Technical University of Denmark

Popular science summary of the PhD thesis

PhD student	Gerald Englmair
Title of the PhD thesis	Combined short and long-term heat storage with sodium actetate trihydrate for solar combi-systems
PhD school/Department	DTU Civil Engineering

Science summary

From 31st December 2020 a near-zero energy consumption is required by all new buildings as stated in the EU Energy Performance of Buildings Directive. Solar heating is a promising technology to achieve this aim. However, due to the mismatch of solar energy resources and the demand patterns of single family houses in central and northern Europe, long-term heat storage is essential for solar combi-systems that cover hot water supply and heating with a solar fraction larger than 50%. Water tanks can be used for this purpose, but large storage volumes are necessary to compensate sensible heat losses.

Therefore, a concept for combined short and long-term heat storage utilizing stable supercooling of sodium acetate trihydrate composite was developed. The concept enables use of the sensible heat capacity of the melted composite while preserving its heat of fusion at room temperature. Thus, loss-free heat storage is achieved, which can be utilized for on-demand supply in periods without solar irradiation available.

A heat storage prototype with four flat units, each containing about 200 kg of composite, was built. It was tested in a full scale laboratory solar heating system with 22.4 m^2 evacuated tubular solar collectors. Experimental findings were used to simulate an improved system with 1 m^3 of composite and a 0.6 m^3 water tank for heat storage in an energy-efficient house, located in Denmark. Results showed that hot water and space heating, with a yearly heat demand of 3977 kWh, could be covered with a solar fraction of approximately 70%. Further, an inexpensive cylindrical unit using novel composites was built with standard components of water stores. Laboratory tests showed that it could be applied in the system.

For the first time, a solar heating system utilizing stable supercooling of SAT composites was demonstrated. The work provides the basis for studying application of the heat storage concept for different climates considering different solar collector types, improved heat storage units and electric grid stabilization via power-to-heat conversion.