Development of Radioactive Inventory Evaluation System using 3D Shape and Multiple Radiation Measurement

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1. Introduction

The increase of the operating NPPs and the superannuation of the equipment in NPPs cause a large amount of the metal radioactive waste. Presently the metal radioactive wastes are stored in the temporary storage facility in NPPs because of the delay of the construction of the final disposal facility. The radioactive level of general metal radioactive wastes is low, and the radioactive level can be lowered by the simple decontamination process. If the radioactive wastes are disposed as the industry waste, the disposal cost is diminished largely. For the disposal of the radioactive wastes as the industrial wastes, the radioactive level of the target wastes are evaluated. It is difficult to know the position of the source term for most of the metal radioactive and the source term is distributed non-homogeneously [1]. And the self-shielding effect of the metal material makes the evaluation more difficult.

In this study, the radioactive inventory evaluation system for the metal radioactive waste is developed. For the correction of the uncertainty of the position and the non-homogeneity of the source term, the 3D shape and multiple radiation measurement are used.

2. Methods and Results

The object of this system is the automation of evaluation using MCNP (Monte Carlo N-Particle) code as the radiation shielding evaluation program. For MCNP evaluation, the geometry modeling and the information of the source term are required. The geometry modeling is performed using 3D shape which is gotten by the 3D scanner. The information of the source term is collected by the multiple radiation measurement system.

2.1 3D shape modeling system

The metal radioactive waste generated in NPP is cut as small scrap for entering in 200L drum. The shape of the metal scrap can be decided as the operator's action. In this study, the pile of the metal scrap is laid broadly and lowly. The maximum of size of the pile of the metal scrap is decided as 1m x 1m. The shape of the pile of the metal scrap is gotten by the 3D scanner using the white light. Six of the scanning images are performed as the turner on which the metal scarp is laid, rotates. Six scanning image is merge as the one shape by the scanner program. The information of the one shape is converted to the space coordinates by the 3Dscanner.

In use of the space coordinates, the geometry for MCNP can be formed as the volumetric element called as voxel which is represent a value on a regular grid in three dimensional space [2]. By the automatic MCNP input making program, the geometry part of MCNP input text file is made. Fig.1. shows the 3D scanning systems, and Fig. 2. shows the automatic MCNP input making program.

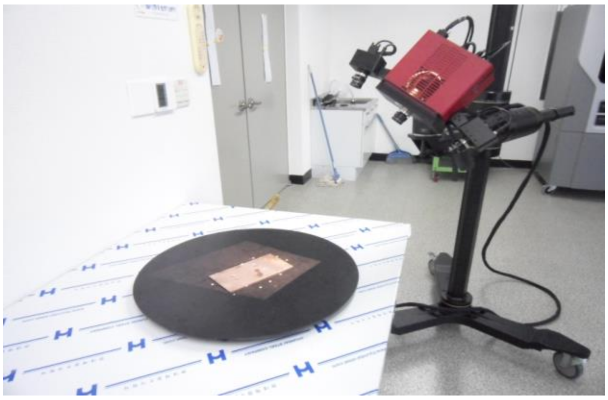

Fig. 1. 3D scanning system

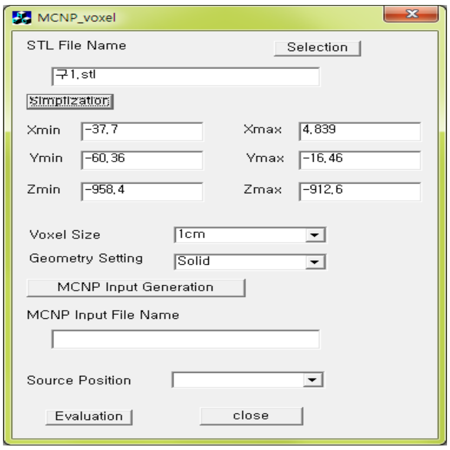

Fig. 2. Automatic MCNP input making program.

2.2 Multiple radiation measurement system

The existing radiation measurement system measures the one position. The system doesn't reflect the position and the uncertainty of the distribution of the source term. The system suggested in this study has 3 gamma-ray detectors. As the detectors move 3 times as top, middle, and bottom part, 9 of positions are measured totally. Nine of the measurement values are applied as the information of the source term for MCNP code. Also the information of the source term is entered in the data card of MCNP by the automatic MCNP input making program. Fig. 3. shows the multiple radiation measurement system.

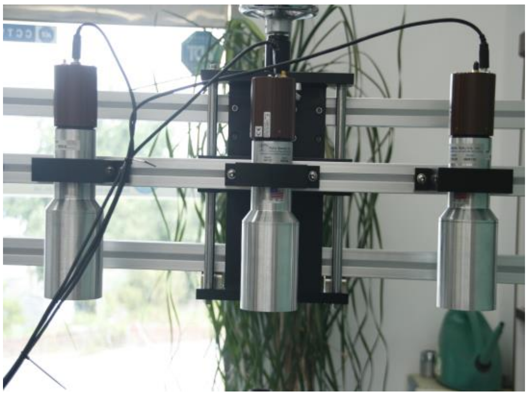

Fig. 3. Multiple radiation measurement system

2.3 Combination System

As the previous section is described, the 3D shape modeling system makes the geometry part of MCNP, and the multiple radiation measurement system makes the data part of MCNP. Finally the MCNP input file for the target metal scrap is completed. As the result of the MCNP execution, the correlation factors for the radioactive inventories of 9 of positions are calculated. The evaluation of the partial inventory of the target metal waste is more profitable than that of the total average inventory as the application of the clearance criteria. Fig. 4. shows the final combination system.

Fig. 4. Radioactive inventory evaluation system using 3D shape and multiple radiation measurement

3. Conclusions

The existing gamma-ray measurement system for the metal radioactive waste cannot reflect the position and the distribution of the source term and the effect of self-shielding. This evaluation system suggested in this system can calculate the reasonable value regarding to the position and the distribution of the source term and the effect of self-shielding. By the calculation of the partial inventory of the target metal waste, the advantage in the application of the clearance criteria can be obtained.

REFERENCES

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