Development of In-situation radioactivity Inspection system

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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. Radioactivity inspections of those foods are executed manually with portable measuring instruments or at labs using their samples. 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 will be developed. The system is to measure the radioactivity level of farm and marine products continuously and automatically at inspection sites of an agency checking radiation of imported foodstuffs to determine radioactive contamination.

2. Methods of Development

In this section some of the contents what we are trying to develop 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 concept of Technology for In-situation real time radioactivity inspection system is shown in Fig.1.

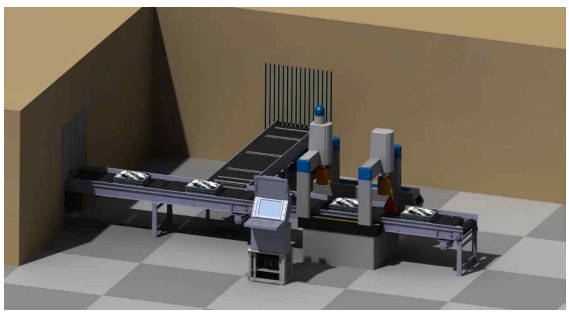

Fig. 1. Concept of Technology for In-situation real time radioactivity inspection system.

2.1 Development plan of the radioactivity inspection system

To develop the In-situation real time radioactivity inspection system, analyses have been conducted about basic data of related technology by investigating trends of technology developed by related overseas research institutes and technology for products supplied by related overseas markets and collecting data.

2.2 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-129 fall within the nation's permissible level. As the existing HPGe detectors should get LN2 gas, they can't work for 24hours continuously. 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. When neutrons should be detected or radioactive should be verified for special purposes, a system will be made using a BF3 counter or a ZnS(Ag) detector. 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 trough numerical analysis model and experiments. The comparative table of measuring equipment is shown in Table.1.

2.3 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 10Bq/kg or less, the MCNP code modeling will be conducted to know structure designing and thickness of a lead shielding board.

Table. 1. Comparative table of measuring equipment

	Portable instrument	High-purity germanium detector	New development
Sensor	GM	HPGe	NaI(Tl)
Detection Efficiency	-	30%	60%
radionuclide analysis	NO	Yes	Yes
Detection time	Within a few minutes	8~9hour	10~15min
Automation	No	No	Yes
Detecting Method	Total inspection	Sampling inspection	Automatic total inspection
Number of inspection (/day)	300	24	144/line
Costs (won)	Millions	Hundreds of millions	50 million

2.4 Measuring Techniques for weight

Measure the weight of foods to be inspected using a weight sensor(load cell) and then convert into radiation measurement unit.

2.5 Measurement of the distance using infrared ray

Measure the distance of foods to be inspected using an infrared ray distance measurement sensor and then put the detector closely to the foods as much as possible using a step motor to maximize the detection efficiency.

2.6 Development of automation transfer system

Design and make a system that is transferred foods and measured radioactivity using a conveyor system and separated if there are contaminated foods.

2.7 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.

2.8 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 and classification devices, 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 will be developed and system will be made using C++ or Labview program so that the central computer can select a menu and adjust it. The transfer and classification system largely depends on environment of the site, so systems suitable for site conditions should be suggested after visiting inspection places.

3. Conclusions

Product performance assessment and tests will be conducted later. When the system develops and its commercialization begins, people's anxiety about radioactive contamination of foods after the Fukushima nuclear accident will be eased and people will be able to trust the radioactive inspection.

Acknowledgement

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