Hydrogen Storage in Salt Caverns – Recent Experiences & Findings

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Hydrogen is regarded as a crucial energy carrier in a future energy system with a high share of variable renewable energy sources, especially in order to balance fluctuations in electricity generation. These can be compensated for by flexibility measures such as large-scale underground energy storage. GIE assessed that by 2050, the total demand for underground hydrogen storage for Europe should be around 0,45 PWh_{H2} and concludes that additional storage sites need to be developed.[1] Salt caverns hereby offer the most promising option for large-scale underground storage. For large-scale application in Europe, a safe operation of hydrogen storage systems has to be ensured to achieve public confidence in underground hydrogen storage; therefore, corresponding requirements for material and operation are to be verified in detail and additional investigations are necessary.
Despite minor differences in the usage of above-ground and subsurface equipment, as well as in the thermodynamic behavior of hydrogen, storage operation of hydrogen can be regarded as widely similar to that of natural gas. From a technical point of view, no major obstacle is therefore identifiable to transfer the experiences of natural gas to the storage of hydrogen gas in salt caverns. However, if all of the currently existing natural gas storage facilities in Europe were to be converted to hydrogen storage, total storage capacity would be insufficient related to the total storage demand identified by GIE. Therefore, the construction of new caverns for hydrogen storage must be considered. Hydrogen storage potential has been investigated recently for Europe[2] and especially Germany[3].
Further progresses in research & development for the storage of hydrogen in salt caverns are rapidly taking place and has so far been largely limited to theoretical studies. Recently, underground hydrogen storage has entered a phase of technical and operational implementation with the launch of numerous pilot projects, primarily in Northern and Western Europe. In some of them DEEP.KBB is assisting as a project partner, such as with the H_2Cast project from STORAG Etzel, which is aiming at rededicating its existing natural gas caverns and surface facilities for hydrogen storage. Another pilot project is currently under way on the natural gas storage site at Zuidwending, NL. Together with DEEP.KBB, N.V. Nederlandse Gasunie has demonstrated the mechanical integrity of one of its existing wells for hydrogen and is now, among other investigations, also examining the influence hydrogen has had on used equipment during testing operations. Further investigations in Etzel, Zuidwending and other cavern sites are ongoing and will provide even more insights on the technical feasibility of long-term hydrogen storage in new and existing gas storage sites.

References:
[1] Gas Infrastructure Europe, (2021), Picturing the value of underground gas storage to the European hydrogen system
[2] Weber et al., (2020), Technical potential of salt caverns for hydrogen storage in Europe, Int. Journal of Hydrogen Energy
[3] Donadei et al., (2020), Informationssystem Salz: Planungsgrundlagen, Auswahlkriterien und Potenzialabschätzung für die Errichtung von Salzkavernen zur Speicherung von Erneuerbaren Energien (Wasserstoff und Druckluft) – Doppelsalinare und flach lagernde Salzschichten