ENGINEERING
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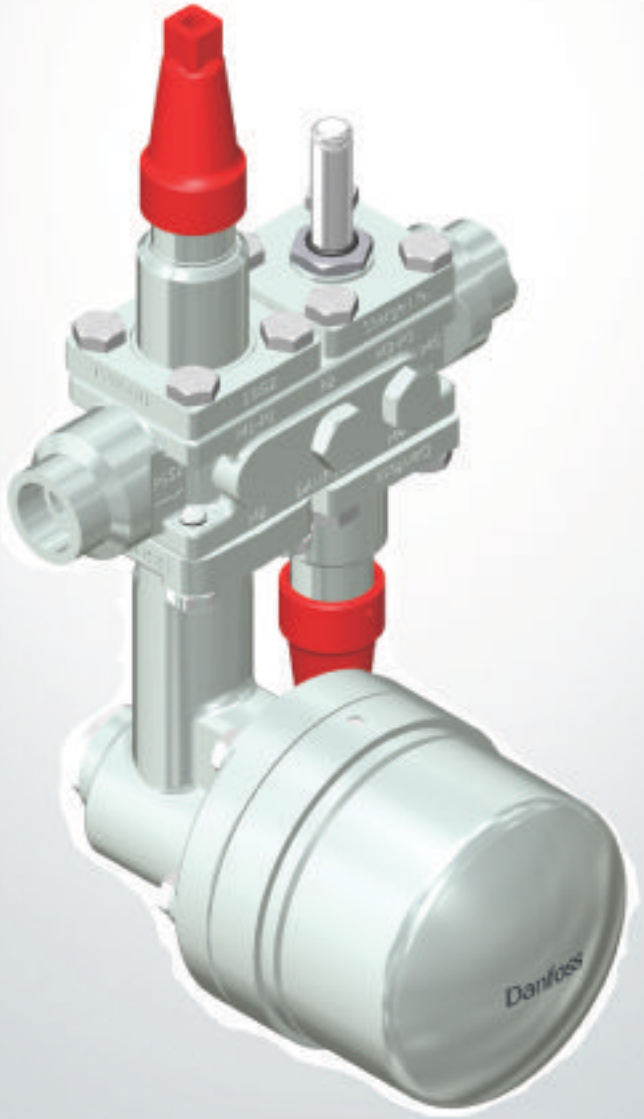
Application Guide

ICFD defrost module
Supplemental application guidelines



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Introduction

This ICFD supplemental application guide describes the special requirements to be taken into account when designing the liquid drain line with ICFD defrost module.

Liquid drain

Liquid drain method is the most energy efficient method. The method ensures that only liquid condensate is drained back to the suction accumulator and minimizing the hot gas consumption.

ICFD liquid drain module (ICFD 20 / ICFD 20-C)

Float operated valve module. The module opens for liquid flow when the float is lifted by the internal liquid level. The ICFD is a balanced type of float valve suitable for high differential pressure. The ICFD is available in two different versions.

ICFD 20 (ammonia)
Is specifically designed for ammonia. In order to operate with low density fluids, the float is manufactured with a very low weight.

Table 1: ICFD 20 (ammonia)

Description	Values
Maximum differential pressure	15 bar/218 psig
Minimum densitet	610 kg/m^3 /38,0 lb/ft^3
Max working pressure with float	28 bar/406 psig

NOTE:
If the refrigeration system includes ICFD 20 module, the test pressure of the system must not exceed 28 bar/406 psig, unless the ICFD float ball is dis-mounted during the pressure test.

CFD 20-C (CO_2)
Is specifically designed for CO_2. In order to operate with high pressure, the float is manufactured with a large wall thickness, and therefor has a higher weight.

Table 2: ICFD 20-C (CO_2)

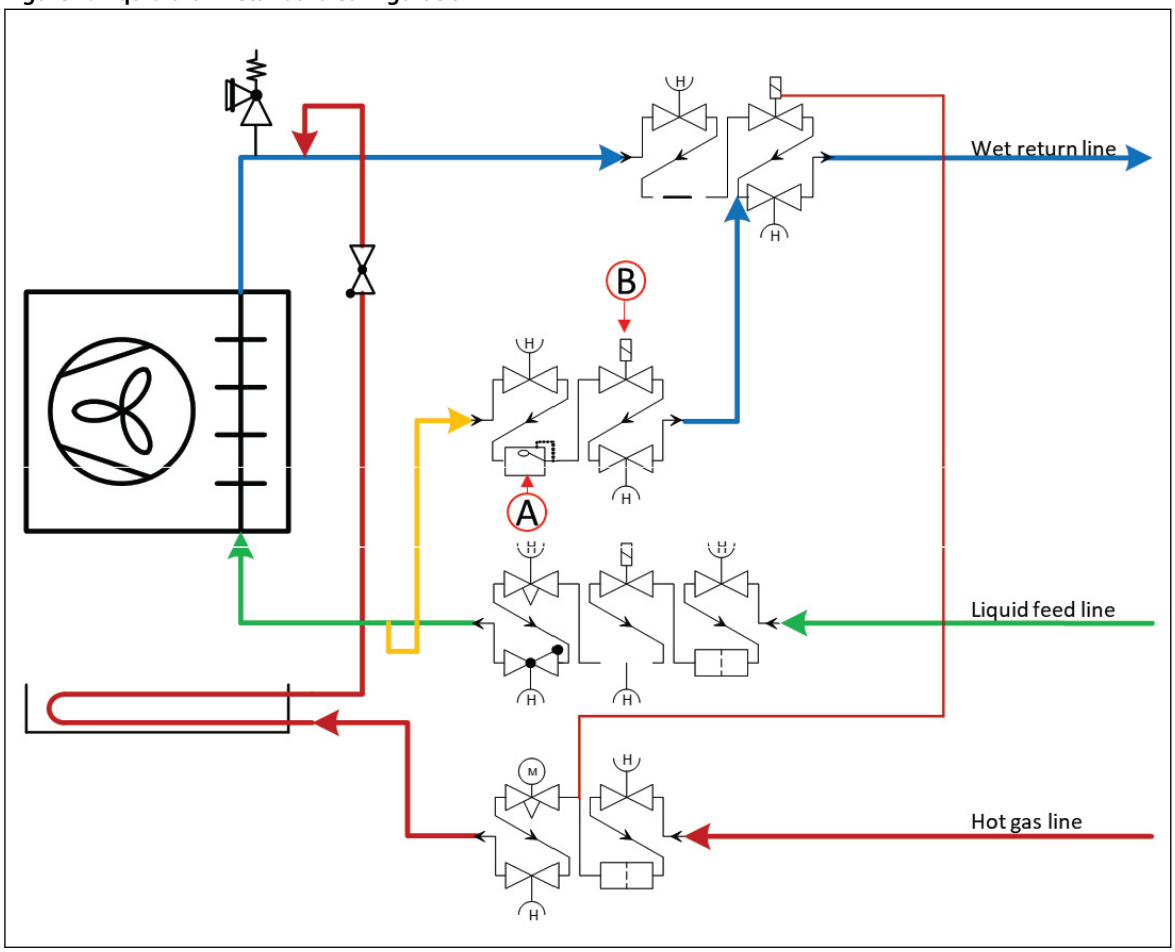
Description	Values
Maximum differential pressure	36 Bar/522 psig
Minimum densitet	860 kg/m^3 /53,7 lb/ft^3
Max working pressure with float	52 bar/754 psi

NOTE:
If the refrigeration system includes ICFD 20-C module, the test pressure of the system must not exceed 52 bar/754 psig, unless the ICFD 20C float ball is dis-mounted during the pressure test.
ICFD liquid drain module is patent pending.

ICF liquid drain method

A common solution with “Liquid drain” is equipped with a solenoid valve function and liquid drain function (see the figuration in Figure 1).

Figure 1: Liquid drain "standard configuration"



A	ICFD (drain module) is the main function of the Liquid drain
B	ICFE (solenoid valve module) ensures that the drain line is closed off during freezing, in order to avoid any liquid bypassing the evaporator

ICF valve station with ICFC 20P1 loaded check valve

The ICFC 20P1 is designed to work together with the ICFD drain module in a pump circulating system, enabling a defrost solution without using a solenoid valve in the drain line.

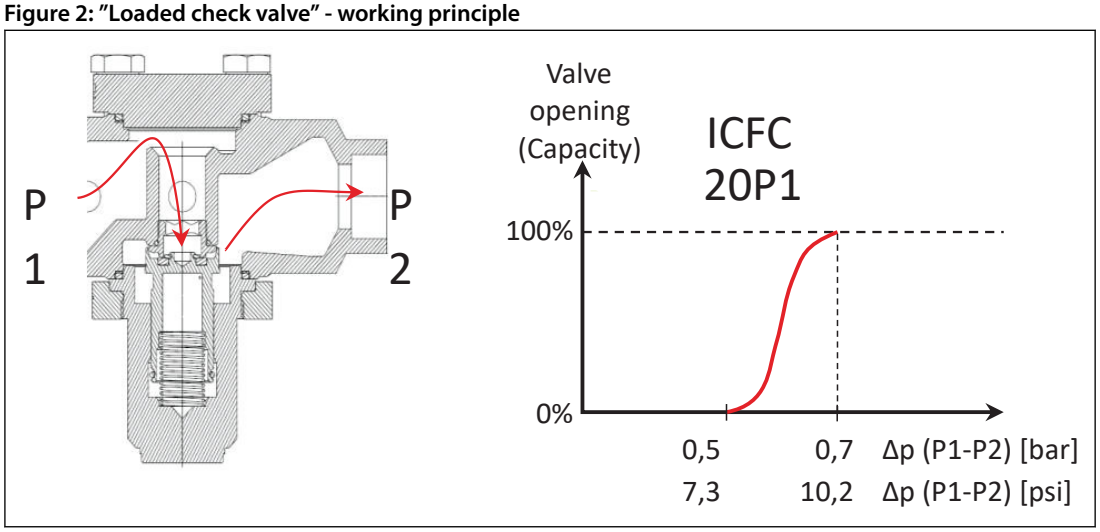
The function of the ICFC module, is to prevent that liquid refrigerant from the pump flow through the ICFD drain module when the evaporator is in freezing mode and at the same time has a high flow capacity when the evaporator in defrost mode. The ICFC 20P1 valve is designed with a special quick opening feature that ensure that the valve start to open when the pressure across the check valve module exceeds 0,5 bar (7,3 psi) and reaches full capacity @ 0,7 bar (10,2 psi). By this feature it is possible to make a defrost configuration where the traditional solenoid valve is replaced by an ICFC 20P1 loaded check valve without reducing the capacity.

Table 3: ICFC 20P1

Description	Values
Refrigerants	All
Opening pressure	0,5 bar/7,3 psi
Max working pressure	52 bar/754 psi

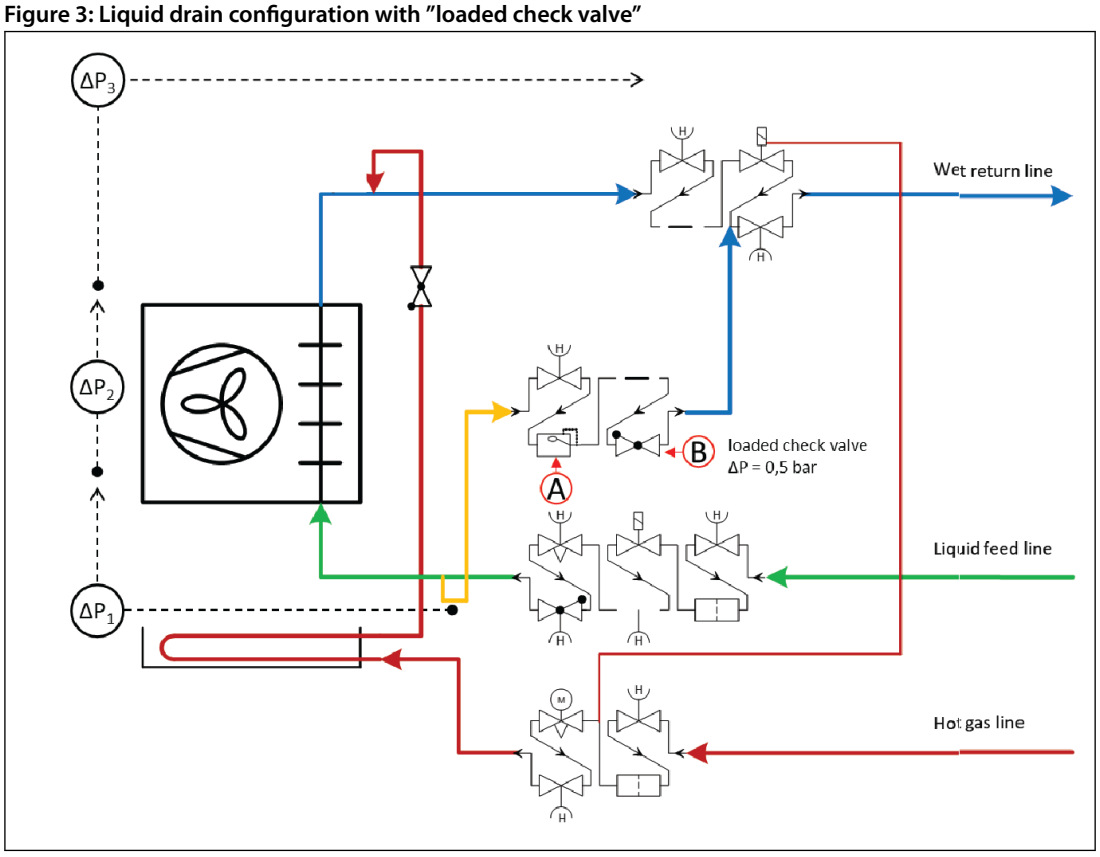
NOTE:
ICFC 20P1 loaded check valve is patent pending.

Figure 2: "Loaded check valve" - working principle



Evaporators and piping system may be designed differently, it is therefore important to validate that the total pressure drop ΔP across the evaporator and connecting pipes is less than 0,5 bar (7,3 psi) during freezing mode (see Figure 3).

Figure 3: Liquid drain configuration with "loaded check valve"



A	ICFD (drain module) is the main function of the Liquid drain
B	ICFC 20-P1 ("Loaded Check Valve") ensures that there is no liquid flow in the drain line during freezing mode and has a high capacity during defrosting mode
ΔP1	Pressure drop from valve station in the liquid supply line incl. liquid head pressure
ΔP2	Pressure drop across the evaporator (typically approx. 0,2 bar (29 psi) but can be higher e.g. for evaporators with distribution nozzles).
ΔP3	Pressure drop in wet return line incl. liquid head pressure

ΔP1 + ΔP2 + ΔP3 ≤ 0,5 bar (7,3 psi)

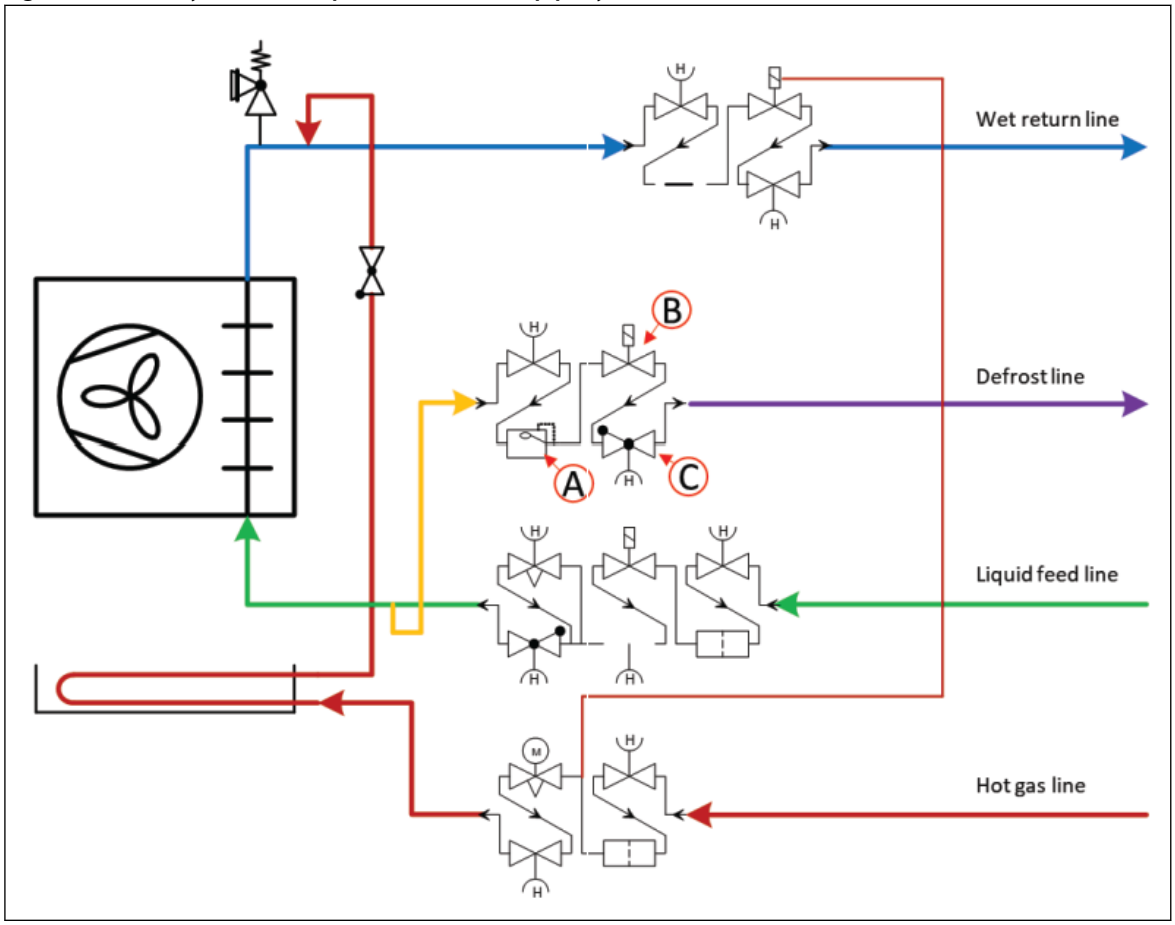
NOTE:
Some systems require more than 0,5 bar differential pressure = > ICFC 20P1 loaded check valve is not suitable. Be aware of systems with multiple evaporators connected to the same evaporator valve station, which normally requires additional regulating valves to balance the flow in each evaporator, or single evaporators systems designed in same way.

The loaded check valve ICFC 20P1 is not recommended to defrost systems draining to a higher pressure than suction pressure e.g. a low temperature system draining to the intermediate temperature (4-pipe system). In these systems standard ICFC 20 check valve is recommended.

Liquid drain to a separate defrost line

Liquid drain to a separate defrost drain line is designed to drain the condensate to a separate drain system, typical intermediate pressure. The system is often called a 4-pipe system. The benefit with this system is that the condensate is drained to a higher-pressure level in the system, and thereby slightly improving the efficiency of the system.

Figure 4: Defrost system with separate drain line (4-pipe system)



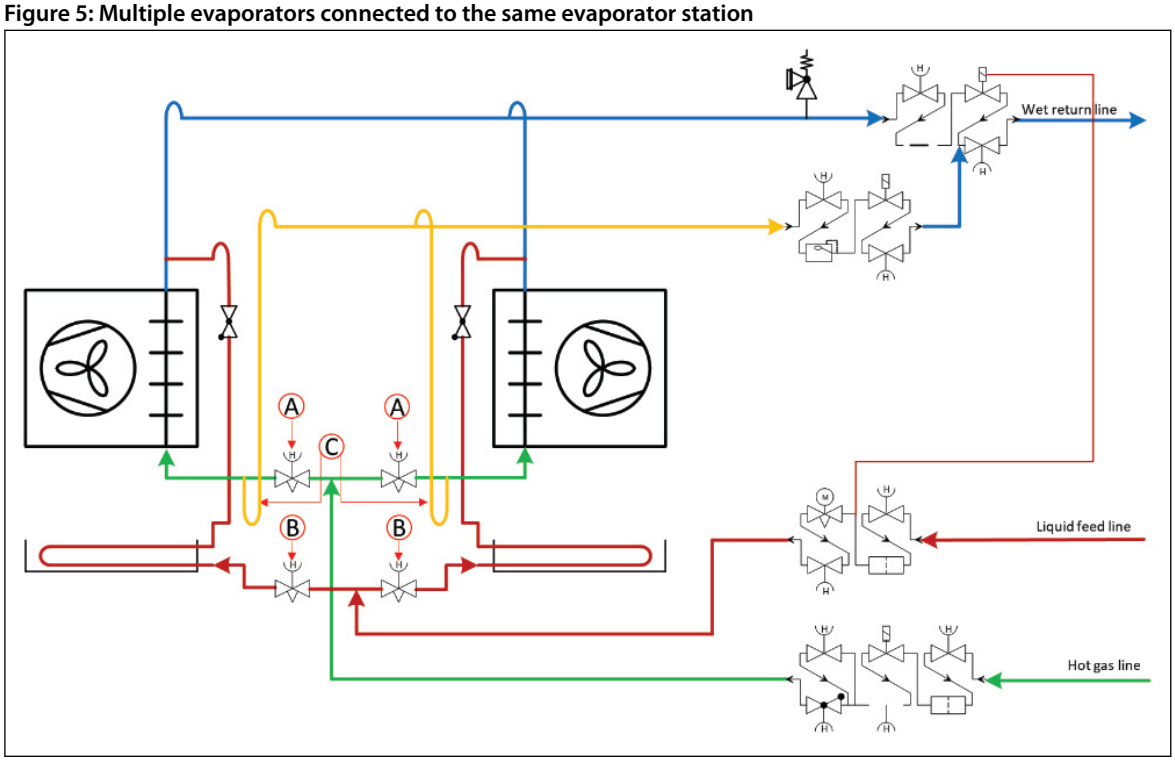
A	ICFD (drain module) is the main function of the Liquid drain
B	ICFE (solenoid valve module) ensures that the drain line is closed off during freezing mode
C	ICFC or ICFN (check or stop check valve) ensures that the pressure from the separate defrost drain line (intermediate pressure) is not pushed backwards into the low temperature liquid line during freezing mode (backflow)

NOTICE:
Due to low pressure drop in standard check valves, the capacity of the ICFD-liquid drain valve is not affected significant compared to the solution with “loaded check valve”.

Multiple evaporators connected to a common ICF evaporator station

The defrost system illustrated in figure 5 shows two evaporators connected to one common valve station. In order to ensure that such a system is operating properly, it is important that the freezers are equally loaded, and the refrigerant flow is distributed equally. It is furthermore important that the evaporators are installed at equal heights and are equipped with a good deep liquid trap (P-trap), in order to avoid that gas from one of the evaporators will block for the liquid flow from the other evaporator.

Figure 5: Multiple evaporators connected to the same evaporator station



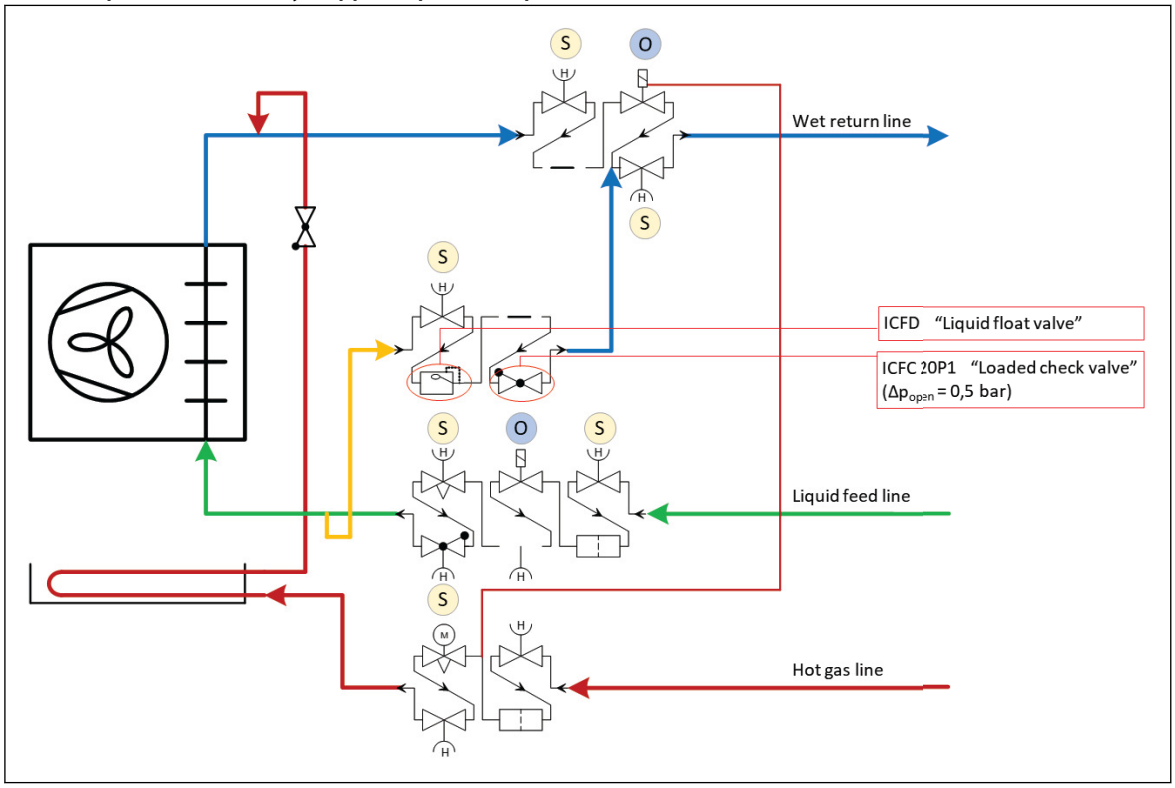
A	Adjusting/balancing valves to ensure equal refrigerant flow
B	Adjusting/balancing valves to ensure equal hot gas flow
C	Deep liquid trap (P-trap)

Protection of evaporators against excessive pressure caused by trapped liquid

The defrost system shown in Figure 6 has two solenoid valves, one in the liquid feed line, and one in the wet return line, but none in the liquid drain line. This mean that the ICFD drain module + loaded check valve (ICFC 20P1) are the pressure barrier between the pressure in the evaporator, and the pressure in the wet return line (liquid separator).

When designing a defrost system with ICFC 20P1 loaded check valve, and without any solenoid valves modules, the loaded check valve can be used to protect evaporators against excessive pressure caused by trapped liquid. The liquid drain valve is connected to the bottom of the evaporator, which will ensure that all liquid in the evaporator will be drained in the event of continuously heat input into the evaporator and avoid unintended pressure increase.

Figure 6: Evaporator station with ICFC 20P1 loaded check valve and the ICFD drain module preventing excessive pressure caused by trapped liquid in evaporator



O	"Operation" valve (solenoid valve)
S	"Service" valve ("locked")

If the pressure in the evaporator exceed more than 0,5 bar higher than the pressure in the liquid separator, the loaded check valve (ICFC 20P1) starts to open, and the liquid in the evaporator will flow to the ICFD drain module, which will then open.

Assuming all stop valve in the evaporator station are treated as “service valve” (S) - (valve only accessed by competent persons), and only solenoid valves are active “operation valves” (O). If liquid refrigerant is present in the evaporator there is a risk of trapped liquid (see Figure 6). Systems having a liquid drain valve and loaded check valve in drain line are protected against trapped liquid. Trapped liquid (100% liquid) => drain valve open and loaded check valve opens @ Δp = 0,5 bar.

Mtv (max trapped volume for ICFD + ICFC 20 P1):
Mtv = 883.23*Kv100 [l] = 883.23*1.116 = 985 Liter (at Kv of 1.116 m^3/h)

NOTE:
The drain valve has a build-in parallel bleed orifice (ø 1,25 mm ~ Kv = 0,064 m^3/h).

In defrost system with 3 solenoid valves, one in the liquid feed line, one in the wet return line and one in the liquid drain line, the evaporator must be protected against excessive pressure caused by trapped liquid in a proper way (see example in Figure 1).

Installation

Figures 7 to 9 shows the most common evaporator types.

If the defrost system is designed with the ICFD liquid drain method, all types of evaporators must be connected to the ICF valve station with the same piping configuration.

- Condensate drain outlet at the lowest pipe of the evaporator
- Hot gas inlet at the top pipe of the evaporator

The ICFD module is designed for drainage of primarily liquid. The gas in the system at the beginning of the defrost process is drained only through a small parallel bleed orifice, built into the ICFD module. For a correct defrost of the evaporator, it is important that all liquid can be drained from the evaporator during the defrost sequence.

Figure 7: Bottom feed

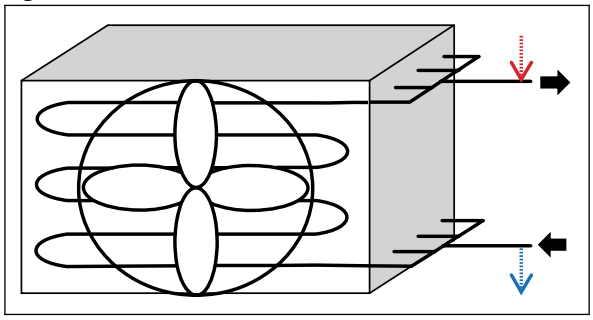


Figure 8: Top feed with distribution nozzles

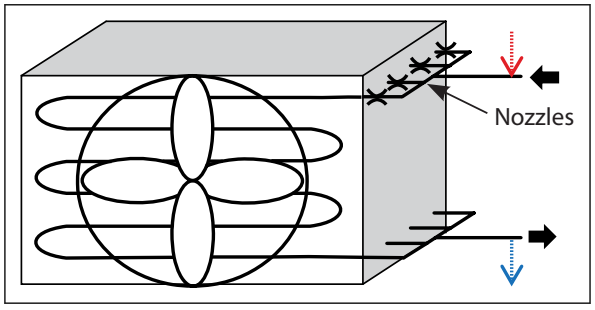
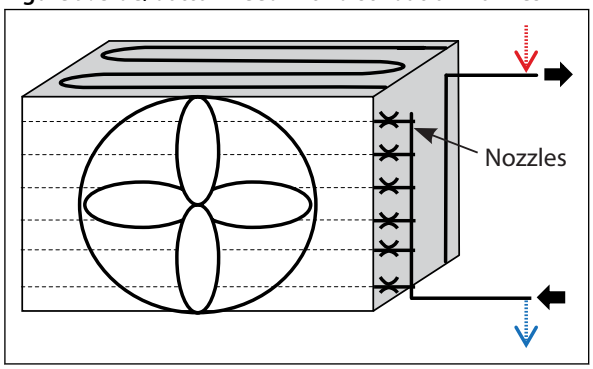


Figure 9: Side/bottom feed with distribution nozzles



Hot gas inlet Condensate drain

Drain line

During piping layout, take all precautions to minimize the pressure drop to avoid flash gas. Any pressure loss will reduce the liquid drain capacity.

For Evaporators with distribution nozzles at the drain outlet (side/bottom feed in Figure 9), the liquid passing the nozzles during defrost will create a certain pressure drop in the drain line. This pressure drop must be taken into account To minimize total pressure drop the lifting height of the liquid should not exceed 5 m (16.5 ft) (see Figure 10 and Figure 11).

To calculate the total pressure drop for ICF with ICFD included, the Danfoss selection tool Coolselector®2 is recommended.

Always install a P-trap at the drain line connection to the evaporator to collect the liquid The optimum piping layout for the liquid drain line is a separate line for the defrost drain (see Figure 10). By this set-up the dimensions of the liquid drainpipe can be determined for optimized liquid velocity and liquid volume and thereby reducing pressure loss. Figure 11 shows alternative piping layouts for the defrost liquid line. An acceptable option is to use the existing liquid line provided that a P-trap is installed.

During piping layout, take all precautions to minimize the pressure drop in the hot gas line to ensure sufficient defrost pressure (temperature) in the evaporator. Any pressure loss may reduce the defrost capacity.

For evaporators with distribution nozzles at the hot gas entrance (top feed in Figure 8), the gas passing the nozzles during defrost will create a certain pressure drop in the hot gas line. This pressure drop must be taken into account when determining the total pressure loss.

For calculation and optimizing of the pressure losses in both liquid drain line and hot gas line the Danfoss selection tool Coolselector®2 is recommended.

The liquid drain setup with ICFD does not include any control of the pressure during defrost. It is therefore recommended to consider the following: If the hot gas supply pressure is higher than the pressure required for defrosting, it is recommended to install a pressure reducing valve like ICS/CVC ahead of the hot gas valve station to prevent too high hot gas pressure entering and potentially damaging the evaporator. The CVC should be set to the pressure intended for the defrost process.

Figure 10: Best solution (Optimized liquid velocity and volume). Always install P-trap

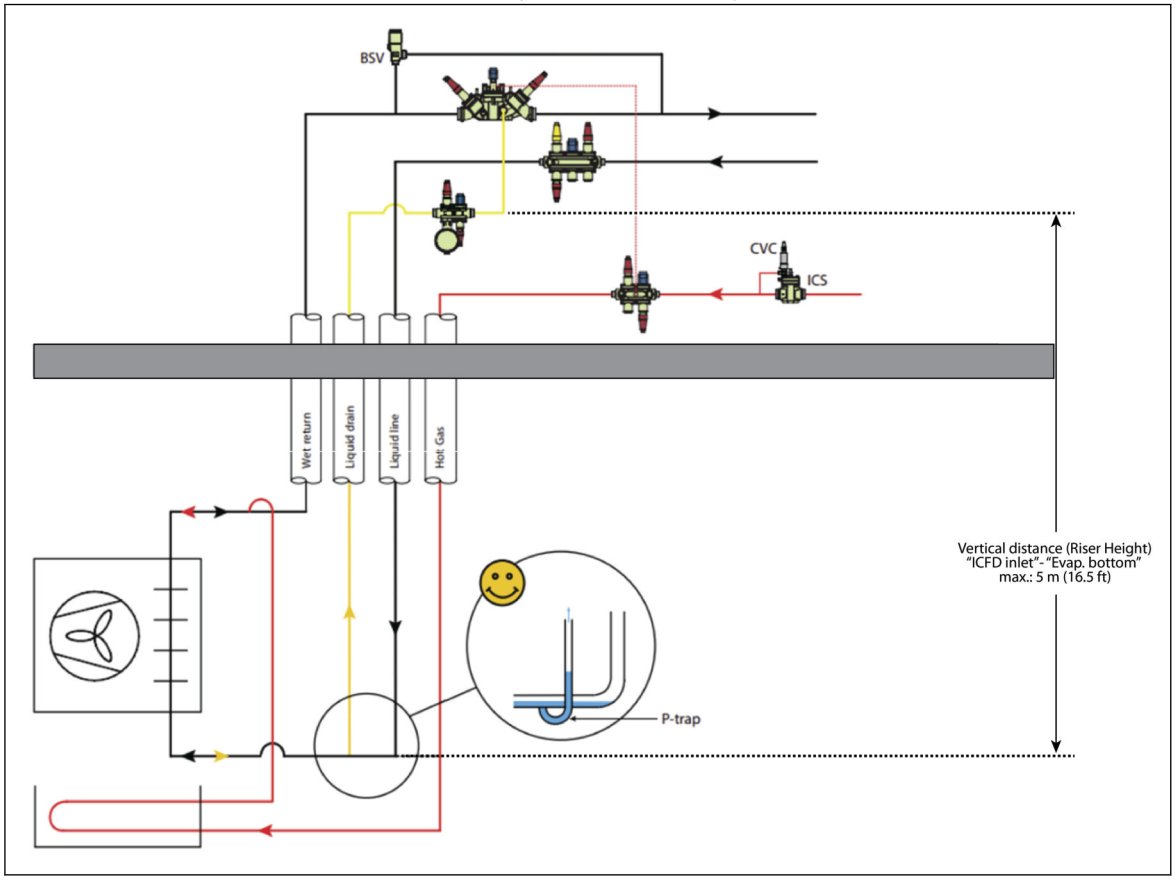
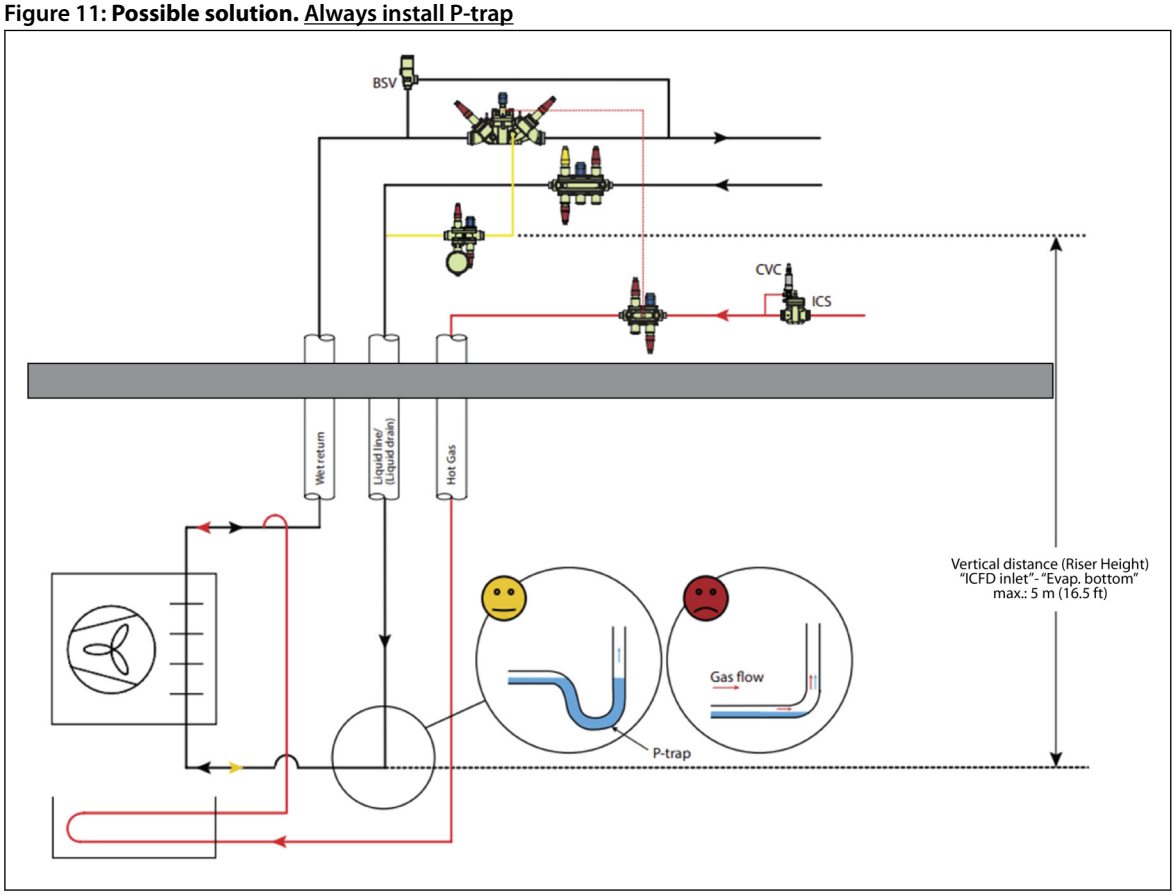


Figure 11: Possible solution. Always install P-trap



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