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Technical Conference Paper

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Abstract

One of the essential tasks of the energy transition will be developing and implementing an effective energy storage method that allows for an increased share of renewable energy sources (RES) in the energy mix while maintaining the stability and reliability of the power system.

Green hydrogen (produced through electrolysis powered by RES) is expected to become the energy carrier. The most promising method for hydrogen storage is underground storage in salt caverns. The cavern storage technology has proven successful for hydrocarbon storage and can now be adapted for hydrogen storage. Several caverns store hydrogen worldwide (in the UK, France, and the USA), and many countries have ongoing demonstration projects.

The storage of hydrogen in caverns will be similar to natural gas storage. However, laboratory research on the properties of rock salt against hydrogen is required. The rock studies must consider local geological conditions, including the deposit form (bedded, domal) and various lithotypes of rock salt.

As part of the implementation of our project on large-scale hydrogen storage in salt caverns, experiments were designed and conducted to determine petrophysical parameters (permeability, porosity) for the main lithotypes of evaporitic rocks isolated in the Mechelinki bedded salt deposit (UGS Kosakowo) and the Mogilno domal salt deposit (UGS Mogilno). The analysis also included studying the interaction in the rock-brine-hydrogen system (seasoning rock samples in autoclaves with brine and hydrogen). Petrophysical studies were conducted before and after the interaction analysis to determine the impact of hydrogen on petrophysical parameter changes.

Permeability (a fundamental parameter for sealing rocks) for co-occurring rocks and pure salts ranges from 1.04×10^{-17} to 3.19×10^{-20} m² for helium and from 1.37×10^{-17} to 0 m² (impermeable samples) for hydrogen (The findings align with the ranges presented in the literature on hydrogen storage).

The analysis of changes in rock salt after interaction with hydrogen revealed:

- Dissolution of anhydrite, halite, and carbonates
- Crystallization of halite and gypsum

These observed processes affect petrophysical parameters (pore size distribution and rock permeability). Due to the opposing nature of these processes, these changes will not adversely affect the integrity of potential hydrogen storage facilities.

Key words: Hydrogen Storage in Salt Caverns, Rock Salt, Salt Permeability, Geochemistry