Transactions of the Korean Nuclear Society Spring Meeting
Jeju, Korea, May 12-13, 2016

Use of Gap-fills in the Buffer and Backfill of an HLW Repository

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1. Introduction

A high-level waste (HLW) repository is constructed in bedrock several hundred meters below the ground surface. The buffer and backfill are significant barrier components of the repository. They play the roles of preventing the inflow of groundwater from the surrounding rock, retarding the release of radionuclides from the waste, supporting disposal container against external impacts, and discharging decay heat from the waste. When the buffer and backfill are installed for the HLW repository, there may be gaps between the container and buffer and between the backfill and the wall of disposal tunnels, respectively. These gaps occur because spaces are allowed for ease of the installation of the buffer and backfill in excavated deposition boreholes and disposal tunnels. If the gaps are left without any sealing as they are, however, the buffer and backfill can't accomplish their functions as the barrier components. The present design concept (Fig. 1) of the Korean Reference disposal System (KRS) [1] does not include the gap-fills in the buffer and backfill, although developed countries [2] have already considered the use of the gap-fills in the disposal concept of their national HLW repository. This paper reviews the gap-fill concepts of the developed foreign countries, and then suggests a gap-fill concept which is applicable for the KRS.

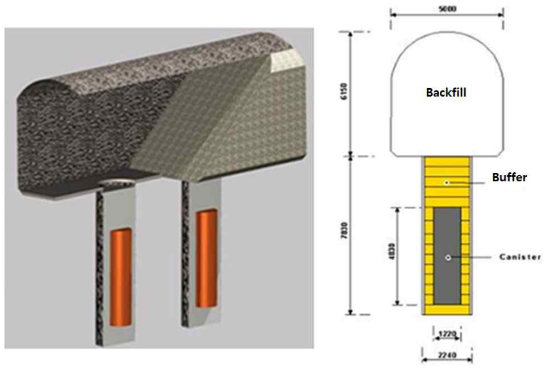

Fig. 1. Buffer and backfill of the Korean Reference disposal System (KRS).

2. Gap-fill Concepts of Developed Countries

The gap-fill concepts, in the present paper, were reviewed for a vertical disposal option of HLW repositories suggested by Sweden, Finland, Canada, Switzerland, and Belgium [3-7] .

2.1 Gap and Layout

For the developed countries, the gap and its layout in the buffer and backfill are different depending on the different disposal concepts of their national repositories. Fig. 2 shows the measure and layout of the gap-fill for the Swedish repository as an example. Summarizing the reviews, the deposition borehole for the buffer has the gap of 1 x 10^{-2} m between a container and buffer blocks and the gap of 2.5 x 10^{-2} m – 10 x 10^{-2} m between the buffer blocks and the wall of the deposition borehole. The disposal tunnel has the gap of 10 x 10^{-2} m – 40 x 10^{-2} m between the backfill and the disposal tunnel.

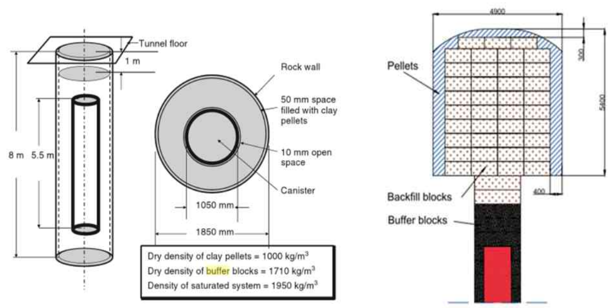

Fig. 2. Gap measure and layout in the buffer and backfill of Swedish Repository.

2.2 Gap-filling Materials

Bentonite-based materials have been considered for use of the gap-fill as a type of pellet, granule, and pellet-granule mixture. The pellet-manufacturing machines include those based on static compaction, roller compression, extrusion and cutting and block-crushing methods (Fig.3). Of these machines, the roller compression and extrusion and cutting methods has been preferably employed because of the mass-production of the pellets. The dry density and integrity of the pellets are sensitive to water content, composition of the materials, manufacturing method, pellet size when they are produced.

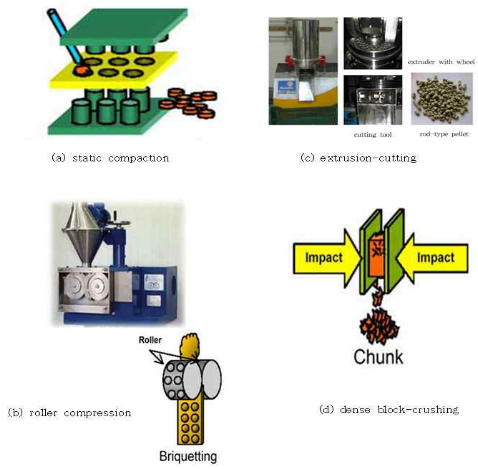

Fig. 3. Pellet-manufacturing methods for use of the gap-fill of the buffer and backfill.

2.3 Installation Technology

Pouring and then pressing method, shotcrete-blowing method, and auger method have been considered for the installation of the gap-fills: in general, the former for the gap of the deposition borehole and the latter two methods for the gap of the disposal tunnel (Fig. 4). These methods have different detailed installations depending on the disposal concept and the layout and dimension of the buffer and backfill. For the developed countries, experiments have been carried out to investigate the detailed installations which are preferably applicable to the disposal concept of their national repository.

Fig. 4. Gap-fill installation technologies: shotcrete-blowing method (upper) and twin auger method (bottom).

3. Suggestion of Gap-fill concept for KRS and Conclusions

Considering the gap-fill concepts of the developed countries, it is thought to be appropriate for the KRS that the gap between the container and the buffer blocks is 1 x 10^{-2} m, the gap between the buffer block and the wall of the deposition borehole is 5 x 10^{-2} m, and the gap between the backfill and the disposal tunnel is 25 x 10^{-2} m. The gap-fill is suggested to employ bentonite-based materials with a type of pellet, granule, and pellet-granule mixture. The roller compression method and extrusion-cutting method are applicable for the fabrication of the bentonite pellets which can have the high density and the required amount for use to the buffer and backfill. For the installation of the gap-fill, the pouring and then pressing method and the shotcrete-blowing method are preferable for the gap of the deposition borehole and the gap of the disposal tunnel, respectively. However, these installation methods are at the beginning stage in their field applications, and thus it is expected that additional related researches need to be carried out for the KRS repository.

ACKNOWLEDGMENT

This work was supported by the Ministry of Science, ICT and Future Planning within the framework of the national long-term nuclear R&D program (NRF-2012M2A8A5025577).

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