Short communication

Innovative Thermal Energy Storage Fluids for Enhanced CSP Efficiency

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Abstract

The efficiency of Concentrated Solar Power (CSP) systems relies on continuous advancements in thermal energy storage (TES) technologies. This paper discusses the latest innovations in TES fluids, focusing on the development of quaternary nitrate salt mixtures and nanomaterial integration. The potential for these advancements to enhance thermal performance and align with sustainable practices is explored.

1. Introduction

CSP plants are essential for a sustainable energy future due to their ability to provide reliable power. Key to optimizing their performance is the use of efficient TES systems, which facilitate heat storage and transfer [1-34]

2. Development of Quaternary Nitrate Salts

Recent work by [21-34] has shown that quaternary nitrate salt mixtures exhibit significant improvements over traditional binary or ternary salts. These new mixtures possess enhanced thermal stability and better heat transfer properties, making them ideal for use in CSP applications.

3. Nanotechnology in TES Fluids

The addition of nanoparticles such as Al_2O_3 has been demonstrated to improve the thermal conductivity and heat capacity of TES fluids. Research indicates that these doped fluids enable higher operational temperatures and more efficient energy storage [29]. This innovation addresses the limitations of conventional fluids, allowing CSP systems to function more effectively.

4. Economic and Environmental Impact

Despite the clear performance enhancements, the integration of new TES fluids must be evaluated for economic feasibility. The alignment of these advancements with the UN Sustainable Development Goals (SDGs) emphasizes the importance of eco-friendly and cost-effective solutions [22]

5. Challenges and Future Outlook

Challenges such as high production costs, stability under long-term use, and the environmental footprint of nanoparticle synthesis remain. Addressing these issues requires interdisciplinary research that incorporates material science, engineering, and sustainability practices [23-26].

Conclusion

The progression of TES fluids through the use of quaternary nitrate salts and nanotechnology represents a significant step forward for CSP efficiency. Continued research and innovation will be necessary to ensure that these technologies are both sustainable and economically viable, fostering a robust renewable energy infrastructure.

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