Environmental Radioactivity Evaluation of Water Samples Around Nuclear Power Plant Near Ulsan

Ki Joon Kang*, Chanki Lee, and Hee Reyoung Kim
Ulsan National Institute of Science and Technology, 50, UNIST-gil, Eonyang-eup, Ulju-gun, Ulsan, Republic of Korea
*roffl1234@unist.ac.kr

1. Introduction

Recently, the public concern about nuclear safety has been elated because of Gyeongju earthquake. In this paper, the radioactivity of tritium, and gross β of samples from sea and river water around nuclear power plant near Ulsan in Korea are measured by using LSC (Liquid Scintillation Counter) and gas proportional counter. The results are analyzed in comparison with radioactivity from the site around other nuclear power plants for the public safety.

2. Material and Methods

2.1 Water Sampling

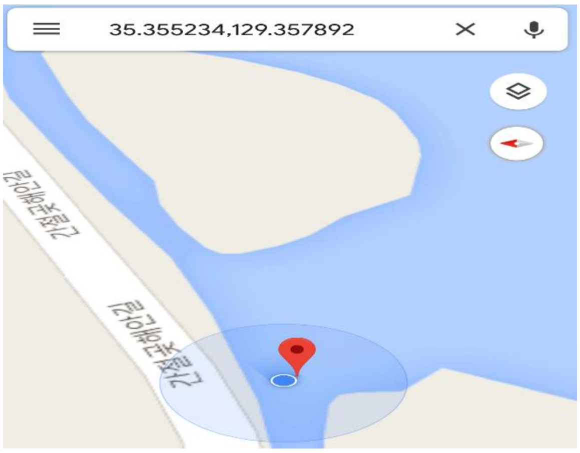

Fig. 1. GPS Data of Sampling Place (Gangeolgot).

Samples are taken in august. Seawater samples are taken from three sites (Gangeolgot, Bangerjin, Columnar Joint) in consideration of the distance from the nuclear power plant. The river water samples are taken from other three sites (Myeongchon bridge, Gaeun bridge, Samho bridge). The consideration of water sampling is TDS (Total Dissolved Solids). TDS is important indicator determine the quantity of gross β pretreatment.

2.2 The Pretreatment

In the case of tritium, samples are pretreated by heat exchange between inner tube and outer tube. By heating samples, water vapor containing HTO molecules is separated from impurities. And water vapor of inner tube is cooled by the cold water (20℃) pass outer tube and liquefied. Liquefied water is captured in vial. Up to be 20 mL of liquefied water, pretreatment process is proceeded. Before pretreated sample is detected by LSC, detection efficiency should be calibrated. Calibration method is referred in "H3 Analysis Guide in Solid Samples", Korea Atomic Energy Research Institute [1]. The cocktails with diverse mixing ratio of tritium standard source and liquid scintillator are detected by LSC. And optimal mixing ratio should be found by calculating quenching efficiency. Quenching efficiency, E_C is calculated by equation (1).

$$E_C = \frac{Net\ count\ rate\ of\ the\ standard\ (cpm)}{Activity\ of\ the\ standard\ (dpm)} \times 100(\%) \qquad (1)$$

Fig. 2. Tritium Pretreatment (Heat Exchange Cooler).

After calibration, pretreated samples are detected in LSC. In the case of and gross β, only river water samples are pretreated. Because there is much natural radionuclide like potassium, so artificial radioactivity detection results can be incorrect. According to TDS value, 10 mL or 250 mL of each river sample are filled in evaporating dish. Preventing burn up, samples of evaporating dish are heated on heating plate during 30~40 minutes. After evaporation of water by heating plate, samples are dried in infrared ray drying machine. And then, dried samples for detection of gross β are measured by using gas proportional counter.

2.3 Radioactivity Analysis

As shown in equation (2), the radioactivity concentration, R is calculated using detection efficiency by calibration, count rate by detector (cpm), the volume of sample, V and detection time, t.

$$R\ (Bq/L) = \frac{60 \times Net\ count\ rate\ of\ the\ sample\ (cpm)}{0.01 \times E_C \times V} \quad (2)$$

3. Results and Conclusion

The results by detection are compared to radioactivity survey results from other nuclear power plants. Tritium radioactivity concentration around other nuclear power plant is referred in "Environmental Radiation Monitoring Around the Nuclear Facilities", Korea Institute of Nuclear Safety [3]. In case of tritium, the results are lower than the radioactivity concentration standard of drinking water, 5 Bq/L. These results can be evaluated as safety data. However, detail detection by more sampling and analysis are needed.

Table 1. Tritium Radioactivity Concentration around Nuclear Power Plant, 2016 (Unit: Bq/L)

Power Plant	KINS Survey Result Average (Min-Max)	KHNP Survey Result Average (Min-Max)
Kori	2.05 (0.09-2.43)	1.62 (0.99-24.4)
Wolsung	11.8 (0.28-113)	2.85 (1.08-33.5)
Hanbit	3.79 (0.34-13.1)	6.40 (1.81-60.9)
Hanul	0.412 (0.15-1.09)	1.39 (1.05-2.96)

In case of gross β, the results from river water is similar with the results from Wolsung power plant. The results from Wolsung power plant is referred in "Environmental Radiation Monitoring Around the Nuclear Facilities", Korea Institute of Nuclear Safety [3]. The difference between 'Samho bridge' and other two points is large. And, the results from other two points are also lower than gross β thresholds. Therefore, the results of gross β are evaluated as safe data.

Table 2. Gross β of Water around Wolsung Power Plant (Unit: Bq/L)

Sample	Radioactivity Concentration Average (Min-Max)
1 Drain	11.01 (6.52-14.5)
2 Drain	11.6 (8.23-12.5)
Bonggil	7.58 (5.77-12.9)

Table 3. Gross β Radioactivity Concentration of Water Samples (Unit: Bq/L), August

Water Type	Sampling Place	Gross β
River Water	Samho bridge	0.52
	Gaeun bridge	6.79
	Myeongchon bridge	9.40

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