Long-term
Performance of
Engineered
Barrier
Systems

PEBS Newsletter No. 2

This newsletter rounds up PEBS progress and the latest results from Work Packages (WP) 1 and 3 presented by SKB and CIMNE at the 2nd annual PEBS plenary at Beijing.

IMPACT OF PROCESSES ON THE LONG-TERM PERFORMANCE, SKB CONTRIBUTION

A state of the art review of the processes in the EBS and their impact on the long-term performance of the repository has been produced and will shortly be made available on the PEBS web site.

This report describes current treatment of the early evolution of the EBS in safety assessments from a number of European national programs (state of the art). The description starts with an overview of the repository concepts. Both HLW and spent fuel repositories are covered as well as both clay and crystalline host rocks. This is followed by an overview of the assessment methodology used in the different programs. One important aspect of the methodology is the definition and application of **safety functions**. Basically, safety functions are a tool that is used for the evaluation of performance as a function of time for individual repository components. The uncertainties in the early evolution in the EBS can generally be evaluated with the aid of the safety functions. The main part of the report describes the treatment of the THMC process in the EBS and their potential impact on the safety functions. Some examples of processes are:

- Saturation of buffer
- Buffer homogenisation
- Buffer upward expansion
- Movement of the canister in the deposition hole
- Homogenisation after loss of bentonite mass
- Thermal evolution
- Iron/clay interaction
- Chemical evolution of the buffer including alteration of the clay
- Effects of gas on the hydration process

The following Figure 1 shows examples of such processes and the timescales of relevance from the Nagra concept. A key purpose of the report is to identify the uncertainties in the process understanding and in the treatment of the processes in the assessment. The impact of the identified uncertainties on the evaluation of the safety functions is also discussed.

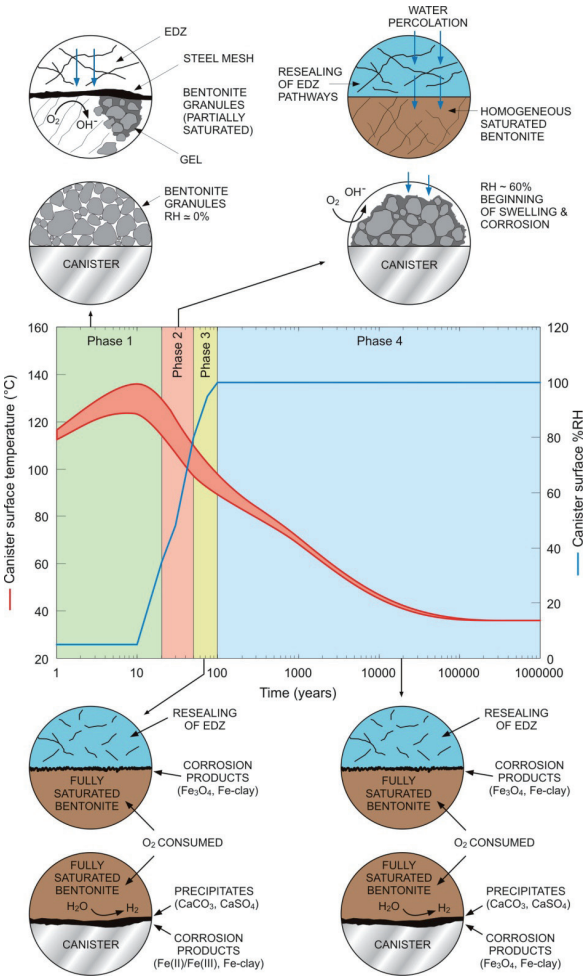

Figure 1. Examples of processes and timscale

The report also summarizes the uncertainties and defines a number of cases or "scenarios" that will be assessed further within the PEBS project.
Despite the differences in repository concepts, the safety functions defined for the engineered clay barriers are similar. The key processes occurring in the EBS in the early evolution of the repository that may affect the long-term performance are identical for all concepts on a fundamental level. However, the significance as well as the treatment of the processes in the safety assessment can differ between the concepts. The key processes identified are:

- Water uptake in clay components of the EBS
- Mechanical evolution
- Alteration of the hydro-mechanical properties

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These processes will be the main topic for further assessments within the project. The details in the cases will be discussed further within the project.

References

Landolt, D. A Davenport, J. Payer and D. Shoesmith 2009: A review of materials and corrosion issues regarding canisters for disposal of spent fuel and high-level waste in Opalinus Clay, Nagra Technical Report NTB 09-02, Nagra, Wettingen, Switzerland.

MODELING OF SHORT-TERM EFFECTS AND EXTRAPOLATION TO LONG-TERM EVOLUTION, SUMMARY OF CIMNE CONTRIBUTION

CIMNE contributes also WP 3.1, 3.2 and 3.3. In WP 3.1, the presentation focused on an enhanced formulation for double-structure material, an essential requirement for the modeling of materials made up of pellets. Two important features were highlighted: i) a double-structure mechanical model that takes into account the macrostructure and the microstructure of the material as well as their interactions (Figure 2), and ii) a coupled formulation in which equilibrium between the structural levels is not assumed, thus leading to a time-dependent water exchange between the two structural levels. The capabilities of the formulation were demonstrated by reference to the modeling of swelling pressure tests performed on mixtures of FoCa clay powder and pellets (Figure 3).

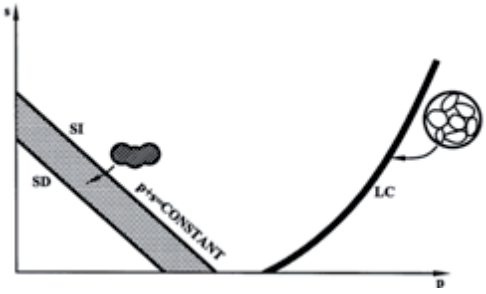

Figure 2. Double-structure mechanical mode

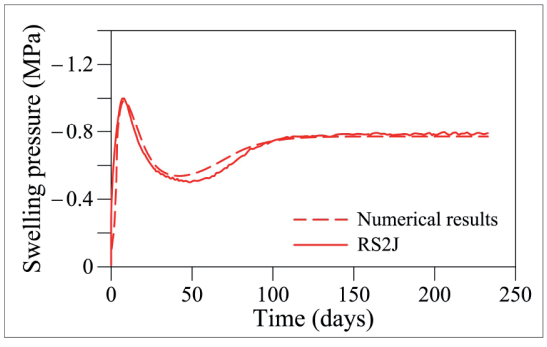

Figure 3. Reproduction of a swelling pressure test using the double-structure formulation

In WP 3.2, the scoping calculations for the HE-E experiment were presented. Calculated distributions and evolutions of temperature, relative humidity, degree of saturation and pore pressure were shown. Special attention was given to the values of pore pressures in the rock and their dependence on a number of parameters. Figures 4 and 5 show the expected evolutions of pore pressures in the bentonite and the rock.

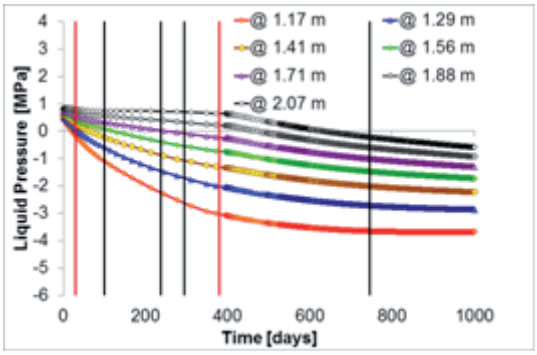

Figure 4. Computed pore pressures in the EB.

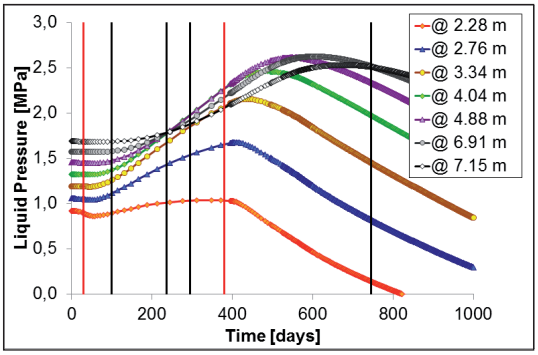

Figure 5. Computed pore pressures in the Opalinus Clay.

Finally, in WP 3.3 the predictions concerning the hydration of the mock-up test were reviewed with special consideration of the long-term observations. Some additional processes that might be taken into account in order to reproduce adequately the longer-term evolution of the hydration process were identified. The following were explicitly considered: existence of a threshold gradient for flow, thermo-osmosis, and the effects of microfabric changes during hydration.

Content of the next Newsletter

The following Newsletter will report on the Mont Terri Experiments and will also include an overview of the proposed bentonite workshop and training course proposed for late summer in 2012.

For more detailed information see the PEBS web site:

http://www.pebs-eu.de

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