Analysis of Gas Vent System in Overseas LILW Disposal Facilities

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1. Introduction

A Low- and Intermediate-Level Radioactive Waste (LILW) disposal facility is currently under construction in Korea. It is located in the aquifer, 80~130 m below the ground surface. Thus, it is expected that disposal facility will be saturated after closure and various gases will be generated from metal corrosion, microbial degradation of organic materials and radiolysis. Generated gases will move up to the upper part of the silo, and it will increase the pressure of the silo. Since the integrity of the engineered barrier could be damaged, development of effective gas vent system which can prevent the gas accumulation in the silo is essential. In order to obtain basic data needed to develop site-specific gas vent system, gas vent systems of Sweden, Finland and Switzerland, which have the disposal concept of underground facility, were analyzed.

2. Gas Vent System of LILW Disposal Facilities in Foreign Countries

2.1. Sweden [1, 2]

SFR1, Swedish LILW disposal facility, is located in underground 60 m below the sea level. It is composed of several areas (silo, BMA, 1BTF, 2BTF and BLA) by the type of waste. However, silo is the part of interest, because other parts have different disposal concept (i.e. horizontal cavern) from Korean disposal facility.

The silo is made of in-situ cast concrete and is founded on a bed of sand and bentonite. During the post closure phase, the silo walls are completely surrounded by bentonite and the outermost barrier is the surrounding rock mass. After the silo is filled with waste packages, which are embedded in porous cement mortar after they are loaded, they are overcast with a cement overpack all the way up to the top rim of the silo. The concrete lid is cast on a thin layer of sand. The lid will be penetrated by sand-filled gas evacuation pipes, so that gases generated in the silo can escape into the sand/bentonite layer. (Fig. 1) If gases were accumulated over the certain pressure (i.e. 50 kPa) in the sand/bentonite layer, gases will penetrate the sand/bentonite layer and will be emitted through surrounding rock mass or concrete plug.

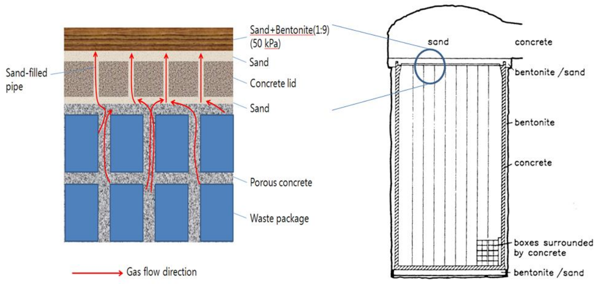

Fig. 1. Closure of upper part of the silo and gas migration path in Swedish concept

2.2. Finland [3, 4]

In Finland, VLJ LILW disposal facility has been operated in Olkiluoto nuclear power plant site since 1992. VLJ disposal facility is located 60~100 m below the ground surface, and it is comprised of silo, operation tunnel and shaft. Intermediate-level radioactive waste drums are packaged into concrete container and disposed in the reinforced concrete silo. The gap between the silo and surrounding rock will be filled with aggregate. (Fig. 2) Low-level radioactive waste drums are disposed in the silo covered with shotcrete.

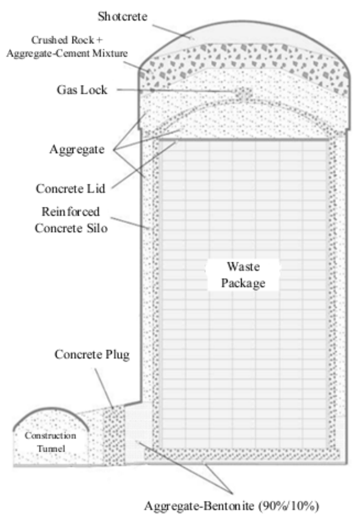

Fig. 2. Backfill of the silo in VLJ disposal facility

The silo lid is made of concrete of 25 cm thickness, and dome-type roof will be installed. The space between concrete lid and dome will be filled with aggregate after closure. The silo wall is made of SRPC

(Sulfate-Resistant Portland Cement) and crushed granite. Gases generated after closure will be gathered into the dome, and they will be emitted through the gas lock.

2.3. Switzerland [5]

Switzerland introduced the cavern disposal concept as LILW disposal facility, and it will be constructed within the Opalinus Clay formation below 300~400 m from the ground surface. The disposal facility is comprised of surface facilities, access ramp, shaft, operation tunnel, pilot facility and seven disposal caverns. The disposal containers are emplaced in caverns with a cross section of approximately 11.0×13.2 m, and length of 200 m. The emplacement caverns are sprayed with shotcrete lining. Inside of the emplacement cavern will be filled with cementitious mortar.

Gases generated from the emplacement caverns could be emitted through not only operation tunnel, also branch tunnel and surrounding rock. (Fig. 3) Nagra drew the concept of EGTS (Engineered Gas Transport System), and it is composed of seal, plug and backfill. After final closure, the operation tunnel will be filled with sand/bentonite (80/20 wt%), and the access tunnel and the operation tunnel are sealed with seal V4.mod and plug V2. V4.mod is composed of highly compacted sand/bentonite (70/30 wt%) with length of 40 m, and V2 is made of highly compacted bentonite with length of 30 m and concrete with length of 30 m. The shaft will be filled with highly compacted bentonite seal V3.

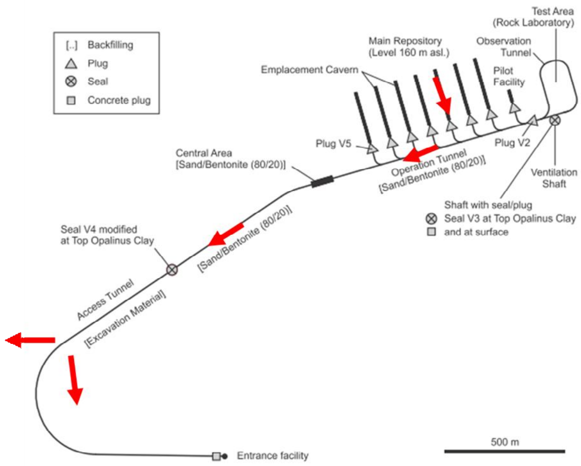

Fig. 3. Plan view of the LILW repository layout and designed gas migration path of Switzerland

3. Conclusions

After closure of the disposal facility, various gases will be generated from the silo. In order to prevent overpressure of engineered barrier and damage of its integrity, it is essential to develop effective gas vent system. Prior to the development of gas vent system, foreign gas vent systems were analyzed to obtain fundamental data proper to Korean disposal facility. And conclusions are as follows:

Sweden, Finland and Switzerland adopted cavern disposal method for LILW. Especially, the silo concept of Sweden and Finland could be benchmarked for the silo of Korean LILW disposal facility. However, they have a special gas vent path in upper part of the silo, while Korean silo concept is totally sealed with reinforced concrete. Thus, it is necessary to consider additional path for gas discharge and it would be located in the connecting part with operation tunnel. The disposal concept of Switzerland is horizontal cavern disposal and it is different from Korean concept. But backfill, seal and plug of tunnel can be referred into the gas vent design of the operation tunnel.

For developing effective gas vent system of the disposal facility, in-situ evaluation through large-scale gas migration experiment and modeling is essential. However before that, lab-scale experiment using concrete, backfill and seal which have the same ingredient as actual engineered barrier of the disposal facility should be performed. As a result, input parameters of the gas migration modeling such as permeability, porosity and gas entry pressure should be estimated.

ACKNOWLEDGMENTS

This work was supported by the Radioactive Waste Management of the Korea Institute of Energy Technology Evaluation and Planning (KETEP) grant funded by the Korea government Ministry of Knowledge Economy (20111720100010).

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