ЕНЕРГИЕН ФОРУМ 2024

COOLING WITH ADSORPTION CHILLERS

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NELBO ENGINEERING

Cooling with Adsorption Chillers

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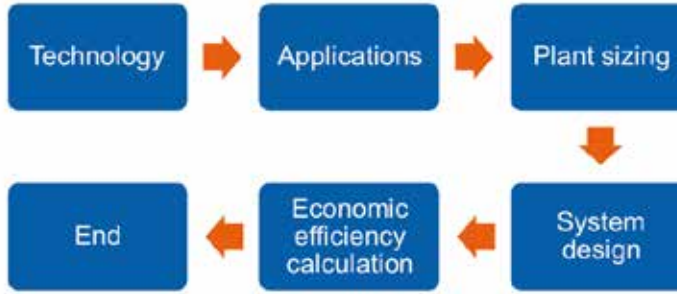
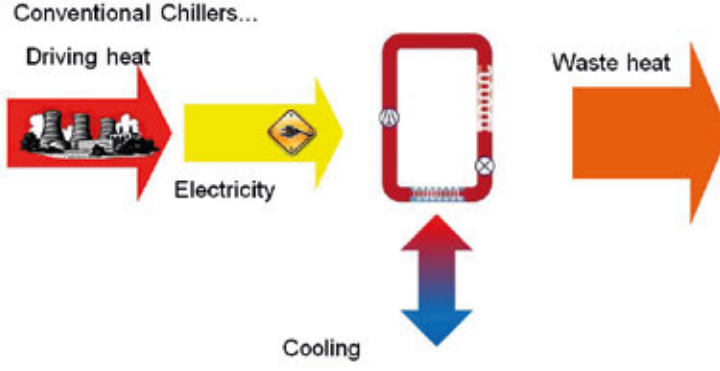
Content



Technology



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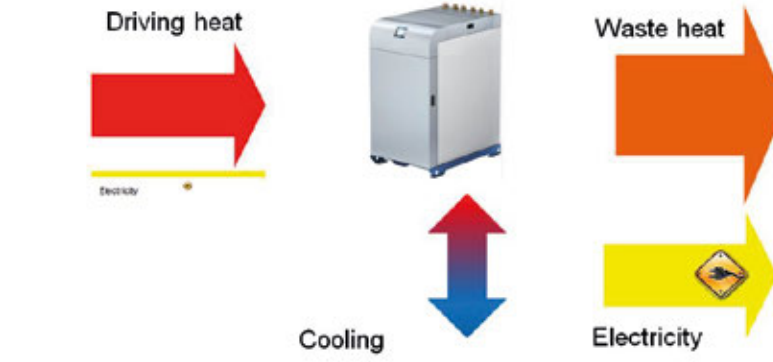
InvenSor Adsorption Chiller...



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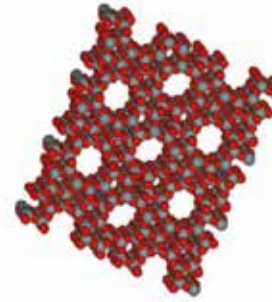
Zeolite

- Greek for: „boiling stone"
- Naturally appearing mineral
- Micro porous structure consisting aluminium und silicon atoms
- Very large inner surface of >1000m² per gram
- Commonly found in e.g. washing detergents



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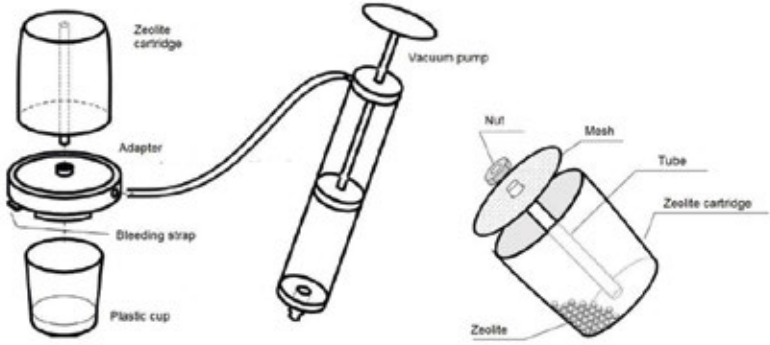

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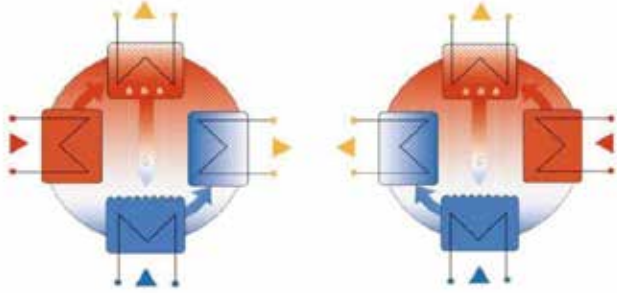
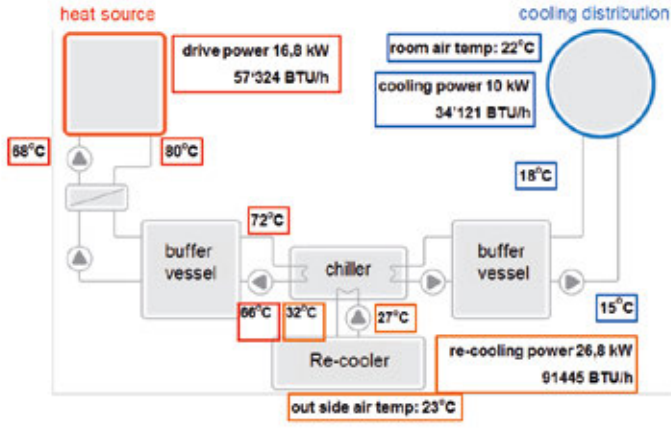


Vacuum tight welded stainless steel container
2 x zeolite adsorber
Water – steam – water – steam cycle „pure physics no chemistry " No pumps / moving parts

- Cooling = Uptake of energy for evaporation
- Re-cooling = Extracting heat from the system
- Thermal drive = Baking the adsorber
- Re-cooling = Extracting heat from the system

Technology



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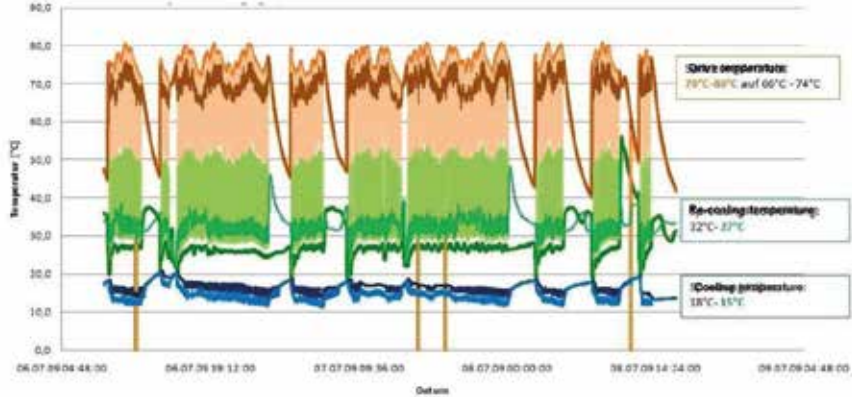

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High and constant cooling demand

Conventional cooling generation:
- using electrical driven compressor chillers
- high electrical power consumption
- high environmental pollution

"Cooling from heat":
- "free" use of waste heat or district heating
- no electricity needed for cooling generation
- load relief for the electrical grid

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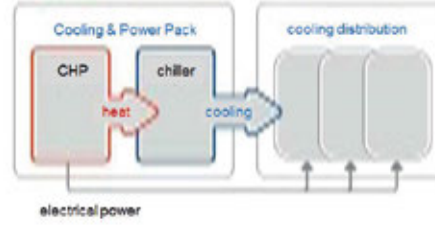
CHPs

- Standard practice in Germany:
- Heat load controlled CHP will not operate in summer
- Limited possible applications

„Cold from heat":

- Extended running time for CHP
- Surplus using cooling and power
- Environmentally friendly system
- Grid independent CHP-chiller system possible



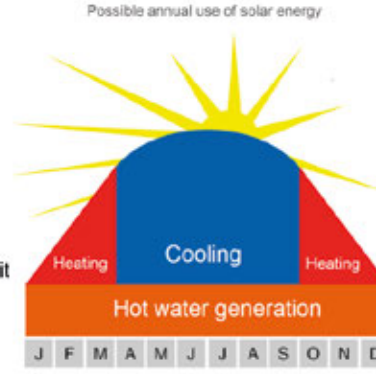
Solar-thermal plant for heating support

Current situation:

- Low heat demand in summer
- Stagnation within the collectors
- Reduction of lifespan due to stagnation
- Reduction of operation hours

Solar cooling:

- higher solar performance
- No oil or gas consumption Additional benefit of cooling
- Increased lifespan of solar components
- Solar + heat pump performs better than condensing boiler



Applications

Motivation of our clients:

Up to 70% electricity + energy cost savings

Reduction of CO2 emissions / climate friendly cooling

Water as refrigerant ➔ very environmental

Water as heat medium ➔ non combustible

Very quiet, very robust, very easy to install

Low maintenance

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Plant sizing

Adsorption chiller plant to cover base load / lower peak load permanetly!

Either based on cooling demand - „Take what you need"

Cooling load calculation
standard VDI 2078; dynamic TRNSYS

Technical data of installed system

Or based on heat source - „Take what you get"
Existing or planned heat source

Technical data CHP

Approx. 60% of heat being transformed into cooling COP = 0,6

Plant sizing

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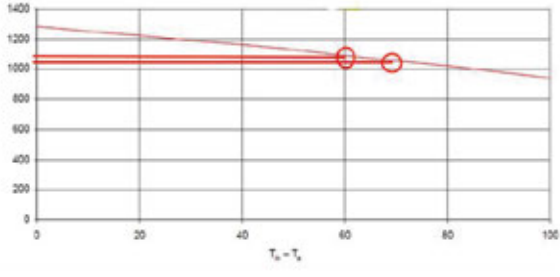
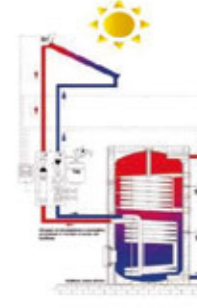
Empirical values solar heat source

Required solar collector area (solar cooling):
depending on specific collector performance rule of thumb ca. 3-4 m²/kW cooling output E.g.:
10kW chiller → 30 - 40m² collector





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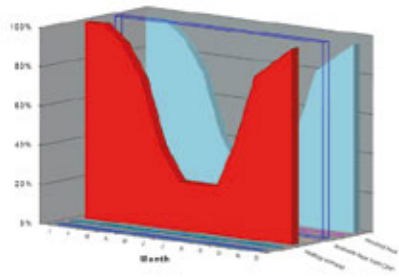
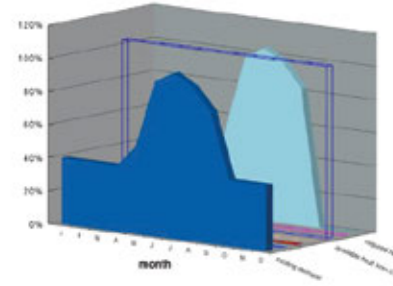
Sizing Trigeneration



Annual heat load for space hearting & hot water generation (red)

Sizing Trigeneration



Annual driving heat load for space cooling (light blue)

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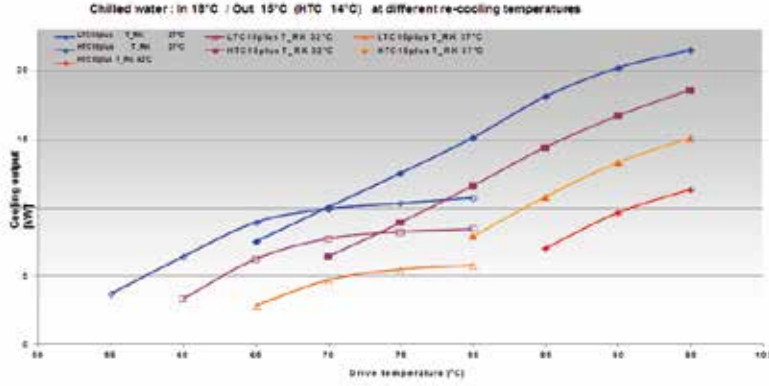
Two product lines on the market

LTC - „Low Temperature Chiller"

HTC - „High Temperature Chiller"

Zeolite – water as working materials

Integrated hydraulic unit
Integrated FreeCooling as option Intuitive controls on touch display Automatic cooling output adjustment Integrated controls for system & chiller Modular systems up to 100kW cooling Compact design



electrical power consumption

CHP power-ratio = 30% electr. / 60% therm.

E.g. Senertec-Dachs: 5,5 kW electr. / 12-14 kW therm.
KW-Energietechnik: 48 kW electr. / 77 kW therm.

Electrical power consumption for 10 kW cooling

our Chiller:	20 W
our Chiller system:	1000 W = 1 kW
Compressor chiller:	4000 W = 4 kW

Electrical (!) COPs

our chiller:	500
our chiller system:	10 - 14
small conventional chiller:	2,5 - 3
large conventional chiller:	4 - 6

Economic efficiency calculation

Gas		Electrical power
3 kWh á 5 ct/kWh = 15 ct/3 kWh	η = 30 %	1 kWh 16 ct/kWh + 5,4 ct/kWh KWK*-Bonus 21,4 ct/kWh

- CHP is already competitive by producing electricity (15 vs 16 ct)
- Cooling for free
- CHP operates also in summer

* KWK-Bonus: Subvention for producing electrical power by CHP with the German electricity grid

Economic efficiency calculation

Economic efficiency calculation

Economic efficiency calculation

Results after 1 year of operation

Parameters used:

Meteorological data DWD

Data logging

Adjustment economic efficiency calculation:

Operation time BHKW + AdKM Operation time FreeCooling	5,5 month 24/7
Operation hours CHP for heating	6 months 24/7
Electric power consumption of our chiller system Electric power consumption FreeCooling	1900 hours
ø used cooling power	1,9 kW
Adjustment performance compressor chiller →	0,9 kW
	18 kW
	COP = 2,0


Costs & savings after 10 years
300.000 Euro
250.000 Euro
200.000 Euro
150.000 Euro
100.000 Euro
50.000 Euro
0 Euro
KK M
AdK M
Einsparun g