CHILLVENTA eSPECIAL

Refrigeration | AC & Ventilation | Heat Pumps

13.–15.10.2020

CONNECTING EXPERTS.

NÜRNBERG MESSE








KTI-Plersch Kältetechnik GmbH

The Application of Ice in the Context of Several Industries

Industrial Ice Applications

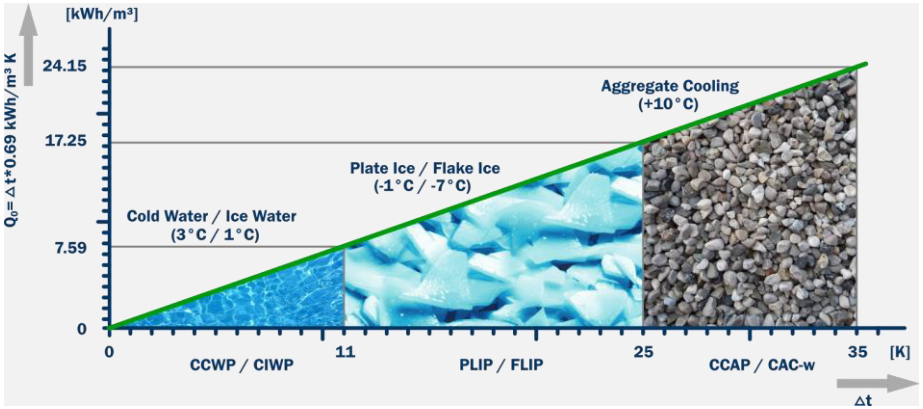
Where ice is used? And for which purpose?

Controlling Exothermic Reactions

Concrete Cooling

- Reaction of water and cement generate the heat of hydration
- A defined maximum temperature of the wet concrete must not be exceeded to meet quality constraints
- The addition of ice (esp. in hot areas) lowers the temperature and rejects the heat

Heat rejection / temperature reduction in concrete



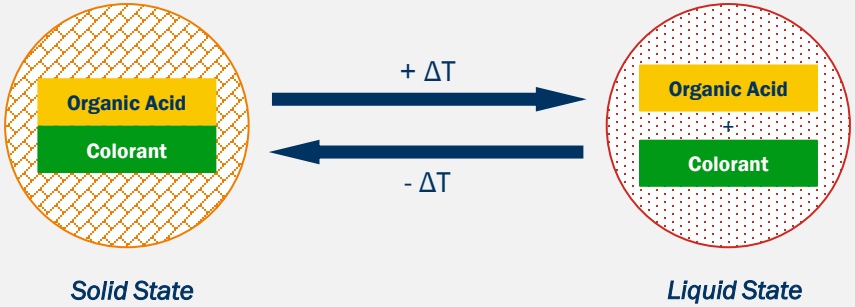
KTI Flake Ice Plant with Integrated Ice Water Plant

Controlling Exothermic Reactions

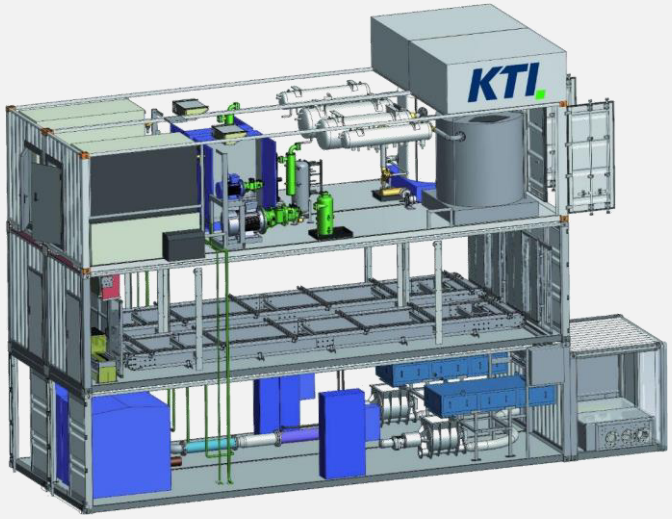
Manufacturing of Dyes & Pigments

- Synthetizing organic dyes & pigments in reactors creates heat due to an exothermic reaction
- Exposed to heat, the color changes
- At a distinct, specific stadium, the reaction must be stopped rapidly to conserve the quality

Thermochromism – Defining the quality of color



KTI Ice Plant with Ice Storage & Ice Delivery

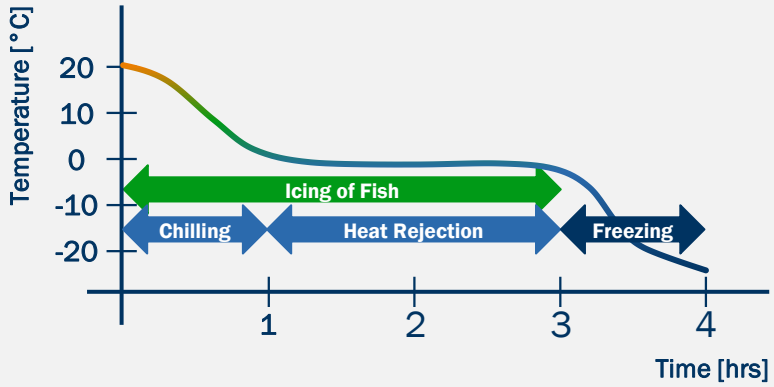


Preservation Of Food

Icing of Fish & Seafood

- Once fish is caught, rapid cooling to 0 °C is necessary to avoid spoiling
- Iced fish enhances the efficiency of processing the fish as the flesh gets firmer
- Ice maintains a very definite temperature slightly above the freezing point of fish at approx. -0.5 °C.

Development of fish temperature



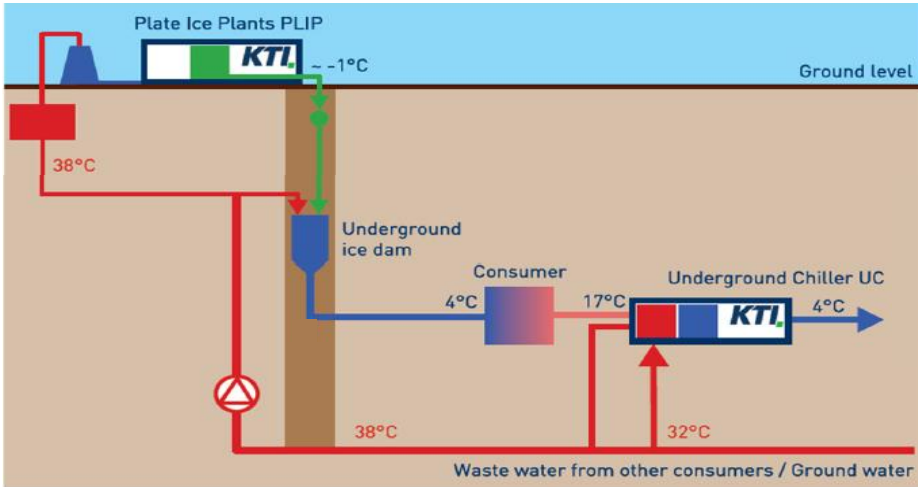
KTI Ice Plant at a Fishery Harbor

Energy Storage

Deep-Mine Cooling

- Latent heat of rock mass & process heat have to be rejected from underground
- Negligible risk of heat stress for mine workers @ $T_{WB} \leq +27.5\,°C$, $T_{DB} \leq +32.5\,°C$
- Ice can be stored in underground ice dams while produced on surface to provide 0 °C water (melted)

Mine Cooling Concept



KTI Large Scale Ice Plants (1600 t/d)

Leisure Activities

All-Weather Snow

- Climate change influences the alpine industry negatively due to missing snow fall
- The trend for indoor skiing domes became an important industry sector (esp. in South-East Asia)
- Modified ice is used to prepare skiing slopes with high effectiveness compared to usual snow guns

"Ice Snow" under preparation of the ski slope

KTI mobile All-Weather Snow Plant

Types of Ice

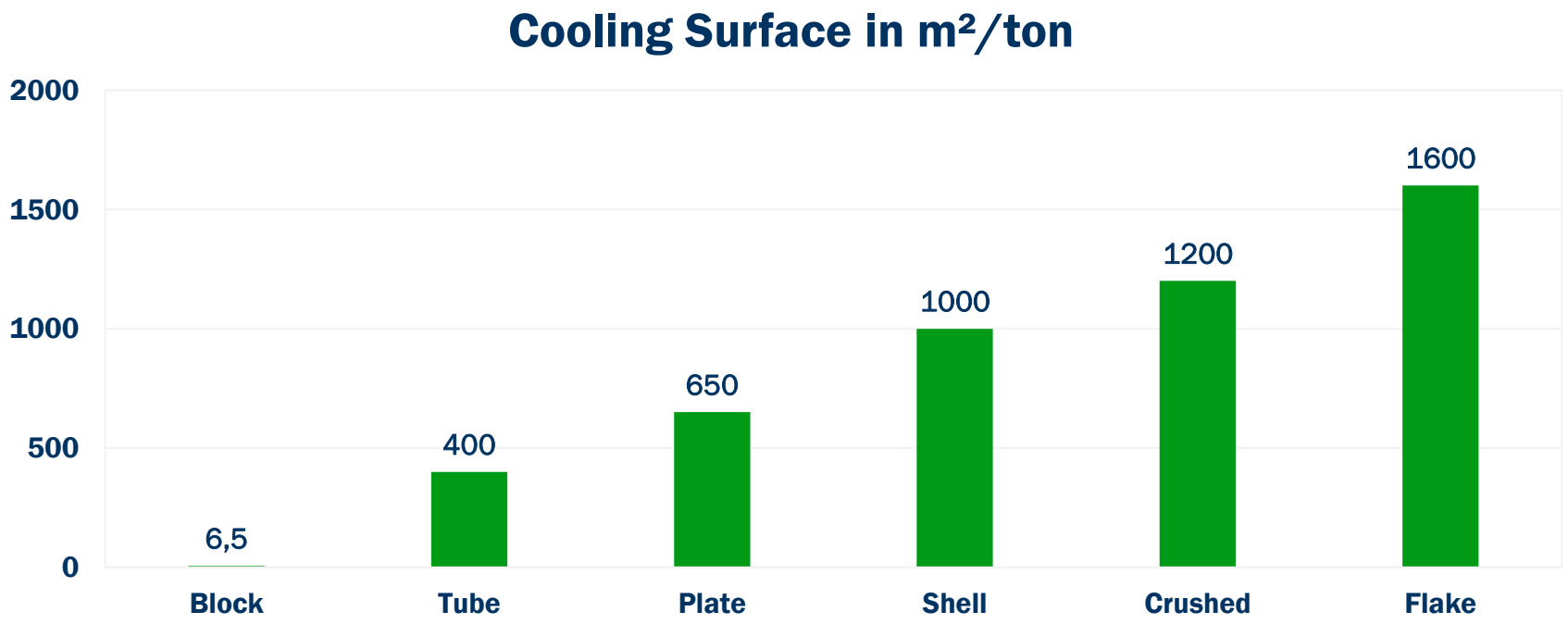
Which ice fits my purpose?

Flake & Plate Ice Are Most Common

Flake Ice	▪ Sub-cooled ice; particle size approx. Ø15mm, 1.5-2.5mm thick ▪ Very quick heat rejection due to high specific surface area ▪ High integration into industrial processes possible	
Plate Ice	▪ Wet ice; particle size approx. Ø40mm, 3-10mm thick ▪ Ice production is very energy-efficient ▪ High integration into industrial processes possible	
Block Ice	▪ Wet ice with sub-cooled core; block size 25 or 50 kg ▪ Very little surface area causing lowest melting rate ▪ Very good transportation means of “cold energy”	
Slurry Ice	▪ Dispersion of salt water and ice crystals, max. 35% solids ▪ Perfect heat rejection due to liquid phase ▪ Pumpable through complex networks of pipes	
Tube Ice	▪ Wet ice; particle size approx. Ø40mm x 40mm (cylindric) ▪ Efficient ice production, slow melting (compare ice cubes) ▪ Large footprint of machinery compared to Plate/Flake Ice	

Many other types of ice such as scale or nugget ice exists. These are not subject of this presentation.

Heat Exchange Surface Of Ice



Flake ice has the largest cooling surface and so the fastest heat exchange / rejection is possible. Block is melts very slowly and provides a perfect storage of cooling energy.

Flake Ice & Plate Ice

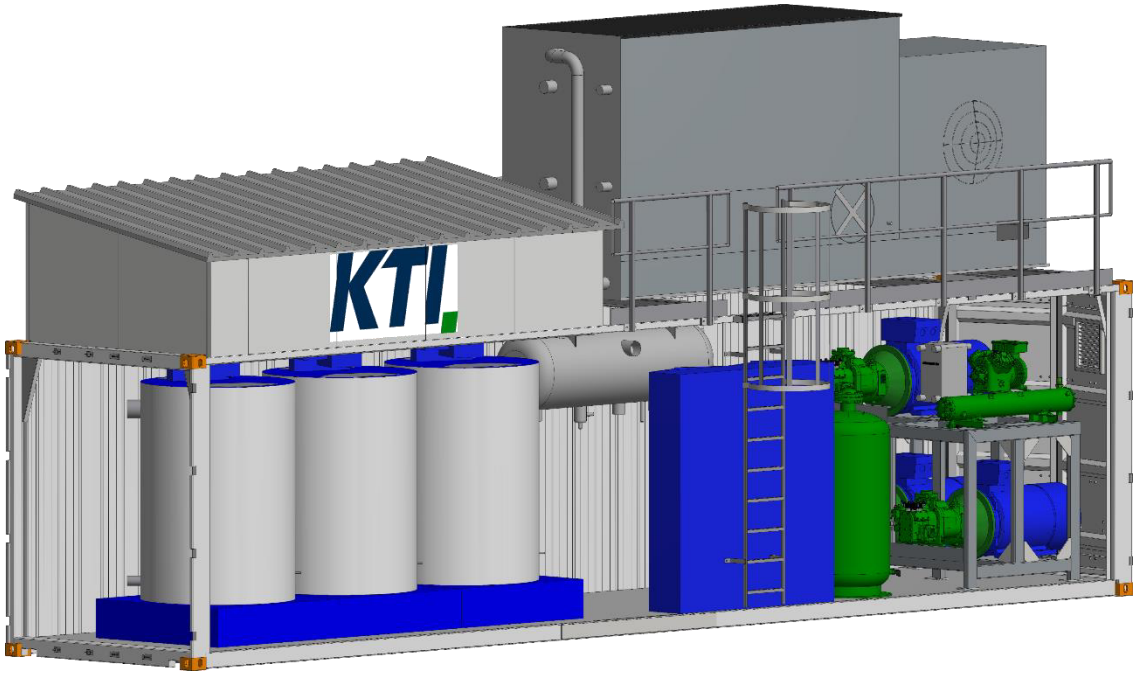
How are these types of ice produced? What is the difference?

Flake Ice Production

Machinery

- Mainly flooded systems for industrial applications due to efficiency
- NH_3 or Freon R448a / R449a as refrigerant
- Ice making process is continuous whereas water freezes on double-wall cylinders
- Ice particles are mechanically removed from freezing surface
- Particle size depends on T_0, water temperature and speed of ice removal

Containerized Flake Ice Plant



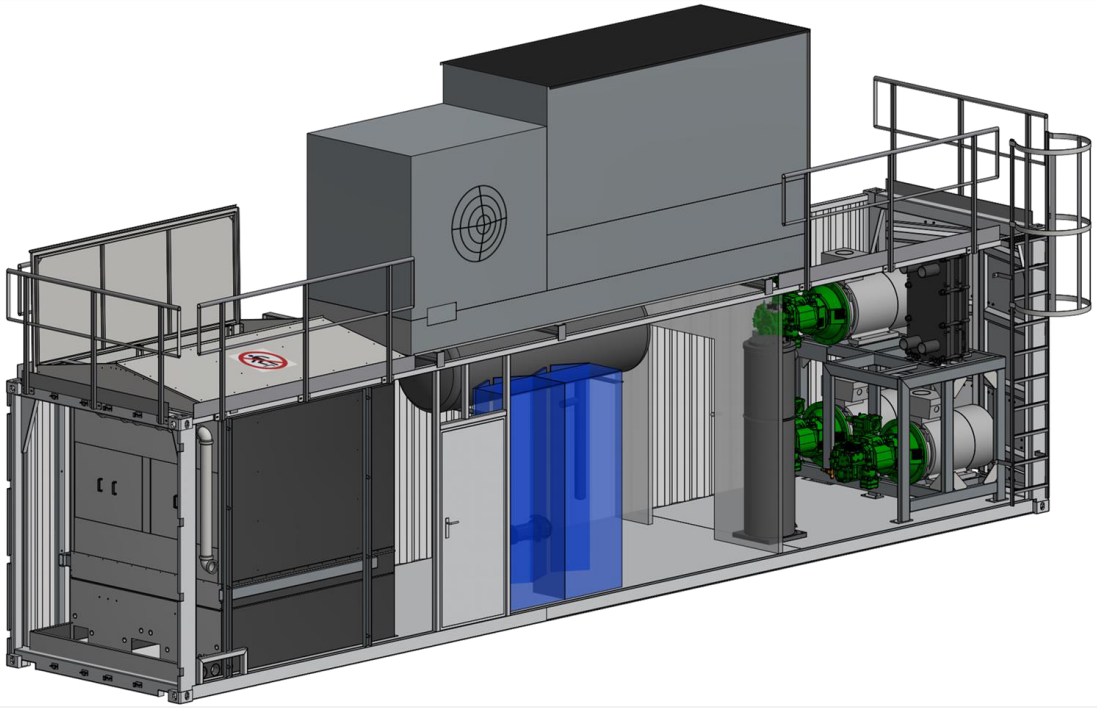
- Fully containerized units up to 100 tons ice per day
- “Simple” refrigeration technology for easy maintenance
- Availability of an integrated water chiller
- Approx. 4.7 kW refrigeration capacity required to produce 1 ton of flake ice within 1 day (5 °C water)

Plate Ice Production

Machinery

- Flooded systems for industrial applications due to efficiency
- NH_3 as refrigerant
- Alternating ice making process – freezing and defrosting
- Ice particles are removed through defrosting with hot gas
- Particle size depends on T_0, water temperature and freezing time

Containerized Plate Ice Plant



- Fully containerized units up to 200 tons ice per day
- Low maintenance due to non-rotating ice makers
- Highly flexible - can be used as a falling film chiller as well
- Approx. 4.55 kW refrigeration capacity required to produce 1 ton of plate ice within 1 day (5 °C water)

Flake Ice vs. Plate Ice

	Flake Ice	Plate Ice
Temperature (t_{UK})	$-7\ °C$ (dry)	$0\ °C$ (wet)
Ice Thickness (s)	$1{,}5\ldots2{,}5\ mm$	$3{,}0\ldots10\ mm$
Bulk Density (ρ_s)	$0{,}45\ldots0{,}55\ t/m^3$	$0{,}6\ldots0{,}65\ t/m^3$
Specific Surface Area in Bulk (a_s)	$1600\ m^2/t$	$650\ m^2/t$
Evaporation Temperature (t_0)	$-23\ldots-29\ °C$	$-12\ °C$
COP [1]	$2{,}1-\ 1{,}6$	$3{,}2$
Required Refrigeration Capacity for 1 t/d (k) [2]	$4{,}7\ kW/(t/d)$	$4{,}55\ kW/(t/d)$
Required Electric Power for 1 t/d (p)	$52{,}2-\ 67{,}5\ kWh/\ t$	$34{,}5\ kWh/t$
Required Storage Temperature (t_{STO})	$<-5\ °C$	$\approx 0\ °C$

[1] Assumption: T_C = 40 °C, one-stage circuit with flooded evaporator, refrigerant R717 (Ammonia), BITZER OSNA8591-K
[2] for make-up water temperature of 5 °C

Storage of Ice

How is ice properly stored? Which storage types are available?

Types Of Ice Storages

Rake Systems	Semi Automatic	"Conveyor Floor"	Orbital Silos	Manual Ice Bins
				

LIFO[1] Ice Storages | ***FIFO[2] Ice Storages***

Degree of Industrial Fit

Available Storage Capacity

Possible Storage Period

LIFO ice storages suit best for industrial applications. They provide the biggest storage capacities and longest storage periods for ice. Especially rake systems can be used for all types of ice and are mechanically robust to handle slightly clogged ice.

[1] *Last-In-First-Out: The later the ice is produced, the earlier it is discharged*
[2] *First-In-First-Out: The earlier the ice is produced, the earlier it is discharged*

Ice Handling

How is ice conveyed? How is ice weighed?

Selecting An Ice Handling System

Key Criteria

- Type of Ice
- Delivery Rate
- Delivery Distance
- Accessibility

+

- Application
- Material Requirements

"Tool Box" - Ice Handling Equipment

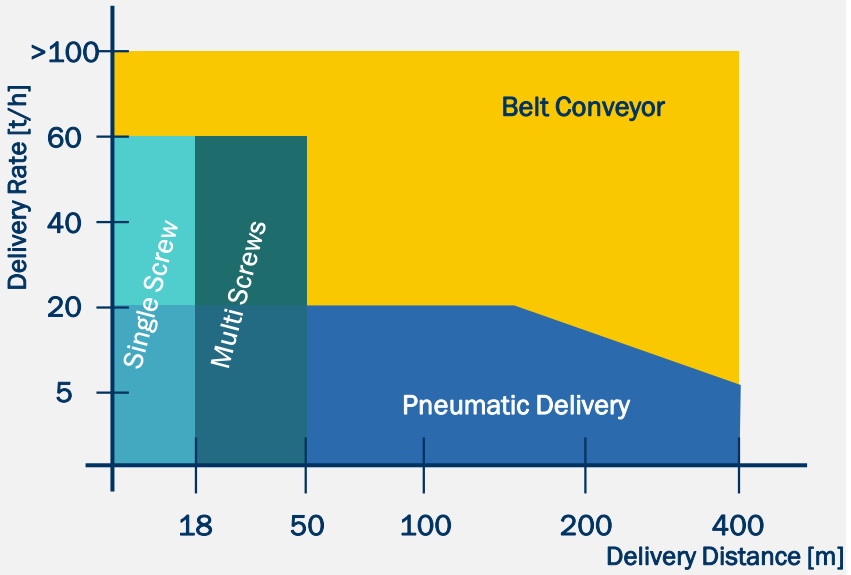
Ice Handling Systems

Delivery Systems		Weighing Systems	
Mechanical	Pneumatic	Continuous	Batch
Screw Conveyors	Blower Stations	Weighing Screws	Weighing Hopper
Belt Conveyors		Weighing Belts	Weighing Screw

Accessories

Controls	Day Tanks	Payment	Packing

Selection Chart



THANK YOU

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Thank you for your attention.

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