

**JH Solar**

# **Numerical simulation of compressed air energy storage**



## Overview

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The thermodynamic model of an underground artificial cavern in a 10 MW compressed air energy storage (CAES) system was developed with a simulation software. The boundary conditions of charging and discharging physical processes for the CAES cycle of the underground artificial cavern were given.

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Compressed air energy storage (CAES) is a technology that uses compressed air to store surplus electricity generated from low power consumption time for use at peak times. This paper presents a thermo-mechanical modeling for the thermodynamic and mechanical responses of a lined rock cavern used for.

Thermodynamic simulation of compressed air energy storage systems HAL Id: tel-03106469 <https://theses.hal.science/tel-03106469v1> Submitted on 11 Jan 2021 HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are pub-

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. What is compressed air energy storage?

Compressed air energy storage (CAES) is a technology that uses compressed air to store surplus electricity generated from low power consumption time for use at peak times. This paper presents a thermo-mechanical modeling for the thermodynamic and mechanical responses of a lined rock cavern used for CAES.

How is CAES simulation performed in COMSOL Multiphysics?

CAES simulation was accomplished in COMSOL Multiphysics by establishing four modules. A comparison of the proposed numerical simulation and some analytical solutions was conducted to verify the simulation. The proposed numerical simulation is consistent with the analytical solutions, which validated the proposed TM modeling.

Is the numerical simulation consistent with the analytical solutions?

The proposed numerical simulation is consistent with the analytical solutions, which validated the proposed TM modeling. The proposed numerical simulation showed that the maximum and minimum temperatures of compressed air in one CAES cycle increased with the increase in cycle number.

Does a CAES cycle increase the temperature of compressed air?

The proposed numerical simulation showed that the maximum and minimum temperatures of compressed air in one CAES cycle increased with the increase in cycle number. Air pressure and temperatures in the concrete lining and sealing layer exhibited the same 'up-down-down-up' trend in one cycle.

How to support underground caverns for compressed air energy storage (CAES)?

A reasonable support could ensure the stability and tightness of underground caverns for compressed air energy storage (CAES). In this study, ultra-high performance concrete (UHPC) and high-temperature resistant polyethylene were used for structural support and tightness of caverns excavated in hard rock.

Which projects have been performed in the field of high-pressure gas storage?

In addition to numerical simulations and analytical calculations, related projects have also been investigated and tested. The first lined rock cavern (LRC) for high-pressure gas storage in Skallen in southwest Sweden was constructed during construction and operation.

## Numerical simulation of compressed air energy storage

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### Temperature Regulation Model and Experimental Study of Compressed Air

Renewable energy has the advantage of being clean and pollution-free. It has many defects such as instability and difficulty in storage which urgently need corresponding ...

### Numerical Simulation Study on Stability of Natural Cave Compressed Air

Gas reservoir is an important part of compressed air energy storage system (CAES), and natural cave is considered as a potential reservoir type. To clarify the feasibility of ...



### Comparison of compressed air energy storage process in aquifers ...

Large-scale energy storage is receiving increasing attention with the rapid growth in the use of intermittent renewable energy sources. Among the energy storage options, CAES ...

### Thermodynamic simulation of compressed air energy storage

...

Similar to adiabatic components, quasi-

isothermal compressor and expander developed by LightSail Energy and Enairys Powertech were also analyzed by solving the energy and heat ...



### Multi-region coupling computational fluid dynamics simulation of ...

Compressed air energy storage (CAES) in underground spaces is a common method for addressing the instability of renewable energy generation. As the construction and ...

### Understanding the influence of aquifer properties on the ...

The implementation of large-scale energy storage technologies is deemed essential in addressing the challenges associated with the integration of increasing renewable ...



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### Numerical simulation on cavern support of compressed air energy ...

Stress and damage evolution of the UHPC lining for both short and long term have been stated, and the extent of crack propagation was evaluated. The numerical result ...

## CASSI - Compressed Air Storage Simulation

CASSI - A software for compressed air storage simulation CASSI is a Fortran implementation of a numerical compressed air energy storage (CAES) plant model.

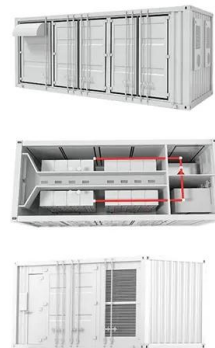


## The underground performance analysis of compressed air energy storage

Compressed air energy storage in aquifers (CAESA) has been considered a potential large-scale energy storage technology. However, due to the lack of actual field tests, ...

## Multi-region coupling computational fluid dynamics simulation of ...

In this study, a numerical simulation model has been developed to describe the air movement within the CAES process. Specifically, the study focuses on two different types of ...



## Analysis of compressed air storage caverns in rock ...

Exploring the material response of rock salt subjected to the variable thermo-mechanical loading is essential for engineering design of compressed air energy storage (CAES) caverns. Accurate design of salt ...

## Thermodynamic simulation of compressed air energy storage

...

It consists of accumulating energy for later use place in a that may be the same or different from the place of production. Converting electrical energy to high-pressure air seems a promising ...

Nominal Capacity  
**280Ah**  
Nominal Energy  
**50kW/100kWh**  
IP Grade  
**IP54**



## Modeling of coupled thermodynamic and geomechanical performance of



Coupled nonisothermal, multiphase fluid flow and geomechanical numerical modeling is conducted with TOUGH-FLAC, a simulator based on the multiphase flow and heat ...

## Modeling of Coupled Thermodynamic and Geomechanical ...

Exploring the concept of compressed air energy storage (CAES) in lined rock caverns at shallow depth: A modeling study of air tightness and energy balance. Submitted for publication, March ...



## Numerical Simulation Study on Stability of Natural Cave ...

Abstract Gas reservoir is an important part of compressed air energy stor-age system (CAES), and natural cave is considered as a potential reservoir type. To clarify the feasibility of natural ...



## Numerical simulation for the coupled thermo

Abstract Compressed air energy storage (CAES) is a technology that uses compressed air to store surplus electricity generated from low power consumption time for use ...



## Design and flow Simulation of compressed Air Energy Storage system ...

Based on Kushnir's study and some hypotheses, the mathematical model of compressed air energy storage in aquifer is established in this paper. Then, taking 3 MW ...

## Numerical simulation on cavern support of compressed air energy storage

To investigate the influence of the fatigue effect of salt rock on the long-term stability of the compressed air energy storage power plant, the numerical simulation method ...



## Thermodynamic Analysis of Compressed Air ...

Million cubic meters from abandoned mines worldwide could be used as subsurface reservoirs for large scale energy storage systems, such as adiabatic compressed air energy storage (A-CAES). In ...



## Numerical Simulation Study on Stability of Natural Cave ...

Gas reservoir is an important part of compressed air energy storage system (CAES), and natural cave is considered as a potential reservoir type. To clarify the feasibility of ...



## Numerical study of heterogeneous condensation in the de Laval ...

Abstract Compressed air energy storage technology (CAES) has an enormous possibilities in terms of energy conversion, environmental protection, and economic benefits. ...

## Numerical investigation of cycle performance in compressed air energy

The slight increase of energy recovery efficiencies from daily cycle to monthly cycle indicate that with the same energy storage scales, the energy produced by daily cycle ...



## Numerical Simulation of Long-Term Stability of Irregular

ABSTRACT: The proportion of green energy, such as photovoltaic and wind power, in power generation is increasing year by year. However, green energy often exhibits ...



## Numerical investigation of underground reservoirs in compressed air

Lined mining drifts can store compressed air at high pressure in compressed air energy storage systems. In this paper, three-dimensional CFD numerical models have been ...



## Thermodynamic analysis of lined rock caverns for initial inflation ...

This study explores the thermodynamic behaviors that arise from complex factors under high-frequency charging and discharging conditions in compressed air energy ...

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????????????????????????????Journal of Energy Storage????,?????Understanding the influence of aquifer properties on the performance of compressed air energy storage in ...





## Numerical simulation on cavern support of compressed air energy storage

Energy, 2023, vol. 282, issue C Abstract: A reasonable support could ensure the stability and tightness of underground caverns for compressed air energy storage (CAES). In this study, ...

## Numerical simulation for the coupled thermo-mechanical

The simulation was accomplished in COMSOL Multiphysics and comparisons of the numerical simulation and some analytical solutions validated the thermo-mechanical modeling.



## Numerical and experimental investigation of static shaft Wankel

Abstract Compressed air energy storage (CAES) is a promising technology for storing mechanical and electrical energy using the gas power cycle. The expansion device is a ...

[?????:????????????????????????????????? ...](#)

Numerical simulation on cavern support of compressed air energy storage (CAES) considering thermo-mechanical coupling effect Liu X.; Yang J.; Yang C.; Zhang Z.; ...



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**Novel Equivalent Physical Simulation Model of a Compressed Air ...**

The numerical simulation of the physical simulation system of CAES system is carried out based on the rotating speed data of the scroll expander and the load torque data of the generator ...

**Compressed air energy storage in hard rock caverns: airtight ...**

Compressed air energy storage in hard rock caverns: airtight performance, thermomechanical behavior and stability ZHANG Guohua<sup>1,2</sup>, WANG Xinjin<sup>1</sup>, XIANG Yue<sup>1</sup>, PAN ...

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