Thermophysical Properties of Sodium Acetate Trihydrate Composites as Heat Storage Material

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Thermophysical Properties of Sodium Acetate Trihydrate Composites as Heat Storage Material

Mark Dannemand1,2, Ana Lázaro2, Mónica Delgado2, Conchita Peñalosa2, Carsten Gundlach3, Camilla Trinderup1, Jakob Berg Johansen1, Janne Dragsted1, Gerald Englmair1, Weiqliang Kong1, Simon Furbo1

1DTU Civil Engineering, Technical University of Denmark, Denmark
2DTU Physics, Technical University of Denmark, Denmark, 3DTU Compute, Technical University of Denmark, Denmark
Aragon Institute for Engineering Research (I3A), Thermal Engineering and Energy Systems Group, University of Zaragoza, Spain
markd@byg.dtu.dk

Introduction: Sodium acetate trihydrate (SAT) can be used as a phase change material (PCM) in heat storage applications. The melting point at 58 °C and favorable thermophysical properties makes it a suitable storage material in solar heating systems applications for space heating and domestic hot water preparation. Additives are used to stabilize the PCM, optimize or enhance the material properties and ensure cycling stability.

SAT can be used for long term heat storage by utilizing its ability to supercool to ambient temperature or for short term heat storage where the supercooling is avoided. Material investigations were carried out considering the behavior of SAT with and without supercooling.

Density - porosity: The density and thermal expansion of SAT in liquid and solid state was measured. The characteristics of the cavities formed inside of solidified SAT were found by x-ray scanning. The measured density of SAT solidified from a supercooled state was less than the typical literature value. The X-ray scanning confirmed that 15% of the volume of a sample which had solidified from supercooled state was cavities.

Thermo-mechanical analyzer (TMA). Open sample holder Density measurements vs. literature

<table>
<thead>
<tr>
<th>Sample</th>
<th>Cavity loss%</th>
<th>Enclosed cavity loss%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid SAT (supercooled)</td>
<td>0.07</td>
<td>0.13</td>
</tr>
<tr>
<td>Solid SAT (unsupercooled)</td>
<td>0.15</td>
<td>0.09</td>
</tr>
</tbody>
</table>

Cavities in SAT samples

<table>
<thead>
<tr>
<th>Sample</th>
<th>Density g/cm³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid SAT (unsupercooled)</td>
<td>1.35 ± 0.01</td>
</tr>
<tr>
<td>Solid SAT (supercooled)</td>
<td>1.33 ± 0.01</td>
</tr>
<tr>
<td>Liquid SAT</td>
<td>1.31 ± 0.01</td>
</tr>
</tbody>
</table>

Expressions for solid and liquid density

- Supercooled solid
- Liquid solid
- Liquid

Specific enthalpy for SAT without additives measured with DSC.

- Solid 20mg
- Supercooled liquid 20mg
- Supercooled solid 20mg
- Solid 20mg
- Supercooled solid 20mg
- Solid 20mg

Specific enthalpy for SAT with 1% CMC measured with DSC.

- Solid 20mg
- Liquid 20mg
- Supercooled liquid 20mg
- Supercooled solid 20mg
- Solid 20mg

Acknowledgement: Experimental investigations on density were carried out in the laboratory of the GITSE research group, University of Zaragoza. X-ray scanning was carried out at Department of Physics, Technical University of Denmark. The authors thank the Spanish Ministry of Economy and Competitiveness for the funding of this work within the framework of projects ENE2011-28269-C03-01 and ENE2014-57125-R and the Danish Energy Agency supporting the joint IEA SHC Task 40/IEES Annex 20 program on Compact Thermal Energy Storage, Grant no. 64012023.

References: