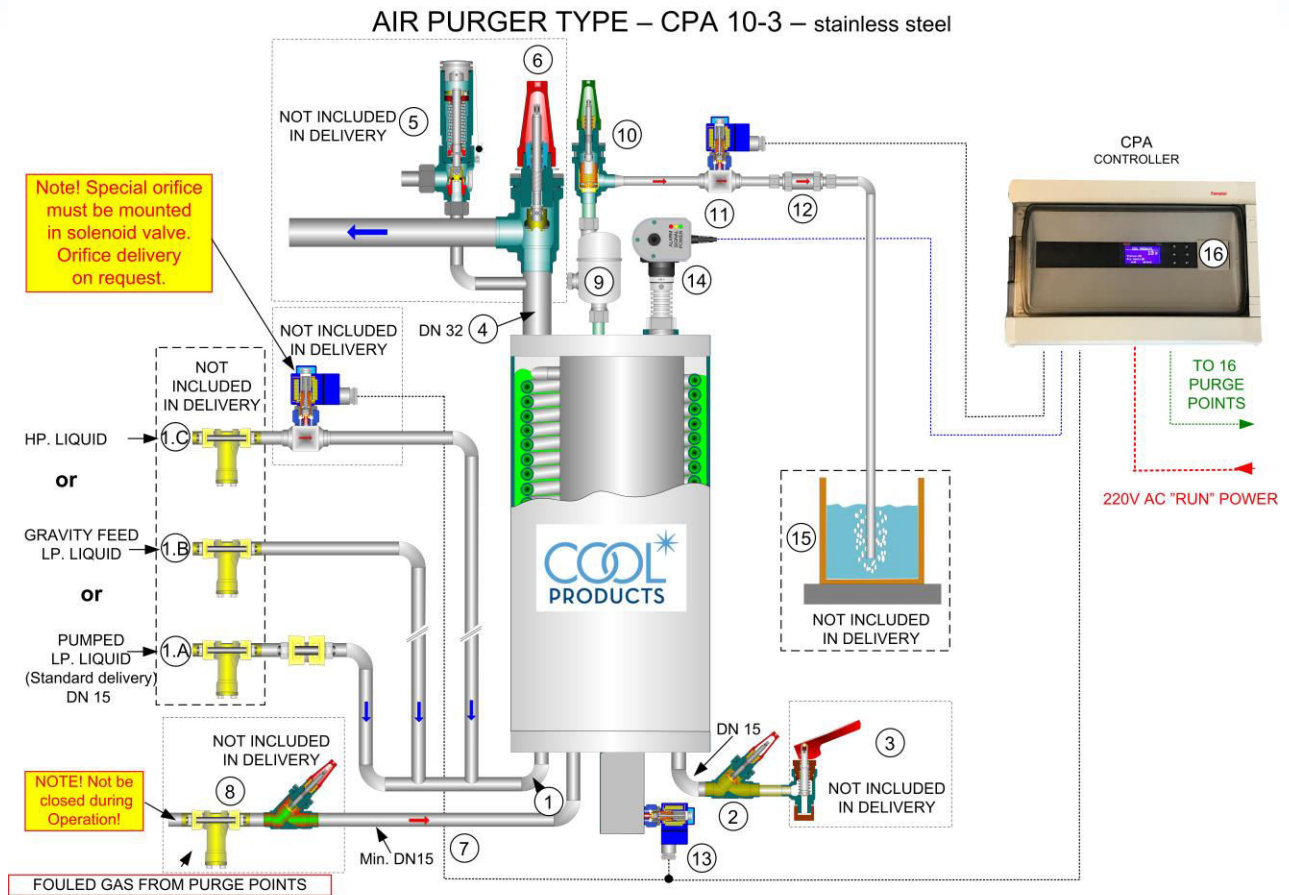


Air purger type CPA 10-3 instruction

(rev. 2, 29-04-19 Per Skærbæk Nielsen)



Cool Products Air purger nominal condensing capacity 10 kW Mk. 3

Description

The heat exchanger in the air purger has a nominal design capacity of 10kW at 10°C differential pressure / temperature between suction pressure and condensing pressure on the system it is connected to. At larger pressure/temperature differences the capacity increase to a maximum of 13kW. The low-pressure side connected to the air purger needs to be able to deliver this capacity. On the high pressure side the air purger draws refrigerant gas and non condensables into the purger with a nominal capacity of 10kW. The refrigerant gas is condensed to liquid and the air (non-condensable gas) is separated and will be vented out of the air purger at condensing pressure when the inner chamber reaches its max. air storage limit.

The energy cost of running the air purger on the refrigeration system can be calculated the following way: $10 \text{ kW} \times 1 / \text{system COP}$. If system COP is 3 the energy cost of running the air purger will be $10/3 = 3.3 \text{ kW}$ power consumption

Once the air purger gains access to large pockets of air, its capacity will be very large and not limited to the condensing capacity of the coil as illustrated in below table.

Purge Flow by volume at condensing pressure
Liters/minute

CT / °C	At condensing pressure	At atmospheric pressure
10	5.23	47.8
15	5.27	56.0
20	5.30	65.2
25	5.33	75.5
30	5.36	86.9
35	5.40	99.5
40	5.43	113.3
45	5.46	128.4
50	5.48	144.9

The table outlines the amount of air purged per minute from the air purger as a function of the condensing pressure.

The column to the right gives the volume of air purged in liters/min. at 1 bar atm pressure.

The column in the middle gives the volume of the air purged in liter/min. at the corresponding condensing pressure.

The mass flow is the same for the two values at the same condensing pressure. The value in the middle will tell how much space the air occupied on the high pressure side of the system.

By using the table the purged volume of air can be calculated, from the total time the purge solenoid valve has been opened.

Example:

If the purge solenoid valve has been open 10.250 seconds since the last venting and the average condensing pressure has been 30°C, the purged air (non condensable gas) volume will be:
 $10250/60 = 170.83$ minutes of open time (2 hours and 51 minutes)

Air (non condensable gas) volume at **atmospheric pressure**: $170.83 \times 86.9 = 14845$ liters of air

Air (non condensable gas) volume at **condensing pressure**: $170.83 \times 5.36 = 916$ liters of air

This means 916 liters of space in the condenser would have been occupied by air (non condensable gas) and would not have been used for condensing refrigerant resulting in higher condensing pressure if it wasn't purged out by the CPA 10-3

Note: The "rule of thumb" is that every degree Celsius the condensing pressure rises the power consumption on the compressors will rise approx 3% and the cooling capacity will be approx 1% lower.

Installation:

CPA 10-3 air purger can be installed with either pumped liquid feed (recommended and standard installation, see pos. 1 A on enclosed drawing) or with HP liquid feed (see pos. 1 C on enclosed drawing). With these connection types CPA 10-3 does not need to be installed in any specific position in relation to the condenser, high pressure receiver etc. The CPA 10-3 can be installed anywhere convenient for your system.

If the CPA 10-3 is installed for gravity feed circulation (see pos. 1 B on enclosed drawing), it needs to be placed min. 0.5 meters below the low min. liquid level in the low-pressure separator to secure the gravity feed liquid feed circulation. See enclosed application drawing.

Important:

The foul gas (pos 8) line from the condenser must be a minimum **DN15 (½")** and all the valves in this line should be a minimum DN 15 (½") (solenoid valves, stop valves) to ensure the necessary capacity can be lead to the air purger while it is purging.

NOTE: Foul gas line must be connected to DN10 (3/8") inlet on purger, but should be DN15 until this connection.

Attention: the differential pressure of the plant has to be minimum 15K before starting the air purger

Description of pos. no. and functions

The following numbers refer to the position numbers in the enclosed drawing.

- 1) **Connection for liquid supply with filter: DN 15 (½")**

Note: a filter must be mounted in the liquid supply line to avoid dirt from system to block orifices etc. in the CPA 10-3 during operation.

Function: The Low-pressure liquid fills the CPA 10-3 outer vessel to keep the inner vessel and coil cooled.

The liquid supply can be done in three different ways either by low pressure pumped liquid, gravity circulation, or by high pressure liquid.

- **Pos. 1 A** is the standard connection for the liquid supply to a low pressure pumped liquid line through the included orifice Ø 3,0 mm.
- **Pos. 1.B** is the connection type to be used if the CPA 10-3 is feed by gravity circulation. When using gravity circulation, the CPA 10-3 must be placed min. 0.5 m below lowest liquid level in the low pressure liquid separator and the Ø 3,0 mm orifice must be removed.
- **Pos 1.C** If the CPA 10-3 is feed by high pressure liquid supply a Danfoss EVM + CVH (not included in delivery) + special orifice screw (Ø 1,2 mm included in delivery on request) must be used. The special orifice screw must be mounted in the EVM solenoid valve (pos. 1.C) and the EVM mounted in the CVH housing. **The EVM solenoid valve (pos. 1.C) must be opened when the air purger get "run" power from the refrigeration system by the same power supply as the EVM in pos. 13. and the CPA 10-3 controller. The CPA 10-3 must be stopped when the refrigeration systems stops and / or when the liquid separator it is connected to gives alarm / warning for high level. Otherwise there is a risk of overfilling the low-pressure liquid separator.**

- 2) **Stop valve:** Danfoss SVA15 or similar

Function: Stop valve for oil draining

Note: The costumer/user must mount a quick closing valve (self closing) (Pos. 3 not enclosed in delivery), for example a Danfoss QDV, according to the local rules and regulations where the purger is mounted.

- 3) **Quick closing drain valve.** Danfoss QDV or similar. (Not enclosed in delivery)

Function: Safety function during oil draining.

Note: This valve must be mounted by the user according to local rules and regulations.

- 4) **Connection to "wet" suction line:** DN 32 (1 ¼").

Function: Connects the air purger to the low-pressure liquid separator.

- 5) **Safety valve:** Danfoss SFV 15 or similar according to local rules and regulations. **Not included in delivery.** For calculation of safety valve for the CPA 10-3, an outer surface of 0.45 M² can be used.

Function: Securing the vessel against excessive pressure. A safety valve must be selected and mounted by the user according to local rules and regulations.

- 6) **Stop valve:** Danfoss SVA 32 or similar. **Not included in delivery.**

Function: Close the "wet" suction line from the air purger for service etc.

The wet suction line from CPA 10-3 to the liquid separator must be designed and dimensioned like a normal wet suction line with appropriate velocities in risers.

- 7) **Connection to fouled gas from purge points:** DN 10 (3/8").

Function: Connects the internal coil with the purge points.

Note: The connection from the coil to the purge points must be min. DN 15 (½") and the connection must never be closed during operation of the CPA 10-3 as this can result in an unintended refrigerant gas release from the air purger.

- 8) **Stop valve:** Danfoss SVA 15 and FA 15 filter or similar. **Not included in delivery.**

Function: Closing the fouled gas line from purge points during service and filtering the fouled gas and possible liquid coming to the CPA 10-3. **A filter must be mounted to avoid the risk of getting dirt in the built in orifices (Pos. 13) in the CPA 10-3**

NOTE: This valve must never be closed during operation of the air purger as it can result in an unintended release of refrigerant gas thru the air purger vent line.

9) Air vent: Armstrong air vent type 11AV.

Function: The air vent is only an extra safety device against liquid refrigerant release in the event of electrical or mechanical problems. The air vent acts as a float valve that will only allow vapor to pass. As the air vent only has a metallic seal, it will not be able to close completely tight, so in the event of a major malfunction of the air purger a very small discharge of refrigerant vapor through this air vent can be observed.

10) Stop valve: Danfoss SVA 15 or similar

Function: Stop valve for service of the air purging pipe and valves.

11) Solenoid valve with special built in orifice: Danfoss EVM pilot solenoid valve, with special orifice mounted in CVH pilot valve housing.

Function: When the solenoid valve opens it allows for air purging.

Regulation: The solenoid opens when the liquid level in the separation chamber is pressed below the lowest switch point of the special level probe by the air (non-condensable gas) above the liquid surface. The solenoid valve closes again when there has been enough air purged to allow the liquid level to reach the upper factory preset switch point of the level probe.

Note: A time counter is integrated in the control box, counting how many hours, minutes and seconds the purge solenoid (pos11) has been open. This gives a measurement of how much air has been purged from the system. (See table and example.)

12) Check valve: Parker stainless steel hydraulic check valve with max. 0.2 bars opening pressure or similar.

Function: The check valve ensures that ambient air or water from a water reservoir/bubbler is not drawn into the CPA 10-3 in the event of a malfunction where the pressure in the CPA 10-3 could drop below atmospheric pressure.

13) Solenoid valve with special built in orifice: Danfoss EVM pilot solenoid valve, with special expansion orifice mounted in CPA 10-3

Function: CPA 10-3 on/off valve. The solenoid valve will start the CPA 10-3 when it opens and stop the CPA 10-3 when it closes. The special expansion orifice and the internal connection housing work as an expansion valve for return of condensed liquid to the suction side of the refrigeration system. Once the solenoid valve opens, the condensed and sub cooled liquid in the CPA 10-3 separation chamber is drained back and expanded through the connection housing to the CPA's external chamber. As the separation chamber is drained for condensed liquid, new refrigerant and non-condensable gas is drawn into the CPA 10-3 for separation.

Regulation: The EVM must be energized when the control box is energized.

- 14) **Special capacitive liquid level probe:** A special level control rod with build in heating element and two factory calibrated preset switch points for correct function.
- Function:** When the volume of air (non-condensable gas) in the separation chamber increase it will displace the volume of condensed refrigerant in the separation chamber and the liquid level will drop. The level probe will open the air vent solenoid valve at the calibrated low liquid level and close it again at calibrated high liquid level.
- Regulation:** When the level drops below the lowest preset switch point on the level probe (pos. 14), the air purge solenoid (pos11) opens and the air (non condensable gas) purge at condensing pressure through the purge solenoid with its special orifice (pos.11). When the liquid level reaches the upper preset switch point on the level probe (pos.14) the air purger solenoid (pos10) closes.
- 15) **Water filled reservoir.** Not included in delivery.
- Function:** Absorption of any ammonia gas that might be purged with the air (non-condensable gas). Bubbles that pass through the water to the surface are air (non-condensable gas), while bubbles that disappear in the water will be ammonia gas.
- Note:** The ammonia content in the purged air will depend on the difference between the saturated condensing and saturated evaporating temperatures respectively. A large difference will result in a very low content of ammonia, while a low difference will result in a somewhat higher content.
- 16) **CPA Control box:** A complete control box for CPA 10-3 with connection for up to 16 purge points
- Function:**
- Start delay:** The control box will delay the possible opening of the air out blow valve in 10 to 60 minutes (adjustable) from the start of the air purger to ensure that the CPA 10-3 and the refrigeration system are in balance before it can vent air out. Recommended standard setting is 30 minutes. The delay time can be set longer on systems where it takes a long time for the starting compressors to make normal differential pressure in the system. The delay time can be set shorter if the starting compressor makes normal system differential pressure very quickly.
- Attention: the differential pressure of the plant has to be minimum 15K before starting the air purger**
- Liquid level indication:** At normal operation the display on the CPA Control box will show the liquid level in the separation chamber of the CPA 10-3. By following the liquid level, it can be seen if air is building up in the separation chamber as the liquid level will slowly drop. When the level reaches the preset low switch point the air vent valve is opened. The air vent is closed again when the liquid level reaches the preset upper level. This can be followed on the CPA Control Box during operation.
- Air purging start and stop:** The control box will allow the CPA 10-3 to vent air when the inner chamber is filled with air (non-condensable gas) and after the start up timer has run out. The air purging starts when liquid level reaches the lower preset switch point of the special HBLC-

SW3 liquid level sensor and stops again when the liquid level reaches the preset upper switch point.

Purge time counter: The control box has a build in purge time counter so the volume of air purged can be calculated from the tables enclosed in the description material. The time counter counts the time the air vent valve (pos.11) has been opened in minutes.

Purge points: The CPA control box has connections for up to 16 purge points. When a time (10 to 120 minutes) is set for a purge point the purge point will be active. If zero (0 minutes) is entered for the purge point the purge point is not active.

Note: It is very important that only the purge points, which are connected to the refrigeration system are set to be active in the control box. Otherwise the air purger can be turned on with no open connection to the fouled HP gas, which can lead to an unintended release of refrigerant vapor.

Regulation: When the refrigeration system is ON and the user wants to run the CPA 10-3 air purger: The CPA 10-3 ON solenoid valve pos. 13 AND the (optional) liquid solenoid valve pos. 1.C AND the control box pos. 16 must be switched ON by 240 V ac. Power supply.

Safety

- It is the costumers/users responsibility to connect the air purger to a safety valve system in accordance with local rules and regulations. For calculation of safety valves an outer surface of the air purger vessel of 0.45 m² can be used.
- The costumer/user must mount a quick closing drain valve on the oil drain in accordance with local rules and regulations.
- The costumer/user must ensure that the air purger cannot be activated without access to an open purge point. If this requirement is not met it can result in refrigerant in the air purge line.
- It is not possible to get trapped liquid in the air purger as long as no service stop valves are closed since solenoid valves can open backwards allowing trapped liquid to escape.

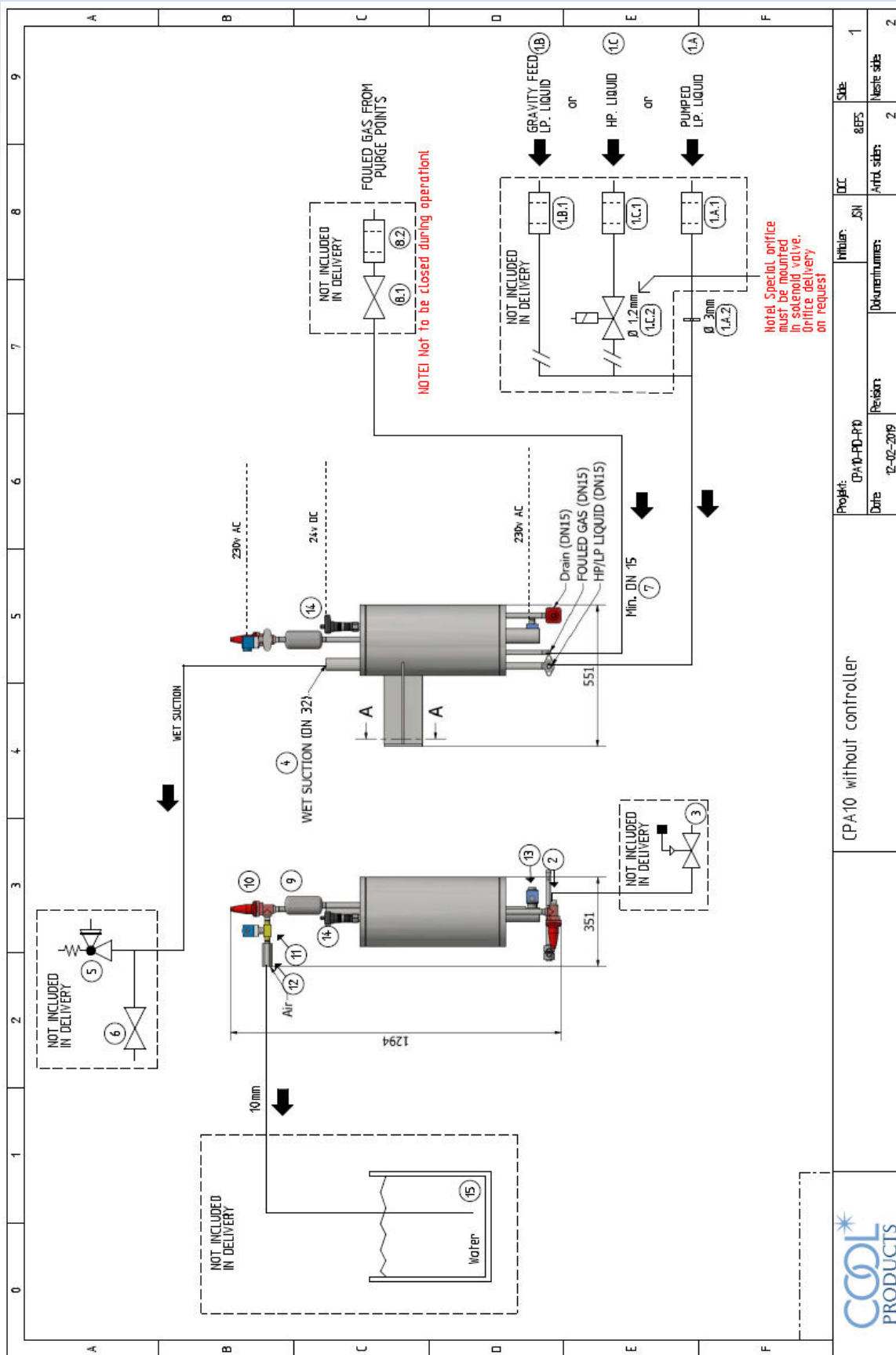
Note:

It is recommended to check the refrigeration systems water content on the low-pressure side, when air is found in the system as the air brings moisture with it. Since air and water are pollutants in a refrigeration system, the presence of them have serious consequences for the system's capacity, power consumption, efficiency and maintenance cost.

If any water is found in ammonia refrigeration systems, it is recommended to mount a CPW-15 (Cool Products Water purger) to clean the system for water and other impurities.

Trouble shooting:

Condition	Cause / Solution
A little constant smell of ammonia from the air vent pipe and Armstrong liquid trap (pos. 9) very cold at the bottom.	<ul style="list-style-type: none"> Electrical failure keeping the air vent solenoid valve (pos. 11) open when there is no air trapped in the air purger. Air vent solenoid valve (pos. 11) is leaking.
High concentration of ammonia gas released when the air purger is purging air.	<ul style="list-style-type: none"> There is no open connection to at least one purge point. This could be caused by a broken coil or an electrical problem where no solenoid valves at the purge points are open or a closed service stop valve in the fouled gas line Liquid feed orifice clogged
The air purger does not seem to have any condensing capacity.	<ul style="list-style-type: none"> The coil on the ON / OFF solenoid valve (pos.13) is broken. The special built in orifice in the ON / OFF solenoid valve (pos. 13) is clogged and must be cleaned. Note the complete CPA 3-10 must be emptied for liquid and high-pressure refrigerant through the oil drain line and the air out blow line must be forced open so no high pressure can stay in the inner vessel before the solenoid valve (pos. 13) can be dismantled.
The air vent never seems to open.	<ul style="list-style-type: none"> No air in the system Foul gas line mounted on the refrigeration system at a spot where no air accumulates.



Air purger type CPA 10-3 instruction

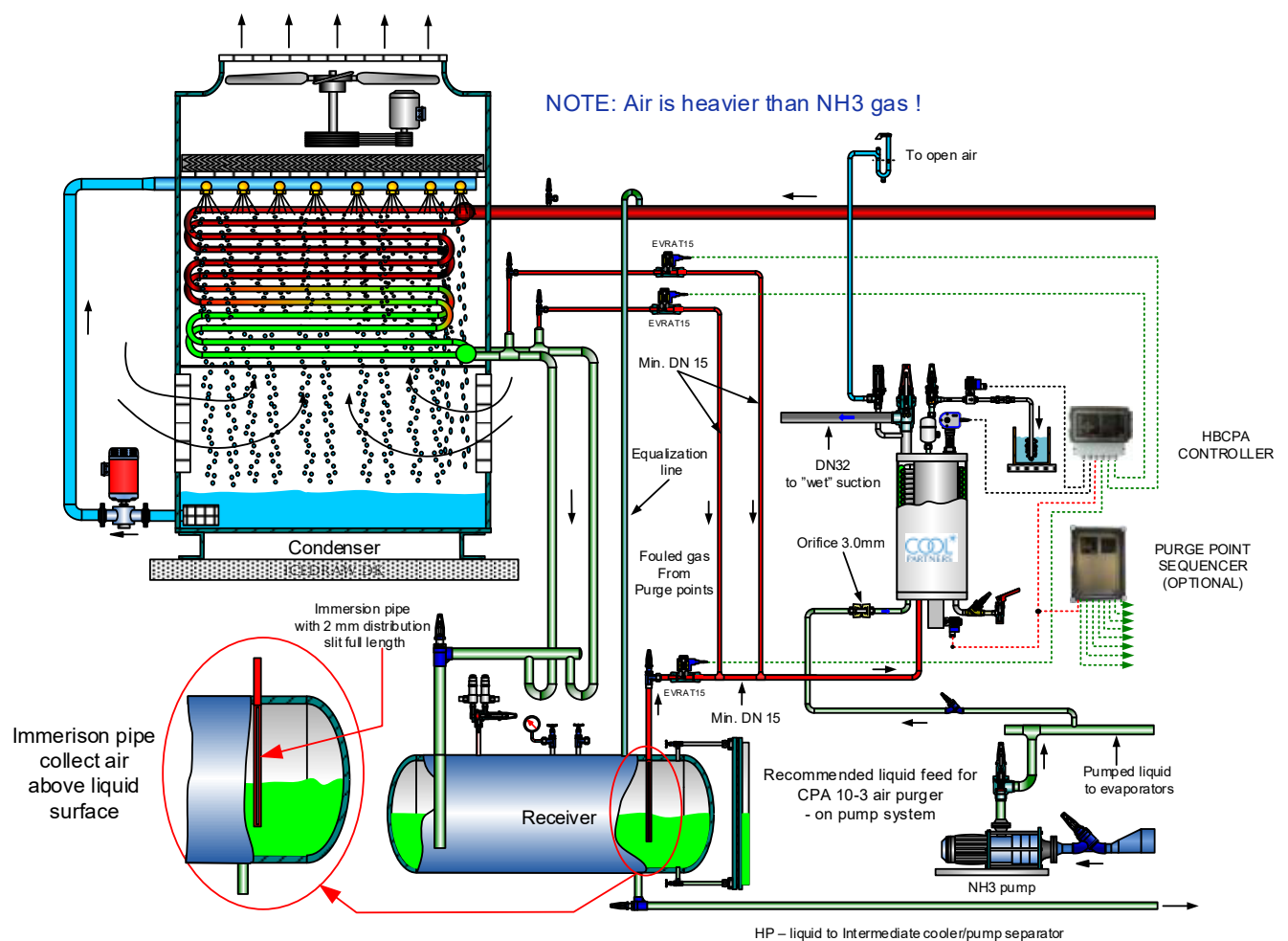
(rev. 2, 29-04-19 Per Skærbæk Nielsen)

Recommended Purge Point installation for LP float valve systems

Recommended Purge Point connections to condenser

Recommended Purge Method from HP receivers

Pumped LP liquid feed to CPA

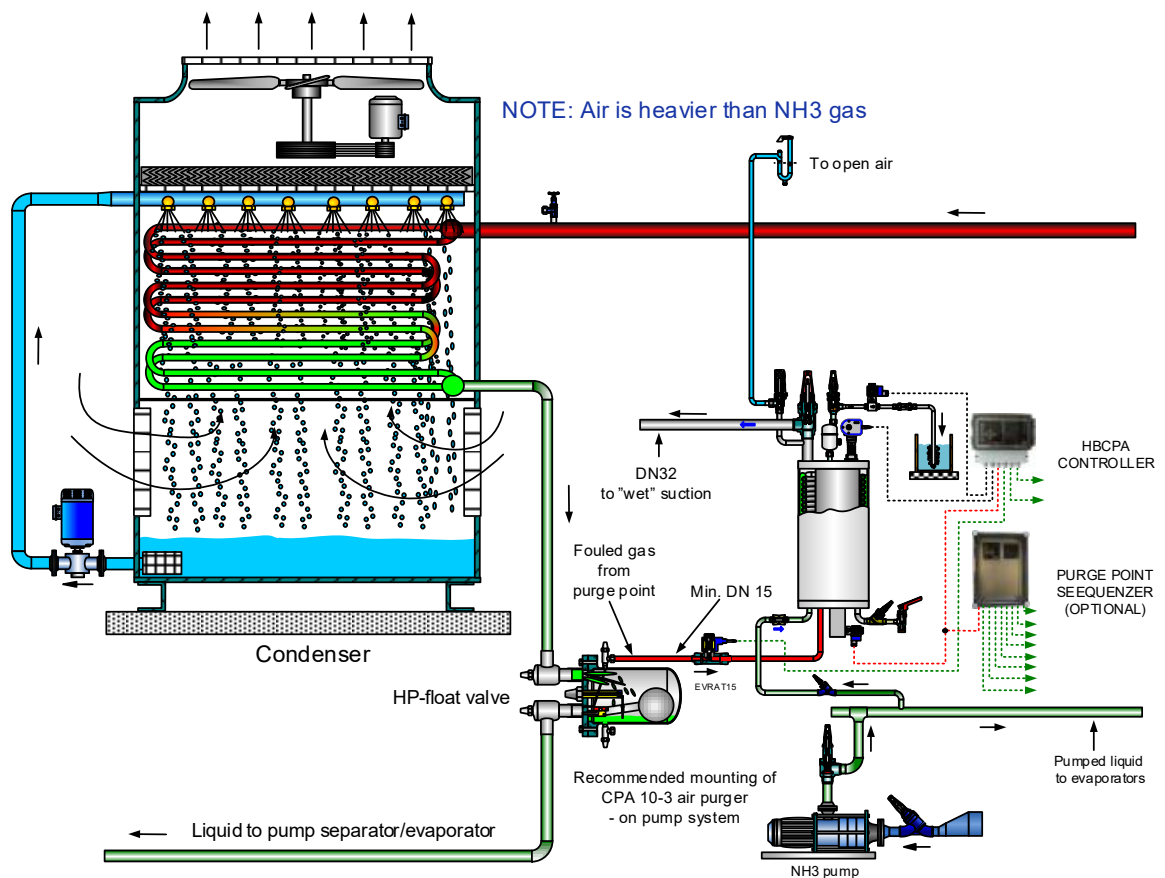


Air purger type CPA 10-3 instruction

(rev. 2, 29-04-19 Per Skærbæk Nielsen)

Recommended Purge Point installation for HP float valve systems

Recommended Purge Point connection to HP float valve
Pumped LP liquid feed to CPA

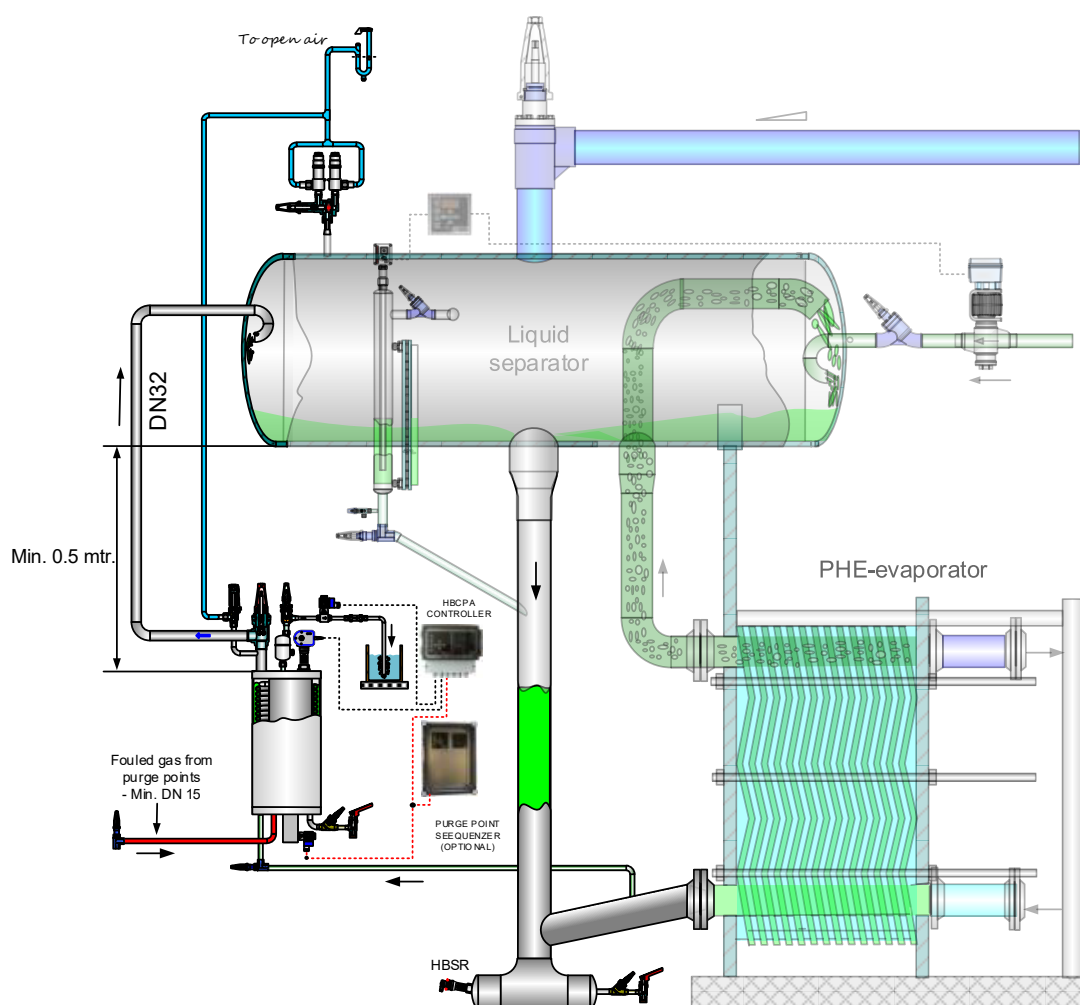


Air purger type CPA 10-3 instruction

(rev. 2, 29-04-19 Per Skærbæk Nielsen)

Recommended installation of Air Purger with self circulation supply

Minimum 0.5m gravity height for self circulation

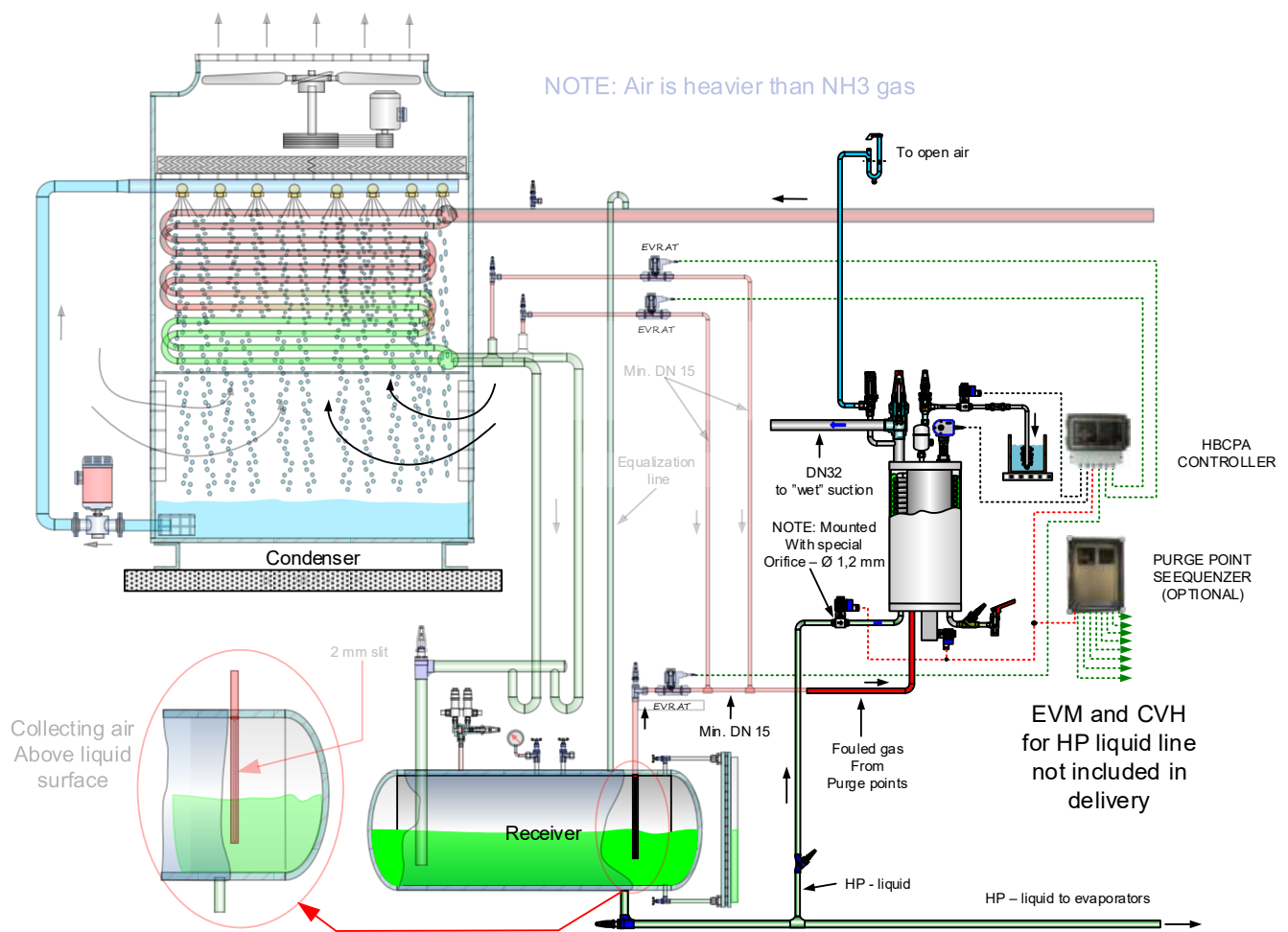


Air purger type CPA 10-3 instruction

(rev. 2, 29-04-19 Per Skærbæk Nielsen)

Recommended installation of Air Purger with HP liquid supply

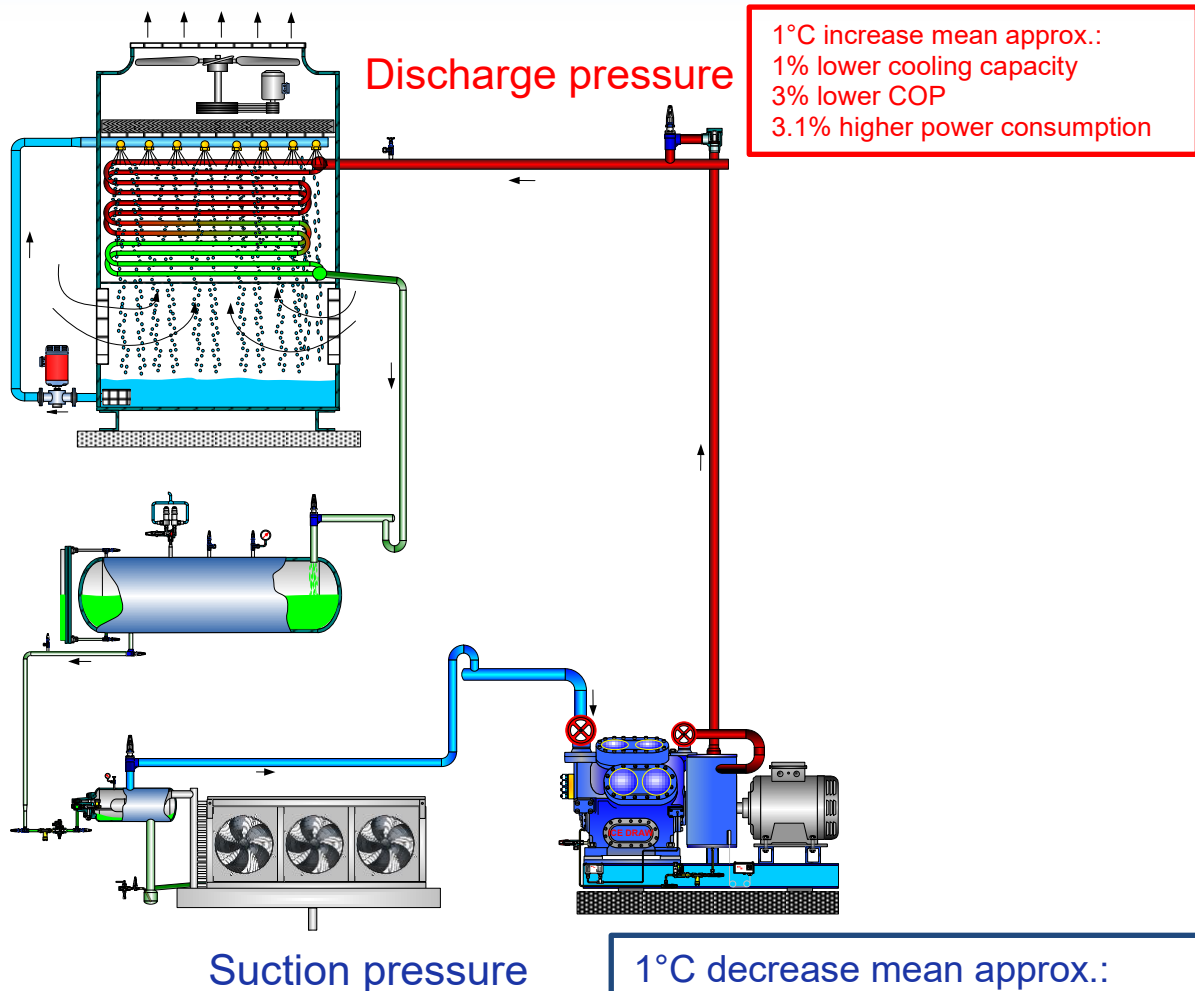
Note $\varnothing 1.2\text{mm}$ orifice in HP feed line, included on request



Air purger type CPA 10-3 instruction

(rev. 2, 29-04-19 Per Skærbæk Nielsen)

Efficient air purging lowers condensing temperature – gains in efficiency can be estimated from the below 'rule of thumb's.



Numbers from average of Sabroe recip and screw
Power is with unchanged cooling capacity

Air purger type CPA 10-3 Capacity (SI)

Purge Flow by volume at condensing pressure
Liters/minute

CT / °C	At condensing pressure	At atmospheric pressure
10	5.23	47.8
15	5.27	56.0
20	5.30	65.2
25	5.33	75.5
30	5.36	86.9
35	5.40	99.5
40	5.43	113.3
45	5.46	128.4
50	5.48	144.9

The diagram illustrates the principle of an ammonia plant using CPW (Circulating Pump Water) and CPA 10-3 (Circulating Pump Ammonia) systems. The process involves the following components and flow paths:

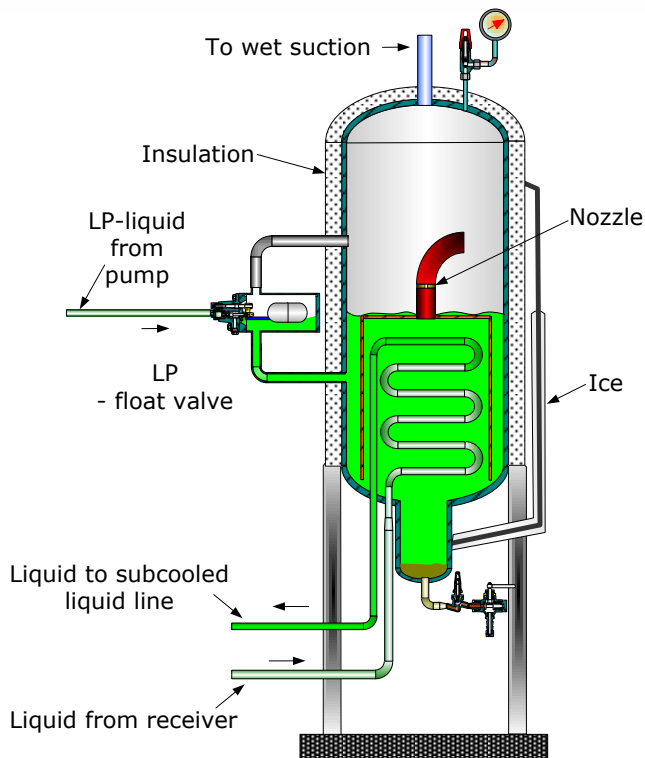
- Air cooler - pump system:** Cools the ammonia gas before it enters the pump separator.
- Plate freezer - pump system:** Cools the ammonia liquid before it enters the pump separator.
- Pump separator:** Separates the ammonia liquid from the gas. The liquid is pumped to the oil collector, and the gas is pumped to the air purger.
- NH3 pump:** Pumps the ammonia liquid from the oil collector to the system cleaner.
- Oil collector:** Collects the oil from the ammonia liquid.
- Air purger - CPA 10-3:** Purges the ammonia liquid of air.
- System cleaner - CW:** Cleans the ammonia liquid using cooling water (CW).
- Liquid line (sub cooled):** Transfers the sub-cooled ammonia liquid to the economizer.
- Economizer:** Pre-cools the ammonia gas before it enters the screw compressor.
- Shell and Tube Chiller:** Cools the ammonia liquid before it enters the flake ice machine.
- Flake ice machine:** Produces flake ice from the ammonia liquid.
- Screw compressor:** Compresses the ammonia gas from the economizer.
- Reciprocating compressor:** Compresses the ammonia gas from the screw compressor.
- Controls:** Monitor and control the entire system.

The diagram also shows connections to open air and various control systems, including a pump separator, NH3 pump, oil collector, air purger, system cleaner, liquid line, economizer, shell and tube chiller, flake ice machine, screw compressor, and reciprocating compressor.

Other products from Cool Partners & Atlas

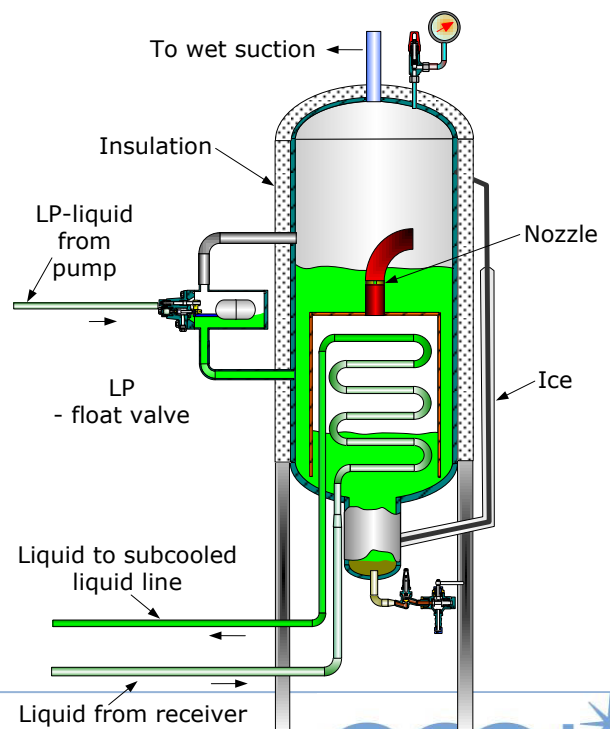
CPW-15 water purger

Low load



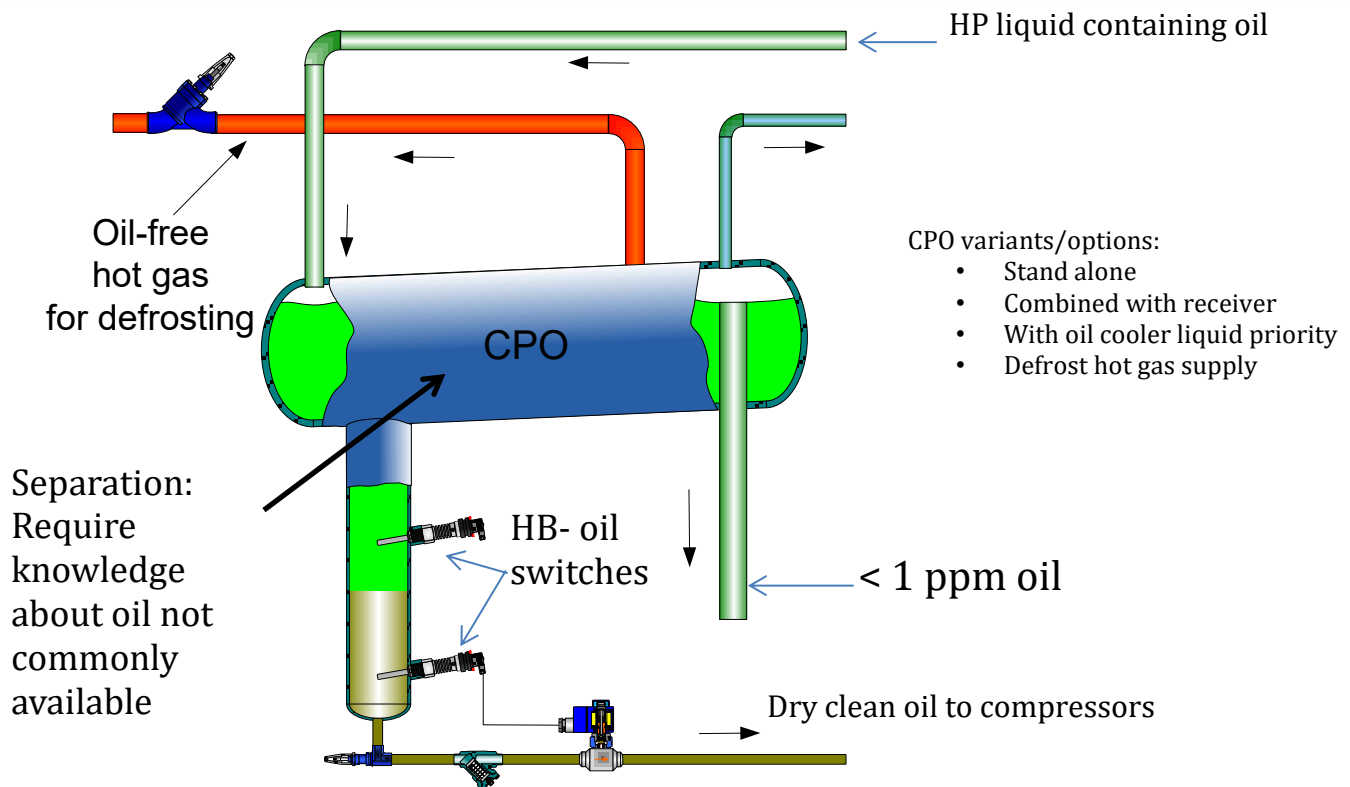
- Self regulating
- No regulation devices
- No maintenance
- No electrical connections
- Easy installation
- Energy neutral

High load



Other products from Cool Partners & Atlas

CPO – HP oil separation unit



Advantages:

- Oil stays on HP side, no pollution or breakdown
- Very simple oil return system
- Maintenance free oil management
- No oil consumption

Disadvantage:

- Increased refrigerant charge

Proof of concept:

178 liters separated in 9 months.

17 liters found on LP side due to hotgas defrost