Introduction

Thermochemical energy storage (TCES) features long-term storage, a wide range of compatible temperatures, applicability as a heat pump system and finally, high energy storage densities. Based on these aspects, medium-temperature waste heat (up to 450 °C and extensively available from industrial processes) is perfectly suitable for TCES-systems. An attractive TCES-material for medium-temperature applications is the system Mg(OH)₂/MgO with a storage temperature around 350 °C. Both Mg(OH)₂ and MgO are industrial base materials and are therefore available in large quantities at low prices.

Experimental

MgO obtained by calcination of Mg(OH)₂, MgCO₃ and MgC₂O₄·2H₂O was compared regarding its rehydration reactivity and cycle stability to assess its applicability in thermochemical energy storage. The three different MgO-precursors led to three MgO samples featuring different particle morphologies with identical chemical compositions. Whereas Mg(OH)₂- and MgC₂O₄·2H₂O resulted in reactive MgO that could be rehydrated by water vapour, Mg(OH)₂ directly following calcination, material originating from MgCO₃ resulted in no conversion on contact with water vapour. Only after rehydration in liquid water and subsequent calcination of the thus formed Mg(OH)₂, 84 % of the resulting material could be rehydrated by water vapour. All materials investigated showed decreased rehydration reactivity during consecutive calcination/rehydration cycles, with MgCO₃ derived MgO showing the smallest decline in reactivity. A regeneration step, consisting of rehydration of the spent material in liquid water over 24 h, restored the initial reactivity allowing for recycling of the material. In the case of Mg(OH)₂ derived material, the initial reactivity could even be improved by repeated regeneration of the material in liquid water.

The particle morphology of the materials changes during calcination (figure 1, second row), leading to three differently textured MgO-samples. Whereas for using Mg(OH)₂ as the precursor material (figure 1a) calcination results in an apparently unchanged particle morphologies, the MgO crystallites obtained from both MgCO₃ (figure 1b) and MgC₂O₄·2H₂O (figure 1c) precursors are characterized by a clear surface fragmentation, which can be attributed to larger degree of structural reconstruction on the release of volatile components. In contrast, the H₂O release from Mg(OH)₂/MgO with a storage temperature around 350 °C. Both Mg(OH)₂ and MgO are industrial base materials and are therefore available in large quantities at low prices.

Conclusions

The results reported herein confirm, that the reactivity of MgO towards rehydration is strongly correlated to origin and physicochemical history of the material - an aspect so far neglected in the research on TCES materials. The correlation between chemical history and performance of storage materials may stimulate additional to coating, chemical dotation [2], etc...the consideration of a further, easily tunable parameter for the research on novel TCES materials.

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