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A systematic screening of salt hydrates as materials for a thermochemical heat transformer

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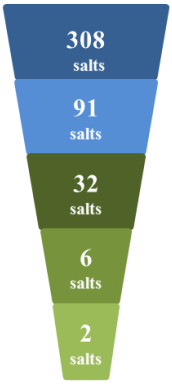
Graphical abstract



First theoretical analysis
on toxicity, formation of hydrates, appropriate thermodynamics
Literature research on thermal behavior
e.g. deliquescence, thermal decomposition, side reactions

Experimental analysis
- The reversibility of dehydration reaction
  Hydration in H_2O-, dehydration in N_2-atmosphere, with heating/cooling rates of 5 K/min between 100 °C and 300 °C
- Reaction hysteresis
  Hydration and dehydration with 5 kPa partial vapor pressure and 1 K/min
- Cycling stability
  Isothermal hydration in H_2O-, dehydration in N_2-atmosphere

$SrBr_2 \cdot H_2O$ meets all the requirements

Abstract

The selection of suitable reaction systems for thermochemical processes, e.g. thermal storage, chemical heat pumps or heat transformers, is challenging. Not only harmlessness of chemicals, theoretical energy storage density and thermodynamics play an important role, but also reversibility, reaction kinetics and cycling stability need to be considered. In this paper a systematic methodology for screening salt hydrates as thermochemical reaction material is suggested and applied to 308 different inorganic salts. It consists of a theoretical analysis of thermodynamic data as well as an extensive experimental analysis of the reversibility, reaction hysteresis and cycling stability. The target application is the heat transformation and reintegration of process waste heat up to 300 °C. $SrBr_2$ meets all requirements for this application and is a promising material.

Keywords

Material screening, thermochemical storage, heat transformer, chemical heat pump, salt hydrates, reaction hysteresis

Nomenclature

Symbols: