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MAG34-15 Room:IC Time:May 24 12:00-12:15

Continuous monitoring of radiocesium in drainage water from a paddy field during puddling

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Decontamination of agricultural lands contaminated with radiocesium after the accident of Fukushima Dai-ichi Nuclear Power Plant of Tokyo Electric Power Company is urgently requested. Ministry of Agricultural, Forestry and Fisheries (MAFF) has currently been undertaking development of decontamination measures for soils in agricultural lands. In cooperation with MAFF, Institute for Rural Engineering (NIRE) has conducted experiments for decontamination in paddy fields of Iitate Village, Fukushima Prefecture, which is included in the planned excavation zone with 20-50 mSv per year due to fallout from the accident. One of the NIRE experiments was a decontamination method "mixing soils and removal using water", in which muddy water was drained from paddy fields where surface soil and radiocesium was mixed with water. The muddy water was extracted by pump for disposal.

In this experiment, a monitoring equipment made up of a NaI(Tl) detector was developed and applied to an experimental decontamination in paddy fields for continuous monitoring of concentration of radiocesium in muddy water. The detector of monitoring equipment was a 5-inch diameter NaI(Tl) crystal with a photomultiplier tube, that was put into a large plastic bucket. A hole was made 30.5 cm above the bottom of the bucket for regulating the discharge flow from the bucket. Its resolution was about 7%. Signals from the detector were amplified by a gain controller and then sent to a 1,024-channel pulse height analyzer. The energy range was set to 0-2,048 keV so that the targeted nuclides (Cs-134: 605 and 795 keV; Cs-137: 662 keV; K-40: 1,460 keV; Bi-214: 1,765 keV) could be observed. The ratio of emissions of gamma ray from nuclides to detected peak counts, called the detection factor here, was determined by measuring 3.0M KCl aqueous solution (3,700 Bq L^{-1}) in the bucket. At depth of 30.5 cm in the bucket, the detected peak count for K-40 was 123 cps, and therefore the detection factor was calculated as 3.2 L^{-1}.

The experiment of muddy water removal was executed in two paddy fields, named as Field C1 and C2. The area of each of them was 420 m^2. In both C1 and C2, the soil was ploughed together with 42 m^3 of supplied water, and then the muddy water was discharged by four suction pumps. In Field C2, additionally, the soil was tilled before the water injection, and the soil and water were manually stirred by dragging PVC pipes during the latter part of the pumping. The drained volume of muddy water was 12 m^3 from Field C1, and 17.6 m^3 from Field C2. The monitoring equipment was installed at an outlet of one of the pumps. The measurement time was set to ten seconds, and obtained spectra were logged every ten seconds. Radioactivity of Cs-134 and Cs-137 was calculated from the peak counts around 795 keV and 605-662 keV, with multiplying the detection factor 3.2 L^{-1}. On the other hand, 300 mL of the emitted muddy water was sampled every five minutes, and then taken back to the laboratory for measurement of radiocesium concentrations (5-inch NaI(Tl) scintillation counter, 600-second measurement). Results of the continuous monitoring and the laboratory measurement are shown in Fig. 1. The former part of the continuous measurement in Field C1 was unavailable because of malfunction of power supply. The fluctuation of radioactivity obtained by the continuous monitoring was well consistent with that by the laboratory measurement, and revealed that radiocesium concentration in the muddy water reached more than 20,000 Bq L^{-1} during the manual stirring although usual radioactivity in the pumped water ranged 5,000-10,000 Bq L^{-1}.

Keywords: NaI(Tl) scintillation counter, gamma ray spectrometry, decontamination evaluation, Fukushima Dai-ichi Nuclear Power Plant

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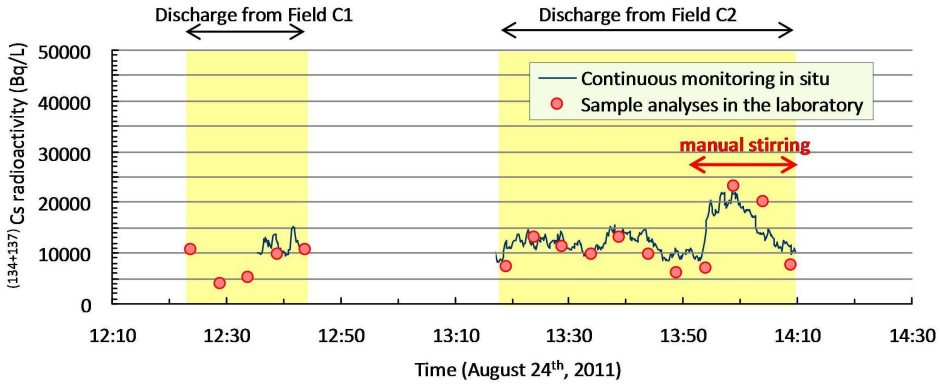

Fig.1 Results of the continuous monitoring of radiocesium in the emitted muddy water by the continuous monitoring equipment and those in the samples measured in the laboratory.