Concept Development of Drift Storage-and-Disposal of Cs-Wastes

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1. Introduction

KAERI is developing a pyroprocessing technology for the effective management of spent nuclear fuels generated in Korea. The main idea of pyroprocessing is the group separation of radionuclides to reuse the fissile nuclides and reduce the footprint of final repository. According to the current material balance, eight kinds of wastes will be generated from the pyroprocessing. Among them, the management of two highly-heat generating wastes, Cs-spent filter waste and Sr-spent filter waste, is not yet fixed.

Considering the relatively short half-life of Cs-137 and Sr-90, it is strongly recommended to store the wastes for several hundreds years at the surface facility and then dispose of them like low-level radioactive wastes. However, it is very difficult to operate the surface facility for several hundreds years. Thus, in this paper we propose a new concept to store and dispose of the Cs-spent filter wastes using drifts located around 300 meters below the ground surface.

The previous concepts, such as Japanese NUMO's CARE [1] and US DOE's Yucca Mountain Repository [2], were reviewed. It was found that the direct application of such concepts was not feasible. Thus, we propose that the concept of the Yucca Mountain Repository was applied to the storage for more than 100 years and then the Canadian NWMO's disposal concept is applied to the final disposal of the waste. In this study, we roughly designed the storage-and-disposal facility for the thermal analysis.

2. Concept Development

2.1 Amounts of Cs-waste

Cs-spent fuel filters will be generated from the preprocessing of spent nuclear fuel. According to the current version of material balance, the amount of the waste from 30 tHM of PWR spent fuels is given in Table 1. With the consideration of 23,618 tHM of PWR spent fuels from 24 reactors, around 14,171 waste forms are expected.

Table 1. Amount of Cs waste from pyroprocessing of 30 tHM of PWR SNF

Total weight of waste, kg	2,750
Size of waste form, mm	300 (D) ×900 (H)
Weight of waste form, kg	160
Number of waste forms	18

The decay heat from one Cs-spent filter waste form was calculated and shown in Fig. 1. As shown in Fig. 1, most of decay heat disappears 200 years after discharge.

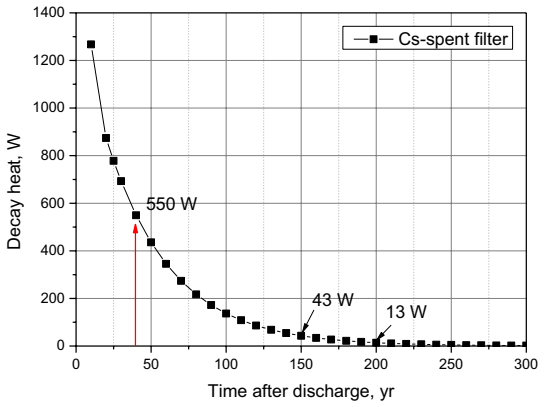

Fig. 1. Decay heat from one Cs waste form.

2.2 Disposal canister

A disposal canister was designed from the viewpoint of thermal management. According to the Yucca Mountain Repository (YRM) design, the thermal loading is around 1.5 kW/m. At the time of disposal, the decay heat from a Cs waste form showed around 0.55 kW as shown in Fig. 1. Thus, we designed a disposal canister which could hold eight storage canisters (Fig. 2), which was equivalent to around 1.83 kW/m. The inner structure was made of steel. However, outer copper coating was not decided

at this study, and it will be decided through a corrosion study.

During the storage period, the drift will be open and cooled by forced convection like YMR. The size of the drift was decided roughly 3.5 m by 3.5 m as shown in Fig. 3. The storage period will be determined through a thermal analysis, which is in progress. Thermal design criteria during the storage period are taken from those of the YMR and modified to the Korean situation:

- Temperature on the drift wall: below 200°C
- Temperature halfway between emplacement drifts: below 100°C

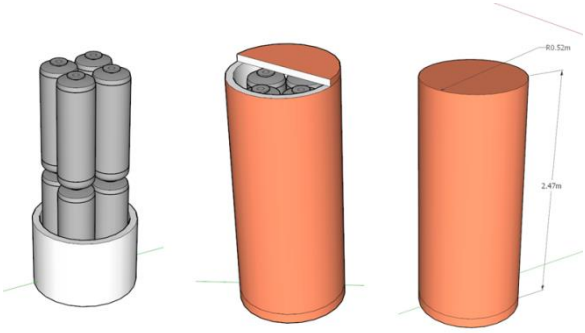

Fig. 2. Schematic of a disposal canister.

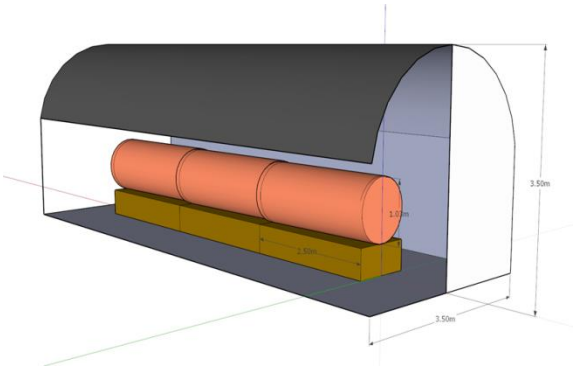

Fig. 3. Schematic of a disposal canister during storage period.

2.3 Buffer and final disposal

The Cs-spent filter waste contains very long-lived Cs-135 as well as Cs-137. Due to the long-lived Cs-135 we designed a disposal facility with bentonite buffer to mitigate the release of the radionuclides. Considering the small size of a disposal canister, we introduced the Canadian NWMO's buffer concept to the disposal of Cs waste [3]. Soon after the storage period when decay heat removed, the disposal canisters will be moved to a surface facility, packaged with buffer blocks as shown in Fig. 4 and disposed of in the drifts for the final disposal. The size of blocks and drift spacing will be determined through the thermal analysis.

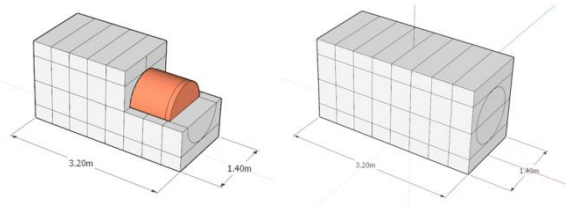

Fig. 4. Conceptual drawing of buffer.

3. Conclusion

Several kinds of radioactive wastes are expected from the pyro-processing of PWR spent nuclear fuels. Among them, the wastes containing cesium and strontium are planned to be stored for removing decay heats for several hundred years. In this paper, a concept for the storage-and-disposal of high-heat generating Cs waste was proposed. Based on the US DOE Yucca Mountain Repository and Canadian NWMO's geological repository, the storage-and-disposal concept was developed for the thermal analysis. Depending on the final calculation results, the specific design features of the system will be determined.

Acknowledgement

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