Combined short- and long-term heat storage with Sodium Acetate Trihydrate for solar heat supply in buildings

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COMBINED SHORT- AND LONG-TERM HEAT STORAGE WITH SODIUM ACETATE TRHYDRATE FOR SOLAR HEAT SUPPLY IN BUILDINGS

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Background:
Due to the mismatch of solar energy resources and domestic heat demand, long-term storage of heat is essential for an innovative system with a high solar fraction in the range of 70%-100%. Therefore a concept based on stable supercooling of a sodium acetate trihydrate (SAT) has been investigated.

Material properties:
- Melting temperature: 58 °C
- Latent heat of fusion: 264 kJ kg⁻¹
- Market prices (food grade): typically below 0.5 € kg⁻¹
- Thickening agents and liquid polymers are used to stabilize SAT
- SAT can supercool to ambient temperature while heat of fusion is preserved

Heat storage units:
Supercooling of SAT composites can be achieved in flat container of 150 L with an internal height of 5 cm. Later, a cylindrical container (Ø 0.4 m) of similar volume was built with an internal spiral heat exchanger. It was situated in a water tank (Ø 0.46 m) so that heat transfer via its outer surface was possible. The total heat exchange surface was 3 m². Units of both design were constructed by Nilan A/S.

Prototype units were tested for their short- and long-term heat storage potential after heating to 90 °C. Controlled activation of SAT crystallization was achieved by either seed crystal injection or local cooling (CO₂ evaporation, Peltier elements).

System simulation:
- Component models were developed and experimentally validated
- Daily hot water demand: 126 L at 45 °C (3 persons)
- High Solar Fractions (SF) for a Passive house in Danish climate

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Conclusions:
- Proof of combined short- and long term heat storage
- Improved cylindrical units are potentially economic
- Application of segmented heat stores in novel energy systems:
  - Power to heat (PV, wind power)
  - Solar combi-system 2.0