Development of the radiation inspection system for food materials

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1. Introduction

After the Fukushima nuclear accident in 2011, a large quantity of radioactivity flowed into the Pacific Ocean. Many Korean people worry about radioactive contamination of Japanese and Korean marine products. Radioactive contamination of processed foodstuffs, livestock, marine products, farm products imported from Japan and fishes caught in coastal waters of Korea has become an important social issue. Recently, there are also needs of inspection system for monitoring of public meals such like school feedings of kindergarten, elementary school, middle school, high school and university. Radioactivity inspections of those foods are executed manually with portable measuring instruments or at labs using their samples. But, radioactivity inspections of those foods should execute field survey in real time. In consequence, there are some problem of time delay and low reliability. To protect the health of citizens from radioactivity contained in Japanese marine products imported to Korea, a system to inspect radioactivity in real time is developed. The system is to measure the radioactivity level of farm and marine products and public meals continuously and automatically at inspection sites of an agency checking radiation of imported foodstuffs to determine radioactive contamination.

2. Development methods and Test results

In this section some of the significant contents what we tried to develop and test results are described. The contents include a development plan of radioactivity inspection system, technology development of radioactivity measurement and dose assessment, a measurement of the distance using infrared rays, Development of automation transfer system and classification system and radioactivity measuring technology, Development of system operation, control and inspection software. The equipment of Technology for In-situation real time radioactivity inspection system is shown in Fig.1.

2.1 Technology development of radioactivity measurement

A main purpose of the inspection system is to determine if the radiation level of Cs-134, Cs-137 and I-131 fall within the nation's permissible level. As the existing HPGe detectors should get LN2 gas, they can't work for 24hours continuously.

Fig. 1. Equipment of Technology for In-situation real time radioactivity inspection system.

In addition, samples should go through pretreatment, there is a problem of time delay. NaI(Tl) detectors of other companies can't do precise measuring due to their low efficiency and resolution. To solve such a problem, high performance detectors are necessary. These detectors with high efficiency and resolution don't need gas supply and they can work continuously without pretreatment. Therefore, this system can be composed and operated for various purposes and the best system composition and operation conditions for each purpose can be deducted through numerical analysis model and experiments.

2.2 Development of Does assessment Techniques

For cesium, the permissible level 370Bq/kg or 100Bq/kg which is the strengthened level of food contaminated by radioactivity are applied under the enforcement rules of a law for protection and preventing radioactive disasters of nuclear facilities. To exclude effects of background radiation and satisfy the detection low set value 50Bq/kg or less, the MCNP code modeling was conducted to know structure designing and thickness of a lead shielding board.

2.3 Development of automatic classification device and radioactivity measuring technology

The system for inspecting radioactive contamination is about establishing all processes with a computer equivalent to the brain and operating, controlling and recording them. The distance measurement and instrument relocation module measures the size and distance of targets using an infrared ray distance detector and sends signals to the computer. The

computer gives an order to adjust the detector distance and move the detector in order to do measurement in the input standard distance. And then the computer sends radiation detection signals to a multi-channel analyzer during a given time period. The Multi-channel analyzer collecting those signals analyzes the strength of radiation and sends the result to the computer. When more radiation than set by the computer is detected, an alarm will go off and a conveyor system will start to work to give an order to separate the contaminated foods so that it can be automatically separated. These processes are conducted continuously totally different from existing methods.

2.4 Development of system operation, control and inspection software

The system operates all systems organized by a designed program and makes decisions and gives an order to do operation following fixed conditions.

Unit techniques necessary for the system are radiation detector and analysis techniques, inspection object transfer, a central system control and operation system, and an infrared ray distance measurement and detector operation system. To develop those related techniques, techniques for each unit were developed and system was made using Visual Basic program so that the central computer can select a menu and adjust it.

2.5 Test results and discussion

The performance test of NaI(Tl) detector was executed using the quantified Cs-137 source 30Bq/kg, 50Bq/kg, 300Bq/kg and 900Bq/kg at Korea Research Institute of Standards and Science(KRISS). Source was put in a box and radioactivity was measured in the middle of the box. Picture of the test for radioactivity inspection system is shown in Fig.2. First of all, Background was measured and Calibration was executed using the Cs-137 300Bq and Ba-133 3700Bq for 60minutes. After setting the Background and Calibration data, test of the Cs-137 30, 50, 300, 900Bq/kg was executed for 10minutes. As a results, measurement value of Cs-137 30Bq/kg is 45Bq/kg (51%), Cs-137 50Bq/kg is 65Bq/kg (31%), Cs-137 300Bq/kg is 289Bq/kg (-3%), Cs-137 900Bq/kg is 802Bq/kg (-8%). Test results is shown in Fig.3.

Fig. 2. Picture of the test for radioactivity inspection system.

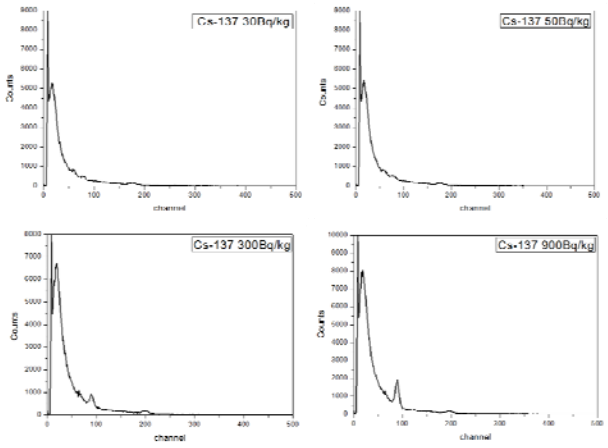

Fig. 3. Performance test results of NaI(Tl) detector using the Cs-137 source of various concentrations.

3. Conclusions

Performance was identified through the performance test (Cs-137 30, 50, 300, 900Bq/kg) at Korea Research Institute of Standards and Science (KRISS). NaI(Tl) detector was satisfied the performance for measurement. Also, anxiety about radioactive contamination of foods after the Fukushima nuclear accident will be eased and trust of the radioactive inspection is expected definitely.

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