Resume of the workshop: Regulatory and technical requirements for responsible abandonment and re-use of caverns.

11 & 12 November 2019, Utrecht, the Netherlands. Organized by TNO-AGE, DEEP.KBB and the Ministry of Economic Affairs and Climate Policy.

Rationale

Since 1911 about 300 salt caverns have been developed in the Netherlands for salt production, 10 of which are currently used for storage. Many more caverns are possibly needed in the coming decades for salt production or storage of renewable gases. Concerns regarding long-term safety after closure raise the need to review abandonment practices and regulatory framework for existing and future caverns.

Question

What are the key challenges and hurdles concerning the abandonment of caverns from both a technical and a regulatory point of view?

Expert workshop

The current situation regarding the regulatory and technical requirements for responsible abandonment and re-use of caverns has been discussed by professionals, such as policy makers, operators, consultants and scientists. The results are summarized below:

State of art

- Historic abandonment practices
- Abandonment experiences
- Operator perspective

The Dutch caverns are in different life-cycle phases, from development to closure. Many caverns are awaiting the proposal or approval of a closure plan.

In the Netherlands salt is produced through solution mining in four different geological settings: i) 400-500 m deep salt beds with disc-shaped caverns, ii) 500-2000 m deep salt pillars with cigar-shaped caverns iii) >2400 m deep salt cushions with rapidly converging caverns, and iv) 1500 m deep highly soluble K-Mg salt layers with an irregular network of connected caverns.

Known incidents are related to roof collapse (sink holes) of old caverns in type i) and pressure-drop (brine escape) incidents in type iii) and iv).

Type ii) caverns are possibly suitable for storage of renewable gases.

Cavern re-use and surface/subsurface interactions: macro-scale

- Technical life-cycle
- Cavern interaction
- Abandonment practices/strategies
- H_2 storage pilot

The cavern life-cycle recognizes 5 phases: i) development/production, ii) storage (optional), iii) closure/suspension, iv) abandonment, v) long term after care/mitigation. Monitoring is considered a prerequisite for all phases.

Cavern behaviour and integrity depends on various aspects, e.g. local geology, cavern and well design, placement in clusters, cavern use and closure strategy. This requires an multidisciplinary approach.

In special situations, backfilling may prevent integrity or stability problems with poorly designed caverns (e.g. sink hole formation, leakage of brine, subsidence).

The current pilot project to investigate cyclic H_2 storage aims at risk identification, design verification and evaluation of well and cavern integrity.

Long-term behaviour of sealed salt caverns: micro- to macro-scale

- Rock salt rheology and permeation
- Combine science and practice
- Numerical simulation

Processes after closure:
Increase of pressure due to thermal brine expansion and convergence of the cavern. Equilibrium pressure reached as brine migrates via micro-permeation and fractures.

In deep caverns (> 1 km) pressure may build up towards geostatic pressure, resulting in possible fractures. Mitigation can be done through brine release, resulting in advancing subsidence. In shallow caverns pressure is maintained below geostatic pressure.

Scientific progress in the understanding of basic mechanisms in salt behavior, the role of heterogeneities and modelling tools. Further improvement is still needed.

Incorporate material science in cavern engineering to predict cavern convergence and brine migration after closure.

Regulatory and legal framework

- Life-cycle; regulatory
- Legal framework Germany
- Legal framework underground storage

The life-cycle phases should be consistently reflected throughout the regulatory framework in order to timely adopt appropriate measures (i.e. related to phase iv and v).

Storage should be integrated as an optional phase in the cavern life cycle.

In Germany legal requirements for cavern closure involve a closure plan, compliance with other environmental laws and financial securities.

When storage becomes prime motive for developing or using caverns, there are some legal gaps (disposal of brine is not allowed; optimal caverns dimensions for storage are suboptimal for production purposes).

Relation to other policy domains

- Subsurface structure vision
- Local perspective

Good alignment between national and local governance is essential.

A need for clear prioritization of the various (subsurface) activities (drinking water abstraction, mining, storage, geothermal energy etc.).

Public acceptance is an important challenge. Re-build trust in government by early and open communication on plans, dilemmas and expectations, a transparent decision process, and by informing stakeholders both in case of problems and if everything goes according to plan.

Questions often heard are: What are the benefits and how are they distributed? What are acceptable risks? And last but not least: who is liable for what and for how long?

Ministerie van Economische Zaken en Klimaat

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