Chillventa Specialist Forums 2022
Chillventa Fachforen 2022

CONNECTING EXPERTS.

Energy-efficient heat exchanger technology for heat pumps using natural refrigerants

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Technical Committe Energy Efficiency

eurammon lecture event at Chillventa, 12 October 2022

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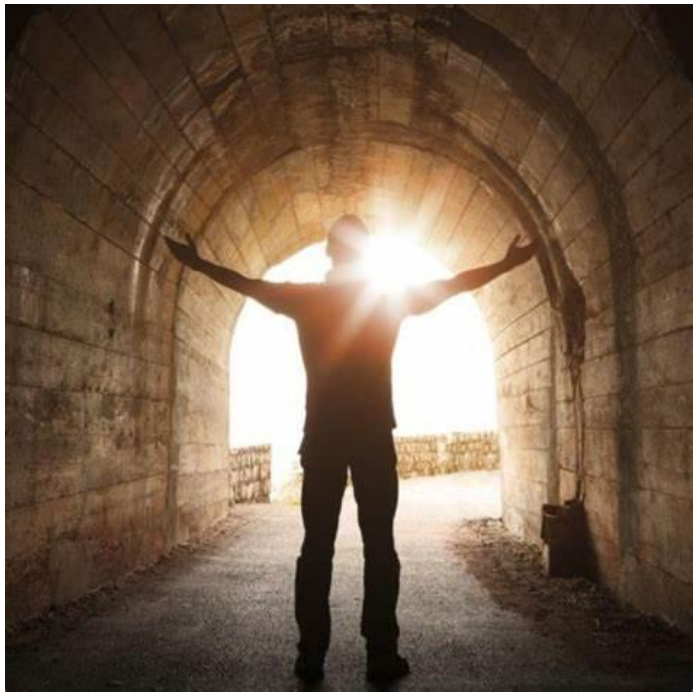
refrigerants delivered by mother nature

Heat Pumps – the answer to very important issues of our society today

Reducing CO_2 emissions

Even before gas prices started to rocket , heat pumps were considered as the solution that would solve the problem of CO_2 emissions in the heating sector.



Reducing the dependence of gas and other fossil fuels

Heat pumps are a now also becoming a key to **reduce dependence on fossil fuels** – and for Europe especially Russian gas.

> But if so

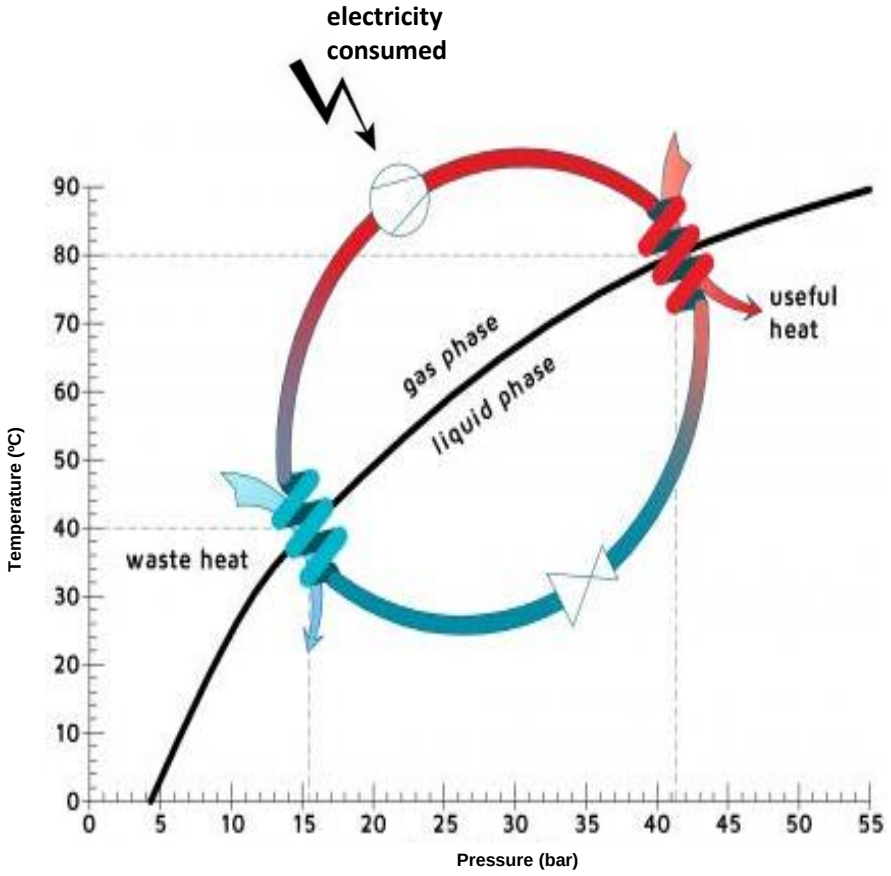
Will Electricity production capacity be enough? Probably not!

- **High efficiency of running the heat pumps is crucial to limit the electrical consumption and cost.**

Heat Pump efficiency - COP_h

Efficiency of the heat pump = COP_h Coefficient of performance heating

COP_h = Heat Energy (useful heat)supplied (kW) / Electricity Power Consumed (kW)



What effects Heat Pump efficiency – some main factors

Relative temperature between the source and the useful heat

Bigger temperature difference between the two reduces the efficiency.

Refrigerant type

Depending on the operation condition there are some options to select from. Choosing a system with natural refrigerant R717/ammonia instead of a common alternative synthetic like R134a should allow for 30% efficiency increase.

System efficiency

Depends on compressors, heat exchangers, pumps, valves, regulation and the joint engineering of the system.

Temperature level of needed heat

Systems for supply temperatures above 100°C has normally the efficiency COP ratio of maybe 50% lower than for something below 90°C.

Natural refrigerants in heat pumps - growing share of market

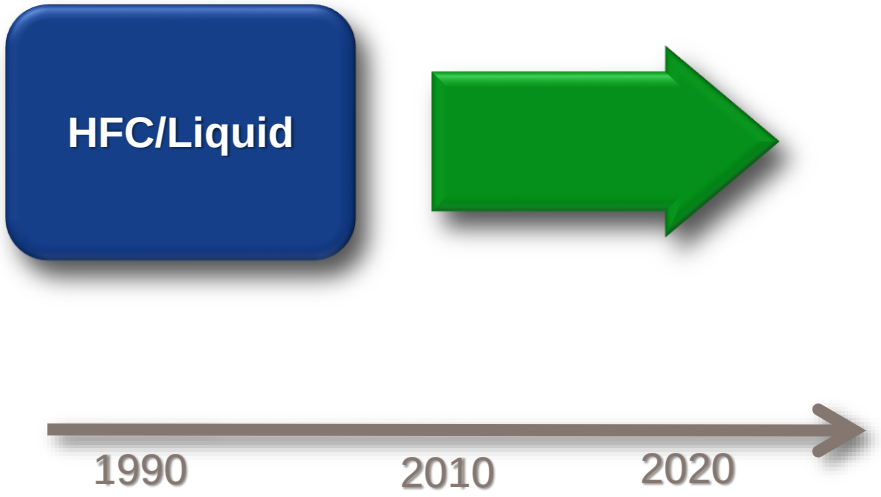
Why the growing use of natural refrigerants?

- ODP zero
- GWP is very low (R717=0, R744=1, R290=3)
- Cost of the refrigerants are modest
- Long term solution & Sustainable and future proof
- Component and systems are developing rapidly to handle the drawbacks (high pressure, toxicity or flammability)
- Higher energy efficiency (COP)
  - Example: choosing a system with natural refrigerant R717/ammonia (with evap. Temp. 30°C and condensing temp. 70°C) instead of an alternative synthetical like R134a should allow for an efficiency increase of some 30%

Heat exchanger products meeting the switch to naturals

Alfa Laval has is since the 80th been investing continuously in development of efficient heat exchangers for all Natural refrigerants

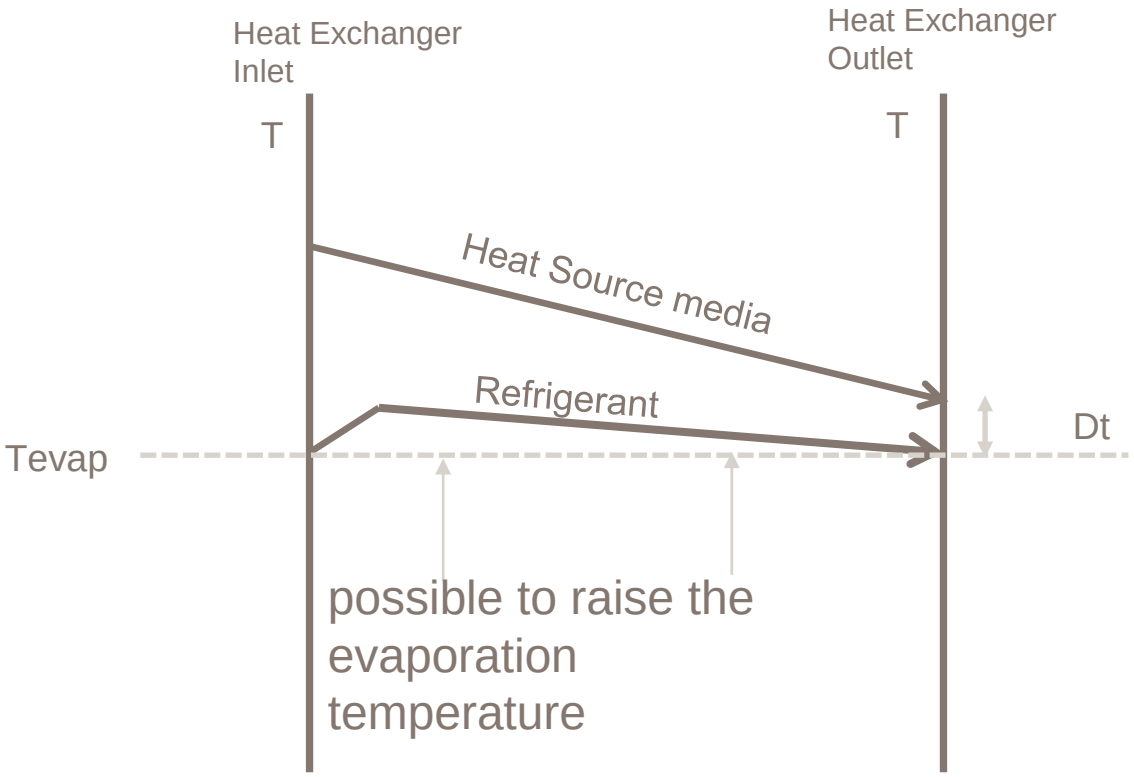
We talk mainly about Liquid Evaporators and Condensers



- R717 Ammonia
- R744 Carbondioxide
- R290 Propane
- R600/a Buthane/Isobuthane

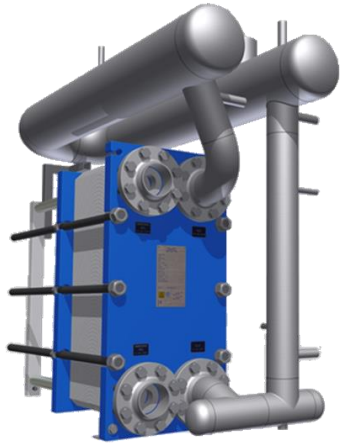
Evaporator – Efficiency impact of Plate Heat Exchanger

Flooded Evaporator



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

- every K higher Tevap (evaporation temperature) saves 3-6% of the heat pump power consumption



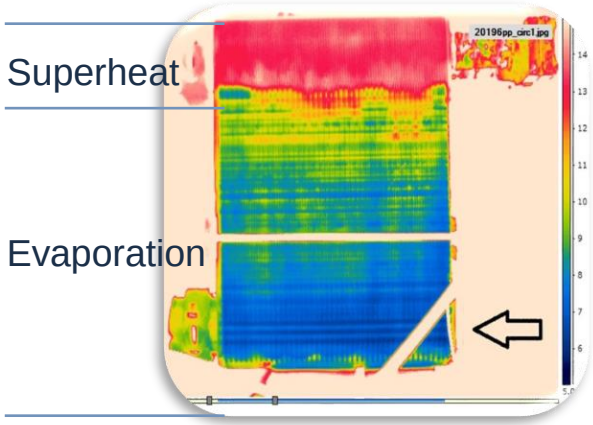
Alfa Laval Heat exchanger with U-turn™ - flooded ammonia separator

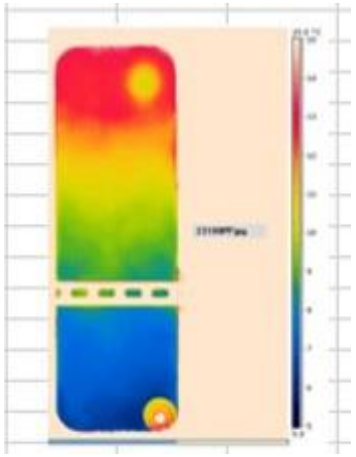
Evaporator – Efficiency impact of Plate Heat Exchanger

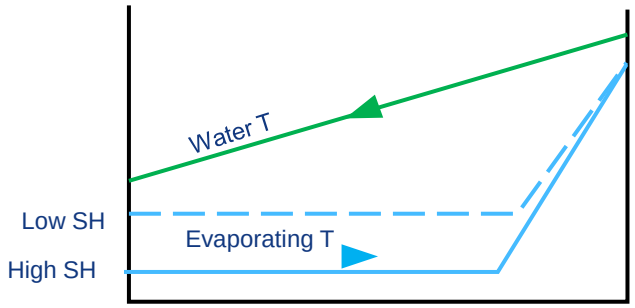
DX Evaporator

Alfa Laval Plate heat exchangers are equipped with DX distribution systems allowing a Superheat reduction of 2-3K compared to conventional systems.
This makes it possible to raise the evaporation temperature.

Every degree K higher saves 3-4 % of compressor power.





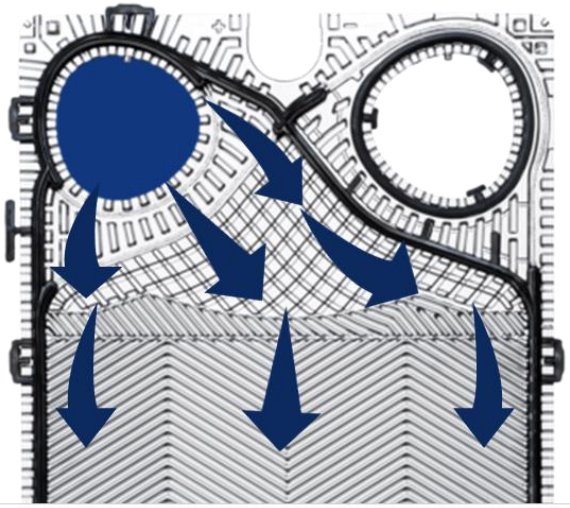


Condenser – Energy efficiency impact of plate heat exchangers

- Good Distribution and Pressure drop utilisation

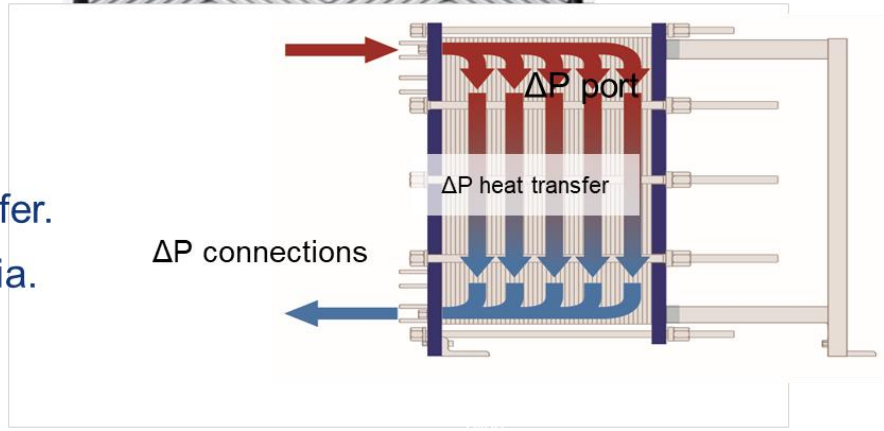
Curve Flow™ distribution area

- ✓ Fully utilizes available surface area.
- ✓ Provides perfect distribution inside channel for best heat transfer and surface stays cleaner

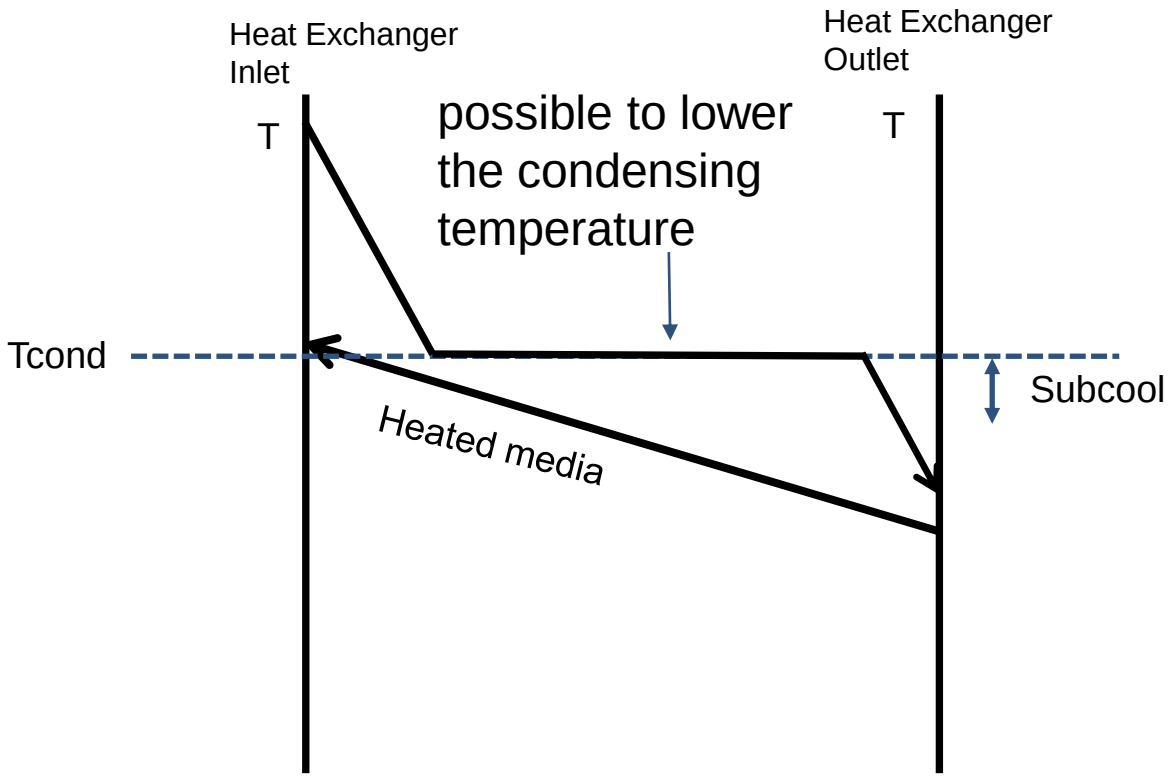


OmegaPort™ noncircular port holes

- ✓ Better distribution of media
- ✓ Pressure drop better utilized for heat transfer.
- ✓ Reduces Pumping cost of the heated media.



Condenser – Energy efficiency impact of plate heat exchangers



- Plate heat exchanger with good distribution of the refrigerant 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

Heat exchanger portfolio for Ammonia heat pumps

Design Pressure

Condensers 200 kW
dt = 20K

5000 kW

8000 kW

AXP112
40 bar

T10EW
63 bar

TK20BW
63 bar

Evaporators
dt = 10K

100 kW

500 kW

1000 kW

1500 kW

4000 kW

AN76
25 bar

M10BW/T10EW
25bar

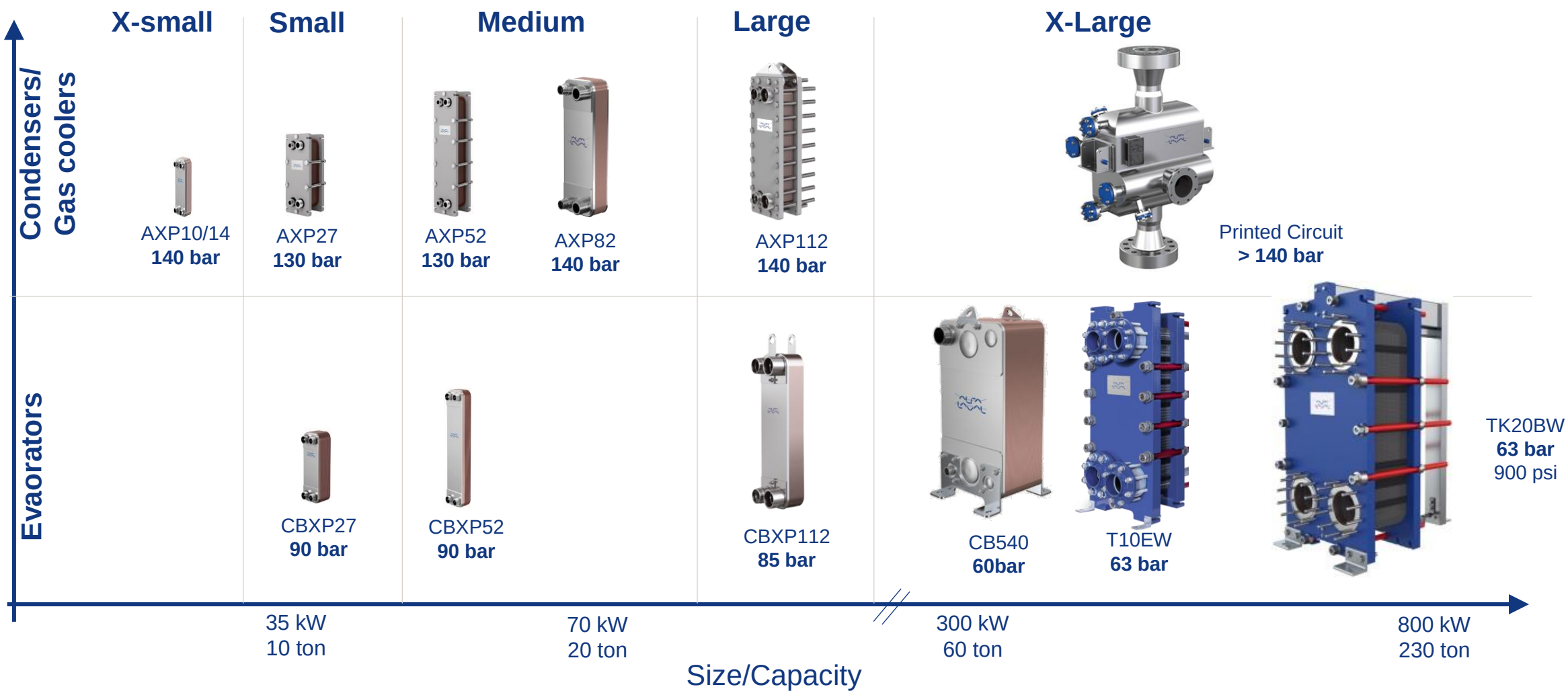
M15BW
25 bar

TK20BW
25 bar

T20BW
25 bar

MA30
25 bar

Heat exchanger portfolio for CO_2 heat pumps



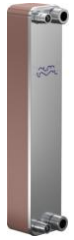
Heat exchanger portfolio Hydrocarbon Heat pumps small

Double wall

High Efficiency Low charge

CBH18DW

CB90DW



AC30

AC43

CB24

CB65

AC65

- Extra safety versus intermixing of media with real double wall

DynaStaticTM distribution system

FlexFlowTM assymmetric channels

PressureSecureTM high performance plates

CBH 410

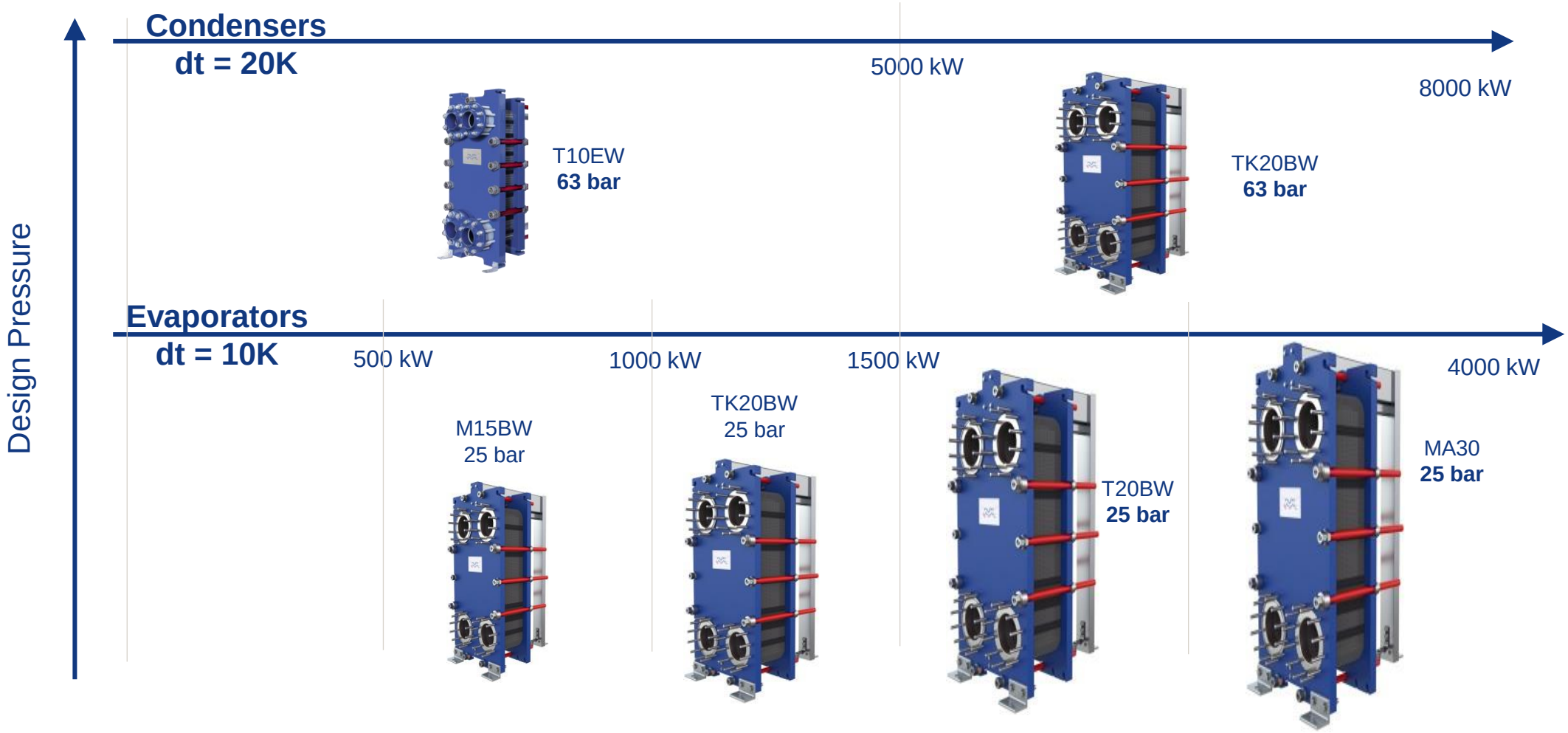
10kW

20kW

Capacity

500kW

Heat exchanger portfolio for Hydro carbon heat pumps large



Efficient heat exchangers also reduces Refrigerant charge

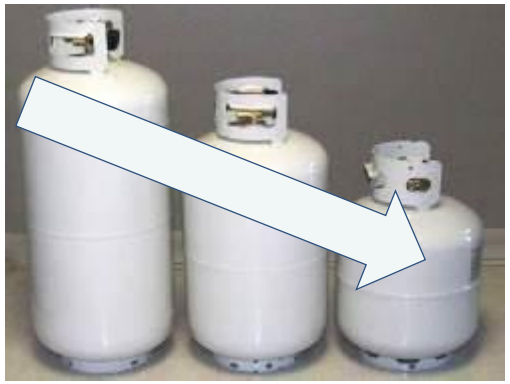
Examples:

Ground source heat pump with Propane

- With 150 grams of propane cases arrives to some 8 kW of heating which is less than **20 grams R290/ kilowatt**

Industrial water to water heat pump with Ammonia

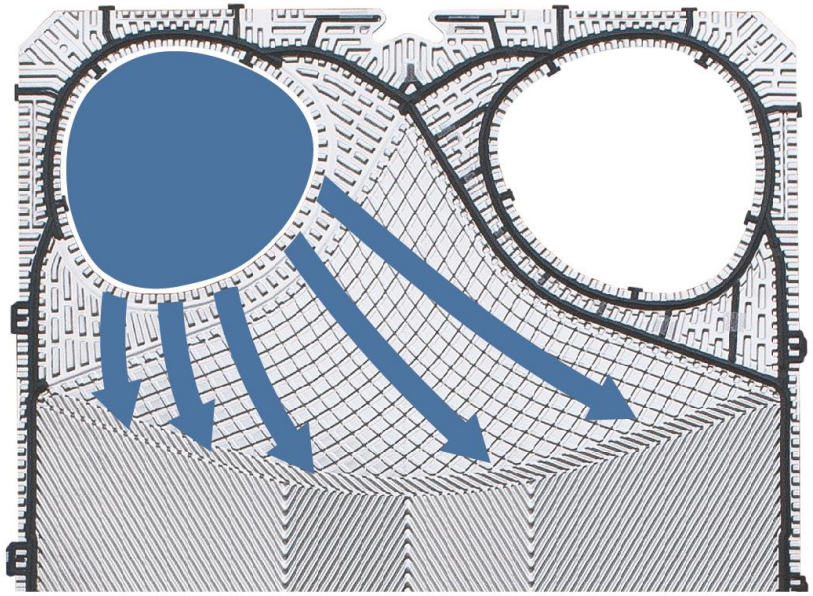
- With 40 kg of ammonia cases arrives to some 1 MW of heating which is less than **40 grams R717/ kilowatt**

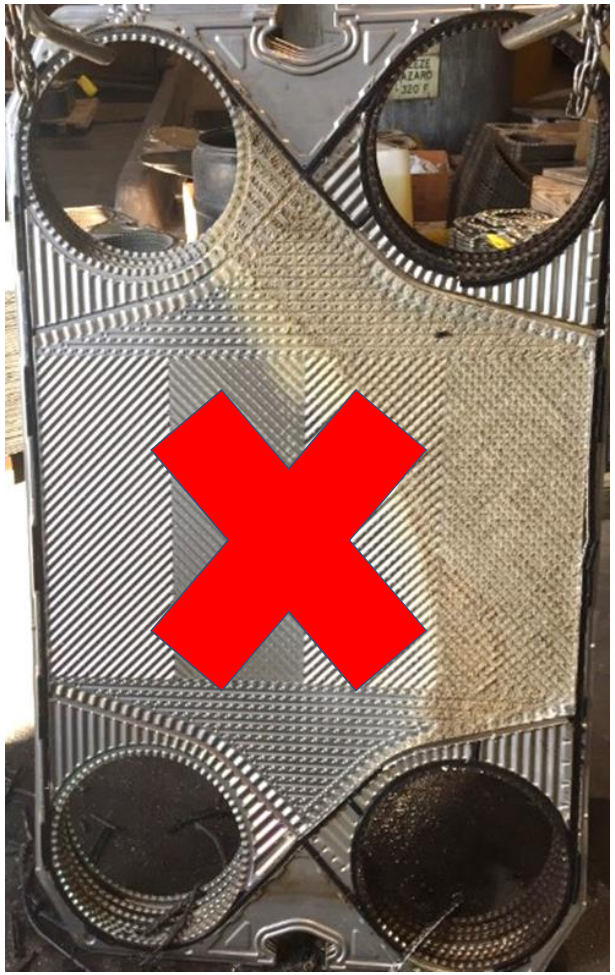


Maintain efficiency – by turbulent and well distributed flow

“ The art of heat transfer is distributing the flow evenly and

…unit stays clean longer!”

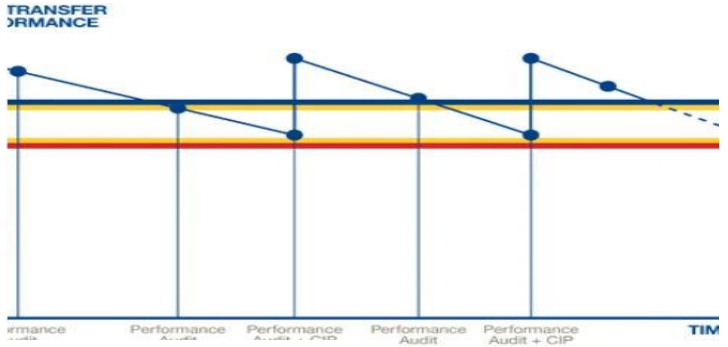




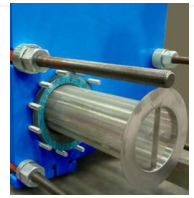
Maintain efficiency

- Establish maintenance program optimising i efficiency performance of the Heat Pump

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.

Being a member of Eurammon ...we are continously

Thanks for your attention!

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

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