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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 about 185 °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.

Heat capacity: The specific heat capacities and latent heat of fusion of SAT composites were measured by differential scanning calorimetry (DSC) and 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.

Expressions for solid and liquid density:

\[ \rho_s = \frac{\rho_{solid - no supercool} + 0.13 \times \rho_{solid supercool}}{1 + 0.13} \]

\[ \rho_l = \frac{\rho_{liquid supercool} + 0.09 \times \rho_{solid supercool}}{1 + 0.09} \]

Specific enthalpy for SAT without additives measured with DSC:

\[ H_{solid - no supercool} = 0.517 \times H_{solid} + 0.483 \times H_{liquid} \]

\[ H_{solid supercool} = 0.517 \times H_{solid supercool} + 0.483 \times H_{liquid supercool} \]

\[ H_{liquid} = 0.62 \times H_{liquid} + 0.38 \times H_{liquid supercool} \]

Reference:


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