A Review on Generation Characteristics of Sludge Waste During Decommissioning of Nuclear Power Plant

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1. Introduction
The decommissioning of unit 1 of Kori nuclear power plant, whose permanent shutdown had been decided in 2017, is expected to begin in 2026. Failure to apply appropriate radioactive waste management measures from the outset of the decommissioning project could cause enormous disruption to the project, including increased disposal costs and early saturation of the disposal sites.

The radioactive sludge wastes generated by nuclear power plant operation include sump sludge, tank sludge, waste oil sludge and other mixed sludge, most of which will be treated in the form of cement solidification and disposed of through securing the disposal suitability of the solids.

In the case of cement solidification, the volume increase due to the low rate of waste loading and the difficulties in securing the disposal suitability will be occur. However, it is expected that there is no significant problem in the application of the technology since the amount of the sludge waste generated is not large.

It is expected that a large amount of various organic and inorganic sludge wastes in the forms of corrosion products, concrete, soil, mixture etc. that are difficult to be processed and disposed of are generated when dismantling NPPs.

Therefore, the origin and physicochemical properties of decommissioning sludge wastes were investigated in order to facilitate the derivation of treatment conditions and technologies for the effective collection, high volume reduction, stabilization of sludge waste and disposal suitability in consideration of the location and physicochemical characteristics of the sludge wastes.

2. Classification of the Sludge
The sludge wastes generated during dismantling of nuclear power plants can be classified as floor sludge, sump sludge and tank sludge, etc. depending on the place of generation. They also can be classified as concrete sludge, soil sludge, organic sludge and mixed sludge depending on the physicochemical properties.

Since decommissioning sludge wastes are incidental wastes generated by the decontamination and dismantling processes carried out at the time of dismantling of NPPs, identifying the types and characteristics of decontamination and dismantling processes first will help to understand the generation characteristics of the decommissioning sludge waste.

2.1 Process-specific Classification
Firstly, corrosion products will be generated by grinding in the process of physical decontamination of piping and equipment, and corrosive sludge will be generated by chemical decontamination with corrosive chemicals.

In the concrete decontamination process, concrete sludge will be generated by scabbling and shaving operations.

Since almost all decontamination processes use water to reduce dust and to dilute chemicals, decontamination sludge will contain a lot of moisture.

2.2 Place-specific Classification
The floor sludge exists at the bottom of the concrete structure in the radiation controlled area and will have a variety of physicochemical properties although it has a small amount of generation.

The sump sludge is a solid that has been deposited into the sump along with waste water, oil, decontamination solution, cleaning water, etc. through the piping of equipment drainage, floor drainage and will include corrosion product, micelle, insoluble compound, dust, etc. as shown in Fig 1.

Fig. 1. Shapes of sump sludge [1].

The tank sludge can occur at the bottom of the tanks during dismantling, as the long-term operation of the tanks that collect and store liquid radioactive waste and boric acid water causes deposits of highly dense corrosion products and insoluble compounds produced by micelles and mineral components as shown in Fig. 2. The insoluble compounds may include hydroxides, sulfates, carbonates, phosphates, silica, silicates, borates and the like.
3. Characteristics of the Sludge

3.1 Organic Sludge

Since corrosive sludge occurs through chemical agents, there will be a mixture of decontamination and corrosion products with the addition of corrosive chemicals used in the decontamination process.

Organic sludge may occur if a large quantity of organic matter such as chelating agent, antifreeze, lubricant, etc. is leaked during the dismantling and demolition of the primary system equipment and is collected in sumps and mixed with particulate matter. A small amount of leakage can be removed with decontamination paper, so it will be generated as DAW rather than sludge waste.

Oil sludge is a type of organic sludge that occurs when oil such as control oil, fuel oil and lubricating oil contaminated by radioactive materials generated during the dismantling and demolition of the primary system equipment is mixed with a large quantity of corrosion product and particulate matter such as dust as shown in Fig. 3. If the oil alone exists, self-sludge created by oxidation and deterioration of the oil may exit but will not be classified as sludge waste.

3.2 Inorganic Sludge

Corrosion product sludge wastes will occur by mixing dust-reducing water with removed corrosion products during physical grinding of equipment and piping.

Concrete sludge is a concrete powder generated by scabbling and shaving of radioactive materials on the concrete structure in the radiation controlled area for decontamination, and will exit with a mixture of dust-reducing water and concrete powder as shown in Fig. 3. From the source point of view, it may also be classified as floor sludge waste.

Soil sludge occurs as fine soil and clay as shown Fig. 4 except rock and gravel, when radioactive liquid leaks from the buried pipe and soil is contaminated under and around the concrete structure. And depending on the degree of contamination, very large quantities may occur.

Mixed sludge refers to a mixture of two or more of the above mentioned sludge wastes.

4. Conclusion

The generation characteristics of decommissioning sludge wastes have been investigated in order to develop a treatment technology that can effectively collect and process and safely dispose of various sludge waste that may occur during dismantling process of NPPs.

First, in terms of generation place, it classified into bottom sludge, sump sludge and tank sludge.

In terms of physicochemical characteristics of decommissioning sludge wastes, they were classified as organic sludge wastes such as corrosive sludge, organic sludge, oil sludge and inorganic sludge wastes such as corrosion product, concrete sludge, soil sludge and mixed sludge waste.

The characteristics of radioactive wastes generated in the nuclear power plant will vary depending on the situation, so it will not be possible to determine the composition or physicochemical characteristics of each type of waste.

Likewise, it is difficult to accurately grasp the physicochemical and radiological characteristics and amounts of decommissioning sludge wastes.

The generation characteristics of sludge wastes may vary depending on the decontamination and dismantling process, and the operation histories of the NPPs.

Therefore, in the basis on general assumptions and forecasts, the generation characteristics of decommissioning sludge wastes have been roughly reviewed in order to capture the concept of development of processing technology such as collection, high volume reduction and stabilization of the sludge waste ensuring the disposal suitability.

REFERENCES