Passive cooling and PCM together

LowEx

PCM materials can contribute to the energy efficiency of buildings by reducing the peaks in the daily temperature cycles. It may be possible that mechanical air conditioning is not needed at all; as a minimum, the energy consumption for air conditioning can be reduced. And this is how it works: as part of normal overnight ventilation, the warm air in the building is replaced by cold night-time air, which also reduces the temperature of the building's solid structures over the course of the night. PCM can increase the heat capacity of the building, meaning that additional 'coldness' can be stored in the building's structures. PCM can be integrated into walls, ceilings or facade elements, for example.

Old people's living quarters can look this good: PCM heat storage integrated into the facade of a nursing home. Macroencapsulated salt hydrates are included in the selectively transparent facade elements and serve to regulate the temperature... © GLASSX, Gaston Wicky

Technology summary

Term of project	07/2006 - 12/2009
Technology status	Demonstration Phase
Key aspects	Facade systems, Glazing + windows, Ventilation + heat recovery, Regenerative + passive cooling, Thermo-active building element systems, Heat / cold storage

Project description

In this project, building components and systems with latent heat storage materials are developed for building cooling applications, used in buildings which serve as pilot projects and tested in real use. The systems employ phase-change materials and their ability to passively store heat, thus buffering temperature peaks and delaying cooling loads by a number of hours. Salt hydrates were used exclusively as phase-change materials.

Paraffins or salt hydrates?

In the temperature range where room cooling occurs (around 20-30 °C), there are generally two classes of PCM available for heat storage: paraffins and salt hydrates.

Paraffins are organic hydrocarbon compounds that are often used because of the slow speed with which they react chemically. In addition, they can be handled easily in microcapsules and integrated into building materials. Microcapsules are capable of flowing as powders or dispersions, can be easily metered, and have good heat-transfer properties because of their high surface-area-to-volume ratio. They have similar energy densities per unit mass compared to those of salt hydrates.

Salt hydrates (and eutectic mixtures of salt hydrates) are inorganic salts with water of crystallisation. They have a higher density, and thus a higher energy density per unit volume. Salt hydrates cannot be microencapsulated; instead, they are handled in larger containers, such as plastic pouches or plastic macrocapsules. Salt hydrates are non-flammable.

Focus

One goal of this research project was to further develop PCM products based on salt hydrates. Another aim was to investigate and quantify how these products work in practice by using them in pilot and demonstration projects.

Measurements of the system properties can be used to validate simulation tools and as a basis for the establishment of design guidelines. Feedback from building users is a source of direct information on user acceptance of these products. This is valuable in helping manufacturers and planners to identify possible improvements.

Detailed measurement data is recorded and evaluated over a period of one to two years in demo rooms in order to investigate the effectiveness of PCM systems. Using the operational data measured, the effects of using PCM systems to dampen load peaks (and shift electricity demand into low load periods) are investigated.

As part of the project, the following steps are being carried out:

Integration of various PCM systems into demo buildings that are in use

Recording of operational data for various PCM systems in real applications

Determination of reliable system characteristic values and the potential for energy-savings

Surveys of user acceptance (which in turn result in the identification of potential improvements)
Investigation of load behaviour (shifting of electricity demand into low load periods)

Successes

The PCM systems were investigated using experiments and optimised on a laboratory scale. The effects of using these systems in real applications were determined using thermal simulations for the buildings. The first prototypes were manufactured.

Milestones

The systems are now being produced as prototypes and integrated into demonstration buildings. The buildings will be monitored in summer 2008 under real operating conditions. A symposium will be held in autumn 2008 where the first results will be presented to the public. A further event is planned at the end of the project (autumn 2009).

Application

Dörken GmbH & Co. KG: manufacturer of PCMs (salt hydrates) for room cooling, e.g. Delta-Cool24, Delta-Cool28. Web link: www.doerken.de
Further information will be made available here as the project progresses.

detailed project description

This project is funded within the framework »Energy Optimized Building« (EnOB) by the German Federal Ministry of Economics and Technology, on the basis of a decision by the German Bundestag. Get further information at www.enob.info.