

EKC 313 – a Dedicated Cascade Controller



Customer benefits

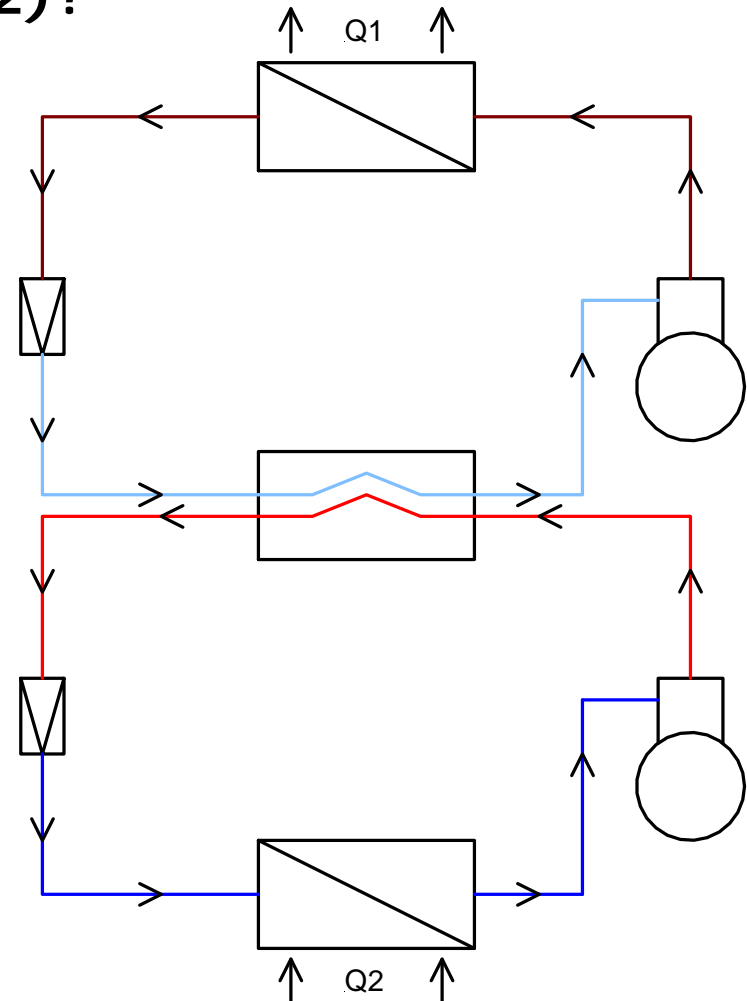
Enhancing flexibility and supporting sustainable solutions



- EKC 313 is a dedicated cascade controller developed for the sole purpose to control and optimize cascade systems.
- It brings you efficient control of a cascade heat exchanger being able to cope with the extreme temperature differences in the heat exchanger (between condenser and evaporator sides) particularly when running with CO₂ as refrigerant
- EKC 313 can run with two different refrigerants whereby you can choose the most efficient refrigerant for high and low temperature circuits in your specific system – could be CO₂ or a HFC or a combination
 - Low temperature circuit using refrigerant R744 (CO₂) can be designed as a standard 40 bar system where cheaper standard components can be used
- **Features: Applying ETS or CCM* valves, 2 AKS 2050 or 32R pressure transmitters. Lon communication as option**
 - *CCM 90 bar valve based on ETS**

What is a cascade system (1/2)?

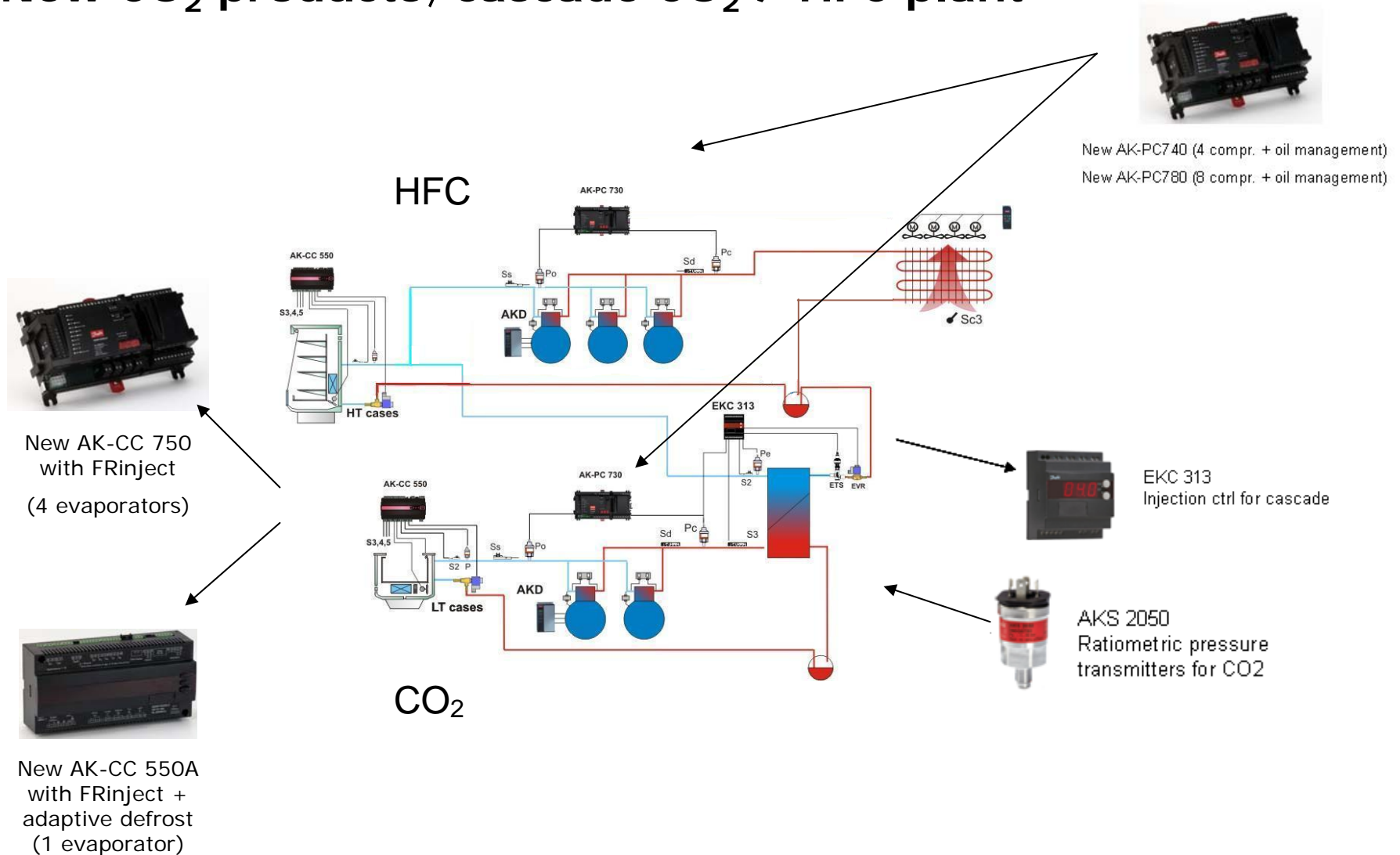
- A cascade system exchanges heat between two separate systems by applying a cascade heat exchanger. The heat exchanger transfers heat from one system to the other:
 - One side of the heat exchanger is used as a condenser – the low temperature circuit
 - The other side of the heat exchanger is used as an evaporator – the high temperature circuit (see sketch).



What is a cascade system (2/2)?

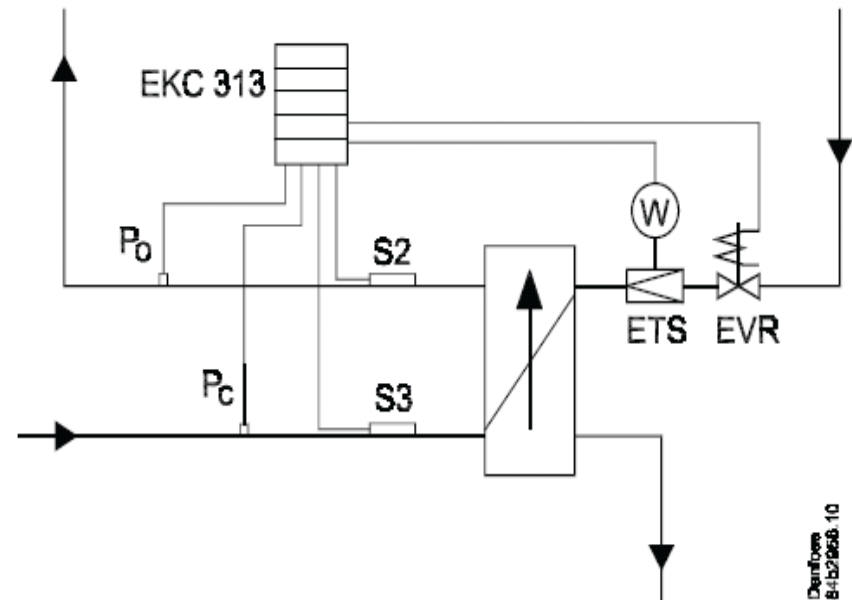
- A cascade system offers the possibility to use different refrigerants in the two circuits. For the low temperature circuit you can choose the refrigerant where the operating pressures in the cycle will be at a suitable level also for very low temperatures in the evaporator. This has an advantage in terms of the volumetric capacity for the low temperature circuit by reducing the dimensions of piping as well as the size of the low temperature compressor(s) compared with a more ordinary system using same refrigerant in both circuits
- The disadvantage of the cascade system is that additional temperature difference is introduced in order to exchange heat between the two circuits in the cascade heat exchanger hence the condensing temperature of the low temperature stage must be higher than the evaporator temperature of the high temperature circuit

New CO₂ products; cascade CO₂ / HFC plant



EKC 313; controlling the cascade heat exchanger

- Controls the cascade heat exchanger with ETS valve, two pressure transmitters and two AKS 11 temperature sensors
- **Handles 2 different applications**



EKC 313; application modes

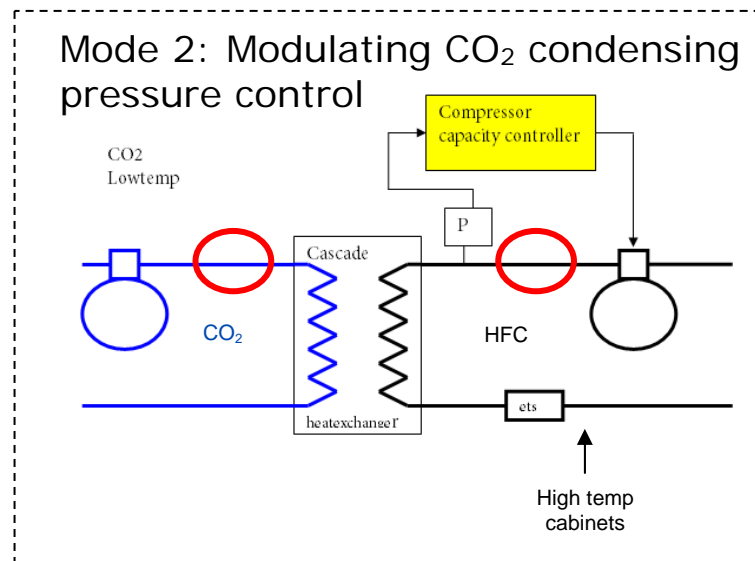
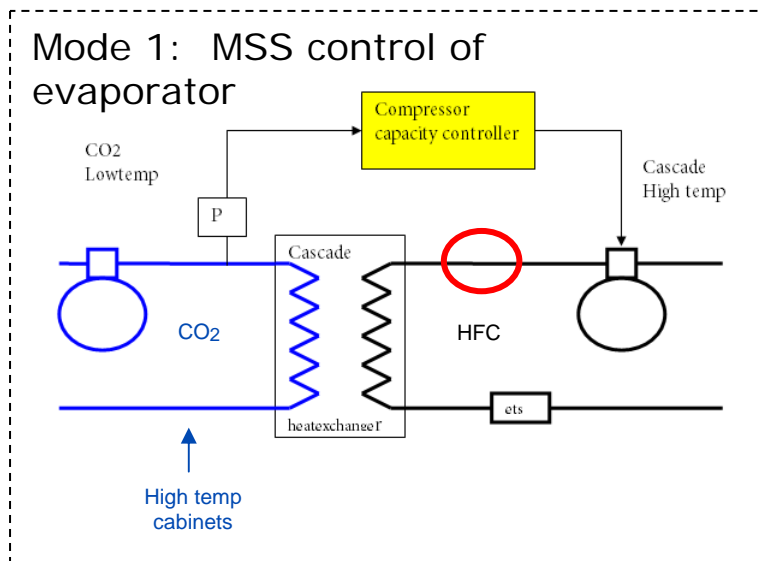
Application:

Control of cascade heat exchangers in CO₂ systems

- The cascade could be subcritical as well as trans-critical
- The cascade could be based on HFC as well as CO₂
- Can use ETS, AKV, ICMT and 3rd party 0-10V servo actuators

The EKC 313 have 2 control modes:

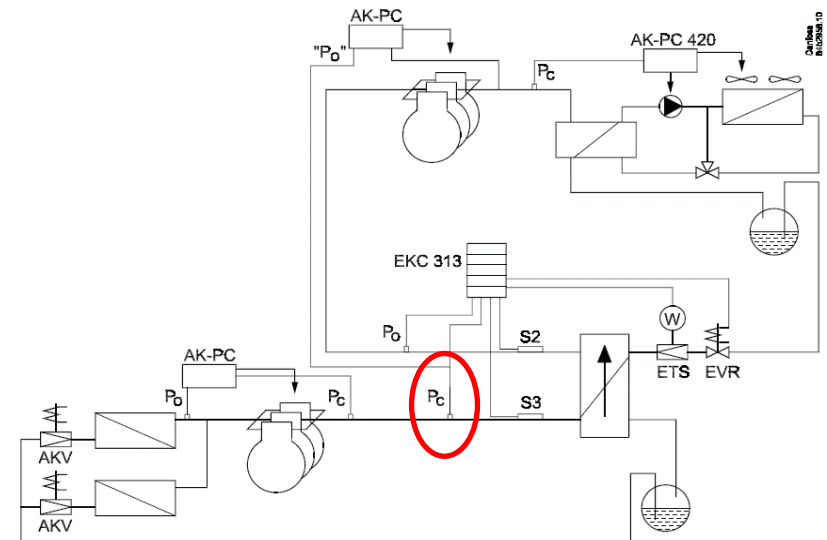
- Application mode = 1: Optimized superheat control on the HFC side.
CO₂ condensation pressure is controlled by the compressor control of the HFC system.
- Application mode = 2: Modulating CO₂ condenser pressure control.
Regulating according to T_c reference and secure SH min. of 10K on the HFC side



EKC 313; application 1

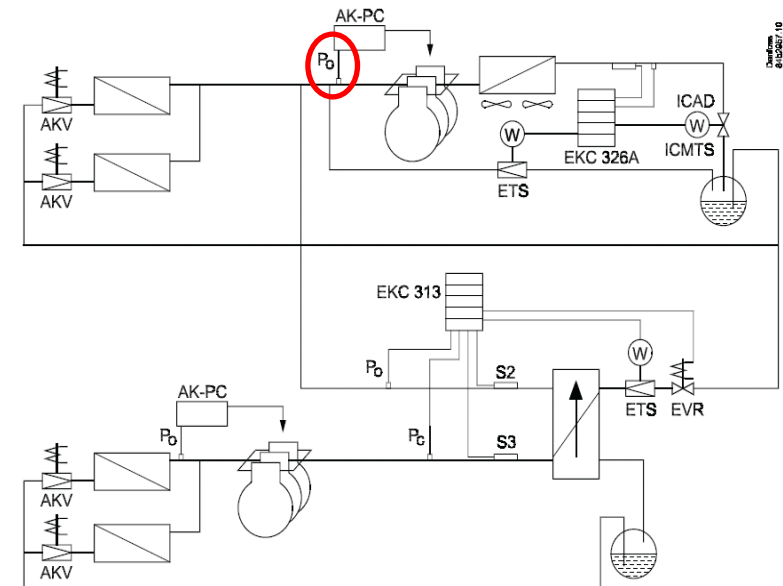
- The pressure transmitter setting the capacity for the HT pack is placed on the ***condenser*** side of the cascade heat exchanger
- Application 1 should be chosen if the AK-PC xxx uses Pctrl.* This is often the case with CO₂ pump systems or combined pump on MT and DX on LT
- Superheat ref. is calculated from Po and S3 sensors (higher superheat at high S3)

*Pctrl. capacity control sensor
placed on opposite side of cascade
heat exchanger



EKC 313; application 2

- The pressure transmitter setting the capacity for the HT pack is placed on the **evaporator** side of the cascade heat exchanger
- If the AK-PC xxx uses Po application 2 should be chosen
- This is often the case with combined HFC/HC systems on MT and CO₂ DX on LT
- Superheat ref. is calculated from Po and S3 sensors (higher superheat at high S3)
- EKC313 is controlling PC on the LT CO₂ system



Application examples with EKC 313

Basic cascade CO₂ - 35/-5° C and HFC -10/35° C

Application mode 1

Advantage of EKC 313 in relation to the previous used EKC 316 / 312 / 315A for this type of application

EKC 313:

Dedicated injection algorithm which is able to handle the extreme temperature difference across the PHE

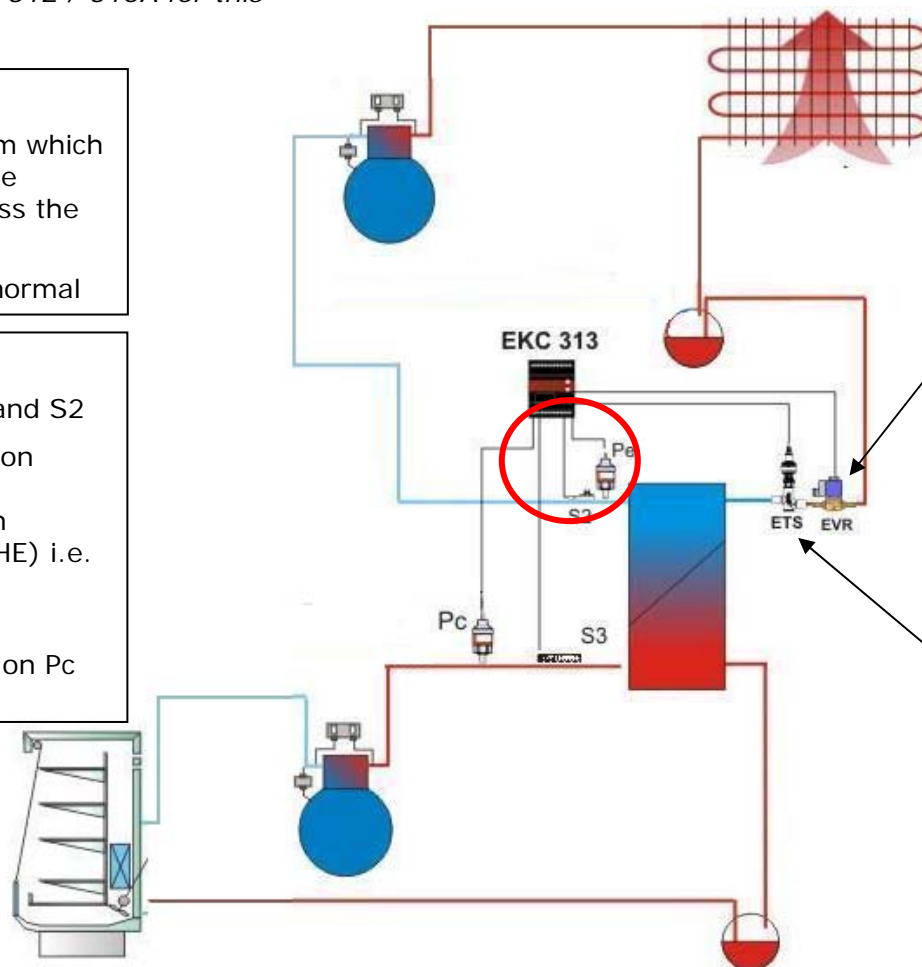
Δt_m of 60 to 80 K is quite normal

EKC 313 :

- Superheat control with P_e and S_2

- Superheat reference adaption according to discharge temperature S_3 and suction pressure P_e (Δt_m across PHE) i.e. higher superheat at high S_3
($SH_{ref} = (S_3 - P_e) \times \frac{1}{2}$)

- Direct ETS OD% response on P_c variation



EVR shut off at :

- Power failure
- EKC 313 signal to ETS is OD% = 0

ETS :

- Modulating injection 5-100% capacity

Basic cascade CO₂ - 35/-5° C and HFC -10/35° C

Application mode 2

Advantage of EKC 313 in relation to the previous used EKC 316 / 312 / 315A for this type of application

EKC 313:

Dedicated injection algorithm which is able to handle the extreme temperature difference across the PHE

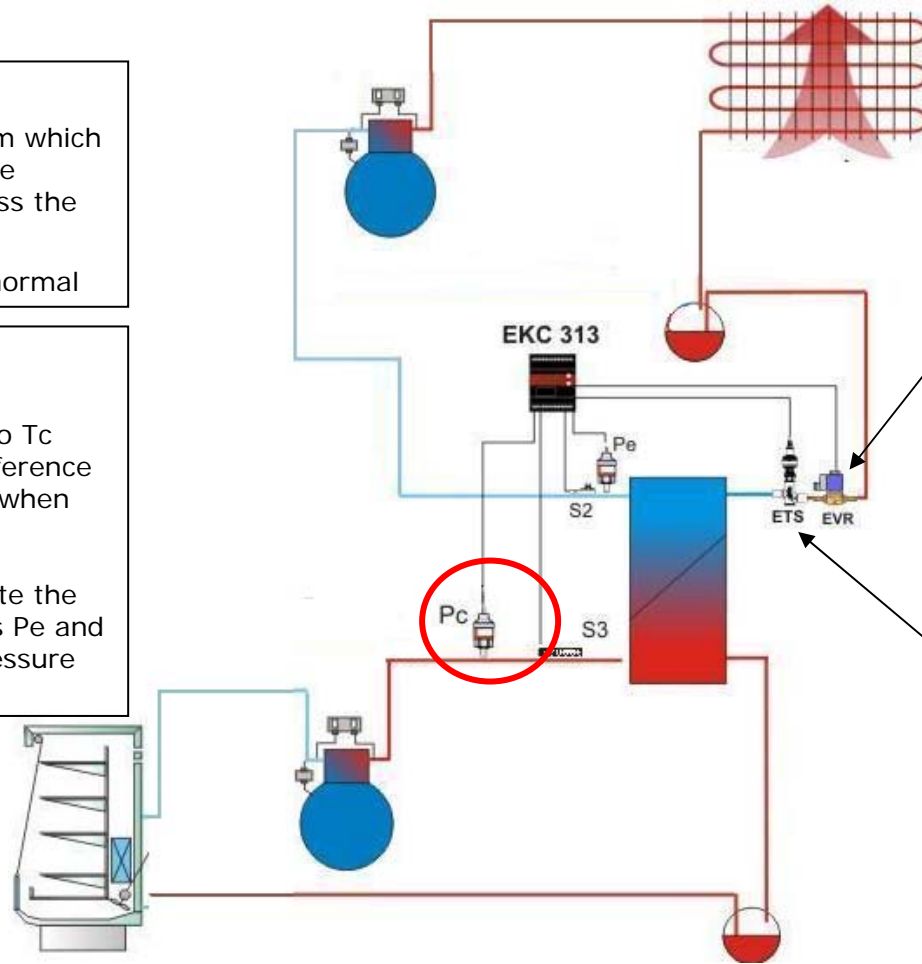
Δt_m of 60 to 80 K is quite normal

EKC 313 :

Modulating CO₂ condensing pressure control according to Tc reference parameter n98 reference for Tc regulation used only when p44 is set to 2.

Restrictor function :

Dedicated algorithm eliminate the risk of overflow with sensors Pe and S2 during modulating Tc pressure control



EVR shut off at :

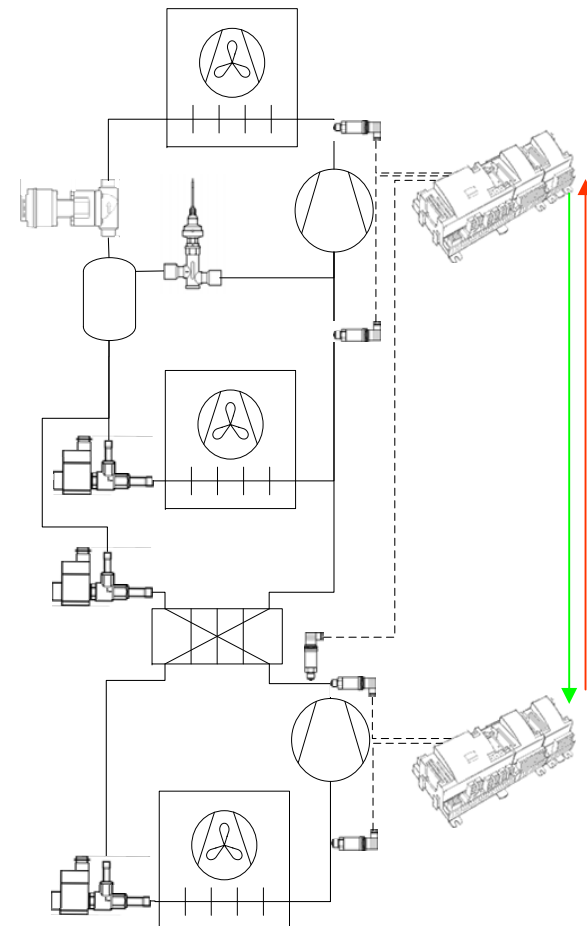
- Power failure
- EKC 313 signal to ETS is OD% = 0

ETS :

- Modulating injection 5-100% capacity

Cascade controls; coordination of HT and LT compressor start

- Monitoring suction pressure and controlling cascade high pressure
- Coordinating start and stop of HT and LT compressors
 - High pressure/Low pressure compressor release
 - High pressure/Low pressure compressor control



Cascade CO₂ / HFC plant with dry cooler

Example:

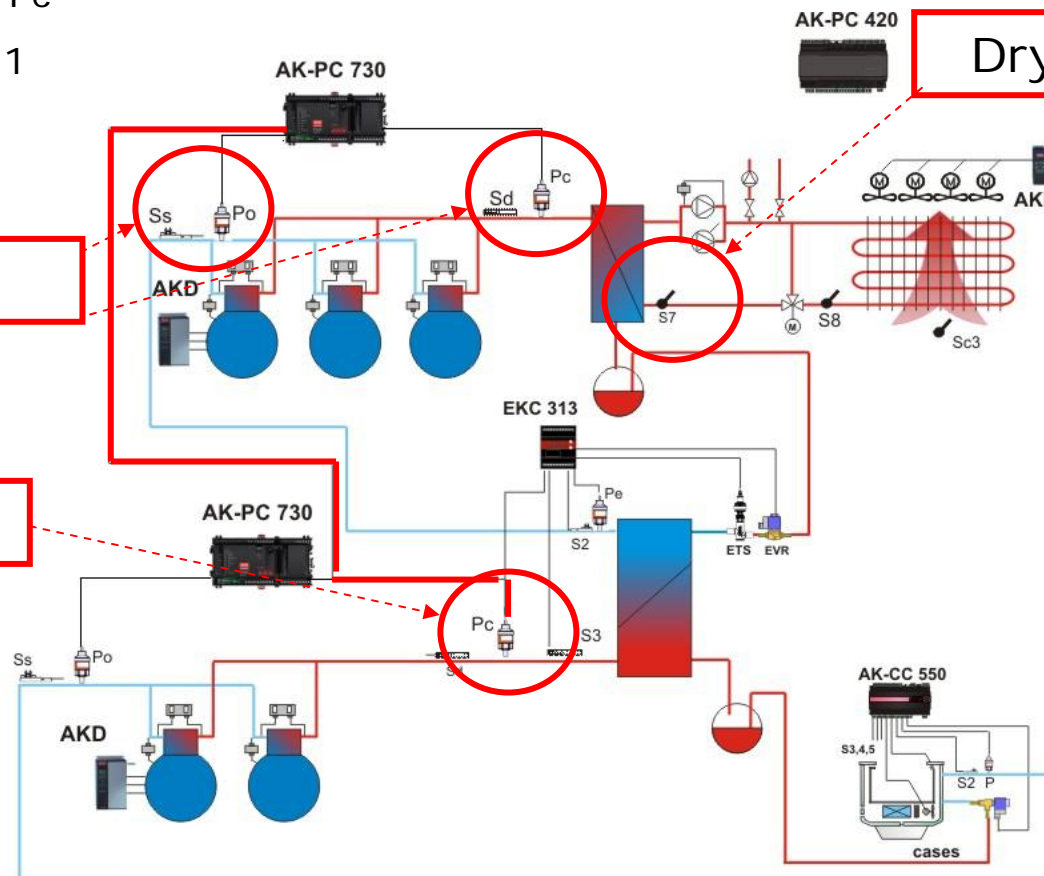
HT pack controls LT
discharge pressure Pc

EKC in Appl. mode 1
parameter p44 = 1

HT Pack Safety

HT Pack Po sensor

Dry cooler sensor



HT
-10/35° C
HFC
<10kg

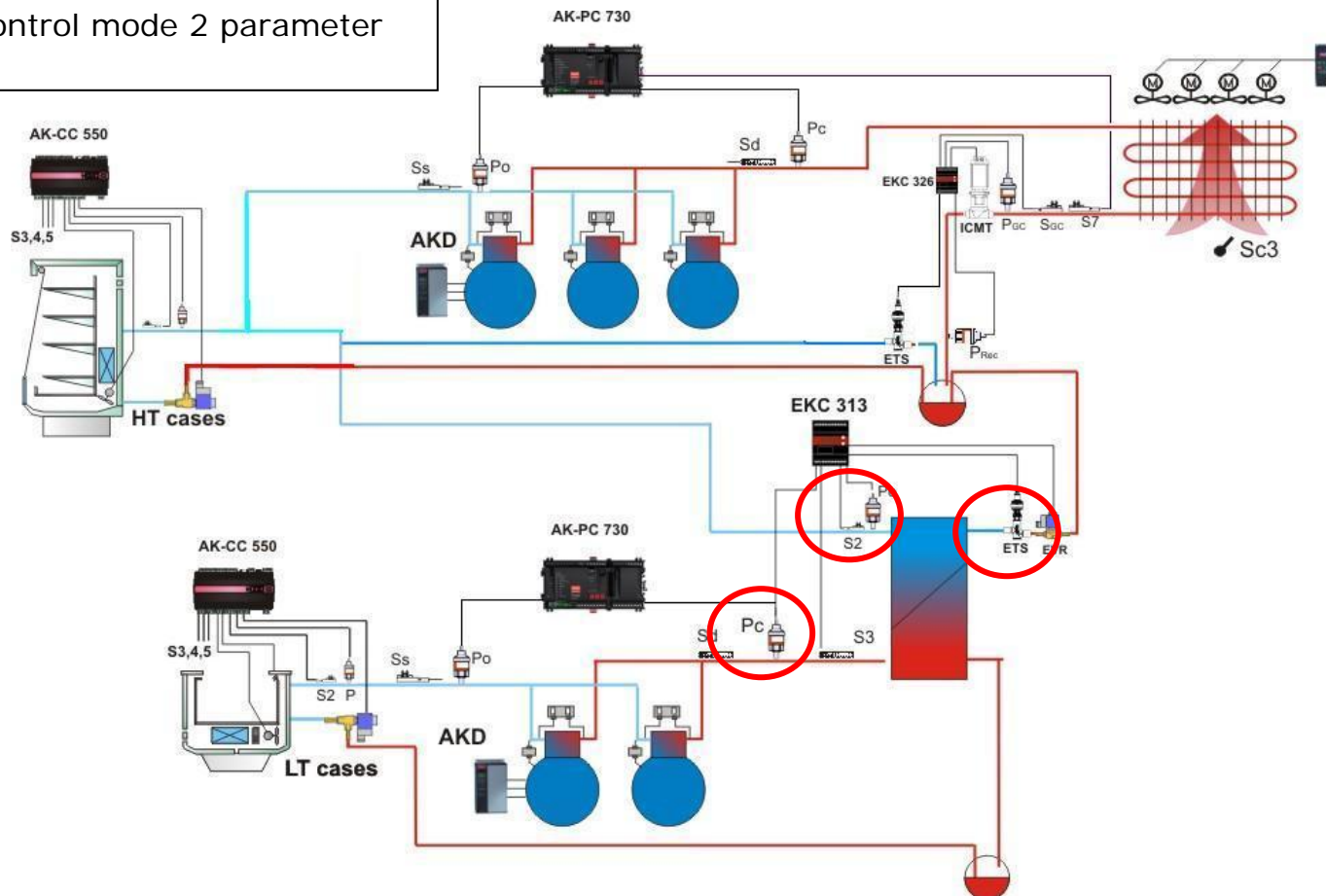
LT < 40Bar
-35 / -5° C
11 / 25bar
CO₂

Trans-critical cascade CO₂/CO₂ plant

Example:

HT pack controls HT suction pressure.

EKC in control mode 2 parameter
p44 = 2

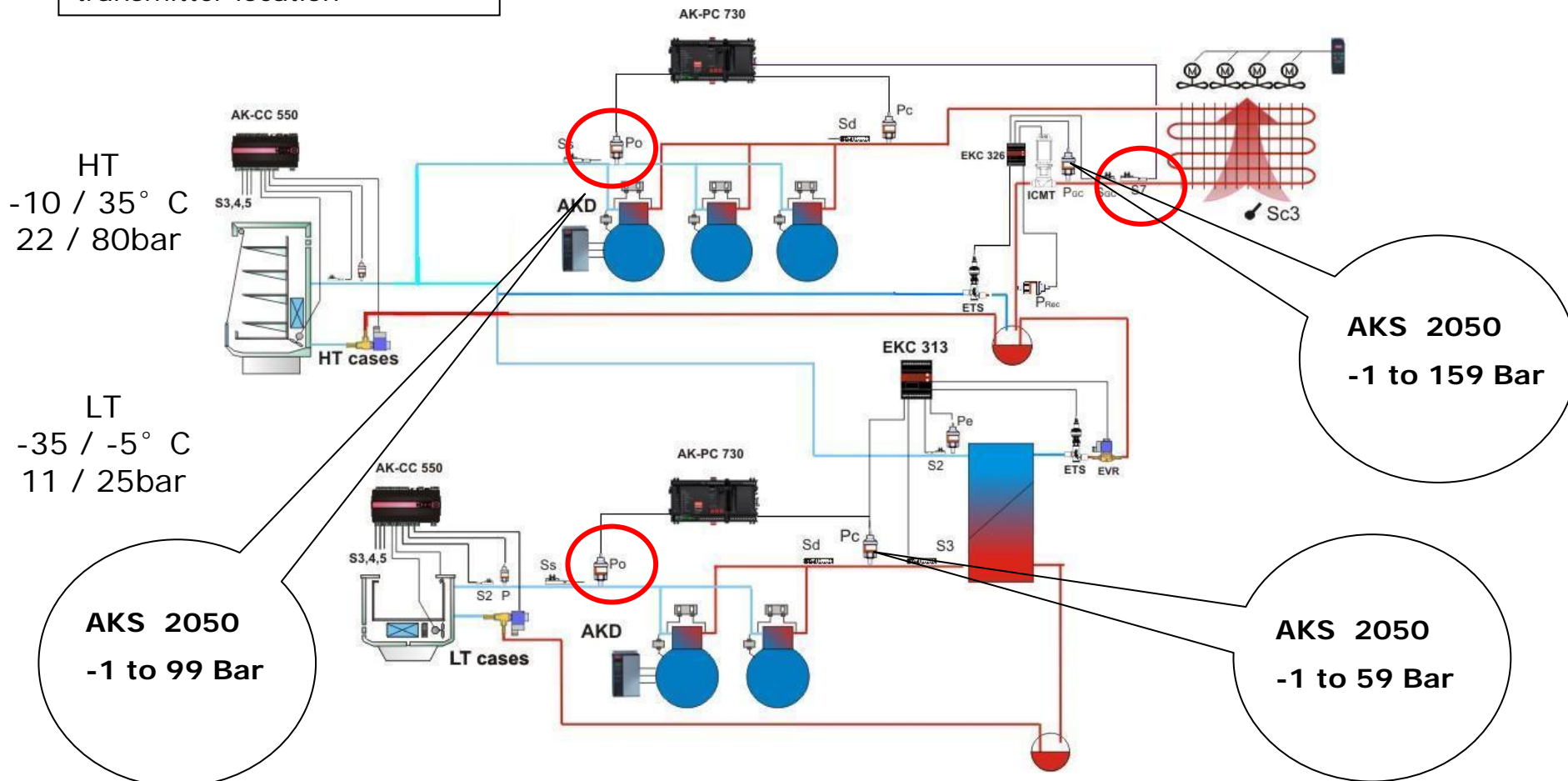


HT
-10 / 35° C
22 / 80 bar

LT
-35 / -5° C
11 / 25bar

Trans-critical cascade CO₂/CO₂ plant

Application example of
dedicated CO₂ pressure
transmitter location



Danfoss