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Design of Performance Experiment for Gas Permeable Seal in LILW Disposal Facility

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1. Introduction

After closure of the LILW (Low- and Intermediate-Level radioactive Waste) disposal facility, the concrete silo will be saturated with ground water. Thus, ground water will contact with waste drums, so that various gases will be generated from several reactions such as metal corrosion, radiolysis and so on.

In order to prevent the overpressurization of concrete silo by generated gases, the gas ventilation system should be applied into the design of silo. A study on the development of gas ventilation system for the LILW disposal facility is under research by Korea Radioactive Waste Agency and the concept of gas permeable seal has been adapted as gas ventilation system from the study. The material of gas permeable seal is S/B (Sand/Bentonite) mixture referred to the international cooperative research [1].

For the performance evaluation of gas permeable seal, the lab-scale performance experiment has been designed.

2. Materials

2.1 Concrete Specimen

The concrete specimen has the same composition with the concrete silo in Wolsong LILW disposal facility (Table 1). The specimens were cured in water during 91 days and thus remain fully saturated.

The shape of specimen is cylinder and it has 15 cm of diameter and 5 cm of height (Fig. 1).

Fig. 1. Concrete specimen

2.2 Sand/Bentonite Mixture

The gas permeability of concrete silo was measured by experiment and the absolute gas permeability was 2.43×10^{-17} m^2 [2]. The gas permeable seal should have higher gas permeability than the silo. Therefore, the density of S/B mixture has been set as 1.52 g/cm^3 to have the absolute gas permeability of 1.0×10^{-16} m^2 from the empirical equation [1]. The mixing ratio of sand and bentonite is 80:20 in weight percent. The S/B mixture should have the same geometry with the concrete specimen. In order to assure the reproducibility of material, the mold with 15 cm of inner diameter was fabricated.

First, sand and bentonite were completely dried in oven and then they were sieved and weighed respectively. After then, sand and bentonite were mixed with the ratio of 80:20. Finally, small amount of water was added as a binder into the S/B mixture and the S/B mixture was compressed (Fig. 2).

Fig. 2. S/B mixture and mold

2.3 Experimental Apparatus

The experimental system consists of two loops: concrete specimen loop and S/B mixture loop. Each loop has a differential pressure gauge and a flowmeter. On the S/B mixture loop, there is a special loop for saturation. Fig. 3 shows the layout of the experiment.

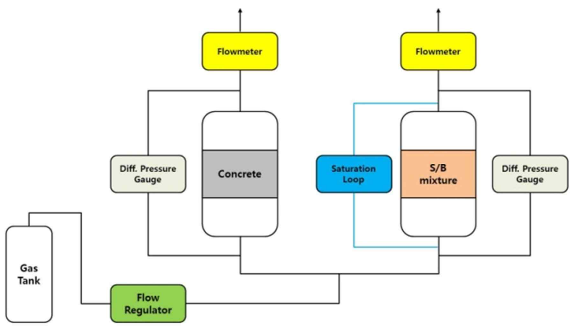

Fig. 3. Layout of the experiment

Table 1. Composition of the concrete specimen

Source of aggregate	Mix Type	W/(C+F) (%)	S/a (%)	Proportion (kg/m^3)							
				Water	Cement	Fly-ash	3/4"	Coarser	Finer	WRA	AEA
Daejong and Jinae Area	E-1-40	40.0	38.4	206	412	103	961	357	241	2.3193	0.1287

The vessel of concrete loop was designed to prevent the leakage along the side of concrete specimen. The side of concrete specimen is surrounded by Viton sleeve (Fig. 4). High-pressured gas will be injected into the outside of Viton sleeve, so that the side of concrete specimen and Viton sleeve will adhere together. Thus, the side of concrete specimen will be completely sealed.

Fig. 4. Viton sleeve and concrete specimen in vessel

However, the Viton sleeve cannot be used in the S/B mixture vessel since the strength of S/B mixture is very low. Therefore, sealing of the side of S/B mixture depends on the swelling pressure of bentonite after saturation (Fig. 5).

Fig. 5. Saturation of S/B mixture

2.4 Gas

It is expected that dominant gases will be hydrogen, methane and carbon dioxide after closure of the disposal facility [3]. However, nitrogen gas was used since hydrogen was excluded for the safety and methane and carbon dioxide were excluded due to high solubility.

3. Method

The concrete specimen and S/B mixture are emplaced in each vessel, respectively. Since the fabricated S/B mixture is not fully saturated, S/B mixture should be saturated first.

After saturation of S/B mixture, nitrogen gas with low flow rate will be injected into both vessels in parallel. The differential pressure and discharging flow rate of each vessel will be monitored continuously.

4. Conclusions

It is expected that nitrogen gas will penetrate S/B mixture than the concrete specimen since the gas permeability of S/B mixture is higher than that of the concrete specimen as designed. With the result, the performance of S/B mixture as gas permeable seal would be verified.

As the effective gas ventilation system is applied on the design of concrete silo, the integrity of engineered barrier in the disposal facility would be improved against the overpressure by generated gases.

ACKNOWLEDGMENTS

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