Nuclide Release Calculation in the Near-field of a Reference HLW Repository

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1. Introduction

The HLW-relevant R&D program for disposal of high-level radioactive waste has been carried out at Korea Atomic Energy Research Institute (KAERI) since early 1997 in order to develop a conceptual Korea Reference Repository System for direct disposal of nuclear spent fuel by the end of 2007. A preliminary reference geologic repository concept considering such established criteria and requirements as waste and generic site characteristics in Korea was roughly envisaged in 2003 focusing on the near-field components of the repository system[1]. According to above basic repository concept, which is similar to that of Swedish KBS-3 repository, the spent fuel is first encapsulated in corrosion resistant canisters, even though the material has not yet been determined, and then emplaced into the deposition holes surrounded by high density bentonite clay in tunnels constructed at a depth of about 500 m in a stable plutonic rock body.

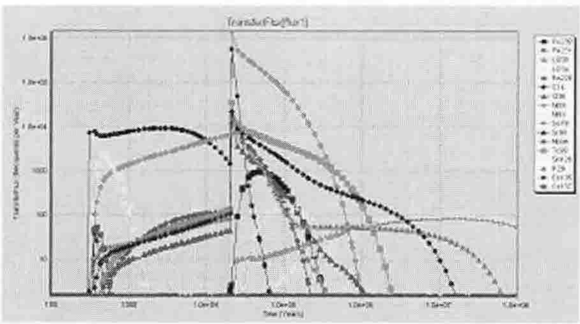

Fig. 1. Nuclide fluxes from the near-field of the HLW repository (suddenly changing hole area @10^4 years).

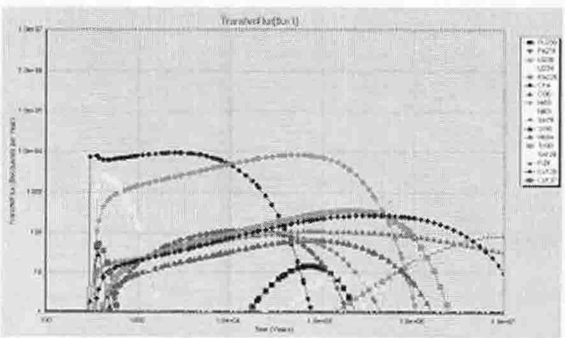

Fig. 2. Nuclide fluxes from the near-field of the HLW repository (constant hole area).

Not only to demonstrate how much a reference repository is safe in the generic point of view with several possible scenarios and cases associated with a preliminary repository concept by conducting calculations for nuclide release and transport in the near-field components of the repository, even though enough information has not been available that much yet, but also to show a methodology by which a generic safety assessment could be performed for further development of Korea reference repository concept, nuclide release calculation study strongly seems to be necessary.

2. Release calculation

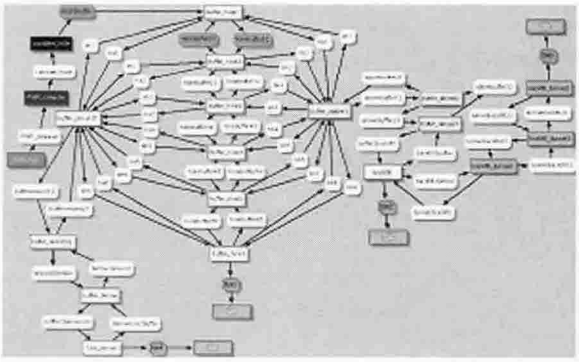

Fig. 3. Compartment modeling for nuclide release calculation.

For normal case assuming or taking reasonably all the values of input parameters from various sources several quantitative calculation and comparisons among various release pathways are made through this study as similarly done for KBS-3 type repository [2-4]. To this end such near-field barriers as canister, surrounding buffer, and excavation damaged zone as well as some far-field components including host rock and outer tunnel part are modeled as independent compartments accounting for their geometry and materials through which nuclides released from the canister are transferred and transported. Most transfers between each near-field compartment are specified in terms of resistances between adjacent two compartments which is given by

$$\Omega^{ij} = \frac{1}{2A^{ij}}\left(\frac{d^i}{D^i} + \frac{d^j}{D^j}\right)$$ where A^{ij} = common area between the two compartment, A = area perpendicular to transport direction, D = effective diffusion coefficient, and d = length of the compartment in the direction of transport except for transfer resistances from the source term as well as to far-field geosphere both of which are differently approached. The associated transfer rate between compartments i and j is then given by

$$\lambda^{ij} = \frac{1}{\phi^i R^i V^i \Omega^{ij}}$$ where ϕ^i =compartment porosity, R^i = retardation, and V^i = compartment volume.

Illustration of quantitative estimation of nuclide release are typically as shown in Figs.1 and 2 under consideration of the material balance over each compartment to the other compartments as introduced in Fig. 3.

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