

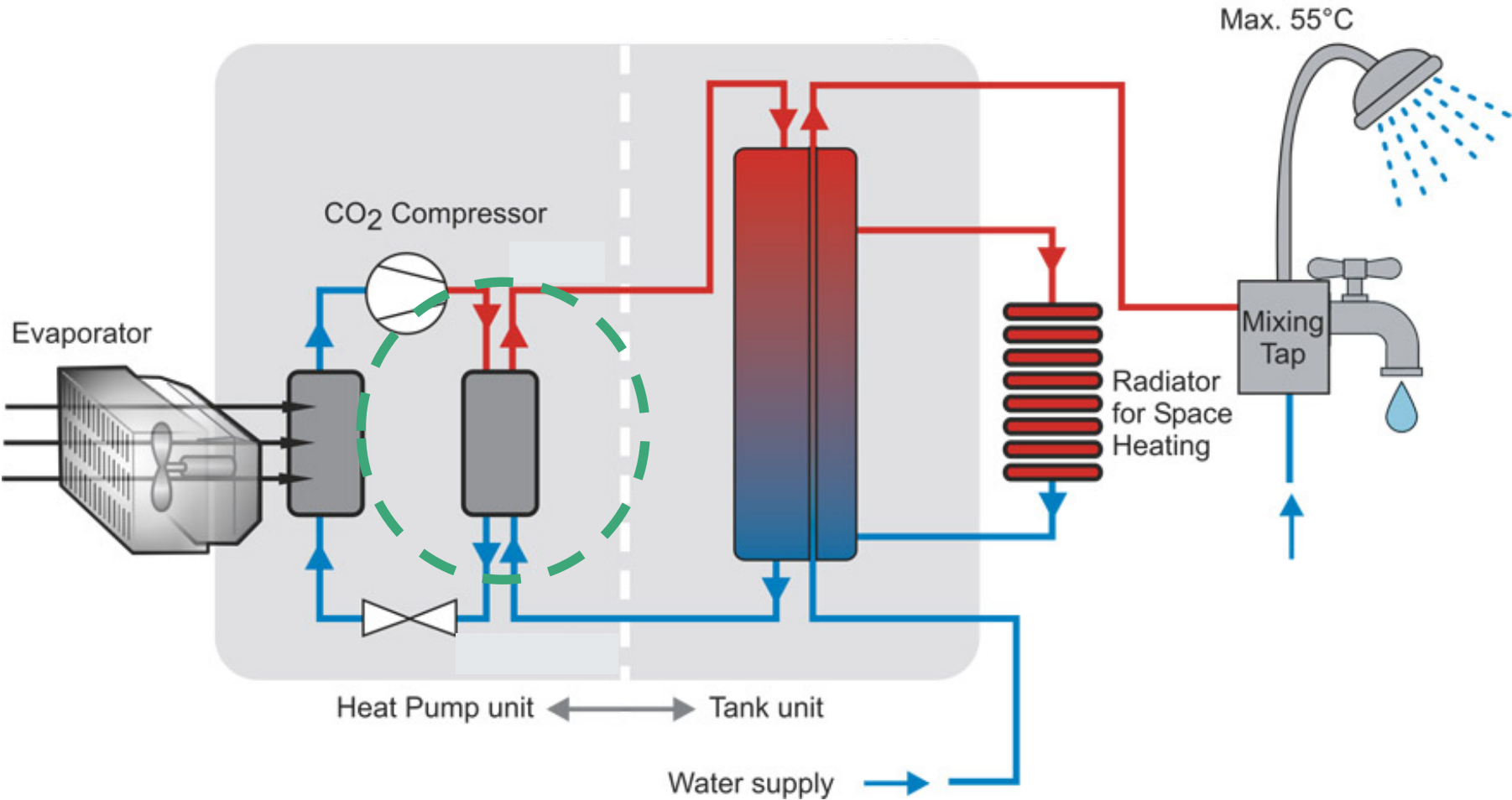
Innovative Design of Compact Brazen Plate Heat Exchanger for Transcritical CO₂ Gas Cooling

Tomas Dahlberg
Innovation Manager
SWEP International AB

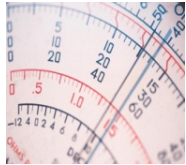
The Challenge



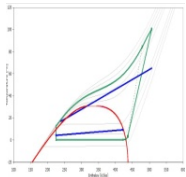
The Application



The Challenges



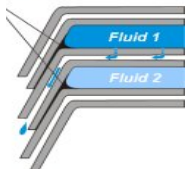
- High working pressure ->140 bar
 - Legal requirements



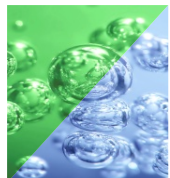
- Close temperature approach

$$\frac{-2 \pm \sqrt{2^2 - 4(1)(1)}}{2(1)}$$
$$\frac{-2 \pm \sqrt{4-4}}{2}$$
$$\frac{-2 \pm \sqrt{0}}{2} \rightarrow \frac{-2}{2} \rightarrow -1$$

- Predict and design difficulties of heat exchanger due to transcritical CO₂ behavior



- Frameless high-pressure double wall technology (low weight)



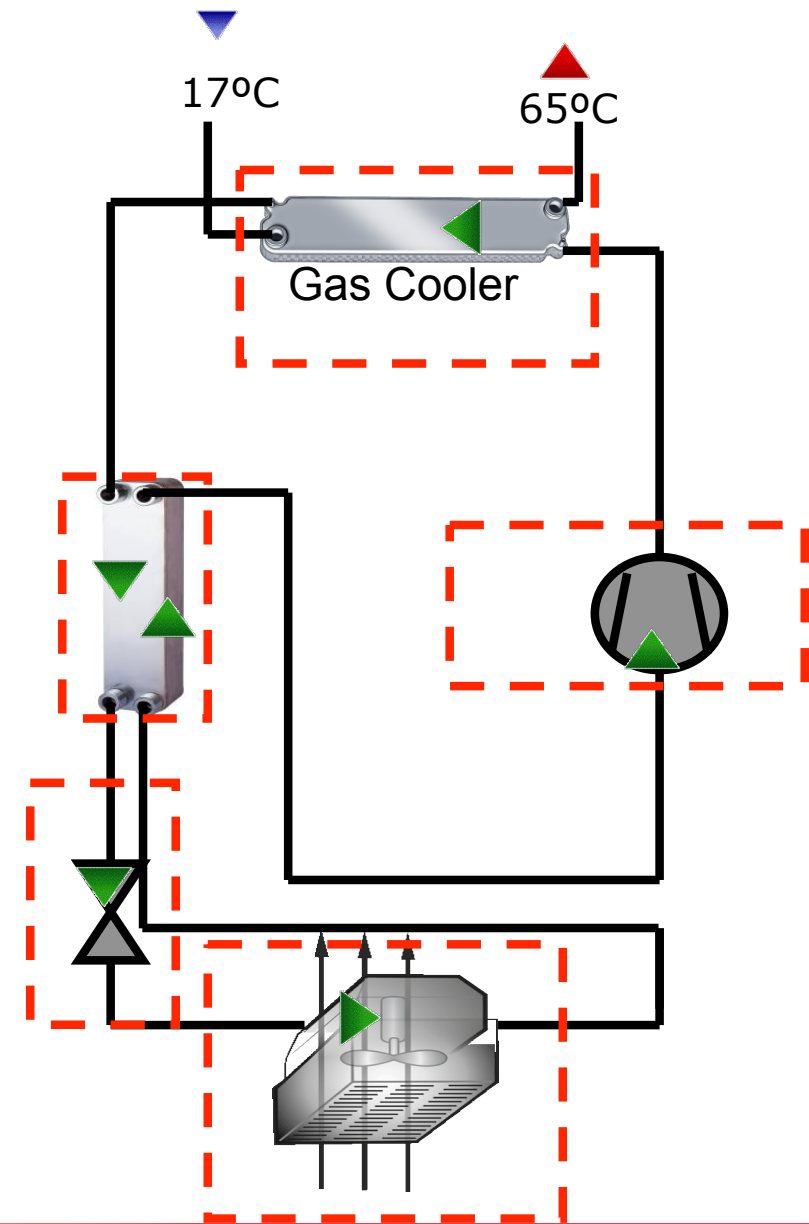
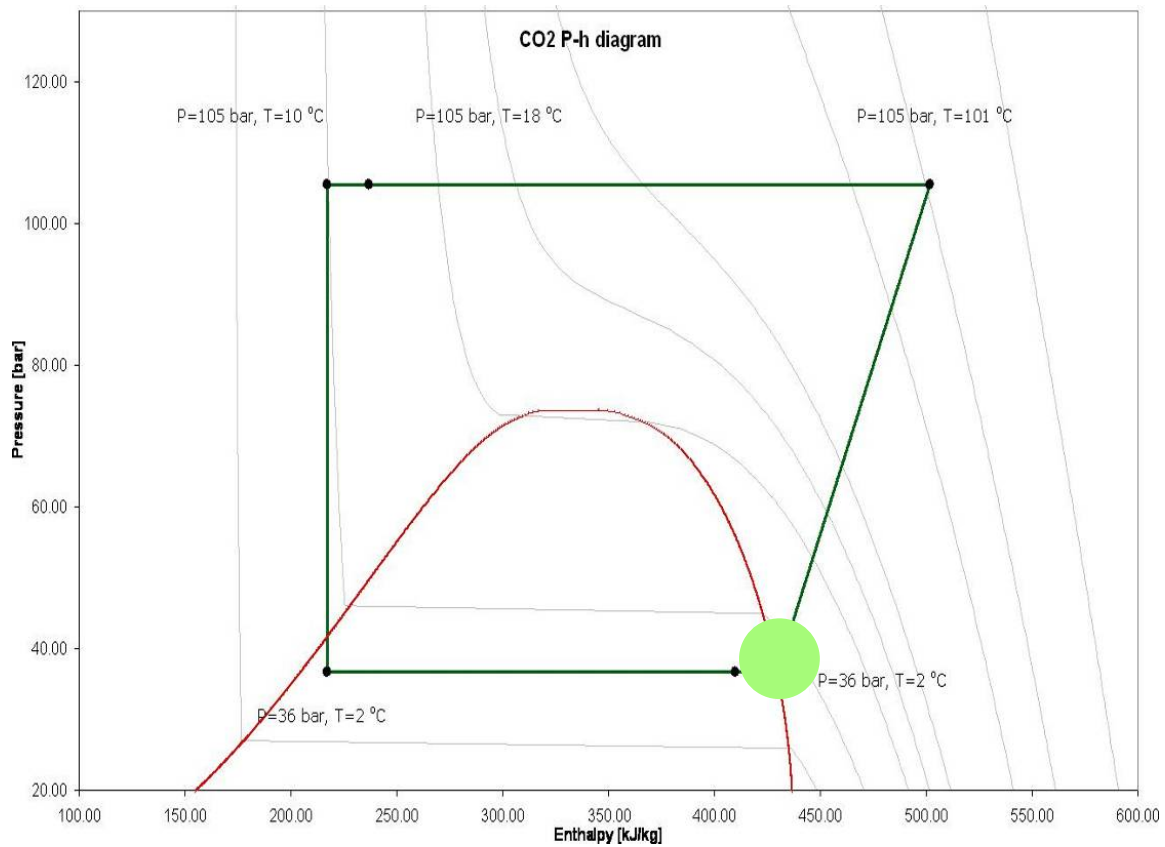
- Plate-to-plate design problem due to H₂O<->CO₂

Legal requirements

- PED static condition
 - Based on working pressure and temperature in relation to yield point of base material.
 - Requires $\approx 5 \times 140 \text{ bar} = 700 \text{ bar}$
- KHK static condition
 - Based on working pressure, max. working temperature and yield point of base material
 - Requires $\approx 4.5 \times 140 \text{ bar} = 630 \text{ bar}$
- JRA Static condition residential systems
 - Based on working pressure and application
 - Requires $\approx 3 \times 140 \text{ bar} = 420 \text{ bar}$

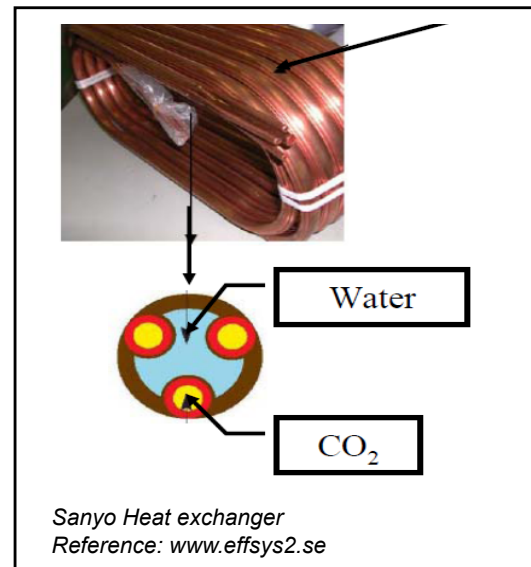
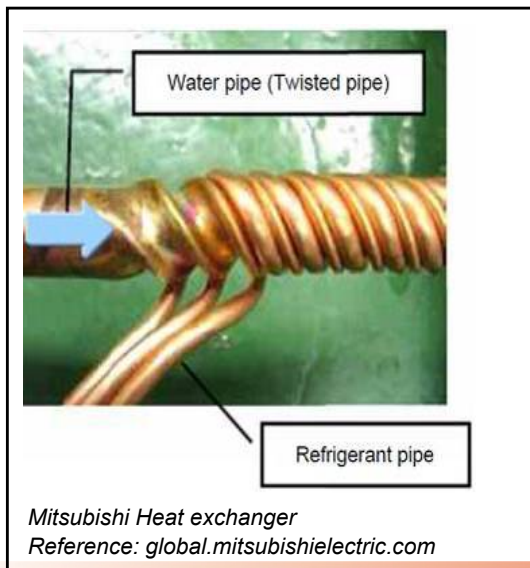


ECO Cute System principle, standard case



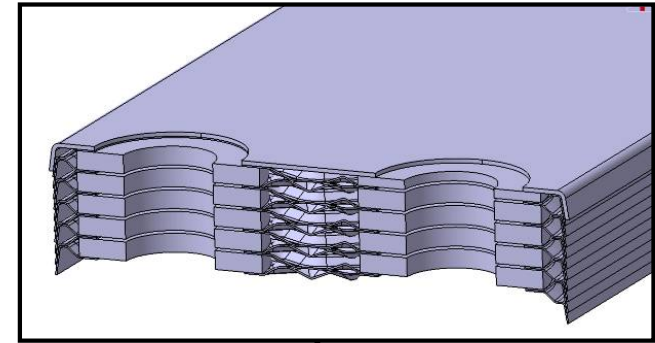
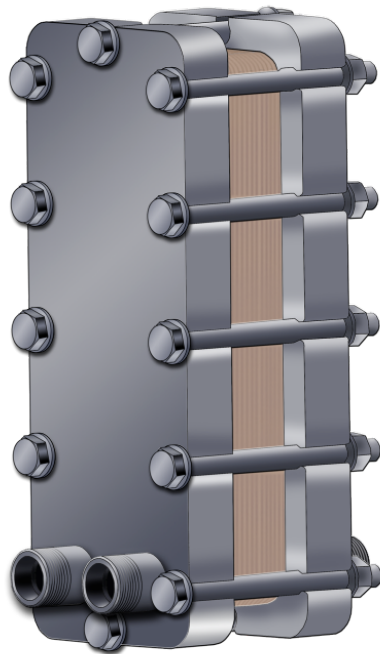
BAT: Best Available Technology for transcritical gas cooler

- Based on:
 - Thermal performance
 - Product weight
 - Footprint (space requirement in installation)
 - Scalable capacity
 - Pressure drop overall (water and CO₂)
 - Double wall function
 - Pressure resistance (mechanical strength)

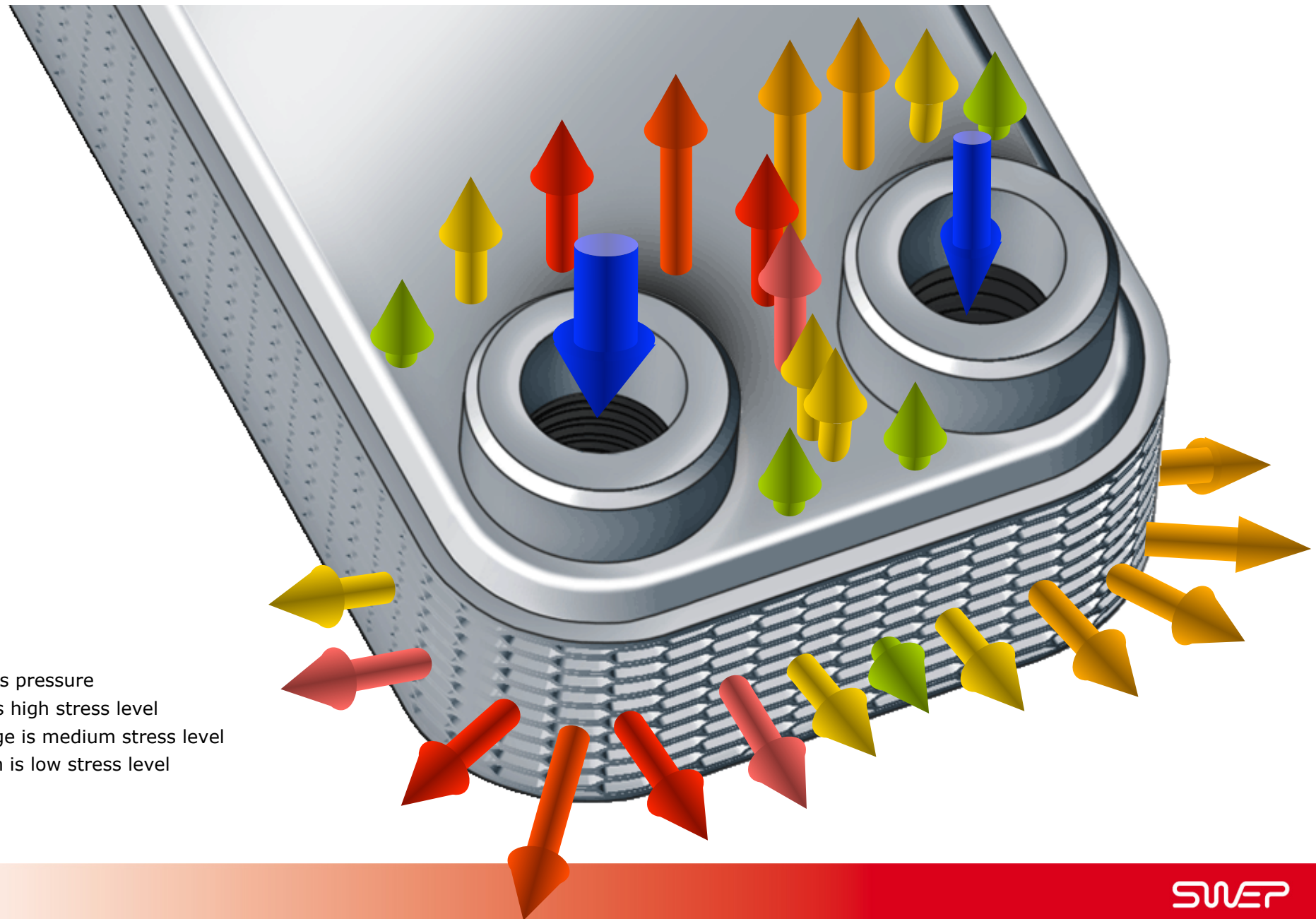


Conventional BPHE Design

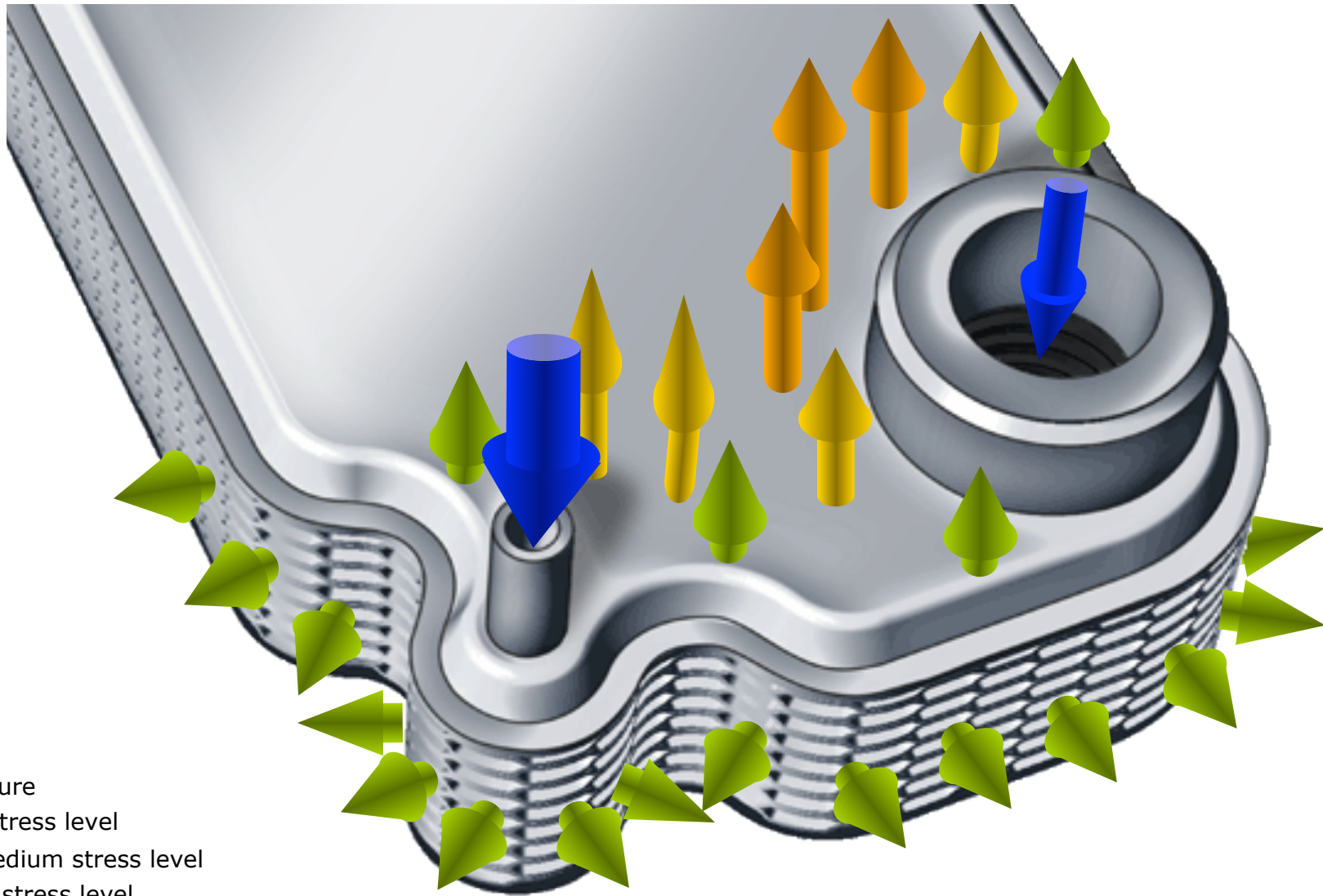
- Conventional BPHE design for high pressure
 - Large pressure surfaces
 - Square product
 - Reinforced by external frames
 - Heavy and expensive
 - Reinforced by internal frames
 - Complex and expensive



Existing BPHE strength / structure

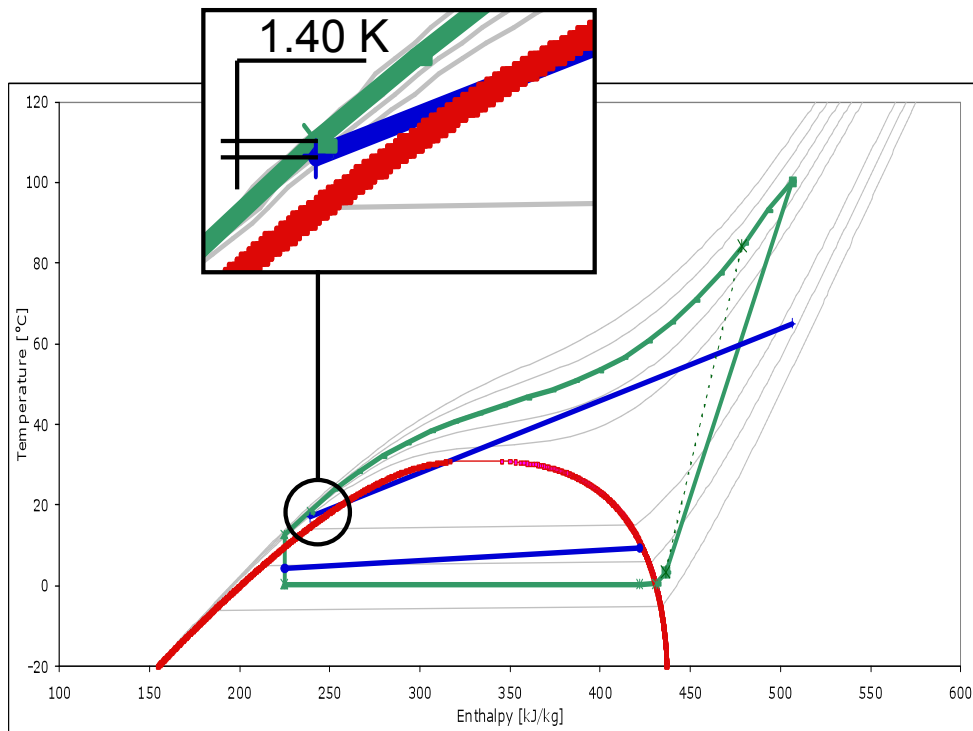


SWEP BPHE Gas cooler strength / structure

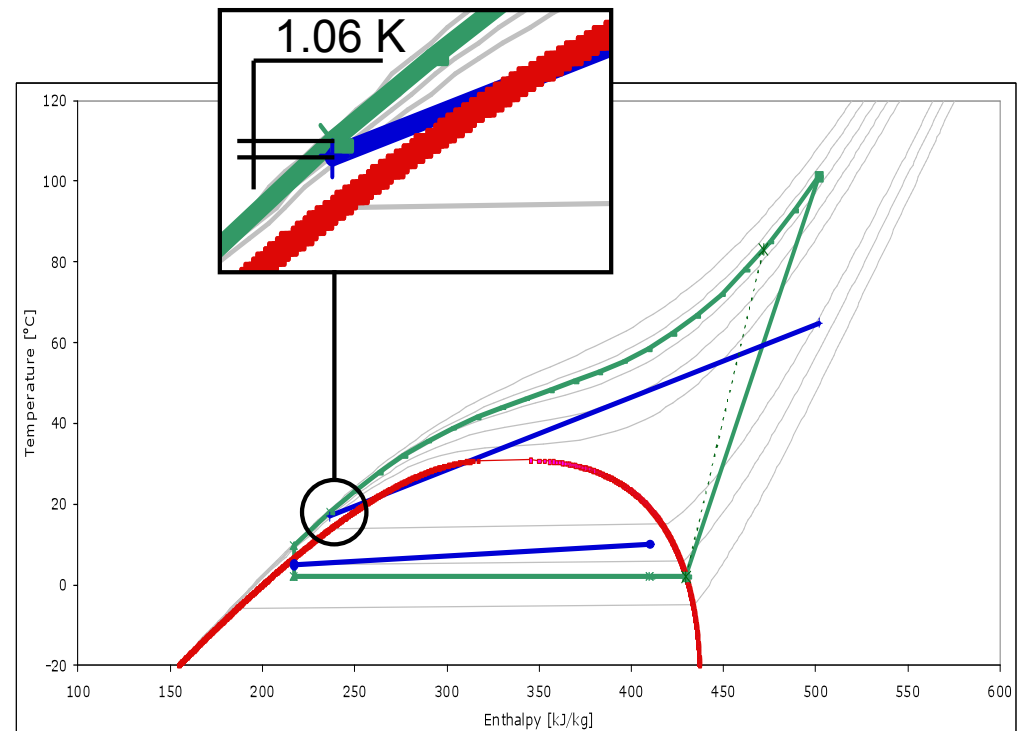


Performance: Gas cooler

- Reference Gas cooler
- ECO Cute standard application case
- **TA = 1.40 K**
- Capacity = 4 kW
- Pressure drop CO₂ = 170 kPa
- Pressure drop H₂O = 10 kPa



- SWEP Gas cooler
- ECO Cute standard application case
- **TA = 1.06 K**
- Capacity = 4 kW
- Pressure drop CO₂ = 50 kPa
- Pressure drop H₂O = 1.5 kPa



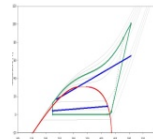
The Solution



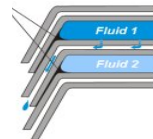
- High working pressure 140 bar
- Complies with PED, KHK, JRA (destructive testing)
- Fatigue +250000 Cycles@140bar

$$\frac{-2 \pm \sqrt{2^2 - 4(1)(1)}}{2(1)}$$
$$\frac{-2 \pm \sqrt{4 - 4}}{2}$$
$$\frac{-2 \pm \sqrt{0}}{2} \rightarrow \frac{-2}{2} \rightarrow -1$$

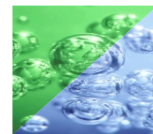
- Predict and design of CO₂ transcritical gas cooler



- Fulfills Eco Cute application requirements

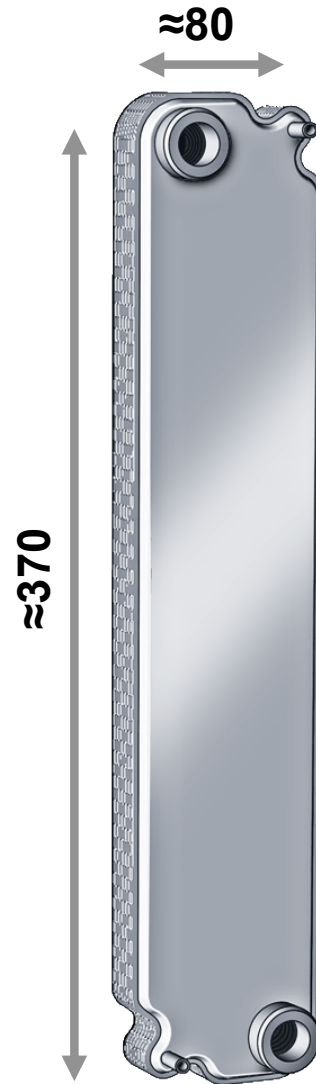


- Frameless high-pressure double wall technology



- SWEP AsyMatrix™ plate design G2

The Solution Size



SWEP transcritical gas cooler as BAT

- By thinking in a new way...
 - Extreme pressure-resistant design
 - High thermal performance
 - Low pressure drops (CO_2 and H_2O)
 - Scalable capacity
 - 40%-60% weight reduction

We have taken the challenge.

