

§5. Water-extraction Method for Measuring Tritium Concentration of Concrete

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When a tritium-handling laboratory was decommissioned, measures were legally required to close the radiation facilities. To comply with these measures, tritium contamination tests of all articles, fixtures, equipment, and the building structures, including concrete walls and floors, were conducted. Aside from the measures required by law, a water-extraction method, which measure tritium contained in concrete, were evaluated by comparison with a heating-cooling method.

1) Method for measuring tritium

The heating-cooling method is effective for extracting tritium contained in concrete. For this method, a 1-g piece of concrete chipped from the concrete wall or floor was placed into a furnace and heated to 1073 K for an hour under a flow of dry air at a flow rate of 200 ml/min. Upon heating, the tritium in the concrete piece is vaporized into the dry air flow as water vapor. The air flowing out of the furnace is directed into a collection tube cooled by dry ice-ethanol (at 200 K). As a result, the water vapor containing the tritium condenses in the cooled collection tube. This collection procedure yielded about 0.5 ml of water. The water collected was placed into a vial containing 10 ml scintillation cocktail, and the tritium concentration was measured using a liquid scintillation counter. Measurement time was 30 minutes and detection limit was less than 0.1 Bq/g.

For the water-extraction method, a 1-g piece of concrete was placed into 10 ml of water in a tube. Tritium in the concrete was eluted into the water. The tritium reached saturation level within several hours (as shown later), after which the water was filtered through a 0.45- μm film. Then, 2 ml of the filtered water was added to a vial containing 10 ml of scintillation cocktail, followed by measurement with the liquid scintillation counter. Measurement time was 10 min and the detection limit was less than 0.8 Bq/g.

The water-extraction method was evaluated by examining the relation between extraction time and extracted tritium. The extraction time was defined as the period beginning when the water immersion process was initiated. The concentration of tritium extracted into the water should correspond to the level of contamination of the concrete walls and floors.

2) Measurement

Four 1-g pieces of concrete sampled from the same lot block chipped from tritium-contaminated areas of the wall and floor were placed into four tubes (first, second, third and fourth tubes) containing 10 ml water. After extraction times of 1, 3, 8, and 24 hours, the water in the first, second, third, and fourth tubes were filtered through a 0.45- μm film and 2 ml of the filtered water were placed into vials containing 10 ml scintillation cocktail. Then, the tritium extracted into the water was measured using the liquid scintillation counter.

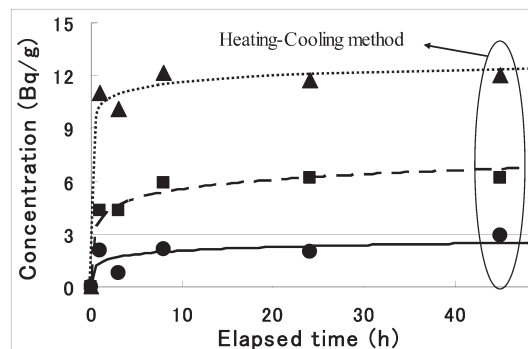


Fig.1. Dependence of extracted tritium on extraction time.

Figure 1 shows the amount of tritium extracted into water plotted as a function of extraction time, with circles, squares, and triangles representing three lot blocks of concrete containing approximately 2, 6, and 12 Bq/g tritium, respectively. As shown in Fig. 1, the extracted tritium in the three lot blocks shows a significant initial increase. This increase leads to saturation, which occurs in less than ten hours and is unrelated to tritium contamination level. In Fig. 1, contamination data from the heating-cooling method are also plotted in the encircled area at the right side of the graph. The saturation data are similar to those obtained with the heating-cooling method, indicating that with sufficient extraction time (>10 hours), the water extraction method is comparable with the heating-cooling method for concrete walls and floors at a tritium-handling laboratory.

Table I compares the data measured with the water-extraction method at 24 hours with those by the heating-cooling method. Data obtained by both methods for

Table I Numerical comparison between data measured with the water extraction and heating-cooling methods

	Water-extraction method	Heating-cooling method
12 Bg sample	11.74 ± 0.57	12.02 ± 0.09
6 Bg sample	6.32 ± 0.57	6.19 ± 0.06
2 Bg sample	1.96 ± 0.57	2.92 ± 0.05

the 6 and 12 Bq/g-samples coincide with each other within standard deviation, and those for the 2 Bq/g-sample, within four-sigma (4-fold standard deviation). This result suggests that we should remember that some cases with comparatively large deviations like the case of the 2 Bq/g-sample possibly occur when the water-extraction method is employed instead of the heating-cooling method.