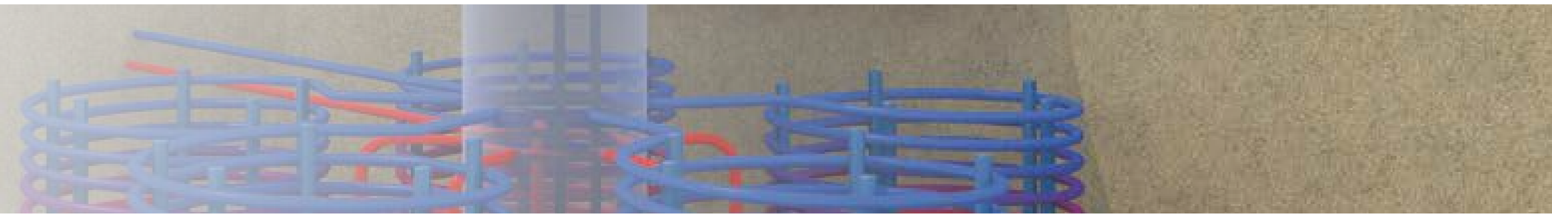


ET 420 Ice stores in refrigeration

With growing decentralisation of the energy supply, the storage of energy is becoming increasingly important. The storage of thermal energy for domestic water heating has been used successfully in building services engineering for years. However, the use of ice stores for cooling buildings is still an exception.

The heat to be dissipated, to cool buildings, fluctuates during the course of the day. The demand for cooling is usually much higher during the day than at night. In order to be able to cool buildings under the highest possible load demand, refrigeration plants are designed to meet the expected peak load. This leads to an over-dimensioning of the refrigeration technology, so that affected plants are operated very inefficiently under partial load conditions.

Ice stores can support the refrigeration plant in the case of particularly high cooling loads. Ice stores for assisting the refrigeration plant are mainly used in large non-residential buildings. In times of low cooling demand, the store is charged via the refrigeration plant and can be discharged again in case of peak loads to support the refrigeration plant. The capacity of the refrigeration technology can thus be designed to be smaller. The use of smaller refrigeration plants saves operating and investment costs.

If heat is removed from a liquid store, the temperature of the storage medium falls. The water remains liquid and there is no change to the aggregate state. The ice store belongs to the group of latent storage. The water in the ice store changes its aggregate state. The temperature of the water is constant during the phase transition. If heat is still dissipated, the temperature of the water in the ice store remains constant at 0°C. The discharged energy corresponds to the phase change work during water freezing.

To discharge the ice store, heat is transferred to the ice. The temperature is constant until the ice in the store has melted. Due to the phase change work, a large amount of thermal energy can be stored at a low temperature difference.

ET 420 offers a refrigeration plant with ice store, which can be operated entirely as required. The plant concept includes a dry cooling tower **9**, which represents the heat exchanger in the building to be supplied during the experiments and a wet cooling tower **8**, which represents the heat dissipation to the free environment. The ice store enables various operating states to efficiently serve as the fluctuating heating and cooling demand of a building.

The following operating states can be set via the position of the valves:

- charging the ice store
- cooling via the ice store
- cooling via the refrigeration plant
- cooling via the refrigeration plant and ice store
- heating via heat pump
- heating via heat pump and charging the ice store
- heat dissipation via the wet cooling tower

1 switch cabinet,
2 glycol storage tanks,
3 circulation pumps,
4 ice store,
5 refrigerant compressor,
6 refrigerant condenser,
7 refrigerant evaporator,
8 wet cooling tower,
9 dry cooling tower

Trainer with refrigeration plant and ice store

Wet cooling tower

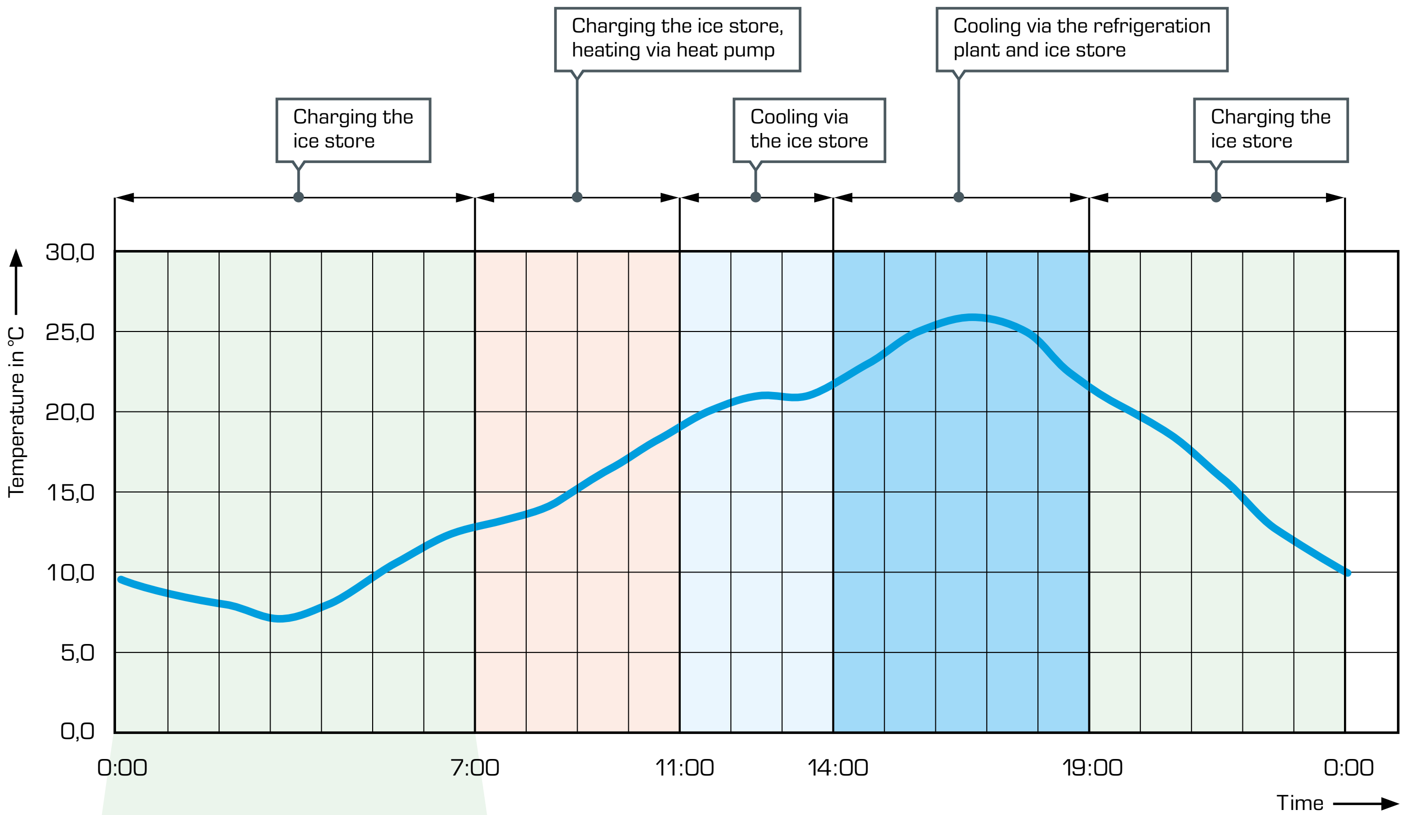
Dry cooling tower

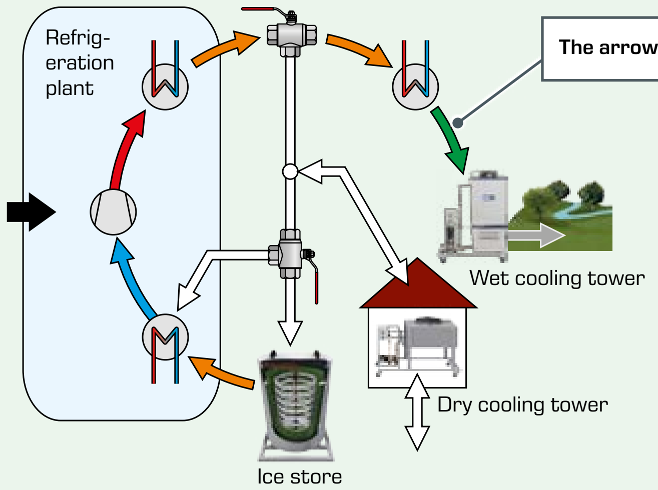
ET 420 Ice stores in refrigeration

Thermal supply of a building, using the operating modes of ET 420 as an example

The following shows how a demand-based supply of thermal energy via a refrigeration plant with ice store functions in practice. The load profile of an office building is taken as an example.

The ice store is operated using the example of a daily cycle. The primary objective is to respond to variable cooling and heating loads and to achieve an efficient supply of the building via a sensible sequence of operating states.





The arrows show the direction of heat transport

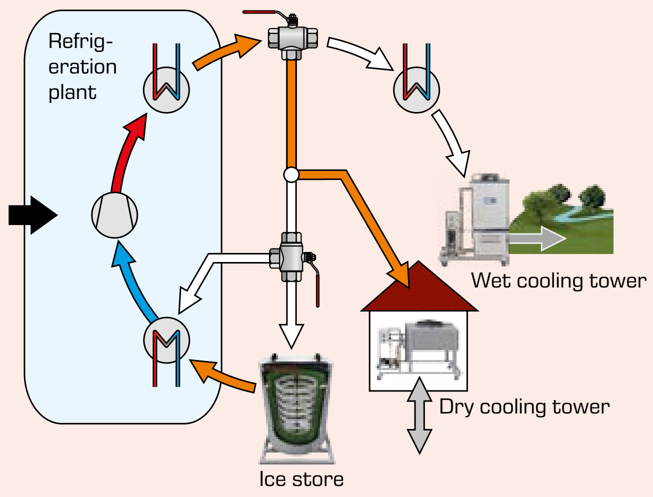
Charging the ice store

No persons are present between midnight and 7 am. There is no need for air conditioning, the ice store is charged.

To do this, the heat is dissipated from the ice store via the evaporator of the refrigerant circuit. (This heat dissipation causes the water in the ice store to freeze; the ice store is charged.)

The waste heat from the refrigerant circuit is dissipated to the environment via the wet cooling tower.

glycol, LP refrigerant, HP refrigerant, water, air,
electrical power, inactive process

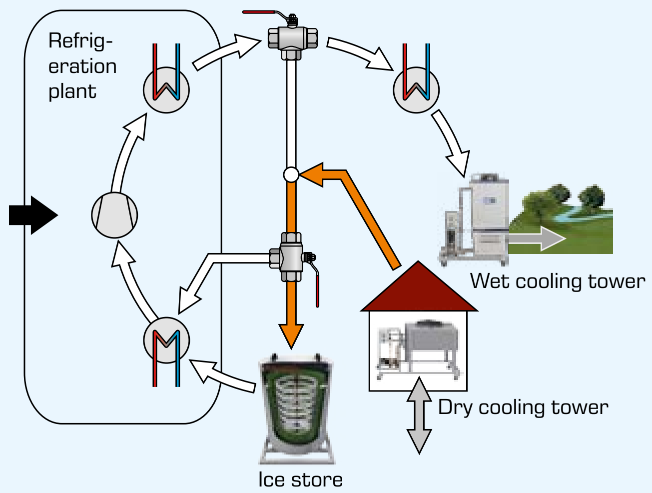


Charging the ice store and heating via waste heat

In the morning hours between 7 am and 11 am the temperature in the building is less than 20°C. There is a need for heating.

The heat generated during the ice store charging process can be used for heating. To do this, the heat is dissipated from the ice store via the evaporator of the refrigerant circuit. The ice store is charged by this heat dissipation.

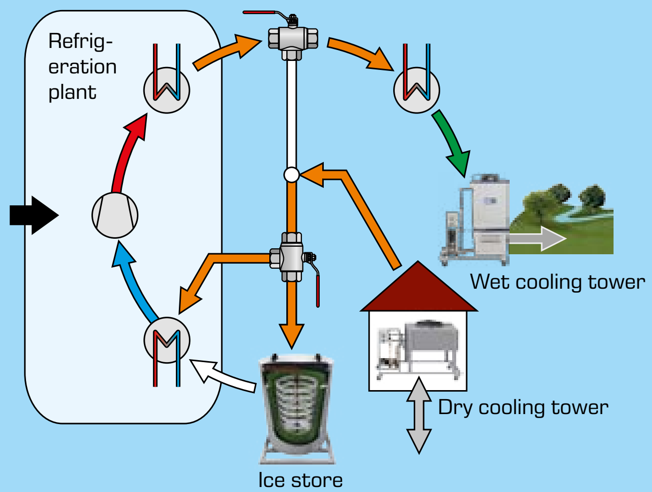
The usable waste heat from the refrigerant circuit is transferred to the dry cooling tower via the condenser, thus heating the building. The system operates in heat pump mode, while simultaneously using heat and cold.



Cooling via the ice store

In the period between 11 am and 2 pm, the temperatures in the building are between 20 and 23°C. There is a relatively low cooling demand, which can be covered via the ice store.

The ice in the ice store melts and absorbs heat from the dry cooling tower. This cools the dry cooling tower. This causes the building to cool down. The refrigeration plant does not need to be operated to dissipate the cooling load.



Cooling via the refrigeration plant and ice store

In the period between 2 pm and 7 pm, the temperatures in the building are between 23 and 27°C. This peak in the cooling load is covered by the combined cooling from ice store and refrigeration plant.

The heat is dissipated from the dry cooling tower and the building is cooled in this way. Part of the heat is transferred to the ice store, where the ice melts in the ice store and absorbs the heat from the dry cooling tower. In order to dissipate the particularly high cooling load, the refrigeration plant is also operated and transfers part of the heat from the dry cooling tower, via the evaporator.

The waste heat from the refrigerant circuit is dissipated to the environment via the wet cooling tower.

Charging the ice store

No persons are present in the building from 7 pm onwards. There is no demand for air conditioning.
During this time, the ice store is charged via the refrigeration plant.