



International Journal of Innovative Research in Science Engineering and Technology (IJIRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.699

Volume 14, Issue 3, March 2025

Concept of Sand Battery for Energy Management System

Rahul Raj¹, Abhinand N², Sooraj S³, Jasmine P⁴

U.G. Students, Department of Electrical and Electronics Engineering, AWH Engineering College, Calicut,
Kerala, India¹²³

Associate Professor, Department of Electrical and Electronics Engineering, AWH Engineering College, Calicut,
Kerala India⁴

ABSTRACT: Sand batteries represent a groundbreaking innovation in energy storage technology, leveraging silicon dioxide (sand) as the primary material. These batteries offer a promising alternative to traditional energy storage systems, boasting exceptional thermal energy storage capabilities, scalability, and sustainability. By utilizing sand, an abundant and inexpensive resource, these batteries reduce production costs and environmental impact.

KEYWORDS: Sand battery, Energy Storage Technology, Scalability, Sustainability.

I. INTRODUCTION

Sand Battery is a groundbreaking thermal energy storage technology that harnesses the thermal mass of sand to store renewable energy. This innovative system achieves 35% efficiency and scalable storage of up to 12 hours, addressing intermittency challenges of solar and wind power. The Sand Battery leverages abundant, non-toxic, and recyclable sand as a storage medium, heated to 800°C, providing long-duration energy storage. This sustainable solution enhances grid stability, resilience, and renewable energy integration while reducing greenhouse gas emissions and energy costs. Ideal for utility-scale applications, commercial and industrial power backup, remote communities, and electric vehicle charging infrastructure, Sand Battery transforms the energy storage landscape. Supporting widespread renewable energy adoption mitigates climate change and ensures energy security, independence, and sustainability.

II. LITERATURE SURVEY

Sand batteries are emerging as a viable solution for sustainable thermal energy storage, utilizing abundant and low-cost silica sand. Unlike conventional batteries that depend on rare and environmentally damaging materials, sand offers a more sustainable alternative, aligning with global efforts to reduce the ecological footprint of energy systems[1]. The primary mechanism of sand batteries involves heating sand to high temperatures, which can then be used for heating or converted into electricity[2]. This method demonstrates high thermal efficiency, making sand particularly suitable for integration with renewable energy sources like concentrated solar power (CSP)[3]. Recent research highlights that variations in grain size and composition can optimize the thermal performance of sand, enhancing its storage capacity and retention.

Pilot projects have validated the technology's potential, showcasing its ability to improve energy reliability and dispatchability[4]. However, significant challenges persist, including achieving competitive efficiency compared to conventional battery systems and scaling the technology for widespread use. Public awareness and acceptance also play critical roles in facilitating adoption. Overall, sand batteries present a promising avenue for advancing sustainable energy storage solutions. Continued research is necessary to address current limitations, refine the technology, and ultimately support the transition to a more resilient and environmentally friendly energy landscape. As interest in sustainable energy solutions grows, sand batteries could play a pivotal role in shaping the future of energy [5].

III. METHODOLOGY

First, a suitable sand material, is selected, cleaned, dried, and sieved to ensure uniform particle size. The sand is then heated to high temperatures (up to 500°C) using excess energy from renewable sources through a electric heating elements. This thermal energy is stored in an insulated container or tank designed to minimize heat loss and maintain the sand at high temperatures. When energy is needed, the stored thermal energy is discharged by using the Peltier module (TEG) to produce electricity. After discharging, the sand is cooled to a lower temperature and reheated using surplus renewable energy to restore its storage capacity. Key components include the sand storage container, heating elements, and thermal insulation. Enhancements to the system like real time monitoring system using IOT can be done.

IV. EXPERIMENTAL RESULTS

Figures shows the components mainly used for implementing a sand battery, Sand is the primary source for energy generation and Fig(a) shows the insulated tank with RCC and a layer of ceramic fiber blanket. the heating coil used in a sand battery. the selected sand is washed dried and sieved to uniform particle a fill inside the tank, then the supply is given to heat it.



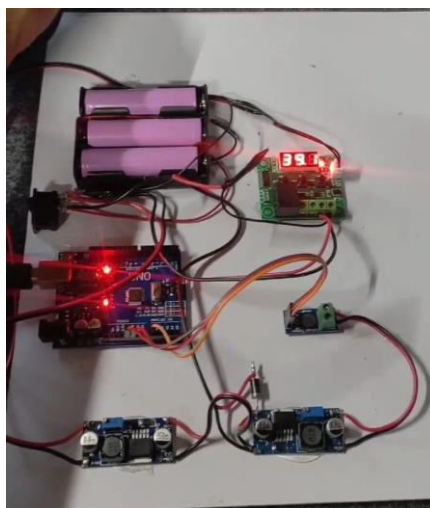
Fig(a) RCC and a layer of ceramic fiber blanket.



Fig(b) 4 ring tubular heating element



Fig(c) heat conversion using peltier module



fig(d) energy monitoring system

V. CONCLUSION

We have implemented a solution for a cost effective ,sustainable solution for energy storage Our product conveniently produce electricity from the stored thermal energy . with proper integration and more advancement in technology we can increase the system to a large scale grid integrated energy system .

REFERENCES

1. Liu J, Wang Q, Ling Z, Fang X, Zhang Z (2017) A novel process for pre paring molten salt/expanded graphite composite phase change blocks with good uniformity and small volume expansion. Sol Energy Mater .
2. Yin W-J, Weng B, Ge J, Sun Q, Li Z, Yan Y (2019) Oxide perovskites, double perovskites and derivatives for electrocatalysis, photocatalysis, and photovoltaics. Energy Environ Sci .
3. Carrillo AJ, Gonzalez-Aguilar J, Romero M, Coronado JM (2019) Solar Energy on demand: a review on high temperature thermochemical heat storage systems and materials.
4. Carrillo AJ, Serrano DP, Pizarro P, Coronado JM (2015) Improving the thermochemical energy storage performance of the Mn₂O₃/Mn₃O₄ redox couple by the Incorporation of Iron. ChemSusChem 8(11):1947– 1954.
5. Du Y, Song B, Duan H, Tsvetanov TG, Wu Y (2019) Multi-renewable management: interactions between wind and solar within uncertain technology ecological system. Energy Convers Manag 187:232–2



INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details