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Thermophysical Properties of Sodium Acetate Trihydrate Composites as Heat Storage Material

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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 stable at 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.

Density measurements vs. literature

Thermo-mechanical analyzer (TMA)

Sample

Cavity

porosity

Density


cavity

Solid SAT (unsupercooled)

0.07

0.13

Solid SAT (unsupercooled)

0.15

0.09

Table of Cavity samples

Density samples

Sample

Solid SAT (unsupercooled)

~78–102 °C, 7 ± 1.4242

For 10 °C, T < 50°C

Solid SAT (unsupercooled)

~78–102 °C, 7 ± 1.2622

For 10 °C, T < 50°C

Liquid SAT

~683–1018 °C, 7 ± 1.3149

For 10 °C, T < 50°C

Expressions for solid and liquid density

Specific enthalpy for SAT without additives measured with DSC.

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

Heat capacity: The specific heat capacities and latent heat of fusions of SAT composites were measured by differential scanning calorimetry (DSC) and the T-history method. The measurements showed that the additives had little effect on the specific heat capacities of the SAT composites. SAT composites with CMC or Xanthan rubber was investigated.

Literature values for specific heat of solid and liquid SAT

Material of interest

Specific heat [J/gK]

Specific heat [J/gK]

Temperature [°C]

T-history measurements

Specific enthalpy for SAT with 0, 5% Xanthan rubber measured with DSC.

References


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