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Use of Laboratory Measurements to Confirm Integrity of Underground Storage

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Abstract

In order to reach the limit of global warming to less than 2 K according to the Paris global warming summit 2016, the emission of CO_2 must be reduced to half in the years up to 2050, while at the same time doubling the energy demand. This ambitious project is only possible by means of the temporary storage of energy e.g. in the form of hydrogen. A major role in this is the use of pore stores and underground Salt caverns.
A reliable assessment of the cavern integrity for underground storage and the cap rocks of pore stores is essential by knowing the permeability as well as the integrity of well completion. The tightness of the cement materials behind the casing is important pretty much as the cement bond with salt rocks, and casing. The expected tightness should be measured using unsteady state method.
The institute owns sophisticated equipment relevant to measure permeability of very tight rocks such as cap and salt rocks (up to 10^{-22} m²) and proving its tightness under high pressure conditions using unsteady state methods. In addition, new equipment has been designed and operated to evaluate the tight rocks using flammable gases e.g. hydrogen and methane.
New experiments have been conducted using appropriate design of testing equipment to meet actual requirements related to underground storage. In addition, moist and dry samples were considered in some cases.
In this paper, procedures to determine the permeability and the additional laboratory measurements will be introduced and discussed. The obtained results using hydrogen, methane, helium and nitrogen are presented and compared. Emphasis will be laid on the influence of the time duration of confining pressure and the type of gas on the permeability. Moreover, results to the tightness of the binding of salt rock and cement, and shear strength between cement and casing are presented as well. Finally, recommendations and remediation are provided.

Key words: cavern for gas storage, well cement evaluation, Leak, permeability measurement