CHILLVENTA eSPECIAL
Refrigeration | AC & Ventilation | Heat Pumps
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CONNECTING EXPERTS.
Ice slurry based energy storage in industrial cooling systems

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How does vacuum ice slurry work?

Heat of evaporation (6.1 mbar; 0.01 °C)
\[ h_v = 2500 \text{ kJ/kg} \]

Heat of fusion
\[ h_{fus} = 333.5 \text{ kJ/kg} \]

Water (liquid, 0 °C)
- 1000 g
- 1.0002 l

Water vapour
- 118 g
- 242.44 l

Ice: 882 g / 0.962 l
Comparison of cold storage technologies

Ice slurry based energy storage in industrial cooling systems
Advantages of vacuum ice slurry

- 7 times higher energy density than chilled water storage
- ~30% higher efficiency than block ice storage
- Flexible operation: 0…100% discharging
- Cheap storage medium (PCM)
- Pumpable storage medium
- Sustainable, using water (R718) as refrigerant

Comparison of storage volume for the same capacity

Storage with cold water (6°C/12°C)
- 10 m³

Storage with ice slurry, 60% ice
- 1.3 m³

Storage with block ice
- 1.4 m³

Ice slurry storages combine the advantages of cold water and ice block
Integration of vacuum ice cold thermal energy storage in chilled water systems

Ice slurry based energy storage in industrial cooling systems
Vacuum ice slurry cold thermal energy storage - example

Göttingen, Germany
- Charging capacity: 180 kW
- Storage capacity: 1 MWh
- Discharging capacity: 300 kW
- Load management at local chilled water network

Ice slurry based energy storage in industrial cooling systems
Vacuum ice slurry cold thermal energy storage - example
Data Center cold thermal energy storage
400 kW / 3.5 MWh / 1.200 kW

Ice slurry based energy storage in industrial cooling systems
Ice slurry application in refrigerated warehouses

- Electricity or heat driven chilled water generation
- Ice slurry generation with low additional energy demand (small temperature lift)
- Cooling of refrigerated warehouse using ice slurry as coolant (thermal energy carrier) with constant temperature (0 °C or down to -5 °C with using additives)

![Diagram of ice slurry system]
Combined Heating and Cooling with ice storage

- Cold for cooling of food or industrial processes (year round demand)

- Ice slurry tank as heat source / cold storage

- Refrigerated warehouse; air-cooler with ice slurry

- Heat Pump (w/w)

- Heating network

- Optional: Hot water tank

- Ice slurry tank

- 0 °C (0...30 %)

- 6 °C

- 2 °C

- Ice slurry
Ice slurry in Industrial Cooling Systems
Ice slurry integration into industrial refrigeration systems

- Ice slurry based energy storage in industrial cooling systems

- Ice cooled \(\text{NH}_3\)-condenser

- Separator \(t_0 = -3\, ^\circ\text{C}\)

- Ice slurry storage

- Ice slurry generator

- Evaporator (cooling water for ice slurry gen.)

- Evaporator/Cooler

- Air-cooled Condenser

- \(\text{NH}_3\) compressor

- Ice slurry \(-5\, ^\circ\text{C}, 0\, \%\)

- Ice Slurry \(-5\, ^\circ\text{C}, 25\, \%\)

- Ice slurry \(-5\, ^\circ\text{C}, 25\, \%\)

- Ice slurry \(-5\, ^\circ\text{C}, 0\, \%\)

- Ice slurry \(-5\, ^\circ\text{C}, 0\, \%\)

- Water \(2\, ^\circ\text{C}\)

- Water \(5\, ^\circ\text{C}\)
Ice slurry based energy storage in industrial cooling systems

- Flüssigeis-erzeuger
- Flüssigeis-speicher
- Kompressionskältemaschine

Verbraucher

Ammoniak-Kondensator

Abscheider $t_0 = -3 \, ^\circ C$

Flüssigeis $-5 \, ^\circ C, 25 \%$

Wasser $2 \, ^\circ C$

Wasser $5 \, ^\circ C$

KKM

- Kühlwasser für Eisgenerator
Ice slurry integration into industrial refrigeration systems 3

Ice slurry based energy storage in industrial cooling systems

Ammoniak-Kondensator

M

Abscheider

Verbraucher

Kondensator

Absorptionskältemaschine

( Kühlwasser für Eiserzeuger)

- Flüssigeis
-5 °C, 25 %

- Flüssigeis
-5 °C, 0 %

- Flüssigeis
-5 °C, 0 %

- Flüssigeis
-5 °C, 0 %

- Wasser
2 °C

- Wasser
5 °C

- Heizwärme

- Rückkühlung

- Kaltwasser

- Wasser
5 °C

M

M

M
Ice slurry integration into industrial refrigeration systems

- Ice slurry based energy storage in industrial cooling systems

- Flüssigkeitspeicher

- Kondensator

- Verbraucher

- Booster

- Verdampfer

(Wasser 2 °C, Wasser 5 °C)

- Flüssigeis-erzeuger

- Abscheider

- Flüssigeis

-1 °C, 25 %

t0 = ... °C, 0 %

Booster

Flüssigeis-
speicher

(Wasser 5 °C)

Verdampfer

(Kühlwasser für Eisenerzeuger)
Vacuum ice slurry technology

More information: www.ilkdresden.de/iceslurry

Brochure: http://www.ilkdresden.de/fileadmin/user_upload/170130_Broschuere_Vakuumeis_eng_mail.pdf

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Thank you for your attention.