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Authors: Hannah Neumann, Sophia Niedermaier, Stefan Gschwander, Peter Schossig

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Title

Cycling Stability of D-Mannitol when Used as Phase Change Material for Thermal Storage Applications

Authors

Hannah Neumann, Sophia Niedermaier, Stefan Gschwander, Peter Schossig

Affiliations

Fraunhofer Institute for Solar Energy Systems ISE
Heidenhofstr. 2
79110 Freiburg, Germany
Phone: +49 (0) 7 61/ 45 88 - 54 31
Fax: +49 (0) 7 61/ 45 88 - 91 32
e-mail: hannah.neumann@ise.fraunhofer.de

Highlights

- Short-term cycling tests of D-mannitol in oxygen and vacuum/nitrogen atmosphere
- Long-term cycling test of D-mannitol in nitrogen atmosphere
- Decrease of melting enthalpy during short-term test with oxygen and during long-term test
- Analysis of cycled samples by FT-IR
- Degradation hypotheses of D-mannitol by thermal treatment

Abstract

D-Mannitol is a potential phase change material to store thermal energy for process heat applications between 120°C and 200°C. This study presents thermal cycling stability tests of D-mannitol and its effect on melting enthalpy. Short-term cycling tests were carried out in differential scanning calorimeter in combination with air and nitrogen/vacuum as atmosphere. Results show that melting enthalpy decreases in contact with oxygen, decreases less in vacuum and stays almost constant in nitrogen atmosphere over the performed cycles. Afterwards, a long-term cycling test in nitrogen atmosphere was performed. Here melting enthalpy decreases about 9 % during 500 cycles. If this effect cannot be overcome, the material is unsuitable for most applications. Fourier-transform infrared spectroscopy was carried out to evaluate chemical stability after the cycling tests. A possible hypothesis for a degradation mechanism of D-mannitol is presented. It assumes that degradation products might be produced during thermal treatment. By additional oxidation the production of further degradation products might be triggered. It is likely that more degradation products were produced in the long-term cycling test than in the short-term cycling test in nitrogen leading to a decrease of melting enthalpy.