A Study on the Development of Advanced Barrier with wasted materials to Prevent TPH Pollution

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1. Introduction

Organic pollutants and inorganic pollutants enter groundwater through advection and diffusion. Pollutants cause various underground environmental pollution. NAPLs (non-equivalent phase liquid), one of the soil pollutants, is a representative organic pollutant that is not easily dissolved in water and does not mix, so it exists in the form of a fluid separated from water when introduced into the ground. NAPLs are divided into DNAPLs heavier than water and LNAPLs lighter than water. DNAPLs such as TCE (Trichloroethylene) and PCE (Perchloroethylene) are toxic pollutants that can cause cancer even in minimal amounts. It is heavier than water, so once it leaks underground, it acts as a groundwater pollutant for a long time. LNAPLs include TPH (Total Petroleum Hydrocarbons), and BTEX is lighter than water, so when it enters the ground, it moves with groundwater and pollutes the surrounding soil and streams. Sites such as railway and gas stations are difficult to apply the excavation method, so new measures are needed. In addition, remediation after contamination consumes high costs and causes social conflicts such as pollution neglect or disputes between interested parties. Therefore, preventing the advection and diffusion of pollutants is essential to prevent environmental pollution. Technologies that prevent the diffusion and transfer of pollutants include slurry walls and geomembrane barrier walls. The slurry wall has a low cost and low water permeability. However, there is a problem in that the water level of the upper class rises by completely blocking the flow of groundwater. Therefore, there is a need for advanced technology that can block only pollutants. Coal mine drainage sludge (CMDS) is sludge obtained by neutralizing acid mine waste from mines, including sulphide minerals, with alkali materials. Mine drainage sludge generally has a high iron and calcium content and a small particle size. Therefore, it seemed that the mine drainage sludge could replace bentonite. In this study, we intend to develop an advanced barrier with CMDS that can selectively block TPH. To this end, first, substances that react when contacting pollutants and exhibit impermeability were selected. Second, the physicochemical properties of a barrier by mixing ratio were analysed. Finally, the optimum mixing ratio of each material was selected.

2. Material and method

2.1. Components of Barrier

Table 1 shows the materials used in this study and the mixing ratio.

Table 1. Mixing ratio of materials for each barrier

	Silica sand (w/w%)	Polyolefin (w/w%)	Spillhound (w/w%)	Bentonite (w/w%)	CMDS (w/w%)
Case 1	55	9	21	12	3
Case 2				9	6
Case 3				6	9
Case 4				3	12
Case 5				0	15

2.2. Environmental hazardous of Materials

All components used in this study were evaluated for environmental hazards. The evaluation was analysed according to Korea Standard Leaching Procedure (KSLP; KS 06400).

2.3. Impermeability evaluation of barrier

The barriers were made by varying the proportion of the components, and the hydraulic conductivity of each barrier was measured. The hydraulic conductivity was analysed according to the Korean Industrial Standard KS F 2322. All tests were repeated three times.

3. Results and Discussions

3.1. Environmental hazards

Table 2 shows the results of the environmental hazards of each material used in this study. As a result of KSLP, heavy metals were not detected, so it was determined that there was no effect on environmental hazards.

Table 2. The results of KSLP

	Silica Sand (mg/L)	Bentonite (mg/L)	Polyolefin (mg/L)	Spillhound (mg/L)	CMDS (mg/L)
Pb	N/D	N/D	N/D	N/D	1.001
As	0.53	0.924	N/D	N/D	0.001
Cd	N/D	N/D	N/D	N/D	N/D
Cu	N/D	N/D	N/D	N/D	N/D
Cr6+	N/D	N/D	N/D	N/D	N/D

3.2. Hydraulic conductivity

Table 3 shows the hydraulic conductivity of each sample according to the mixing ratio. The hydraulic conductivity before TPH contact shows a value of 1.5×10-3 to 3.1×10-3 and 5.8×10-6 to 5.3×10-5 after contact.

Table 3. The results of hydraulic conductivity

	Case 1	Case 2	Case 3	Case 4	Case 5
Before	3.1×10^{-3}	2.1×10^{-3}	2.0×10^{-3}	1.8×10^{-3}	1.5×10^{-3}
TPH After	5.8×10^{-6}	5.9×10^{-6}	7.1×10^{-6}	3.5×10^{-5}	5.3×10^{-5}

4. Conclusion

This study attempted to develop an advanced barrier that selectively blocks the movement of pollutants with wasted materials. The characteristics of substances that can selectively adsorb pollutants were analysed and selected to develop an advanced barrier. The characteristics of changes in the hydraulic conductivity according to the mixing ratio of substances were examined. The change in the hydraulic conductivity was the largest in case 2, from 2.1×10^{-3} to 5.9×10^{-6}. Therefore, it is judged that the advanced barrier developed in this study can be applied to prevent TPH contamination.

5. References

Choi *et al* (2019)
Jang (2019)
Kim (2021)

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