

Compact Storage Module & PCM compact storage unit

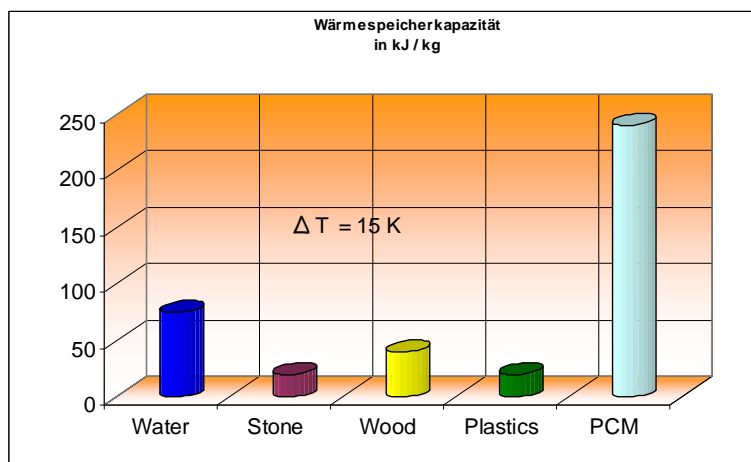
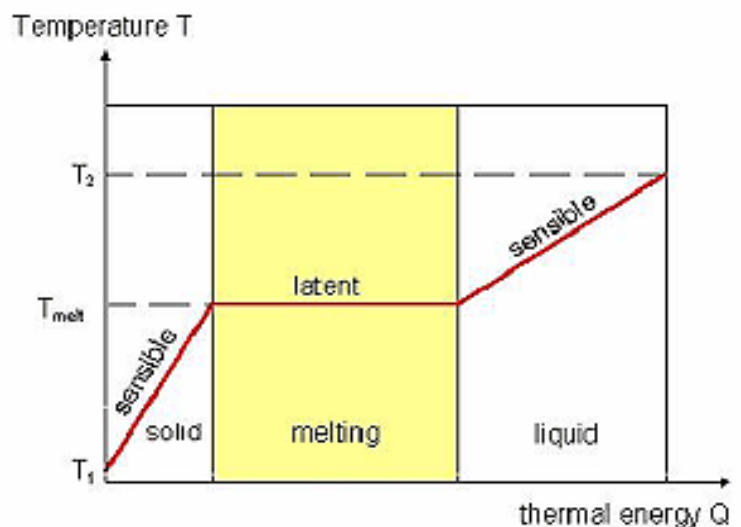
1 Application

Using Phase Change Materials (PCMs), for example in our compact storage unit it is possible to extract and store heat or cold. This allows to extract the thermal energy at a later stage and at pre-determined temperature, which results in diverse application possibilities:

- climatisation storage for indoor climate control
- storage of cooling energy for reduction of peak loads
- buffer storage for solar-, fossil fuel- and waste heat systems
- buffer storage for heating systems

The storage elements (CSM-panels) within the compact storage unit are filled with a latent heat storage material, the Phase Change Material (PCM). PCM uses the latent heat during the phase change from solid to liquid or from liquid to solid (see graph).

Because it benefits from this phase change effect the PCM has five to ten times more storage capacity than other standard materials (see graph) over a small temperature range.

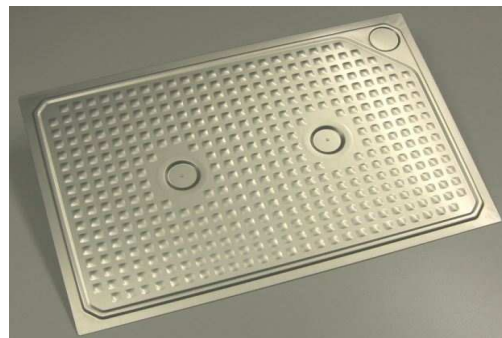


Using a latent heat storage unit makes sense if at least 50 % of the storage units' volume is filled with PCM and if the working temperature difference is maximally 15-20K.

2 Technology:

2.1 CSM module

The CSM modules are Rubitherm's standard multi-purpose PCM panels. They are made from aluminium with an efficient anti-corrosion coating and can be filled with both our RT and SP materials, providing maximum flexibility to the user, depending on intended use.



CSM Panel / total thickness	Total weight with SP	Approximate stored energy SP 22	Approximate stored energy SP 29	Total weight with RT	Approximate stored energy RT	Approximate stored energy RT HC
CSM 5/5 – 10mm	1,4 kg	40 Wh	50 Wh	0,9 kg	24 Wh	35 Wh
CSM 10/0 – 10mm	1,5 kg	45 Wh	56 Wh	1,0 kg	27 Wh	39 Wh
CSM 10/5 – 15mm	2,3 kg	80 Wh	99 Wh	1,5 kg	49 Wh	70 Wh
CSM 10/10 – 20mm	3,3 kg	121 Wh	149 Wh	2,0 kg	73 Wh	105 Wh

Outer dimensions are 450 x 300 mm, metal sheet thickness is 0,5mm

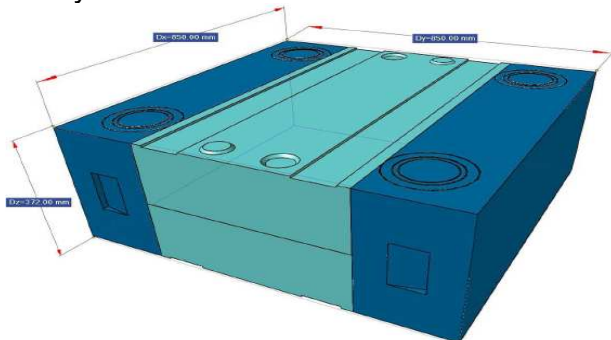
Storage capacity per panel varies depending on phase change temperature of the chosen PCM - for RT and RT HC an average value is given

The core advantages of the CSM panel are

- flexible volume and storage capacity with thicknesses from 5 to 27mm available
- can be filled with all our proven PCMs RT, RT high capacity and SP
- wide temperature range from -10 to 86°C depending on intended use and requirements
- stable and rugged casing for maximum resistance to rough conditions and treatment, survives drop test from 3m height
- excellent heat transfer from medium to PCM through aluminium casing
- leak proof, 100% test of CSM panels to ensure pressure tightness
- anti-corrosion coating inside and outside – usable in most heat transfer media including sea water
- non-flammable
- maximal use of available volume and automatic volume adaptation to PCM expansion
- suitable for large order quantities
- easy and fast to clean smooth metal surface, ideal for HVAC applications
- flexible surface design and colouring available on request

2.2 Compact storage unit

The compact storage unit holds 50 CSM panels 5/10 with a maximal storage capacity of 4000Wh. The extended version contains 100 panels with up to 8000Wh. Because of the modular construction of the unit it is possible to extend it in steps of +4000Wh. In the housing the CSM panels are placed at a defined distance of 5 mm on a twin rail system.



	Standard Version	Extended Version
Dimensions: L x B x H [mm]	950 x 1112 x 360	1400 x 1112 x 360
Number of CSM-modules	50	100
Weight filled with SP	ca. 110 kg	ca. 215 kg
Weight filled with RT	ca. 65 kg	ca. 125 kg
Storage capacity with SP 22	ca. 4000 Wh	ca. 8000 Wh
Storage capacity with RT	ca. 2200 Wh	ca. 4400 Wh

Recommend air flow: 230 – 420 m³/h

The total heat transfer area is 12,04 m² (50 panels x 2 sides x 0,43m x 0,28m).

To handle higher air flow rates it is recommended to use additional compact storage units in parallel to increase the system capacity.

Example:

At a volume stream of 310 m³/h and a cross section of 0,0014 m² (0,005m x 0,28) per gap between the panels this corresponds to a stream velocity of 2,37 m/s. This ensures an optimal heat transfer between air stream and panel.

Casing

The storage casing is assembled from modular EPP components. EPP is a solid elastic foam with a closed-cell surface. The advantages of this housing are:

- low weight
- good insulation against warmth and cold
- high absorption of kinetic energy (also in case of multiple impacts)
- good dimensional stability and resilience against static and dynamic strains
- good resistance to chemicals
- easy to disinfect because of the closed surface pores

3 References

3.1 Main tropical greenhouse – Botanical Garden Berlin

The two towers of the air circulation system have been specifically designed as giant jungle trees to blend in with the tropical plants surrounding them. Their purpose is to guarantee an optimal temperature distribution in the greenhouse. Inside the tower our CSM panels with a special PCM operating at 26°C are installed.

During the day the air at the roof of the greenhouse heats up quickly. An extractor fan at the top of the tower draws in this air and transports it down to the plants. On the way down the excess heat is absorbed from the air stream and stored in the CSM, with “cooled” air arriving to the plants. During the night cool air is taken from the roof area, heats up on the way down and arrives warmed up at the plant level.

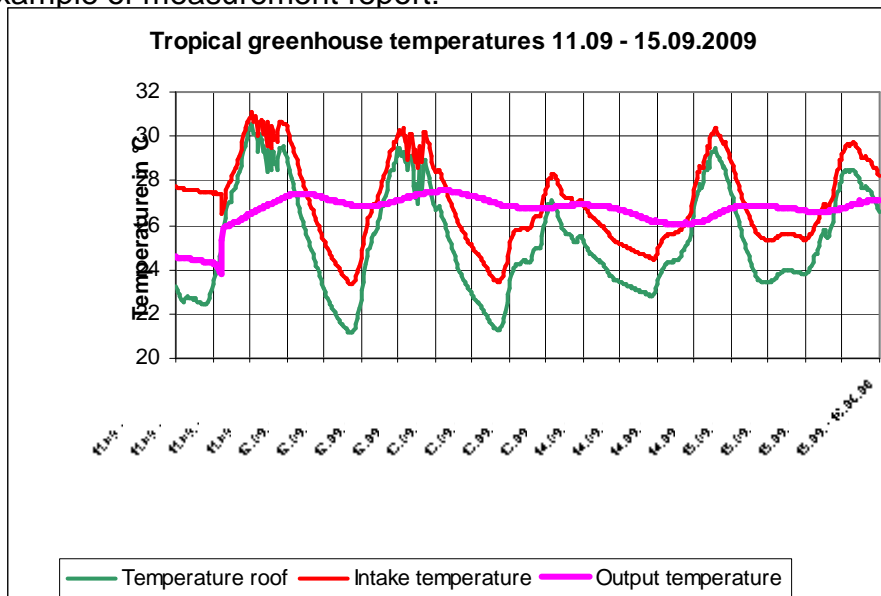
Both cooling & heating are accomplished using only a small electrical fan, thus saving fossil fuels, carbon dioxide and costs whilst considerably smoothing the temperature profile!

The technical details are the following:

Volume air stream :	7.500 m ³ /h
Pressure drop Δp:	50 Pa
Connected power (el. fan):	1,1 kW
Storage capacity:	110 kWh / cycle (8 h/d)
PCM – mass:	ca. 3000 kg

Estimated saved thermal energy over approximately 200 days (= 200 cycles):
ca. 22.000 KWh/a (corresponds the savings of 5to CO²)

Example of measurement report:



3.2 Heat pumps for an industrial production hall

The system consists of two heat pumps with a total volume flow of 4000 m³/h, solar thermal collectors and 6 compact storage units. Each contains 100 CSM modules. The RT12 PCM inside, has a storage capacity of around 26 KWh for the low temperature months where it stores the heat of day for use in the night. This leads to an efficiency increase of the heat pumps whilst also decreasing the peak loads.