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The Influence of the Accumulator and Internal Heat Exchanger Design as separate and combined Components on the System Behavior of a R744 A/C System

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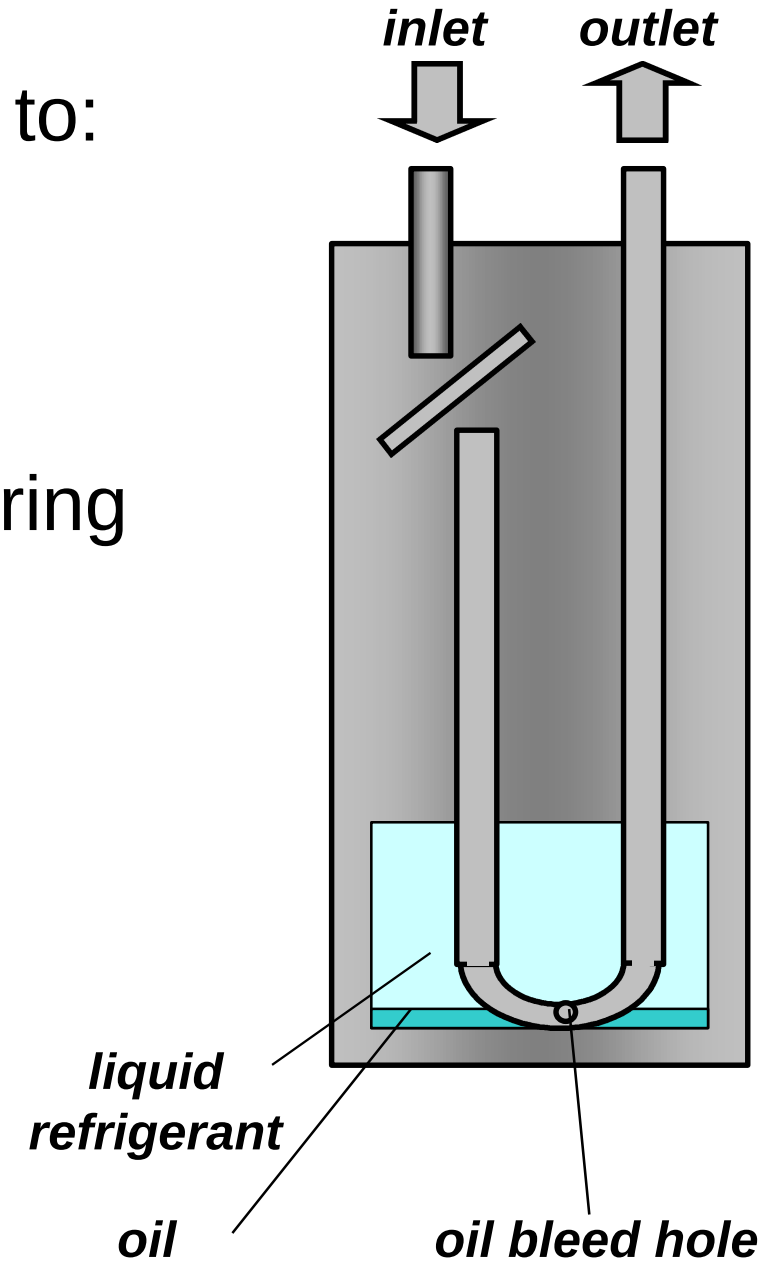
Accumulator - functions

- Store non-active refrigerant due to:
  - changing operating conditions
  - changing ambient conditions
  - leakage protection
- Reduce equilibrium pressure during high load conditions
- Ensure oil return to compressor
- Separate liquid and gaseous refrigerant during load changes



Accumulator – influence of control strategy

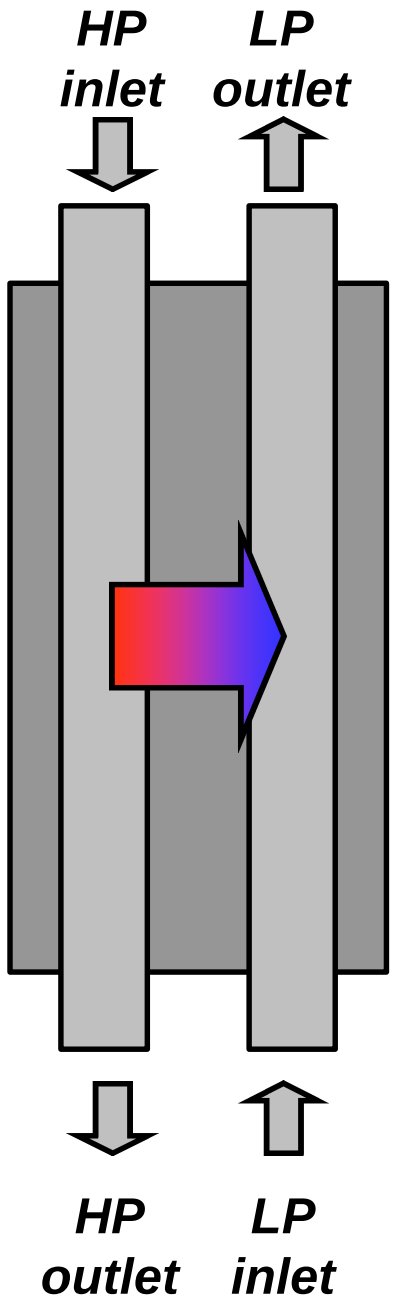
	EXV-system	Orifice tube system
45°C	370 g	370 g
30°C	292 g	289 g
20°C	323 g	255 g
5°C	361 g	212 g

Accumulator – required storage volume

	EXV-system	Orifice tube system
Maximum charge in accu	70 ml	150 ml
Condition	25°C	5°C
Leakage protection	to be added	to be added

Internal heat exchanger - functions

- Transfer heat from high pressure side to low pressure side
- Enhance system performance at high ambient temperatures
- Reduce required high pressure for optimum COP at medium ambient temperatures
- Increase COP at low and medium ambient temperatures

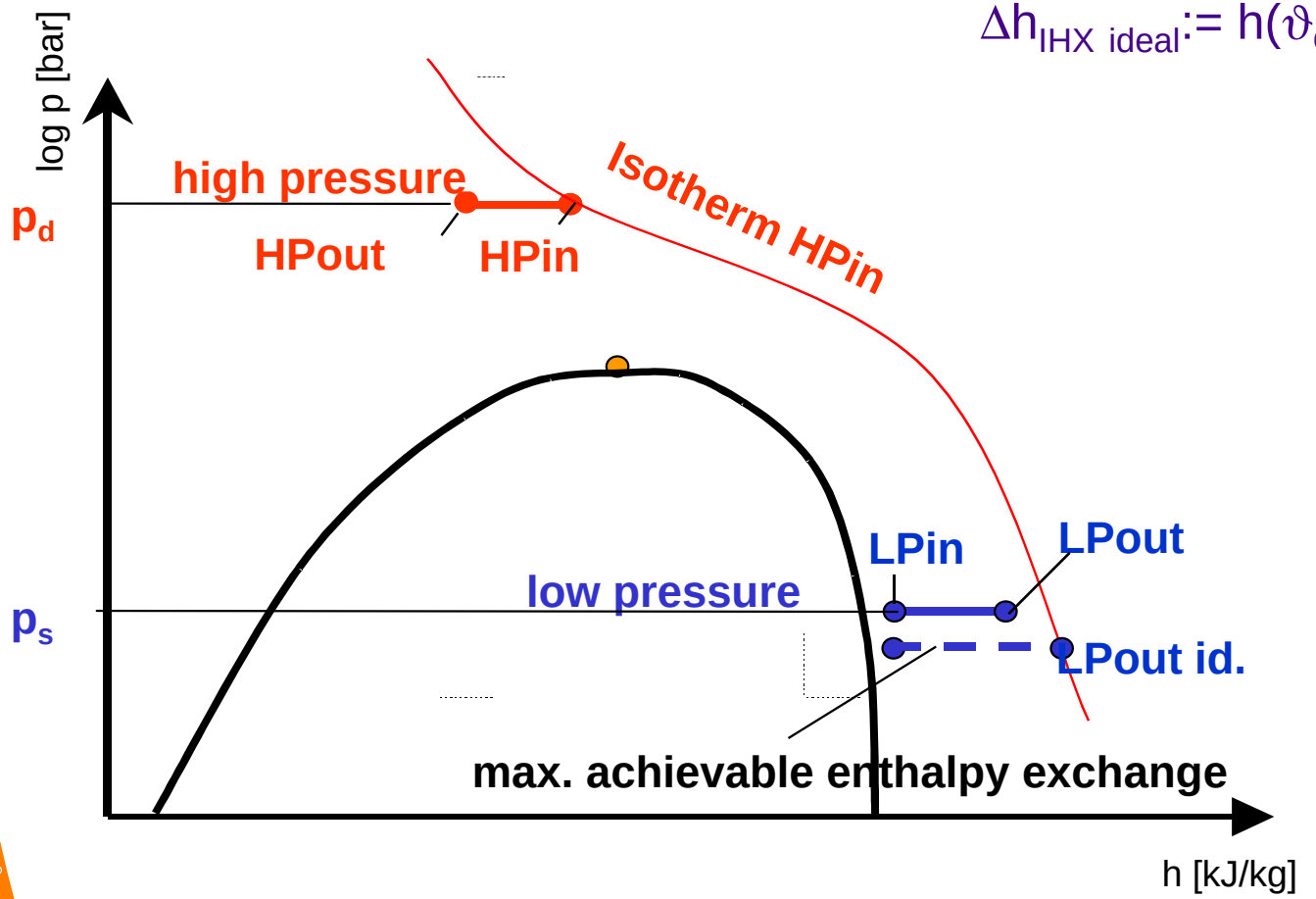


Internal heat exchanger - efficiency

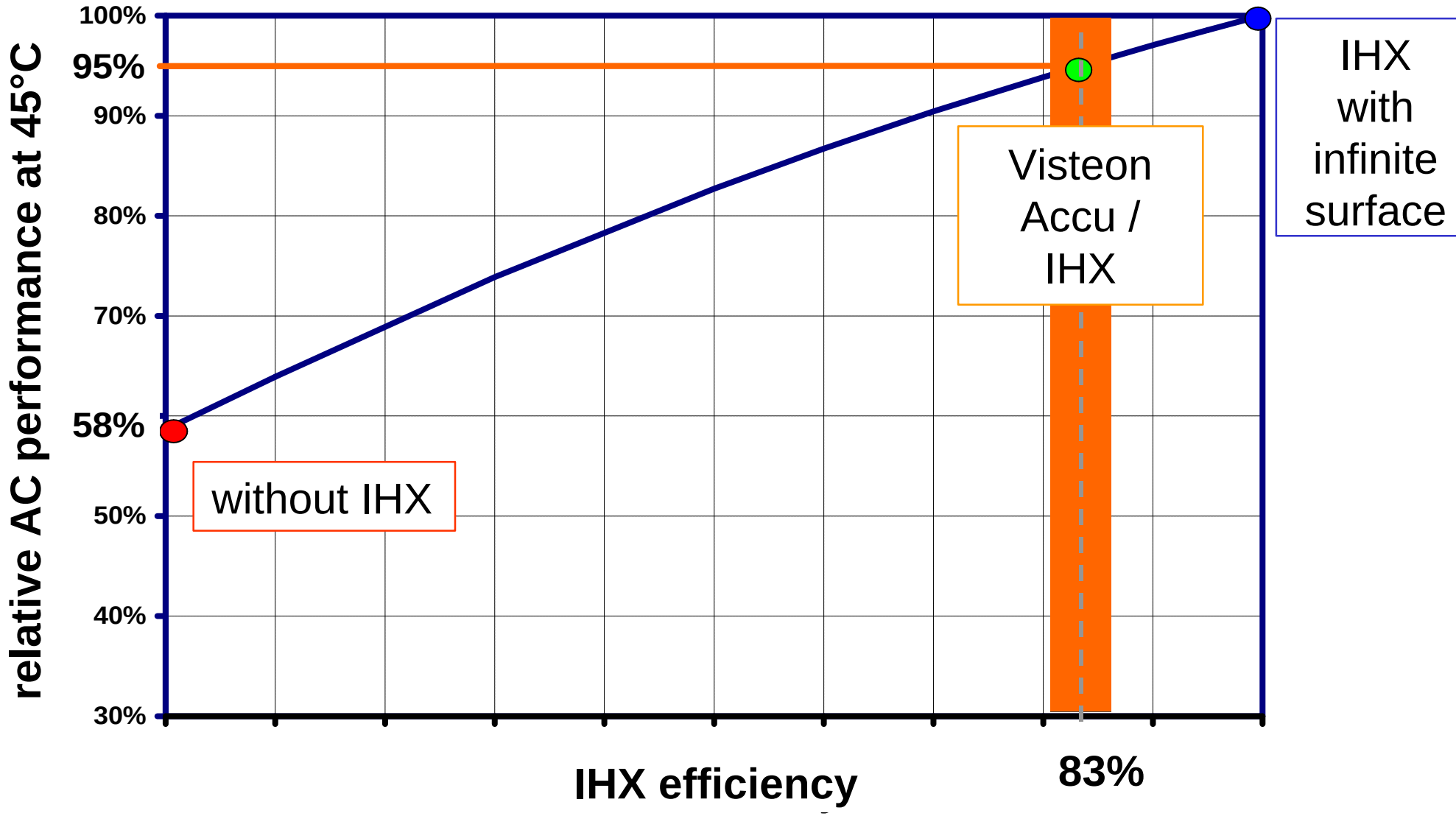
IHX efficiency:

$$h_{IHX} := \frac{Dh_{IHX\ real}}{Dh_{IHX\ ideal}}$$

$$\Delta h_{IHX\ ideal} := h(\vartheta_{GCout}, LP) - h(\vartheta_{IHX\ LPin}, LP)$$

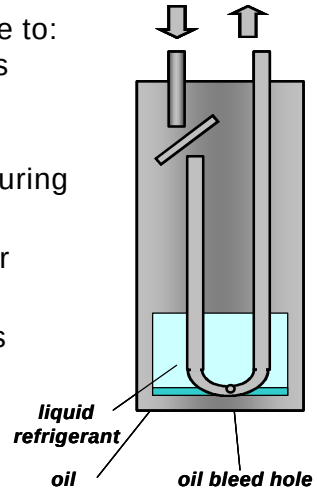


Internal heat exchanger - efficiency

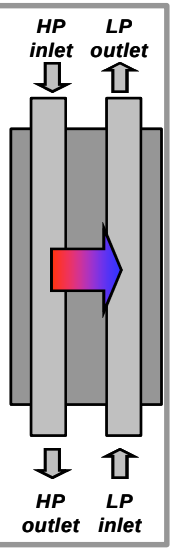


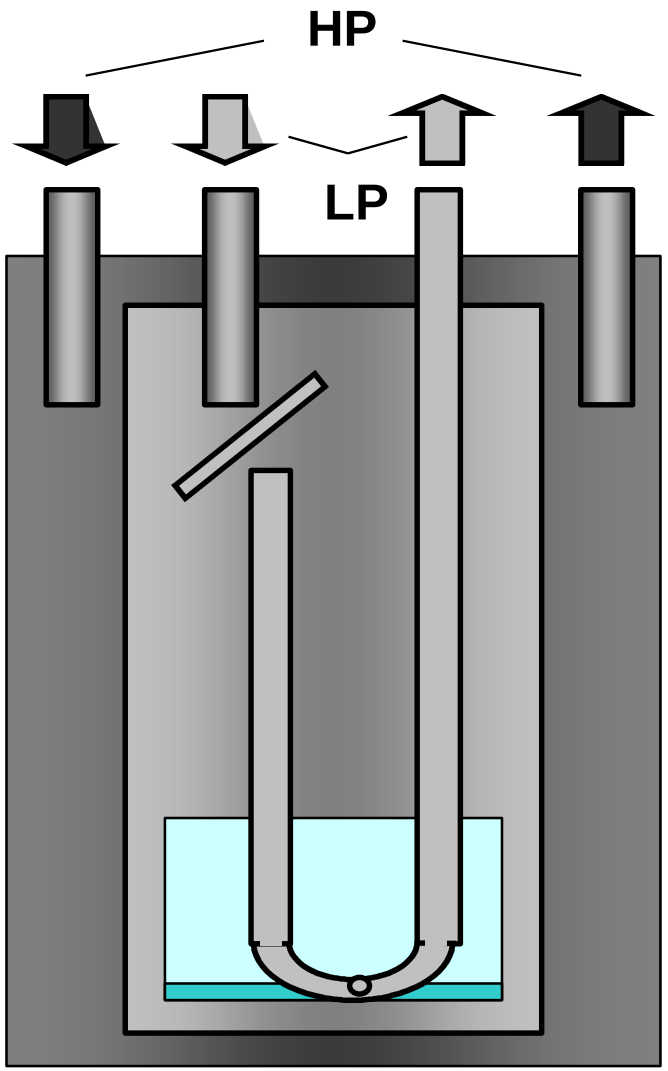
Combined component - functions

- Accu:
  - Store non-active refrigerant due to:
    - changing operating conditions
    - changing ambient conditions
    - leakage protection
  - Reduce equilibrium pressure during high load conditions
  - Ensure oil return to compressor
  - Separate liquid and gaseous refrigerant during load changes



- IHX:
  - Transfer heat from high pressure side to low pressure side
  - Enhance system performance at high ambient temperatures
  - Reduce required high pressure for optimum COP at medium ambient temperatures
  - Increase COP at low ambient temperatures





- Combined component:
  avoid influence of heat transfer into accumulator

Validiation heat transfer into accumulator

Validation of risk that heat transfer from HPside evaporates Accu charge

Assumption:
Accu charge is
completely evaporated!

- during transcritical operation the evaporated refrigerant causes significant higher discharge pressure
- AC system operates with decreased COP

EXV-system

p_s =	35 bar
p_d =	80 bar
$t_{GC,Out}$ =	33°C
m_{Accu} =	78 g
COP =	2,59

EXV-system + heat transfer into Accu

p_s =	35 bar
p_d =	130 bar
$t_{GC,Out}$ =	33°C
m_{Accu} =	0 g
COP =	1,86

Þ Avoid any heat transfer in Accu for max COP

Requirements for combined accu / ihx

for EXV system	for Orifice tube system
Accumulator storage volume needed at	
25 °C 70 ml + charge protection	5 °C 150 ml + charge protection
Internal heat exchanger performance is needed at high ambient temperatures	
Heat transfer from IHX into Accu should be minimized to achieve maximum COP	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