Hydrogen Energy Research Center

The Concept of Underground Hydrogen Storage IN WYOMING

01

DID YOU KNOW?

Large-scale H_2 production is most useful when the H_2 can be stockpiled for later use, but doing so requires a large H_2-safe container. Traditional containers lack either the size or integrity to store H_2 for later use and smooth out fluctuations in supply and demand.[1] Fortunately, researchers at University of Wyoming's School of Energy Resources are investigating non-traditional containers created by natural resource production, including underground trona mines. Trona is a special kind of rock salt which contains carbonate (Na_2CO_3) and bicarbonate ($NaHCO_3$) instead of chloride (NaCl). Wyoming has the largest trona deposit in the world in the center of southwest Wyoming's Green River Basin.[2]

02

WHY IS IT IMPORTANT?

To date, hydrogen has only been successfully stored in bulk within underground salt caverns.[3] These salt caverns are constructed by injecting water and producing brine from a well drilled into the formation. This process dissolves the salt from the inside out, and carries the salt to the surface, leaving behind a salt cavern suitable for holding hydrogen or other non-aqueous fluids. Trona is similar to common salt and a trona cavern can be formed in the same way. However, whereas the salt-laden brine in a traditional salt dome poses a disposal challenge and may cause environmental problems, the trona-laden brine is valuable. In Wyoming's trona mining district trona-laden brine is refined into soda ash (a valuable commodity used in glass, detergents, soaps, and metallurgical processes, and pharmaceuticals).

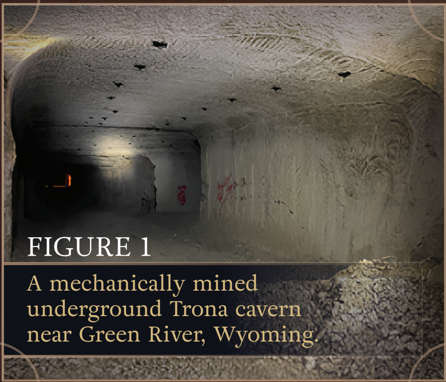

FIGURE 1
A mechanically mined underground Trona cavern near Green River, Wyoming.

Historically trona has been extracted by mechanical excavation (Figure 1). These mechanically mined halls tend to have less empty-space than caverns, but due to the long history of trona mining in Wyoming, represent a cumulatively large storage volume. Some Wyoming companies have started a modern technique called solution mining, which is functionally identical to the process used to make a trona cavern (Figure 2). These trona caverns (both mechanical and solution-mined) are potential H_2 storage opportunities.

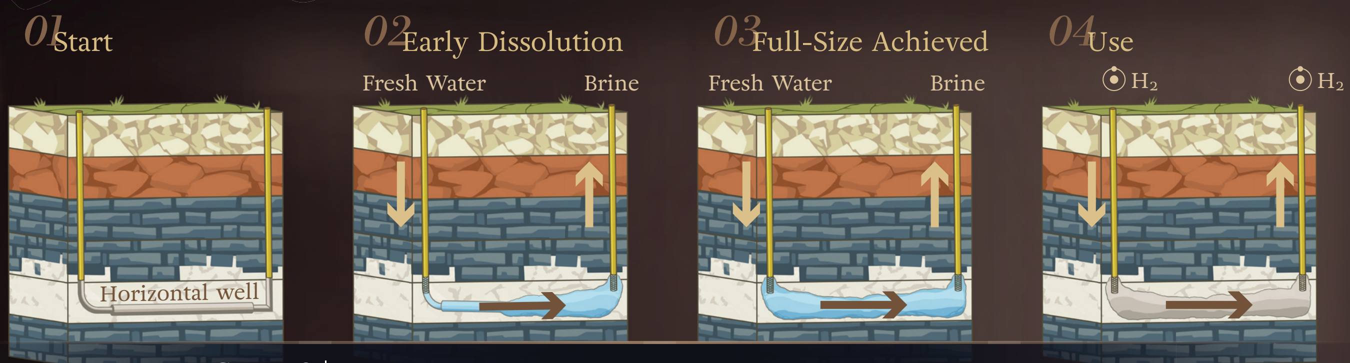

FIGURE 2 | Schematic of Trona Cavern Development by Solution Mining for H_2 Storage

03 THE RESEARCH

Although the theory behind storage of H_2 in trona caverns is sound and seems simple, there are numerous aspects which must be investigated before it can be performed commercially. H_2ERC's researchers are studying the effects of physical and chemical interaction between hydrogen and the rock around the cavern. The rock must be able to withstand cycles in pressure as hydrogen is pumped in and out, and not become too brittle from chemical reaction with the hydrogen. The researchers are also studying the optimal shape for trona-caverns. Whereas salt domes are tall and narrow, trona forms in thin laterally-extensive beds. Is a horizontal well the best way to form a cavern, or should a vertical well seek to connect many beds together vertically? Can such a cavern be regulated under existing laws or are new rules needed? By answering these and other questions H_2ERC's researchers hope to guarantee long-term safe, cost-effective, and efficient H_2 storage in Wyoming leveraging Wyoming's existing trona industry.

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[1] Tarkowski, R., and Uliasz-Misiak, B., (2022). Towards underground hydrogen storage: A review of barriers, Renewable and Sustainable Energy Reviews, Volume 162, 112451, https://doi.org/10.1016/j.rser.2022.112451.

[2] Wyoming Trona, Wyoming State geological Survey, https://main.wsgs.wyo.gov/mineral-resources/industrial-minerals/trona.

[3] Williams, J. D. O., Williamson, J. P., Parkes, D., Evans, D.J., Kirk, K. L., Sunny, N., Hough, E., Vosper, H., and Akhurst, M.C., (2023). Does the United Kingdom Have Sufficient Geological Storage Capacity to Support a Hydrogen Economy? Estimating the Salt Cavern Storage Potential of Bedded Halite Formations. Journal of Energy Storage Vomue 53, 105109, https://doi.org/10.1016/j.est.2022.105109.