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Abstract

Subsurface hydrogen (H_2) storage is a key component of the emerging H_2 economy. Currently, H_2 storage in salt caverns serves refineries and the petrochemical industry; however, H_2 storage for power generation is a novel concept. This study presents engineering and subsurface considerations that are part of a new H_2 web application for salt caverns. It incorporates thermodynamic modeling of H_2 for storage and cycling purposes, geomechanical simulation of salt creep closure, and the distribution of salt domes across the U.S. Gulf Coast, Texas, Louisiana, and Mississippi for regional H_2 storage assessment in a geographical information system (GIS).

The GeoH_2 web application is a modular tool that consists of seven modules: 1) H_2 physical properties, 2) volumetric, 3) withdrawal, 4) injection, 5) cycling, 6) geomechanics, and 7) GIS. The physical properties module provides the user with the main thermodynamic, transport, and thermal properties of H_2. The volumetric module allows the user to estimate H_2 storage capacities in salt caverns. The withdrawal, injection, and cycling modules simulate the withdrawal, the injection, and cycling of H_2, respectively. The geomechanics module models creep closure during the cycling processes. Finally, the GIS module incorporates a database with the U.S. salt domes of the Gulf Coast in Texas, Louisiana, and Mississippi. This last module provides the user with comprehensive information regarding salt dome location, depth, dome diameter and estimates: (a) the maximum number of caverns that can be built, (b) total volume of caverns, (c) H_2 working gas volume, (d) H_2 energy, and (e) H_2 mass for each salt dome in the database. The module displays the information using interactive maps and tables and summary-statistics figures.

This work presents the first interactive screening tool for H_2 storage capacity evaluation in areas where salt formations are present and to evaluate the engineering and safety constrains associated with high-frequency H_2 injection and withdrawal cycles. The novel information that this works provides is a two-dimensional modeling approach to initiate subsurface and engineering screening of prospective areas where subsurface H_2 storage might be feasible.

Key words: subsurface hydrogen storage, salt caverns, thermodynamic simulator, web application, interactive screening application