DBE TECHNOLOGY NEWS 3

2014

Jurassic oil shale (Lias ε) with ammonite (Harpoceras falciferum), Dotternhausen (Southern Germany), quarry of HOLCIM GmbH

SHAFT SEALS FOR REPOSITORIES FOR HIGH-LEVEL WASTE

METHODOLOGICAL APPROACH FOR A SAFETY DEMONSTRATION AND VERIFICATION CONCEPT FOR A HLW REPOSITORY IN CLAYSTONE

STRATEGIES FOR THE FINAL DISPOSAL OF CARBON-CONTAINING WASTE

DBE TECHNOLOGY GMBH AT THE ANNUAL MEETING ON NUCLEAR TECHNOLOGY 2014

CONSEQUENCES OF PARTITIONING AND TRANSMUTATION (P&T) FOR REPOSITORY CONCEPTS

Verantwortung für Generationen
Responsibility for Generations

DBE TECHNOLOGY GmbH

Repository safety team

Dear readers,

In this newsletter, we take the opportunity to introduce our dedicated repository safety team and to present the steps that are essential to demonstrate repository safety. Our team consists of highly qualified geoscientists and mining, civil, and geotechnical engineers who have a sound scientific background and are also dedicated to implementing their theoretical knowledge in practical solutions.

Throughout the world, experts agree that high-level radioactive waste and spent nuclear fuel as well as long-lived low- and intermediate-level waste should be disposed of in deep geological formations. In Germany, deep geological disposal has been chosen as the only way to dispose of radioactive waste. As potential host rocks for repositories salt, clay, and granite are considered.

Our repository safety department is involved in the planning, design, and dimensioning of repositories in deep geological formations, which includes the relevant backfilling and sealing measures. Among others, this comprises the following tasks:

- *Demonstrating that the mining excavations are stable and that the geologic barrier maintains its integrity during the operational phase, closure phase, and the post-closure phase.*
- *Demonstrating that the geotechnical barriers function properly during construction and in the post-closure phase and demonstrating their hydraulic behaviour in the long term.*

These tasks, however, need some groundwork:

- *Analysis of site-specific host rock properties and host rock behaviour based on laboratory and in situ measurements*
- *Identification or – if necessary – development of backfilling and sealing materials tailored to the requirements pertinent to their intended use.*
- *Adaptation or development of material models for backfilling and sealing materials in order to perform numerical analyses, and identification of related parameters.*

In each step, uncertainties in the analyses due to variations in the host rock and properties of the backfill material have to be taken into account. Furthermore, tolerances during construction have to be considered. To contain these variations and tolerances within admissible limits, quality assurance methods have to be established and documented in quality control plans. Compliance with quality control measures is verified by specialists, and the results are reviewed. Adherence to this procedure guarantees that the backfilling materials and sealing constructions fulfil and maintain their safety functions. A particular challenge in this context is the requirement that the repository be maintenance-free and at the same time fulfils its long-term safety function.

During the entire procedure, it is essential that every step, from planning to design, dimensioning, and implementation is carried out properly and documented after implementation in order to demonstrate from the beginning that the repository complies with the safety requirements.

Happy Reading!

Nina Müller-Hoeppe

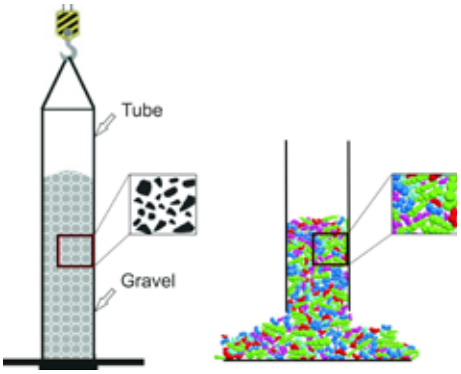
Head of Repository Safety Department

DBE TECHNOLOGY GmbH

Shaft seals for repositories for high-level waste

DBE TECHNOLOGY GmbH together with Technical University of Freiberg are developing shaft sealing concepts for repositories for high-level waste (R&D project ELSA). The goal of the project is to design shaft seals that are based on material investigations, site-specific boundary conditions, and the different safety cases for salt and clay formations in Germany.

First, site-specific boundary conditions as well as general and specific requirements pertaining to the design of shaft sealing constructions were identified. In claystone, for instance, the following additional requirements need to be taken into account: prevention of advective fluid flow from the repository or from the isolating rock mass, stable geochemical environment, adjustment to the various geology, material and technological requirements for the shaft liners, use of materials with high sorption capacity.



Graval column for shaft stabilisation. Calibration of the mechanical behaviour of particles. Left: illustration of tube with gravel used for laboratory measurements. Right: 2D model of gravel-pouring simulation.

One important aspect of the safety assessment concept is the demonstration

Investigations of the Opalinus Clay at a quarry of HOLCIM GmbH, Dotternhausen (Southern Germany)

of proper long-term functioning of the sealing components, which is usually done by means of predictive calculations. Therefore, laboratory measurements on sealing and supporting materials in combination with computer simulations were used to identify the mechanical properties of the materials used in sealing constructions and to predict their future behaviour. The two-dimensional Particle Flow Code (PFC2D) was applied to simulate the stability of gravel columns, which are used as supporting elements, under geomechanical load. Based on experimental data the friction angle was investigated by gravel-pouring simulation to calibrate the mechanical behaviour of particles.

Large-scale experiments that are based on established methods are proposed as a next step in concept development.

Methodological approach for a safety demonstration and verification concept for a HLW repository in claystone in Germany

Within the framework of the R&D project "AnSichT", DBE TECHNOLOGY GmbH, the Federal Institute for Geosciences and Natural Resources (BGR), and Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) are developing a methodology to demonstrate the safety of a high-level waste (HLW) repository in claystone in Germany.

In the course of the R&D projects ISIBEL and Preliminary Safety Analysis for the Gorleben site (VSG), the methodology of safety demonstration for a repository in salt formations has been further developed substantially. In this context, a holistic concept (Safety Case) has been adopted, which is based on demonstrating that the geologic and geotechnical barriers maintain their integrity in the long term. The concept also includes an analysis of the radiological consequences. The strength of this holistic methodology lies in the strong link between legal and geologic boundary conditions, disposal and closure concept, demonstration of barrier integrity, and long-term analysis of probable and less probable repository evolutions.

The R&D project AnSichT adopted this approach and started with the selection and description of two reference regions – one in Northern and one in Southern Germany – and the generation of the corresponding geological models. Subsequently, a general safety strategy for the final disposal of HLW in clay formations was developed. For both regions, geoscientific long-term predictions have been made and suitable disposal, repository, and closure concepts have been developed. These implementation-related aspects are essential for the system analysis. A FEP catalogue with a specific structure has been compiled for the reference region "North" as a basis for the scenario and integrity analyses. Following a systematic approach, the scenarios can be derived directly from the FEP catalogue. A reference scenario (probable evolution) is being developed.

In addition to this, quantitative criteria for demonstrating the integrity of the geologic barrier have been prepared, and criteria for the geotechnical barriers are under development.

Strategies for the final disposal of carbon-containing waste from German high-temperature and research reactors

In numerous research reactors as well as in the two German high-temperature research reactors (AVR and THTR 300), graphite or carbon bricks were used as reflector and/or moderator material. For this waste, suitable conditioning and packaging concepts have not yet been developed. Additionally; it has not fully been clarified whether the graphite and carbon bricks will comply with the waste acceptance criteria for the Konrad repository. To solve this problem, the Project Management Agency Karlsruhe (PKTA) acting on behalf of the Federal Ministry of Economics and Energy contracted DBE TECHNOLOGY GmbH with the appropriate R&D project CarbonForeSt.


AVR reactor building, status 2007, Jülich (Germany) (source: EWN)

The goal of the research project is to inventory the graphite and carbon bricks from the high-temperature reactors and research reactors in terms of activity and quantity for purposes of disposal in Germany. A suitable conditioning and packaging concept should be developed that takes into account

Information booth of DBE TECHNOLOGY GmbH during the Annual Meeting on Nuclear Technology 2014

the legal framework requirements for intermediate storage, transport and disposal. The corresponding disposal concept should be compatible with the requirements of the Konrad repository. Because of the high C-14-activity associated with the graphite and carbon bricks from the AVR, the disposal concept should also include considerations for their disposal in a repository for heat-generating high-level waste and spent fuel elements.

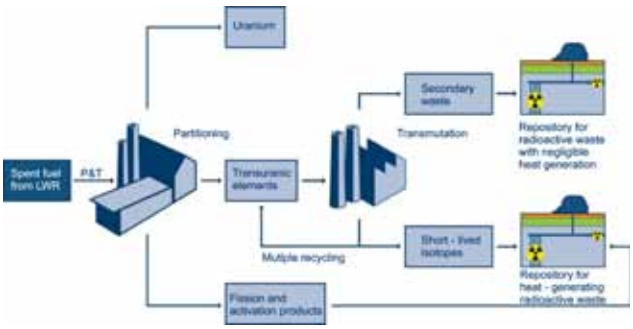
DBE TECHNOLOGY GmbH at the Annual Meeting on Nuclear Technology 2014

Organized by the German Atomic Forum (DAtF) and the German Nuclear Society (KTG), the Annual Meeting on Nuclear Technology took place at the Congress Center of the Frankfurt Messe from May 06 till May 08, 2014. Here, DBE TECHNOLOGY GmbH presented the results from their comprehensive work in German R&D projects as well as in international projects during a technical session and at her information booth.

In a presentation Wilhelm Bollingerfehr indicated the mutual effects of host rock selection and repository system especially with regard to repository design and repository safety. Therefore, for evaluation and comparison of potential repository sites, it is necessary not only to consider the host rock but the overall repository system including the site- and host rock specific repository concept.

Consequences of partitioning and transmutation (P&T) for repository concepts and long-term safety of repositories for heat-generating radioactive waste

On behalf of the Federal Ministry for Economic Affairs and Energy, 12 expert organisations led by Karlsruhe Institute for Technology (KIT) and the University of Stuttgart prepared a study on Partitioning and Transmutation (P&T). Within the course of this study, scientific and technological aspects as well as socio-scientific, ecological, and economic issues were analysed. The aim of the study was to prepare a detailed report on the state of the art in P&T technology and to identify its potentials, chances, and risks.



Flowchart of spent fuel management applying transmutation (source: ACATECH)

DBE TECHNOLOGY GmbH and Gesellschaft für Anlagen- und Reaktorsicherheit mbH (Brunswick) were significantly involved in the evaluation of the consequences of P&T on repository concepts and the long-term safety of repositories. The results are:

- Even if P&T technology was applied, a repository for heat-generating waste would still be needed to dispose of already existing waste including spent fuel from research/prototype reactors and waste generated in the P&T processes.
- Irrespective of the reduction in waste volume resulting from P&T processes, 50 % of the repository area currently planned would still be necessary for the drift emplacement concept and 70 % for the borehole emplacement concept.
- Most likely, the so-called secondary waste resulting from P&T processes (approximately 100,000 m³) would require an additional repository as co-disposal of heat-generating waste and secondary waste in the same repository could cause long-term safety issues.
- In a repository in salt, relevant radionuclide releases via a solution path are not expected. P&T processes are most suited to transmute radionuclides that are less relevant to long-term safety while transmutation may even increase the amounts of relevant fission and activation products.

For further information visit our website www.dbe-technology.de or scan the QR code below.

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