



# Cooling Matters

*Danfoss News for the Refrigeration & Air Conditioning Industry*

- Exhibition News - A look back at Danfoss at Mostra Convegno
- Products - PSH range of heat pump scroll compressors
- Refrigerants - Products for ammonia and CO<sub>2</sub> for Supermarkets
- Fitters Notes - Pressure Controls





The refrigeration and air conditioning industry has made tremendous progress over the past two decades in reducing the use of ozone-depleting refrigerants. The original targets of the Montreal Protocol, established in 1987 to reduce emissions of ozone depleting substances, are being met and exceeded. Another consequence of these initiatives is that during the 1990s and the early part of the present century, there was considerable uncertainty regarding future refrigerant options. Now a path has started to appear, defined by the global agenda on climate change and global warming.

Seen from a global perspective, the tendency is that the industry is moving more and more toward natural refrigerants where this is technologically feasible. Synthetic refrigerants are still likely to play a large role in the refrigeration and air conditioning industry, but this will be in minimal charge systems and with new low GWP substances. Parameters such as efficiency, safety, environmental impact, relatively short atmospheric lifetimes, chemical properties and economy all influence the choice of future refrigerant options.

In this issue of Cooling Matters we look at the products and solutions offered by Danfoss for natural refrigerants such as ammonia and carbon dioxide (CO<sub>2</sub>). We also introduce the newest edition to our range of PSH scroll heat-pump compressors and review the products presented at the recent Mostra Convegno exhibition in Italy. We continue with our Fitters Notes series, this time looking at Pressure Controls. Finally, we introduce you to the free on-line training platform, Danfoss Learning.

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# Change in type designation for specific hydrocarbon products.

Specific refrigeration control products released for use with hydrocarbon refrigerants are to have the letter "E" removed from the type designation.

The products affected by this change are shown in the table opposite.

This is only a change in the type designation the specifications and code numbers will remain the same.

Old type designation	New type designation
EVRE	EVR
BMLE	BML
SGIE	SGI
SGNE	SGN
NRVE	NRV
NRVHE	NRVH
DCLE	DCL
DMLE	DML



# Danfoss showcases latest products and solutions at Mostra Convegno Expocomfort

Every two years sees the staging of the Internationally Important Mostra Convegno Expocomfort, with this years event being held on 27<sup>th</sup> to 30<sup>th</sup> March in Milan. Once again Danfoss was in attendance presenting our latest products and solutions for both Air Conditioning and Refrigeration.



The Danfoss stand was divided into 2 main areas, one for Air Conditioning products and the other for Refrigeration products.

In the Air Conditioning section products displayed included compressors, heat exchangers and controls whilst in the Refrigeration area were packaged condensing units, compressors, commercial and industrial controls along with electronic controls for the Food Retail industry.

Danfoss also participated in the seminars with presentations on "Heat pump and liquid injection technology", Variable speed for HVAC, close control, industrial applications and also Turbor compressors and applications.

Highlights from the show included:

## Optyma Plus™ New Generation Condensing Units

As already introduced in a previous edition of Cooling Matters the new generation of the silent Plug & Play series of Optyma Plus™ Condensing units were displayed at the stand. Optyma Plus™ New Generation offers the same robust quality with added technology, for outdoor cooling units.



Further information is available on the local Danfoss websites: [www.danfoss.com/optymaplus](http://www.danfoss.com/optymaplus)

## PSH commercial heat pump scroll compressors

After the Performer® PSH038-077 heating optimized R410A scroll compressor release in November 2011, Danfoss announces the availability of new models to complete the PSH range. Six additional displacements are now ready for heat pump markets in smaller capacities. The complete range now covers heating capacities from 19 to 80 kW at -7°C evap., 50°C cond., superheat 2K, subcooling 5K rating point.

Further information is available in the following article and the article in Cooling Matters volume 2 2011.

## New VZH: the breakthrough in high efficient compressor solution for all commercial applications.

The new Performer® VZH, R410A scroll compressor, second generation of large size variable speed scroll compressor after the release of VSH in January 2010, will open new horizon for all commercial applications. First variable speed compressor achieving 25TR at standard ARI conditions, VZH will also provide unmatched performance levels.



Other compressors at the show included the new SH295 Performer® scroll compressor for air conditioning, MLZ refrigeration scroll compressor and the SLV15CNK.2 variable speed compressor for refrigerant R290.

## AKS 4100/4100U with the Guided Radar technology, adapted and qualified to Refrigeration Applications.

The new AKS 4100/4100U Liquid Level Sensor with Guided Radar technology was one of the products from Danfoss Industrial Refrigeration, also on show were the ICF valve station and the ICM direct motor controlled valve complete with an ICAD actuator.

Further information on all of these products can be found in the article on products for ammonia on page 6.

## Reduce the Energy Consumption of your Refrigeration, Heat Pump and Air Conditioning Systems

With the new ETS 6 valve, Danfoss' range of ETS electrically operated expansion valves has just got even stronger. Designed to control liquid injection into evaporators, the ETS range improves energy efficiency in refrigeration, heat pumps and air conditioning systems.



Increasing environmental concern, and tighter CO<sub>2</sub> emission and energy consumption regulations have made air conditioning, heat pump and refrigeration unit manufacturers look for new ways to improve the energy efficiency of their systems. The electronic expansion valve, which can adapt to the exact capacity demands of a system, is one component that's making a positive difference to the energy consumption.

## Heat exchangers

Rapidly rising raw material and refrigerant prices; environmental regulations and taxes; how to remain profitable in an increasingly competitive market place. Today's manu-

facturers have a lot to think about.

Danfoss shows the way forward with a new generation of heat exchangers that addresses all these concerns. Our Micro Plate and Micro Channel Heat Exchangers generate significant savings for producers and at the same time, reduce sensitivity to rising prices.



### Take Control of Your Refrigeration Applications with the ERC Range

Flexible and easy to install, Danfoss' ERC electronic refrigerator controllers are designed to reduce energy consumption. Presented at the show the latest to join the range, the ERC 101 is designed for a broad range of applications, while the 103 is ideal for commercial freezers, counter-top bottle coolers and the refurbishment market. Extremely versatile, the ERC 103 can be used as an electronic stand-alone controller, or it can be integrated with a remote display or spindle. With input from multiple sensors, the cost-efficient controller saves energy by controlling the compressor, light, fan and defrost mechanism operations for optimum efficiency.



### Electronic controls for Food Retail

On show where a selection of electronic controls for food retail applications including the new AK-SC355 system

controller, the brand new multi-functional pack controller AK-PC 781 dedicated to CO<sub>2</sub> installations as well as compressor controls and gas detectors.



### Danfoss Learning - Your online access point to knowledge

For 2 years, Danfoss has been developing a training platform - Danfoss Learning - which aims to suit professional training requirements with focus on Refrigeration & Air Conditioning techniques, products, applications and services. The Platform was introduced to visitors at the show.



Whether you are an installer, wholesaler, student, technician or developer at an OEM, you can sign up to the platform and enrol in the courses. This platform is available online 24/7, anytime from everywhere. Users can access self study courses (e-lessons) as well as face-to-face training courses and virtual classrooms.

You can find out more about Danfoss Learning in our final article on page 12.

*For further information, including literature, on any of the products or solutions exhibited at Mostra Convegno please visited the dedicated danfoss website at ; [www.danfoss.com/mostra](http://www.danfoss.com/mostra)*

## Dedicated heat pump scroll compressors

### Danfoss Commercial Compressors announces the extension of the recent Performer® PSH heat pump scroll compressor range

After the Performer® PSH038-077 heating optimized R410A scroll compressor release in November 2011, Danfoss announces the availability of new models to complete the PSH range. Six additional displacements are now ready for heat pump markets in smaller capacities. The complete range now

covers heating capacities from 19 to 80 kW at -7°C evap., 50°C cond., superheat 5K, subcooling 5K rating point. The features and technology make this range suitable for sanitary water, radiators (both retrofit and new installation) and fan coil applications.



Heat release	Water			
	Heat Recovery Units (Condensing up to 65°C)	Radiator (Retrofit, Condensing up to 60°C)	Radiator (New, Condensing up to 50°C)	Sanitary Hot Water (Condensing up to 65°C)
Source				
Air Source (Evaporating down to -25°C)				
Ground (Brine) (Evaporating down to -10°C)				

## Innovative liquid injection technology offers new possibilities within the heating market

### 65°C water at -25°C ambient thanks to extended operating envelope

Equipment manufacturers will benefit from the liquid injection that delivers a wider temperature envelope.

In comparison to gas or oil furnaces for space heating and Hot Sanitary Water (HSW) production, a heat pump system offers very large energy savings up to 50%. But until now, most heat pumps were limited in operating temperatures.

The Performer® PSH compressor with liquid injection technology offers an increased operating envelope. With 65°C saturated condensing temperature it allows for safe Hot Sanitary Water production and comfortable space heating even with old radiator systems. And with low evaporating temperatures down to -30°C it can be applied in colder regions.

Thanks to its extended map, the Heat Pump is able to operate all year long and doesn't need a furnace backup. Simulations demonstrate a 10% energy saving with Heat Pump when equipped with PSH versus ones with furnace backup.

### Simpler and more efficient solution for OEMs

#### 25% cost reduction\*:

The Performer® PSH019-039 requires fewer components in the system and save economizer, EXV or extra piping, which successfully reduces the application costs. The new integrated liquid injection valve and controller makes it simpler for designing and manufacturing heat pumps.

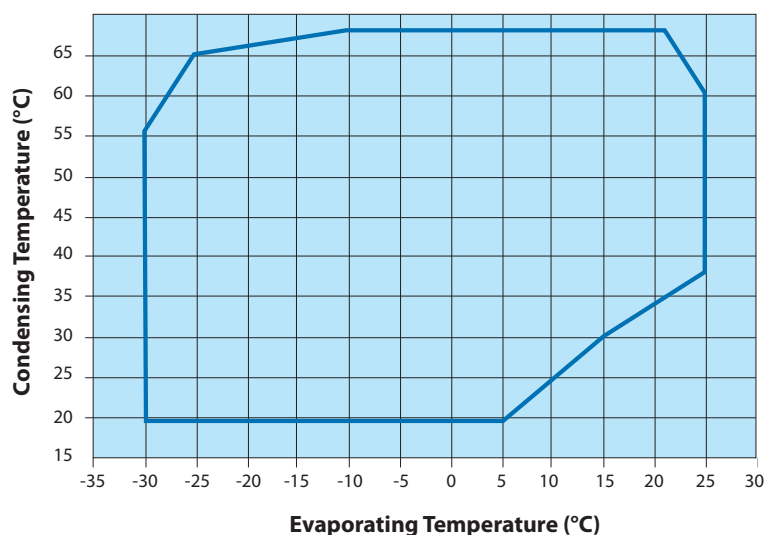
\* Compared to vapor injection

#### 20% more compact:

Based on a R410A refrigerant unit, heat exchanger size will be smaller compared to R407C systems. It reduces installation space.

### Energy efficient solution with Eco-label

The Performer® PSH019-039 range achieves more than the required



Operating Envelope for light commercial PSH

Heating Efficiency for air to water heat pumps		
Outdoor condition	Inlet dry bulb 2°C Inlet wet bulb 1°C	Inlet dry bulb 2°C Inlet wet bulb 1°C
Indoor condition	Inlet 30° / outlet 35°C	Inlet 40° / outlet 45°C
ECO label COP requirement on units	3.1 (W/W)	2.6 (W/W)
Compressor working condition	-7°C/40°C/5K/4K	-7°C/50°C/5K/4K
COP requirement on compressor	3.4 (W/W)	2.9 (W/W)
Danfoss PSH 019	3.77 (+12%)	2.95 (+4%)
Danfoss PSH 023	3.79 (+12%)	2.95 (+8%)
Danfoss PSH 026	3.90 (+15%)	3.15 (+8%)
Danfoss PSH 030	4.05 (+15%)	3.16 (+8%)
Danfoss PSH 034	4.11 (+15%)	3.20 (+8%)
Danfoss PSH 039	4.10 (+18%)	3.22 (+10%)

Table 1

compressor COP for Eco label (3.4W/W). All displacements will offer a minimum 3.77 COP and up to 4.11 depending on models in Air to Water heat pumps (see table 1).

### Innovation leads to benefits:

#### 30% higher reliability

The Performer® PSH038-077 has a new built in operating control system (OCS) which pilots the liquid injection and protects the compressor by keeping it within operating limits. The system also stores operating data and events for improved servicing. The OCS reduces downtime and cuts system warranty costs.

#### Lower sound levels, higher comfort

The largest Performer® PSH complies with the market requirements and legislation when it comes to sound levels. The compressor generates by average 3 dB(A) lower sound level than equivalent products. All large commercial

PSH compressors (038-051-066-077) are standard equipped with a patented surface sump heater - integrated insulation which largely contributes to the sound reduction. All commercial PSH019-039 compressors are compatible with the Surface Sump Heater and we highly recommend this option for end-user best comfort.

Danfoss offers an optimized scroll compressor range for use in residential and commercial heat pumps from 5 to 240 kW. Thanks to the Performer® HHP compressors for refrigerant R407C with a range of 5 to 14kW and the Performer® PSH scroll compressor for commercial heat pumps with models from 20 to 80kW that can be combined in tandem and trio configuration up to 240 kW.



# Ammonia – the natural choice for present and future demands



The use of ammonia as a refrigerant began in the mid-19<sup>th</sup> century and it is probably best known today for its use in industrial refrigeration applications. It is a natural substance with zero ODP and zero GWP, this in combination with its efficiency makes ammonia one of the most environmentally friendly refrigerants available. There are, however, some compatibility, toxicity and flammability issues which mean installations using ammonia are governed by national regulations to ensure that safety is not compromised.

With its abundant availability, low price and the proper safety precautions taken, the benefits of ammonia are compelling so it continues to be the refrigerant of choice for large storage applications, food processing plant and breweries etc.

There are on-going efforts to develop low-charge ammonia systems in order to utilise the beneficial thermodynamic and environmental properties of ammonia.

These efforts include:

- Development of low-charge systems and associated control algorithms.
- Optimisation of heat exchangers.
- DX (Direct Expansion) systems.
- Cascade systems or combination with secondary systems with CO<sub>2</sub> as a brine.

Danfoss is one of the principal suppliers of industrial refrigeration components for these facilities and we continue to design and develop innovative products for this industry sector.

## Main Valves

The modular ICF concept, discussed in Cooling Matters volume 1 – 2011, offers low weight and compact design making them easy to install. Direct coupled connections greatly reduce the potential for leaks and the modular design makes servicing quick and simple. The innovative v-port design offers higher suction pressure settings leading to energy savings.

ICM direct motor controlled valve

ICS pilot controlled servo valve

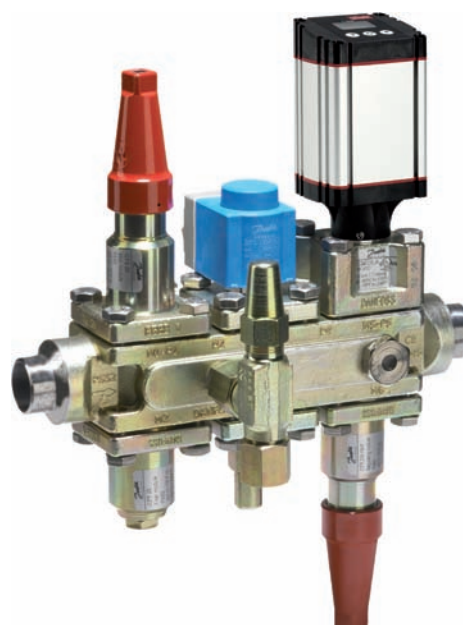


ICV modular valve programme

## Valve stations

Based on advanced technology the ICF control solution incorporates several functions, in one housing, which can replace a series of conventional mechanical, electro-mechanical and electronically operated valves. This solution not only provides a number of advantages in the design phase but also in the installation, service and maintenance. When using TIG/MIG welding technology it is possible to install the ICF solution without removal of the function modules from the housing.

Supplied as a complete assembly, it is leak tested at high pressure and its functions are tested under factory controlled conditions. One code number equals one application solution.



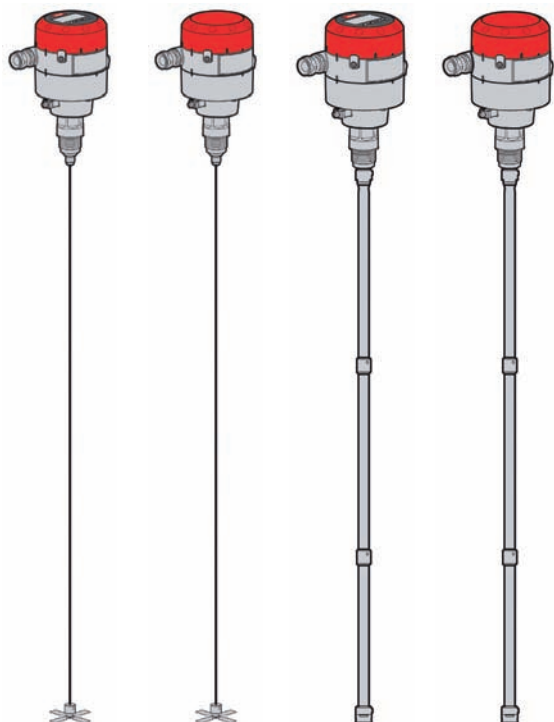
ICF control solution

## Liquid Level

As introduced in Cooling Matters Volume 3 - 2011 the new AKS 4100/4100U Radar Liquid Level Sensor uses the proven TDR technology (Time Domain Reflectometry) fully adapted to the Industrial Refrigeration segment and ensuring reliability and high accuracy.

All sensors in the new AKS 4100/4100U family are easy to install and fully flexible. No on-site calibration is needed, and the probe length can easily be adjusted on site.

Due to the very easy on-site adjustment procedure, with AKS 4100 you will experience significant time savings during installation.



AKS 4100/4100U Liquid Level Sensors

## Gas Detectors

Although ammonia's distinctive odour makes it 'self-alarming' when a leak occurs, social sensitivity and strict regulations make it essential to install gas detectors. The Danfoss Gas Detection program, type GD is a range of products designed to meet all industrial refrigeration applications.

GD sensors incorporate an interchangeable pre-calibrated sensor board, which makes it very easy to replace the sensor when service or calibration is required.



GD Gas detectors

The GD products feature reliable, real time continuous monitoring. No blocked filters, tubes or technical / maintenance problems experienced by air sampling / aspirated systems. For ammonia the type GDA offers a range of products from 0-100 ppm up to 0-30,000 ppm.

## Danfoss solution for DX ammonia applications

Traditionally ammonia is used in "flooded" systems where the refrigerant remains in a liquid state. However, it is also possible to use ammonia in a direct expansion (DX) system whereby an expansion device facilitates a change of state of the refrigerant from liquid to vapour.

A combination of a motorised valve (ICM/AKVA) and an electronic controller (EKC 315A) together with a pressure sensor and a temperature probe helps meet the challenge of using ammonia in compact DX chillers. The system has a very short response time, and it maintains a very stable, low superheat level under all load conditions, thereby minimising the risk of liquid flow back to the compressor and maximising energy efficiency.



ICM/AKVA & EKC 315A for DX ammonia applications

These are just some of the products and solutions Danfoss can offer for ammonia refrigeration systems, other products in our range include expansion devices, solenoid valves, line components, pressure and temperature regulators, stop and regulating valves, safety valves, electro mechanical controls, electronic controls and transmitters, variable speed drives and heat exchangers.

Contact your official Danfoss Wholesaler or local Danfoss Sales office for assistance with your ammonia refrigeration system needs.

For further information on natural refrigerants please visit the Danfoss Solutions Ready website @ [www.danfoss.com/SolutionsReady/](http://www.danfoss.com/SolutionsReady/)

Other Cooling Matters articles on natural refrigerants can be found on the local Danfoss website @ [www.danfoss.co.uk/coolingmatters](http://www.danfoss.co.uk/coolingmatters)

# Increasing Interest for CO<sub>2</sub> Refrigeration – and not only from an Economic Perspective

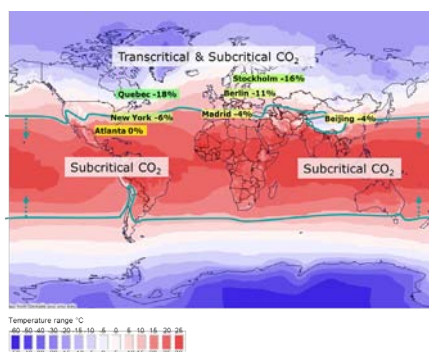
It is no longer only the Scandinavian countries, who show interest for refrigeration systems with CO<sub>2</sub> as the refrigerant. More supermarket chains in Great Britain are installing CO<sub>2</sub> systems and it is also spreading to other European countries. Lately the Danish Danfoss sales company has experienced an interest from South American countries, who would like to learn more about how to build various CO<sub>2</sub> systems.

Historically CO<sub>2</sub> systems have been seen as a Scandinavian phenomenon because it was considered that CO<sub>2</sub> was only feasible in relatively cold climates. However, it has become apparent that it can compete against traditional refrigeration plant even in the warmest months in Denmark where there the energy consumption should be higher.

It is however not only Danfoss who is of the conviction that CO<sub>2</sub> systems can be feasible in many different climates. The large supplier of refrigeration solutions to supermarkets, Carrier, is installing more and more CO<sub>2</sub> systems. In an article published on the website [www.r744.com](http://www.r744.com) on the 7th of December 2011 they say that their studies show that CO<sub>2</sub> installations can be feasible in climates with an average temperature of up to 20-26°C. They further more say that in 2012 they will start tests on their second generation of transcritical CO<sub>2</sub> systems to prove that they are at least as energy effective as traditional HFC refrigeration plant in all European climates.

Illustration 1, which shows the possible efficiency savings in comparison to R404A systems has been revised due to installation of both medium and low temperature CO<sub>2</sub> systems that has proven the feasibility of using CO<sub>2</sub> in all climates..

The new interest, that Danfoss is experiencing, is not based on instant economic savings or profitability but more from an environmental aspect. The two South American countries - Chile and Brazil, from where the installers came to Danmark to learn



*Illustration 1 shows average yearly temperatures and expected possible savings comparing to a plant with R404A. (Source: Map made by <http://globalis.gvu.unu.edu>)*

more about CO<sub>2</sub> systems, have climates which hardly make CO<sub>2</sub> installations profitable from just an energy consumption perspective. Further more these countries do not have duties on the environmentally damaging refrigerants as for example R404a, duties that are implemented in many European countries.

The driver behind the interest for CO<sub>2</sub> in Chile and Brazil is on the contrary a focus on the environment. There is from society a large focus on the fact that we have to show more consideration to the environment in many different processes. Therefore the installers experience an increasing interest for CO<sub>2</sub> systems from supermarket chains, because this will make them able to reduce their "Carbon Footprint" considerably. This also gives the supermarkets the opportunity to portray themselves with a green profile.

In Denmark the installers experienced, how it is possible to use CO<sub>2</sub> in supermarket cooling and also in cooling of large distribution centres with a capacity of up to 1,5 MW. The type of installations were both cascade and transcritical systems.

The primary concern of the installers in regards to CO<sub>2</sub> was the high pressure which is necessary in these types of systems. However after they saw the installations and learned about the different solutions and the development

the systems have been through they felt better equipped to return to their home countries and start building CO<sub>2</sub> refrigeration plant. Because of the climates in Brazil and Chile the most profitable type of installation would probably be a cascade system. Examples of booster and cascade systems can be seen at the end of this article.

From a broader perspective there are more advantages with a CO<sub>2</sub> installation than just the economical profitability that you get up front together with less damaging impact on the environment when you compare CO<sub>2</sub> with HFC.

In the cooling process a CO<sub>2</sub> system develops an amount of heat which gives you the possibility for heat reclaim, which can be used for heating of the remaining buildings.

The heat surplus can also be used for heat driven air condition systems (sorption) which can then be used as air condition in the buildings.

As many synthetic refrigerants are imposed with a duty or are in the risk of having duties added companies who switch to CO<sub>2</sub> will also be minimizing the economical risk linked with using a refrigerant regulated by political measures.

Establishing a CO<sub>2</sub> installation today is slightly more expensive than a traditional HFC refrigeration plant but there are indications that the costs are becoming more alike.

## What are the environmental "savings"?

By changing to CO<sub>2</sub> the yearly potential for environmental "savings" can be illustrated with an example from a Danish supermarket chain. The example is calculated on approximately 800 stores with a number of different plant sizes:

- Yearly leakage (10% of the plans charge) equal to apx. 18 mio. kg. CO<sub>2</sub>
- Yearly energy savings with CO<sub>2</sub> (10%) equal to apx. 1 mio. kg. CO<sub>2</sub>
- Total yearly reduction of apx 19 mio. kg. CO<sub>2</sub>

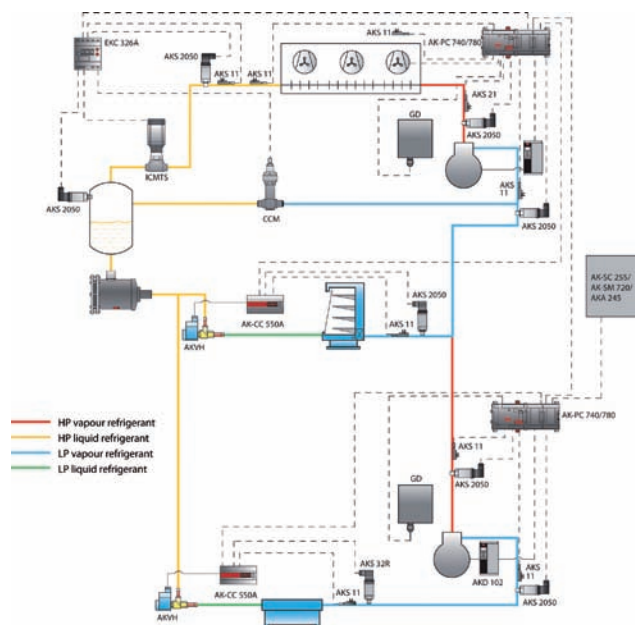


If this is converted to driven km in a modern car, releasing 99 g. CO<sub>2</sub> per km. (eg Golf Blue Motion) this equals:

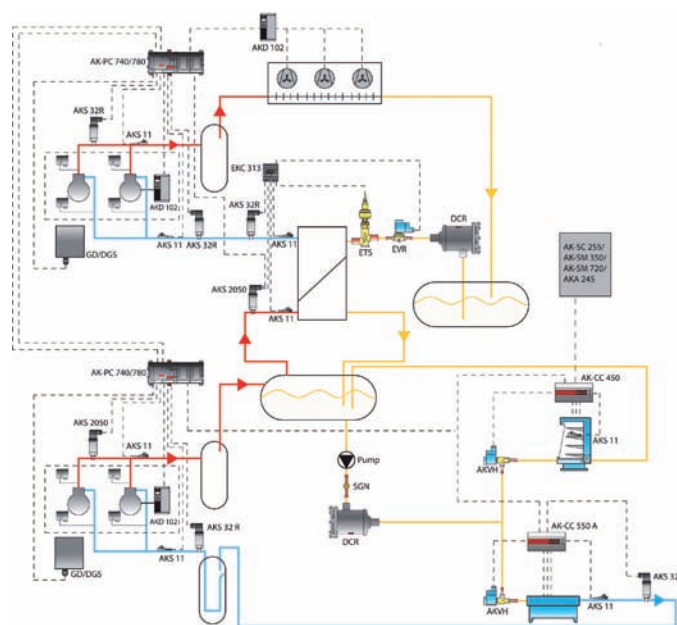
- 193 mio. km. or
- Almost 13,000 cars yearly emission at 15,000 km/year

Danfoss is a global leader within energy efficient solutions which help to reduce CO<sub>2</sub> and thereby fight the global climate changes. Today Danfoss already offers many solutions that can reduce the amount of CO<sub>2</sub> released into the atmosphere. You can read more about the solutions on the international web

page [www.solutionsready.danfoss.com](http://www.solutionsready.danfoss.com), where exciting articles on technologies within cooling of food, air conditioning, regulation of electrical engines, heating of buildings and solutions for renewable resources. Technologies that can help fight the climate changes and also make modern living possible in the future.



Transcritical Booster System

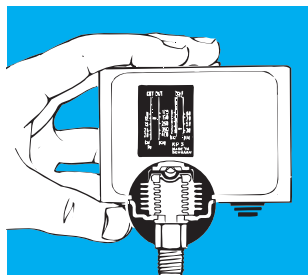


Cascade System

For further information on CO<sub>2</sub> please visit the Danfoss dedicated website at [www.danfoss.com/co2](http://www.danfoss.com/co2) where you will find information on products and applications for CO<sub>2</sub> including the recently updated leaflet "Components for CO<sub>2</sub> applications in Industrial Refrigeration" (DKRCI.PA.000.D3.02)

## Pressure Controls

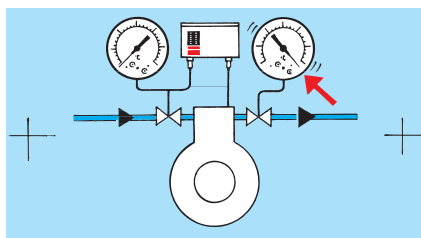
**The actual pressure in the system at the point monitored by the pressure control is usually provided via a branch line or – if the pressure control is installed directly on a line – applied directly to the pressostat. The pressure actuates a potential-free set of contacts that can be used to control a device such as a compressor or a fan.**



### The job of a pressure control

What are these controls good for, and why are they necessary? Let's start with the function of a low-pressure control in a compressor refrigeration system. Low-pressure controls, which

are usually fitted close to the compressor on the suction side, are most often used to protect the compressor by switching it off if there is not enough refrigerant. The reason for this is that a loss of refrigerant in the system can lead to a variety of problems. For example, suction gas cooling is reduced, which especially with compressors that rely entirely on suction gas cooling is a major problem.

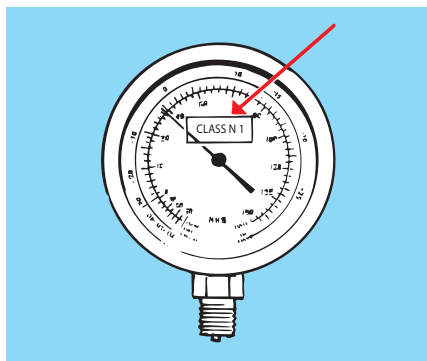


In addition, compressor oil always escapes in addition to the refrigerant because it is constantly passing through the entire refrigeration circuit along

with the refrigerant. This can lead to insufficient lubrication. It is thus very beneficial to switch off the compressor as a precautionary measure if the low pressure level drops sharply, in order to avoid compressor damage or total failure of the compressor. It should be noted that the low-pressure control can also shut off the compressor for reasons other than a shortage of refrigerant. If a problem with low-pressure control-off occurs, the service fitter should always check the volume flow rate of the media cooled in the evaporator. If it is too low due to some other malfunction, there is probably not a shortage of refrigerant. A simple example here would be a defective evaporator fan or a defective pump with a water chiller unit (refrigerant/water evaporator). In the latter case, however, the flow switch in the water circuit should have also tripped, as otherwise there would be a risk of evaporator icing (and breaking).

### Pump-down and pump-out circuits

A low-pressure control can also be used for control purposes. For example, it is used in pump-down and pump-out circuits (which are commonly used in refrigeration systems) to switch off the system when the compressor is switched off for control reasons (such as when the switch-off temperature of the thermostat is reached). This occurs when the pressure resulting from closing the liquid solenoid valve while the compressor continues to run has been sucked down from the liquid solenoid valve through the evaporator all the way to the suction side.

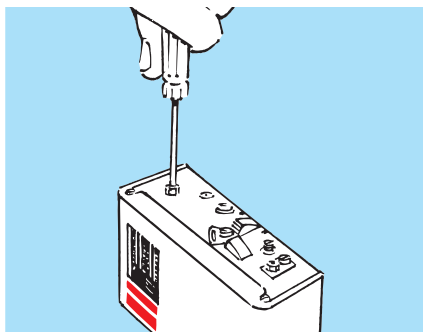


When a certain threshold value is passed, the low-pressure control shuts off the system. When the switch-on temperature of the room thermostat has been reached again after a while and the solenoid valve opens, the pressure in the suction line rises and the low-pressure control starts the compressor again when the pressure exceeds its switch-on point.

### High-pressure safety controls (DWK – DBK – SDBK)

One application for high-pressure controls is the high-pressure protection. The EN 378 standard specifies that a high-pressure control must always be fitted in a commercial refrigeration system. Its purpose is to switch off the compressor, which is normally the primary source of pressure in a compressor refrigeration system. If the allowable operating pressure has been reached and an overpressure situation arises, the compressor is switched off by the high-pressure control and the pressure on the high-pressure side decreases.

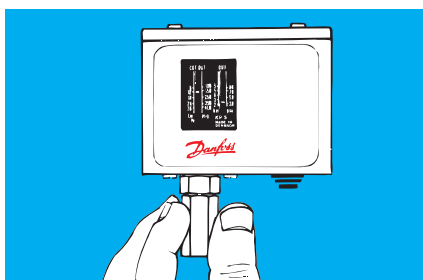
High-pressure safety controls for this purpose are classified into three types: with automatic reset (DWK), with manual reset by hand (DBK) and by tool (SDBK).



With an automatic reset (DWK) version, it is always possible for the system to be switched on again automatically after the pressure decreases by a certain amount. With a manual reset by hand (DBK) KP, a manual reset must be performed after a protective switch-off. It must be possible to initiate this reset by hand without using a tool. Finally, with a manual reset by tool (SDBK) device a tool is necessary to perform a manual reset.

### Condenser fan control

Another possibility on the high-pressure side is to use a pressure control to control the condenser fan. This provides an economical alternative to a variable-speed fan control for ensuring that the condensing pressure does not drop too low, especially in cold weather. This option is especially attractive for very small commercial refrigeration systems, which are naturally quite cost-sensitive, as well as for larger systems with three-phase fans for which a variable-speed controller can be very costly.



### Types of construction

There are basically two types of construction for pressure controls. The first type is an adjustable standard pressure control for wall mounting, and the second type is a cartridge-type pressure control. Wall-mounted pressure controls (such as the Danfoss KP) are especially popular with fitters. They have an adjustable switching pressure, and the tubing does not have to support their entire weight. In addition, it is possible to fit the pressure control remotely in a machine cabinet

at the front of the system, which can distinctly increase accessibility and ease of servicing. By contrast, a cartridge-type pressure control is the solution preferred by mass-production manufacturers because its fixed setting cannot easily be modified in the field by unauthorised persons. In addition, cartridge-type pressure controls are usually very inexpensive.

### Contact rating

An important consideration when using pressure controls with potential-free contacts is the contact rating. This can be confusing at first because manufacturers generally specify three different contact ratings. Which value should you be guided by? The three values are normally given for the following cases: a pure ohm load (the highest load is traditionally possible in this case), a partially inductive load, and a purely inductive load. An example of a pure ohm load (load designation: AC 1) is an electrical (resistance) heater for defrosting. An example of a partially inductive load (AC3) is an electric motor (which also includes compressors).



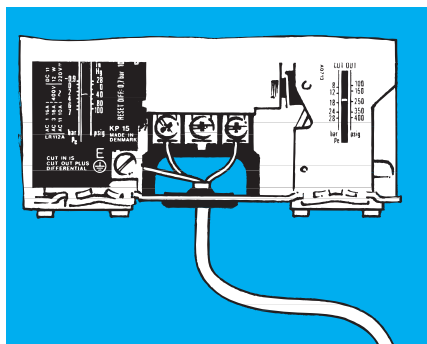
On the other hand, a coil (AC 15), such as the coil of a solenoid valve, acts as an inductive load on the contacts of a pressure control.

### Electrical connection

A standard pressure control with changeover contacts normally has three contacts to which the conductors of the electrical cable can be connected. The functions of these three contacts are 'phase in', 'fault', and 'phase out (to the motor)'. If only two contacts are wired, it does not make any difference which of the two phase contacts is connected to each conductor. The 'fault' contact is rarely used. It could possibly be used for a fault indication, such as driving a red signal lamp or sending a signal to a remote maintenance station.

With the Danfoss KP1 (low-pressure control), the 'phase in' connection is contact 1 and the 'phase out' connection is contact 4. If it is desired to use

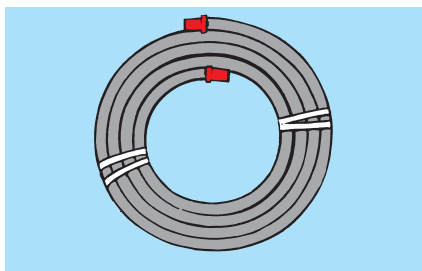
the fault function, a connection can be made to contact 2 (please note that in case of pump down the fault contact is active). Here it is important to note the connections for the KP7 high-pressure control are not the same. Although the 'phase in' connection is still contact 1, the 'phase out' connection is contact 2, while contact 4 is for the fault signal. This may appear confusing, but it is easy to explain the logic of this for service fitters, using the KP pressure control as an example. After removing the plastic cover, you will see the set of contacts at the right. They are labelled '1', '2' and '4'. With a KP 1 low-pressure control, contact 4 is at the top and contact 2 is at the bottom. The switch-off condition occurs when the pressure drops (for example, due to a shortage of refrigerant). As the bellows of the pressure control always moves upward with increasing pressure (the bellows expands) and downward with decreasing pressure, switch-off must occur when it moves downward. This means that contacts 1 and 4 of a KP1 should be used for the connecting circuit between the AC mains and the compressor.



By contrast, with a KP7 high-pressure control the switch-off occurs when the bellows moves upward. As contact 4 is always at the top and contact 2 is always at the bottom, the conductors must be connected to contacts 1 and 2 in this case. In the case of a dual pressure control, which combines a high-pressure control and a low-pressure control (with the exception of the Danfoss KP7BS, which contains two high-pressure controls – DBK and SDBK), there are versions with a low-pressure fault contact or two fault contacts (high-pressure and low-pressure). Using a dual pressure control eliminates installation of a second electrical cable and a second mounting bracket. In addition, a dual pressostat is usually less expensive than two pressure controls.

### Refrigeration circuit connection

When connecting a wall-mounted pressure control to the refrigeration circuit, you should pay particular attention to the fact that high-pressure controls for safety functions (such as KP7W, KP7B, KP7S, and KP7BS) must always be connected using a branch line with an inside diameter of at least 4 mm. In other words, 6-mm copper tubing must be used. Of course, it is also possible to use a special plastic connection line for refrigeration systems, such as has become fashionable in the last 15 years, with an inside diameter of at least 4 mm.



Pressostats for condenser fan control and low-pressure controls can also be connected using capillary tubing, although many system builders always use 6-mm copper tubing or alternative plastic tubing for all pressure controls for the sake of appearance and to avoid unintentional blockage or pinching of capillary tubing.

### Manual testing

A manual test of switch operation should only be performed in exceptional cases. If such a test is absolutely necessary, it can be performed with a KP pressure control by inserting a screwdriver from the front side.

Use the screwdriver to raise the steel

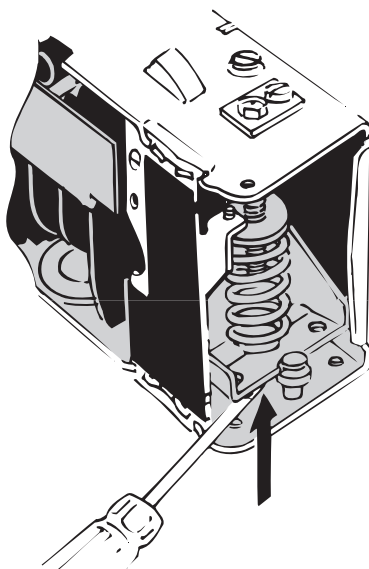


plate attached directly to the bellows in order to simulate an upward motion of the bellows (increased pressure). This test should be performed with extreme care, and it should only be performed under exceptional circumstances.

### IP protection class

The IP protection class can also be an important consideration, depending on local circumstances and ambient conditions. The first digit of the IP protection class code (e.g. 'IP54') stands for the degree of protection against object penetration, while the second digit stands for the degree of protection against water. An IP class of IP4x means that it must not be possible for a wire with a diameter of 1 mm to penetrate the device. IPx4 means that the device is suitable for use with splashed water from all directions. Generally speaking, it can be said that the higher the protection class, the better the device is protected against dust, dirt particles and moisture.

Standard Danfoss KP pressure controls have a protection class of IP33 with respect to the effects of dust and moisture if they are not fitted with a top cover. If the top cover provided with the control is fitted, the protection class is increased to IP44.

A protection class of IP55 can be achieved by using an accessory protective housing. If an even higher IP protection class is desired, you can use the RT series, which is designed for especially harsh environments.

The controls in this series have a protection class of 54 to 66, depending on the model.





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 Denmark  
 WWW-Address: > [www.danfoss.com](http://www.danfoss.com)  
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