



ENGINEERING  
TOMORROW

*Danfoss*

# A complete portfolio of **CO<sub>2</sub>** refrigeration solutions

CO<sub>2</sub> has long proven to be one of the most sustainable natural refrigerants. And for the last 20 years, Danfoss has developed innovative solutions to ensure supermarkets and food retail applications in climates all over the world can take full advantage of CO<sub>2</sub> refrigeration.

More than  
**30%**  
reduction of  
carbon footprint  
on store level

> **START HERE**

# Discover the opportunities of CO<sub>2</sub> refrigeration

CO<sub>2</sub> has proven itself to be a highly reliable, cost effective, and environmentally friendly natural refrigerant. And transcritical CO<sub>2</sub> refrigeration technology delivers game-changing benefits to supermarkets and small retail stores alike – in cold and warm climates.

Danfoss has pioneered transcritical CO<sub>2</sub> technologies for food retail applications around the world – and because no two systems are the same, there is a complete portfolio to suit any need.

**In this eBook, discover how to take full advantage of the environmentally compliant, efficient, safe, and future-proof benefits of CO<sub>2</sub> refrigeration systems.**

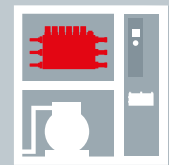
Why choose  
CO<sub>2</sub> refrigeration?



Danfoss partnership  
and expertise



A full portfolio of  
CO<sub>2</sub> solutions



# Why choose **CO<sub>2</sub> refrigeration?**

- ✓ Reduced complexity with low and medium temperature compatibility
- ✓ Zero ozone depletion and one of the lowest possible Global Warming Potentials (GWP), one.
- ✓ Viable and profitable solution even in warmer climates
- ✓ Outperforms traditional HFC systems on energy efficiency in all climates



# CO<sub>2</sub> is the **refrigerant of tomorrow**

Since 1850, CO<sub>2</sub> has proven to be one of the most reliable, efficient, and environmentally friendly refrigerants. Now, CO<sub>2</sub> is being used worldwide to provide a sustainable and cost-effective refrigerant solution – one that is compliant with the increased environmental requirements of today – and tomorrow.

CO<sub>2</sub> is a natural, sustainable refrigerant suitable for food retail stores of all sizes, and in all climates.

## Superior **thermodynamic properties**



### EXPERIENCE HIGH VOLUMETRIC COOLING CAPACITY

- Small volume – high capacity
- Up to 5 times greater than R404A
- Possible to use smaller pipes and compressors



### HIGH PRESSURE REFRIGERANT

- +30°C - 71 bar
- Very low pipe pressure drop effect

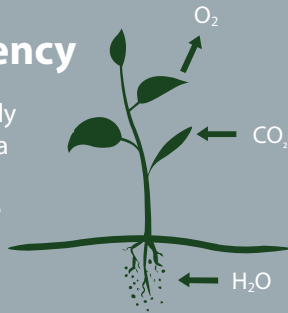


### HIGH DENSITY GAS

- Increases heat exchanger efficiency
- Greater capacities with smaller surfaces

## A wonder of **natural efficiency**

Environmentally friendly and sustainable, CO<sub>2</sub> is a natural substance that plays an important role in many natural and industrial processes.



CO<sub>2</sub> provides the lowest cost of ownership for end-users because of high volumetric efficiency, low power consumption, and refrigerant charge reduction.

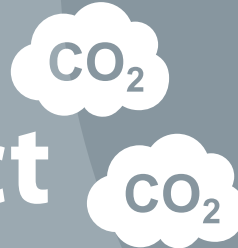


Supermarket systems can easily leak up to **20%** of their refrigerant. Replacing HFCs with CO<sub>2</sub> reduces refrigeration cost and accelerates a positive climate impact.

More than  
**30%**  
reduction of  
carbon footprint  
on store level

CO<sub>2</sub> HAS

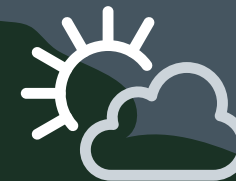
**0 impact**  
on global warming



## A refrigerant accompanied **by cool cash**



SAVE UP TO  
**20%**  
on energy by replacing HFCs  
with CO<sub>2</sub> in warmer climates.



Transcritical systems provide an efficient, simple, and cost-effective solution **in all climates.**



# Danfoss **partnership** **and expertise**

Our engineers are on the frontline of CO<sub>2</sub> refrigeration, developing the solutions needed for CO<sub>2</sub> transcritical systems – with installations all over the globe.

- ✓ Achieve unparalleled energy efficiency while protecting food safety
- ✓ An all-in-one solution customized to your need – with expert support and training
- ✓ Heat recovery unlocks business-critical efficiency and cost benefits
- ✓ CALM™ is a truly optimized CO<sub>2</sub> refrigeration solution for all climates



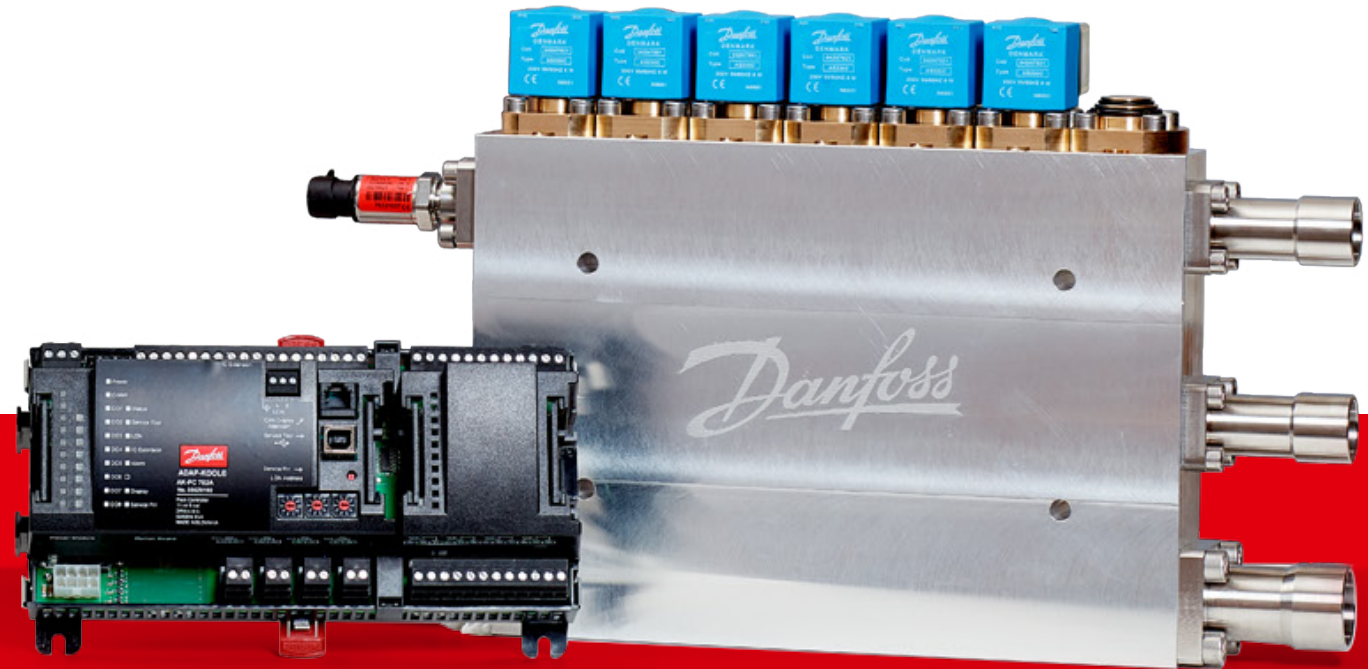
# Embrace the power of CO<sub>2</sub> with **future-proof technology**

Our portfolio of pioneering CO<sub>2</sub> technologies for transcritical refrigeration systems has evolved from more than 20 years of frontline experience – and thousands of installations around the world.

And because there is no one-size-fits-all solution, our adaptive refrigeration technology makes it possible to harness the environmental and energy-saving benefits of CO<sub>2</sub> in food retail stores of all sizes, and in all climates.

## The Danfoss **Multi Ejector Solution™**

With a complete portfolio of Multi Ejector solutions for all store sizes, CO<sub>2</sub> systems, and climates, it's possible to take full advantage of the future-proof technology.



✓ **Optimization of compressors**  
15% – 25% less compressor capacity needed, controlling three suction groups.

✓ **High system reliability**  
Max uptime and reliability with 4–6 redundant ejectors, backup systems, and emergency operations.

✓ **One solution for all climates**  
Apply transcritical CO<sub>2</sub> refrigeration systems in all climates for optimal performance.

✓ **Easy installation**  
Reduced complexity with built-in strainer and connectors for welding and soldering.

✓ **Service**  
Easy service with tools, fast strainer and ejector operation, and an LED plug for troubleshooting.

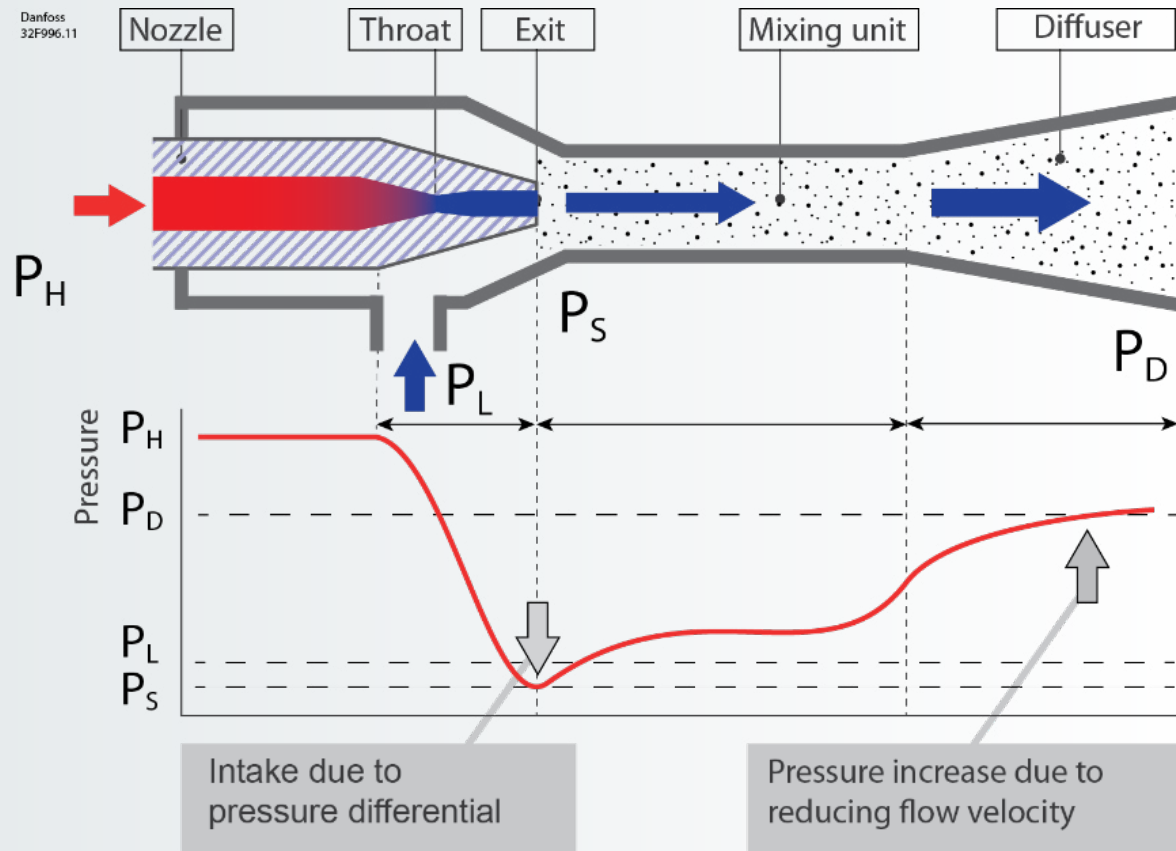
✓ **Savings**  
Gain initial operational savings with easy installation, reduced compressor needs, and lower energy consumption.

# How the Multi Ejector Solution™ works

1. CO<sub>2</sub> leaves the gas cooler. Then, the high-pressure CO<sub>2</sub> (P<sub>H</sub>) enters the motive nozzle where the expansion takes place.
2. At the exit, the speed is very high resulting in low pressure. The low pressure then drags in gas from the MT suction (P<sub>L</sub>).
3. The two units are then combined in the mixing unit where the pressure is higher than at the outlet due to mixing gas from a higher pressure.
4. After mixing, the flow enters the diffuser where it slows down. The shape of the diffuser enables the conversion from kinetic energy (velocity) to potential energy (pressure). From the diffuser, the flow returns to the receiver.



See how the **Multi Ejector Solution™** works

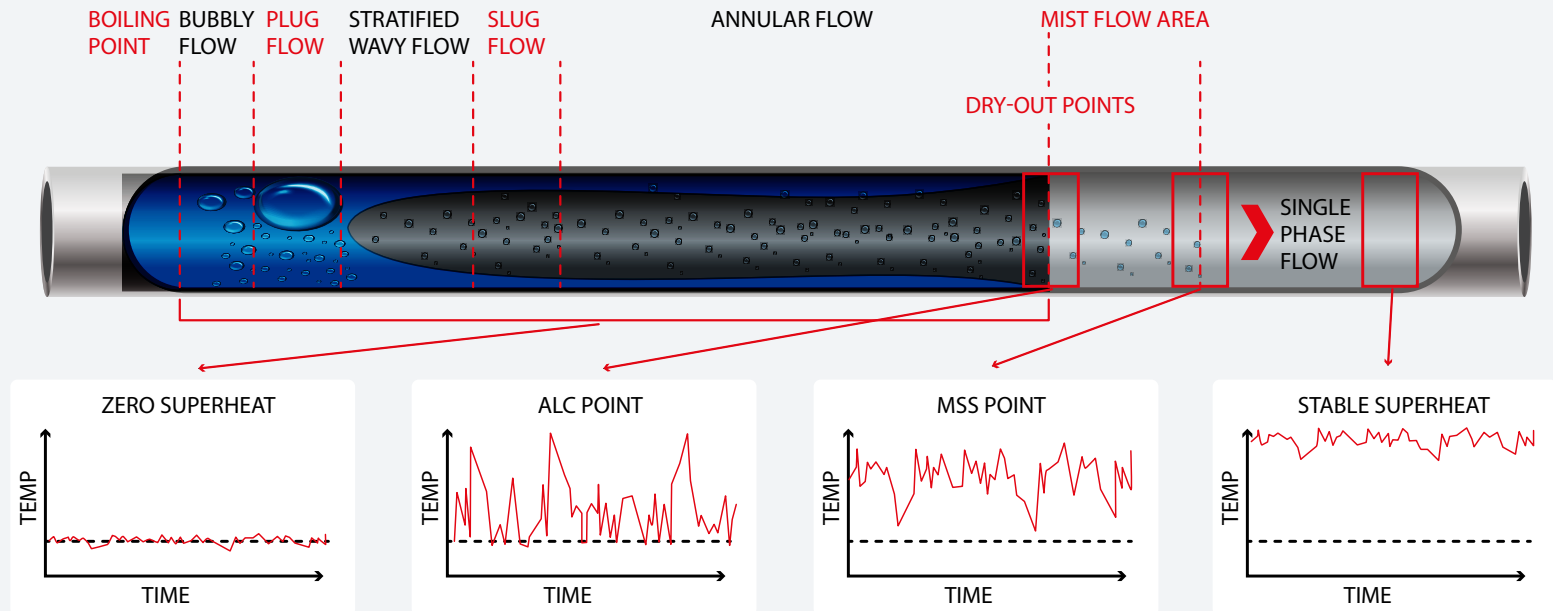


# Save energy and enhance food safety **with adaptive control algorithms**

Adaptive superheat control has proven to be a robust, efficient, and superior solution, saving 8–12% of energy use by ensuring the evaporator is always fully utilized under all conditions. Plus, adaptive controls mean you no longer have to manually adjust system operation for changing conditions – reducing operating and maintenance costs.

[READ MORE HERE](#) >

The evaporator illustrated as a tube presenting the **evaporation process**

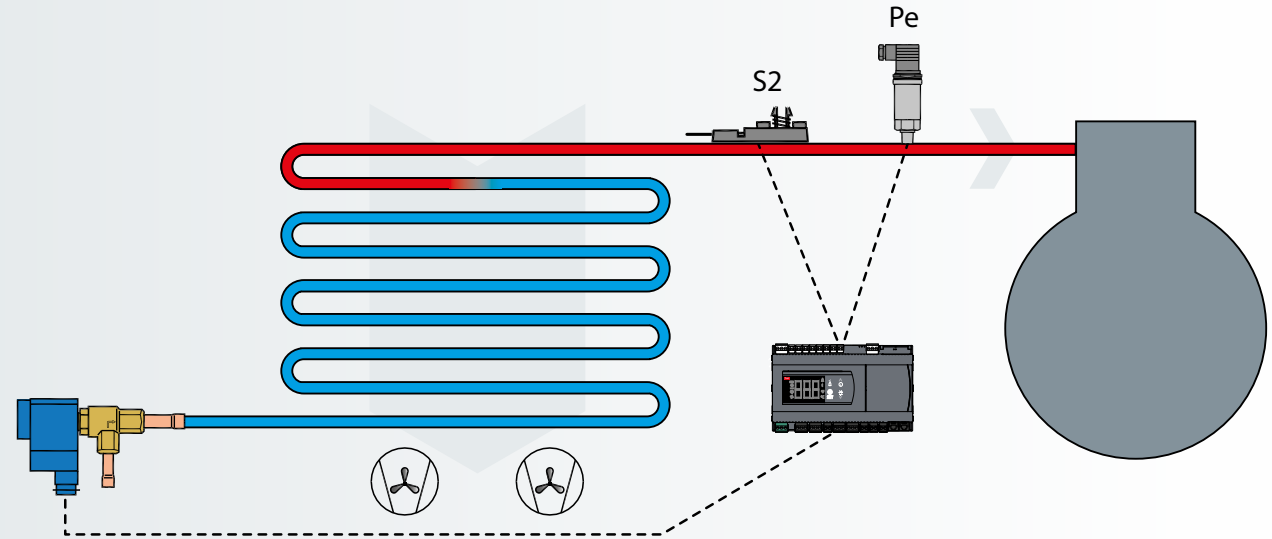




# Danfoss Adaptive **Minimum Stable Superheat** Control (MSS)

Utilization of the evaporator surface is maximized while ensuring that no liquid exits the evaporator – safeguarding the compressor and delivering significant energy savings and optimal food safety.

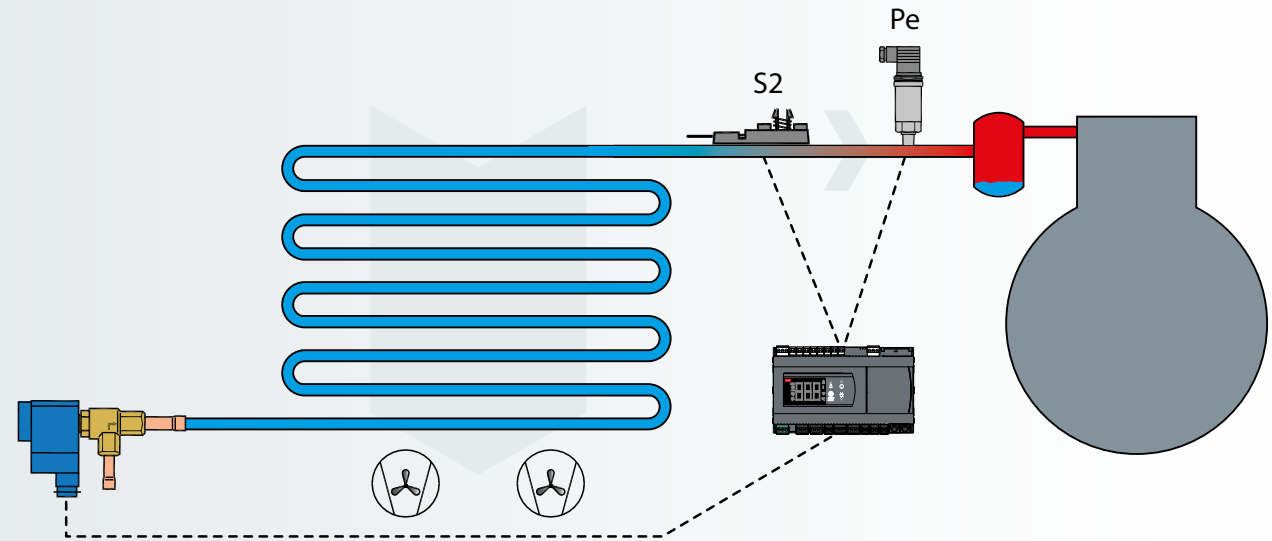
- Maximum system efficiency in systems with dry expansion
- Exceptional precision, stability, reliability, and efficiency
- Minimum energy consumption regardless of fluctuating ambient temperature
- Ensures all liquid is evaporated before reaching the end of the evaporator, optimizing suction pressure while keeping a fully loaded display case at the desired temperature



# Danfoss **Adaptive Liquid Control** (ALC)

Greater amounts of refrigerant are injected into the evaporator, fully utilizing the entire surface – bringing the superheat very close to zero.

- Suitable for systems with a suction accumulator and Liquid Ejector
- Reduced compressor load with high suction pressure
- Significant energy savings with increased evaporation temperature up to 5 Kelvin compared with MSS systems
- Highly precise liquid control ensures limited liquid to be captured in the suction accumulator

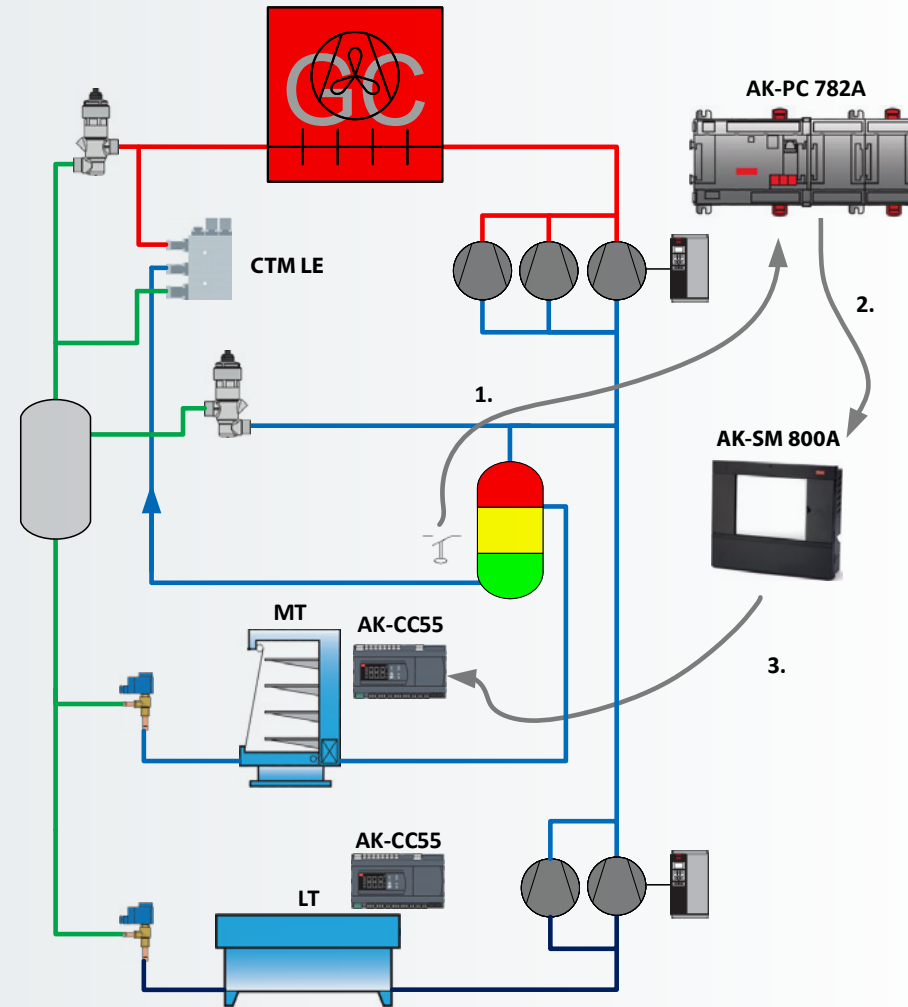


# CO<sub>2</sub> Adaptive Liquid Management (CALM™)

CALM™ is a complete solution for the entire system, optimizing all evaporators in a store. This is only possible when all components are optimized to work perfectly together, This is the case for Danfoss AK-CC55, AK-PC 782A, AK-SM 8xxA and Liquid Ejector.

- Globally optimized for any climate, efficient in all ambient temperatures
- Significant energy savings and cost reductions with a reduced risk of first-cost investments
- Liquid Ejector optimizes any transcritical CO<sub>2</sub> booster or parallel compression refrigeration system
- Optimized evaporation effect from refrigerant with superheat controlled close to zero and fully utilized evaporator

[READ MORE HERE](#) >

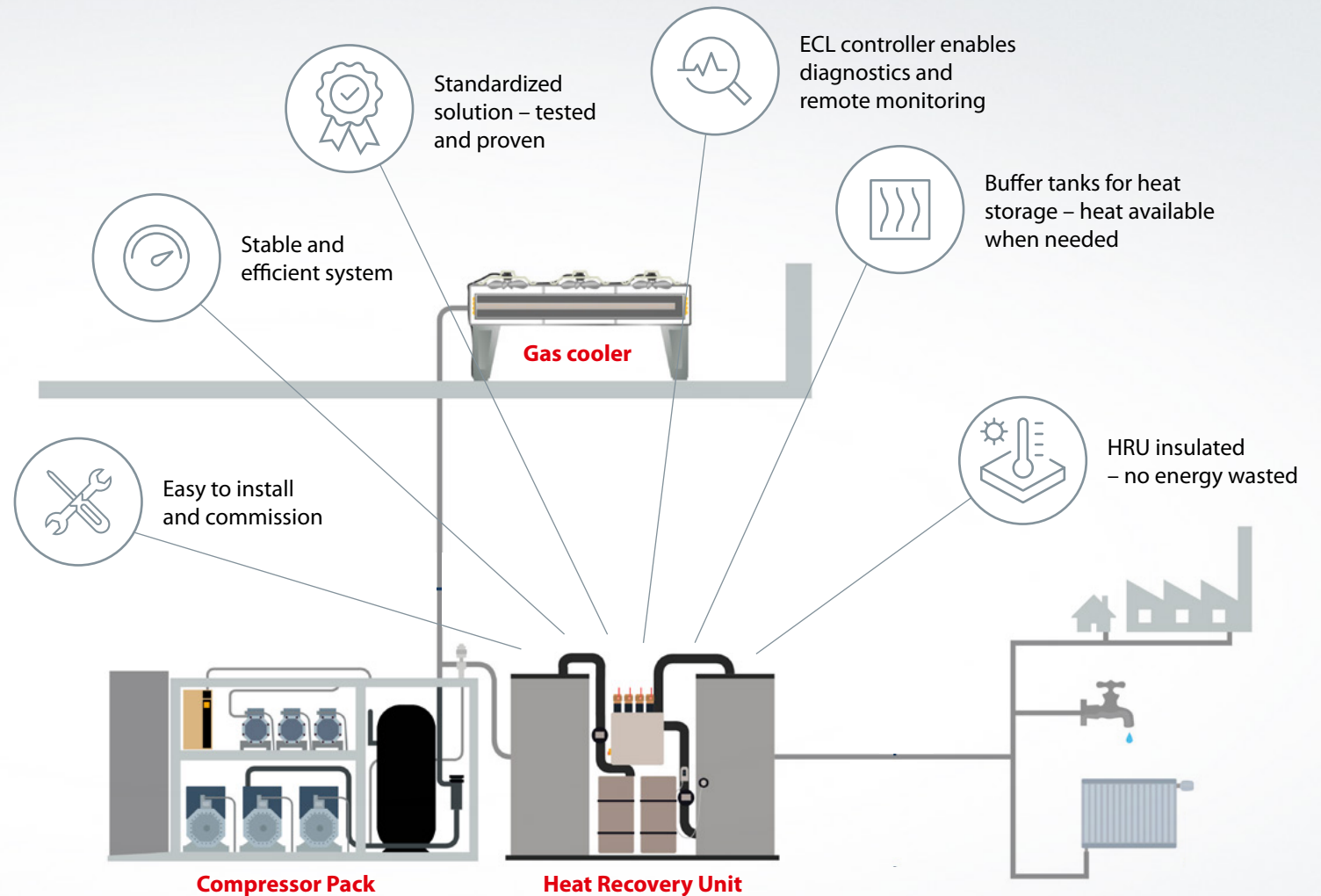


# Heat reclaim technology maximizes energy efficiency

CO<sub>2</sub> is a highly suitable refrigerant for heat reclaim. By closely aligning heating, ventilation, air conditioning, and refrigeration systems, you save money, safeguard stock, and reduce your environmental impact.

The Danfoss Heat Recovery Unit (HRU) helps to eliminate the technical challenges of managing heat recovery. The HRU is an integrated solution managing and buffering the heat from the refrigeration pack – to be reused for space heating, hot tap water, or even sold to neighbors or district heating grids.

- Maximum heat recovered and reused
- Standardized solution – tested and proven
- Easy to install and commission
- Stable and efficient solution
- Eliminates the need for a boiler



[LEARN MORE >](#)

With an HRU unit, **get maximum heat recovered and reused** with no or minimum need for additional heat sources.



## Case Study

# A supermarket turned into a **heat supplier**

**A Danish supermarket fulfills 95% of its heating demand from its own cooling display cases.**

With Danfoss Heat Recovery Units installed in 12 of its 13 stores, BALS (Brugsen for Als og Sundeved) has managed to halve its CO<sub>2</sub> footprint in just five years – and saves 70% on district heating costs and 37% on electricity.

- Excess heat supplies store with heating and hot water
- Surplus heat can heat up to 15 households in the neighborhood

[READ THE STORY >](#)



## Case Study

# The largest transcritical CO<sub>2</sub> system in Russia

**A 25,000 square meter hypermarket in Russia – Globus – uses transcritical CO<sub>2</sub> for its vast refrigeration and heating needs, chosen for its reliability, efficiency, and sustainability.**

1MW of cooling and heating capacity was needed to cover a mix of 191 low, medium, and dual-mode temperature display cabinets; 51 low and medium temperature cold rooms; and 29 climate chambers supporting a vast range of food sections.

With a need to deliver huge cooling capacity without a huge price tag, the use of transcritical CO<sub>2</sub> refrigerants and heat recovery fulfilled the need to cut installation costs, reduce operating costs, and achieve a 25% energy savings.

- Installed capacity reduced by 15% with efficient heat recovery
- CO<sub>2</sub> costs 20 times less than traditional refrigerants
- Significantly reduced environmental impact



[READ THE STORY >](#)

## Case Study

# CO<sub>2</sub> technology transforms German supermarket

**Danfoss Multi Ejector technology optimizes reliability, efficiency, and sustainability at one of EDEKA's mid-sized supermarkets in Germany.**

EDEKA, Germany's largest supermarket corporation, installed the Danfoss Multi Ejector Combi HP/LP together with the CO<sub>2</sub> Adaptive Liquid Management (CALM™) system in one of its mid-sized supermarkets to boost energy efficiency, reduce its carbon footprint, and leverage heat recovery to heat the entire store.

- Installation of CO<sub>2</sub> parallel compression system, Multi Ejector technology, and CALM™ system increased reliability and efficiency in various ambient climate conditions
- Multi Ejector Combi HP/LE decreases thermal stress on the MT compressors
- CALM™ system includes Danfoss case controllers that enable MT evaporators to run at maximum by getting superheat control close to zero



[WATCH THE VIDEO >](#)

# Worldwide training in CO<sub>2</sub> refrigeration

## Take the next step in CO<sub>2</sub> refrigeration – together.

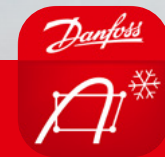
CO<sub>2</sub> has become industry standard in food retail refrigeration with proven technology and components for transcritical refrigeration readily available today. But, there is no one-size-fits-all solution – which is why our team of CO<sub>2</sub> champions is ready to guide you on your refrigeration journey.

Get industry-leading application support and guidance – and access to a series of e-lessons available through Danfoss Learning:

- Introduction to Carbon Dioxide: Properties and Impact
- Advantages of Carbon Dioxide as a Refrigerant
- System Understanding
- Phase Change
- Food Retail Systems and Product Selection



Join our **webinars, e-lessons and face to face courses**



We did complex —  
**you do awesome**

Coolselector®2 helps you optimize energy consumption and increase efficiency in any HVACR system.





# Hands-on CO<sub>2</sub> training is coming your way

The Mobile CO<sub>2</sub> training unit has provided more than 2,000 installers, service technicians, and OEM engineers with hands-on CO<sub>2</sub> training since 2016 – providing easy-to-access, hands-on training on how to take full advantage of the natural refrigerant.

Manned by dedicated Danfoss CO<sub>2</sub> champions, visitors can view demonstrations and experience hands-on training with actual systems and interactive panels.

- Simple booster system
- Parallel compression
- Parallel compression with ejector
- Commissioning of CO<sub>2</sub> systems
- Set up of pack and case controls
- Service procedures
- Troubleshooting and correction

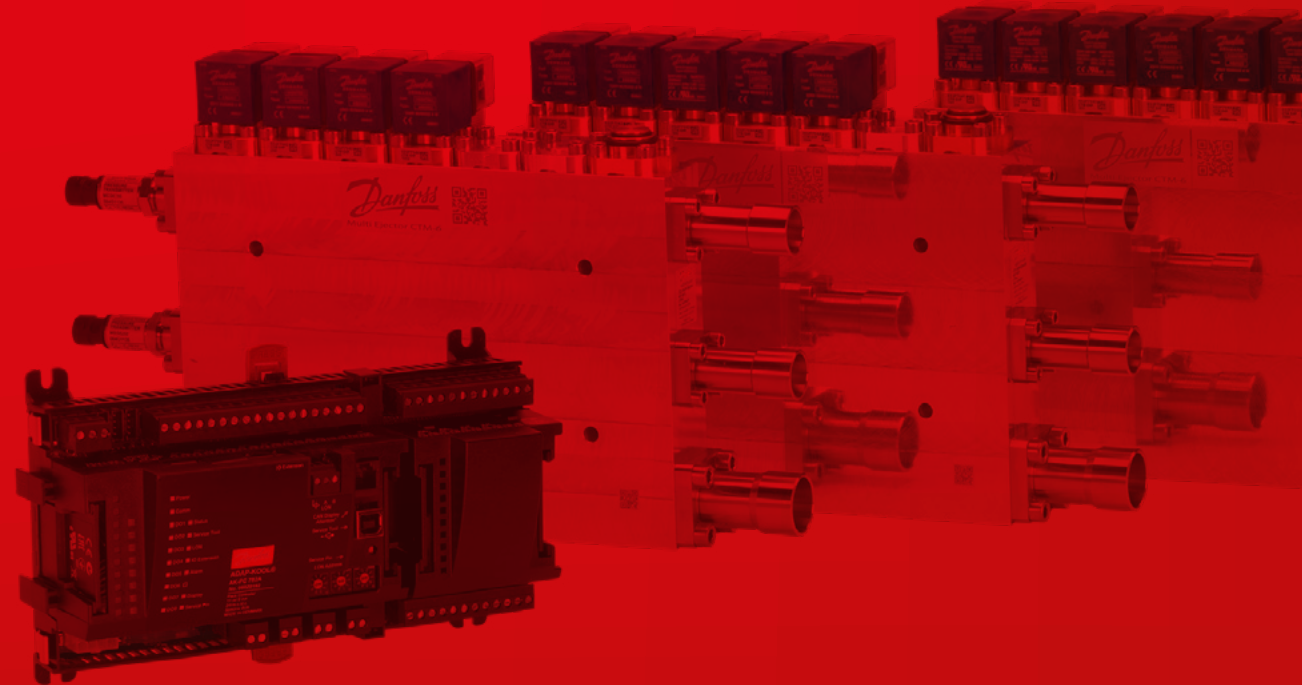


Learn more about the  
**Mobile Training Unit**

# A full portfolio of **CO<sub>2</sub> solutions**

Because no two applications are alike, choose from a full portfolio of CO<sub>2</sub> solutions – tailored to your specific need.

- ✓ CO<sub>2</sub> MiniPack Solution
- ✓ Transcritical Booster Solution
- ✓ Transcritical Booster with Parallel Compression Solution
- ✓ Multi Ejector Solution™



CO<sub>2</sub> MiniPack Solution – from 20-70 kW

# CO<sub>2</sub> made easy for small stores

The CO<sub>2</sub> MiniPack Solution empowers owners of small stores to harness the energy efficient, cost-saving benefits of CO<sub>2</sub> refrigeration systems, combining five compatible products into a single solution.



**Pack Controller AK-PC 572**

An all-in-one solution that makes using CO<sub>2</sub> approachable



**Stepper Valve Driver EKE 1P**

An extension module for Danfoss controllers



**Midi Drive VLT FC 280**

Flexible and efficient motor control



**Safety valve, SFA 10H**

Highly reliable safety valve designed for Food Retail applications.



**Electric Regulating Valve CCMT Light**

Highly robust and reliable electric valve



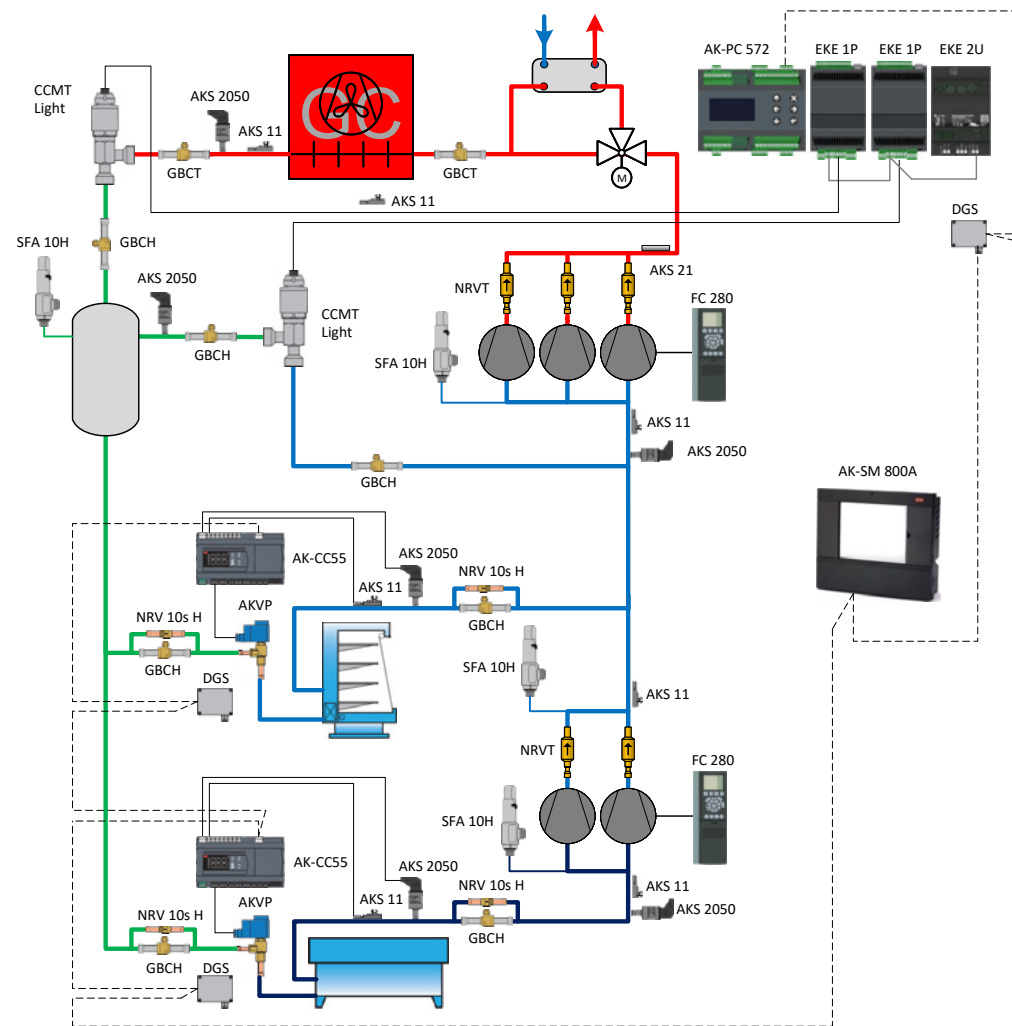
**Backup Power Module EKE 2U**

Effective energy storage device



**Pressure Transmitter AKS 2050**

Reliable, durable, high-performance pressure transmitter



- HP High Pressure (120-140 bar)
- HP Receiver Pressure (60-90 bar)
- LP Suction Pressure MT (45-55 bar)
- LP Suction Pressure LT (25-30 bar)

Transcritical Booster Solution – from 40-100 kW

# Uncomplicated and reliable CO<sub>2</sub> solution for mild climates

The first generation of transcritical supermarket systems, the simple booster solution proves the efficiency and simplicity of CO<sub>2</sub> systems in milder climates.



**Pack Controller AK-PC 772A**  
Complete regulating unit for capacity control of compressors and condensers



**Gas-Detecting Sensor DGS**  
Refrigerant gas detection to safeguard buildings



**Case Controller AK-CC55**  
Complete control with excellent flexibility



**Shut-off Ball Valve GBCT**  
Engineered specifically for use with CO<sub>2</sub>



**Electric Regulating Valves CCMT 2-8 and CCMT 16-42**  
Highly reliable electric valve for all CO<sub>2</sub> systems



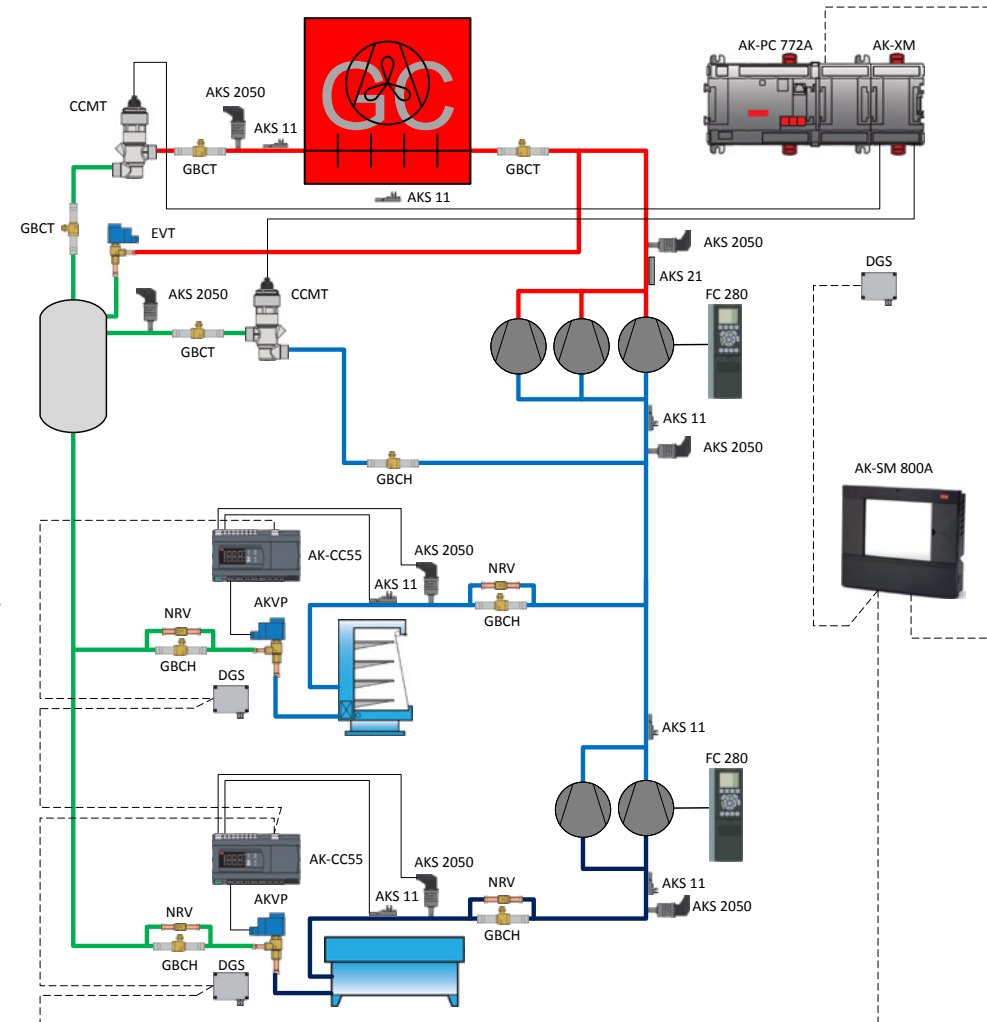
**CKB Pressure Switch**  
CO<sub>2</sub> safety pressure switch to protect compressor and the system against too high pressure.



**Solenoid valve EVT**  
EVT high pressure range is a direct or servo operated solenoid valve specially designed to fit into CO<sub>2</sub> transcritical refrigeration systems.



**Electric Expansion Valve AKVP**  
Precise liquid injection for evaporators



— HP High Pressure (120-140 bar)  
— HP Receiver Pressure (60-90 bar)  
— LP Suction Pressure MT (45-55 bar)  
— LP Suction Pressure LT (25-30 bar)

Transcritical Booster with Parallel Compression Solution – from 100kW and up

# An industry-leading CO<sub>2</sub> solution for warm climates

The most common CO<sub>2</sub> solution today, transcritical booster systems with parallel compression boost efficiency and increase viability in warmer climates.



**Pack Controller AK-PC 782A**  
Scalable control for up to 12 compressors



**Electric 3-Way Valve CTR**  
Full proportional control of heat reclaim



**Case Controller AK-CC55**  
Complete control with excellent flexibility



**Refrigeration Drive VLT FC 103**  
Simple energy efficiency



**Electric Regulating Valve CCMT 16-42**  
Highly reliable electric valve for all CO<sub>2</sub> systems



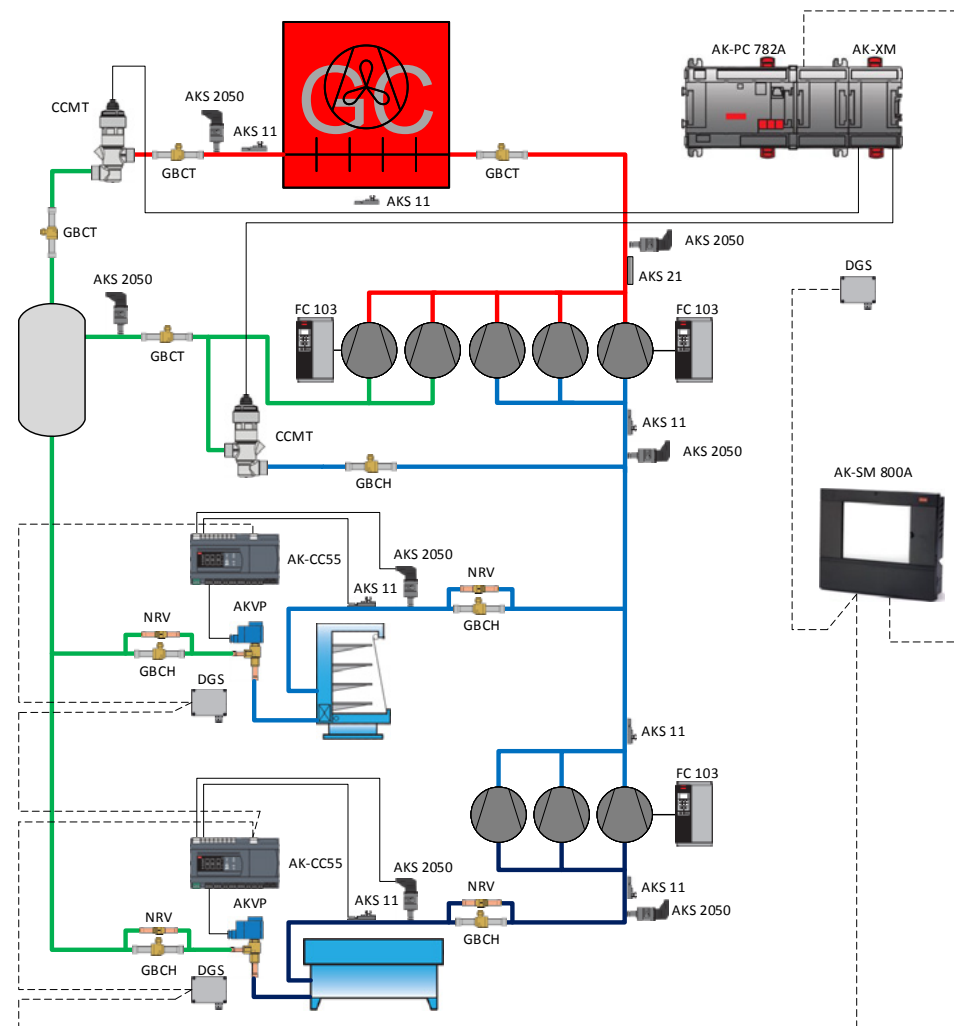
**Motor-Operated Valve ICMTS**  
Regulate the flow of transcritical gas or subcritical liquid



**Electric Expansion Valve AKVP**  
Precise liquid injection for evaporators



**Temperature Sensor AKS 11**  
Temperature-dependent resistance sensor



— HP High Pressure (120-140 bar)  
— HP Receiver Pressure (60-90 bar)  
— LP Suction Pressure MT (45-55 bar)  
— LP Suction Pressure LT (25-30 bar)

## Multi Ejector Solution™

# A solution for every size and climate

The complete portfolio of Multi Ejector solutions covers the needs for all store sizes, CO<sub>2</sub> refrigeration systems, and climates.

**Multi Ejector****– High Pressure lift (HP)**

Add-on to enhance efficiency in a parallel compression system

**Multi Ejector****– Liquid Ejector (LE)**

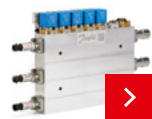
Full evaporator optimization via CALM™

**Pack Controller AK-PC 782A**

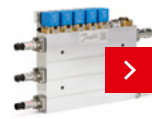
Complete regulating unit for capacity control of compressors and condensers

**System Manager  
AK-SM 800A**

Take advantage of the CALM™ solution

**Multi Ejector****– Low Pressure lift (LP)**

Add-on to the booster system improving efficiency during warm ambient conditions

**Multi Ejector****– Combi HP/LE**

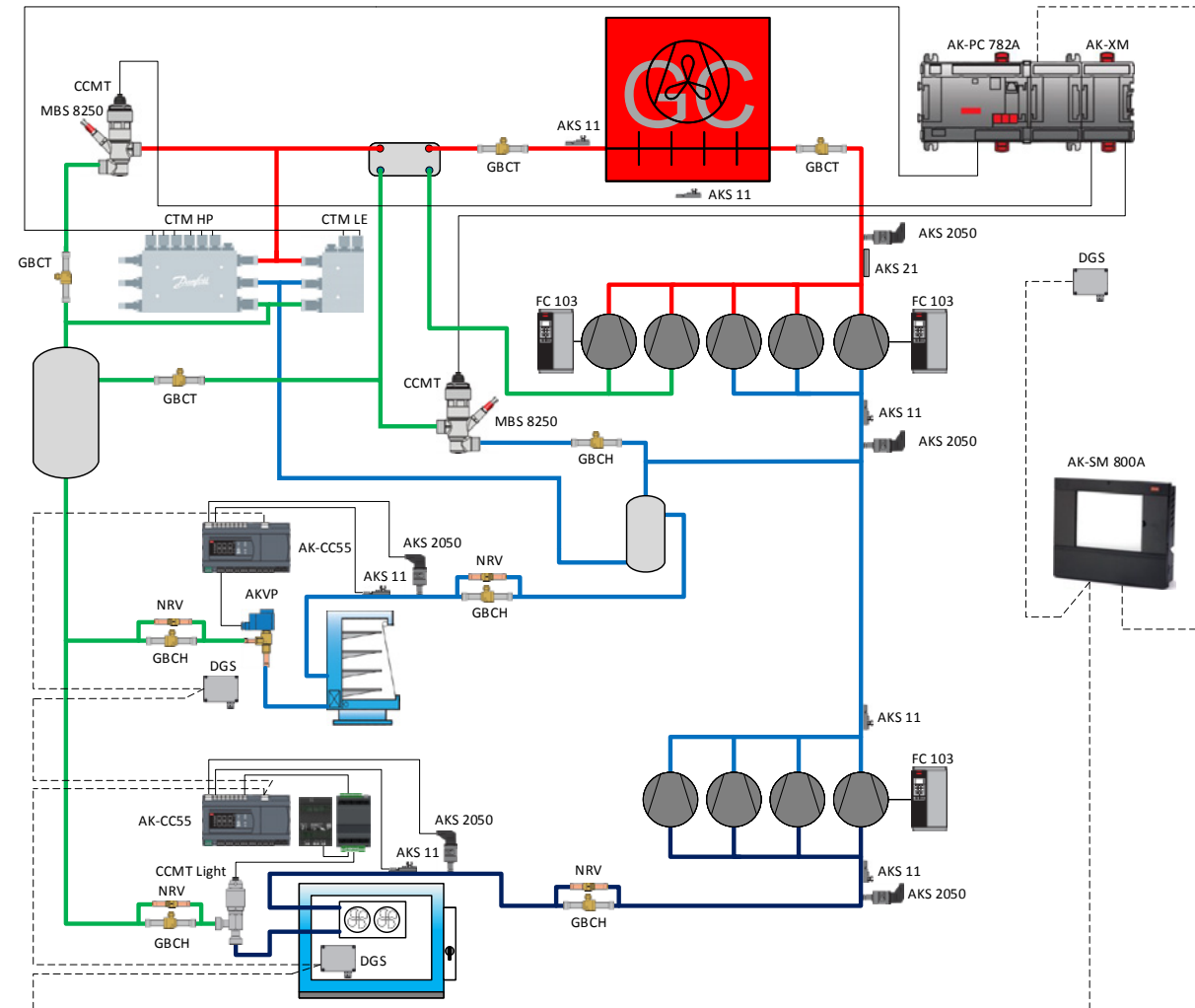
The benefits of the High Pressure and Liquid Ejector in one solution

**Case Controller AK-CC55**

Complete control with excellent flexibility

**Electric Regulating Valve  
CCMT Light**

EEV for larger cold rooms



- HP High Pressure (120-140 bar)
- HP Receiver Pressure (60-90 bar)
- LP Suction Pressure MT (45-55 bar)
- LP Suction Pressure LT (25-30 bar)

How to choose the  
right Multi Ejector



# Controllers **Overview**

Controllers	Type	MiniPack	Transcritical Booster	Transcritical (IT)	CALM™	Cascade
AK-PC 572	Pack	✓				
AK-PC 772A	Pack		✓	✓		
AK-PC 781A	Pack		✓	✓		✓
AK-PC 782A	Pack		✓	✓	✓	
AK-PC 783A	Pack					✓
AK-CC55	Case	✓	✓	✓	✓	✓
AK-CC 750A	Case	✓	✓	✓	✓	✓
AK-SM 800A	Front end	✓	✓	✓	✓	✓
EKE 1P	Driver	✓	✓	✓		✓
EKE 1A, EKE 1B, EKE 1C	Superheat	✓	✓	✓		✓
EKC 313	Superheat					✓
EKE 2U	Battery back up	✓	✓	✓		✓

# Valves and Sensors **Overview**

Valves	Type	MiniPack	Transcritical Booster	Transcritical (IT)	CALM™	Cascade
AKVP/PS	Electronic expansion valves	✓	✓	✓	✓	✓
CCMT	Electronic expansion valves		✓	✓	✓	✓
CCMT Light	Electronic expansion valves	✓	✓	✓	✓	✓
ICMTS	Electronic expansion valves		✓	✓	✓	
SFA 10H	Safety valve (65 bar)	✓	✓	✓	✓	✓
EVT	Solenoid valve	✓	✓	✓	✓	✓
CTM Multi Ejector Low Pressure	Multi Ejectors	✓	✓			
CTM Multi Ejector High Pressure	Multi Ejectors			✓	✓	
CTM Multi Ejector Liquid Ejector	Multi Ejectors	✓	✓	✓	✓	
CTM Multi Ejector Combi HP/LE	Multi Ejectors			✓	✓	
CTR	3-way valve		✓	✓	✓	
Sensors						
AKS 11 Temperature Sensor	Sensor	✓	✓	✓	✓	✓
AKS 4100	Sensor				✓	
AKS 2050 Pressure Transmitter	Sensor	✓	✓	✓	✓	✓
DST P110	Sensor	✓	✓	✓	✓	✓
CKB	Pressure switch	✓	✓	✓	✓	✓
DGS	Gas detection	✓	✓	✓	✓	✓



# Line components and Frequency drives **Overview**

Line components	Type	MiniPack	Transcritical Booster	Transcritical (IT)	CALM™	Cascade
DMT (140 bar)	Filter drier	✓	✓	✓	✓	✓
DMSC (52 bar)	Filter drier	✓	✓	✓	✓	✓
GBC (90 bar)	Ball valve	✓	✓	✓	✓	✓
GBCT (140 bar)	Ball valve	✓	✓	✓	✓	✓
Frequency drives						
VLT FC 280	Frequency drive	✓	✓			
VLT FC 103	Frequency drive		✓	✓	✓	✓

# CO<sub>2</sub> refrigeration is part of the **Danfoss Smart Store**

Danfoss Smart Store solutions help build the supermarkets of tomorrow by reducing costs, minimizing environmental impact, and creating future-proof advantage – all while maintaining the highest level of food safety.

## Installed in more than 50,000 food retail stores worldwide, smart store solutions:

- Use smart refrigeration to reduce operating costs
- Use connectivity to eliminate food waste and reduce service costs
- Provide long-term sustainability
- Integrate systems to gain economies of scale
- Reduce energy prices through optimized demand

**Get started today – and prepare for a better tomorrow:**  
[Smartstore.danfoss.com](https://Smartstore.danfoss.com)

## Tools and support for your CO<sub>2</sub> journey



### RefTools

The essential all-in-one app for air conditioning and refrigeration technicians. Get seven powerful tools to support your CO<sub>2</sub> journey all from the palm of your hand.

[> Download it here](#)



### Alsense Food Retail

Our newest cloud solution for supermarkets and food retail applications, offers a sustainable, scalable, and secure portal for optimizing the performance of operations.

[> Learn more here](#)



### Coolselector®2

Significantly reduces complexity on the job by running unbiased calculations based on a set of operating conditions to determine the best components for your design.

[> Download it here](#)

