Nuclide Transport Behavior in the Fracture Around a Conceptual German HLW Repository

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1. Introduction

After Fukushima NPP accident, Germany has decided to gradually abrogate nuclear power generation. By 2018 more than 28,000 cubic meters of high-level radioactive waste are expected to be stored when all the NPP and research facilities are finally decommissioned.

Currently radioactive waste is placed in interim storage facilities, with spent nuclear fuels mostly stored at reactor sites. Most German used fuel is reprocessed overseas, from which vitrified HLW arises (for the part of contracts signed up to 1989) is stored in surface facilities at Gorleben and Ahaus.

According to a draft national radioactive waste disposal program proposed by environment ministry and adopted by the German cabinet in 2015, for the final disposal of radioactive waste, the former iron ore mine, Konrad is proposed exclusively for LILW waste, and for HLW another site which will be determined in 2022 around when the last NPP is shut down.

In 2016, another report that provides a recommended method for the disposal of waste in a geologic repository was prepared. According to the report, the safest site is to be sought in a three-phase process and defined by federal law. The site selection should be accompanied by extensive nationwide public participation. And the rock in which repository will be placed could be such various rock type of clay or crystalline over salt.

The research project, ENTRIA[1] is disposal options currently being considered in Germany in cooperation with 11 institutes at German universities and research facilities as well as one Suisse partner for radioactive residues which requires interdisciplinary analyses and development of evaluation principles.

For analyzing radioactive waste management subjects from the viewpoint of all involved academic disciplines such as natural sciences, engineering, and possible whatever, ENTRIA is engaged in finding options for the disposal of HLW, which actually means heat generating radioactive waste in Germany.

Past discussions in decades throughout the society and feedback on recent political events have clearly shown that this kind of complex issues may never be solved from solely pure technical, academic, or natural science viewpoints through research and development. That is the reason ENTRIA combines technical and social aspects of the following three most important radioactive waste management options: 1) Final disposal in deep geological formations without retrieval (maintenance-free), 2) Disposal in deep geological formations with monitoring and retrieval option, and 3) Simple surface storage.

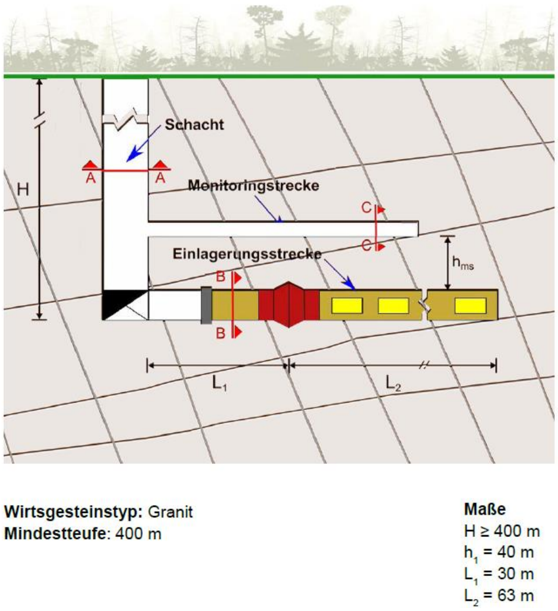

Fig. 1. An ENTRIA HLW disposal concept.

Working independently from politics, any specific consideration of sites and their qualification studies for a repository is excluded in the project.

Through this study we have tried to technically assess a limited far-field part of the hypothetical repository (Fig. 1.) in the crystalline geological rock medium, which is conceptually being considered for

ENTRIA as a candidate among possible other rock media, in which HLW is supposed to be disposed of.

Two physical sensitivities of travel distance and matrix diffusion perpendicular to the wall of the fracture associated with nuclide transport in the fractures were investigated in view of safety assessment of the repository.

2. Results

Along the fracture zone in the crystalline rock medium with a higher hydraulic conductivity than the near-field area and through which nuclides that are released from artificial barriers, a fast nuclide transport is anticipated with advection dominated as well as the dispersion and rock matrix diffusion. Two separate results, one of which is from probabilistic assessment for sensitivity of the travel length variation, and the rest of which is from a deterministic comparative evaluation to see the effect of the matrix diffusion are shown in turn. All the data used are found in the report. [2]

2.1 Travel Length

In order to observe the behavior of the nuclide flux released from the fracture in accordance with varying travel lengths in the fracture, a hypothetical pdf following a triangular distribution for the stochastic travel lengths were introduced.

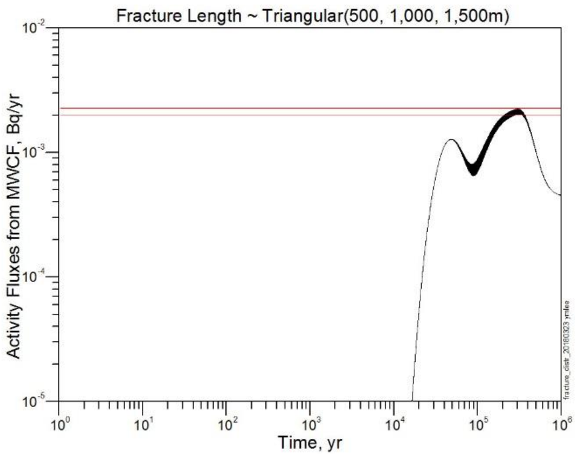

Fig. 2. Sensitivity of the travel distances for selected nuclides to their released rates from the fracture, based on a (Tri(500, 1000, 1500m)) distribution of all travel lengths.

Breakthroughs for selected nuclides from a probabilistic calculation with several thousand Latin hypercube sampling for the travel length is shown in Fig. 2. A rather broad band of the second peak values are found in the figure, showing rather high sensitivity of the travel length to the nuclide flux.

2.2 Matrix Diffusion

Behavior of nuclide fluxes from the fracture was also observed and compared with each other in Fig. 3, when matrix diffusion into the rock matrix takes place or not.

As seen in the figure some nuclides such as ^{241}Am and ^{243}Am which have relatively high degree of retardation show their large difference in their peak fluxes are found.

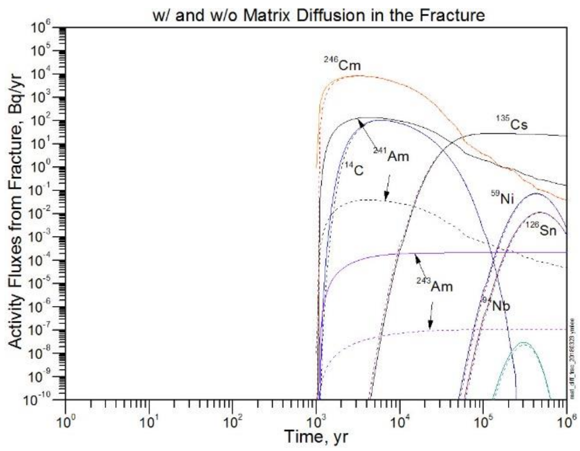

Fig. 3. Breakthroughs in case of no matrix diffusion (solid), compared to the case of matrix diffusion (dashed).

REFERENCES

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[2] Youn-Myoung Lee and Dong-Keun Cho, A GoldSim Model for Performance Assessment of a Horizontal-Type ENTRIA Repository, KAERI/TR-7189/2018.