On-site Analytical Laboratory During Decommissioning: Mobile Lab

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1. Introduction

Kori-1 was decided to shut down in June 2017 and is about to be decommissioned. KHNP, the operator of the nuclear power plant, expected that the amount of radioactive wastes (RWs) produced during decommissioning is about 15,000 – 18,000 drum (200 L). The scaling factor could be applied for determining the activity of hard-to-measure (HTM) radionuclides. However, this methodology can lead to overestimate the activity of HTM radionuclides in some cases. Therefore, the direct analysis of HTM radionuclides using chemical separation should be performed.

It creates issues related to the shipment of radioactive samples from the site to the external analytical laboratory. It is complex, expensive and time-consuming, and can sometimes cause a delay in the dismantlement planning. Radiological measurements of decommissioning sample out of site is not good way to manage high throughput of samples in a timely manner. The on-site radiological characterization is a reasonable and cost-effective approach.

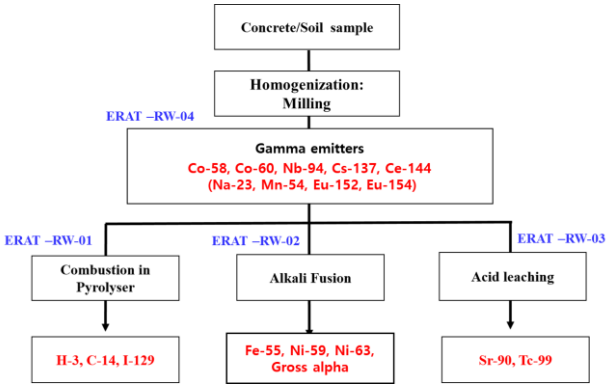
In this study, we conceptually designed the mobile lab for the on-site radiological characterization during decommissioning and described the analytical method and instruments which are optimized for the mobile lab.

2. Conceptual design of mobile lab

2.1 Analytical method

The main characteristic of the analytical method is the sequential separation of several radionuclides from a single sample. It is resulting in less production of secondary wastes during the analysis process and reducing the analytical time. In the analytical process, lots of waste are generated than expected. All of these wastes are classified as radioactive waste and waiting for another radiological characterization to be transferred to the repository. It leads to increasing the decommissioning cost.

According to the nuclear act, the following 14 radionuclides should be analyzed: 3H, 14C, 60Co, 59Ni, 53Ni, 90Sr, 94Nb, 99Tc, 129I, 137Cs, and gross alpha. We divided them into three groups: volatile radionuclides, activated radionuclides, and fission products. The pretreatment method for each group was applied. Then, radionuclides in each group were properly separated from the sample with the extraction chromatography application.



2.2 Characteristics of instrument

We installed instruments for the pre-treatment, chemical separation and detectors for alpha, beta, gamma radionuclides in the mobile lab. (Some of

them are made by other company and we made others.) Except some detectors such as liquid scintillation counter and low background alpha/beta counter, we have developed instruments which allow the analysis process to be simple and complete in a short time, such as pyrolyzer, automated separation system, and smart filtration system.

The developed pyrolyzer is designed for extracting the volatile radionuclides from the sample. Compared with the commercialized equipment for the same purpose, it can extract only 3H and 14C as well as 129I and 99Tc also. The modified combustion tube made it. The automated separation system which is called FIRST (fast and intelligent radionuclide separation technique) allows the user to separate target radionuclide from the sample with less labor and time. The filtration system can be applied for a large or small volume of liquid sample at the same time. It allows the user to produce less wastes compared with typical filtration approach.

Fig. 1. Instruments in the mobile lab (developed by KAERI).

2.3 Site planning

The on-site radiological laboratory is consisted of three containers: 1. Sample preparation lab, 2. Chemical separation lab, 3. Analysis lab. Each lab has a suitable instrument and equipment for its objective. After collection of the representative sample of each drum, it is transferred to the sample preparation lab and being homogenizing. Then, each radionuclide is chemically separated from the homogenized sample in the chemical separation lab. Finally, it is measured with proper detector in the analysis lab, and then the report on it would be produced.

Fig. 2. Schematic diagram of the mobile lab.

3. Conclusion

KAERI is a major player in the fields of research and development in the nuclear chemistry field in Korea. We have developed the on-site analytical laboratory based on mobile lab, in which most of radiological characterization work will be carried out. This mobile lab allows the prompt analysis of decommissioning wastes on the site and leads to reduce the decommissioning cost.

REFERENCES

[1] Goudeau V., Daniel B., “Mobile laboratories: An innovative and efficient solution for radiological characterization of sites under or after decommissioning”, Journal of Environmental Radioactivity, in press (2017): doi/10.1016/j.jenvrad.2017.04.010.