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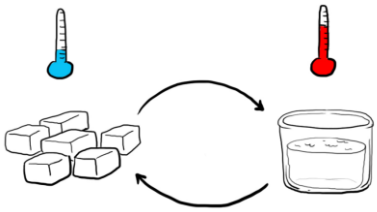
FAQ (Frequently Asked Questions)

How it works

What is PCM?

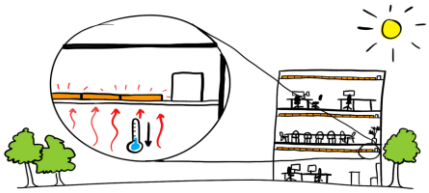
Phase Change Materials are a combination of salt and water, which solidify and melt at a set temperature. For offices, heat absorption starts at approximately 21 degrees and has a melting range up to 23 degrees, but for other applications, a different range can be chosen.



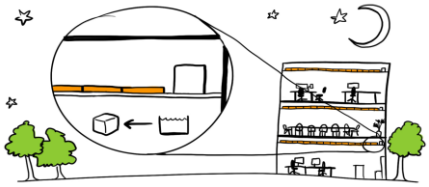
The principle of PCM can best be compared to the phase transition of ice to water at a temperature of 0 degrees. The ice cube absorbs heat from the ambient temperature, causing a phase transition from solid to liquid, and the temperature around the ice cube remains stable for a certain period.

By adding salt crystals to the water, the temperature of the phase transition can be adjusted, and the phase transition is set around the desired temperature, which is approximately 23 degrees for indoor applications.

The phase transition from solid to liquid occurs in the summer situation when the temperature in the room rises.



During the day: absorbing heat in the room



At night: regenerating from liquid to solid

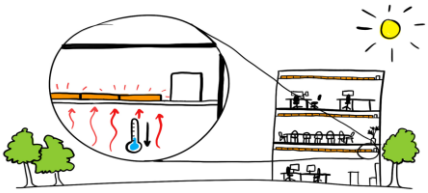
Additional effect: releasing heat to the room

The application in winter situations can be found under the question: How can I cool and heat with PCM?

For an informational video about the functioning of PCM: Werking van PCM in klimaatplafonds (youtube.com)

How can I cool and heat with PCM?

In the summer situation, the PCM will absorb heat from the ambient air (in the room or HVAC system) and thus essentially 'cool' the room passively and maintain the desired room or supply air temperature.



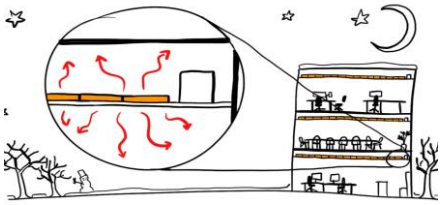
Depending on the use of the space and the occurring heat load, the PCM will undergo the phase transition, during which the temperature will gradually rise until the PCM has absorbed all the occurring heat.

During the design process of the building, we consider the amount of PCM in relation to the building's usage duration, ensuring that the peak load situation is under control and the GTO hours are minimized.

Active heating with PCM is unfortunately not possible and will need to be supplemented by additional heat sources in the building.

In the winter situation, another additional effect occurs, namely the storage of thermal energy during the day, which is released again at night (during the cooling of the building).

FAQ (Frequently Asked Questions)



During the day, natural heat sources such as people, equipment, and solar radiation will warm the building, partially causing the temperature in the room to rise.

Additional heating power can be obtained from water-based or electric reheaters, as well as the application of underfloor heating if this is possible.

During the winter period, the PCM will absorb the heat and change from solid to liquid state due to the temperature rise in the room, and this process will be reversed at night by the natural cooling of the building. Night ventilation is therefore not required during the winter situation, as the cooling of well-insulated buildings is already approximately 1.5 - 2 °C.

If you want more information about the application of reheaters, please visit: Appendages – Orange Climate

How do I recharge my PCM?

The regeneration (from liquid to solid) of the PCM materials depends on the application in the building or home. Orange Climate advises and describes a regulation per application for the regeneration of PCM. PCMs have the property of temporarily storing heat and cold and releasing them later for heating and cooling. For example, the cooling of a commercial building during the summer period.

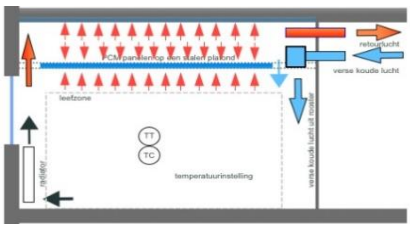
During the day, during office hours, the heat load is the highest. The excess heat is temporarily stored in the thermal building and PCM mass.

Isothermal or pre-cooled air is blown in during the day for CO2 refreshment and/or additional cooling.
Outside of business hours, the stored heat in the PCM and building mass is expelled to the outside.
Outside business hours means when:

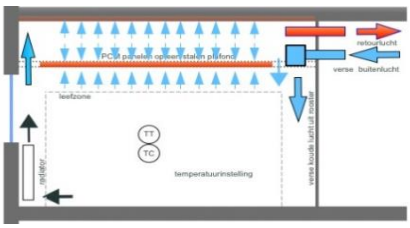
- At night when there is no more sunlight;
- The personnel are no longer present;
- It is colder outside than during the day.

During the night, the space is ventilated using summer night ventilation (or in case of extreme outdoor temperatures, the cooling coil in the HVAC system should be activated). With this 'free' cooling, the PCM is cooled down again and releases the stored thermal energy from the day to the space, undergoing the phase transition from liquid to solid. This ensures that on the next tropical hot day, a sufficiently cooled building and regenerated PCM mass are available to thermally comfortably cool the living areas.

The required supply air temperature and duration of ventilation depend on the load that occurred during the day. Therefore, customized advice is always necessary, along with the addition of temperature sensors to determine these values.



During the day: absorbing heat from the space



At night: Ventilating with phase transition from liquid to solid

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FAQ (Frequently Asked Questions)

What are the benefits of applying PCM?

- Energy savings on the generation side (heat pump, ATES, etc.);

By applying PCM, you save on the energy consumption of your generation systems in both summer and winter situations. On average, an energy saving of approximately 50% can be achieved compared to traditional systems, such as water-based climate ceilings. Compared to fan coil units or air conditioners, the savings are even greater.

- Meeting the PARIS-PROOF requirements;

  With the application of PCM in your building, we can implement solutions that meet the PARIS-PROOF agreement for total energy consumption in your building or home.
  nI many cases, these requirements cannot be met with traditional systems, resulting in the need for even more sustainability measures mandated by the government by 2040.

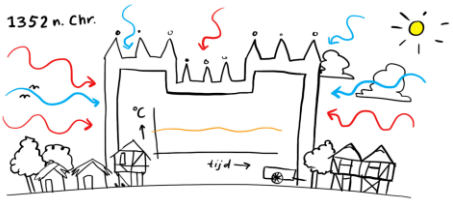
- The PCM product in all its applications is maintenance-free.

  Because the PCM product contains no water-carrying parts, valves, or other moving parts, it is completely maintenance-free.

- Low initial costs, low maintenance costs, and high comfort

  The lifecycle costs (TCO approach) of applying PCM are always lower than other climate concepts, such as air conditioning (split units), VRF, induction units, and traditional climate ceilings. This is demonstrated in independent calculations using software like Life Cycle Vision. Why? Less energy and equipment are needed, resulting in lower energy and maintenance costs.
  Additionally, a better performance on the energy label is achieved.

- Heavier building with less material



By local heat storage in phase transition, we turn every ceiling/building into a heavy building. One kilogram of our solution is equivalent to 36 kilograms of concrete. Your building transforms in terms of temperature to the comfortable stability of an old Romanesque church.
Additionally, there is less CO2 burden for the production of new materials that need to be used for the construction/renovation of your building.

- Simple installation in new construction and renovation
- Less CO2 emissions during the construction and use of the building

  On one hand, the energy savings achieved by applying PCM in the building, and on the other hand, the reduced material usage for climate control (copper, steel) and structural components (concrete), result in savings on CO2 emissions during the annual use of the building.

  Additionally, during the construction phase of the building, CO2 is also saved due to the reduced need for the production of new building materials.

FAQ (Frequently Asked Questions)

Are there also disadvantages to the application of PCM?

- No control/adjustment possible during usage hours: The PCM material is not adjustable, and the room is brought to the desired level based on a temperature regulation at night. As a result, the day will start with a temperature of 19-20°C and slowly rise to a maximum of, for example, 23°C. Our advisors determine the required PCM mass based on this.

- ncreased load on structural floors: Since the weight of the PCM material (between 5 - 8 kg/m²) often needs to be hung or laid on the structural floor, the structural floor may need to be reinforced.

- Risk of leakage or perforation during work (drilling) when PCMs are installed out of sight, for example, in a wall or floor.

What happens when the PCM material is 'depleted'?

If the PCM material is in a liquid state, it no longer absorbs heat, which automatically affects the room temperature of your building and the number of GTO (weighted temperature exceedance hours).

This situation can occur due to several reasons:
- Longer usage hours than assumed in the design/Program of Requirements (PvE).
- Higher internal/external load than assumed in the design/PvE.
- PCM material insufficiently regenerated outside of usage hours.

The causes can be made visible through a Building Management System (BMS), allowing us to identify potential adjustments in the control systems even after implementation.

Therefore, advising during the building design is crucial, and that is why Orange Climate is keen to collaborate to optimize the use of PCM material.

TOEPASSINGEN

Where can I apply PCM?

Orange Climate first provides advice for the application of PCM products based on the customer's needs. This can depend on the building type, load or function of the building, and the phase of realization.

Based on these factors, we offer recommendations for the following applications:

- PCM Climate Ceilings

  The application of PCM climate ceilings is ultimately provided by Inteco through an engineering proposal for the ceilings, incorporating all components and customer requirements. Primarily, the use of PCM climate ceilings is common in school buildings and office functions. Here, the heat load from equipment and people during the day is absorbed by the PCM, keeping the space at a stable temperature, and then regenerated outside of usage hours through summer night ventilation.

  If you want more information about the application of climate ceilings, please visit: Klimaatplafonds (inteco.nl)

FAQ (Frequently Asked Questions)

- PCM underfloor heating and cooling.

  The application of PCM floors is provided by SST Europe, supplying materials that can be combined with traditional underfloor heating systems, mainly in new residential buildings and offices. The PCM in the floor ensures that heat/cold can be accumulated even faster. Thanks to the PCM, the floor acts as a large thermal buffer where energy is stored and later released. Energy peaks are reduced, and it remains comfortable in the home for longer periods.

  Less cooling load is required, the heat pump operates less frequently, and CO2 emissions are reduced.

  If you want more information about the application of PCM floors, please visit: Energy floor (PCM) – SST

- PCM Air Handling Units

  Every commercial building needs an air handling unit (AHU) to refresh the air in the building. The application of PCM material in the air handling unit (AHU) ensures that less energy needs to be supplied by the generation system, achieving an approximate 50% saving on the installed capacity and energy use of the AHU.

  With this 'simple' addition to the AHU, by blowing outdoor air over the PCM materials, free cooling is achieved before the air is further treated, as the PCM will pre-cool a portion of the air.

  If you want more information about the application of PCM in AHUs, please visit: Luchtbehandelingskasten

- PCM Climate Tower
- PCM Induction Units
- PCM Buffer Tanks

How can we apply PCM within the existing regulations?

PCM is included in the method for calculating energy performance, the NTA 8800 (also known as BENG).

This means that applying PCM results in an improvement for the environmental permit and the energy label. PCM provides, depending on the design, a saving of 4 – 10 kWh/m²/year in BENG 1 and a reduction in TOjuli (the measure for temperature exceedance) between 10 and 40%.

Are there different temperatures at which you can set or control PCM?

The PCM material cannot be set (adjusted) on-site but is configured per project or application. The phase transition temperature can be regulated with the ratio of the salt solution.

We primarily apply the following PCM mixes for the corresponding applications, with the rule of thumb being that the temperature of the PCM material matches the desired room or supply air temperature.

- PCM 20; Application in air handling units: The material has a melting/freezing range between 17°C and 20°C.
- PCM 23; Application in climate ceilings for offices, schools, or other commercial buildings with a maximum room temperature of 25° C:The material has a melting/freezing range between 20.5°C and 23°C.
- PCM 24; Application in climate ceilings for offices, schools, or other commercial buildings with a maximum room temperature of 26° C:The material has a melting/freezing range between 20.5°C and 24°C.
- PCM 26; Application in PCM floors for residential buildings:The material has a melting/freezing range between 20.5°C and 26°C.

Deviating temperatures can also be mixed by us; however, the types mentioned above are the most common.

FAQ (Frequently Asked Questions)

What else do I need to add to my building to make the PCM work?

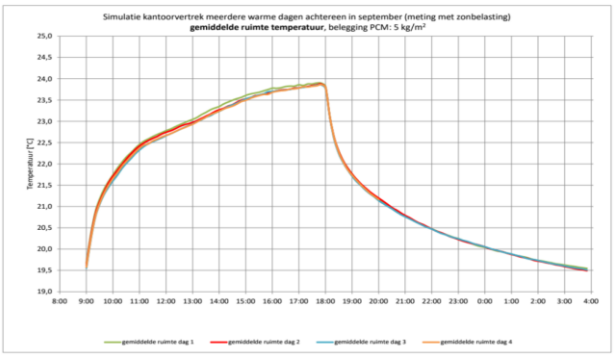
- A basic ventilation system with air handling (preferably with heat recovery) and air ducts. For homes/offices, the above is not necessary when PCM is applied in the floor system.
- No cooling or a basic cooling system (including top cooling).
- A basic heat source and heat distribution system (e.g., radiators, underfloor heating, or reheaters).
- A programmable measurement and control system with temperature regulation for daytime and nighttime, to control the PCM range and regenerate the PCM during the night.

COMFORT AND CONTROL TECHNOLOGY

What power and climate class (comfort) can be achieved with PCM?

The cooling capacity delivered by the PCM material depends on the amount of PCM applied per square meter (in kg), or in the case of air handling units, the total number of kilograms.For example, the energy content of PCM 23 (used in climate ceilings) is 170 kJ/kg and is applied at a coverage between 5 and 7 kg/m², resulting in a cooling capacity between 40 - 60 W/m². The addition of pre-cooled air from the air handling unit is not included in this.

For determining the comfort class, a measurement was conducted by PEUTZ using a PCM climate ceiling, where temperatures were recorded per time unit. The result is an average comfort class B with an average application of 5 kg/m² of PCM material in the ceiling.However, 3 hours after the start of the measurement (i.e., the start of the day), a comfort class A is achieved until the end of the measurement, with a usage duration of 8 hours.



Simulation of multiple hot days in September, with solar load and 5 kg/m² PCM

The comfort class is related to the heat load, amount of applied PCM, and duration of building usage. Based on the above units, Orange Climate provides advice to maintain the comfort class and keep the temperature within the specified requirements.

What temperature or setting do I need to use to regenerate the PCM material?

The temperature required to facilitate the phase transition in the PCM depends on the extent of the phase transition (i.e., how much heat has been absorbed during the day) and the type of PCM material.

Depending on both factors and the application of the PCM, you can regenerate the PCM using air or water systems. For example, in the case of PCM used in climate ceilings, the supply air temperature will typically be between 16 - 18 degrees Celsius, while for floor systems, a water temperature between 17 - 20 degrees Celsius is sufficient.

During the design process, we advise the customer on a project-specific basis regarding the temperature and duration for which the PCM product should be regenerated, ensuring it returns to a fully solid state.

FAQ (Frequently Asked Questions)

How should I regulate ventilation (especially for ceilings) to regenerate the PCM material?

The application of a ventilation system operating with constant air volume (CAV) is best suited for storing thermal energy in phase change material. If you wish to apply a ventilation system that operates with variable air volume and where the carbon dioxide (CO2) level is a controlling factor, temperature control is also required. The VAV damper will not only respond to CO2 but will also open further as the room heats up. Additionally, the damper will remain open during night discharge and will close again once the room and the PCM are cooled down.

The advantage of using a VAV damper is achieving better post-adjustment per room or zone. For example, if the thermostat controlling the VAV damper is set to cool to 21 °C, it will start supplying pre-cooled air as soon as the room begins to warm up, providing thermal cooling to the room through both the PCM and the pre-cooled air.

During night discharge, the room and the PCM will cool down to 21 °C, bringing the room back to the same temperature in the morning, and it will remain around this setpoint throughout the day. If a higher temperature is desired, such as 23 °C in a room of a healthcare facility, the pre-cooled air will become more available above this temperature, and the cooling of the room and the PCM will only stop at this temperature during the night. This room will thus remain in a higher temperature range during the day than the previously mentioned room.

A room that has not been occupied by people may have a low CO2 concentration but may still have an excessively high room temperature. In this case, CO2 control is ignored, and temperature control takes precedence. When applying VAV, always ensure proper calibration and adjustment, minimum airflow, and possible large air leaks.

How do I handle the control during holiday periods (schools and offices)?

During school holiday periods, especially when outdoor temperatures and solar radiation are high, the building tends to gradually heat up. It's desirable to avoid activating night ventilation or active cooling every day during these periods just to regenerate the PCM.

Our recommendation is to activate night ventilation (or active cooling if outdoor temperatures are too high) only when the maximum indoor temperature set for the day is reached. This means that the PCM has completely melted, and the building won't cool sufficiently through transmission losses, leaving the PCM unable to reach its temperature range for absorbing the next day's heat load.

By implementing this control strategy, energy is still saved when the PCM is functioning normally, while preventing excessive heating of the building during the holiday period. Otherwise, there's a risk of the building mass getting excessively heated, requiring both daytime and nighttime active cooling to cool not just the PCM but primarily the building mass.

Sustainability

Do I get subsidies for the application of PCM materials?

For phase change materials, which PCM cooling utilizes, there is a maximum energy investment allowance of €10 per kg applicable. However, it is important that the building is under one's own management to qualify for this. It is intended for reducing energy consumption for cooling commercial buildings and consists of phase change material with a defined transition range and a capacity in the transition range of at least 100 kJ/kg.

Measure 210405 [W]; Phase Change Material	
Intended for:	*Intended for: Consisting of: reducing energy usage for cooling or heating commercial buildings, phase change material with a defined transition range and a capacity in the transition range of at least 100 kJ/kg. The maximum investment amount eligible for Energy Investment Allowance is €10 per kg of phase change material. Source:* Energielijst (rvo.nl)
Consisting of:	

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FAQ (Frequently Asked Questions)

Will I also save (construction) materials when using PCM?

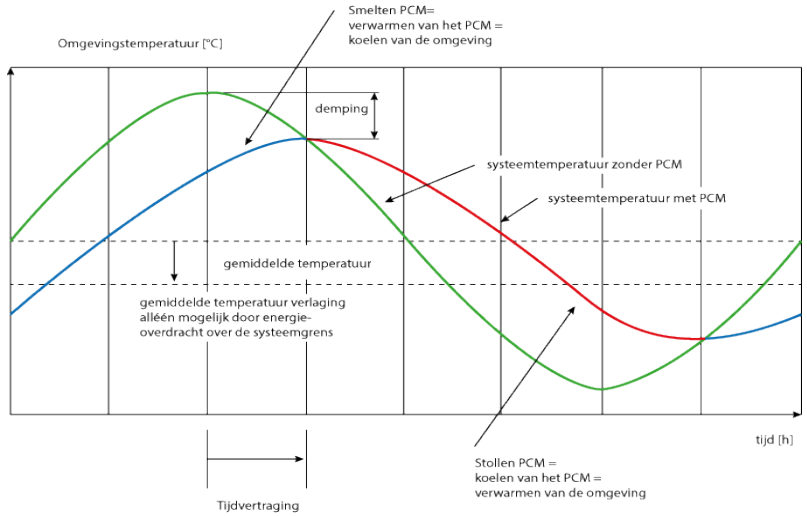
Yes, the combination of PCM (used as passive cooling) saves a lot of material in terms of installation components, as all generation energy, distribution pipes, pumps, and valves are no longer needed. As a result, buildings using PCM consume fewer raw materials and contribute less to earth depletion.

Since PCM material has approximately 30 times the heat capacity of concrete in a smaller package, PCM application is also highly suitable for lightweight buildings. This is because PCM acts as a heat buffer when concrete is either absent or very lightweight.

Hence, we also see that the rise of wooden buildings and the application of PCM go hand in hand for further sustainability of buildings and homes.

Does PCM result in savings in installed or connected power?

The application of PCM results in less cooling in summer and less heating in winter compared to traditional systems. This leads to a more constant temperature, reducing the required cooling or heating power, and consequently allowing for a smaller generation capacity. This effect is illustrated in a graph published by ISSO 111.



Thermally non-ideal PCMs contribute to attenuating and slowing down the ambient temperature through free convection with radiation and forced convection.

At Orange Climate, we assess your building and requirements, followed by simulation calculations or comparison charts to further estimate your property's power demand. This process helps to address potential issues related to grid congestion and ensures compliance with the PARIS-PROOF agreement, which all buildings must meet by 2050. Recent data from several projects indicates that by employing PCM, you can achieve savings ranging between 40 - 50 A on your connection (3-phase).

What is the lifespan of the PCM material?

Because solidification and melting are natural processes, there is hardly any degradation. In Germany, PCM tests have been developed by the RAL-Gütergemeinschaft. These tests show that the lifespan of the supplied PCM, even under continuous and heavy load, exceeds 25 years with virtually no degradation.

For more information about these tests, please visit the website of the RAL-Gütergemeinschaft.

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FAQ (Frequently Asked Questions)

Is the PCM material sustainable and suitable for use in BioBased buildings?

Unlike electrochemical energy storage (such as regular electric batteries), heat storage in terms of material choice is environmentally benign.

The material is 100% reusable in the packaging with an HDPE panel, commonly used in ceilings and air distribution units. The PCM material itself consists of a technically modified salt solution, which is extracted from the Wadden Sea and then mixed with water.

The casing that enables the application of PCM is made of high-quality material and thus has the greatest impact on the recyclability of PCM products and a detrimental effect on their application as BioBased total products.

Is the application of PCM solutions also suitable for BREEAM?

PCM is included in the method for calculating energy performance, the NTA 8800 (also known as BENG). This means that the application of PCM results in an improvement for the environmental permit and for the energy label. Depending on the design, PCM provides savings of 4 – 10 kWh/m2/year in BENG 1, and between 10 and 40% reduction in TO juli (the indicator for temperature exceeding).

For someone who wants to, there are more than enough points of reference to positively assess PCMs and more specifically the products such as PCM climate ceilings, PCM floors, and/or PCM air handling units. The following sections apply:

- **HEA = Health (indoor climate)**
  - HEA 5; controlling climate conditions. Since it's sustainable heating and cooling, opening windows is also not a problem.
  - HEA 28; regulating ventilation rates
  - HEA 106; thermal comfort
- **ENE = Energy**
  - ENE 1; EPC increase / energy savings through equivalence declarations
- **MAT = Material**
  - MAT 002; maintenance policy is exceptionally simple with PCMs
  - MAT 007; PCMs lend themselves to other uses
  - MAT 102; the material has a low environmental impact
- **POL = Pollution**
  - POL7; alternative to CFCs and HCFCs
  - POL8; refrigerants (no refrigerants so 10 bonus points)!!!
  - POL9; reduced NOx
  - POL10; GWP<5

For further inquiries about the application of PCM solutions in your building or if you require customized advice for your project, please feel free to contact our climate advisors at Orange Climate.

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