important to know that radiations are substantial certainly. For the purpose, the cloud chamber is the most suitable. Students may prepare familiar goods: a pyrex vessel, dry ice, ethyl alcohol, black paper, tissues, plastic wrap, towel and a flashlight in a darkroom [2].

FIGURE 1. The tools for the observation to radiation by the cloud chamber.

V. CONCLUSIONS

Most of misunderstandings and misconceptions on radiation and radioactivity come from short of learning in the schools. It is important to teach them with impression. As the cause of fears about radiation is its invisibility, the cloud chamber will be suitable teaching material.

REFERENCES

[1] Report of Japanese Government to the IAEA Ministerial Conference on Nuclear Safety - The Accident at TEPCO's Fukushima Nuclear Power Stations –, June (2011).
[2] Hyodo, T., *The Contents of Physics Experiments for High School Students,* (Gakujutsu Tosho Shuppan-sha Co. Ltd, 2007, ISBN978-4-7806-0071-1).