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■論 文■

Cs-137 distribution around Kori Nuclear Power Plant

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Abstract - To ensure the safety of the currently operating nuclear power plant, the Periodic Safety Review program has been conducted. In PSR program, the cumulative behavior of the radionuclide that might be released from the power plant is addressed. The Cs-137 in soil around Kori nuclear power plant was investigated. The soil sample was analyzed and compared with the reference area. The model calculation explained the depth profile of Cs-137.
Key words : Cs-137 in soil, PSR

INTRODUCTION

Since the first Nuclear Power Plant has been in operation in 1978, number of nuclear power plants in Korea has been increased playing an important role of electricity production. Accordingly the public increases the concern of the safety of the nuclear power plants. To ensure of the safety of the operating nuclear power plants, the government revised the related law to include the concept of periodical safety review (PSR). The PSR activities are composed of 11 items, in which the environmental radiation related activities are included. The purposes of PSR related to environmental radiation are to check the monitoring system integrity and alarm setting points. It also includes the assessment of the environmental radiation behavior in terms of its cumulative action.

The release of Cs-137 from the operating nuclear power plants has not been mentioned in the annual reports published by KHNC, KINS, or elsewhere[1,2]. It means the release of Cs-137 from the nuclear power plants has been restricted. However Cs-137 is detected in soil around the area of nuclear power plants, and it is found elsewhere in territory either. It might be due to the global fallout of Cs-137 which is the result of nuclear tests in 60s. This study outlines the Cs-137 concentration behavior around the nuclear power plants. The soil near the nuclear power plants were sampled vertically and analyzed. They are compared with the reference data. The vertical concentration profile was interpreted by the model calculations.

MATERIALS AND METHODS

The sampling sites were determined taking wind direction into account. At Kori site, the major wind direction is from the west. Thus the most air plum is escaping to east side, the east sea. Sometimes wind comes from south, and this is the most likely case that effluents from the nuclear power plants deposit onto the terrestrial surface. Three sampling sites were selected to locate about 1 km north of Kori nuclear power plants.

The experimental device for sampling soil vertically has the diameter and the length 55 mm and 300 mm respectively. The thin layer of 0.1mm thick is inserted into the column before sampling. Then after sampling, the thin

layer containing sample soil is removed from the column. The soil column is cut to small pieces with 50mm height. The Cs-137 activity in the soil pieces is measured by the EG&G MCA system.

RESULTS AND DISCUSSION

The surface soil concentration of Cs-137 ranged 5-20 Bq/kg soil. This is almost in the same range that has been published[1,2]. The published data and measured data were shown in Fig.1. The surface soil concentration of Cs-137 does not show remarkable change with time. The Cs-137 concentrations at the reference site 40km apart from the nuclear power plants show the same range with the onsite concentrations either. These imply Cs-137 has not been built up near Kori nuclear power plants. The measured concentrations in Fig. 1 showed wide variety depending on the samples even though the samples were taken closely each other. The surface soil concentrations of Cs-137 were compared with those in the water samples taken near the sampling sites, shown in Fig. 2. The difference between the surface soil concentration and the concentration in the water showed the order of magnitude 3-4. Providing the equilibrium state of the nuclide between the surface soil and the water, this is the order of sorption, and this is also within the range of published data[3].

The Cs-137 deposited onto the soil surface migrates into the ground. Comparing with Sr-90, Cs-137 is relatively easily fixed with the soil so that the migration is known to be a slow process. The distribution of vertical migration of Cs-137 was summarized in Table 1 and shown in Fig.3. The distribution of Cs-137 decreases monotonically at all sites except Hyoam. At Hyoam there is a maximum concentration in the ground. The similar profile can be found elsewhere[4]. This might be due to rapid Cs-137 migration, or soil erosion.

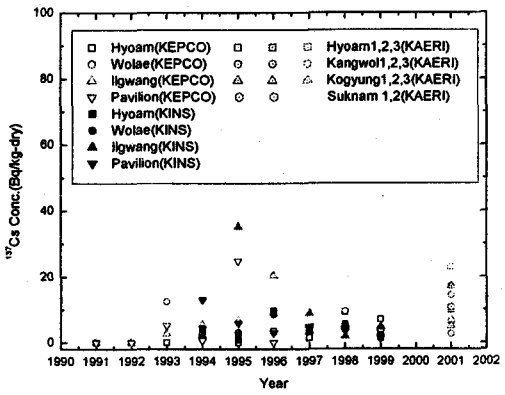

Fig. 1. Cs-137 concentration in soil near Kori nuclear power plants.

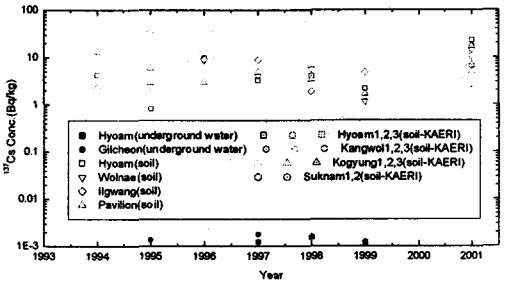

Fig. 2. Cs-137 concentration in soil and groundwater near Kori nuclear power plants.

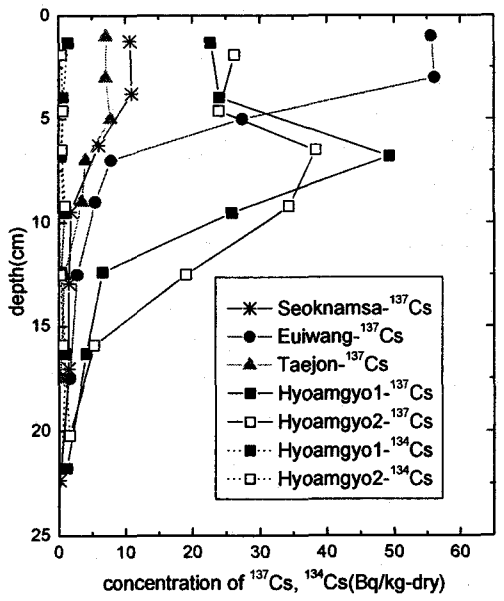

Fig. 3. Vertical distribution of Cs-137 at the site near Kori nuclear power plants

Table 1. The vertical distribution of Cs-137 at the site near Kori nuclear power plants

Hyoam		Kangwol		Kokyongsa		Suknamsa	
Depth(cm)	Cs-137(%)	Depth(cm)	Cs-137(%)	Depth(cm)	Cs-137(%)	Depth(cm)	Cs-137(%)
0 ~ 2.6	22.7	0 2.1	25.7	0 2.1	36.0	0 2.5	32.8
2.6 ~ 5.3	24.0	2.1 4.7	20.8	2.1 4.3	23.8	2.5 5.1	33.4
5.3 ~ 8.4	49.3	4.7 6.9	27.7	4.3 6.3	8.5	5.1 7.5	18.4
8.4 ~ 10.7	25.8	6.9 9.6	13.5	6.3 8.5	5.8	7.5 11.5	5.5
10.7 ~ 14.1	6.5	9.6 11.3	6.0	8.5 11.5	9.5	11.5 14.4	4.6
14.1 ~ 18.6	4.1	11.3 14.6	2.7	11.5 15.2	7.9	14.4 19.7	4.6
18.6 ~ 25	1.2	14.6 - 29	3.6	15.2 - 27	8.4	19.7 - 25	0.6

Table 2. Vertical migration velocity of Cs-137 at the site near Kori nuclear power plants

	Hyoam	Kangwol	Kokyongsa	Suknamsa	Belarus
v (cm/yr)	0.22	0.18	0.19	0.16	0.4 1.2

The migration velocity is defined from the averaged infiltrated depth as follows[5].

$$z_{avg} = 2\sqrt{\frac{Dt}{\pi}} \quad or \quad v = \frac{z_{avg}}{T} = \frac{2}{T}\sqrt{\frac{Dt}{\pi}}$$

where D is the diffusion coefficient, t and T are the elapsed times with the dimensions sec and year respectively. The calculated migration velocity is shown in Table 2, in which the migration velocity of Cs-137 in Belarus is also shown. The migration velocities at the on sites range 0.16 to 0.22, being relatively small comparing with that of Belarus. The soil texture and soil mineral components influence the migration velocity.

ACKNOWLEDGEMENT

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