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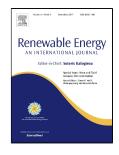
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Thermodynamic Analysis of a High Temperature Hybrid Compressed Air Energy Storage (HTH-CAES) System

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13 Highlights

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- A novel hybrid thermal and compressed air energy storage design is presented.
- An asymptotic isentropic condition in an adiabatic cavern is reported.
- An optimum operating pressure leading to maximum roundtrip efficiency is reported.
- 17 Realistic isentropic component efficiencies and throttling losses were considered.
- A hybrid design is more efficient & energy dense than an advanced adiabatic design.

Abstract

21 The integration of energy storage with renewable sources is imperative as it mitigates the 22 intermittency of the available energy. A novel high temperature hybrid compressed air energy 23 storage (HTH-CAES) system design is presented as a viable solution, which has the benefit of 24 eliminating the necessary combustion and emissions in conventional CAES plants. The hybrid 25 configuration incorporates two stages of heating through separate low-temperature and high 26 temperature thermal energy storage units. A thermodynamic analysis of the HTH-CAES system 27 is presented along with parametric studies, which illustrate the importance of the operating 28 pressure and thermal storage temperature on the performance of the storage system. Realistic 29 isentropic component efficiencies and throttling losses were considered. Additionally, two 30 extreme cavern conditions were analyzed and the cyclic behavior of an adiabatic cavern was 31 investigated. An optimum operating pressure resulting in maximum roundtrip storage efficiency 32 of the hybrid storage system is reported. The hybrid system was found to be more efficient and 33 energy dense as compared with an advanced adiabatic design of the same power output.

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35 Keywords

- 36 Hybrid Compressed Air Energy Storage
- 37 Compressed Air Energy Storage
- 38 CAES
- 39 Thermal Energy Storage
- 40 Grid Storage
- 41 Renewable Energy Storage
- 42

43 1. Introduction

Increasing the presence of renewable sources in the energy mix is challenging, as renewable generation is intermittent by nature. The mismatch between production and the user demand

- throughout the day can diminish the economic value of renewable sources, making them less
- 47 competitive compared to fossil fuels. The gap between renewable energy supply and demand has
- 48 led to the emergence of storage as a crucial element in the management of energy and is one of

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