SafeInCave – H2 salt cavern storage model

A novel model to predict physical implications (de)pressurizing salt caverns for hydrogen loading. The model includes several mechanisms that are typically misrepresented in salt cavern storage models and are specific for hydrogen storage.

Problem

Need for hydrogen buffer storage
Hydrogen is crucial for the future renewable energy mix, with applications ranging from industrial processes to fuels. However, producing green hydrogen from renewable sources can lead to price fluctuations, requiring hydrogen buffer storage for daily and seasonal availability.

Studies indicate that hydrogen salt-cavern storage is far more cost-effective per TWh than other methods. While salt cavern storage is common for other gases, limited data exists for hydrogen storage. As the hydrogen market is small, hydrogen behaves differently than these gases, requiring a different set of knowledge.

Need for better salt cavern modeling
Accurate predictions of salt cavern behavior in various scenarios are essential for proper dimensioning, development, and management, as mismanagement could lead to seismic activity, subsidence, and gas leakage. Existing models often fail to fully account for the complex behaviors of salt caverns when storing hydrogen, such as viscoplasticity, short-cycling loading, and hydrogen's unique thermodynamic properties.

Solution

Combining state-of-the-art modeling with geo-science
By integrating viscoplasticity, short-cycling loading, and hydrogen's unique thermodynamic properties, SafeInCave offers a prediction in cavern stability. Its adaptability through calibration for various salt samples sets it apart from existing deterministic models, making it a powerful tool for real-life operational conditions in salt cavern storage.

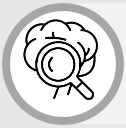
An all-in modeling toolbox for salt cavern gas storage
The technology in question is a modeling toolbox for salt caverns called SafeInCave, with a special focus on, but not limited to, hydrogen gas. The model couples multiple mathematical laws to accurately simulate creep deformation, stresses and pressures of a salt cavern or a field of multiple salt caverns.

The model takes a multitude of input parameters making it highly adaptable and challenging possible existing deterministic models. These include but are not limited to, surrounding rock layers, salt rock material parameters, cavern shape, cavern depths, cavern pressure, gas or liquid parameters and pressure changes that are aimed to represent real-life operational conditions of salt caverns for storage purposes. The model is likewise suited to simulate multiple types of gases.

Applications; planning, certifying, constructing, managing and abandoning salt caverns

About the technology

TRL: 3 (experimental proof-of-concept) - the model has been tested through several conditions; next step would be to test with data from several existing salt caverns
Patent status: No patent, model is partially public, partially secret
Department: CiTG, Geosciense engineering, Reservoir engineering
Team: TU Delft: Herminio Tasinafo Honorio **- Ideation labs:** Luuc Roemer



Increased transparency and accessibility for operators
the best performing models are only for internal use, often managed by consultants. This limits the transparency to the public, ability to verify the reliability, and makes it costly for operators to frequently refine the model with actualized data.

Build trust towards local communities
a clear, trusted open-source model that has been validated with much public data can help to improve the trust from local communities in the development- and operational plans for salt caverns.

We are looking for:

Financing
to perform application-specific pilots and prototyping

Network
ydgrogen infrastructure experts, electrolyzer & fuel cell developers and users, investors

Next steps

- ✓ Continued collaboration between Impact Studio Customer Discovery Support team, Optical Hydrogen sensor team and Thomas
- ✓ Explore and quantify business case further
- ✓ Build focus-group with experts and end-users to determine product and evidence requirements for adoption
- ✓ Find investors for co-financing university spin-off