Investigation of Dry Unit Weight for Bentonite Buffer Block

Seok Yoon[1], Seungrae Lee[2*], Jinseop Kim[1], Geonyoung Kim[1], Donghwa Noh[2] , and Minjun Kim[2]

[1] Korea Atomic Energy Research Institute, 111, Daedeok-daero 989beon-gil, Yuseong-gu, Daejeon, Republic of Korea

[2]Korea Advanced Institute of Science and Technology, 291 Daehak-ro, Yuseong-gu, Daejeon, Republic of Korea

[*]srlee@kaist.ac.kr

1. Introduction

The geological disposal of high level waste (HLW) is designed to isolate the radioactive materials from human being until the radionuclides decay [1]. The principal of engineered barrier system (EBS) was suggested for this reason, and EBS is composed of a disposal canister with packed spent fuel, a buffer material, backfill material, and near field rock mass (Fig. 1). The role of a buffer material is very important to guarantee the disposal safety of HLW, and play a role to protect the waste and canister against any external mechanical impact. In terms of dry unit weight, its value should be higher at least 1600 kg/㎥ in order to satisfy the performance criteria [2], and it is necessary to investigate dry density of buffer material exactly. Therefore, this paper analyzed the method for investigating dry unit weight of cylindrical bentonite buffer block.

2. Experimental Setup

2.1 Theoretical background

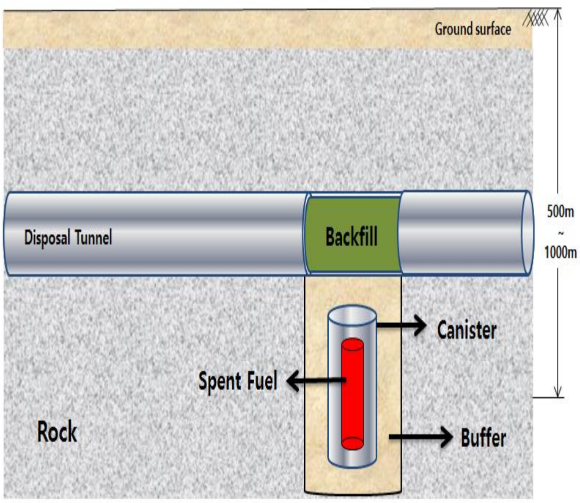

Fig. 1. Concept of engineered barrier system.

The diameter of cylindrical bentonite block was 30cm, and height was 40mm. Three samples were prepared and water dried for 48 hours in the oven. The relationship between dry unit weight (γ_d) and moist unit weight (γ_t) is like Eq. (1).

$$\gamma_d = \frac{W_s}{V_t} = \frac{\gamma_t}{1+\omega}, \quad \gamma_t = \frac{W_s + W_w}{V_t} \tag{1}$$

Here, V_t means total volume of bentonite block, W_s is weight of dried bentonite block, ω is water content, and W_w is weight of water.

2.2 Results and Discussion

Table 1 shows the moist unit weight and dry unit weight for three bentonite block samples. Initial moist unit weight was obtained by dividing weight by volume. Initial volume was measured with vernier caliper. Calculated dry unit weight was obtained by Eq. (1) with initial moist unit weight and water content. Also, measured value of dry unit weight was obtained with dried weight and volume. Dried volume was also measured with vernier caliper after 48 hours in the oven. Measured value showed 3~5% higher than calculated one.

In real geological disposal system, bentonite buffer block is confined with rock mass and backfill materials, and it is thought that volume change may not occur according to temperature and water content variation. Therefore, it is more accurate to use calculated value in order to obtain dry unit weight of benotonite buffer material, not measured value after drying in the oven.

3. Conclusion

This paper investigated methods to obtain dry unit weight for bentonite buffer material which is a very important component in the EBS system for the geological disposal of HLW. Three different

Table 1. Results of dry unit weight value

	Calculated value from Eq. (1)	Measured value	Note
Dry unit weight, γ_d (kg/cm³)	1,769	1,821	Initial γ_t=1,952
	1,714	1,802	Initial γ_t=1,917
	1,684	1,768	Initial γ_t=1,903

cylindrical sample of bentonite buffer block were prepared. Dry unit weight was valued from two different methods. One method describes that dry unit weight was obtained from Eq. (1) with water content and initial moist unit weight. The other method is that dry unit weight can be obtained by measuring dried volume and weight. Measured value showed 3~5% higher than calculated one. Since bentonite buffer block is confined with rock mass and backfill materials in the real disposal condition, volume change may not occur according to temperature and water content variation. Therefore, it might be more accurate to use calculated value in order to obtain dry unit weight of benotonite buffer material, not measured value after drying in the oven.

ACKNOWLEDGEMENT

This research was supported by the Nuclear Research and Development Program of National Research Foundation of Korea (NRF) funded by the Minister of Science, ICT and Future Planning.

REFERENCES

[1] Lee, M.S., Choi, H.J., Lee, J.W., Lee, J.P., Improvement of the thermal conductivity of a compact bentonite buffer, KAERI/TR-5311(2013).

[2] Lee, J.W., Choi, H., Lee, J.Y., Thermal conductivity of compacted bentonite as a buffer material for a high-level radioactive waste repository, Ann Nucl Energy 94(2016a), 848-855.