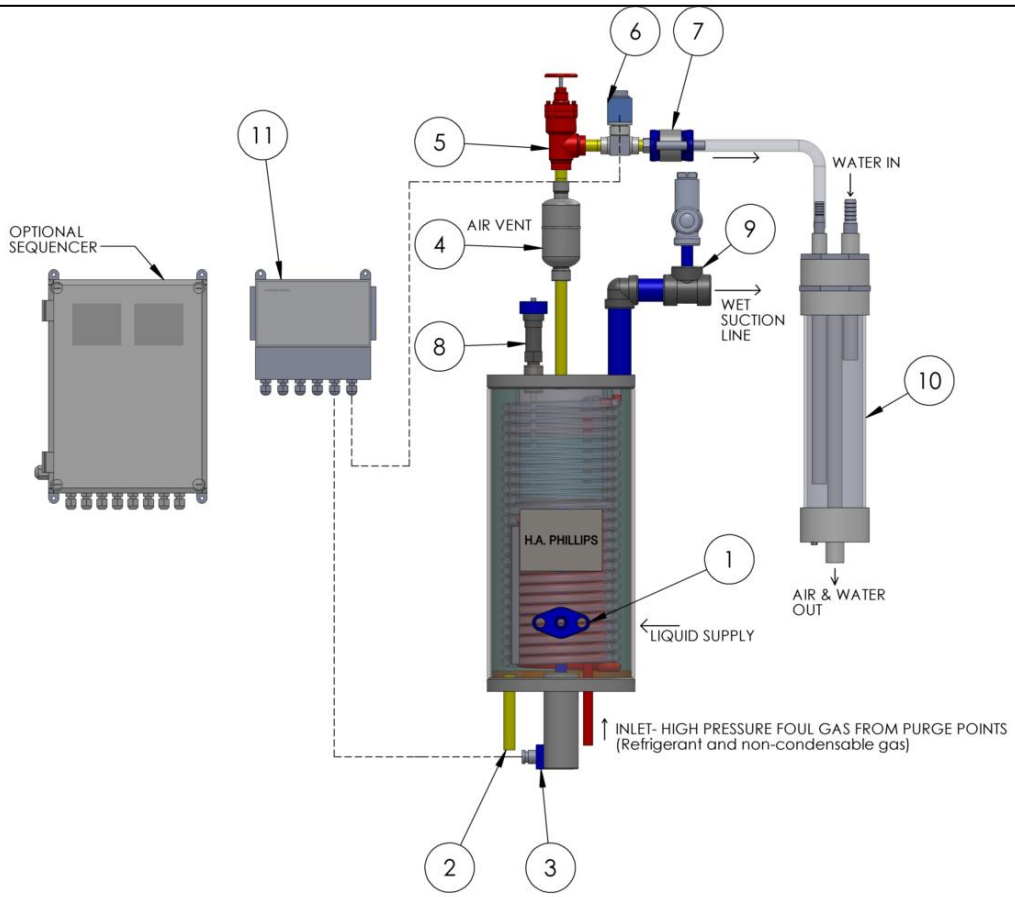

Figure 1: PUR Air Purger General Layout

The general layout of the Phillips PUR Purge and all relevant components are shown in Figure 1.

Description of positions

1) **Orifice:** For pumped circulation the diameter of orifice hole is 0.118" [3.0mm]. This orifice plate is made of Teflon or steel and placed between two flanges. For high pressure feed systems this orifice is changed to a 0.047'' [1.2mm] stainless steel screw.
   Function: The orifice limits the amount of refrigerant that is fed from the refrigerant pumps to a circulation rate of approximately 3:1 in the evaporative part of the purger.
   Note: When the air purger is used on gravity fed systems (no refrigerant pumps), this orifice needs to be removed and the air purger should be mounted a minimum of 20" [500mm] lower than the lowest liquid level in the separator feeding it in order to ensure sufficient gravity feed. When fed by high pressure liquid the union is replaced by a 110 VAC solenoid valve and orifice.
   Note: Unless fed with high pressure liquid, solenoid valves must not be fitted in the liquid supply line as this could make the air purger vent refrigerant during startup or standby.

2) **Oil Drain:** Danfoss SVA15 and QDV15 or similar
   Function: Stop valve for oil draining
   Note: The costumer/user should supply and mount a stop valve and quick closing "deadman" valve, (such as a Danfoss QDV, valve train) according to the local rules and regulations where the purger is mounted.

3) **Solenoid valve with built in orifice:** Danfoss EVM pilot solenoid valve, with orifice bolt with 0.035" [0.9mm] diameter orifice hole screwed into the bottom and mounted in a Phillips solenoid fitting.

Function: Air purger on/off valve. This solenoid valve will start the air purger when it opens and stop the purger when it closes. The orifice bolt with 0.035" [0.9mm] diameter hole functions 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 subcooled liquid in the purger separation chamber is drained back through the built-in orifice to the purger external chamber. When the separation chamber is drained of condensed liquid, new refrigerant/non-condensable gas is drawn into the purger for separation.
Regulation: The solenoid is **only allowed** to open when there is an open connection to a purge point.
Note: This is very important. The solenoid valve (pos. 3) must not open unless a purge point is open. Otherwise the purger will drain the separation chamber of liquid without being able to draw in new gas to condense, resulting in a unintended release of refrigerant gas from the air purge line.

4) **Air vent:** Armstrong air vent type 11AV
Function: The air vent is an extra safety against liquid refrigerant release in the event of controls, electrical or mechanical problems. The air vent acts as a float valve that will only allow vapor to pass. Since the air vent 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 it can be observed through a very small discharge of refrigerant (gas) through this vent.

5) **Stop valve:** Danfoss SVA15 or similar
Function: Stop valve service of the solenoid and check valve.

6) **Solenoid valve with built in orifice:** Danfoss EVM pilot solenoid valve, with orifice bolt with 0.04" [1.0mm] diameter orifice hole mounted in a Danfoss CVH pilot valve housing.
Function: The solenoid allows air purging. The solenoid opens when the liquid level in the separation chamber is depressed below the lowest switch point of the level probe by the presence of non-condensables above the liquid surface. The solenoid valve closes again when enough air has been purged to allow the liquid level to reach the upper switch point on the level probe.
Regulation: When solenoid (pos. 3) is "on" (air purger running) and level probe (pos. 8) indicates low level, this solenoid valve (pos. 6) opens This solenoid valve is kept open until level probe (pos. 8) indicate a high level, as long as the air purger is running (solenoid pos. 6 is on).
Note: A purge time counter is included in the optional controller, which counts how many seconds the purge solenoid (pos. 10) has been open. This gives a fairly accurate representation of how much air has been purged from the system.

7) **Check Valve:** Danfoss NRVA 15 or similar
Function: The check valve ensures that ambient air or water from a bubbler is not drawn into the purger in the event of a malfunction where the air purger pressure drops below atmospheric pressure.

8) **Capacitive liquid level probe:** HB Products HBLC special calibrated level control rod with two pre-set switch points, one for low level and one for high level.
Function: When the volume of non-condensables (air) in the separator chamber increases, it will displace the volume of condensed refrigerant in the separation chamber and the liquid level will drop. When the level drops below the lowest switch point on the level probe (pos. 8), the air purge solenoid (pos. 6) opens and the non-condensables purge at condensing pressure through the purge solenoid and its built-in orifice (pos. 6). When the liquid level reach the upper switch point on the level probe (pos. 8) the air purge solenoid (pos. 6) closes.
Regulation: When the solenoid (pos. 3) is "on" (air purger active) and the level probe (pos. 8) indicates low liquid level, then the air purge solenoid (pos. 6) opens and is kept open until the level probe (pos. 8) indicate a high liquid level.

9) **Wet Suction Line:**
Function: Return liquid to low temp accumulator or other low side vessel. Factory piped with elbow and tee for relief valve. Relief valve ships loose.

10) **Bubbler (Optional)**
Function: Absorption of any ammonia gas that might be purged with the non-condensable gases. Bubbles that pass through the water to the surface are non-condensable, while bubbles that disappear in

the water will be ammonia gas. The water supply should be run whenever the air purge solenoid is energized.
Note: This bubbler is an optional supply item.
Note: The user must make sure that a minimum of 1 GPM of water is being pumped through the bubbler per every 1 lb. of vent gas.
Note: The ammonia content in the purged air will depend on the difference between the saturated condensing temperature and the saturated evaporating temperature. A large difference will result in a very low content of ammonia, while a low difference will result in a somewhat higher content. For this reason the purger is limited to temperature differences above 23°F [13°C].

11) **Complete control of the air purger. (Optional)** The control can be supplied in 2 different versions:
1) Control of the air purger alone, where control of switching between purge points is limited to 3 purge points.
2) Control of the air purger and control of purge point sequencer module that will allow switching between up to 16 or 32 purge points, depending on the purge point sequencer module.
Function: The control system ensures correct operation of the air purger within the limitations described above. The control system contains a timer that will delay the possible air venting from the air purger, adjustable between 10 to 120 minutes, after the RUN signal is received from the refrigeration system. This is to ensure the air purger is in pressure / temperature balance after start-up of the refrigeration system making sure it is non condensables which is purged out of the vent line. We recommend a delay time of approximately 25 minutes to insure the conditions are met for non- condensables to condense. The control also contains a purge time counter that tracks the total amount of time that the air purge solenoid (pos. 6) has been open. Using the formulas and table supplied below, the amount of purged air can be determined. On the display on the controller the liquid level in the inner vessel during operation will be monitored and is shown in % of the whole length of the level probe.

Capacity and Performance

The heat exchanger in the air purger has a design refrigerant condensing capacity of 2.85TR [10kW], however the actual air purging capacity is dependent on the amount of non-condensable gases in the condenser. The low pressure side connected to the air purger needs to be able to deliver the 2.85 TR [10kW] capacity. On the high pressure side the air purger draws refrigerant gas and non-condensable gases into the purger with 2.85TR [10kW] capacity, ensuring that the purger gets the maximum volume of non-condensable gases during operation. Due to its high capacity it is recommended that on small systems the purger is only run for a short period of time each day once the general level of non-condensable gases have been brought down to a low level. One hour once or twice a day is often appropriate on small systems.

It is recommended to compare the time the air purger is in operation with the time it vents. If the purger vents during most of the time in operation, it will most likely be possible to get more air out by increasing the operating time. On the other hand, if the air purger vents for a small portion of the operating time, it is recommended to decrease the operation time, thereby saving the 2.85 TR [10kW] of heat load.

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 diagram below.

Figure 2 outlines the amount of air purged per hour from the purger as a function of the condensing pressure. The dashed curve shows the volumetric flow of purged air out of the air purger at condensing pressure while the solid curve illustrates the volume flow out of the air purger (atmospheric pressure).
By using the solid curve the total volume of the purged air at atmospheric pressure can be determined. This shows how much air that came into the refrigeration system.

By using the dashed curve the total volume of the purged air at condensing pressure can be determined. This shows how much space (volume) the purged air had occupied in the condenser/receiver and can give an idea about how much less condensing capacity the system would have if the air was not purged out of the system.

By using Figure 2 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 10.25 seconds and the average condensing temperature has been 72°F [22°C], the purged volume will be:

$$\frac{10.25\text{s}}{60\frac{s}{\text{min}}} = 0.1708 \text{ min}$$

Volume at condensing pressure (dashed curve):

$$\frac{0.188 \text{ ft}^3}{\text{min}} \times 0.1708 \text{ min} = 0.0321 \text{ ft}^3 \qquad \left[\frac{0.00531 \text{ m}^3}{\text{min}} \times 0.1708 \text{ min} = 0.0009 \text{ m}^3\right]$$

Volume at atmospheric pressure (solid curve):

$$\frac{2.443 \text{ ft}^3}{\text{hr}} \times 0.1708 \text{ min} = 0.417 \text{ ft}^3 \qquad \left[\frac{0.06917 \text{ m}^3}{\text{min}} \times 0.1708 \text{ min} = 0.0118 \text{ m}^3\right]$$

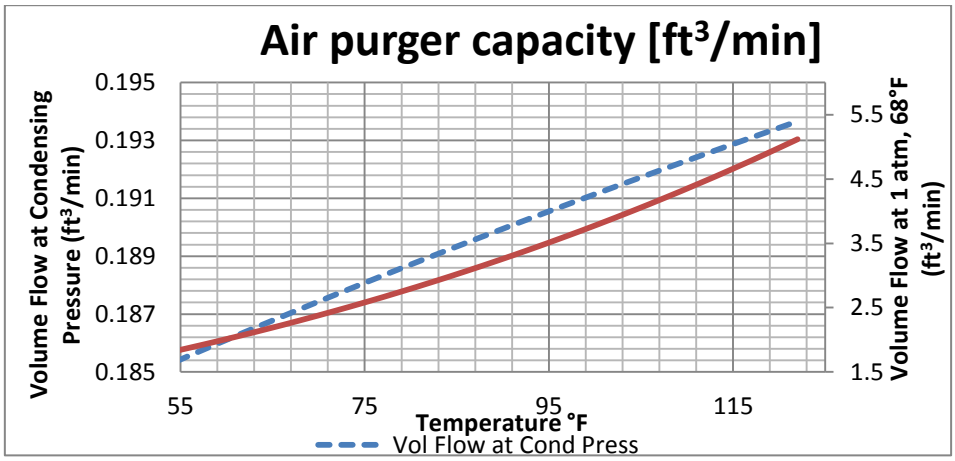

Figure 2: Purger Capacity

Safety

- It is the costumers/users responsibility to connect the air purger to a safety valve system in accordance with local rules and regulations.
- 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 condition is not met it can result in refrigerant in the purge line.
- It is not possible to trap liquid in the air purger as the solenoid valves can open backwards allowing liquid to escape.

Note:

It is recommended to check the refrigeration system water content on the low pressure side. When air is found in the system, it is certain that moisture is also in the system. As with air, water is a pollutant of the system with serious consequences for the system capacity, power consumption, efficiency and maintenance cost.

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