



BROAD U.S.A. INC.

ENERGY MODELING & ANALYSIS OF MODERN ABSORPTION COOLING & HEATING IN DISTRICT & CHP SYSTEMS

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**Track 6B – Challenges & Solutions for
Advancing Energy Infrastructure,
IDEA2019**

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Agenda

- Basics of Absorption Cycle in Cooling & Heating
- Modern Absorption “New Normal” Technologies
- Applications of Absorption Technologies in District Systems
- Q&A



Introduction of Absorption Cycle

How

Burning gas (Steam/Waste heat)
produces cooling?

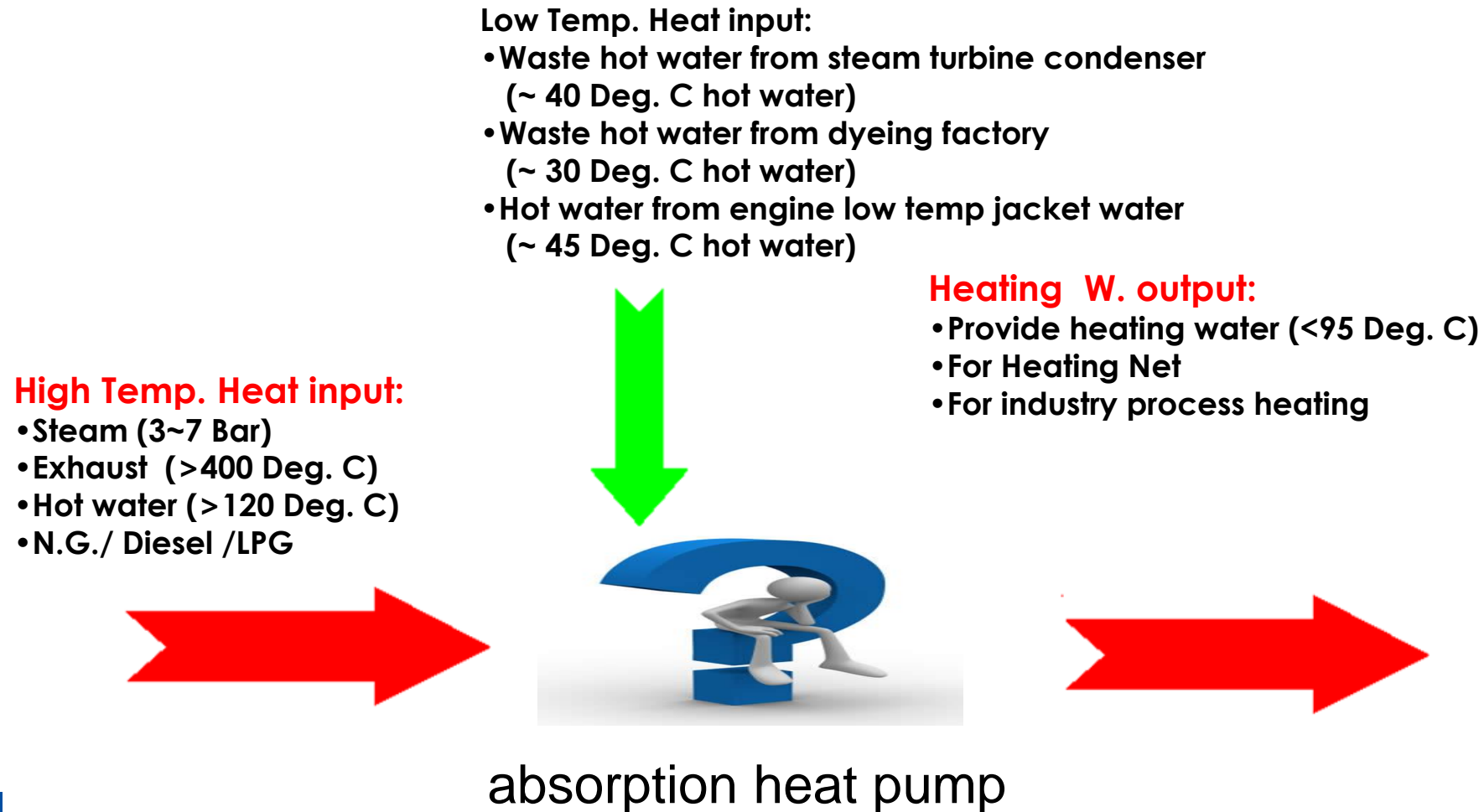


absorption chiller



Introduction of Absorption Cycle

■ Absorption Cycle for Heating



Introduction of Absorption Cycle

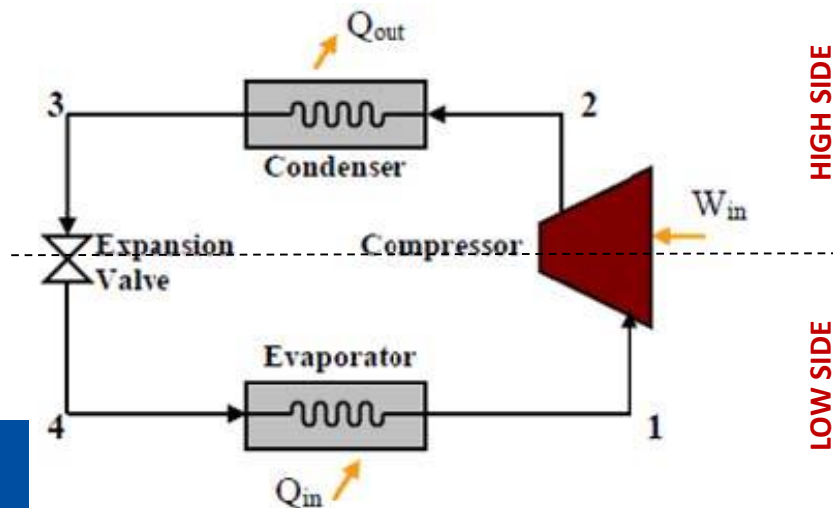
■ Absorption Cycle

– Similarity:

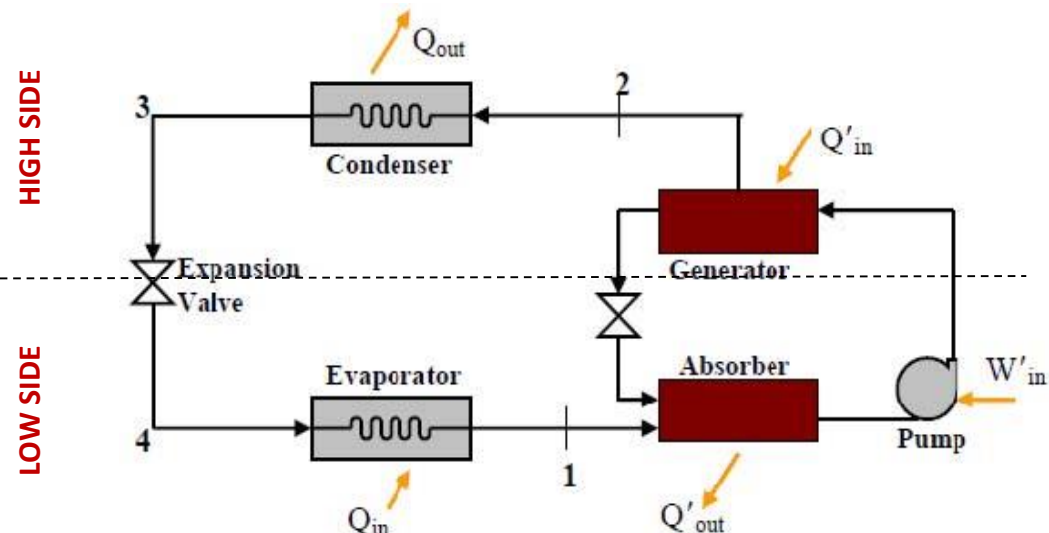
- Heat removal through refrigerant evaporation at low pressure side
- Heat rejection through refrigerant condensation at high pressure side

– Differences:

- VCC uses mechanical compressor to create pressure differences necessary to circulate the refrigerant
- Absorption cycle uses thermal energy source as the driving force with a generator and an absorber



vapor compression cycle

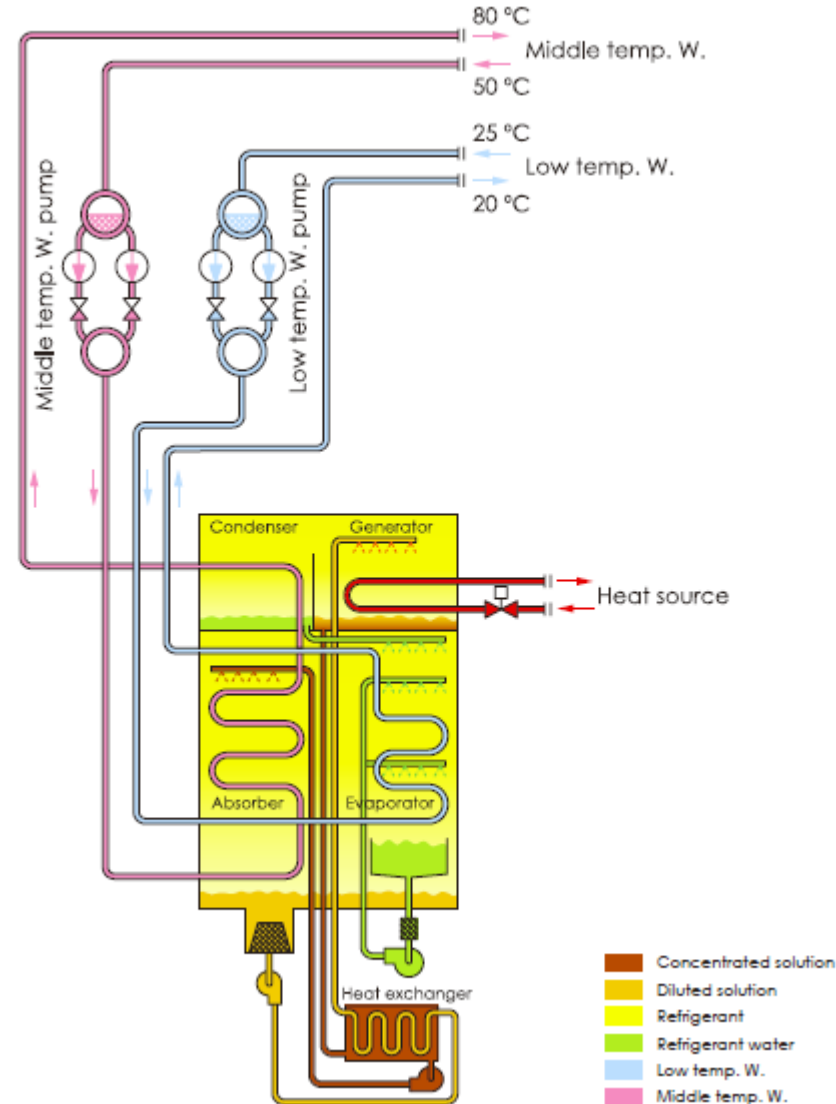


absorption cycle



Working Principle of Absorption Cycle

- Absorption Heat Pump



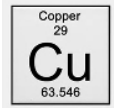
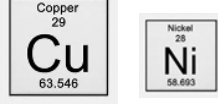

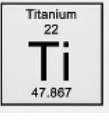
Modern Absorption Technology – New Normal

- **Corrosion** and degradation of performance was an issue with absorbers in the past
- **Old Absorption technology** requires operators to periodically run a vacuum pump to insure operation and to maintain chilled water set point
- **Oxygen** is the source of corrosion inside an Absorber. If proper vacuum can be maintained for the absorbers life **there is no opportunity** to have corrosion form inside the Absorber.



Modern Absorption Technology – New Normal

- Titanium Tube Material: Best Corrosion Resistant Metal for long life and low life cycle cost

Tube Materials	Pure Copper	Copper-Nickel	Stainless Steel	Titanium
Solution Media				
Chlorine	Resist corrosion under low temp& low concentration	Resist corrosion under low and medium temperature	Resist corrosion differs by types of stainless steel	No corrosion
salt water (speed)	1.2 m/s	3.6m/s	5-7m/s	No limitation
Ammonia	Serious corrosion	Corrosion	No corrosion	No corrosion
Polluted air & water	Corrosion	Slight corrosion	No corrosion	No corrosion



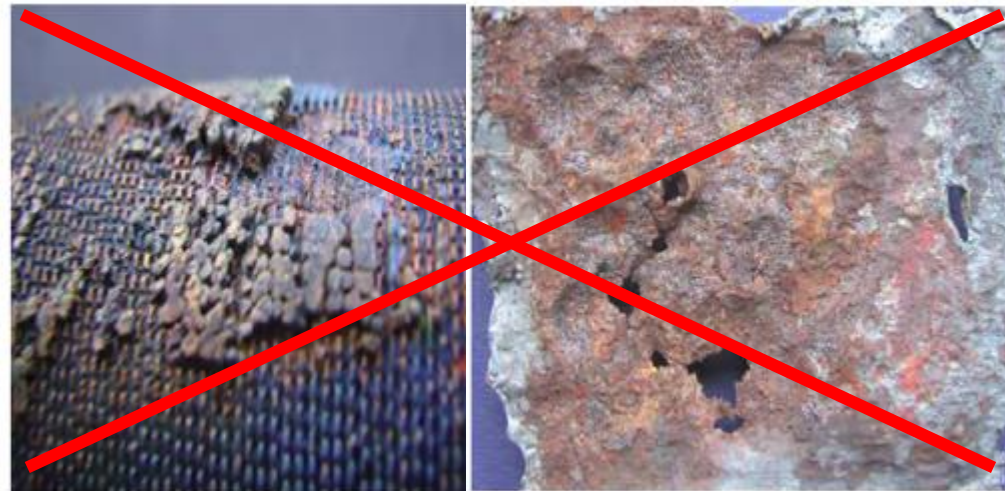
Modern Absorption Technology – New Normal

- Titanium Tube Material: Best Corrosion Resistant Metal for long life and low life cycle cost

Titanium is low density, light weight and high strength **element**.

Titanium does not corrode when exposed to salt water, acid & chlorine..... or in absorber.

A Titanium tube in an Absorbers will likely **never** need to be re-tubed



Applications of Absorption Heat Pump Technologies

- Typical applications
 - Recover the waste heat of steam turbine condenser, engine jacket water for district heating----power plants
 - For preheating of makeup water to boiler----power plants, boilers
 - Recover the process waste heat for district heating----all kinds of industrial processes
 - Recycle the waste heat of boiler's flue gas or other low temp. heat for district heating



Applications of Absorption Heat Pump Technologies

- Steam type absorption heat pump at South Korea Ilsan & Bundang Power Plant



Korea Ilsan Plant

- Korea Ilsan Plant and Bundang Plant both are affiliated with Korea electric power corporation, they utilize 4 heat pumps to recycle waste heat of power plants to provide district heating.

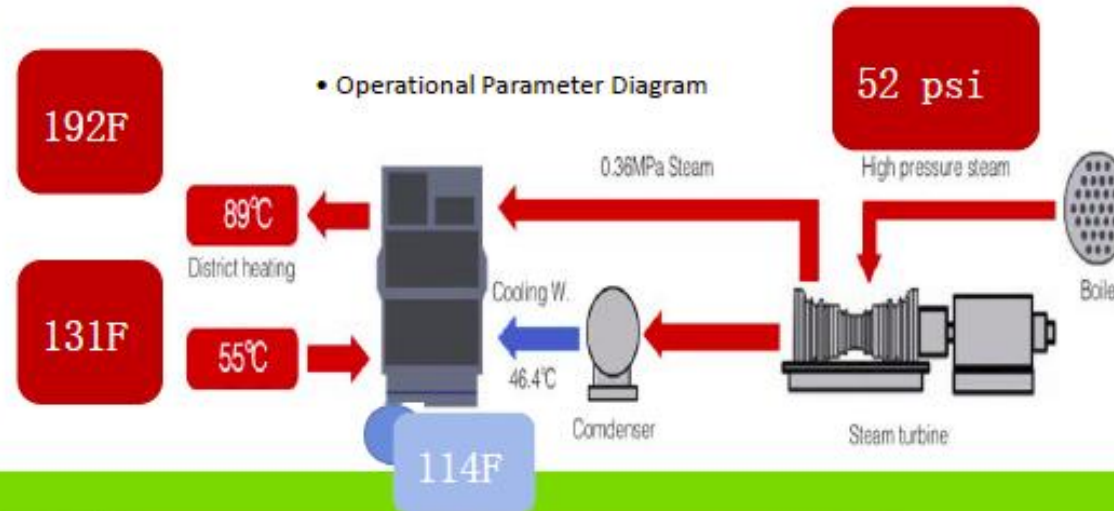
- Heating capacity: 57,600kW
Steam type heat pump × 4 units
Heating COP: 1.70
Yearly energy saving equivalent: 7,753 ton oil
Yearly CO₂ cutting: 23,258 ton



Steam Type Heat Pump



Korea Bundang Plant



Applications of Absorption Heat Pump Technologies

- Steam type absorption heat pump at Banwol ECO Park, South Korea



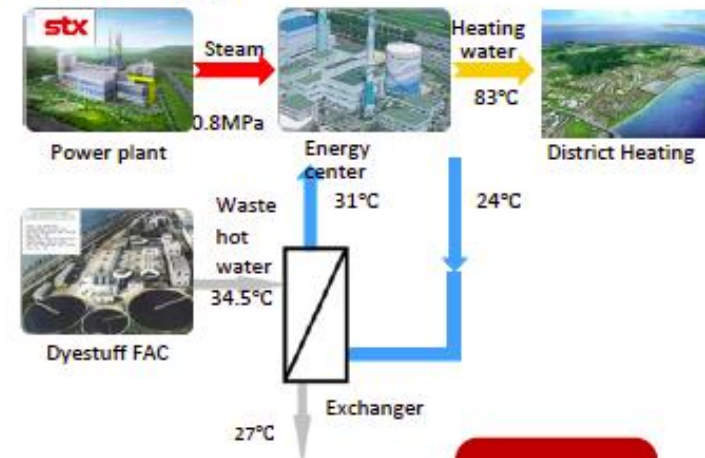
STX power plant supplies steam source



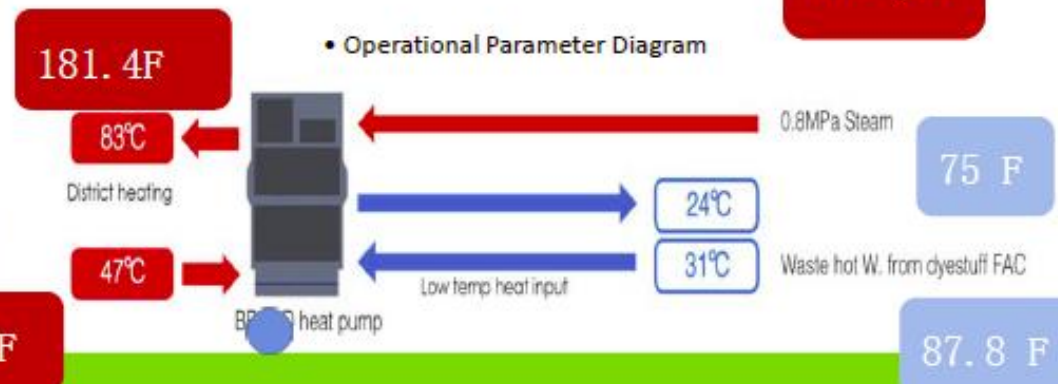
BROAD Steam Type Heat Pump

- 4 heat pumps, 27MW waste heat from dyestuff process is recovered and supplied to Ansan district heating system.

- Heating capacity: 55,000kW
- Steam type heat pump × 4 units
- Heating COP: 1.70
- Yearly energy saving equivalent: 7,908 ton oil
- Yearly CO₂ cutting: 23,724 ton



- Operational Parameter Diagram



Applications of Absorption Heat Pump Technologies

- Steam type absorption heat pump at RIGAS Siltums, Latvia



Rigas Power Plant

- District heating supplier in Baltic sea area . Applied heat pump to recycle the heat from gas engine for central heating.

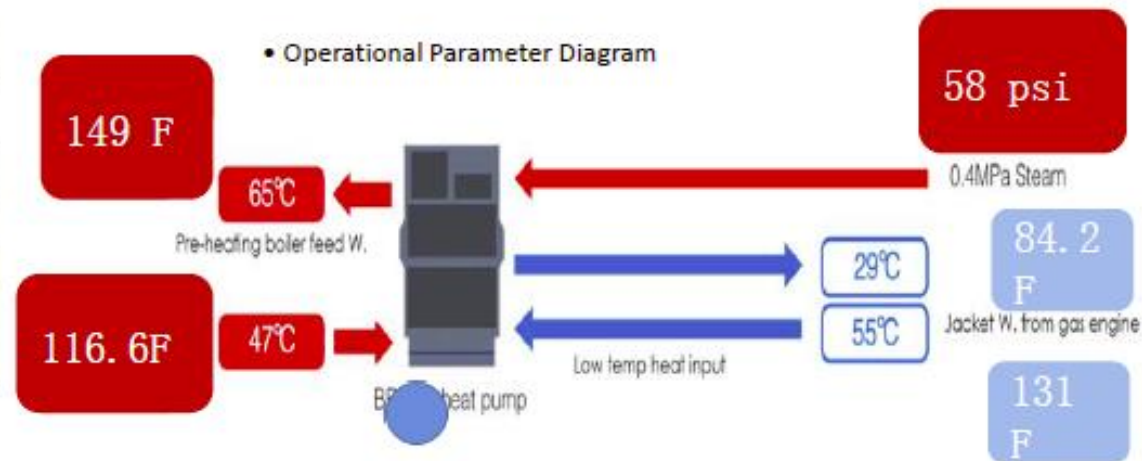
- Heating capacity: 5,000kW
Heating COP: 1.74
Yearly energy saving equivalent: 425 ton oil
Yearly CO₂ cutting: 1,275 ton



Steam Type Heat Pump



Steam Type Heat Pump



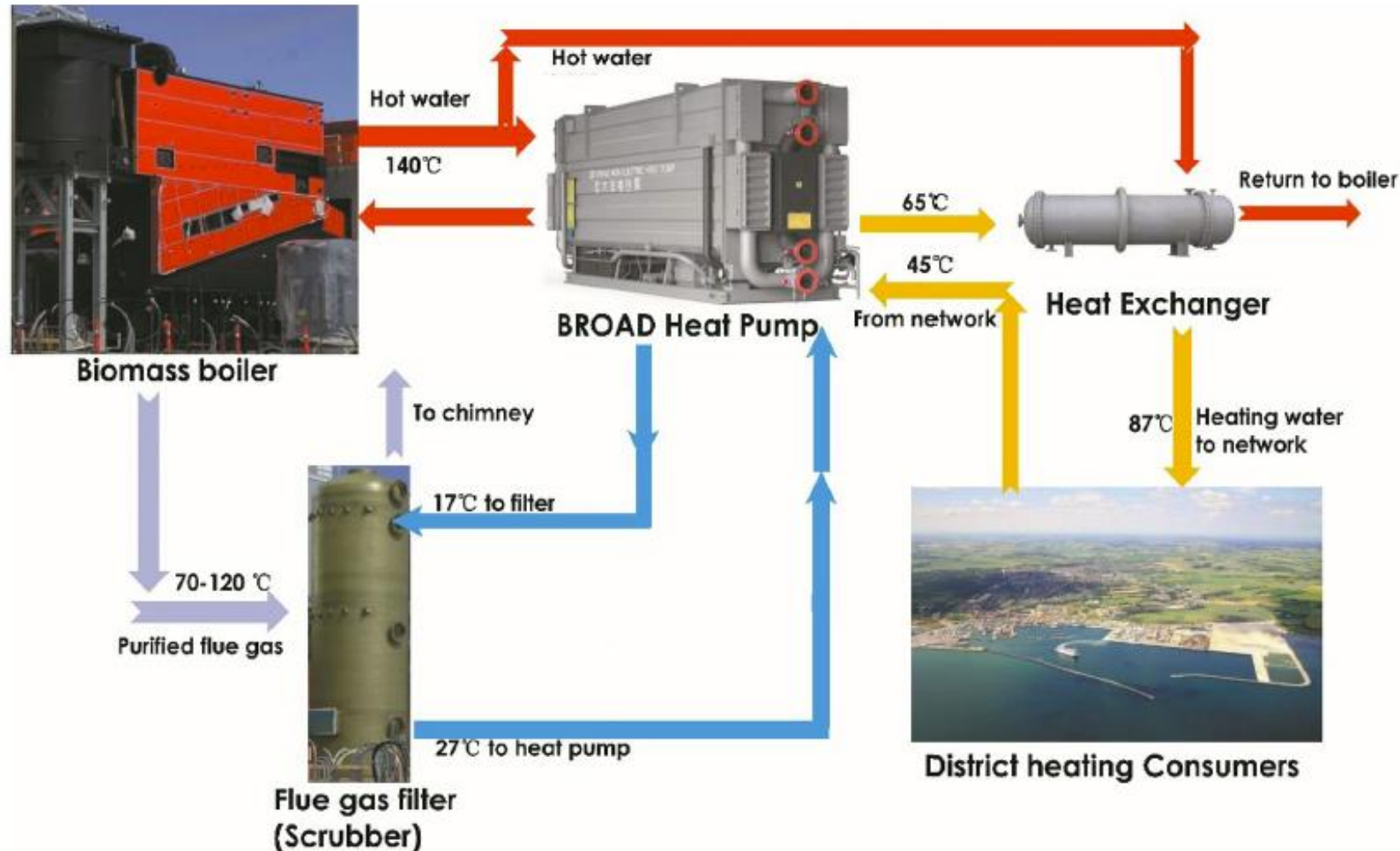
Applications of Absorption Heat Pump Technologies

- Hot water type absorption heat pump at biomass Heating Plant, Grenaa, Denmark
- The project is designed by famous design company- COWI. It installs a combined cycle of wood chip biomass boiler and heat pump. Heat pump recover the low temp. flue gas waste heat from boilers, and provide heating to DH network.



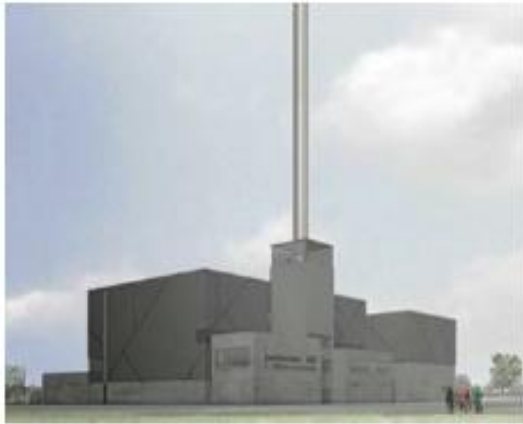
Applications of Absorption Heat Pump Technologies

- Hot water type absorption heat pump at biomass Heating Plant, Grenaa, Denmark



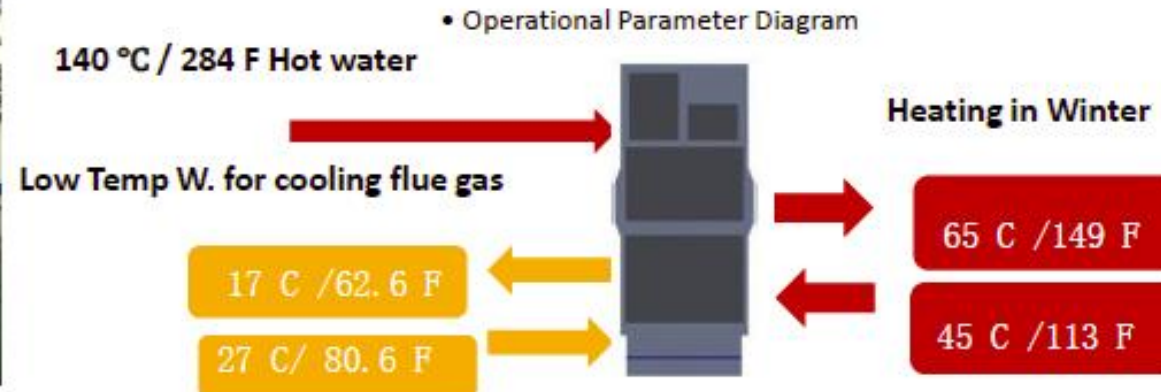
Applications of Absorption Heat Pump Technologies

- Hot water type absorption heat pump at biomass Heating Plant, Grenaa, Denmark



- Two absorption heat pumps recover 10 MW of the biomass boiler's flue gas waste heat, achieving 30% increased energy efficiency. The plant provides district energy to the town of Grenaa and is a new state-of-the-art model for energy-savings and emission reduction.

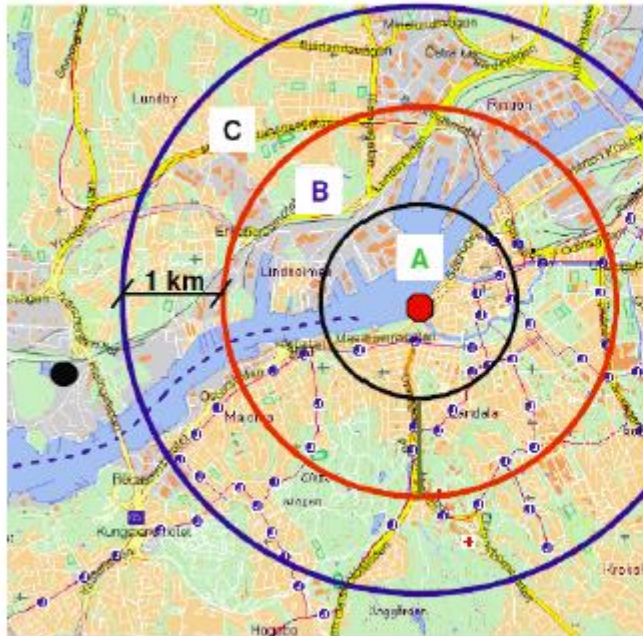
- Heating capacity: 10 MW
Heating COP: 1.70
Yearly CO₂ cutting: 3,000ton



Applications of Absorption Technologies in District Cooling

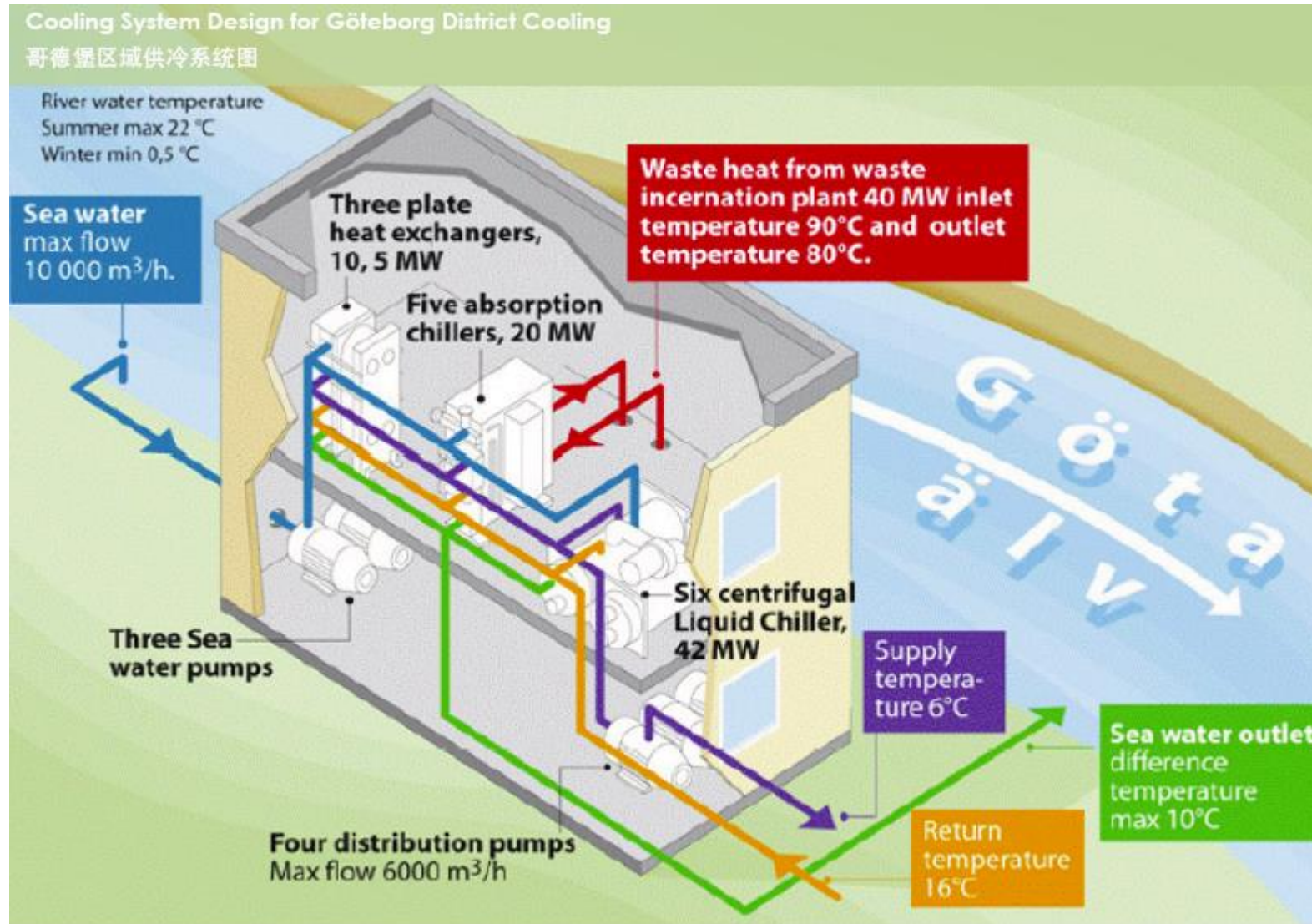
■ Göteborg District Cooling System

- Göteborg Energi AB is the 4th largest energy company in Sweden and leads the field in western Sweden. They provide customers with energy services, district heating, cooling, natural gas and the electricity.



Applications of Absorption Technologies in District Cooling

- Göteborg District Cooling System



Applications of Absorption Technologies in District Cooling

- Göteborg District Cooling System



Applications of Absorption Technologies in District Cooling

■ Energy data for Göteborg district cooling system project

Table 1, Cooling Source 表 1, 冷源

	Energy 能源 (GWh)	Percentage of Produced cooling 冷量比例
Cooling delivery 总制冷量	121	100%
Free cooling 免费冷量	43	36%
Electrical Chillers 电空调	35	29%
Absorption chillers 非电空调	45	37%
Losses 损耗	-2	-2%

Table 2, Electric consumption 表 2, 电耗

	Energy 能源 (GWh)	Percentage of Produced cooling 冷量比例
Electrical consumption 耗电量	8.3	7%
Distribution 输配系统	1.6	1%
Cooling water 冷却水	2.4	2%
Electrical Chillers 电空调	3.5	2%
Absorption chillers 非电空调	0.4	0%
Auxiliary & losses 损耗	0.5	0.004

Table 4, Environmental Impact Key-figures

表 4, 环境影响的主要数据

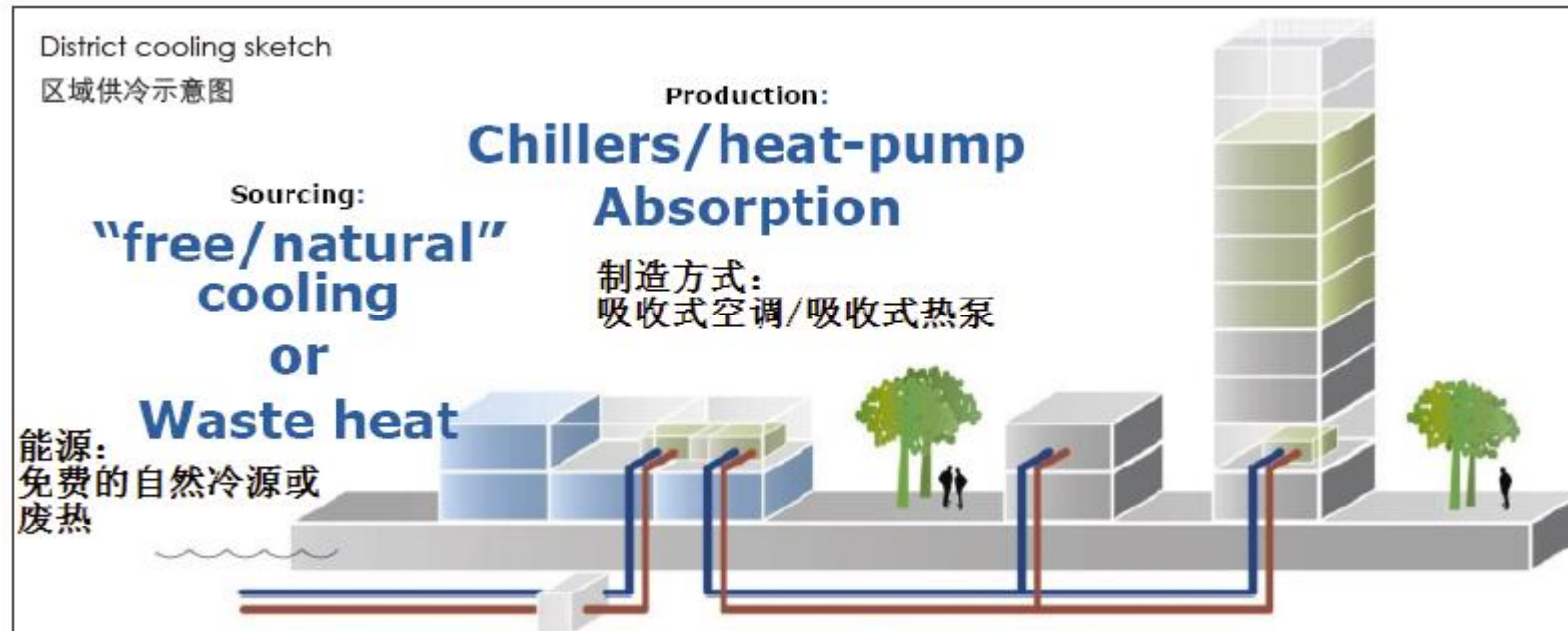
	District Cooling 区域供冷	Customer Alternative 用户选择
Cooling demand (MWh/year) 能量需求	121	121
SSEER 系统能源的季节效率	14.6	2.8
Electrical demand (MWh/year) 电力需求	8,300	43,200
CO2 emissions (tons/year) 碳排放	7,900	35,400
Refrigerant (tons) 制冷剂	17	33

Remarks: Comparing to individual building units (customers' alternative to DC) the environmental impact of the District Cooling system in Göteborg is a success story.



Absorption Technologies in District Cooling & Heating

- District cooling & heating
 - Fundamental idea
 - Energy Efficiency
 - Steady supply
 - Environmental friendly
 - Simplicity and safety





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THANK YOU!

Q&A

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