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Impact of different factors on gas migration in the disposal cell of conceptual geological repository for high level radioactive waste

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1. Introduction

The usage of the nuclear materials in the industry and health care areas lead to appearance of the nuclear waste of different kind (activity, radionuclide inventory, etc). Some of these waste, i.e. low and intermediate level waste is being disposed of in near surface repositories. The long-lived and high level radioactive waste (HLW) such as spent nuclear fuel, which is a minor part of all nuclear waste by volume, but contains major piece of the radioactivity are best disposed of in geological repositories using a system of engineered and natural barriers [1]. The multiple barrier concept is the cornerstone in all proposed schemes for the underground disposal of radioactive wastes. The concept invokes a series of barriers, both man-made and natural, between the waste and the surface environment. Depending on the waste category and disposal concept, the barriers are: (a) the chemical barrier (conditioned waste), (b) the physical barrier (waste canister), (c) the engineered barrier (clay buffer/backfill, linings, high-integrity seals, etc.) and (d) the geological barrier or low-flow geological environment. The intention of such disposal is to provide sufficient isolation from human activities and natural processes, such, that the transportation of radioactive nuclides in the geosphere will be a very slow process and their eventual release to the biosphere will be in such low concentrations that they do not pose a hazard to human health and the natural environment.

Although there is no repository for HLW operating worldwide, a significant progress has been made on this subject. International nuclear community has conducted extensive research related to deep disposal of these waste over the past few decades. The underground research laboratories have been developed in several countries such as Belgium, Canada, Germany, Finland, France, Sweden, Switzerland, United Kingdom and USA, to address the fundamental issues on whether or not a particular rock mass type would be suitable as a repository host rock. Scientists from different countries perform own investigations and also participate in international collaborative research projects within experimental and numerical analyses are being performed, obtained results are compared and new theories are formulated. Furthermore, development of more sophisticated models is becoming more important to provide the theoretical background for performance and safety assessment of the waste disposal system.

Gas and its influence on the long-term safety of geological repositories have been investigated for almost fifteen years. EVAGAS [2], MEGAS [3], PEGASUS [4], GASNET [5] and PAMINA [6] are the international projects which were held to investigate gas problem in the perspective of geological repository safety. During these investigations it was established that radioactive wastes and their disposal packages (steel canisters), as well as reinforcement steel used in the construction of the repository, are the principal sources of gas generation. Among four possible ways of gas generation (corrosion of metal components, microbial degradation, radiolysis and radioactive decay), anaerobic corrosion of the steel components in the engineered barrier system (EBS) is a dominant source of hydrogen gas. The impacts on the geological repository long-term safety could be grouped into categories according to the type of effect caused by the generation of gas: (a) the mechanical effects on repository and rock structures caused by the pressure build-up that may follow if the gas cannot escape through the low-permeability host rock in dissolved state (disruption of the EBS, fracturing of the host rock), (b) the direct effect of gas on groundwater flow around the repository (induced groundwater flow, forcing of contaminated water from the repository or canisters, transport associated with bubbles), (c) the release of volatile radionuclides and toxic gas up to the biosphere.

At present no facts of existence of the potential risks or their possible rejection have been found, hence international investigations are going on. Investigations carried out within EU-FP7 project FORGE (Fate Of Repository Gas) are concentrated on the analysis of the generated gas behaviour in the geological repositories. Researchers of nuclear engineering laboratory of Lithuanian energy institute (LEI) are participating in the numerical investigations section, which is coordinated by the French national radioactive waste management agency ANDRA. For a comprehensive understanding of the long-term hydraulic evolution of geological repository, numerical two-phase flow simulations are compulsory. It is effective approach for investigating the processes of pressure build-up due to gas generation and its influence on the repository system.

In the recent study [7] the LEI results of gas migration modelling in single disposal cell of conceptual geological repository for high-level radioactive waste were presented. Only case using reference parameter values which were proposed in FORGE benchmark specification [8] were analyzed. The gas transport modelling was performed using TOUGH2 code, which is applicable worldwide for such type of problems [9-11].

In this study the LEI results of the parameters sensitivity analysis is presented. This analysis was done in order to investigate the behaviour of hydrogen gas comparing with reference case. The analysis was focused on the evaluation of peak pressure in disposal system and hydrogen gas fluxes through different surfaces.

2. Definition of the problem

To be able to understand water and gas flow at the repository scale it is necessary to understand the water and gas flow at cell scale (e.g. on the scale of a vault or tunnel). For this reason, the first benchmark was defined at cell level. The type of cell considered [8] is a somehow generic HLW cell in a clay host rock (Fig. 1). In the direction of the disposal cell axis, the extension is assumed to be 60 m taking into account the length of the cell, the distance between the bottom of two adjacent cells in this direction and the radius of the access drift. The radius of the axisymetric domain is a compromise between the inter-cell distance along the access drift and the thickness of the geological layer and is assumed to be 20 m.

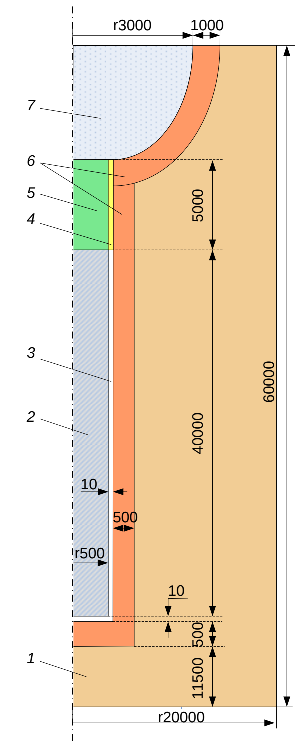

Fig. 1 Principal scheme of disposal cell: *1* – clay rocks; *2* – HLW canisters; *3* – waste interface; *4* – plug interface; *5* – bentonite plug; *6* – EDZ; *7* – access drift

The HLW canisters *2* are transported by shafts down to the main tunnel at the 500 m depth below ground level, from which they are transported by access drifts *7* to the disposal cell situated in the clay rock *1*. The HLW canisters are placed in these cells one after another and finally they are sealed with bentonite plug *5*. As the diameter of disposal cell will be slightly more than diameter of HLW canisters, there will be thin engineered gaps *3, 4* between the HLW and engineered disturbed zone (EDZ) *6* and between the bentonite plug and EDZ after the placement of the canisters. During the operational phase of the repository, shafts, main tunnel and drifts are ventilated. The clay and the EDZ are depressurized and desaturated. After the emplacement of the HLW canisters the access drift, main tunnel and shafts are backfilled with the mixture of crushed rock and compacted bentonite. Then start the resaturation of the clay rocks and backfill material. At the same time the corrosion of steel canisters causes hydrogen to be generated in a repository.

The objective of this benchmark exercise is to model gas source (located in the disposal cell) and the transport pathways constituted by interfaces, plug and drift using a full physical model described in task specification [8]. The following questions concerning long term behaviour of the system should be answered: (a) what is the peak pressure expected in disposal cell during the gas generation phase and could this pressure affect the mechanical stability of repository, (b) which could be the relative role of the interfaces, EDZ and backfill to the migration of gas, (c) where are the main gas pathways.

3. Multiphase flow analysis

3.1. Basic concept of gas migration

The materials contained within the system being analyzed are assumed to be a three phase porous medium, consisting of solid skeleton, pore-liquid and pore-gas (Fig. 2).

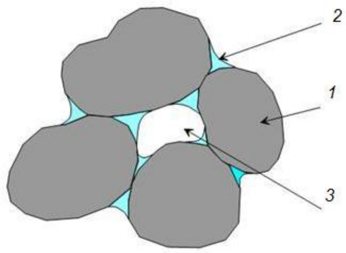

Fig. 2 Schematic representation of unsaturated media: *1* – solid phase; *2* – liquid phase (water and/or dissolved hydrogen); *3* – gas phase (hydrogen and/or water vapour)

Gas migration through low-permeable rock formations is controlled not only by the hydraulic and mechanical properties of the rocks (intrinsic permeability, porosity, rock strength), but also by the gas pressure and the hydro-mechanical state of the rock (liquid saturation, porewater pressure) [12].

Due to anaerobic corrosion of the disposal canisters, hydrogen will be released in the engineered gap between these canisters and the EDZ. At the beginning hydrogen will dissolve in the pore water and diffuse through the EDZ towards undisturbed clay formations. Once the concentration of gas in the pore water reaches the gas solubility limit, a free gas phase will appear. It is important to note that the existence of a two-phase system, i.e. water-gas, does not necessarily imply two-phase flow [6]. Gas flow will only happen when the gas saturation is large enough to displace pore water, or equivalently, when the gas pressure exceeds the gas entry pressure of the saturated porous medium. These values depend on the characteristics of the capillary pressure / liquid saturation function, also called “water retention curve”, of the considered porous material. Up to now, there is no definite conclusion about what will happen if the gas pressure keeps increasing. Two hypotheses exist:

1. Some kind of cyclic behaviour of opening and closing of the preferential flow paths is expected [13]. If

the gas pressure locally exceeds the lithostatic (rock mass) pressure, large mechanical deformations will affect the solid skeleton and eventually fractures may appear. The gas may then escape through a preferential flow path, which will most likely be situated along the EDZ. Continuous fluid flow models such as TOUGH2 will then no longer be applicable to such kind of discrete flow paths.

2. Dilatancy-controlled gas flow is expected to take place [14]. The process of gas-driven microfracturing leads to an increase of the pore space, which is accompanied by a detectable increase in intrinsic permeability. Because the dilatation does not create a discontinuous pore network, gas flow is still controlled by a continuous two-phase flow model applicable to a porous medium. The main difference with respect to the conventional two-phase flow is that the transport properties of the porous media depend on the mechanical deformation.

3.2. Modelling tool

The gas transport modelling was performed with the original version of TOUGH2 [15] code using PETRASIM as the graphical interface. TOUGH2 is a numerical simulator for nonisothermal flows of multicomponent, multiphase fluids in one, two and three-dimensional porous and fractured media. The EOS5 fluid property module was selected for the description of the thermodynamics of hydrogen gas.

In this study all the gases are treated as hydrogen. Hydrogen dissolution in the pore water follows Henry's law. Gas and liquid flow is governed by a multiphase extension of Darcy's law

$$V_\beta = -\frac{k k_r^\beta \left(S_\beta\right)}{\mu_\beta}\left(\nabla P_\beta + \rho_\beta g \nabla z\right) \tag{1}$$

where β denotes the phase of the fluid (liquid or gaseous), V_β is Darcy's velocity for phase β, k is the intrinsic permeability, k_r^β is relative permeability, S_β is saturation level, μ_β is the viscosity, P_β is the phase pressure, ρ_β is the phase density, g is the gravity of acceleration, z is the altitude.

Diffusion processes in the gas and liquid phases are described by Fick's Law. The diffusive flux for the mixture of hydrogen and water vapours can be written as

$$f^{gas} = \rho_{gas} D_{H_2}^{gas} \nabla X_{H_2}^{gas} \tag{2}$$

where $D_{H_2}^{gas}$ is the diffusion coefficient of hydrogen in the water vapour and $\nabla X_{H_2}^{gas}$ is the gradient of mass fraction of hydrogen gas.

The diffusive flux for the dissolved hydrogen is written as:

$$f^{liq} = \rho_{liq} D_{H_2}^{liq} \nabla X_{H_2}^{liq} \tag{3}$$

where $D_{H_2}^{liq}$ is the diffusion coefficient of hydrogen in the water and $\nabla X_{H_2}^{liq}$ is the gradient of mass fraction of the dissolved hydrogen.

The TOUGH2 solves mass balance equations by the integrated finite difference method. The equations are set up by combining mass balance, advection flux and diffusion flux and solved by supplementing with a number of constitutive equations. The van Genuchten [15] model has been selected to express capillary pressure in relation to the saturation of the porous medium. Relative permeability depends on effective saturation and is expressed by van Genuchten – Mualem [15] model.

3.3. Numerical model

The numerical model representing the system being analyzed was developed according to the given task specification [8], that defines model geometry, description of physical processes and their mathematical expression, characteristic of materials and the initial and boundary conditions.

As most of the materials in this benchmark are assigned very low permeability, capillary process will be dominant over gravity. Therefore two-dimensional symmetric disposal cell model in cylindrical r-z system was analyzed. As the scale is quite small (few tens of meters) it is possible to represent fine geometric features and especially the interfaces. Both interfaces considered as centimetre-thick regions and are represented with one layer of grid elements. The whole domain was meshed with ~5,000 rectangular elements and is refined in EBS due to higher gradients of the physical variables and a finer result resolution required.

The canisters are constituted of a material impermeable to both liquid and gas flow and were not explicitly represented in the model. Gas transport analysis was conservatively considered to be isothermal with a constant temperature of 20°C, i.e. residual heat removal from canisters was neglected. The gas source term ($Q_g^{H_2}$ = 100 mol/year/disposal cell) was represented by a simple step function lasting 10000 years. In the numerical model hydrogen gas was injected direct to the waste interface. The simulation time was limited to 100000 years.

It is assumed that after the closure of the repository, gas saturation is 30% in the bentonite plug and access drift and 95% in both interfaces. The remaining part of computational domain is fully water saturated. Initial groundwater pressure is set to be 5 MPa in all water saturated parts of the model (according to a continuous formulation, the gas and water pressures are the same if there exist only dissolved gas). In parts of the model that are not initially fully water saturated, gas pressure is set to be 0.1 MPa. Then water pressure is in capillary equilibrium with the gas pressure and is deduced from the gas pressure and the saturation by applying van Genuchten model associated with each material. The outer radial boundary condition (constant liquid pressure) and the condition on the boundary of the access drift (time varying gas pressure and gas saturation) were implemented precisely as they described in task specification. All other boundary conditions were designated as no-flow.

3.4. Sensitivity cases

The sensitivity cases were intended to explore the system behaviour when physical parameters are varied within their uncertainties range. A series of sensitivity cases (Table 1) were performed in order to compare the results with reference case.

Table 1

Description of analyzed sensitivity cases

Analysis no.	Analysis ID	Description
1	REF	**Reference case**
2	S1	**Self healing of the EDZ**. The EDZ is supposed to have the same intrinsic permeability value as the undisturbed clay, because the evolution of the EDZ permeability with time is not well known, some data shows a reduction of permeability with time down to values similar to those of the undisturbed rock. Concerning the relative permeability and retention curves of the EDZ, no consistent data are available; consequently these functions are still the same as in reference case
3	S2	**Change of relative permeability function**. Some experimental measurements shows, that depending of the type of clay rock, van Genuchten – Mualem function is not always the best choice for relative permeability. For certain data a power law (Fatt and Klikoff function) fits quite well the measurements. In this analysis van Genuchten – Mualem relative permeability function has been changed to Fatt and Klikoff function for clay rocks and the EDZ
4 5	S31 S32	**Variation of diffusion coefficient**. Uncertainties for the diffusion coefficient of dissolved hydrogen in porous medium are quit high and this parameter can have real impact on hydrogen content in gas phase. Two opposite sub cases were analyzed: (S31) – higher diffusivity: diffusion coefficient for dissolved H_2 is multiplied by a factor 10 in all materials, (S32) – no diffusion at all: in order to determine potential peak of gas pressure (unrealistic case)
6 7 8	S41 S42 S43	**Gas generation delay**. Hydrogen production is linked to steel corrosion in reductive chemical conditions, which is likely at water saturated conditions. Initially the cell is not saturated and hydrogen generation should not be possible in reference case. Three sub cases were analyzed: (S41) the gas generation delay for 10 years, (S42) the gas generation delay for 100 years, (S43) no gas generation at all – in order to examine the response of the system and the influence of time dependent boundary conditions to the results
9 10 11	S51 S52 S53	**Less permeable interface**. Data on interface hydraulic parameters are very poor and less permeable interface is in the range of uncertainty. Three sub cases were analyzed: (S51) decreasing the intrinsic permeability value of the waste interface from the base value of 10^{-12} m^2 to 10^{-15} m^2, (S52) intrinsic permeability value of the waste interface decrease to $8\cdot10^{-18}$ m^2 (is the same as EDZ), (S53) analysis without considering the interface (gas generated direct to the EDZ)

4. Results

As has been stated before, LEI results of gas transport modelling for reference case were presented in [7]. The obtained results could be summarized as: (1) observed peak pressure (5.8 MPa) within modelled domain does not cause mechanical effect on repository and rock structures; (2) significant levels of gas saturation are reached in the interfaces and access drift, minor amount of free gas concentrates in some parts of the EDZ, no free gas is detected in undisturbed clay rocks; (3) most of generated gas is transported in gas phase by advective flow while remaining part is dissolved and is transported by diffusion into the clay rock. The interfaces play an important role for gaseous hydrogen movement from the disposal cell toward the drift.

4.1. Peak pressure

Comparing observed peak pressure in all analyzed cases (Table 2), it can be seen, that pressure increase up to 0.2-2.8 MPa from initial groundwater pressure and these values do not exceed allowed (lithostatic) pressure which is about ~10 MPa in this repository concept. In many cases the peak pressure is fixed just before the end of gas generation (after 10,000 years). In two cases (S31 and S43) the peak pressure (~5.2 MPa) is very close to initial pressure (5 MPa) and is observed on the outer boundary of access drift after 20,000 years. This is related with time dependent boundary conditions which were implemented according benchmark specification. These results are coherent, because most optimistic cases – of higher diffusivity and without gas injection were analyzed.

Table 2

Comparison of observed peak pressure in analyzed cases

Analysis ID	Peak pressure, MPa	Occasion time, years	Zone in the model
REF	5.8	10000	Waste interface
S1	7.8	20	Bentonite plug
S2	5.7	10000	Waste interface
S31	5.2	20000	Access drift boundary
S32	6.2	20000	Bentonite plug
S41	5.7	10000	Waste interface
S42	5.7	10000	Waste interface
S43	5.2	20000	Access drift boundary
S51	5.7	10000	Waste interface
S52	6.2	10000	Waste interface
S53	6.6	10000	EDZ

The highest pressure (7.8 MPa) is observed in the case S1 (in the bentonite plug). This is linked to the fact that intrinsic permeability of the EDZ is lower than in bentonite plug in this case. Dissolved hydrogen is transported by advection toward the unsaturated plug first. After resaturation of the bentonite plug the dissolved hydrogen is transported toward the drift by diffusion and the pressure is decreased despite the gas generation continues. Similar scenario is analyzed in case without diffusion at all (S32), where pressure is rising up not only during the gas generation period but after that as well. The peak pressure (6.2 MPa) is observed after 20000 years. In this case fluid transport is performed only by advective flow, which is controlled by the prescribed boundary condition at the outer boundary of access drift. The peak pressure in other sensitivity cases is not so high compared with reference case and always at the waste interface is observed.

Summarizing, it may be noted that the highest peak pressure is observed in the cases S1 and S53. Removal of EDZ (S1) has significant impact at early times, limiting gas migration from the access drift and modifying the distribution of pressures in the bentonite plug and the EDZ. The case without waste interface at all (S53) determines the higher depressurization and pressure in the EDZ and close preferential flow path along interfaces.

4.2. Hydrogen fluxes

The generated hydrogen could be in gaseous or liquid (dissolved in porewater) forms. Gaseous hydrogen flow results of reference case (Fig. 3, positive flow rate imply flow toward the drift or out of the system) showed that the loss of the gas from the disposal cell is dominated by the transport of gaseous hydrogen into the access drift (Fig. 3, curve *2*) during the period of gas generation. The large negative flow rate at early time is caused by the gas movement from the drift toward the EDZ as the groundwater flows towards the access drift boundary and displaces gas in the access tunnel. The gaseous H_2 flux toward the drift stops after the gas generation period and loss of gas from the disposal cell become dominated by the dissolved H_2 flux through the radial boundary (Fig. 3, curve *3*).

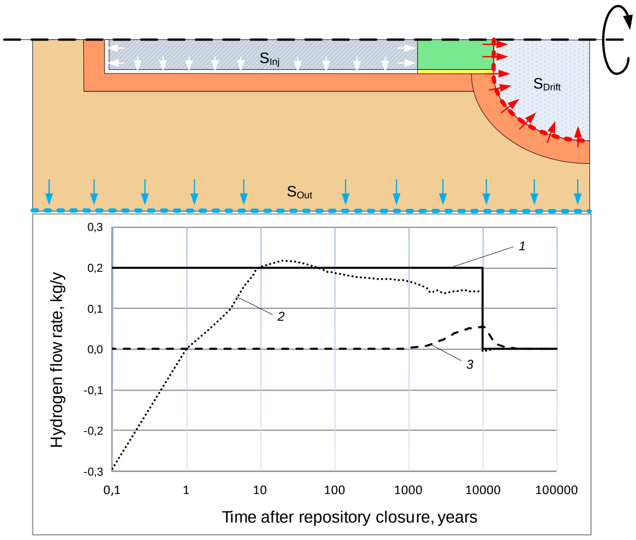

Fig. 3 Comparison of hydrogen flow rates: *1* – hydrogen gas injection rate; *2* – gaseous hydrogen flow into the drift from the bentonite plug, plug interface and EDZ; *3* – dissolved hydrogen flow out of radial boundary

The hydrogen flow rates through different surfaces are compared with reference case and are summarized in Table 3. As could be seen no effect on the flow rates are determined in cases S2, S41, S42 and S51. The alternative relative permeability function for EDZ and clay rocks (S2) does not change gaseous fluxes, because free gas movement is dominating through the interfaces. This factor does not influence dissolved hydrogen flux through S_{EDZ} as well. The delay of gas generation (S41 and S42) has minor impact on fluxes only at early times (delay period). Less permeable interface (S51) does not change the fluxes while the waste interface still remains most permeable component in the analyzed system.

Table 3

Hydrogen flow rate through different surfaces for analyzed cases comparing with reference case

Analysis ID	Gaseous H_2 through S_{Drift}	Gaseous H_2 through S_{EDZ}	Dissolved H_2 through S_{EDZ}
S1	=	<<	>>
S2	=	=	=
S31	<<	<	>
S32	>	<<	<<
S41	=	=	=
S42	=	=	=
S43	<<	<<	=
S51	=	=	=
S52	<	>	<
S53	<	>>	<

Unrealistic and most pessimistic case without diffusion at all (S32) determines highest flow rate of gaseous H_2 toward the drift. Other cases (S31, S52 and S53) demonstrate lower rates comparing with reference case. The exceptional case without gas generation at all (S43) demonstrates only negative gaseous fluxes from the drift.

The gaseous H_2 fluxes from the EDZ to undisturbed clay are lower in all analyzed cases except sensitivity cases S52 and S53. The value of intrinsic permeability is the same in both cases, but other material properties (porosity, relative permeability and capillary pressure functions) are different. These changes have significant impact on the fluxes (Fig 4). It is noticed that the gas fluxes toward undisturbed clay are increased significantly in these cases due to build-up of free gas in the EDZ. The interface plays less important role for gaseous H_2 movement from the disposal cell toward the drift comparing with reference case.

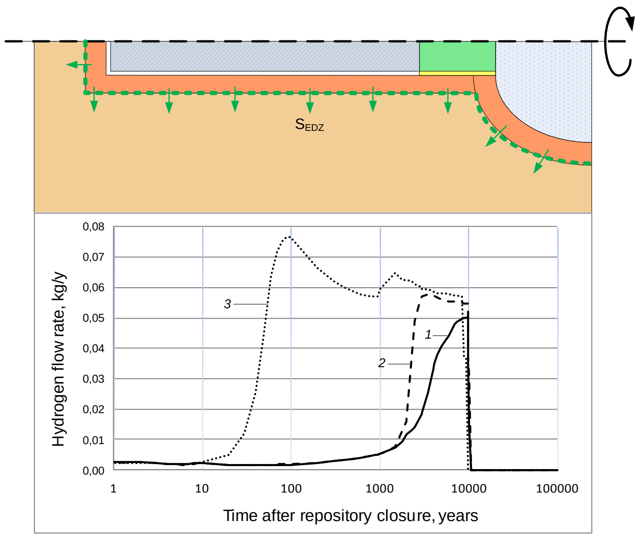

Fig. 4 Comparison of gaseous hydrogen flow rates through the EDZ (*1* – reference case, *2* – sensitivity analysis when permeability of waste interface is equal to the permeability of EDZ, *3* – sensitivity analysis without considering interface)

Dissolved H_2 fluxes through analyzed surface are higher in case with higher diffusivity (S31) and case where highest peak pressure was determined (S1). It is very important that in case without considering gas generation (S43) the flow rate of dissolved H_2 through the EDZ is similar to the flow defined in reference case. This means that the diffusive fluxes originate mainly from the partial desaturation of the access drift rather than from the gas generation around the canister. The boundary conditions imposed at the drift can have strong impact on the results.

5. Conclusions

After assessment of the impact of different factors (Table 1) on hydrogen gas migration in the disposal cell of conceptual geological repository for radioactive waste such conclusions can be made:

1. Modelling results revealed that in the case of self healing of EDZ (S1) the highest peak pressure (7.8 MPa) is observed. However this factor has minor impact on gaseous H_2 flow rate from disposal cell toward the access drift comparing with reference case.

2. In the case of different relative permeability function for geological medium (S2), the peak pressure and H_2 flow rates through different surfaces are similar to reference case.

3. Variation of diffusion coefficient has strong impact on the results. In the case of higher diffusivity of dissolved hydrogen (S31), the lower peak pressure (5.2 MPa) is observed comparing with reference case (5.8 MPa). In the case without diffusion at all (S32), the observed peak pressure is higher (6.2 MPa). The higher flow rate of gaseous H_2 into the drift and lower flow rates through EDZ are observed also.

4. Delay in H_2 gas generation for 10 years (S41) and for 100 years (S42) has no impact on peak pressure and very minor impact on H_2 fluxes. In the case without gas generation at all (S43) much lower peak pressure (5.2 MPa) than in reference case is observed. However the flow rate of dissolved H_2 through the EDZ is similar to reference case. This means that the boundary conditions imposed at the drift can have strong impact on the results.

5. Different intrinsic permeability values for waste interface have different impact on peak pressure and hydrogen flow rates. While waste interface remains most permeable component in the disposal system (S51) there is no impact on the results. As permeability of waste interface is the same as in the EDZ (S52) and in the case without considered interface (S53) the observed peak pressures are higher (6.2 MPa and 6.6 MPa respectively) comparing with reference case. The gaseous H_2 flow rates toward the drift are lower and interface plays less important role for gas movement.

6. The results on different factors effect showed the peak pressure increase up to 0.2-2.8 MPa from initial groundwater pressure and these values do not exceed allowed (lithostatic) pressure (~10 MPa). This proves that numerical tool based on two-phase flow approach is capable to model the gas transport in such geological repository system.

Acknowledgments

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ĮVAIRIŲ VEIKSNIŲ ĮTAKOS TYRIMAS VERTINANT DUJŲ SKLAIDĄ KONCEPTUALIAME GEOLOGINIAME LABAI RADIOAKTYVIŲ ATLIEKŲ LAIKYMO TUNELYJE

R e z i u m ė

Straipsnyje pateikiami skaitinio įvairių veiksnių įtakos dujų sklaidai, konceptualiame geologinio atliekyno tunelyje laikant labai radioaktyvias atliekas, vertinimo rezultatai. Įvertinta, kokią įtaką turi tokie veiksniai kaip absoliučiojo skvarbos koeficiento sumažėjimas inžineriniame tarpelyje ir kasimo sutrikdytoje zonoje, santykinio skvarbos koeficiento geologinėje aplinkoje pasikeitimas, vandenyje ištirpusio vandenilio difuzijos greičio pasikeitimas, dujų generacijos vėlavimas. Nustatyta, kad didžiausią įtaką maksimaliam slėgiui turi absoliučiojo skvarbos koeficiento sumažėjimas kasimo sutrikdytoje zonoje. Absoliučiosios skvarbos koeficiento mažėjimas inžineriniame tarpelyje lemia jo, kaip pirmenybinio dujų kelio iš laikymo tunelio į transportavimo tunelį, užsidarymą.

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IMPACT OF DIFFERENT FACTORS ON GAS MIGRATION IN THE DISPOSAL CELL OF CONCEPTUAL GEOLOGICAL REPOSITORY FOR HIGH LEVEL RADIOACTIVE WASTE

S u m m a r y

The numerical modelling results of different factors impact on hydrogen gas migration in the disposal cell of conceptual geological repository for high level radioactive waste is presented in this paper. The assessment of various factors such as self healing of EDZ, different relative permeability function for geological medium, variation of diffusivity factor of dissolved hydrogen, delay of gas generation, lower intrinsic permeability values for waste interface has been performed. Modelling results showed that decreasing of intrinsic permeability value in the EDZ has major impact on peak pressure. Decreasing of intrinsic permeability value in waste interface closes the preferential flow paths for gaseous hydrogen from disposal cell toward the access drift.

Keywords: geological repository, high level radioactive waste, gas migration modelling

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