BEKA
KLIMA-KOMFORT

sp.ICE

speedy & powerful ice storage

FASCINATING ICE STORAGE

Whenever a substance changes from one physical state to another, energy is either absorbed or released. When we convert liquid water into ice, energy is removed from the liquid water until all the water has turned to ice. The energy required for a change from one state to another does not affect the temperature of the medium, and is called latent heat. The latent heat of fusion of ice stores 80 times more energy than water at 0°C.

Ice storage technology has been in use for a very long time. The Chinese were already using ice stores to preserve food and to make ice cream 5,000 years ago.

Around 1900, it was still mostly natural ice that was used; it was taken from lakes, rivers or areas that were flooded especially for the purpose of obtaining ice. The ice was harvested in winter, cut into blocks, and stored in "ice cellars". In the summer, the stored ice was used to cool manufacturing processes such as beer production. In those days ice was stored for a long period. Modern processes need ice stores that can be filled and emptied quickly. In addition, the need for "cooling energy" has to be satisfied even in regions where there is no natural ice.

Short charging and discharging cycles, as in the case of daytime shuttle storage systems, in which the ice store is filled up at night and discharged during the day, require a relatively large surface area for heat transfer compared to the volume of ice.

Advantages of ice storage systems:

- Reduced costs of electrical operation
- Reduced electrical peak loads
- Reduced capacity charge
- Shifting cold production to cheaper tariff periods (night-time)
- Shifting cold production to times of day with low outdoor temperatures
- Cooling is maintained (emergency refrigeration) during power outages
- Good partial-load behaviour

sp.ICE HIGH-PERFORMANCE ICE STORAGE SYSTEM

Features of an ideal ice storage system:

- Large surface area for heat transfer in relation to the volume of ice
- Thin layer of ice at the surface for heat transfer
- Small temperature differential between the production system and the ice
- Large ice filling factor
- No energy losses

Main fields of application:

Air-conditioning
- Offices
- Hotels
- Hospitals
- Cinemas
- Theatres and concert halls
- Museums
- Congress centres
- Supermarkets, shopping centres, galleries
- Trade fair halls and function rooms

Process cooling
- Automotive industry
- Pharmaceutical industry
- Chemicals industry
- Biotechnologies
- Food industry

District cooling
- Local cooling networks
- District cooling networks

Emergency cooling systems
- Server rooms
- Operating theatres
- Process technology

Energy supply
- Heat pump systems
- Buffer storage

These requirements are met in the conceptual design of the new sp.ICE.

The ice container can be made locally as a tub, or alternatively as a transportable container. For the transportable sp.ICE, standardised containers are used; they come in 10', 20', 40' sizes or in special sizes. The modular ice storage heat exchanger allows the construction of various container dimensions with a single heat transfer element. The heat transfer system has been developed especially for the sp.ICE. Manufacturing ice effectively at a moderate production temperature of approx. -3°C requires a large area for exchanging heat. In the newly developed sp.ICE this has been achieved using fine tubes with a diameter of only 3.5 mm. The individual polypropylene heat transfer tubes are connected to a manifold and arranged only 10 mm apart. Individual heat transfer elements are linked together to form a module. The sp.ICE contains several heat transfer modules.

The sp.ICE container consists of the container wall, an insulating layer of rigid polystyrene foam, and a sealing film of glass-fibre reinforced polyethylene.

The sp.ICE has been developed especially for:
- Extremely short charging and discharging times
- Efficient ice production
- High energy density
- Modular construction
- Low pressure loss
- Easy transportation
- Low level of investment

OPERATING PRINCIPLE

For charging up (i.e. producing) ice, a refrigeration machine supplies the sp.ICE with a cooling medium (mixture of water and glycol). The large area for heat transfer results in system temperatures in the refrigeration circuit that are very modest compared with a conventional ice storage system. Charging can take place even at a moderately cold temperature of -2°C. This small temperature difference makes the sp.ICE extremely efficient. On the one hand it saves operating energy, and on the other it allows very short charging times. The sp.ICE is designed to meet individual cooling requirements. For example, an office building has a cooling demand of 1,200 kW. The cooling load is identified to determine the energy demand over time. This is shown in Fig. 1. The amount of energy was calculated as 10,000 kWh. Normally the cooling demand would be covered in full by refrigeration machines. In combination with a sp.ICE, however, the number of refrigeration machines can be halved. The supply curve with a sp.ICE is shown in Fig. 2. Another option is to store as much cooling as possible in the ice storage system in order to cover demand during the day. Fig. 3 shows the energy required for a sp.ICE that is charged in 6.5 hours.

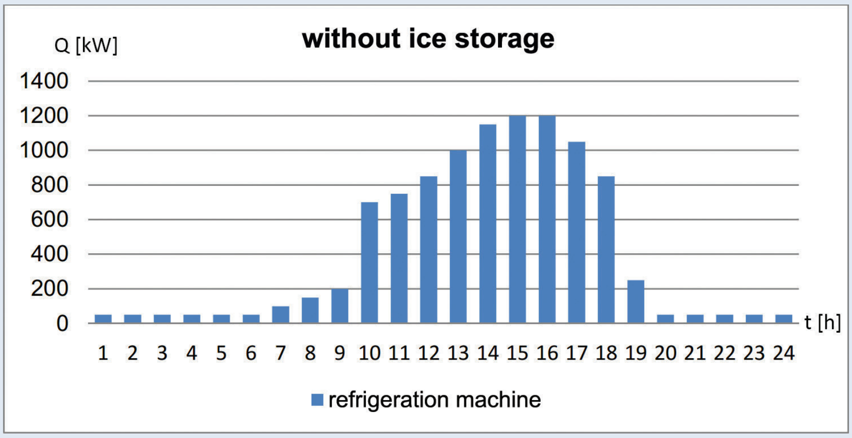

Fig. 1: Cooling energy required for an office building without ice storage

If the cooling is supplied without an sp.ICE, the cold water for cooling purposes is provided during the period when it is needed solely by refrigeration machines with an output of 1,320 kW (1,200 kW plus 10% reserve capacity). The energy required for this cooling amounts to 10,000 kWh.

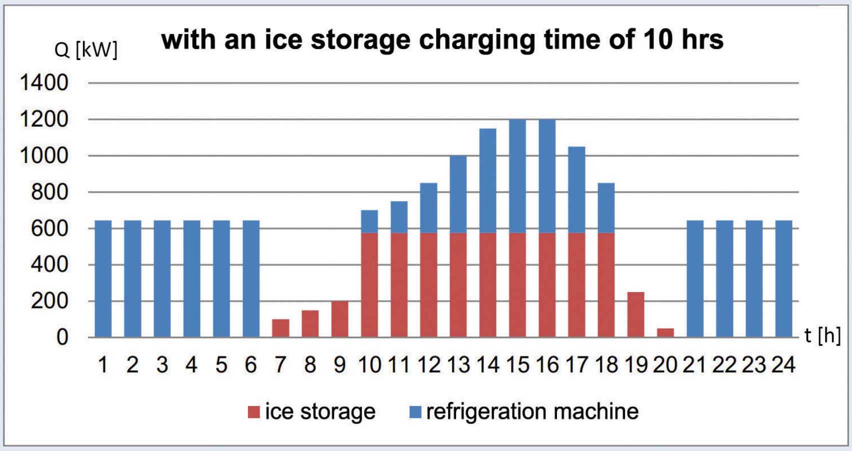

Fig. 2: Refrigeration with an ice storage charging time of 10 hrs

If the cooling is supplied with an sp.ICE with a charging time of 10 hours, the cooling power can be reduced to 650 kW. The ice storage is integrated into the base load, and the refrigeration machines cover the peak loads. The ice storage system allows 6,000 kWh of energy to be stored taking into account the base load. This represents 60% of the daily requirement. In spring and autumn, it can cover 100% of the daily requirement.

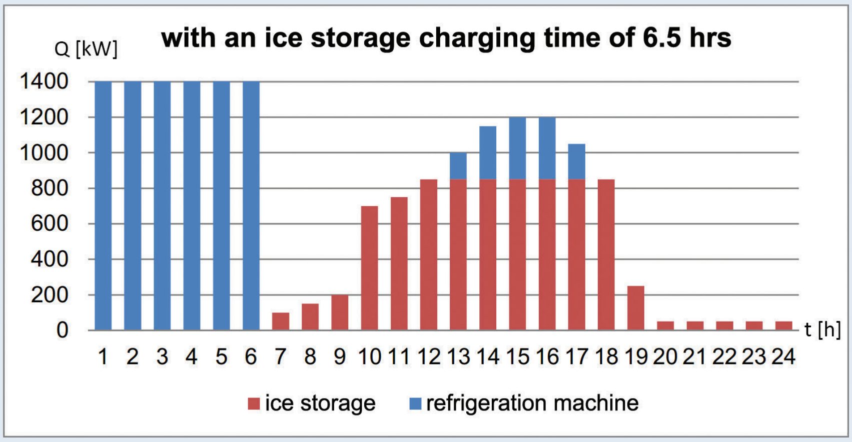

Fig. 3 Refrigeration with an ice storage charging time of 6.5 hrs

If cooling is supplied with an sp.ICE with a reduced charging time of 6.5 hours to take advantage of lower power price, the cooling power is adjusted to the capacity of the ice storage system – to 1,320 kW in the case shown. During those 6.5 hours the ice storage system can take up 8,250 kWh, which corresponds to a daily requirement of 82.5%. In spring and autumn, it can cover 100% of the daily requirement. It is also possible to design systems to cover the entire demand.

In the system for emergency cooling, cold is stored for potential emergencies. The system is designed to operate for the duration of the emergency cooling with the necessary cold output. For example, a server room with a cooling requirement of 25 kW can be cooled by the sp.ICE-10' over a period of 40 hours.

A cooling system using a sp.ICE stabilises control of the cooling supply. A network system consisting of an sp.ICE and several stages of cold production behaves like an infinitely adjustable refrigeration machine.

Shifting the production of cold to the night-time offers considerable advantages. Firstly, the external temperatures during the night are on average 10°C below daytime temperatures, which more than balances out the disadvantages of the lower starting temperature. Secondly, cheaper night-time prices can be arranged with the electricity company.

The heat exchanger in the sp.ICE is made of polypropylene. The patented heat exchanger ensures total ice block formation. The temperature change in the charging cycle enables the generation of a control signal to switch off the charging process (flow temperature of the charging circuit = -6°C sp.ICE when fully charged).

The sp.ICE is manufactured in the factory with quality assurance; locally the sp.ICE only has to be connected to the system's technology. The sp.ICE comes with a ten-year warranty obligation.

EFFICIENCY TO MAKE YOU MELT

Typical system circuit diagram:

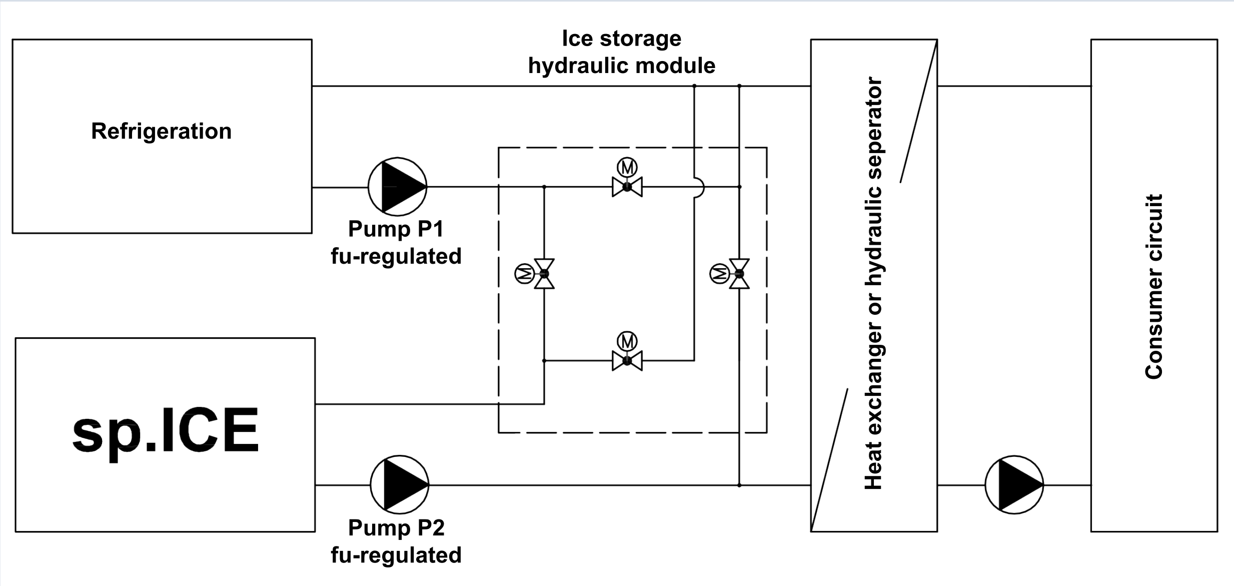

Fig. 4: Cooler and ice storage operating in parallel

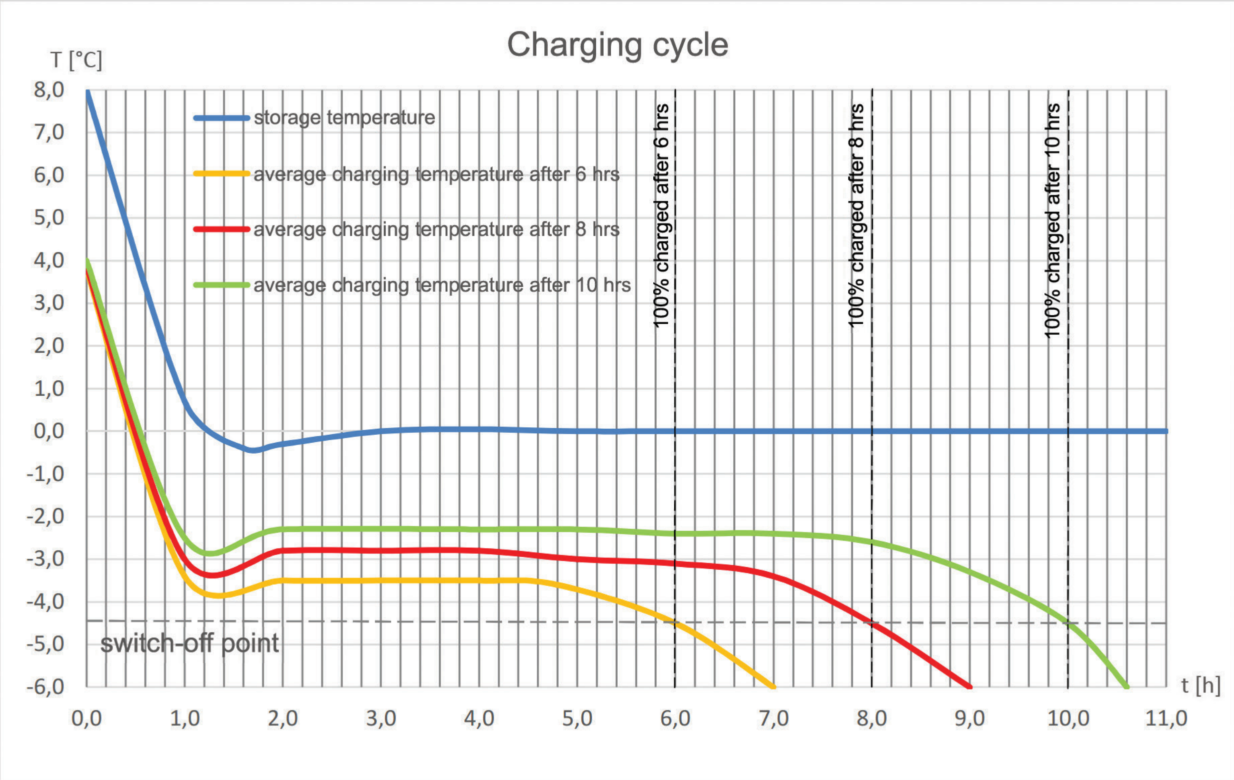

Fig. 5: Temperature diagram for charging cycle

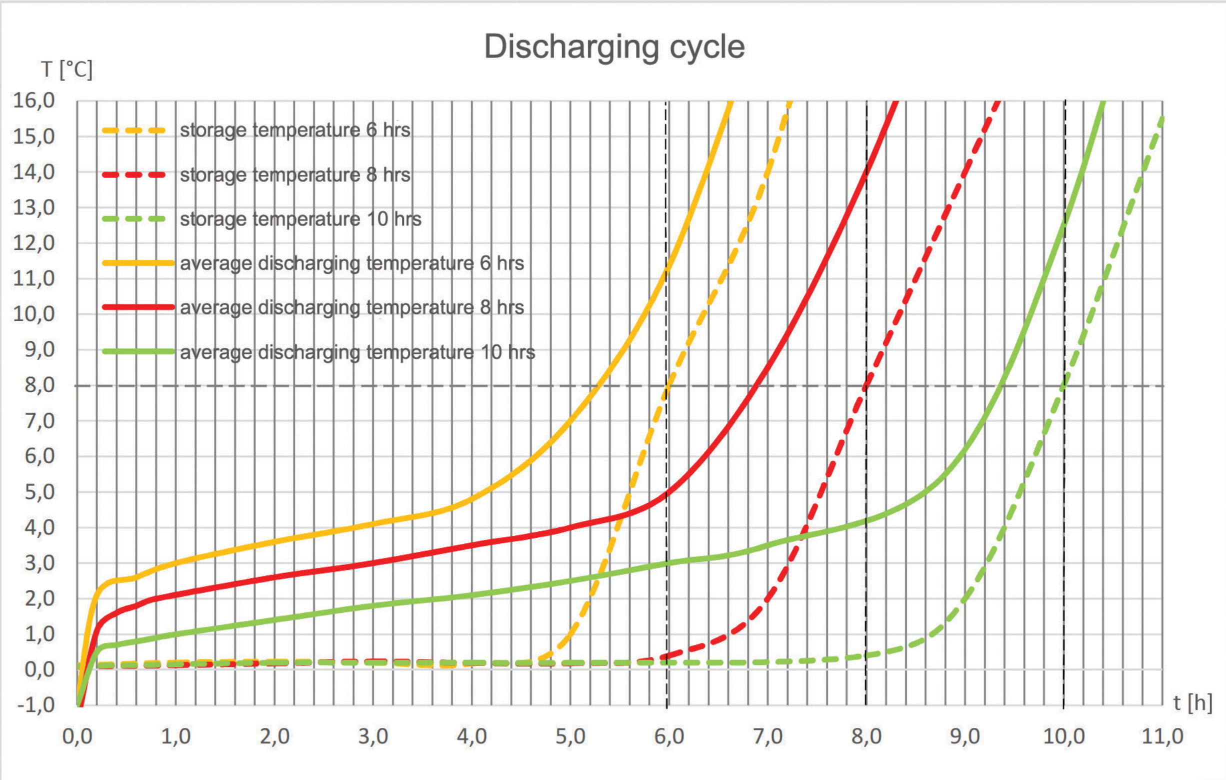

Fig. 6: Temperature diagram for discharging cycle

Fig. 7: Pressure loss

TECHNICAL DATA

sp.ICE
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Particulars	Units	sp.ICE-10'	sp.ICE-20'	sp.ICE-40'
Length	mm	2.991	6.058	12.192
Width	mm	2.438	2.438	2.438
Height	mm	2.591	2.591	2.591
Effective volume	m^3	11,74	25,13	51,89
Transport weight	kg	2.200	3.900	6.200
Service weight when filled	kg	15.500	23.820	57.400
Heat transfer area	m^2	680	1.345	2.640
Total capacity with starting temperature of 10°C	kWh	1.280	2.495	4.905
Sensible capacity	kWh	155	300	595
Latent capacity	kWh	1.125	2.195	4.310
Charging capacity, 6 hour operation	kW	213	416	818
Charging capacity, 8 hour operation	kW	160	312	613
Charging capacity, 10 hour operation	kW	128	250	491
Ice mass	kg	12.200	23.800	46.685

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