Construction and Utilization of a Dedicated Gamma Nuclide Analysis System for Nuclear Decommissioning Waste

Seokhan Kim*, Seung-Ho Lee, Eunmi An, Homeyeong Lee and Yeong su Ha
Koera Research Institute of Decommissioning (KRID)
**sky@krid.re.kr*

Keywords : HPGe, Gamma-ray Spectrometry, Radioactive Waste, Radiochemical Analysis

1. Introduction

The Korea Research Institute of Decommissioning (KRID) is actively conducting research to address the growing demand for radionuclide analysis in decommissioning waste as part of its efforts to safely manage the vast amount of radioactive materials generated during nuclear power plant decommissioning.

In March 2025, KRID established a radiochemical laboratory, equipped with state-of-the-art facilities, marking a significant advancement in enabling precise radionuclide characterization. Accurate analysis of radionuclides is essential to ensuring compliance with the regulatory requirements set by the Nuclear Safety and Security Commission (NSSC) and the Korea Radioactive Waste Agency (KORAD).

Since there are many different types of nuclear waste from decommissioning activities, the reported methods do not cover all types of waste, and there is an ongoing need to develop new methods for analyzing different types of samples [1]. To address these challenges, this study aims to develop and optimize systematic methodologies for analyzing gamma-emitting radionuclides, focusing on key isotopes critical for the safe handling and disposal of decommissioning waste.

Fig1. KRID Main Research Building

2. Methods and Results

For the analysis of gamma-emitting radionuclides, the energy range was divided into two categories: the low-energy region (≤300 keV) and the medium-to-high-energy region (≥300 keV). The low-energy range was specifically calibrated using a GLP HPGe detector optimized for low-energy measurements, while a standard P-type HPGe detector was calibrated for gamma rays above 300 keV, ensuring precise measurements across all energy ranges [2].

Fig2. HPGe system

Accurate characterization of radioactivity requires that the detector be suited to the energy levels of the radiation being emitted and that the resolution and accuracy of the detector be sufficient to meet the needs of the characterization programme [3].

Fig3. Autosampler JIG

To meet the challenge of analyzing the large volumes of radioactive waste generated during nuclear power plant decommissioning, a specialized JIG was designed for the autosampler. This design allows the automated system to accommodate a variety of sample container shapes and sizes, enabling efficient and high-throughput measurements.

These advancements have facilitated the development of a dedicated, efficient, and automated system for the analysis of radionuclides in decommissioning waste. This system ensures consistent performance under diverse sample configurations and experimental conditions, supporting reliable and scalable waste management processes.

3. Conclusions

This study has successfully developed a systematic analytical framework for the precise and efficient characterization of gamma-emitting radionuclides in nuclear decommissioning waste. Utilizing the advanced capabilities of KRID's radiochemical laboratory, including the deployment of energy-specific HPGe detectors, signal processing optimization, and the design of custom JIGs for automated sample handling, the methodologies established in this research provide a robust foundation for compliance with regulatory standards and environmental safety requirements.

Moreover, the integrated and automated system constructed during this study significantly enhances throughput and accuracy, addressing the need for high-volume sample processing in decommissioning waste management.

The methodologies developed through this research will be fully implemented in the state-of-the-art Demonstration Analysis Building, scheduled for completion in 2026. This facility will adopt the optimized techniques for large-scale radionuclide analysis, ensuring efficiency and reliability in processing the growing volume of waste generated by nuclear power plant decommissioning. By advancing technical standards in radiochemistry and contributing to international research efforts, these developments firmly establish KRID as a key leader in radiological waste management and nuclear decommissioning research.

Acknowledgements

This research project was carried out with support from the Korea Institute of Energy Technology Evaluation and Planning (Establishment of radionuclide analysis system for below the low-level decommissioning wastes and the quality management system for the validation of radionuclide analysis procedure, RS-2023-00234176) and the Ministry of Trade, Industry & Energy (MOTIE) of the Republic of Korea.

REFERENCES

[1] Hou, Xiaolin, Radiochemical Analysis for Nuclear Waste Management in Decommissioning, Internal Report, Nordic Laboratories, p. 5, 2009.
[2] ORTEC, Overview of Semiconductor Photon Detectors, Internal Document, ORTEC, 2002.
[3] International Atomic Energy Agency (IAEA), Radiological Characterization of Shut Down Nuclear Reactors for Decommissioning Purposes, Technical Report Series No. 389, Vienna: IAEA, p. 57, 1998.