# Preliminary Analysis on Radionuclides Transport in the Unsaturated Environment

Jaechul HA*, Jeonghwan LEE, and Jeonghyoun YOON
Korea Radioactive Waste Agency, 168 Gajeong-ro, Yuseong-gu, Daejeon, Republic of Korea
*jcha@korad.or.kr

## 1. Introduction

The assessment of the Wolsong LILW Disposal Center (WLDC) as a repository of radioactive wastes critically depends on the performance of the engineered containment system, and the natural, geologic system underlying the repository. The inventory of radionuclides, their mobilization and release from the repository, and their transport through the unsaturated zone (UZ) to the groundwater table and eventually to the biosphere are key factors and processes affecting the long-term performance of the system [1].

This study is performed using TOUGH2 code for multiphase flow and transport simulator [2]. And preliminary modeling has done to predict radionuclide transport using a physically based description of the relevant processes. In other words, simulations were performed and analyzed to the development of a simplified model of the WLDC.

## 2. Modeling approach

As shown in Fig. 1, 2-dimensional (2D) model representing the LILW second disposal facility was developed. It includes the host rock (saturated and unsaturated zone) and engineering barriers that consist of waste, concrete lining and cover.

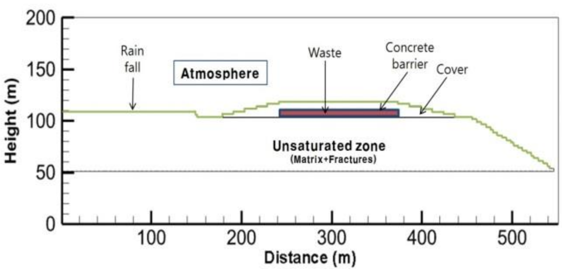


Fig. 1. Geometry and boundary conditions of the model.

Boundary conditions (specifically infiltration rates) and their implementation were appropriately adjusted in the model as well as steady-state simulation to obtain hydrological initial conditions under long-term infiltration.

Initial condition is shown as Fig. 2 and steady-state hydraulic head obtained from hydrological initial conditions under long term infiltration is shown as Fig. 3. Simplified groundwater flow path is shown as Fig. 4.

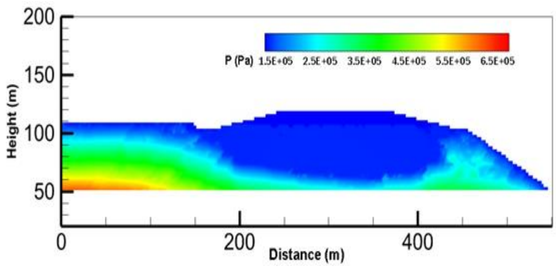


Fig. 2. Initial condition of unsaturated modeling area.

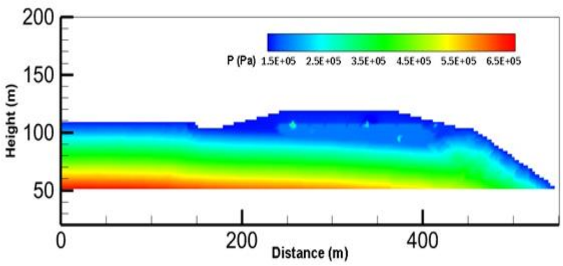


Fig. 3. Hydraulic head on the steady state.

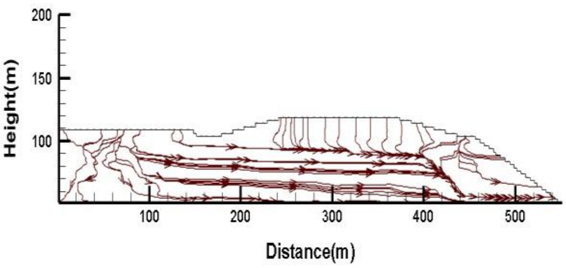


Fig. 4. Vector of groundwater flow path .

As for radionuclide property data set (specifically for the C-14 → N-14 decay chain), it was developed simple sub-model behavior of radionuclides in a simplified representation of the repository. Waste element in the modeling as represented by C-14 only.

Radionuclides transportation by advection and diffusion was simulated from the repository into unsaturated zone [3].

## 3. Results

Radioactive nuclide C-14 transportation was simulated for 300 years after closure, and the result is shown in Fig. 5. Most of C-14 including in the LILW disposal facility transported along ground-water flow path to east-south direction.

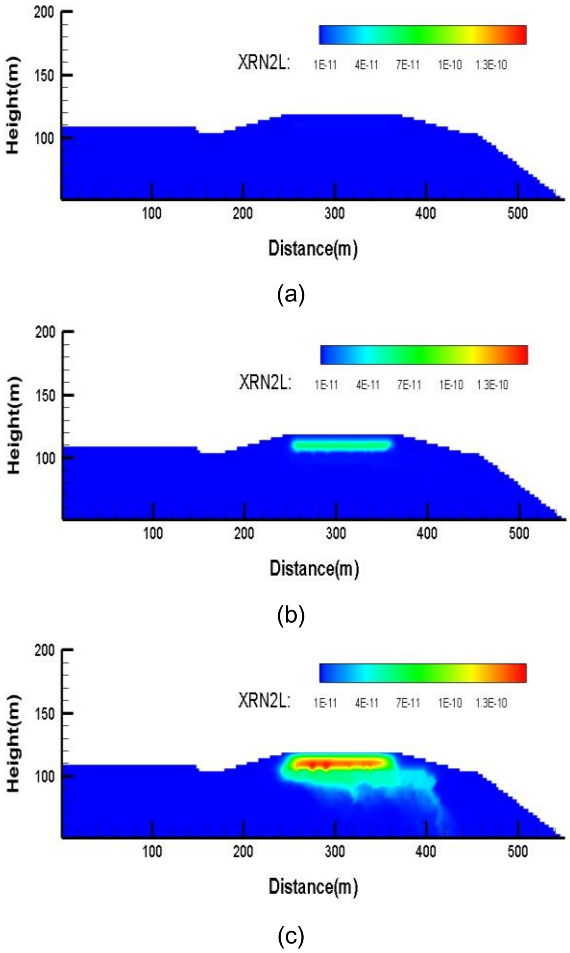


Fig. 5. Radioactive nuclide C-14 transport at (a) after 1 year, (b) after 50 years, and (c) after 300 years.

## 4. Conclusion

The preliminary modeling was carried out to analyze the RNs transportation in the LILW second phase disposal facility in Korea which is under licensing. In this modeling the amount of groundwater penetrating into the ground is important. The most important factors determining the unsaturated environment are the infiltration rate and medium permeability. For accurate modeling, validity of physical properties is required.

As a further detailed model to develop, it is essential to calculate the source term and condition in and around the repository. Such a model may either implement some conservative scenarios and assumptions about containment breaching and waste mobilization.


## Acknowledgements

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 Trade, Industry and Energy.


## REFERENCES


[1] Van Genuchten, M.Th., “A closed-form equation for predicting the hydraulic conductivity of unsaturated soils. Soil Sci. Soc. Am. J. vol. 44 (1980).

[2] Pruess, K., Oldenburg, C., Moridis, G.,” TOUGH2 user`s guide, Version 2.0, LBNL Report, LBNL-43134, Berkeley,CA (1999).

[3] Hinds, J., “Development of Numerical Grids for UZ Flow and Transport Modeling”, US DOE, 70p. (2001).