

# Multi-field coupling of aquifer energy storage

What is the coupling relationship for CO<sub>2</sub> storage in saline aquifers?

The THM coupling relationship for CO<sub>2</sub> storage in saline aquifers, illustrated in Fig. 1, excludes the effects of CO<sub>2</sub> dissolution and mineralization on temperature, stress, and flow. It also omits changes in saturation during the two-phase flow of water and gas during CO<sub>2</sub> injection.

Does multifield full coupling effect of dissolution and mineralization affect CO<sub>2</sub> storage?

Therefore, in recent years, many study achievements focus on the research of coupled THMC calculation model. Unfortunately, the multifield full coupling effect of dissolution and mineralization of long-term CO<sub>2</sub> storage in saline sandstone reservoir is not considered in this study.

How does mineralization affect the sequestration of CO<sub>2</sub> in saline aquifers?

In addition, carbonate minerals generated by mineralization during the long-term sequestration of CO<sub>2</sub> injected into saline aquifers reservoirs will fill and plug the pores and fissures of saline aquifers reservoirs, resulting in reduced injectability and sequestration of CO<sub>2</sub>.

How is CO<sub>2</sub> storage capacity determined in a Fu 1# injection well?

The CO<sub>2</sub> storage capacity and potential of the Fu 1# injection well are determined by continuous injection of CO<sub>2</sub> into the storage formation, without considering CO<sub>2</sub> leakage at the interface between the fault structure and the storage formation, as shown in Fig. 12.

Compressed air energy storage (CAES) in underground spaces is a common method for addressing the instability of renewable energy generation. As the construction and testing of CAES systems are often of high cost, the numerical simulation which offers a more efficient and low-cost research method can provide a better alternative to research the process.

The air leakage in CAES caverns constitutes a complex thermo-hydro-mechanical (THM) multi-physics field coupling process. Periodic variations in cavern temperature and pressure have a significant impact on air leakage. Simultaneously, air leakage counteracts the cavern's temperature and pressure. ... Aquifer Thermal Energy Storage (ATES) is one ...

Aquifer Thermal Energy Storage (ATES) is a promising renewable energy technology due to its availability, rationality, and storage capacity [4]. However, there is ...

The combined heat and power generation (CHP) is an efficient and economical solution to the intermittency and instability faced by renewable energy power and however, the heat-power coupling lowers its regulation depth. Thermal energy storage is a valid measure to solve the above problem, however, the major bottleneck is lack of thermal energy storage ...

In addition to accurately characterize the natural fracture networks using the DFN method, integrating multi-physical field coupling simulations allows for a more comprehensive ...

With the world's need for energy rising, scientific energy use has emerged as a crucial component of future sustainable development [1, 2]. The demand for heating and cooling in the built environment accounts for around 40% of the world's total primary energy consumption [3, 4]. Underground thermal energy storage (UTES) is a practical way to lower this energy ...

Environmental concerns and the escalating energy consumption in buildings have spurred a growing interest in shallow geothermal energy [1]. Aquifer thermal energy storage (ATES) presents an appealing avenue for harnessing shallow geothermal energy, using groundwater in the aquifer as a storage medium for thermal energy [2]. An ATES system typically consists of well pairs ...

A plug-and-play coupling approach for parallel multi-field simulations. Comput Mech (2014) ... The rest of the paper focuses on modelling methods for borehole thermal energy storage and aquifer thermal energy storage in energy system analysis. Energy system tools for planning and detailed design stages are reviewed. Gaps are identified for ...

A multi-physical field coupling numerical analysis model, considering the seepage of groundwater and the heat transfer of the heat exchangers and porous media, was ...

To reveal the mechanisms behind the influence of multi-field coupling on the transport-transformation of organic contaminants, a structural equation model (SEM) ... Impacts of subsurface heat storage on aquifer hydrogeochemistry. Environ Earth Sci, 69 (2013), pp. 1999-2012, 10.1007/s12665-012-2037-9. View in Scopus Google Scholar

Despite the small scale of calculation, this seminal work provided the fundamental methodology to perform the THM coupling study. Later, Noorishad et al. [7] developed a computer code ROCMAS using a variational principle and Galerkin finite element method (FEM) to explore the potential application of THM coupling in the rock mechanics field.

The model is verified using experimental data. The temperature and pressure fields of the multilateral-well ATES are analyzed. ... it is crucial to reduce energy consumption and improve heat utilization efficiency. Aquifer Thermal Energy Storage (ATES) is one of the promising solutions to balance the uneven distribution of seasonal energy ...

Aquifer thermal energy storage (ATES) has significant potential to provide largescale seasonal cooling and heating in the built environment, offering a low-carbon ...

The injection of large amounts of CO<sub>2</sub> into the deep subsurface may be associated with a number of

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geomechanical risks. Fig. 1 illustrates the main typical observations during CO<sub>2</sub> injection into brine aquifer (Ringrose et al., 2013). The fault or fracture zone will behave as a flow conduit for CO<sub>2</sub> and a focal point for rock failure. The pressure buildup inside the storage ...

Aquifer thermal energy storage (ATES) has significant potential to provide largescale seasonal cooling and heating in the built environment, offering a low-carbon alternative to fossil fuels. To deliver safe and sustainable ATES deployments, accurate numerical modelling tools must be used to predict flow and heat transport in the targeted aquifers. This paper ...

A Fully Coupled Model of NonIsothermal Multiphase Flow, Geomechanics, and Chemistry During CO<sub>2</sub> Sequestration in Brine Aquifers, TOUGH Symposium 2012.

Research prospect on reliability of Li-ion battery packs under coupling of multiple physical fields[J]. Energy Storage Science and Technology, 2022, 11(7): 2316-2323.

multi-scale heat storage, as well as the multi-field coupling simulation of wellbore and heat storage a re deeply analyzed. The resear ch statuses, the positives and negatives, and

Given the variability of renewable energy sources like solar and wind, as well as the challenges posed by low-quality industrial waste heat and limited geothermal resources, a ...

?, 2060. , - ...

2) Coupling fluid flow and pressure with rock deformation 3) Geochemical reactions between injected CO<sub>2</sub> and aquifer rock 4) Modeling of density instability at CO<sub>2</sub>-brine interface 5) Development of efficient parallel computing algorithms 6) Development of general fracture conceptual models 7) Verification and application using lab and field data 4

Research on the multi-field coupling effects in rocks has been ongoing for several decades, encompassing studies on single physical fields as well as two-field (TH, TM, HM) and three-field (THM) couplings. However, the ...

Injecting CO<sub>2</sub> into gas reservoirs can achieve CO<sub>2</sub> Storage with enhanced gas recovery (CSEGR). The development of liquid-CO<sub>2</sub> injection has the characteristics of high injectability, high mobility ratio, and low diffusion coefficient. Therefore, this paper established a wellbore-reservoir-thermo-hydro-mechanical-diffusion (WR-THMD) multi-physics fully coupled ...

A multi-physical field coupling numerical analysis model, considering the seepage of groundwater and the heat transfer of the heat exchangers and porous media, was constructed by combining the distribution characteristics of power abandonment and a theoretical analysis of the heat transfer principle of an aquifer. ...

Aquifer energy storage ...

This paper presents a comprehensive thermo-hydro-mechanical (THM) modeling framework for high-temperature aquifer thermal energy storage (HT-ATES) systems, ...

Based on the geo-sequestration storage project of saline aquifer CO<sub>2</sub> in Fushan Sag, Hainan Province, under the premise of considering the change of permeability and porosity after the mineralization of CO<sub>2</sub> in the ...

Doughty and C.-F. Tsang, Investigation of the vertical-flow aquifer thermal energy storage concept and numerical simulation of the Dorigny field experiment, Enerstock 85, Proc. of the 3rd International Conference on Thermal Energy Storage, Toronto, Canada, September 22-26, Public Works, Canada, Ottawa, 1985, pp. 58-64 (1985 ).

To assess the storage capacity and thermal losses of the HT-ATES system, a multi-field coupling numerical model was developed to characterize its hydraulic and thermal behavior. The entire reservoir consisted of non-deformable, saturated, homogeneous porous media with ...

The undesired permeability in the target aquifer led to an energy storage scale that was economically uncompetitive ... The multi-field coupled T2Well/EOS3 simulator and numerical methods need improvement. ... Numerical investigation of a novel approach to coupling compressed air energy storage in aquifers with geothermal energy. Appl Energy ...

A machine learning-based approach to the multi-objective optimization of CO<sub>2</sub> injection and water production during CCS in a saline aquifer based on field data February 2023 Energy Science ...

Solar energy is considered to be one of the most potential alternative energy resources because of its free, pollution-free and abundant reserves. How...

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## CONTAINER TYPE ENERGY STORAGE SYSTEM

Energy storage system

FC RoHS CE 