Mission ‘Energy Efficiency’

German-Philippine Chamber of Commerce and Industry

06 May to 10 May 2019
Company outline

- Founded in 2000, Pioneer of the 'Cooling Kit' solution
- Specialist for system solutions & systems integrator in the field of thermal cooling
- Design, engineering and sales as well as maintenance of thermal cooling solutions from 3 RT to 3,000 RT (10 kW to 10 MW) cooling capacity
- more than 100 systems realised worldwide
- ISO 9001 certified
- Continually awarded by the Stifterverband for R&D since 2014

Headquarter at Bernau am Chiemsee
From Heat → Cooling

thermal cooling - with chillii® technology
Advanced and climate friendly cooling solution

Traditional cooling solution

- additional electricity for lighting, computer etc.
- Chiller
- Boiler
- Fuel

Advanced cooling solution

- additional electricity for lighting, computer etc.
- Trigeneration
- Absorption chiller
- Cooling chiller
- Chilled water
- HVAC system
- CHP
- Fuel
- Electricity
- Heat
- "Top up" heat
- Boilers
- Supply CHP heat

Energy saving / energy efficiency
CO₂ reduction
Increase of operating hours of CHP unit
Base load covered
Reduction of electrical peak load
Thermally driven chillers – Energy flow diagram

- **Electricity generation**
- **Thermal energy**
  - **Electrical energy**
- **Losses during electricity generation**
- **Thermal waste heat**
- **Adsorption and absorption technology**
  - **Cooling capacity**
- **Office air-conditioning**

Useable electricity

Source: Senergy

**thermal cooling - with chillii® technology**
Market trends & drivers

The global market for Absorption Chillers is projected to exceed US$ 1.1 billion by 2022, driven by the rising demand for energy efficient cooling systems in response to the urgent need to replace energy-guzzling compressor-based systems.

The future growth in the market will be driven by the growing focus on energy saving against the background of increasing concerns over
- uninhibited rise in energy consumption,
- shortfalls in electricity supply,
- rising electricity costs,
- global warming and depletion of ozone layer.

Kyoto Protocol implementation benefits the demands for solar & waste heat powered chillers

Urbanisation: a mega trend spurring demand for air cooling & conditioning solutions
Advantages of absorption chillers compared to compressor-based cooling systems

- less electricity consumption (> 75% of savings regarding electricity costs)
- lower operating costs (because of very few mechanical components)
- non-usage of refrigerants as CFCs and HCFCs for cooling that are typically associated with ozone layer damaging greenhouse gas emissions
- lack of issues related to mechanical vibrations
- stable coefficient of performance (COP)
- easy maintenance and longer life time
- environmental-friendly solution
## Basis of the adsorption and absorption chiller

<table>
<thead>
<tr>
<th></th>
<th>Adsorption chiller</th>
<th>Absorption chiller</th>
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<tbody>
<tr>
<td><strong>Physical cooling effect</strong></td>
<td>Evaporation of refrigerant (vapour compression cycle)</td>
<td></td>
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<tr>
<td><strong>Compression principle</strong></td>
<td>Thermal (Adsorption of water vapour)</td>
<td>Thermal (Absorption cycle)</td>
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<td><strong>Driving energy</strong></td>
<td>Thermal energy 55°C - 95°C</td>
<td>Thermal energy 70°C - 95°C</td>
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<tr>
<td><strong>Refrigerant</strong></td>
<td>Water with solid adsorbents (silica gel, zeolith)</td>
<td>Water with LiBr or NH3 as absorbents</td>
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<td><strong>Cooling capacity</strong></td>
<td>8 kW - 500 kW (per module)  3 RT - 150 RT (per module)</td>
<td>18 kW - 5,000 kW (per module)  5 RT - 1,500 RT (per module)</td>
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<tr>
<td><strong>Chilled water temperatures</strong></td>
<td>+6°C to +20°C (flow temperature)</td>
<td>+4°C to +20°C (LiBr-chiller)</td>
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<td></td>
<td></td>
<td>-20°C to +20°C (NH3-chiller)</td>
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<tr>
<td><strong>COP (th)</strong></td>
<td>0.5 - 0.65</td>
<td>0.65 - 0.85</td>
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<tr>
<td><strong>COP (el)</strong></td>
<td>8 - 10</td>
<td>10 - 20</td>
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System principle of an adsorption chiller

Chilled water is cooled by the vaporization heat when the water (refrigerant) which was sprayed to chilled water circulation tubes in the evaporator in the vacuum circumstance with evaporates. Vapor damper (1) or (3) opens by the pressure of the refrigerant vapor which occurred in the evaporator.

As adsorbent silica gel adsorbs the refrigerant vapor which produced in the evaporator. There are cooling water circulation tubes through adsorption heat exchanger units filled with silica gel to accelerate absorb of refrigerant vapor.

Hot water flows through the tubes of the adsorption heat exchanger that heats the silica gel. Heated silica gel makes a water (refrigerant) evaporate, and vapor damper (2) or (4) opens by its pressure.

The water vapor (refrigerant) created in the adsorption heat exchanger is cooled on the outside of the tubes that causes the water vapor to become the water. The water is transferred into the evaporator and can be used again for the evaporation.
System principle of a single-effect absorption chiller
Heat sources for sorption cooling

- CHP - Cogeneration
- Solar thermal system
- Waste heat from compressed air
- Process heat
- ORC technology
- Waste heat from condenser

Adsorption and absorption technology
chillii® Cooling Kit – Suitable Heat Exchanger

Adsorption Cooling Systems

Absorption Cooling Systems

thermal cooling - with chillii® technology
chillii® Cooling Kit – Adiabatic Recooling

thermal cooling - with chillii® technology
Ways of distributing chilled water

Cold water distribution

- Fancoil
- Cooling ceiling
- Cooling surface
- Concrete core cooling
- Cooled floor

Cold water temperatures: 7/12, 10/15, 15/18, 17/20, 19/22

thermal cooling - with chillii® technology
Installation Principle – Hydraulic System

- Heat source
- Backup system
- Buffer reservoir
- Heating circuit
- Chillii® absorption chiller
- Cold water reservoir
- Cooling circuit
- Cooling tower

thermal cooling - with chillii® technology
Installation Example – Hydraulic System

Solar thermal system

Heat sink solar

domestic hot water

storage heat

Distribution cooling

storage cold

sorption chiller

Biomas CHP

Distribution heating

heat rejection unit

Hydraulic System

thermal cooling - with chillii® technology
Components of a chillii® Cooling Kit

- Ad- or Absorption chiller
- Re-cooling system
- Optional: Cold and hot water storage
- Pumps and mixer
- System Controller and electric cabinet
- Other components (e.g. temperature sensors)

thermal cooling - with chillii® technology
chillii® Cooling Kits < 1 MW Cooling Capacity

Adsorption chillii® Cooling Kit

- optimally harmonized system components
- system solution for your application
- ready-to-install solution
- no layout and dimensioning required by customer

Absorption chillii® Cooling Kit

thermal cooling - with chillii® technology
In future: chillii® Cooling Kits with adsorption chiller up to 600 kW Cooling Capacity

Adsorption chillii® Cooling Kit

- optimally harmonized system components
- system solution for your application
- ready-to-install solution
- no layout and dimensioning required by customer
chillii® Cooling Kits (water-fired chiller) > 1 MW Cooling Capacity

Absorption chillii® Cooling Kit

- optimally harmonized system components
- system solution for your application
- ready-to-install solution
- no layout and dimensioning required by customer

thermal cooling - with chillii® technology
chillii® Cooling Kits (steam-fired chiller) > 1 MW Cooling Capacity

Absorption chillii® Cooling Kit

- optimally harmonized system components
- system solution for your application
- ready-to-install solution
- no layout and dimensioning required by customer
chillii® Cooling Kits (direct-fired chiller) > 1 MW Cooling Capacity

Absorption chillii® Cooling Kit

- optimally harmonized system components
- system solution for your application
- ready-to-install solution
- no layout and dimensioning required by customer
chillii® System Controller

- different heat sources
- back-up system for heat
- thermal cooling machine
- additional system for cooling
- heat and cold air reservoir management
- domestic water heating
- heat rejection system
- heating and cooling circuit
chillii® System Controller – State of the Art

- System adaptation by parameterisation
- Multi user levels
- Data logging
- Remote access
- Remote maintenance
- External interface (GLT integration)

thermal cooling - with chillii® technology
Installation principle – Hydraulic / sensor
chillii® System Controller – Output data logging to SD card

Log file:

- Measurements are saved on the SD card. (csv format)
- **Data can be imported** into spreadsheets (e.g.: Microsoft Excel)
- Actively switching the data logger → permanent recording
- **Measurement time frame** (adjusted by the operator) of one day (e.g. 7 a.m. to 11 p.m.)
- **Measurement interval** individually selected (starting from: 1.5 s → e.g. 60 min.).
- Recording of **instantaneous values**.
- Data points with **date and time** recorded
- **Fixed range** of relevant measurement and operational data.

Excerpt of possible measurements:
Temperatures: Hot water storage as a buffer
                      Cold water storage as a buffer
                      Inlet and outlet flow of cooling unit
                      Inlet and outlet flow of unit circuit
                      4 volume flows
                      Pump output
                      Solar thermal collector

thermal cooling - with chillii® technology
### Imported and formatted log file

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Representation over a period of time (example time frame)

Collector temperature and pump control

- temperature °C / pump capacity %
- time

Legend:
- TSOC_1
- TSOC_2
- PSOP
- TDSH
Conclusion
Advantages of Sorption Cooling

**Active Climate Protection**

- Energy saving / increased energy efficiency
- Strong CO$_2$-reduction

- Reduction of the Global Warming Potential (GWP) by 99.9 %
  - no toxic and environmental unfriendly refrigerants
  - instead: water as refrigerant

**Cost savings**

- Reduction of electricity consumption and energy costs (Ø 75% less electrical power consumption compared to compression cooling)
- Increased autonomy regarding energy suppliers
- No peak shaving
- Lifetime extension of CHP
- Less maintenance costs
- Significant reduction of total costs

Cost savings with a simultaneous improvement of the eco-balance
Excerpt of References
chillii® Cooling Kit WFC35
Air-conditioning of an office building, Bavaria, 2014

- Energy source: industrial waste heat
- Absorption chiller: chillii® WFC35 (water / lithium bromide), 35 kW nominal capacity
- Wet cooling tower with performance control and automatic draining in danger of frost
- Cooling distribution by underfloor cooling and floor convectors
- High-efficiency circulating pumps, energy label A
- System controlled by superior control unit: chillii® System Controller
chillii® Cooling Kit WFC175

Energy source: combined heat and power unit (CHP) + heat from air compressors
Chiller: chillii® WFC175 (water / lithium bromide), 175 kW nominal capacity
Adiabatic recooling unit with performance control
High-efficiency and energy saving circulating pumps, energy label A
System controlled by the chillii® System Controller
chillii® Cooling Kit WFC175
Process Cooling of a factory, Baden Wuerttemberg, 2019
chillii® Cooling Kit WFC175
Process Cooling of a factory, Baden Wuerttemberg, 2017

2 chillii® Cooling Kit WFC175
Energy source: combined heat and power unit (CHP)
Chiller: 2 chillii® WFC175 (water / lithium bromide), 350 kW nominal capacity
Adiabatic recooling units with performance control
High-efficiency and energy saving circulating pumps, energy label A
System controlled by the chillii® System Controller
chillii® Cooling Kit WFC175
Process Cooling of a factory, Baden Wuerttemberg, 2017
chillii® Cooling Kit WFC175adb + WFC70adb
Air-conditioning of server rooms, Saxony-Anhalt, 2014

chillii® Cooling Kit WFC175adb + chillii® Cooling Kit WFC70adb
- Energy source: combined heat and power unit (CHP)
- Chiller: chillii® WFC175 (water/lithium bromide) + chillii® WFC70 (water/lithium bromide), 245 kW nominal capacity
- Heat rejection unit with adiabatic and speed controlled EC-motors
- High-efficiency circulating pumps, energy label A
- System controlled by the chillii® System Controller
chillii® Cooling Kit WFC175adb + WFC70adb
Air-conditioning of server rooms, Saxony-Anhalt, 2014
chillii® Cooling Kit WFC175
Process cooling and air-conditioning of a factory, Thuringia, 2012

2 chillii® Cooling Kit WFC175
- Energy source: process heat (by usage of industrial waste)
- Chiller: 2 chillii® WFC175 (water / lithium bromide), 350 kW nominal capacity
- Wet cooling tower with performance control and automatic draining in danger of frost
- High-efficiency and energy saving circulating pumps, energy label A
- System controlled by the chillii® System Controller
chillii® Cooling Kit WFC175
Process cooling and air-conditioning of a factory, Thuringia, 2012
chillii® Cooling Kit WFC70
Air-conditioning of a turkey production farm, Lower Saxony, 2012

- Energy source: biogas CHP unit
- Absorption chiller chillii® WFC70 (water / lithium bromide), 70 kW nominal capacity
- Chilled water storage: 8,000 l
- Wet cooling tower with performance control and automatic draining in danger of frost
- Chilled water distribution by a ventilation system
chillii® Cooling Kit WFC70
Air-conditioning of a turkey production farm, Lower Saxony, 2012

High efficiency and energy saving pumps
System controlled by the chillii® System Controller
chillii® Cooling Kit STC15wet
Energy source: waste heat of a paper machine
Adsorption chiller chillii® STC15 (water / silica gel), 15 kW nominal capacity
Wet cooling tower with performance control and automatic draining in danger of frost
Cooling water distribution by the existing ventilation system by means of a water/air heat exchanger
System controlled by superior control unit: chillii® System Controller
chillii® Cooling Kit WFC35
Air-conditioning of a factory, Bavaria, 2012

- chillii® Cooling Kit WFC35
  - Energy source: industrial waste heat
  - Absorption chiller: chillii® WFC35 (water / lithium bromide), 35 kW nominal capacity
  - Wet cooling tower with performance control and automatic draining in danger of frost
  - Chilled water distribution by cooling ceilings
  - High-efficiency circulating pumps, energy label A
  - System controlled by superior control unit: chillii® System Controller
chillii® Cooling Kit WFC18
Solar cooling system in a showroom, Mexico, 2010

- Energy source: solar thermal collectors
- Absorption chiller: chillii® WFC18 (water / lithium bromide), 18 kW nominal capacity
- Wet cooling tower with performance control and automatic draining in danger of frost.
- Vacuum tube collectors
- Cold water distribution by a ventilation system
- System controlled by superior control unit: chillii® System Controller
chillii® Cooling Kit WFC18
Air-conditioning of a children’s hospital, Kabul, Afghanistan, 2010

- Energy source: solar thermal collectors
- Absorption chiller chillii® WFC18 (water / lithium bromide), 18 kW nominal capacity
- Cold water storage: 5,000 l, hot water storage: 20,000 l, domestic hot water: 500 l
- Wet cooling tower with performance control and automatic draining in danger of frost.
- 350 m² flat plate collectors
- Heating and cooling water distribution through heating and cooling ceilings
- High-efficiency circulating pumps, energy label A
- System controlled by superior control unit: chillii® System Controller
Chillii® Cooling Kit ISC10
Solar cooling system in a public library, Australia, 2010

- Energy source: solar thermal collectors
- Adsorption chiller Chillii® ISC10 (water / zeolite), 10 kW nominal capacity
- Dry heat rejection unit with speed controlled EC-motors and water sprinkling system
- Cooling water distribution by ventilation system
- High-efficiency circulating pumps, energy label A
- System controlled by superior control unit: Chillii® System Controller
Thank you for your attention

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