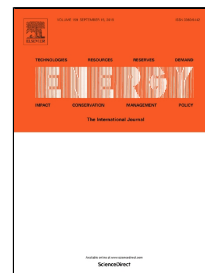


Accepted Manuscript

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PII: S0360-5442(18)31729-8

DOI: 10.1016/j.energy.2018.08.192

Reference: EGY 13668

To appear in: *Energy*

Received Date: 20 April 2018

Accepted Date: 26 August 2018

Please cite this article as: Abbas Mehrabadi, Mohammed Farid, New salt hydrate composite for low-grade thermal energy storage, *Energy* (2018), doi: 10.1016/j.energy.2018.08.192

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New salt hydrate composite for low-grade thermal energy storage

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Abstract

This study aims to develop a new salt-based thermochemical composite for long-term storage of low-grade thermal energy which enables overcoming mismatch between energy demand and supply. The energy density and dehydration behavior of five different salts; $\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$ and $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$, $\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$, $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$, and $\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$ are examined. Subsequently, the performance of two low cost host porous structures; expanded clay and pumice, impregnated with the most suitable salt for storing low-grade thermal energy is studied over a few number of cycles using a lab-scale packed bed reactor. The results showed that $\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$ has the highest energy density and lowest dehydration temperature so that $>80\%$ of its energy density can be stored at $<90^\circ\text{C}$. Thermal cycling the composite materials revealed that up to 87 kWh/m^3 and 22 kWh/m^3 energy can be stored using expanded clay- SrCl_2 (40 wt%) and pumice- SrCl_2 (14 wt%), respectively. However, the performance of expanded clay dropped sharply over four cycles while the generated power using pumice composite was sustained almost constant over ten cycles. Although pumice- SrCl_2 is a promising composite in terms of cyclability, further research is required to improve its energy storage capacity to make it attractive for large scale applications.

Keywords: Solar energy, Energy storage, Salt hydrate, SrCl_2 , Pumice, Expanded clay

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