Phillips REFRIGERATION
VALVES • VESSELS • SYSTEMS • CONTROLS

PURGER INSTALLATION AND OPERATION
BULLETIN PUR-SB19-02
SERVICE BULLETIN

System drawings shown in this bulletin are for illustration purposes only. Refrigeration systems should only be serviced by a qualified technician. Always observe proper safety procedures when servicing a refrigeration system. For more information see the latest revision of Phillips Safety Bulletin SGRV.

GENERAL INFORMATION

Pressure Rating: 300 psig [20.6 bar, gauge]

For System Suction: -50ºF to +35ºF [-45ºC to +2ºC]

Cold Liquid Supply Req'd: Approx. 2.85 TR [10 kW]

Approximate Weight: 250 lb. [115 kg]

Overall Dimensions: See Figure 1

Main Vessel : 10-3/4" dia. x 23" OAL SS [273mm x 584mm]
Net Volume: 1.01 ft^3 [0.028 m^3]
Excluding Coil & Collection Chamber

Connections: Foul Gas In –⅜" Connection
Non Condensable Vent – ½" Soc Weld
Wet Suction – 1-¼" Soc Weld
Safety Relief – ½" x ¾" FPT
Drain - ½'' FPT
Cold Liquid Feed – ½'' SW (flange)

Refrigerants: Ammonia or halocarbons
This Bulletin focuses on ammonia applications.
Halocarbon refrigerants are discussed briefly.

The Phillips Purger is a simple, robust, high-capacity device that removes non-condensable gases from the refrigerant vapor in a system. The unit operates by condensing foul gas (the mixture of refrigerant vapor and non-condensables) from one or more purge points, metering the purified liquid refrigerant back to the system through a protected suction connection, and venting the non-condensables to atmosphere.

Although only extremely small traces of refrigerant are present with the vented non-condensable gases and several safety components prevent the accidental release of pure refrigerant, it is recommended that vented gas be "bubbled" through a liquid reservoir or optional bubbler. The reservoir should be filled with water for ammonia applications, or oil for halocarbons. Due to the fact that halocarbon refrigerants are difficult to detect (compared to ammonia) it is recommended that a gas detector be installed near the non-condensable vent for added safety when the purger is applied to R-22 or other halocarbons.

The primary component of the Phillips Purger is a stainless-steel main vessel that contains a separate inner stainless-steel collection chamber and a condensing coil. A probe responds to the liquid level inside the collection chamber. An optional electrical control panel provided with the purger includes connections for electrical power and control of the vent solenoid, with provisions for up to (3) purge points, (10) purge points, and (30) purge points. Purge solenoids are not included with the purger.

The Purger includes brackets for mounting on a wall or other structure capable of safely supporting the unit weight.

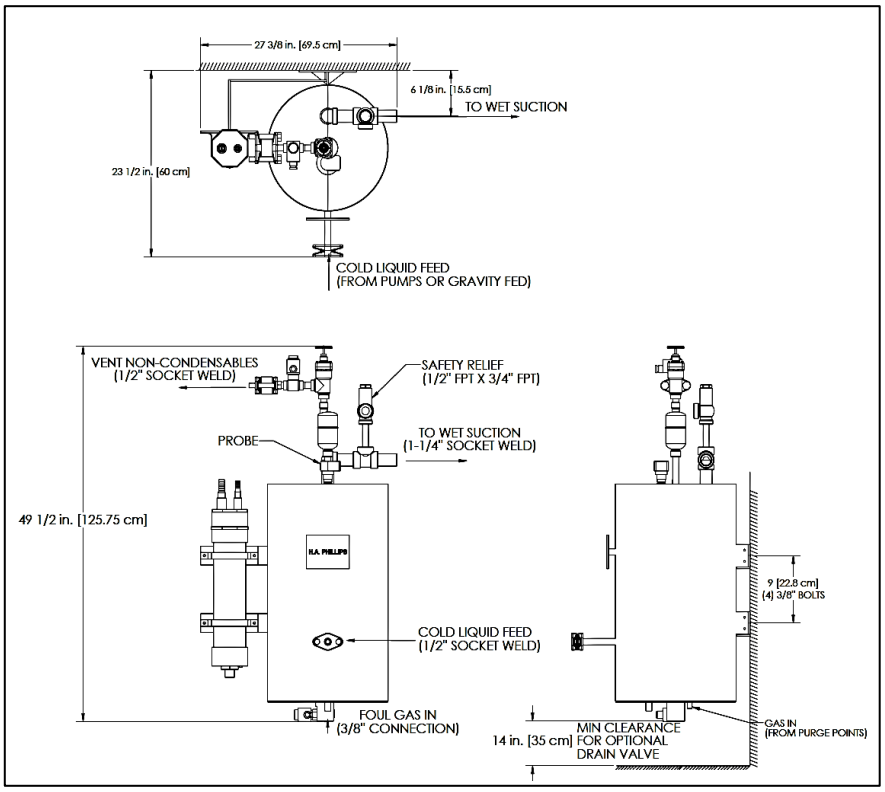

Figure 1: Overall dimensions and major connections shown with optional insulation and bubbler

OPERATION

The unit consists of a 10-3/4" dia. x 23" long [273mm x 584mm] optionally insulated main vessel which contains a condensing coil and small collecting chamber, as shown in Figure 2. (Note that control devices have been omitted from the figure for clarity but are fully discussed in this bulletin.) The following discussion focuses on ammonia, but the operating principles are the same for halocarbons.

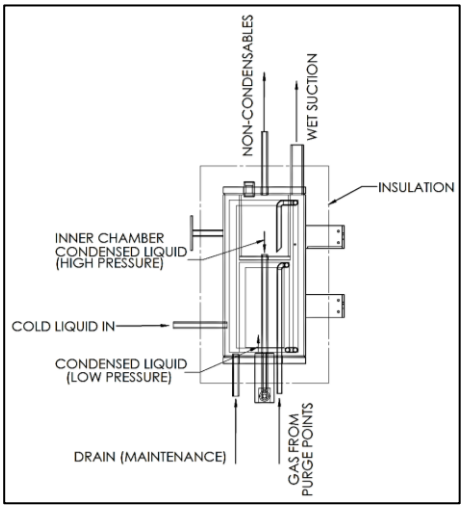

Figure 2: Basic flow through the Purger

During operation, gas inlet from the purge point is drawn into the condensing coil at a rate of about 71.65 lb/hr [32.5 kg/hr]. Ammonia vapor condenses into liquid and flows into the collecting chamber along with any non-condensable gases. The pure liquid ammonia exits the chamber through a drainpipe and is returned to the system through an expansion orifice. The orifice is sized so that the liquid generated by the condensing coil is always greater than that which can flow out through the expansion orifice. In this way, the presence of liquid inside the chamber is assured. Safe purger operation is maintained by a level probe, temperature sensor, and control scheme that prevents the vent solenoid from opening until safe conditions are met.

BASIC OPERATION

To understand the interactions between the unit components, first consider a purger connected to a single purge point with almost no foul gas present in the inner chamber. (Refer to Figures 2 and 3 for relevant components). The following conditions exist:

- No compressors are running
- The main purger vessel is flooded with refrigerant, and suction at the top connection lowers the temperature in the vessel.
- The purge point is feeding foul gas to the condensing coil.
- The vent solenoid and the expansion solenoid are both closed (de-energized), isolating the inner chamber and drainpipe.

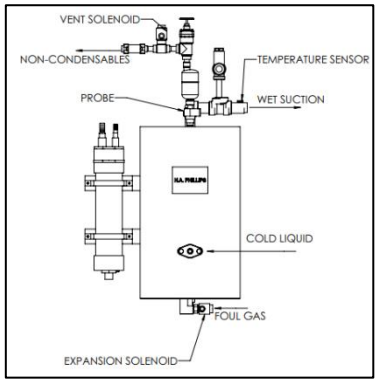

Figure 3: Purger Control Components

As ammonia in the foul gas condenses inside the coil, it flows upward into the collecting chamber. Any non-condensables also flow to the collecting chamber and rise to the top. Liquid fills the drainpipe and collecting chamber. The liquid passing through the expansion solenoid valve is expanded back into the outer chamber and out through the protected wet suction line. Temperature sensors on the wet suction and foul gas are used to make sure the temperature difference is enough that all condensables condense. If the difference is not met there is an adjustable time delay to ensure sufficient temperature difference has been achieved. Then the purger can run safely, and the liquid level probe is allowed to open the air vent solenoid valve if the liquid level in the inner chamber is low.

Because the temperature inside the purger is close to suction and the pressure in the collecting chamber is near condensing, the liquid ammonia and non-condensable gases continue to flow into the collecting chamber via the condensing coil. Eventually, enough non-condensable gas accumulates in the inner chamber to force the liquid level in the chamber down. As a result, the probe will read a low-level. Since the coil length, temperature sensors, and the expansion orifice ensure that the temperature and suction pressure is near condensing, the low liquid level indicates that the gas in the chamber must be highly concentrated non-condensables. The vent solenoid is therefore signaled to open, and the non-condensables are expelled through the vent orifice and into an optional bubbler or water reservoir. Cold liquid ammonia continues to accumulate in the chamber until the probe detects high liquid level again, at which time the vent solenoid is signaled to close.

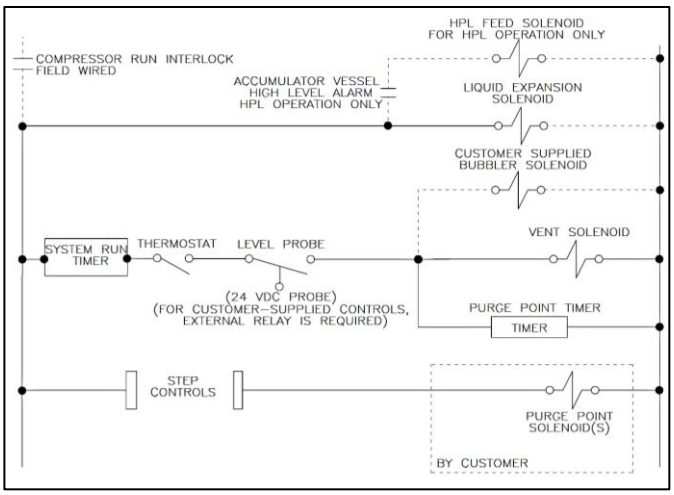

Figure 4: Basic Purger Control

TYPICAL OPERATING CONDITIONS

Before reviewing the safety-related components of the purger, consider two circumstances (1) with almost no ammonia present, and (2) with almost no air present at the purge point.

1. Almost no ammonia in the foul gas

   With the expansion solenoid open and vent solenoid closed, only cooled non-condensable gas will collect in the chamber because the small amount of condensed ammonia will flow down the drainpipe. As the probe is at a low-level, the vent solenoid will open and blow the non-condensable gas out through the bubbler.

   The condensed liquid ammonia will flow through the expansion orifice back to the system, and the air (and other non-condensables) will flow through the vent orifice. Flow from the purge point will continue to feed the inner chamber, and eventually the ammonia concentration will provide enough liquid to raise the level on the probe. At this point the probe de-energizes the vent solenoid and the flow of chilled air through the vent solenoid ceases. Only liquid ammonia is permitted to leave the inner chamber via the expansion orifice.

2. Almost no air in the foul gas

   With the expansion solenoid open and vent solenoid closed, ammonia vapor will condense in the coil, fill the drainpipe and finally begin collecting in the inner chamber. Because the probe is at high position, the vent solenoid will not open.

   Liquid will continue collecting in the chamber, ultimately reaching the liquid trap (described below). Liquid ammonia from the purge point will begin backing up in the foul gas line. This condition is acceptable.

SAFETY FEATURES

Safety features of the PUR purger are shown in Figure 5. To safely accommodate high liquid levels and any possible control failures or problems, a liquid trap is installed above the collecting chamber outlet. This ensures liquid refrigerant can never be released from the air purger as the result of any kind of malfunction. A check valve is located after the solenoid valve to prevent water from being drawn into the unit from a water reservoir/bubbler. A safety relief valve protects the main vessel. A stop valve and spring return valve should be mounted on the drain connection to permit periodic maintenance.

Two temperature sensors are provided to ensure that the minimum 24°F temperature difference is achieved between the suction and condensing temperatures. If for any reason during operation the temperature difference becomes less than 24°F, the control will not allow the purger to vent non-condensables until the temperature difference is achieved again. The user can set this difference to a larger temperature difference, which will make the separation of non-condensables more efficient and will reduce the possibility of venting ammonia vapor. The sensor should be attached to the outside surface of the wet suction line on the purger and the foul gas inlet.

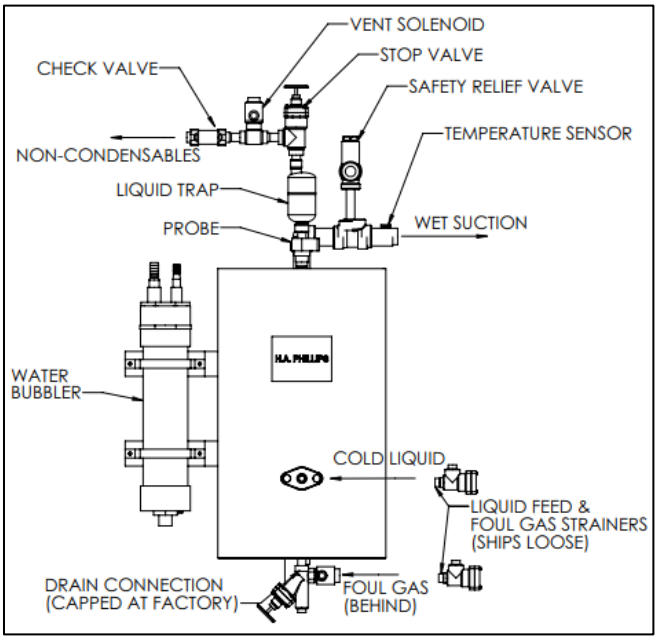

Figure 5: Purger Safety and Maintenance

APPLICATION

The purger can be fed by either pumped recirculation liquid or high-pressure liquid or it can be gravity fed. Application in a pumped overfeed system is shown in Figure 6. A liquid feed orifice is supplied with the unit to provide between 3 and 4:1 overfeed for pumped liquid at 20 to 30 psi [1.5 to 2 bar] above suction.

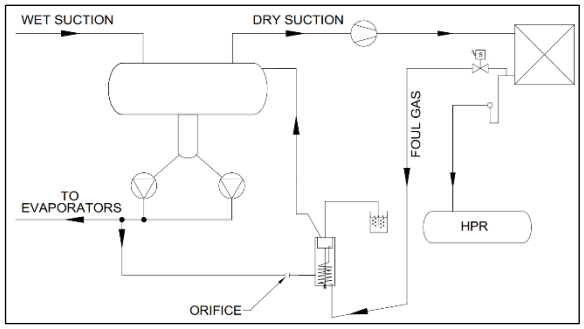

Figure 6: Recirc System Installation Example

Application in a gravity feed system is shown in Figure 7. On a gravity flooded system, the liquid feed orifice is omitted, and the unit must be situated lower than the liquid level of the source vessel. The entire purger main vessel must be filled with liquid (covering the collecting chamber), and sufficient static head be available to provide good circulation.

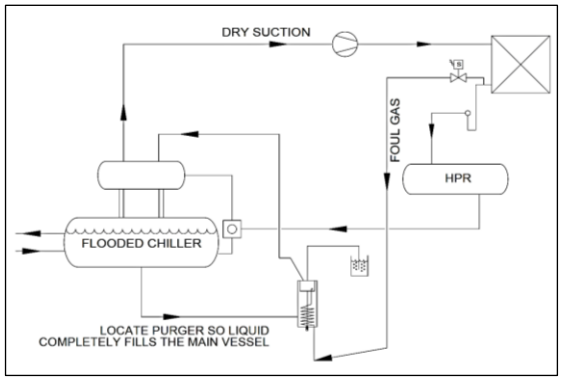

Figure 7: Flooded System Installation Example

Application in a high-pressure liquid feed system is shown in Figure 8. An EVM solenoid and orifice will be supplied with the unit to change from high pressure, high temperature liquid to low temperature liquid at suction pressure. This solenoid must close when power to the purger is off, or if the high-level alarm on the liquid separator is giving a high alarm.

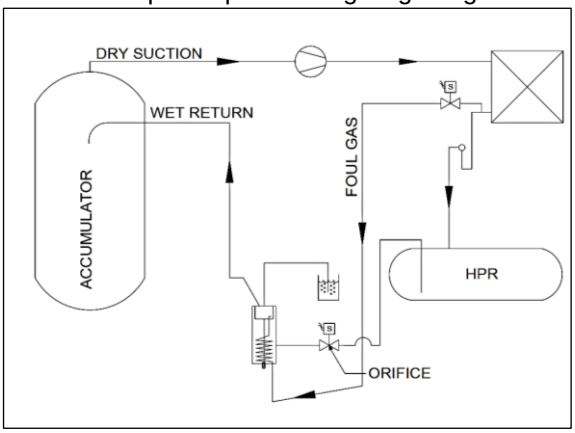

Figure 8: HPL Feed System Installation Example

Any equipment in a refrigeration system that can accumulate non-condensable gas should be periodically purged. This includes equipment on the high side of the system such as condensers and high pressure receivers. Multiple purge points may be connected to a single purger, as shown in Figure 9. (Note that on halocarbon systems the optimal purge point locations may differ somewhat.) Adjustable controls, such as the optional control offered by Phillips, should be provided to permit purge points to open individually for up to 60 minutes. Foul gas flow should be continuous to maintain pressure inside the collecting chamber. A brief "overlap" time when two purge points are open simultaneously is permissible. However, because slight pressure differences between purge points could enable air or non-condensable gases to pass from one purge point to another, overlap time should be limited to ten seconds or less. Aside from this brief overlap, at least one purge point must be open whenever the purger is running.

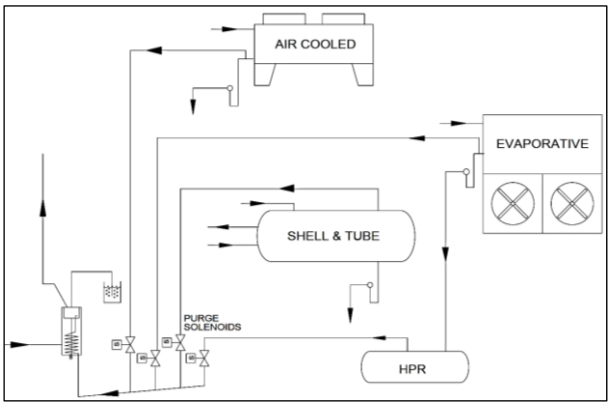

Figure 9: Multiple Purge Points (Ammonia application)

The purge solenoids are preferably placed close to the purge points and may be arranged on a manifold connected to the purger. Condensed liquid ammonia in the foul gas lines is permissible since the liquid is quickly sucked into the collecting chamber when the solenoid opens. However individual purge points should be left open for sufficient duration in order for all this liquid plus any air to reach the purger before switching to another purge point. To assure proper flow the maximum foul gas line size ½" is recommended. The line size should not exceed 1" pipe and not smaller than ½". Velocity through a ½" Schedule 80 purge line is about 6.5 ft/s [2 m/s], so it will take about 8 seconds to clear 50 ft [15 m] of pipe. The purge point should be open for another 30 to 40 minutes to assure that any non-condensable gas makes its way into the collecting chamber. Once a majority of non-condensables have been evacuated from the system, this time can be reduced to 10-15 minutes.

INSTALLATION

The purger should be located in a safe place where it will not be damaged by material handling equipment, but where it is accessible to service personnel. The unit should be secured to a wall or other structure capable of supporting the weight of the unit. A minimum 1 gallon [4 liter] water bubbler should be provided for venting the unit. (Ambient temperatures should therefore not drop below 32ºF [0ºC].) The location should have good ventilation to permit safe dispersal of non-condensables leaving the water reservoir. Locate the electrical control panel away from the area where non-condensables are vented.

As discussed in the previous section, pipe size between the purge points and the unit are recommended to be size ½". The line size should not exceed 1" pipe or be smaller than ½". Purge solenoids should have ½" [15 mm] ports for maximum flow and be of the direct operated type (not requiring pressure drop to operate). Purge solenoids and controls are not included with the purger as standard. However, controls and purge solenoids can be supplied by Phillips.

Two ½" angle strainers are included with the PUR air purger assembly as loose items. One should be installed in the liquid feed line before the orifice and the other in the foul gas line before entering the vessel. These are included to prevent any debris build-up in front of the orifices, potentially clogging them and causing the unit to malfunction.

Before welding any connections to the purger, be sure to temporarily remove any nearby orifice plates from the flanges. Replace the orifices after welding is complete (Figure 10). A liquid feed orifice is located in the flange connection at the lower side of the unit. (See Figure 1), or for HPL feed systems an orifice is located in the EVM solenoid.

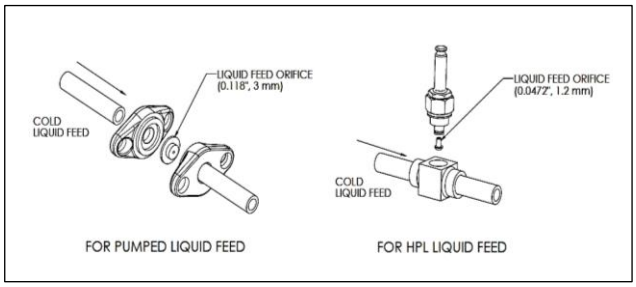

Figure 10: Temporarily Remove Orifices before Welding

Do not install a stop or check valve on the foul gas inlet (Figure 11). Closing such a valve in combination with a closed isolation or suction solenoid valve could result in trapped liquid.

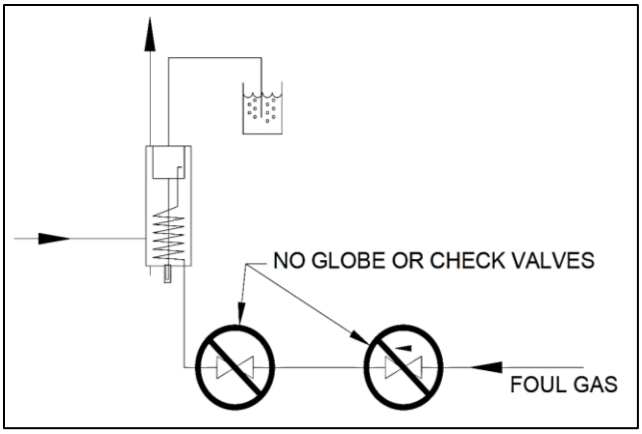

Figure 11: Do not trap liquid

The Phillips purger is typically provided with the following items shipped loose (see Figure 12):

- Vent Valve Sub Assembly
- Relief Valve
- Temperature Sensors
- Liquid Feed Strainer
- Foul Gas Strainer
- Optional Control Panel
- Optional Bubbler
- Optional Controls
- Optional Purge Solenoids

Install the vent Sub-Assembly, Liquid Trap, Temperature sensors, Strainers, and Safety Relief Valve in the locations indicated in Figure 12.

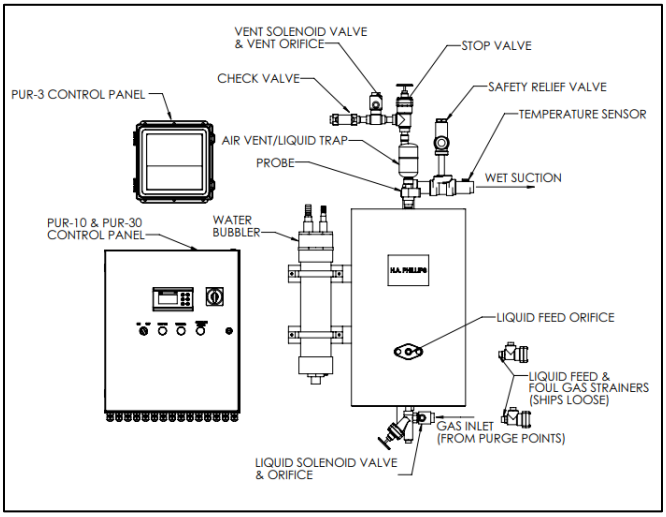

Figure 12: Major Components

OPTIONS

The PUR air purger can be supplied with the following factory options: Insulation, Electrical Controls, and Water bubbler.

OPTIONAL ELECTRICAL CONTROL PANEL

The 3-point control panel is a smart control using the Danfoss MCX controller. This panel is a NEMA 4 enclosure and has UL and CSA approval. This control must be interlocked with the compressor run signal to prevent purger operation when the compressors are not running. For installations requiring more than 3 purge points, optional 10- and 30-point control panels are also available. All controls are capable of using 110/230 VAC. The purge points can all be programmed individually or skipped as needed. The master controller present in each of the control panels has a resettable clock that sums the running total purge vent time. The electrical control panel should be located away from the area where non-condensable gases will be vented. Wire the components to the electrical system as shown in the electrical control drawing.

OPTIONAL BUBBLER:

The Phillips bubbler is attached to the purger as a safety feature which will allow any vented ammonia gas to be absorbed by the water in the bubbler before being disposed into an approved waste location. The bubbler is supplied with mounting brackets to attach to the purger. The bubbler has three connections: ½'' vent gas inlet, ¾'' water inlet and ¾'' drain. The bubbler should be filled with water prior to initial startup through the top water connection with external water source. The water feed solenoid should be wired to the vent solenoid to allow fresh water to enter the bubbler each time the purger vents. We recommend a minimum flow rate of approximately 1/2 gpm, to allow complete absorption of any ammonia vapor released in an unforeseen failure. The optional purger controls are equipped with an auto flush feature that allows the user to setup a time to automatically flush the water in the bubbler. This removes any possible contaminants that may exist.

While running, the purger imposes a maximum 2.85TR (10kW) load on the system. If there is little or no non-condensables in the foul gas, this represents an unnecessary operating cost. This unnecessary cost may be eliminated by stopping the purger over periods of time. This is done by cutting the "run" signal to the purger which will stop the purger. Depending on the size of the refrigeration system and the amount of air coming into the system the customer can decide how often and how long to run the purger. However, the capacity of the purger is so high that it will handle even very large refrigeration systems with high amounts of air and / or non-condensable gases if it runs whenever the refrigeration system is running. It should never be necessary to install more than one Phillips PUR air purger on even the largest system.

Phillips can assist with additional enhancements and modifications of the purger controls.

BENEFITS OF A TIME COUNTER

An additional benefit of the air purger cumulative time counter is that it allows estimates of the actual amount of air being vented from the system. Because the air is being released at approximately condensing pressure through a known orifice, the volume of air being purged can be determined by reading the curve in Figure 13. The estimated value is also displayed on the main screen of the purger display.

For example, consider a system operating at 90ºF condensing. If the time counter indicates that the vent solenoid was open for a total of 5 minutes, then about 16 cubic feet (3.25 scfm x 5 minutes) of air was purged from the system. This example illustrates the enormous effectiveness of the purger.

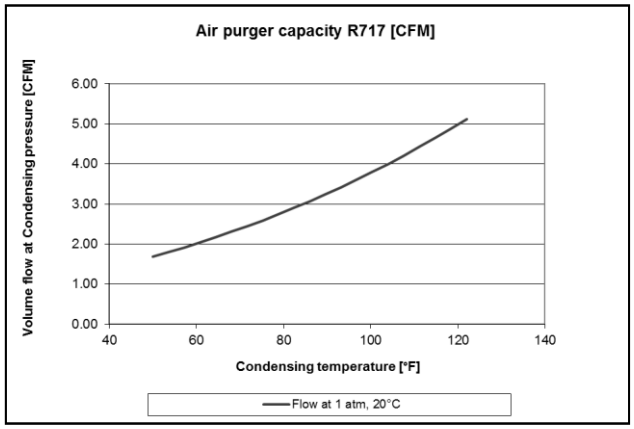

Figure 13: Purger Capacity

START-UP OF PURGER

1. Close the vent stop valve. (Refer to Figure 12)
2. Make sure there is an open connection to at least one purge point. Open all stop valves, and if there is a solenoid valve in the line between purge points and air purger this must be open. **Note: The air purger must never be allowed to run if there is not an open connection to at least one purge point.**
3. Open the suction globe valve. Allow cold liquid ammonia to slowly fill the main vessel with cold liquid through the liquid feed connection. If purger is fed by HPL, liquid feed will not start until power is turned on to the purger which takes place in step 6. Evaporated ammonia will leave the main vessel through the top wet suction connection.

4. If using optional bubbler, make sure bubbler is full of water before first start-up of purger.
5. Open the vent stop valve.
6. Power on the control panel. Condensed refrigerant gas will start flowing to the suction side through the expansion solenoid valve. If HPL fed, the liquid feed solenoid will open and slowly fill the main vessel during this step. Non-condensables will begin collecting in the collecting chamber.
7. When the temperature difference has been achieved, and the liquid level measured by the level probe is low inside the collecting chamber, the vent solenoid valve will open. When the liquid level measured by the level probe is high the vent solenoid valve will close.
8. The purger is not allowed to vent air if the difference between suction temperature and condensing temperature is lower than 24°F. (13°C) This condition is ensured by the controls, and temperature sensors which will only allow the vent valve to open after the delay (5 minute default time) times out and required temperature difference has been met.

The vent solenoid will open if a considerable amount of non-condensables have collected inside the chamber (purge indicator light will illuminate). Venting will cease when liquid ammonia has displaced the non-condensables.

UNIT PUMP DOWN

1. Drain any oil gathered in the air purger thru the oil drain connection.
2. Mount a service hose on the oil drain connection and connect it to a protected wet suction line connection.
3. Shut-off the suction globe valve
4. Shut-off the stop valve in the air vent line.
5. Shut-off liquid feed to the main vessel. If HPL fed, then this will be done when power is turned off to purger control panel. Allow the main vessel to pump-out thru the oil drain connection, using gas from the purge point as a heat source.
6. When the liquid in the main vessel has drained to the suction line (frost clears from main suction pipe), the temperature will rise in the vessel. To clear ammonia from the foul gas lines and prevent ammonia from accumulating in the collecting chamber close the purge point solenoid(s).
7. When oil drain valve is not frosted any more the air purger should be empty of liquid.

MAINTENANCE

Change or Renew Water in Reservoir or Bubbler

A strong ammonia odor indicates that water in the reservoir or bubbler has absorbed all the ammonia that it can from the vented gas. The water solenoid can be activated manually to flush the bubbler. Please dispose of the water following your organization's established guidelines.

- Reservoir- Empty reservoir and refill with fresh water.
- Bubbler- Drain through drain plug or by removing top cap assembly and dumping water out. Refill with fresh water. This process occurs with the use of water solenoid when purger is venting. If the purger has not vented over a two-week period we recommend running water through the bubbler to add fresh water, removing any possible contaminants that may still exist.

Drain Oil

1. If the air purger operates at positive suction pressures the air purger can be easily drained thru the oil drain valve during operation.
2. If the vessel works at suction pressures in the vacuum area: Close the air vent stop valve and the suction globe valve to raise the pressure in the air purger vessel without discharging refrigerant gas.
3. Use the oil drain connection to drain any oil from the air purger vessel.
4. Use normal precautions for draining and disposing of oil, as established by your organization.
5. After oil draining is complete, open the suction globe valve and wait a couple of minutes.
6. After a couple of minutes, when pressure and temperature in the air purger vessel has returned to normal operating conditions, open the air vent stop valve. The air purger is now back to normal operation.

Preventive Maintenance Cleaning Strainers

Strainers should be installed on both the liquid feed and foul gas lines. During normal operation these strainers should help catch any debris that might have a chance of clogging the orifices. If the liquid feed orifice gets clogged the unit will not be able to get down to temperature, which is indicated by lack of frost on the suction line, and the purger will not be able to condense the ammonia out of the foul gas. If the expansion solenoid were to get clogged, liquid ammonia will back up in the collection chamber and open the vent solenoid in the presence of air. Cleaning these strainers should be done on an as needed basis during normal operation.

TROUBLESHOOTING

CONDITION:	CAUSE / SOLUTION
Unit does not reach suction temperature	• Main suction valve not open • Liquid feed orifice clogged • In gravity applications, liquid feed orifice not removed

Ammonia escapes through vent solenoid	• The foul gas connection to purge points is not open to at least one purge point • Sequencer, if used, does not have power • Probe incorrectly reading low position • Vent solenoid leaks • Liquid feed orifice clogged
Vent solenoid energizes (vent light illuminates), but no gas vents	• Vent orifice clogged • Faulty vent solenoid coil
Vent solenoid never opens (Vent light never illuminates)	• No air in system • Probe stuck in high position
Expansion solenoid never opens (Expansion light never illuminates)	• Missing “compressor running” signal from refrigeration system

- Small orifices are key components used in the air purger. Any debris getting past the strainers has the potential to clog these and impede performance of the unit.
- For suspected issues with the controller please call H.A. Phillips

REPLACEMENT PART NUMBERS

PART	PART NUMBER
Probe	PUR-PROBE
Air Vent	1204
Vent Orifice	1203
Expansion Orifice	1205
Gravity Feed Union	U-4S
Pumped Feed - Union Orifice	U-4S 1201
HPL Feed - Housing Solenoid Coil (110V) Orifice	027F1091 027B1120 018F7991 1207
Temp Sensors (Foul Gas & Suction)	084N3210
Strainer Insert (250 Micron)	148H3126

PURGER MODEL NUMBERS

DESCRIPTION	MODEL NUMBER
Bare Purger	PUR
Purger with bubbler	PUR-B
Purger with insulation	PUR-I
Purger with control panel	PUR-P
Purger with bubbler and insulation	PUR-BI
Purger with bubbler and control panel	PUR-BP
Purger with insulation and control panel	PUR-IP
Purger with bubbler, insulation, and control panel	PUR-BIP

OPTIONAL PART NUMBERS

PART	PART NUMBER
Bubbler	PUR-BUB
Purger Insulation Kit	PUR-INS
Optional control panel 3 purge points (110/230 VAC)	PUR-3
Optional 10-point control panel (110/230 VAC)	PUR-10
Optional 30-point control panel (110/230 VAC)	PUR-30

PART	PART NUMBER
Purge Point EVRAT Solenoid with strainer	027X0142 006-1012
Purge point ICF Valve Station solenoid valve	027L4527
Coil 220 VAC w/terminal box	018F6814

Ordering Instructions:
-Specify liquid supply source (HPL, Pumped Liquid, or Gravity)
-Specify model number
-Specify other options

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