

Decarbonize Heating - securing high Energy Efficiency with plate heat exchangers

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Decarbonize heating: Benefit low value heat sources using industrial heat pumps

Why Industrial Heat Pumps?

Heat pumps makes it possible to use waste or natural low temperature heat sources to supply heat at a higher more useful temperature while reducing energy and fossile fuel consumption.

Typical heat sources are sea-water, ground-water or waste heat from industries, refrigeration plants or data centers and then the higher output temperature could be used in:

Industries

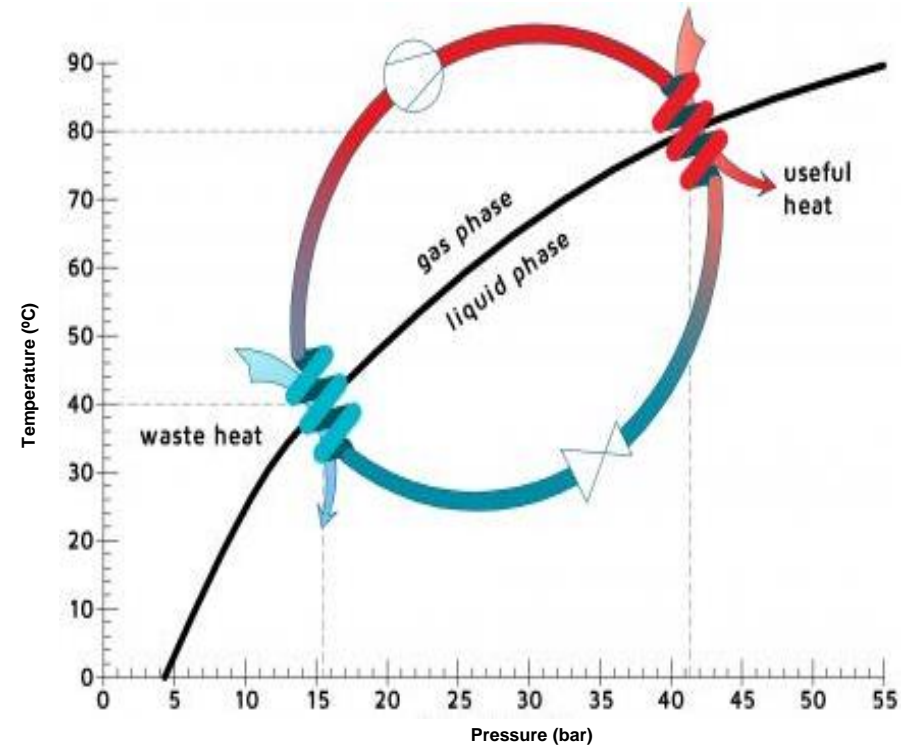
For various processes like dehumidification, distillation evaporation processes, water heating and combined heating and cooling.

District heating

To supply heating into networks for space and tap water heating.

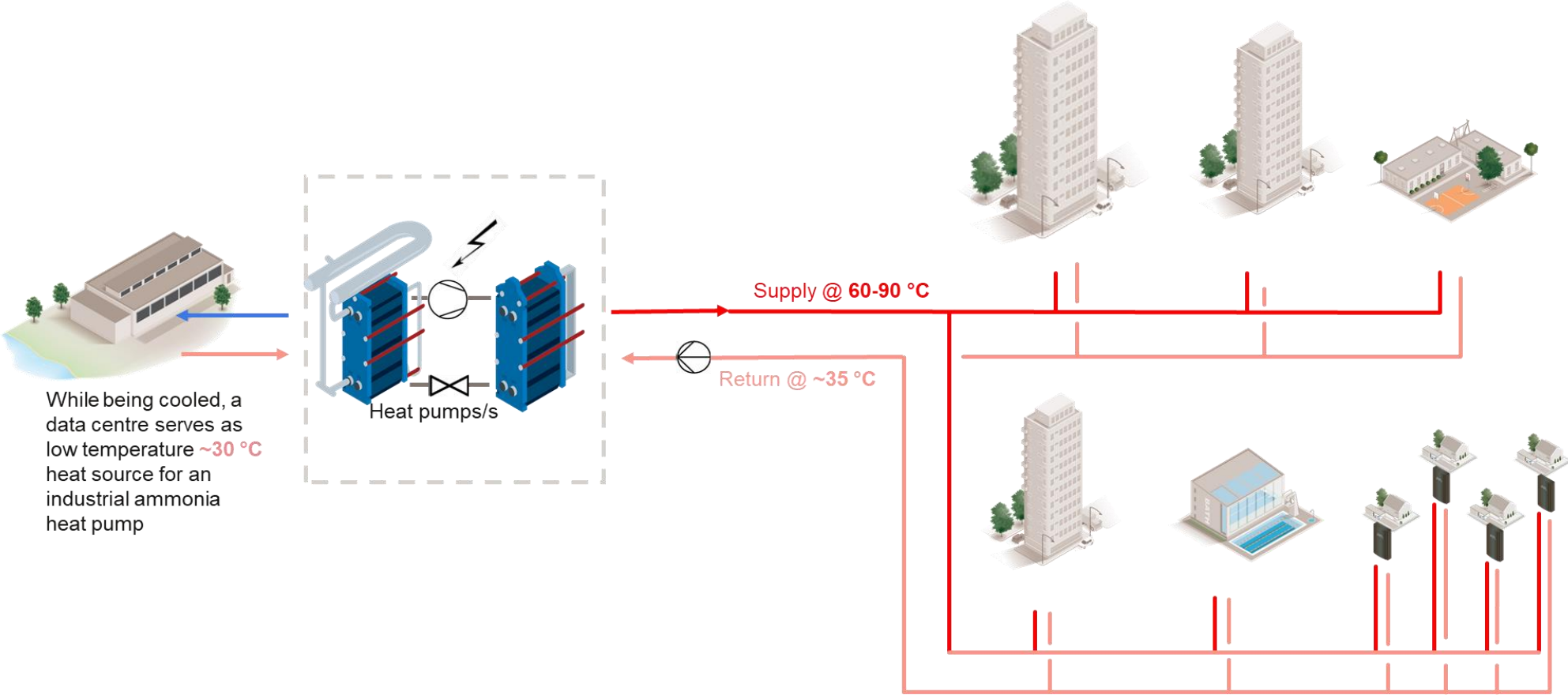
Commercial buildings

Connected to heat space and/or tap water.

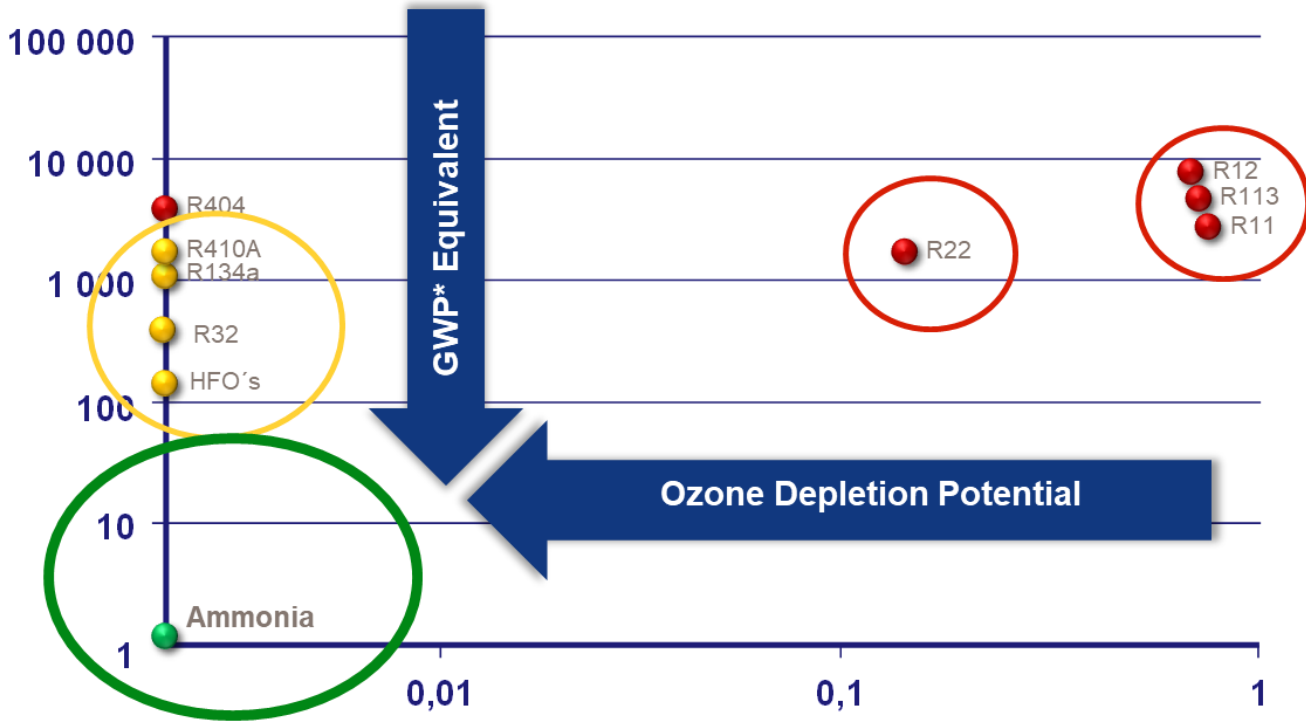


Industrial Heat Pump: Recovering heat for district heating

- Example: Using low value excess heat from a Data centre cooling



Selecting a future proof refrigerant: Ammonia is efficient with low GWP

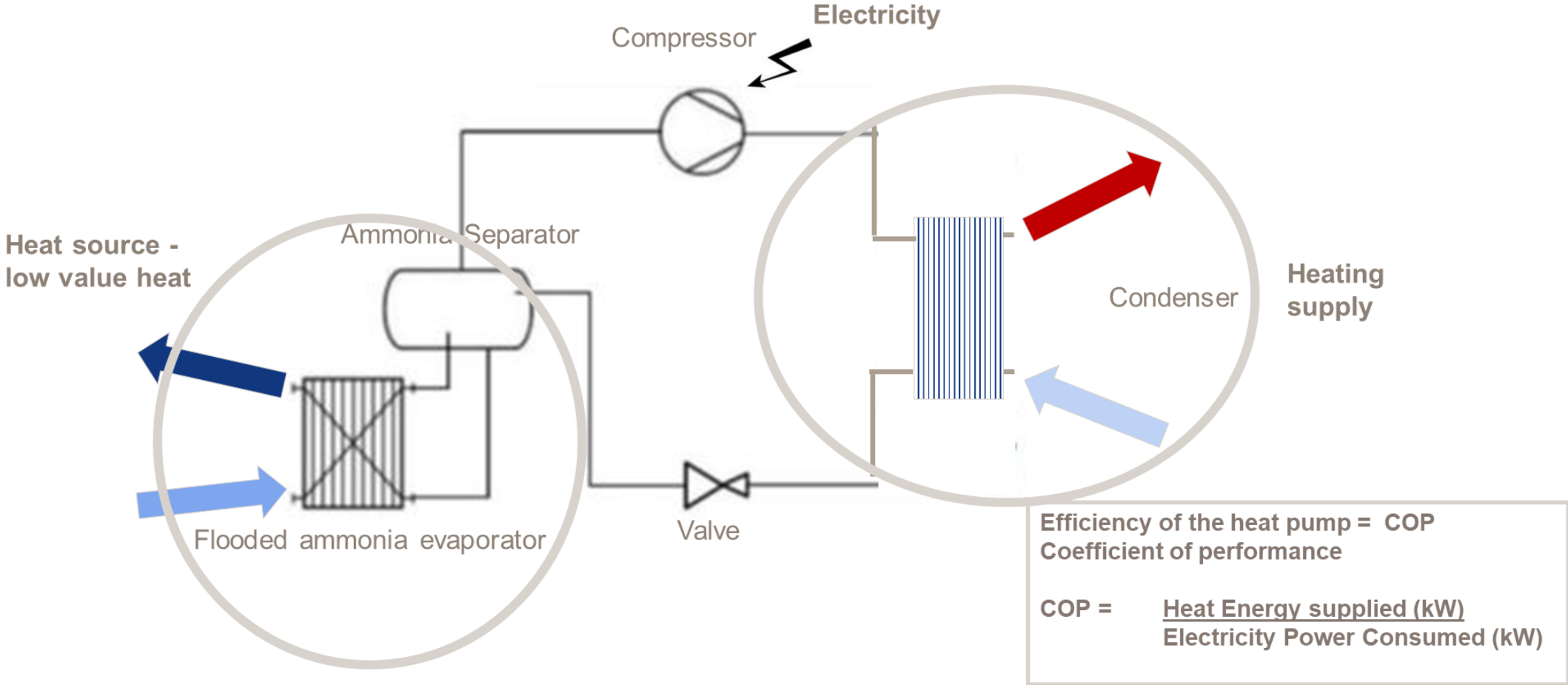


- Natural refrigerant
- GWP=0
- ODP=0
- High volumetric capacity
- More effective and cheaper than synthetic alternatives
- Lowest total lifetime cost

- Remember
- Classified as B2L Refrigerant and in Fluid Group 1 for PED (toxic and moderately flammable), so various local legal requirements must be met incl machine-room ventilation but normally no ATEX requirements
 - Copper and its alloys are not allowed as material

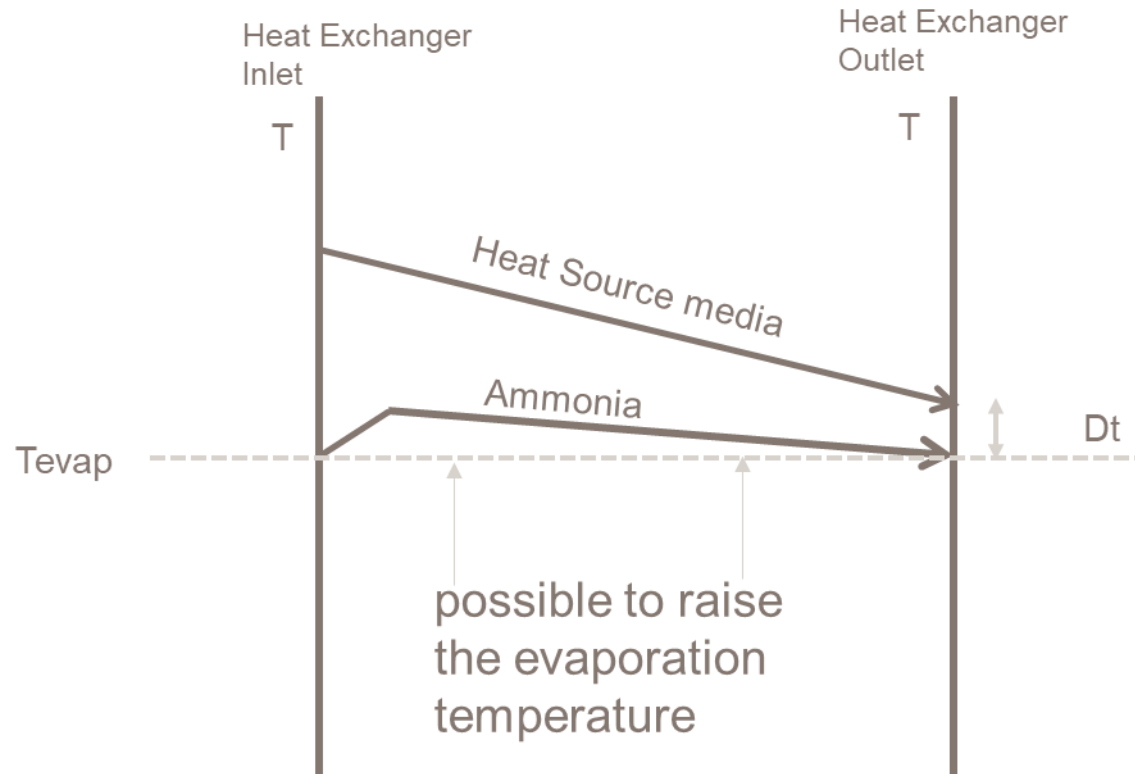
Heat Pump Impact – How semi welded plate heat exchanger increases the COP

Efficiency (COP) of the heat pump



Flooded Ammonia Evaporator

- Semi Welded Plate heat exchangers enables high energy efficiency

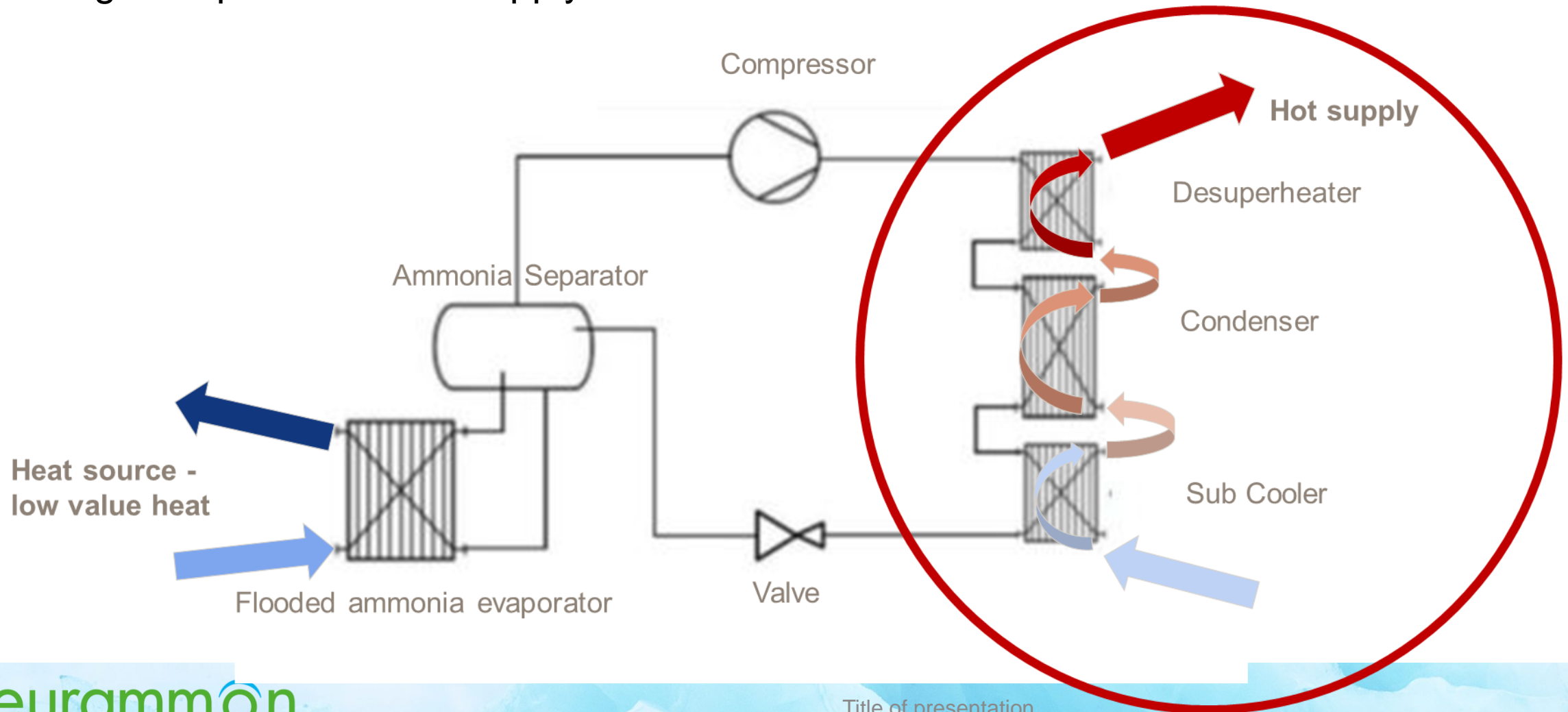


In general possible to obtain 2K closer approach with semi welded plate heat exchangers compared with other heat exchanger technology at comparable size and cost

- every K higher T_{evap} (evaporation temperature) saves 3-6% of the heat pump power consumption.

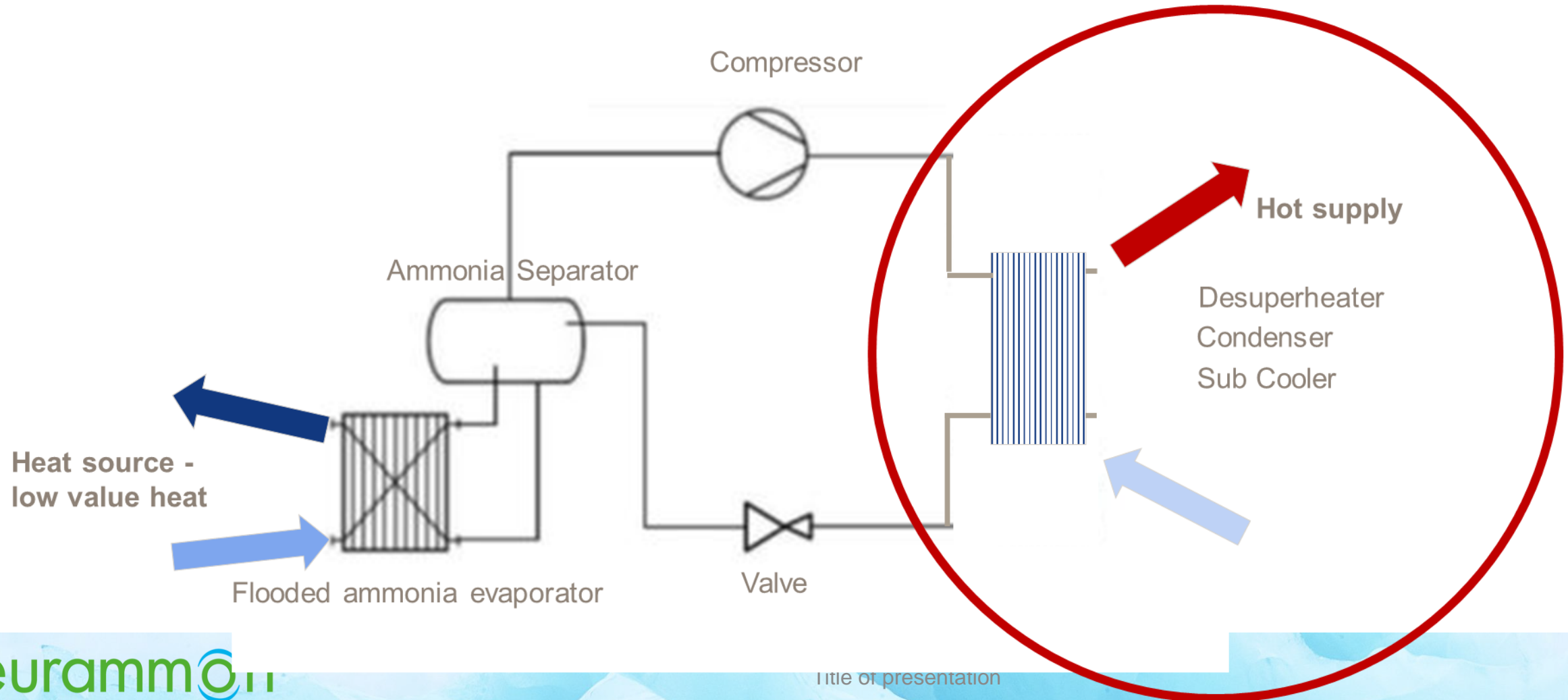
Condenser position

- High temperature heat supply

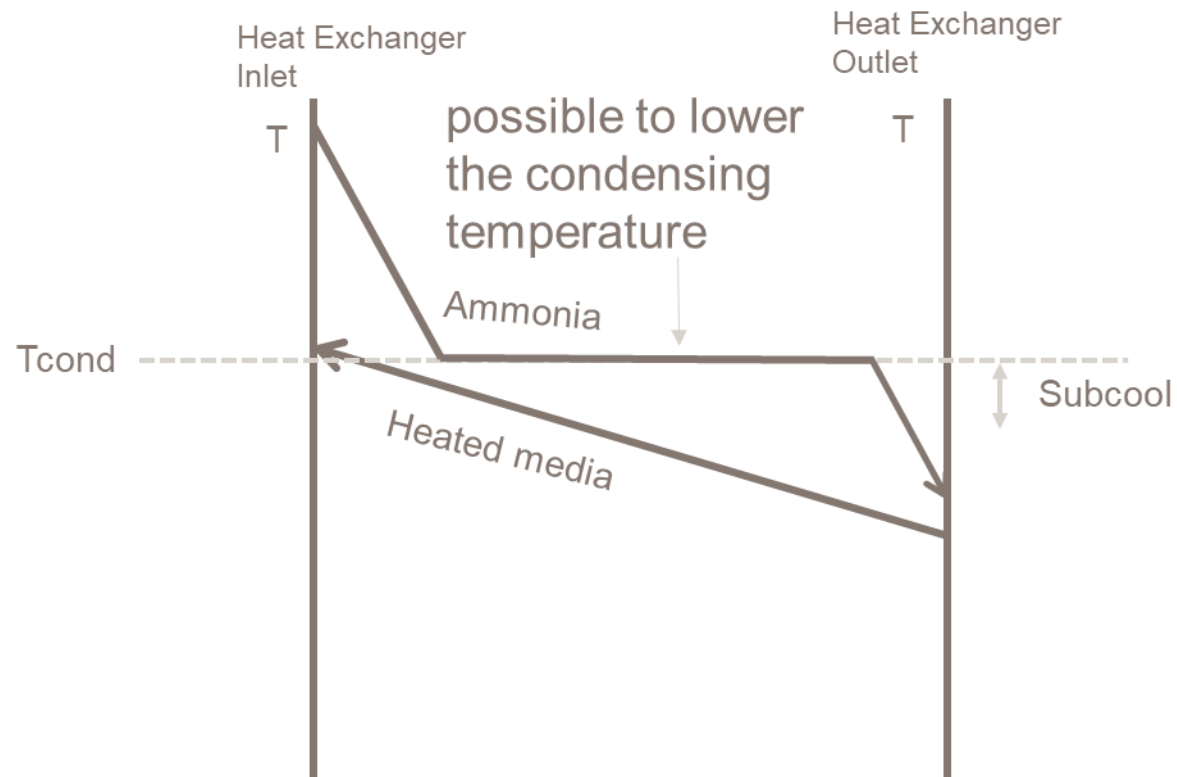


Condenser with integrated Subcooling

- SWPHE with integrated Subcoolcondense™ is compact and efficient



Condenser with integrated Subcooling

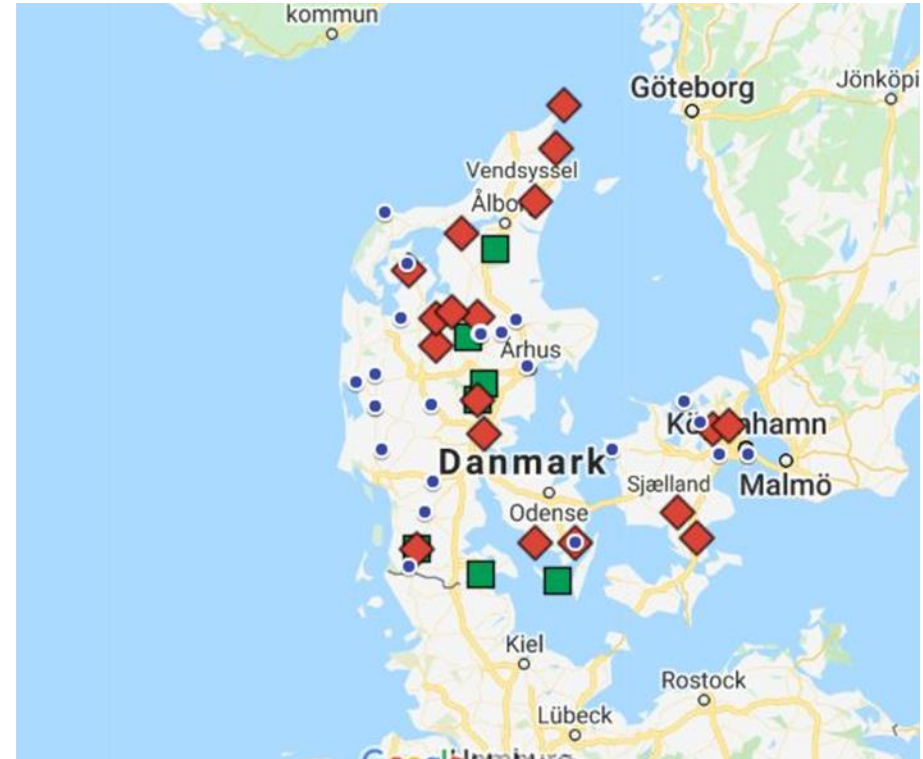


- Semi welded plate heat exchanger with Subcoolcondense™ enables to do desuperheating, condensing and subcooling in one unit thus:
 - Increases energy efficiency of heat pump by lowering condensing temperature and include larger sub cooling function
 - every K lower condensing temperature saves 1-3% of the heat pump power consumption.
 - Reduces piping cost and makes installation compact

References

Large heat pumps in Denmark

- Alfa Laval has supplied plate heat exchangers to large numbers of these sites plus some more industrial process sites
- Enclosed some examples



Map of the large Heat pumps supplying heat to the Danish District heating network

Source: PlanEnergi

District heating – heat recovered from sea and wastewater

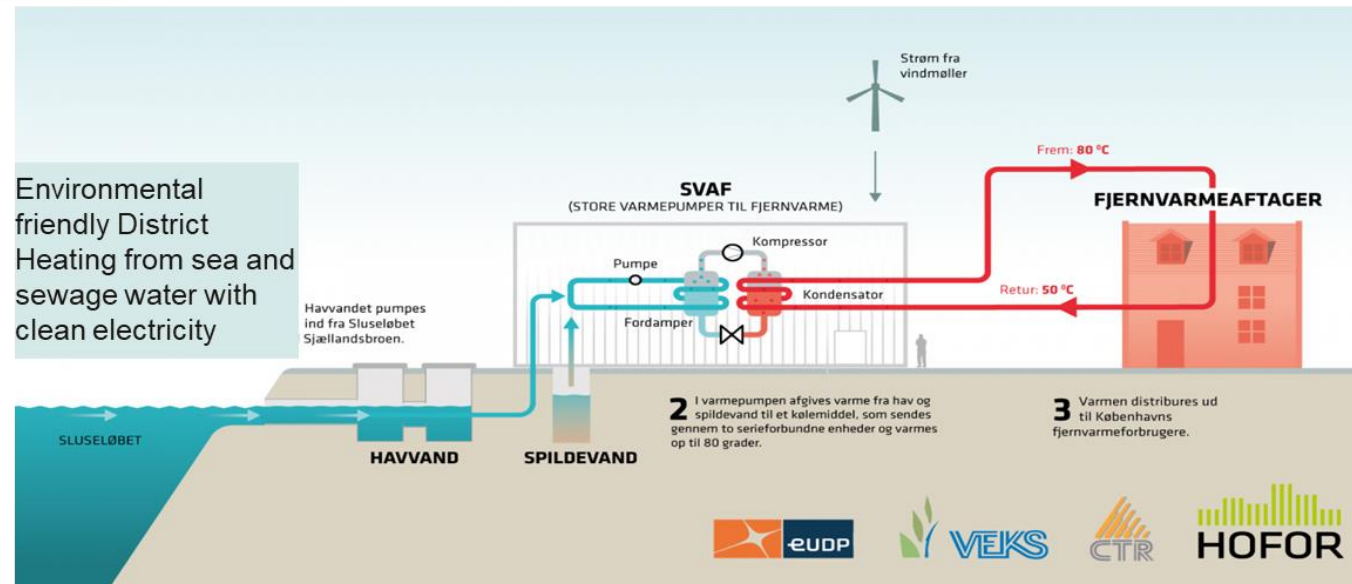
- Joint venture of HOFOR, CTR and VEKS for Copenhagen city

- Inaugurated in April 2019
- 5 MW full scale ammonia heat pump test
- Servicing 1100 households
- Heat sources: seawater and wastewater
- Power source: wind mills at sea
- COP = 3.2



Alfa Laval supplied:

- Flooded Ammonia Evaporators for heat recovery from sea-/wastewater 4°C → 0.5°C:
Alfa Laval semi-welded TK20-BWFG
- Condensers delivering hot water from 50°C → 80°C:
Alfa Laval semi-welded MK15-BWFT and Alfa Laval semi-welded TK20-BWFX
- Sub-cooling duties:
Alfa Laval ANH76 and Alfa Laval ANXP52



District heating company in Broager

- 4 MW Ground water heat pump started operation end 2016



System builder: ICS - Industrial Cooling system a/s

Consultant: PlanEnergi

Purpose: The heat pump uses 250 m deep ground water at 9°C (48.2°F) as heat source delivering district heating supply of hot water at 70°C (158°F). The total capacity of 4 MW covers approximately ¾ of the heating need for Broager or about 18.000 MWh/year.

Alfa Laval supplied: Semi Welded Plate Heat exchangers as evaporators cooling/recovering the ground water heat from 9° C to 2 C (48.2°F to 35,6°F) evaporating ammonia of the heat pump

COP Heat pump = 4,1

Combined cooling and district heating

- Bjerringbro energicentral

System builder: ICS - Industrial Cooling system a/s

Purpose: The heat pump is cooling the process of nearby Grundfos factory

Cooling capacity is 2,85 MW.

The heat pump is then raising the heat to reach the need of the city district heating network.

Heating capacity is 3,6 MW or 13.500 MWh yearly.

Refrigerant: Ammonia

Alfa Laval supplies: Semi Welded Plate Heat exchangers as ammonia evaporators to cool/recover heat from the industrial process



Waste heat recovery from Brewery process

- Project in final stage

System builder: ICS - Industrial Cooling system a/s

Consultant: PlanEnergi

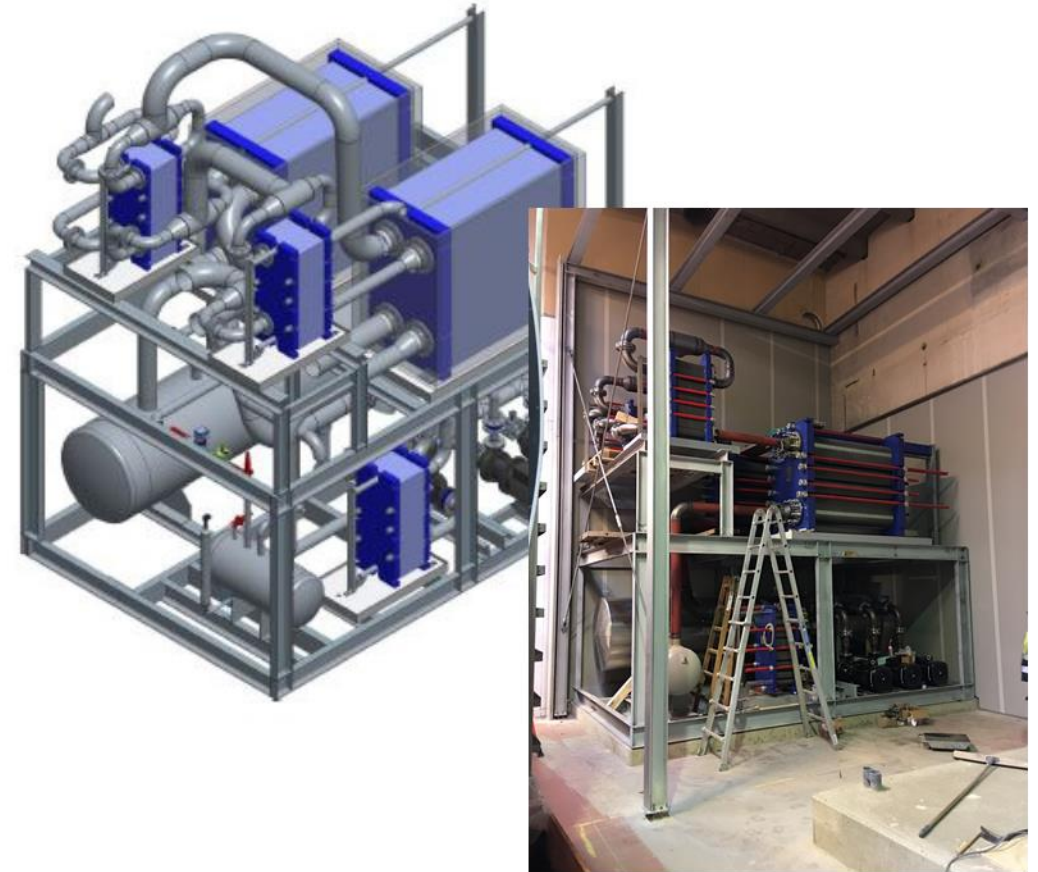
Purpose: Recovering heat from process ..evaporating ammonia at 12° C (53,6°F)

The heat pump is then delivering heating of hot side media from 45 to 70°C (113 to 158°F)

Heating capacity is 7,1 MW

COP = 4,0.

Alfa Laval supplies: Semi Welded Plate Heat exchangers as evaporators and condensers



Condensing part of system in workshop for assembly

Further Industrial Ammonia Heat pumps

- With efficient semi welded plate heat exchangers

District Heating Kloster Ringkobing

Source: ICS Industrial cooling systems



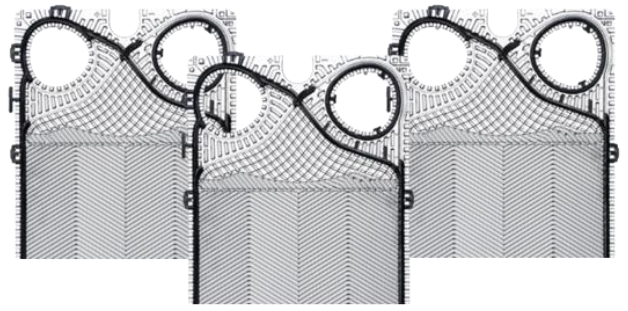
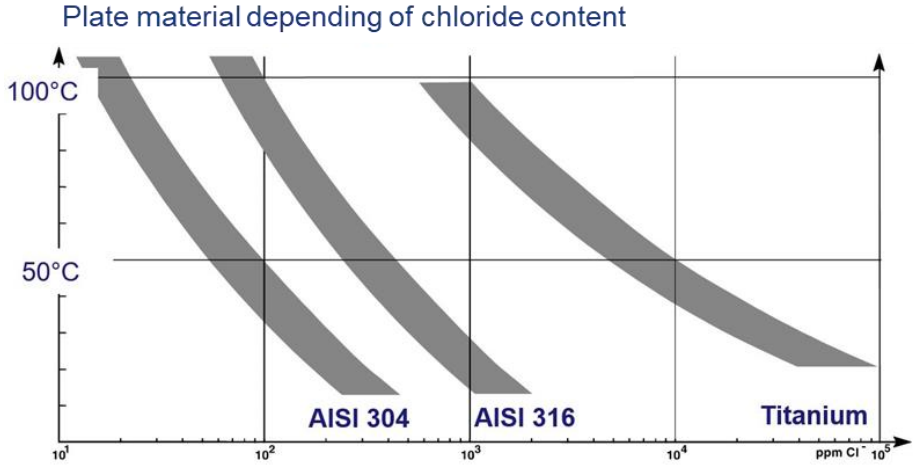
District Heating Stovring

Source: IES energy A/S (consultant)



Design and Maintenance for long lifetime operation

Reliable and Easy to service



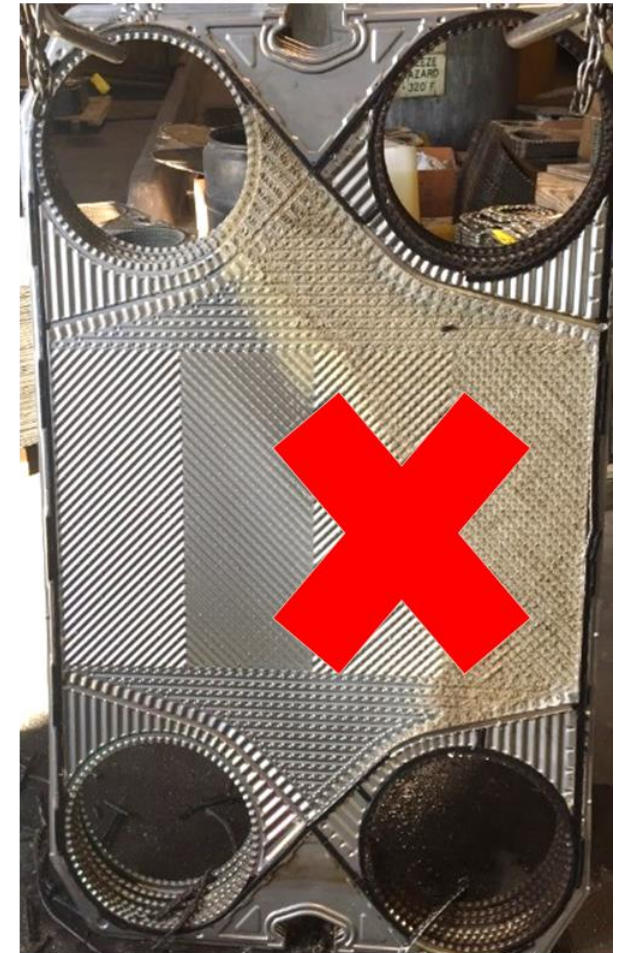
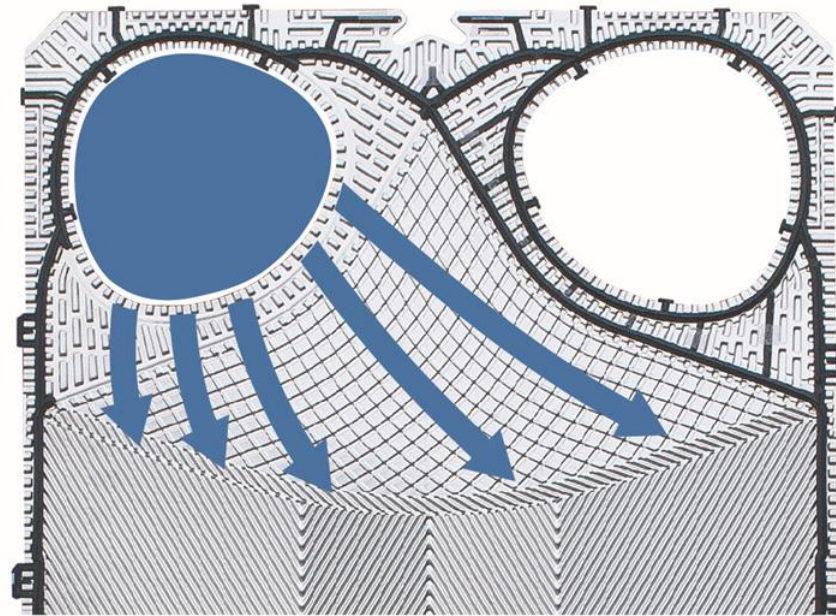
Easy to service and maintain



Keep efficiency high

- Also over time

“ The art of heat transfer is distributing the flow evenly and ...unit stays clean longer!”



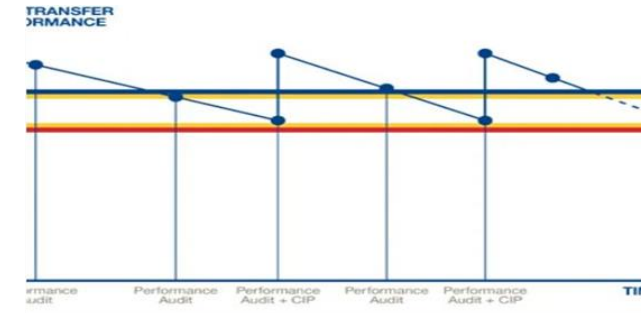
Maintenance options

Prevention depending of heat source

Alfa Laval service experts can assist to review and analyze the performance of the equipment. Modern tools are used to detect fouling or other risks so that all CIP cleaning can be predicted and planned to optimize system efficiency.

In order to benefit best various heat sources Alfa Laval include various optional equipment to optimize performance and uptime. In line self cleaning filter or port filters can be such options.

For sea and river water Alfa Laval recommends a back-flushing sequence on the incoming flow of cooling water at frequent short periods of time. In this sequence the reversed water direction scrapes off and flushes out accumulated debris from the plate heat exchanger surface. Using automatic back flush equipment saves time and money and minimizes downtime.



Summary benefits

Ammonia heat pumps

- Superior efficiency with Semi welded Plate heat exchangers



Major benefits

- Close temperature approach increases COP
- Turbulent flow keeps efficiency high
- Space saving
- Reduces Ammonia charge
- Reliable and easy to serve

Heat Pumps are vital in a sustainable energy system

Alfa Laval has a strong focus of accelerating the development of sustainable solutions including offerings for

- Energy efficiency
- Reduced emissions
- Clean energy
- Circular economy

We have given ourself a sustainability target of being carbon neutral over the supply chain by 2030



“Walking the talk“ An ammonia heat pump recovering waste heat from plate pressing is heating the main factory and head office in Lund, Sweden.

eurammon e. V. is always available as a sparring partner for questions on refrigeration with natural refrigerants.

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