



Basics of refrigeration

BAC Product, system and
application training

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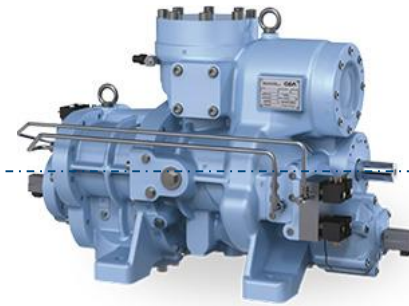


Purpose

Remove heat from a space or product and to reject that heat to the environment

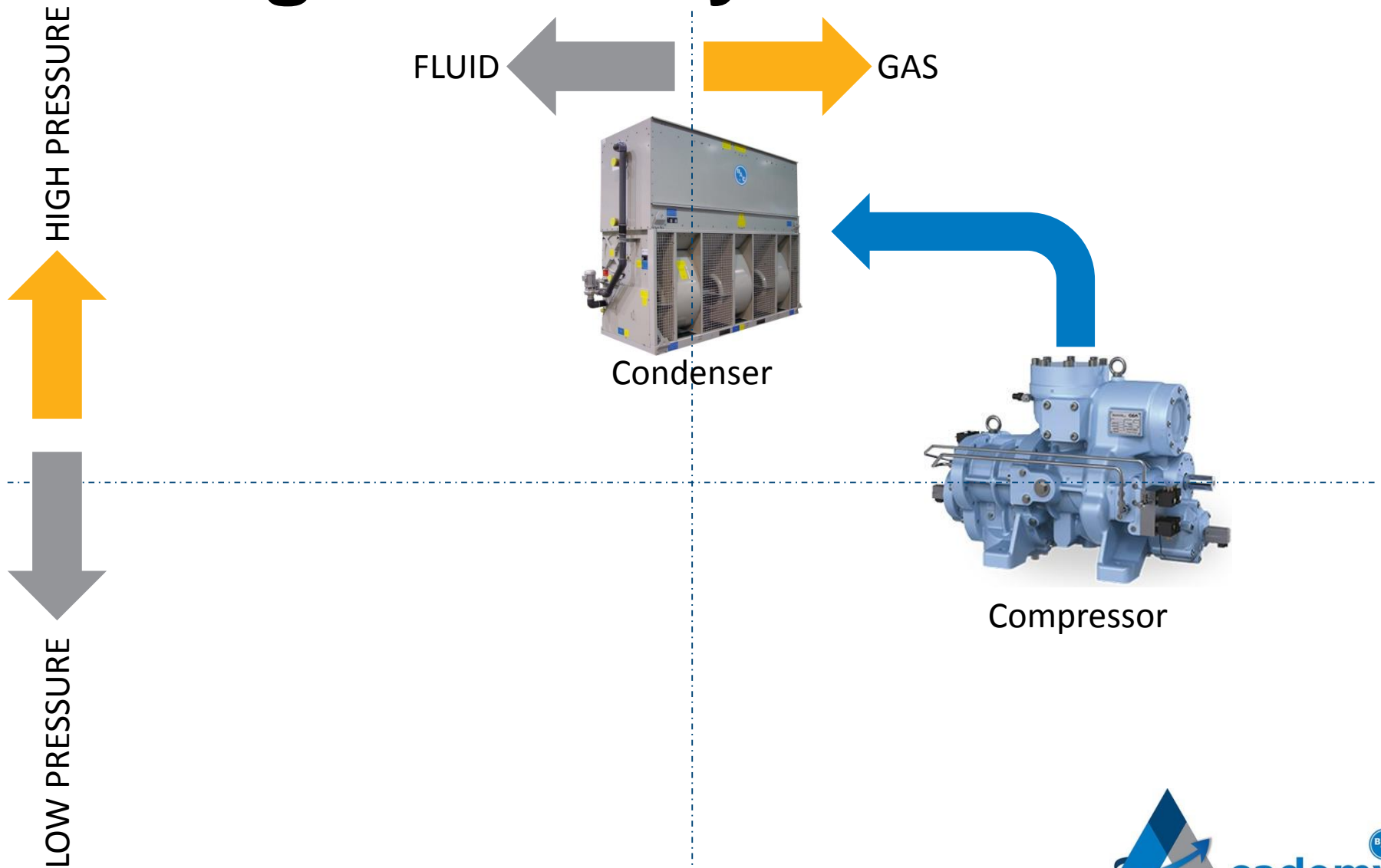


Refrigeration Cycle

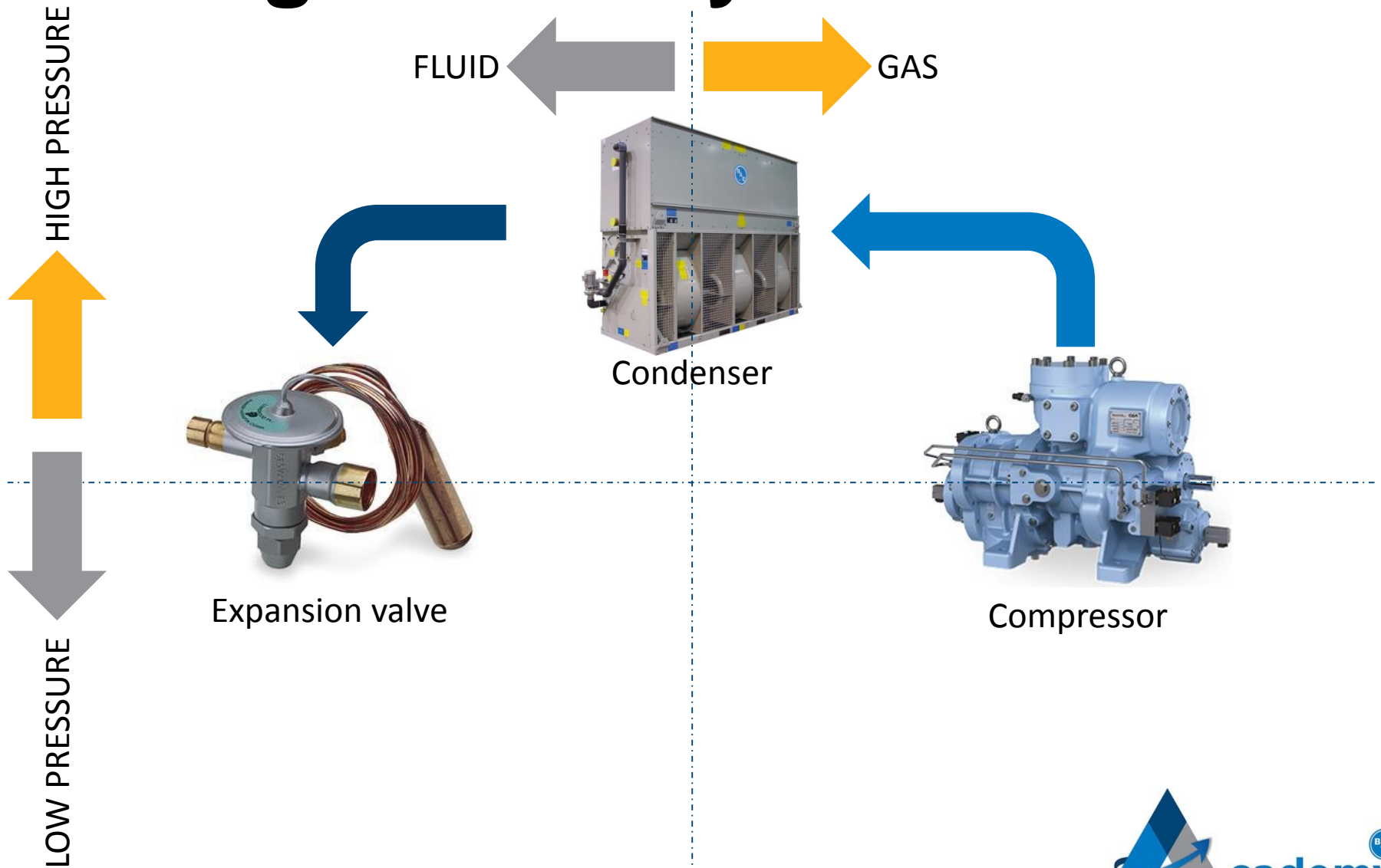


Compressor

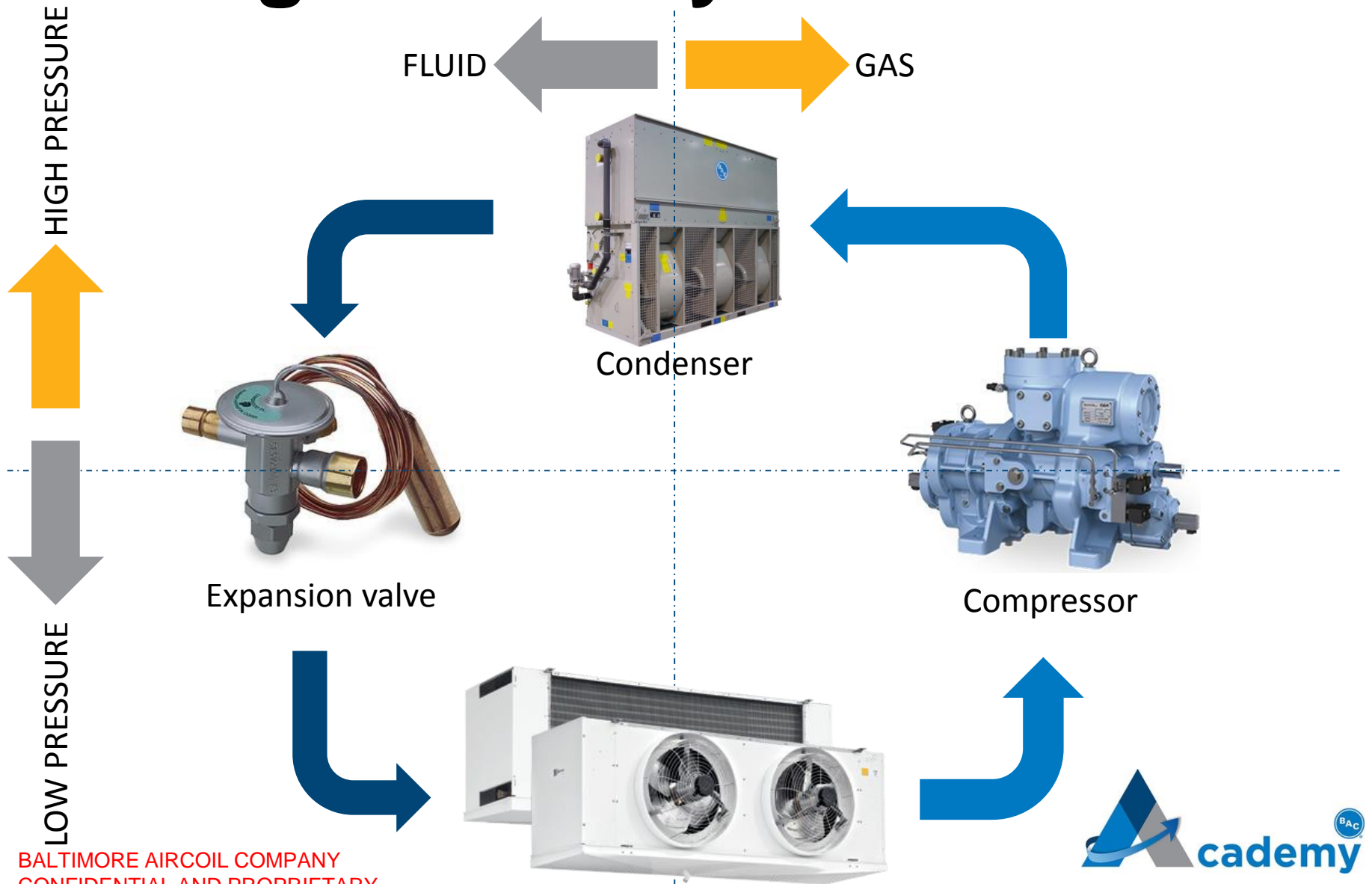
Refrigeration Cycle



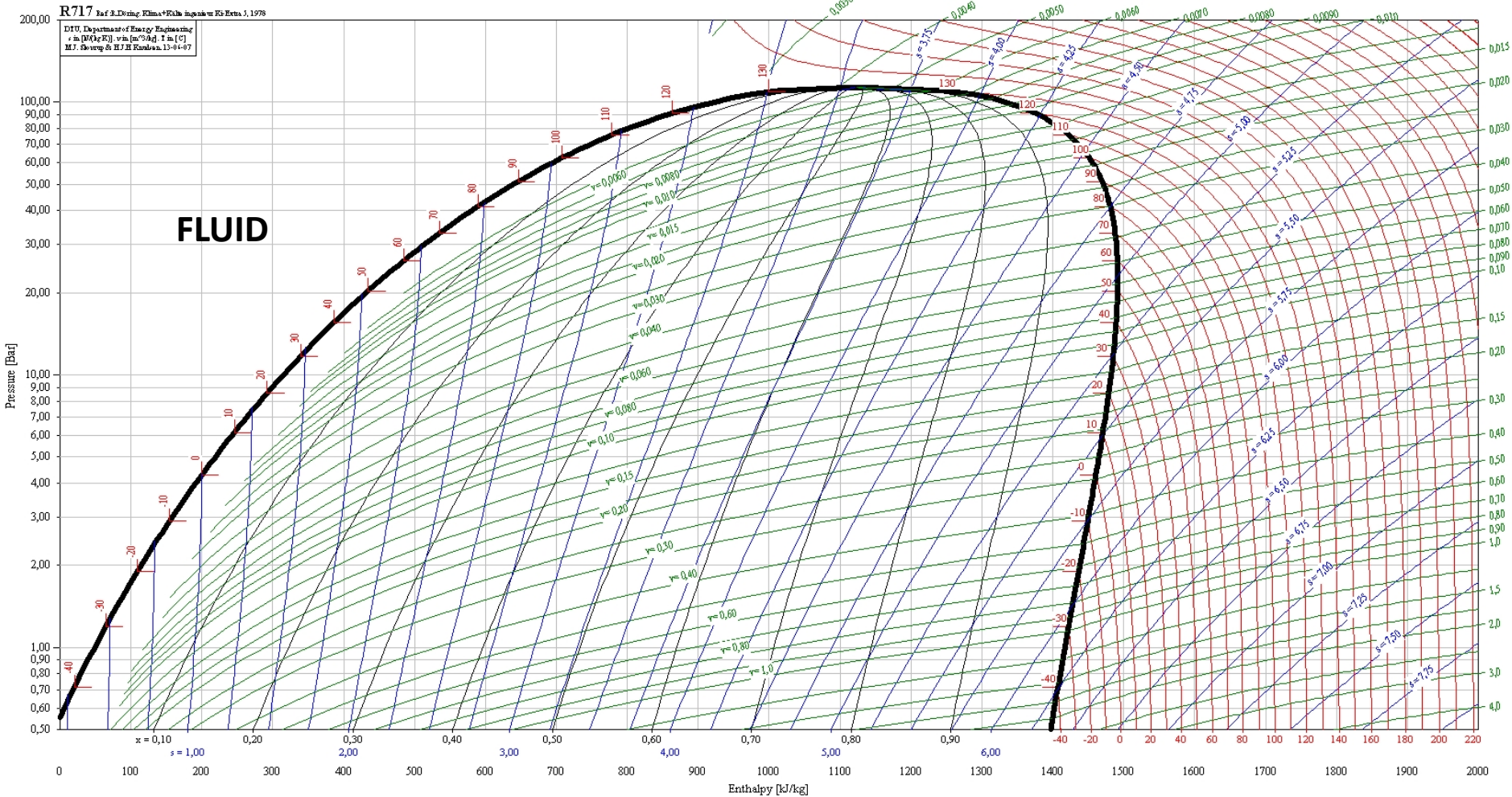
Refrigeration Cycle



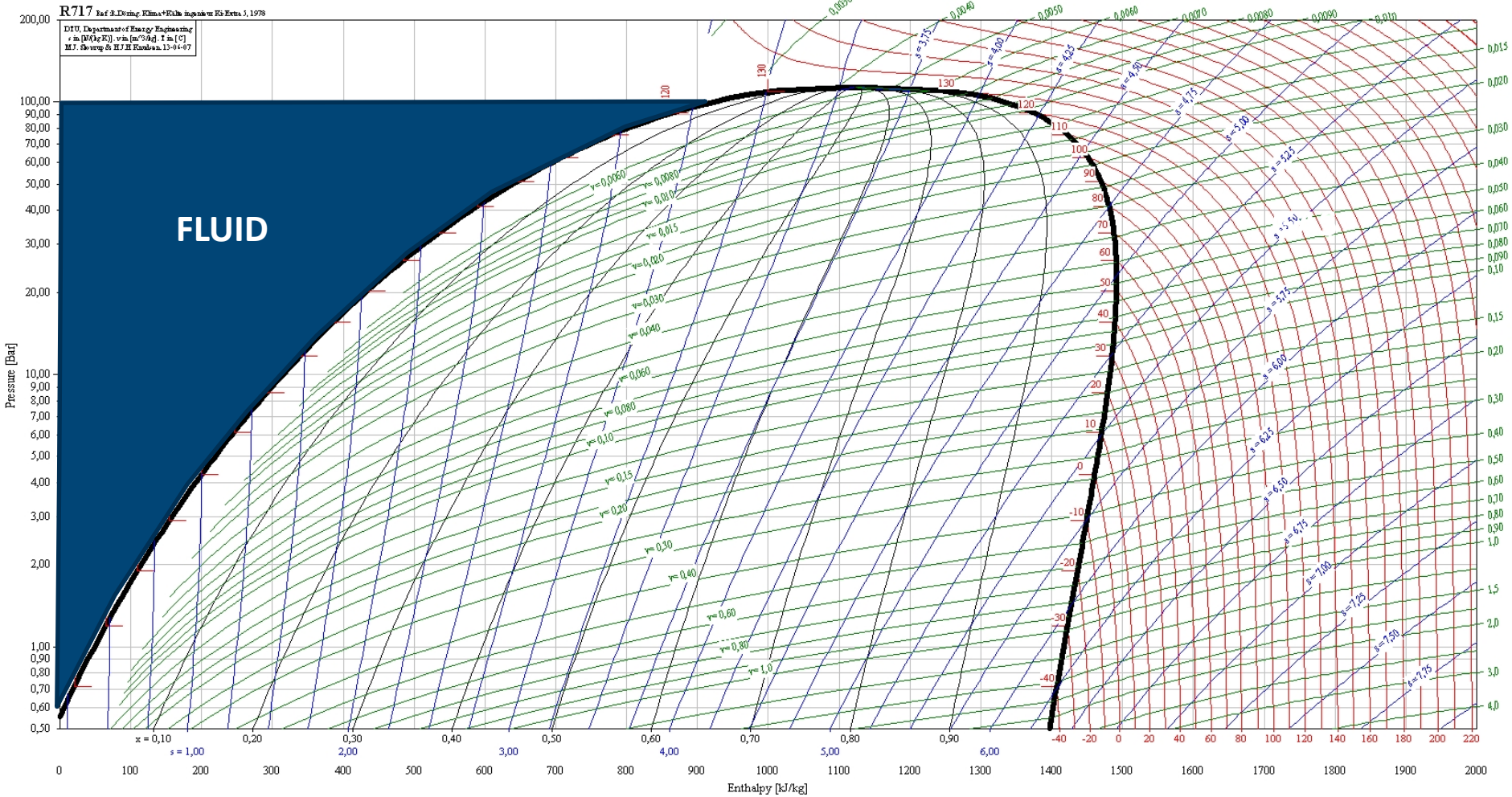
Refrigeration Cycle



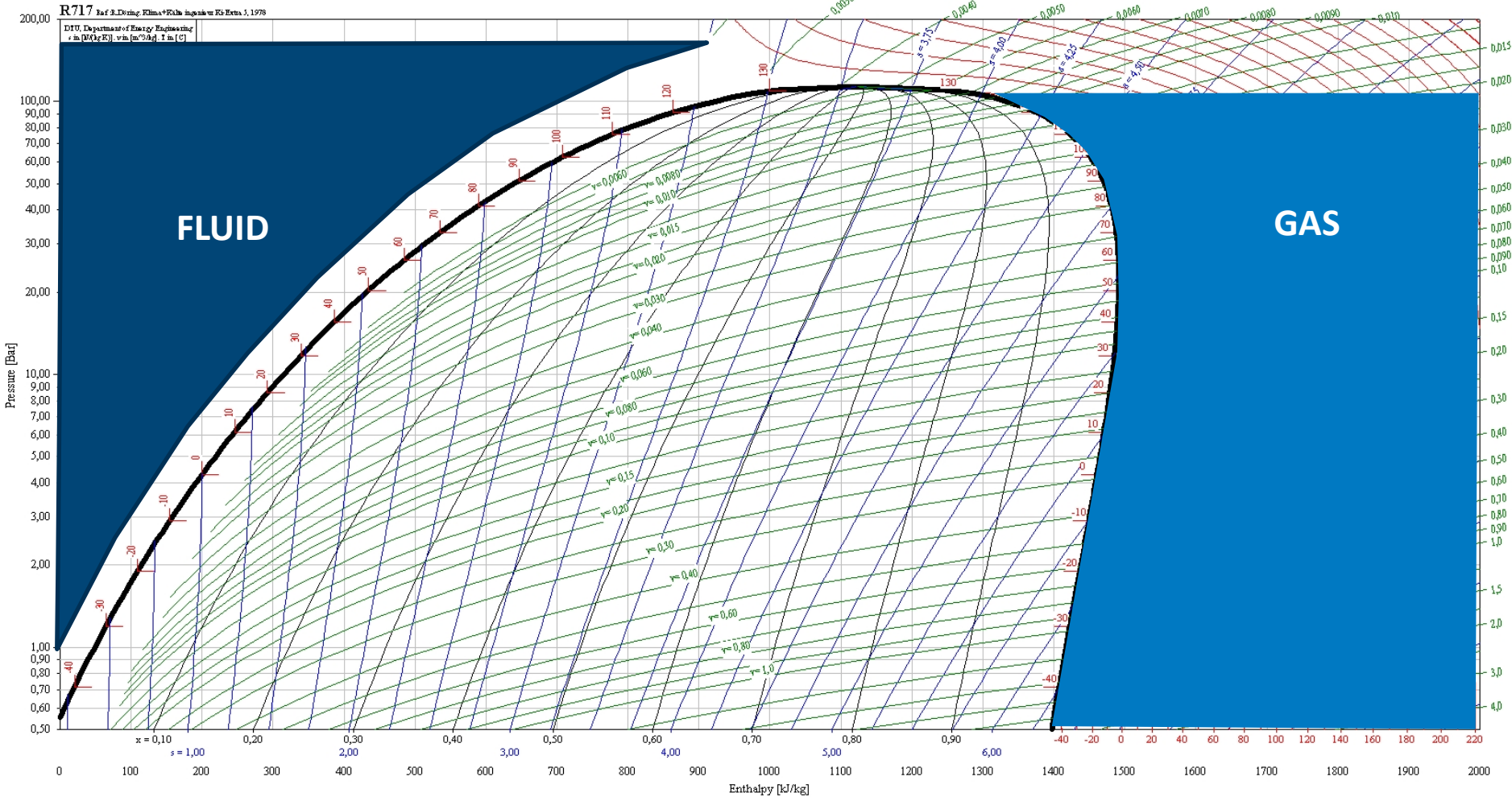
Psychrometric diagram



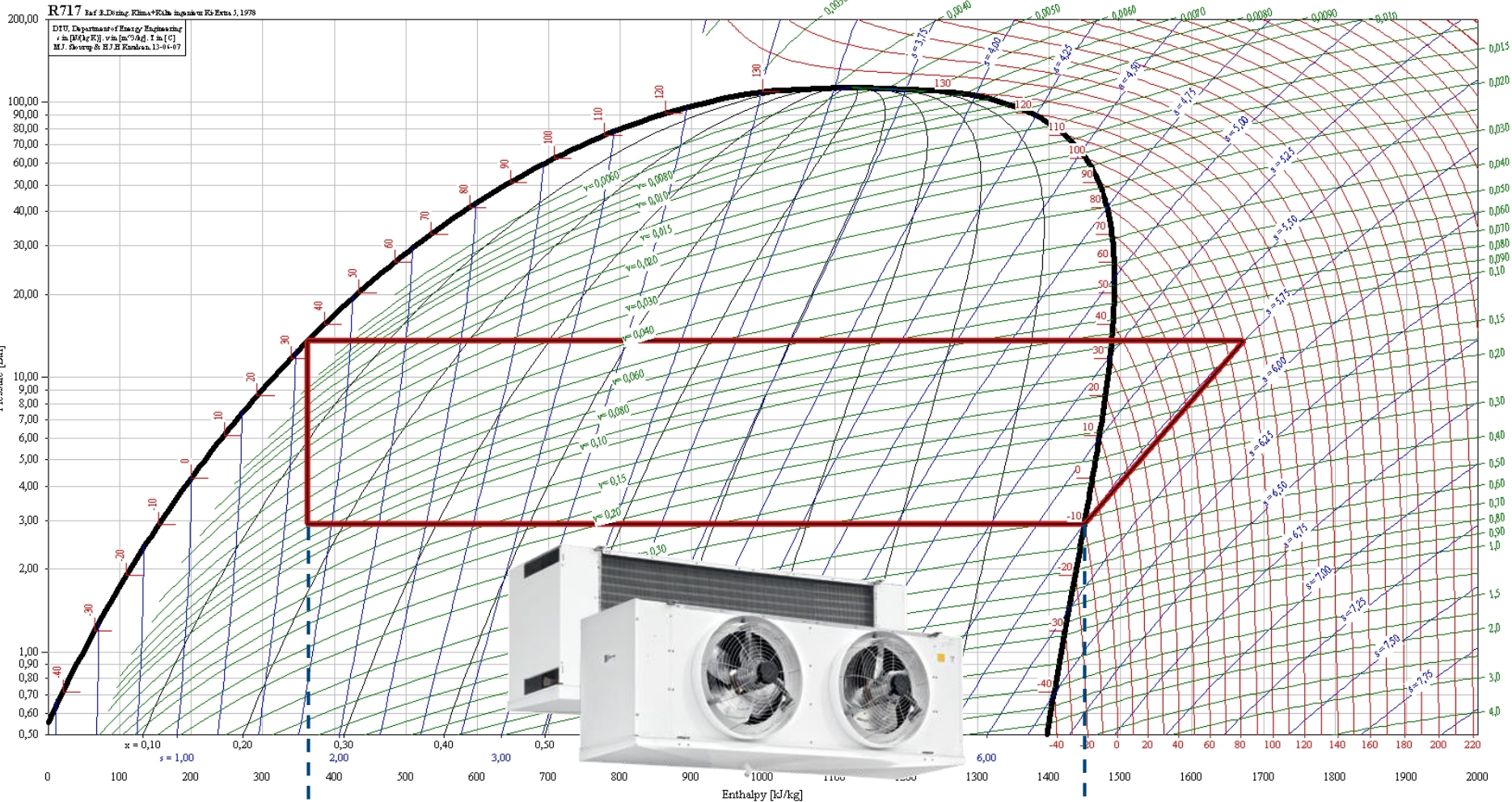
Psychrometric diagram



Psychrometric



Evaporator

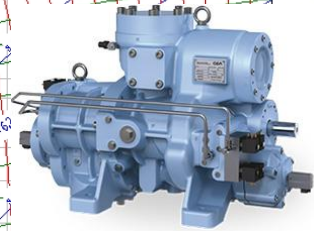
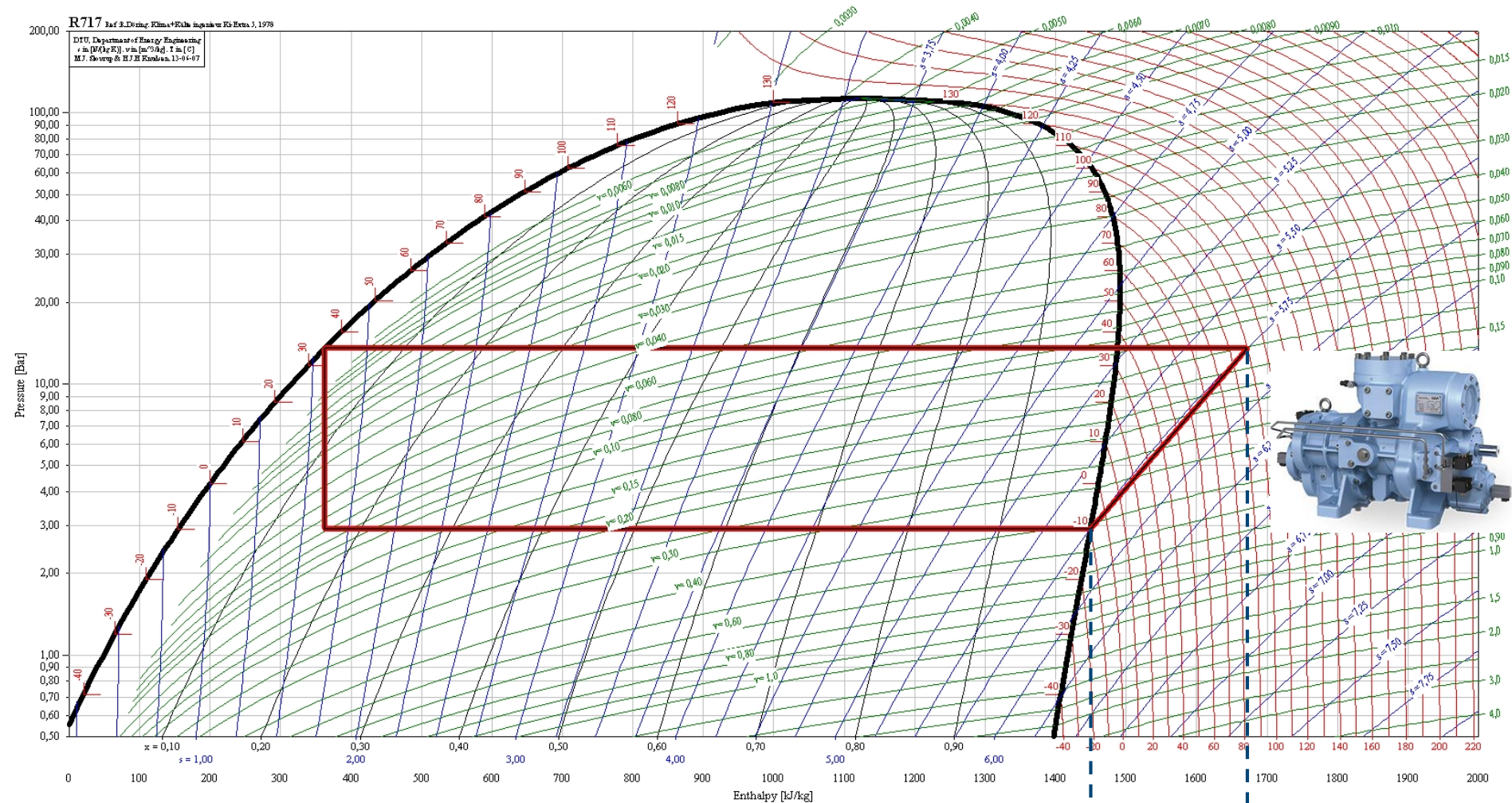


$$\text{evaporator capacity (kW)} = \Delta h \left(\frac{\text{kJ}}{\text{kg}} \right) \times \text{mass flow} \left(\frac{\text{kg}}{\text{s}} \right)$$

Compressor

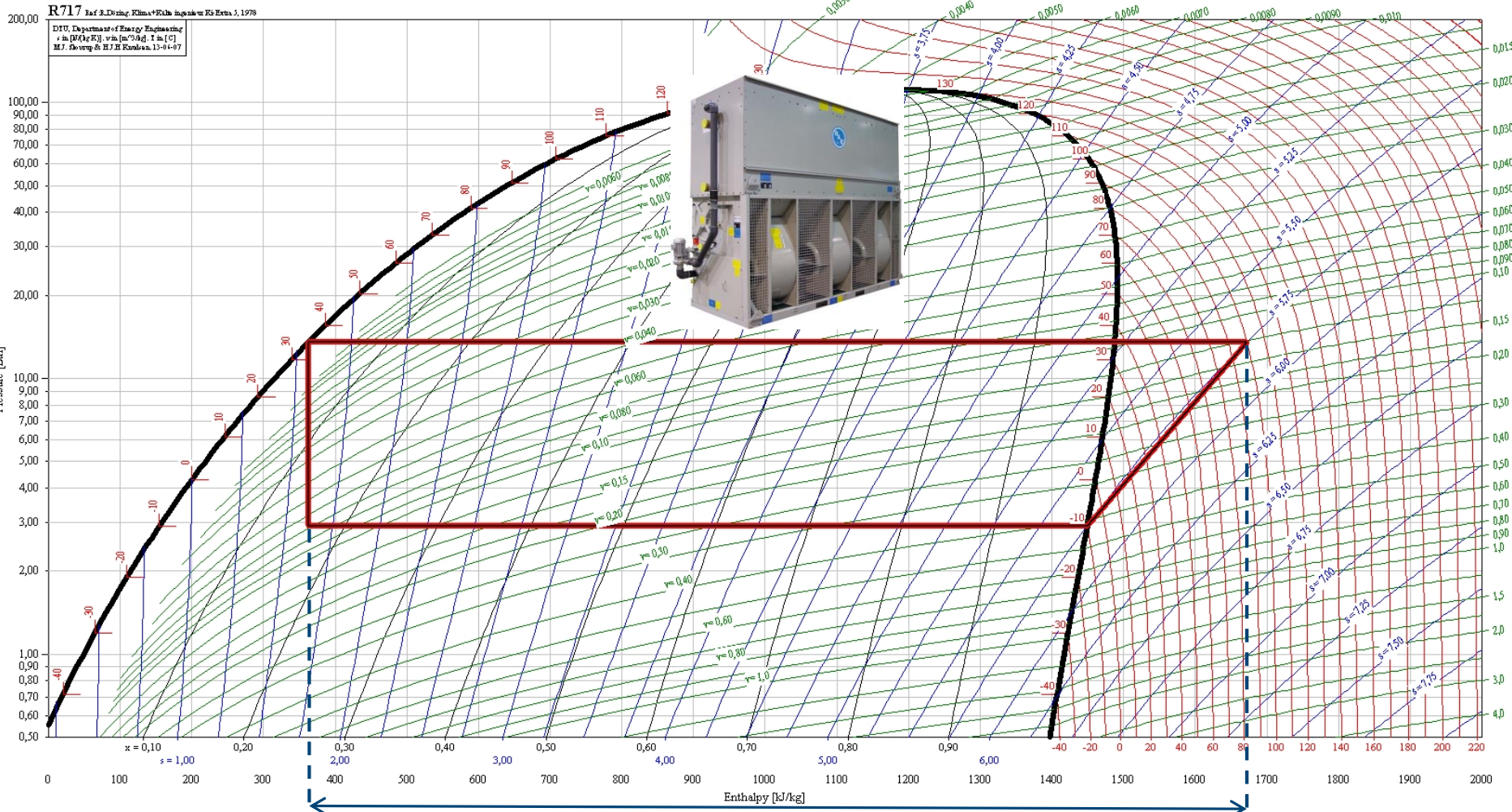
R717 Ref. 3. Design, Klima+Kälte magazine, 1978

DTU, Department of Energy Engineering
 s in [m³/kg], v in [m³/kg], T in [°C]
 M.T. Steing & R.T.H. Kunkela, 12-4-67



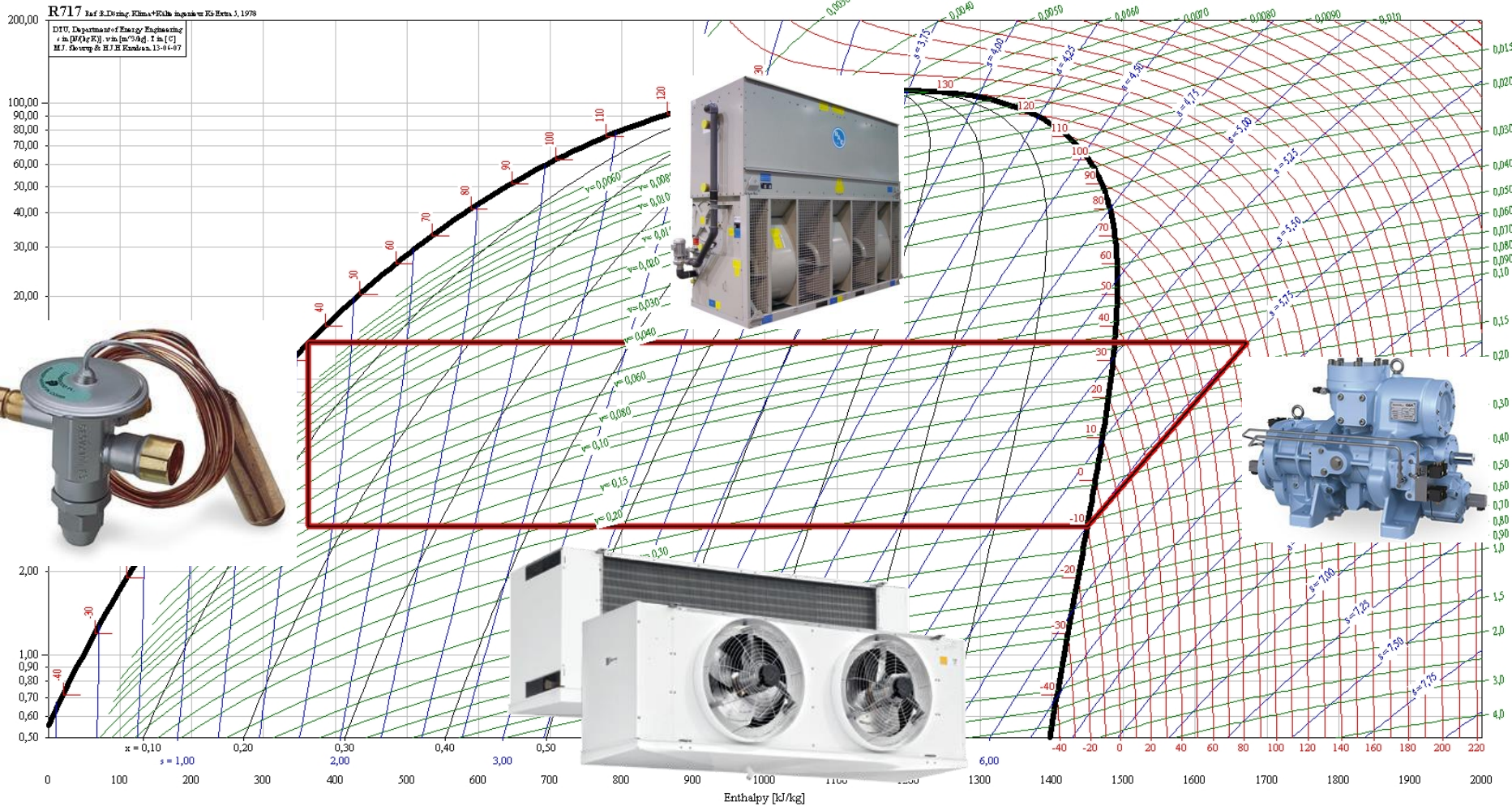
$$\text{compressor energy (kW)} = \Delta h \left(\frac{\text{kJ}}{\text{kg}} \right) \times \text{mass flow} \left(\frac{\text{kg}}{\text{s}} \right)$$

Condenser



$$\text{condenser capacity(kW)} = \text{evaporator capacity(kW)} + \text{compressore energy (kW)}$$

Refrigeration Cycle



condenser capacity = evaporator capacity + compressor energy

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Exercise (solutions)

Consider mass flow = 1kg/s

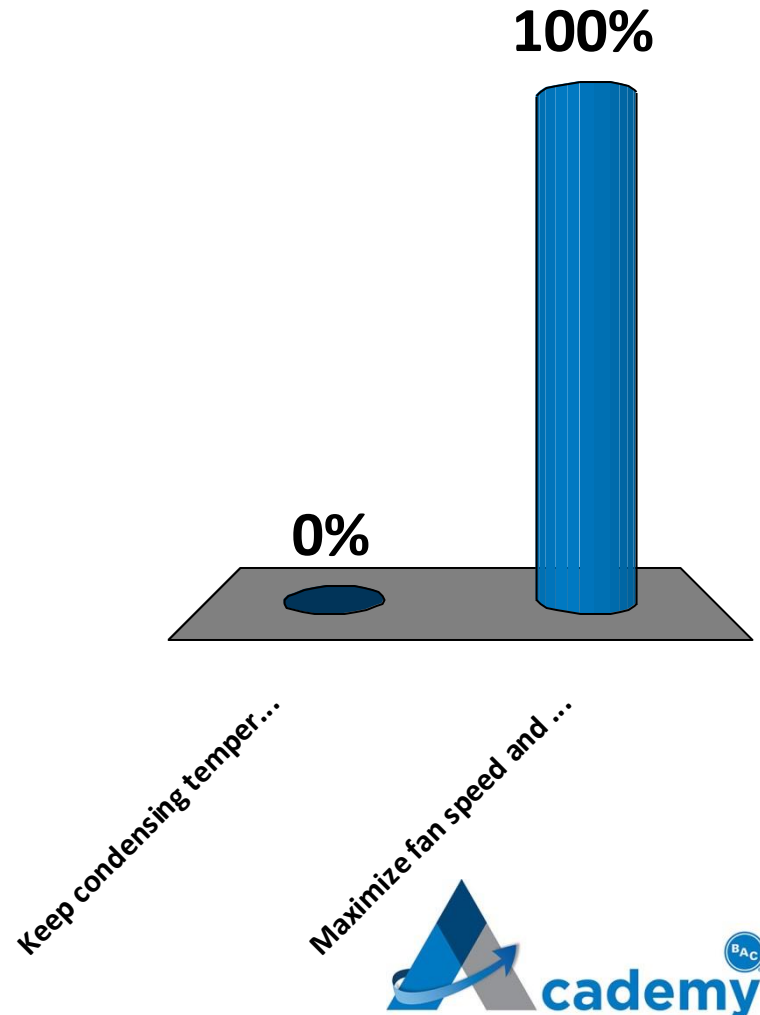
- ◆ $T(e) = -10^{\circ}\text{C}$
- ◆ $T(c) = 35^{\circ}\text{C}$
- ◆ $Q(e) = 1086,7\text{kJ/kg} \rightarrow 1086,7\text{kW}$
- ◆ $Q(c) = 1309,7\text{kJ/kg} \rightarrow 1309,7\text{kW}$
- ◆ $W = 223\text{kJ/kg} \rightarrow 223\text{kW}$

Condenser selection ($w_b=21^{\circ}\text{C}$): VXC S328

- ◆ Fan motor: 30kW
- ◆ Pump motor: 2,2kW

Which operating strategy results in the lowest operational cost?

- A. Keep condensing temperature constant and vary the fan speed
- ✓ B. Maximize fan speed and lower the condensing temperature



Condenser operation strategy

$$COP = \frac{\text{condenser capacity (kW)}}{\text{compressor energy (kW)}}$$

Low condensing pressure/temperature



Low compressor energy



HIGH COP



Maximize fan speed!