Cushion gas requirements for hydrogen storage in global underground gas storage facilities

Talukdar, Mayukh; Behera, Chinmaya; Heinemann, Niklas; Miocic, Johannes; Blum, Philipp

DOI:
10.5194/egusphere-egu24-5508

EGU24-5508, updated on 08 Apr 2024
https://doi.org/10.5194/egusphere-egu24-5508
EGU General Assembly 2024

Cushion gas requirements for hydrogen storage in global underground gas storage facilities

Mayukh Talukdar[1], Chinmaya Behera[1], Niklas Heinemann[2], Johannes Miocic[3], and Philipp Blum[1]
[1]Karlsruhe Institute of Technology, Institute of Applied Geosciences, Karlsruhe, Germany
[2]University of Edinburgh, School of Geoscience, Edinburgh, United Kingdom
[3]University of Groningen, Energy and Sustainability Research Institute, Groningen, Netherlands

To ensure system security and flexibility, storing excess renewable energy as hydrogen is considered an integral component of future energy systems. Cyclic underground hydrogen storage (UHS) with injection production cycles is planned to meet energy demand until new subsurface sites are prepared for storage. To avoid geomechanical risks caused by dynamic pressure fluctuations during cyclic storage, cushion gas is stored in such reservoirs. Cushion gas requirements for sites are still unknown. Therefore, in this study, we calculate the cushion gas requirement of various hydrogen storage sites using reservoir properties.

Hydrogen requires less cushion gas by volume than methane. Cushion gas volume in UHS sites varies with the initial reservoir pressure, gas flow rate, well tubing size, and erosional velocity. Cushion gas requirement decreases with increasing reservoir pressure, increasing gas flow, increasing well tubing size, and decreasing erosional velocity. In the studied sites, cushion gas volume ranged from a few % (0-5%) to 99% of the total gas volume. Shallow sites cannot store much hydrogen because of the high cushion gas %. On the other hand, sites deeper than 1100 m are unsuitable owing to insufficient structural trapping and enhanced biogeochemical reactions. Considering these factors, we report the optimum cushion gas volumes for various underground storage sites worldwide.