

*It is necessary to purge absorption chillers due to the potential for the systems to collect non-condensable gases. Non-condensables, if allowed to accumulate will reduce the absorption unit's performance and may cause corrosion within the unit. It could be speculated that over ninety per cent of all capacity related complaints on ParaFlow™ units involve the presence of non-condensables.*

## Non-Condensables

A *non-condensable* is defined as a gaseous substance that cannot be liquefied or condensed at the pressure and temperature surrounding it.

Non-condensables appear in two forms in absorption units.

1. Internally generated non-condensables are formed as a by-product of corrosion.
2. Air may be drawn into a unit via leaks.

Non-condensables that collect in the absorber section of the unit blanket the heat transfer tubes and reduce the absorber's ability to capture the refrigerant vapor.

This loss of absorber performance could be compared to a plugged suction strainer in a conventional compression-type system. The evaporator pressure rises but the actual compressor suction pressure becomes lower in the compression system.

In the absorption system, a similar thing occurs. The evaporator pressure rises with a corresponding rise in the boiling temperature of the refrigerant spraying on the tubes. The absorber pressure actually goes down because the solution concentration becomes higher.

Non-condensables that collect in the high side of the unit end up in the condenser where they blanket the condenser tubes, reducing the condenser's capacity. Full load capacity will be prevented by high condensing pressure.

## Non-Condensable Quantities

An absorption unit's general health can be determined by both the quantity and quality of non-condensables it produces. A properly maintained ParaFlow™ unit will produce very few non-condensables—the fewer the better. A small amount of internally generated gases will always be present and should be considered normal. Air leaks, no matter how small, will almost always cause noticeable increases in the amount of non-condensables a unit produces.

Since it is important to correct any air leaks as soon as possible, it is essential to develop a disciplined method of purging a unit so that any abnormalities can be discovered quickly. On *SmartPurge™* equipped units, the purge tank is automatically evacuated only when necessary and the frequency of evacuation is continuously monitored.

## Types of Non-Condensables

The most common type of non-condensable is air. Air enters the unit via leaks or accidentally during maintenance procedures. Air is made up of two main gases; nitrogen and oxygen. Other gases may collect inside the unit due to chemical reactions, some of which are caused by the oxygen in the air.

**NITROGEN**—A colorless, odorless gas considered inert from a corrosion standpoint, comes from air entering the unit. Air is comprised of approximately eighty per cent nitrogen. Although nitrogen causes no chemical reactions or corrosion

within the unit, it does cause capacity problems if it collects in the absorber or the condenser.

Where the nitrogen accumulates will depend on the actual location of the leak. A leak in the absorber or evaporator side of the main shell will generally result in the nitrogen collecting in the absorber. High side leaks, i.e. leaks occurring in the high temperature generator, low temperature generator or the condenser will normally result in the nitrogen collecting in the condenser.

**OXYGEN**—As air enters a unit via a leak or an accidental event, oxygen in the air reacts with the steel and copper materials inside the unit.

**CAUTION**  
**NO Air**  
**Allowed**

**EXTREME CARE**  
**SHOULD BE TAKEN**  
**WHENEVER PER-**  
**FORMING MAINTEN-**  
**NANCE ON THE SYS-**

**TEM TO AVOID ALLOWING ANY AIR**  
**TO ENTER THE UNIT. EXPOSING THE**  
**INTERNAL SIDE OF THE**  
**PARAFLOW™ UNIT TO AIR WILL**  
**CAUSE SEVERE CORROSION WHICH**  
**WILL INEVITABLY SHORTEN THE LIFE**  
**OF THE UNIT.**

*Refer to the solution chemistry section of this manual for a more detailed discussion on oxygen reacting within the unit.*

Several other types of non-condensables are generated within the unit itself. Self-generated non-condensables are a result of the chemical reactions occurring in the unit. Corrosion inhibitor depletion and the slow and ever present reactions between the solution and the metal parts of the unit cause the formation of these self generated non-condensables.

**HYDROGEN GAS**—Hydrogen gas is colorless, odorless and much lighter than air. Place a lit match near purge gas bubbling out of a container filled with water. If the purge gas contains large amounts of

# PURGING

## Purging Theory

hydrogen, a pop and slight flame-up will occur as the hydrogen in the gas is ignited. See Figure VP-1.

If only small amounts of hydrogen are present in the purge gas, it may be necessary to first collect the purge gas in an inverted water-filled, graduated plastic cylinder before testing for hydrogen. Slowly remove the cylinder from the water filled bucket, keeping it inverted. As it is removed, point the bottom of the cylinder away from you and try to ignite it by holding a lit match an inch or so from the open end of the cylinder. If a

small balloon with the purge gas may help determine how much of the purge gas is hydrogen. If the balloon easily floats in air, the purge gas may be considered mostly hydrogen.

Hydrogen is created as a by-product of corrosion. How much hydrogen is being generated and when it is generated are important clues to the source of the problem. The rules are slightly different depending on the type of corrosion inhibitor present in the solution.

Lithium nitrate inhibited units seldom produce large quantities of hydro-

gen unless the inhibitor quantity is low or non-existent. Small air leaks will increase the rate of inhibitor depletion but as long as the lithium nitrate inhibitor levels are within the allowable range, nitrogen and/or

unit produce the most hydrogen since the rate of corrosion will be higher in these areas. It is occasionally very difficult to determine whether hydrogen generation is a result of depleted inhibitor or an external air leak. A chemical analysis will generally help to determine this by revealing large amounts of dissolved copper in the solution when an air leak is present. Addition of inhibitor will reduce hydrogen generation if the cause of the hydrogen is strictly low inhibitor levels.

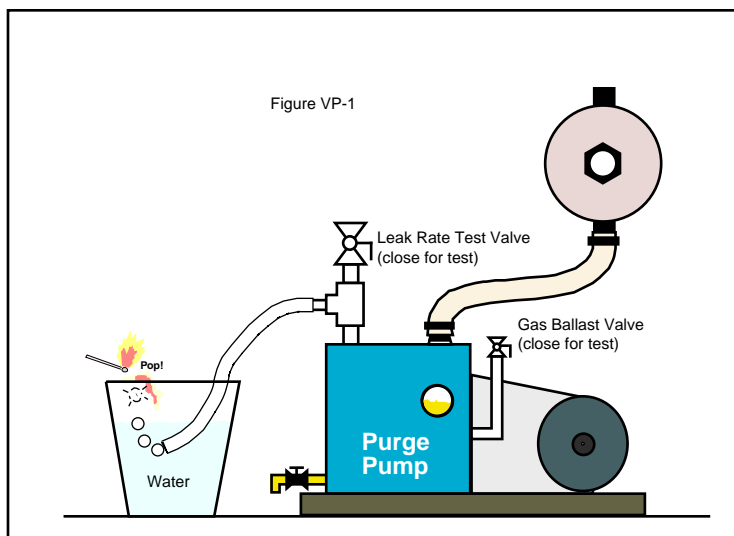
**AMMONIA (NH<sub>3</sub>)**— Ammonia is a colorless, pungent smelling gas which is extremely soluble in water. It is lighter than air. Most of the ammonia in a unit will remain dissolved in the refrigerant water or solution, however depending on the amount of ammonia in a unit, some will find its way into the purge system.

**NO<sub>x</sub>**—Several different oxides of Nitrogen may be produced by a ParaFlow™ unit. Although not nearly as common as hydrogen, one or more of these compounds may be produced by a unit where lithium nitrate inhibitor is being consumed at a higher than normal rate. The most common cause of high inhibitor consumption is an air leak.

**NITROUS OXIDE (N<sub>2</sub>O)**—Colorless, somewhat sweet smelling although the odor of the alcohol in the purge gas may overpower any odor it may have. 1.5 times as heavy as air. Supports combustion much like oxygen. Commonly referred to as laughing gas.

**NITRIC OXIDE (NO)**—Colorless, slightly heavier than air, does not support combustion, and usually is oxidized to NO<sub>2</sub> when exposed to air.

**NITROGEN DIOXIDE (NO<sub>2</sub>)**—Reddish brown gas, 1.6 times heavier than air, very soluble in water, unpleasant odor, and is considered noxious to breathe.



popping sound occurs, hydrogen is present.

The flammability limits of hydrogen in the presence of air are between 4 and

**DANGER**  
FLAMMABLE

**DO NOT ATTEMPT TO IGNITE HYDROGEN IN THE PURGE PUMP DISCHARGE WITHOUT FIRST PASSING IT UNDER WATER. THIS WILL PREVENT A DANGEROUS FLASHBACK INTO THE PURGE PUMP SUMP HOUSING.**

75 per cent. Since the flammability range is so wide, it is difficult to predict what percentage of the non-condensables are hydrogen based on a "pop" test. Inflating

an oxide of nitrogen (NO<sub>x</sub>) will be present in the purge gas.

Lithium molybdate inhibited units will produce hydrogen when an active air leak is present even if the inhibitor level is within the acceptable range. Air leaks will cause increased depletion of the corrosion inhibitor which will accelerate the generation of hydrogen. After a leak is repaired, lithium molybdate inhibited units may still produce some hydrogen for approximately forty eight hours of unit operation.

No matter which type of inhibitor is present, if a unit is producing hydrogen, the hydrogen amounts will increase as the unit firing rate is increased. High temperature, high concentration areas of the

**NITROGEN TETROXIDE (N<sub>2</sub>O<sub>4</sub>)**—Pale yellow gas formed as two molecules of NO<sub>2</sub> combine to form one molecule of N<sub>2</sub>O<sub>4</sub>.

## Non-Condensables in the Absorber

Non-condensables entering or generated in the absorber will be swept into the area of lowest pressure and temperature by the refrigerant vapor flow from the evaporator.

These non-condensables will surround the absorber tubes in that particular area of the absorber and prevent absorption of the refrigerant vapor from taking place.

The presence of non-condensables results in a reduction of the ability of the refrigerant vapor to be absorbed into the solution surrounding the absorber heat exchanger tubes. This is because of the affect the non-condensables have on the localized area around the absorber tube surface. Since the non-condensable vapor pressure adds to the total pressure around the tube, the available refrigerant vapor pressure is less in that localized area. Lower available refrigerant vapor pressure results in a reduction of the driving force that powers the absorption process—the solution and refrigerant vapor pressure difference.

Absorption is actually a *diffusion* process. Refrigerant vapor diffuses into the solution liquid on the absorber tube surface. Diffusion will only occur if there is an adequate difference in vapor pressures of a substance. The refrigerant vapor must have a higher vapor pressure than the refrigerant in the solution in order for it to diffuse into the solution. When refrigerant vapor diffuses into solution, the process is a type of *mass transfer*. The refrigerant vapor *mass* is transferred to the solution total mass.

As the mass transfer (refrigerant vapor absorption) rate is reduced, evaporator pressure and temperature rise

accordingly. Absorber solution concentration increases, because less refrigerant mass transfer means less dilution. As solution concentration increases, the solution vapor pressure decreases. Solution subcooling also increases.

## How to Detect Non-Condensables in the Absorber

Non-condensables in the Absorber will cause the following:

1. **Reduced unit performance.**
2. **Higher than normal solution concentration leaving the absorber.** Compare actual absorber solution concentration to the solution concentration charts in troubleshooting section of this manual. If the actual concentration is higher than the chart values, it may mean there are non-condensables in the absorber.
3. **High absorber solution subcooling.** Measure the actual absorber solution subcooling to determine if non-condensables are causing excessive subcooling.

## Absorber Subcooling

Absorber solution subcooling can be defined as the reduction in solution temperature below the solution saturation temperature for a given solution concentration and pressure.

If the solution concentration and pressure are known, the solution saturation temperature can be determined from a PTX diagram for lithium bromide and water.

When the mass transfer rate is reduced in the absorber due to non-condensables, less refrigerant vapor is absorbed than would be if the absorber were non-condensable free. Therefore, the total amount of solution heat rejection

due to the latent heat of condensation and the heat of dilution will be reduced proportionately with the reduction in refrigerant mass transfer. Since the latent heat rejection to the tower water is reduced, the tower water has the ability to subcool the solution. Less latent heat load allows more sensible cooling to take place since the available heat rejection capabilities of the absorber have not changed.

Some absorber solution subcooling is a fact of life, however the amount of solution subcooling should be no more than 5°F (2.8°C) if non-condensables are not present.

## How to Measure Absorber Subcooling

In order to obtain accurate results in this procedure, it is important to accurately measure:

- absorber pressure
- absorber solution concentration
- leaving absorber solution temperature.

The vacuum indicator should be accurate within ±0.5 mm Hg.

The solution temperature measurement should be accurate within ± 0.5°F.

The solution temperature may be measured using a conventional thermometer or an infrared thermometer.

When using a conventional thermometer, the thermometer must be in a thermowell with heat conductive compound present.

When using an infrared thermometer, use a paint stick to paint a black dot on the solution outlet pipe where the temperature will be read. This can be done using the paint stick that typically comes with infrared scanners.

For the steps necessary to calculate absorber solution subcooling, see the next page.

### How to Measure Absorber Subcooling

1

Measure absorber pressure using the absolute pressure gauge. Locate that pressure on the left hand side of the PTX chart. For this example we found the absorber pressure to be 5.5 mm Hg absolute. Draw a horizontal line across the PTX chart at this point.

2

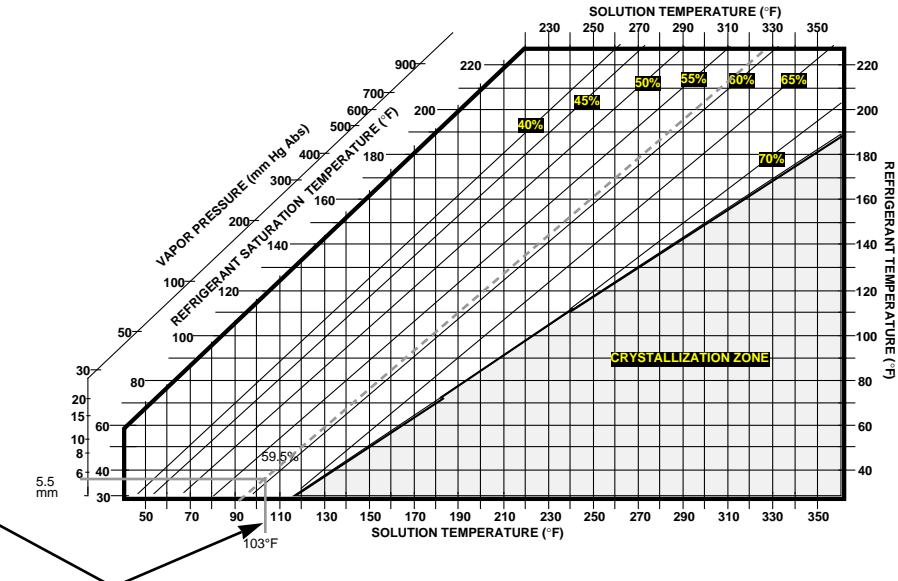
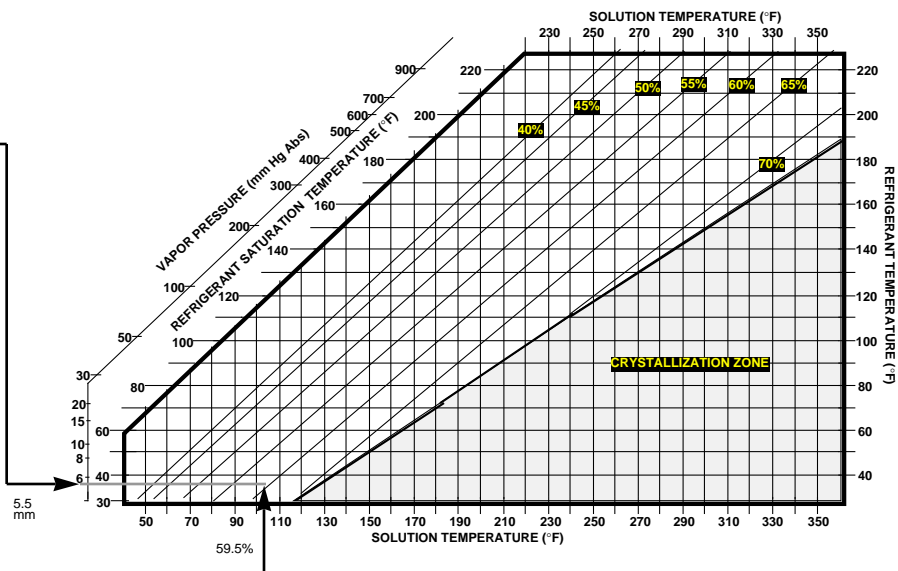
Take a solution sample of the absorber solution at sample valve VS14 (see solution sampling section for more specific instructions). After determining the concentration of the sample find the concentration line on the PTX chart. The solution concentration lines are the slanted lines. The concentration lines are in 5% increments so it may be necessary to estimate the spot on the chart. For this example we will use 59.5 % which falls just to the left of the 60% line. Make a mark where the horizontal line from step 1 intersects the 59.5 % point.

3

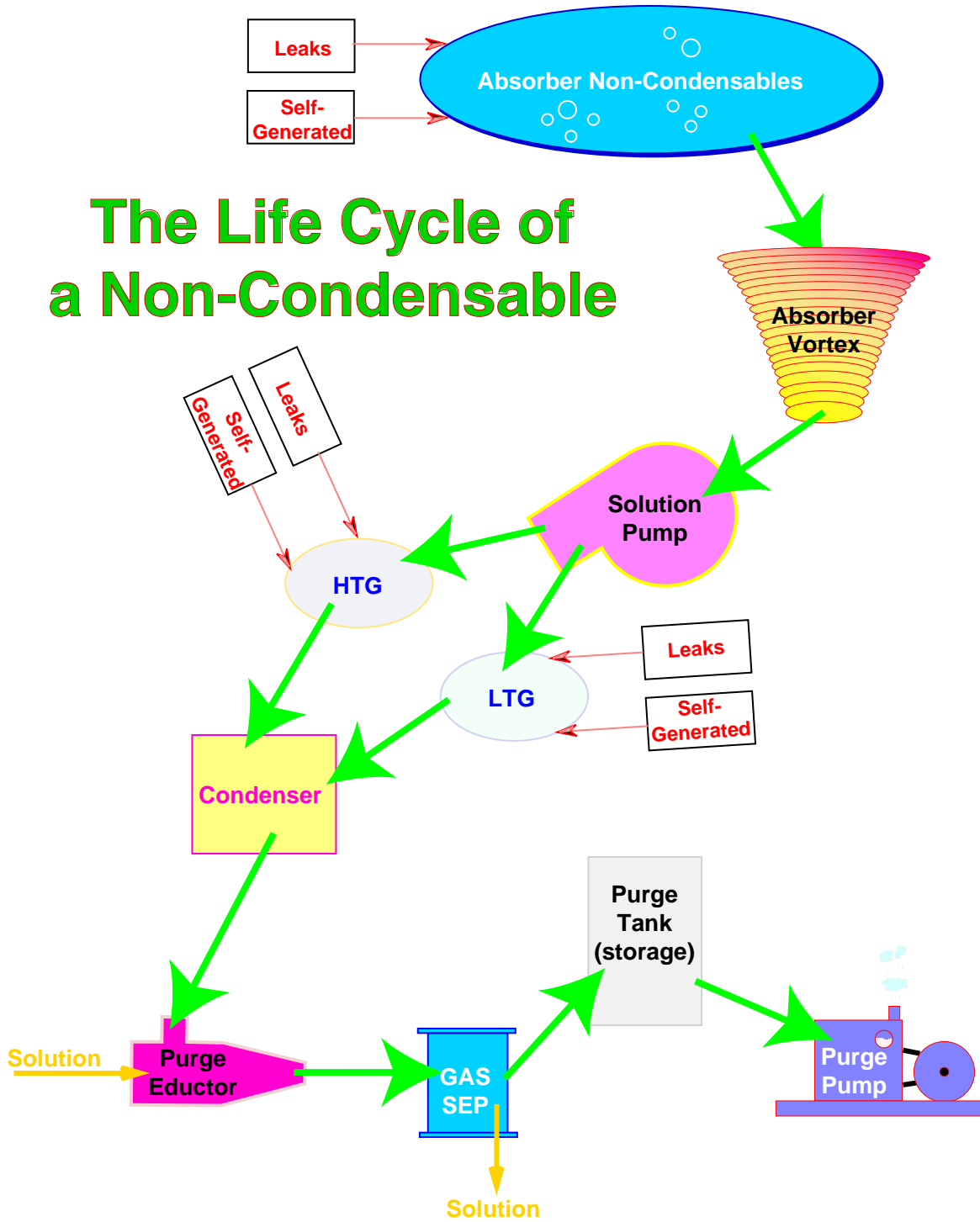
Draw a vertical line where the horizontal line drawn in step 1 and the concentration line from step 2 intersect. Read the temperature where this vertical line intersects the solution temperature scale along the bottom of the PTX chart. In this example, the temperature where the line intersects the temperature scale is 103°F. This is the solution saturation temperature. If there was no solution subcooling, this is what the actual solution temperature would be.

4

Measure the actual solution temperature leaving the absorber at the outlet of the solution tank (P1 suction) using an accurate infrared thermometer. For this example we measured 95.2°F. Subtract the actual solution temperature from the solution saturation temperature obtained in step 3. For this example,  $103 - 95.2 = 7.8^\circ\text{F}$ . There is 7.8 degrees of absorber subcooling. Since  $7.8^\circ\text{F}$  exceeds the normal amount of subcooling ( $5^\circ\text{F}$ ) by 2.8 degrees, there is reason to suspect non-condensables in the absorber.



## The Life Cycle of a Non-Condensable



### Absorber is Continuously Self-Purged

The purge system on a ParaFlow™ unit is designed to automatically and continuously remove non-condensables from the absorber and condenser section of a unit and store them in an area called a purge tank where they can be manually or automatically evacuated by the unit purge pump. The transport of the non-condensables to the purge tank is a continuous process accomplished without the use of any moving parts.

Non-condensables are drawn out of the absorber by the *vortex* action created as the solution drains out of the absorber. The center of this swirling vortex is at a very low pressure and much like a tornado pulls the non-condensables in where they are pumped with the solution to both the low and high temperature generators. For this process to work, it is necessary for the solution level in the absorber to be at the correct level so that a vortex can form.

In the *G* series unit, the solution level must be no higher than the upper sight glass in the solution tank. For *S* series units, the arrangement is slightly different and the vortex will form over a greater range of solution levels.

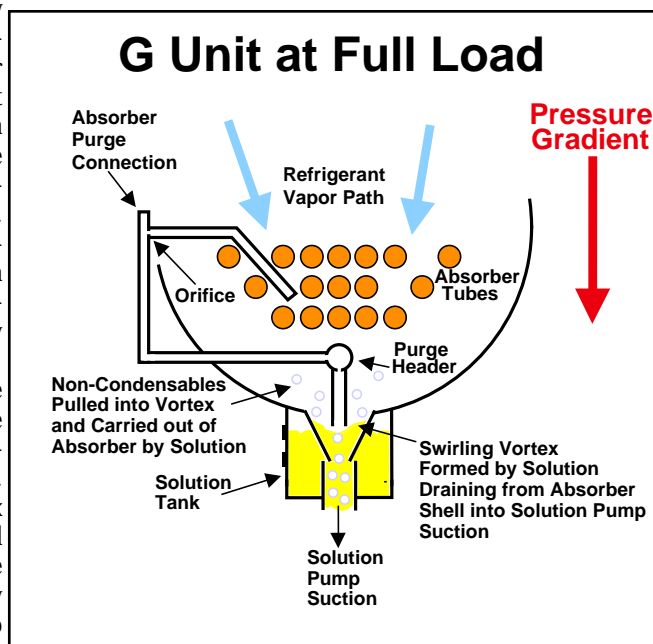
Generally speaking, the absorber will purge much better via the solution vortex when the unit is running at full load. At full load, providing the proper solution charge has been installed in the unit, the absorber solution level is low enough so that the vortex forms at the outlet of the absorber. However, if non condensables

accumulate in the absorber and the unit for some reason does not have enough load demand to reach full load, the solution level in the absorber may drop on its own, since the solution concentration

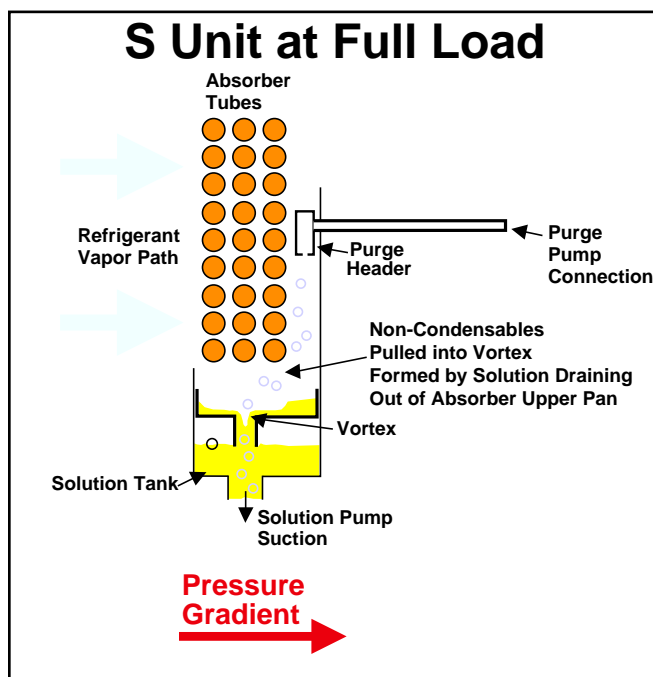
will gradually increase. As the solution level drops into the solution tank, the vortex will form in the bottom of the absorber, the non-condensables will be drawn into the solution and the solution concentration will again become weaker. This is an unusual occurrence since a well maintained unit will produce few non-condensables.

Most of the non-condensables from the absorber that are transported to the generators by the solution leave the solution with the refrigerant vapor as it boils off and travels to the condenser section of the unit. A continuous sample of vapor is drawn out of the condenser via the condenser purge connections. The gases are collected using an eductor-type pump driven by a small quantity of high pressure solution from the solution pump discharge. The high pressure solution passes through a small nozzle which induces flow from the condenser purge connections. The sample gas from the condenser passes into the side of the eductor and mixes with the solution from the eductor nozzle. The condenser gas consists of mostly water vapor with some entrained non-condensables. The water vapor is condensed into the solution in the eductor. As the refrigerant vapor from the condenser is absorbed into the solution, the heat of dilution is given off raising the outlet temperature of the solution eductor. Typically a 10°F (5.6°C) temperature rise will be evident between the inlet solution temperature to the eductor and the outlet mix of solution and non-condensables.

The condenser will purge better at light loads. At light loads, there is less turbu-

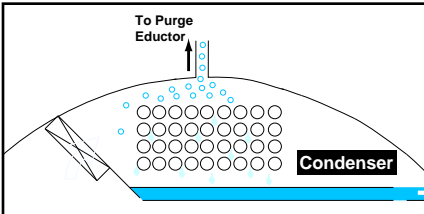


Solution Vortex Purges both G and S Series Absorbers



## How It Works

lence in the condenser and the non-condensables tend to congregate making it easier to collect greater quantities in a shorter period of time.



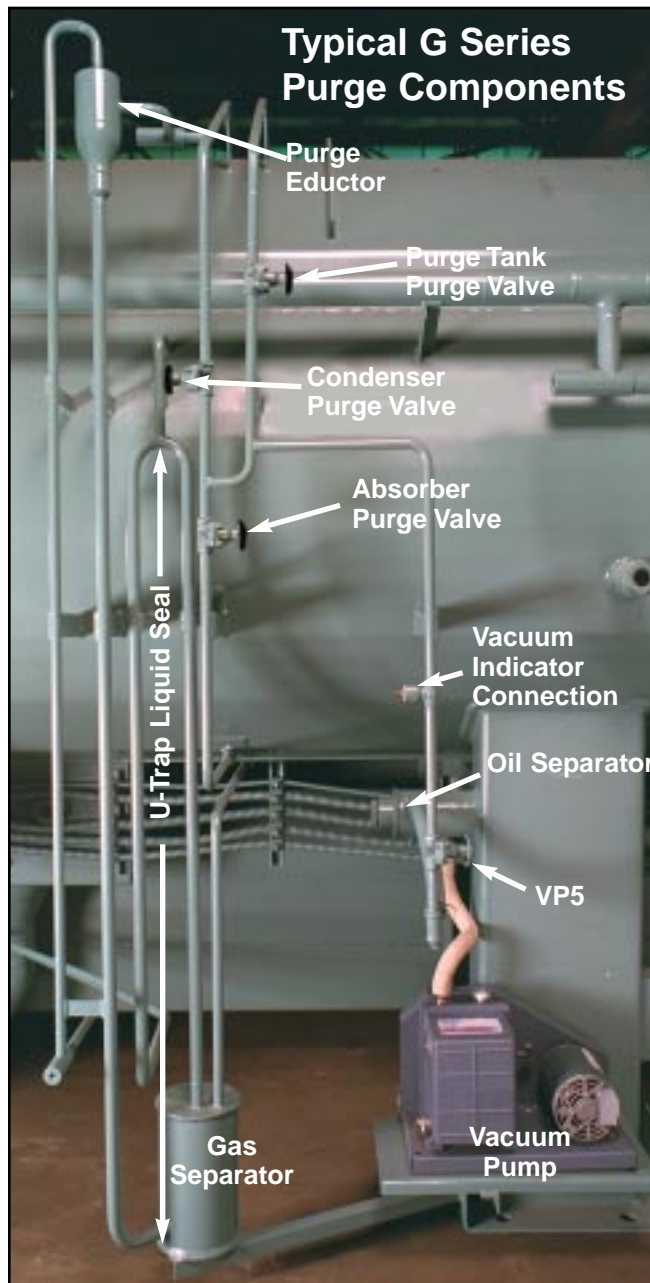
The weak solution/non-condensable mixture leaving the eductor flows to a gas separator where the non-condensables separate and flow into the purge tank. The solution is forced out of the bottom of the separator back to the absorber. The piping is configured in such a way so that the gas separator is located at the bottom of a *u-trap*. The *u-trap* provides a liquid seal between the purge tank and the absorber section. The liquid seal prevents the pressurized non-condensables in the purge tank from flowing back through the gas separator into the absorber during the unit off cycle. The height of the *u-trap* allows the purge tank to hold a pressure of approximately 100 mm Hg without the non-condensables back-flowing into the absorber.

The purge tank must be evacuated by the unit purge pump. This can be done either manually or automatically depending if the unit is equipped with SmartPurge™ or not. SmartPurge™ monitors the purge tank pressure and evacuates the purge tank when the tank pressure reaches 60 mm Hg absolute. The automatic purge system stops evacuating the purge tank when its pressure is reduced to 30 mm Hg.

## Purge Components

Several devices combine to provide the functional purge system. Many of the components can be found on the *purge tree*. The *purge tree* is a series of piping and valves connected together and locat-

# PURGING



ed on the opposite-generator side of the unit. The valves are manifolded together for convenience so that nearly all purge operations can be performed from one location.

On the G series unit the purge tree also consists of other purge system

devices such as the gas separator and the purge eductor. On most *S* series units, the purge tree consists of only the purge valve manifold. The other purge devices are located further away.

## Purge Pump

Each unit is equipped with a purge pump which is essentially a vacuum pump specially modified to work well in lithium bromide service. *G* series units have a 5.6 cfm vacuum pump. *S* series units have a 0.9 cfm pump. Both are belt driven, two-stage, rotary vane-type pumps.

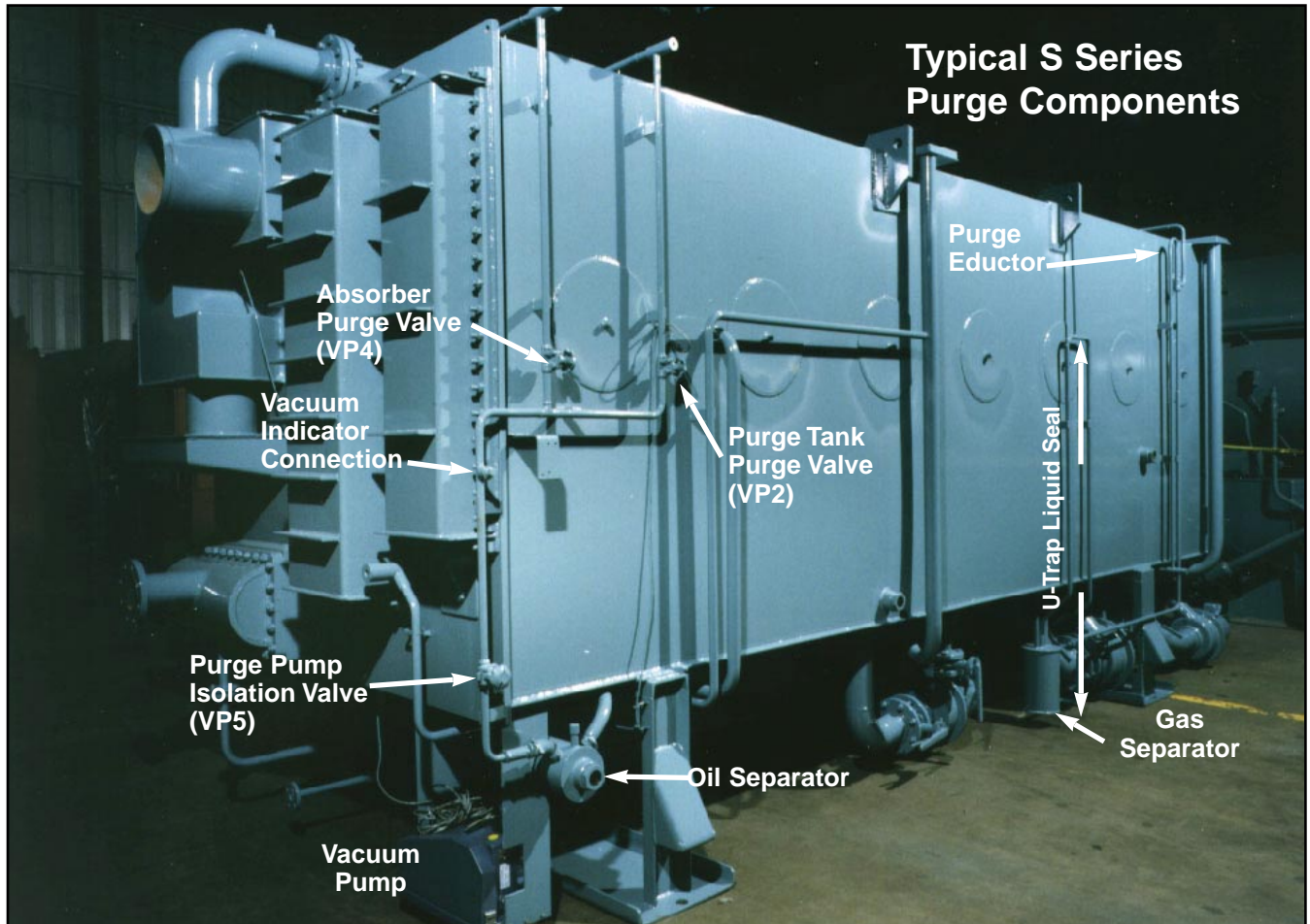
Purge pumps are mounted differently on different model units. The purge pump is factory mounted on an under-slung sliding bracket system on the *S* series units. On 22G and 22GL models, a shelf-type base is provided for field mounting of the pump. On all other *G* series units, the pump must be mounted on a customer supplied base near the unit.

The purge pump is used to:

1. Remove stored non-condensables from the purge tank
2. Manually purge the absorber

# PURGING

## How It Works



**DANGER**  
Keep Belt Guard in Place

**DO NOT OPERATE THE PURGE PUMP WITHOUT THE BELT GUARD IN PLACE**

**CAUTION**  
Automatic Starting Equipment

**ON UNITS WITH SMARTPURGE™ BE AWARE THAT THE PURGE PUMP STARTS AND STOPS AUTOMATICALLY**

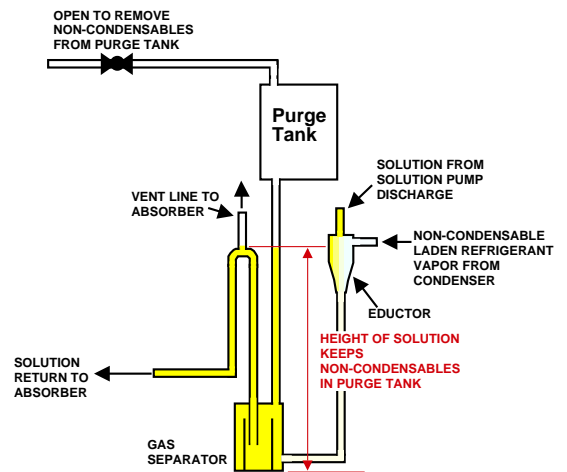
3. Evacuating the unit after pressurization or at the initial start-up.
4. Used to pull a vacuum on solution sample apparatus or remove non-con-

densables from hoses prior to charging solution or refrigerant.

The purge pump should be warmed up for at least 10 minutes prior to purging. This will help keep the oil free of refrigerant.

The purge pump exhausts the unit non-condensables.

Although occasionally some of the non-condensable gases produced are unpleasant in odor, the normal quantities are very small. If venting the purge exhaust is required, it can be done by



running the purge piping outdoors or into a scrubbing unit of some type. Common sense should prevail in the piping design if venting the purge pump out doors. Total pressure drop of vent piping must not exceed 5 psig.

The purge pump should be operated with the gas ballast open to prevent refrigerant vapor from condensing in the oil. Close the purge pump gas ballast when performing a leak test procedure.

Leave the leak test valve in the open position except when performing a leak test.

See the Purge Pump section of this manual for further purge pump maintenance information.

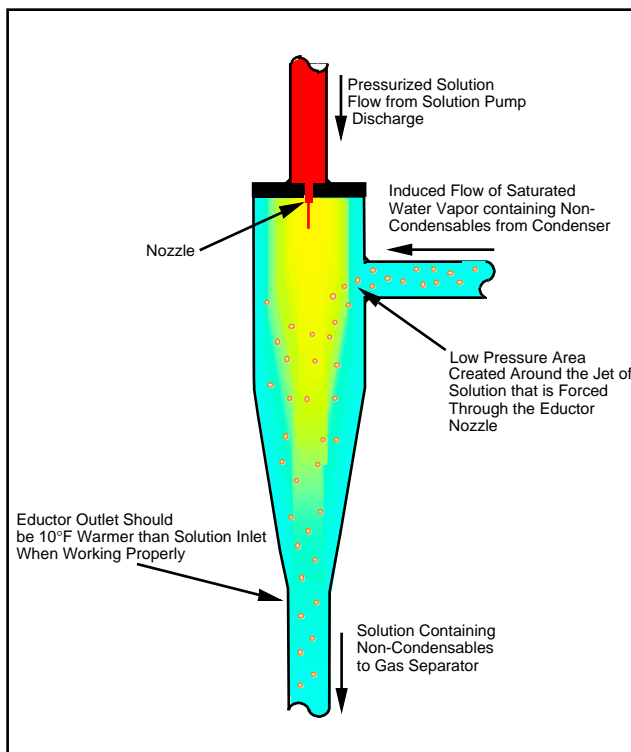
## Purge Tank

The purge tank is essentially a storage container where non-condensables are kept until they can be pumped out of the unit by the purge pump. The stored non-condensables are pumped into the purge tank by the purge eductor system.

The purge tank is a long round tank located above the high temperature generator on an S series unit. It is part of the alcohol separator assembly (although both alcohol separator and purge tank are individual vessels welded together) on most of the G series unit. On the 22G and 22GL the purge tank is a separate rectangular tank located on the opposite-generator side of the unit.

Non-condensables stored in the purge tank do not affect the unit performance. The purge tank is kept separate from the rest of the unit by a liquid U-trap seal. Due to the liquid seal height, the purge tank can safely hold at least 100 mm Hg absolute of pressure without fear of the non-condensables venting into the absorber.

## Purge Eductor



The purge eductor is a liquid powered jet pump (ejector). Jet pumps have no moving parts and use a high pressure stream of liquid (solution from the solution pump discharge line) passing through a nozzle to cause a portion of a low pressure stream (condenser refrigerant vapor and non-condensables) coming into the side of the pump to combine with the nozzle stream. This causes a reduction in pressure at the low pressure inlet and induces the rest of the low pressure inlet substance to flow into the body of the pump. In the diffuser section of the pump some of the velocity of the combined liquid flow is converted back to pressure. The eductor outlet will be at a pressure between the high pressure inlet and the low pressure inlet.

The G series unit purge eductor is larger than the S series eductor, however they both function in the same way.

The outlet of the eductor will be approximately 10°F (5.6°C) hotter than the solution inlet to the eductor nozzle when the eductor is performing properly. This is due to the water vapor from the condenser being absorbed into the solution coming through the nozzle.

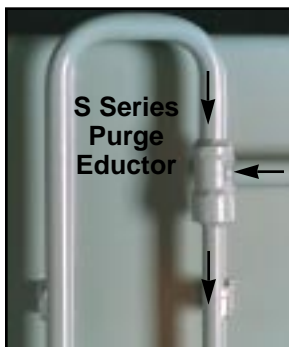
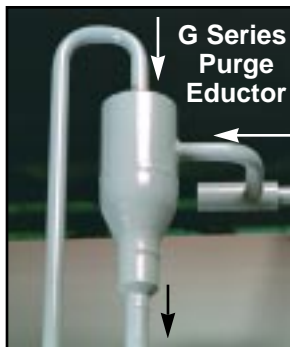
Flow control valves regulate the amount of solution flow into the eductor nozzle on some units. The flow control valves should generally be set at full open (4 turns open).

The low pressure inlet from the condenser will have a flow control valve. This flow control valve should normally be set for full open (4 turns open.)

## Absorber Purge Header

The absorber purge headers are internal collection pipes that are strategically located in the absorber section of the units. Using the purge headers, non-condensables can be removed directly from the absorber with the purge pump.

The purge header system in the G series unit consists of two individual pip-



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ing systems. One pipe enters the absorber shell and penetrates into the tube nest. It is used to remove non-condensables when the absorber level is high. The other pipe runs the length of the absorber shell just under the tube bundle. It is closed at the ends and has holes periodically so that non-condensables in the lower portion of the absorber can be removed when the absorber solution level is low. The upper and lower piping systems are connected together so that when the solution level is covering the lower header, the upper pipe will be functional. The lower header is situated so that when the absorption unit is running at full load with the correct solution level, the header is in the lowest pressure area of the absorber. Non-condensables will accumulate in the lowest pressure areas of the absorber.

The S series has only one purge header. It is similar in function to the lower header in the G series units. It runs the length of the absorber. It also has holes in the bottom to allow non-condensables to be drawn into it over the length of the header. It is located approximately midway up the tube bundle of the absorber instead of the bottom like the G unit. This is because the S series refrigerant flows horizontally through the

tube bundle instead of vertically like the G unit. Since the refrigerant vapor flow pushes the non-condensables, the best collection point for the S unit purge header is different from the G unit.

The absorber purge headers are normally not used once a unit has been thoroughly purged after commissioning. The solution vortex does a better job of removing non-condensables from the absorber. However, should a leak occur or if the unit needs to be evacuated after service, the absorber purge headers can be used to quickly remove the bulk of the non-condensables from the absorber.

If the unit is equipped with *SmartPurge™*, the unit purge system

**NOTICE** *On G series units, do not purge from the absorber if the absorber solution level is in the top sight glass of the absorber shell or solution may be drawn into the vacuum pump.*

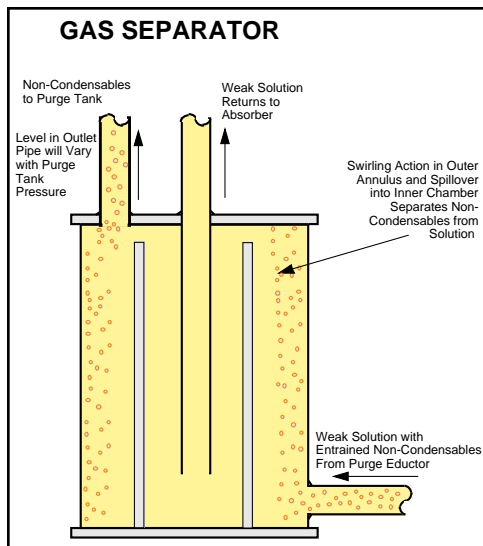
Observe Absorber Solution Level

must be put in manual mode to purge the absorber.

### Gas Separator

The gas separator is where the non-condensables are removed from the solution flowing out of the purge eductor.

Solution mixed with non-condensable gases flows into the side of the separator where it enters an annulus between the inner chamber and the outer wall of the separator. The swirling and overflowing action induced by the inner chamber causes the non-condensables to rise up and accumulate near the top of the separator. The solution outlet pipe extends down into the inner chamber where solution with no non-condensables is present. The non-condensables accumulating near the top of the gas separator pass upward through the non-condensable outlet pipe into the purge tank.



There will be a standing level of solution in the non-condensable outlet pipe which will vary in height depending on the purge tank pressure.

### Valves

Many valves are used on the purge system. All of the valves are designed to be reliable and leak free.

Most of the manual valves are diaphragm-type.

A few flow control valves are used which are the spindle-type. Spindle-type valves require a seal cap to be removed before any adjustments can be made. The seal cap of the spindle valve and the adjustment spindle require a metric allen wrench. The spindle valve requires four counter clockwise turns to fully open the valve. Do not open the spindle valve past 4 turns open or a leak may occur.

There are several special purpose valves used such as the check valve and the automatic purge valves as well as several angle-type globe valves.

The following is a description of each individual valve and its functional purpose. Note that an individual model unit may not have all of the valves listed.

*Please refer to the individual unit valve location information specifications located in the valve location section of this manual for more detailed information on a specific model unit.*

**VP1:** Spindle valve. Controls flow of refrigerant vapor/non-condensable mixture from the condenser into the purge eductor. Normally this valve is set for full open (4 turns open) during operation.

**VP2:** Diaphragm valve. Used to remove non-condensables from the purge tank (with VP5 open) or to read the purge tank pressure.

**VP3:** Diaphragm valve on G series units and smaller S series. Spindle valve on larger S series units. Used to purge from the condenser before the unit has been commissioned or after pressurizing unit. On G series unit, this valve must not be

opened during normal operation since it is piped to the purge tree. After a G series unit has operated, the line will be filled with liquid refrigerant since the refrigerant vapor will condense in the line. On S series units, the line is piped into the purge tank and can be opened if necessary, since any liquid in the line will drain into the purge tank and then back into the absorber. *On S series units this valve was previously called VP9.*

**VP4:** Diaphragm valve. Used to manually purge the absorber. This pipe is connected to the internal absorber purge header system. Used in conjunction with VP5, the purge pump will pull non-condensables from the absorber. Normally this process is only necessary when first starting a unit that was under a nitrogen or argon holding charge or first commissioning a unit. On G series units, be sure the absorber level is visible in the middle shell sight glass before purging from the absorber. On properly charged S series units, the absorber level should always be below the purge header. *This valve was formerly called VP3 on S series units.*

**VP5:** Diaphragm valve. Use as an isolation valve between the purge pump and the other purge valves. On units with SmartPurge™, VP5 is located between the automatic purge valves (VP18 and VP19) and the rest of the purge valves. VP5 must be open when using the purge pump to purge from any section of the unit.

**VP6:** Diaphragm valve. Used to purge the hot water heat exchanger on direct fired units equipped with the auxiliary hot water heat exchanger. This valve should only be opened for a maximum of 3 minutes/month during the heating operation if non-condensables are causing a high pressure situation. By opening this valve, non-condensables in the hot water heat exchanger will be vented to the purge tank on G series units and to the condenser on S series units. If VP6 is left open too long, enough refrigerant vapor will leave the high side of the unit to cause abnormally high solution con-

centration in the high temperature generator.

**VP7:** Spindle valve on G series. Diaphragm valve on some S series. This valve is meant to be used as a connection point for an auxiliary vacuum pump for evacuation purposes. On G series units and larger S series units it connects to the absorber section of the unit. On smaller S series units it connects to the evaporator section of the unit. VP7 was formally called VP11 on S series units.

**VP8:** Check Valve. This valve is in the purge line between the purge pump and the rest of the purge piping. It is a flapper type check valve which must be installed horizontally with the "hinge marking" up. Its purpose is to provide added protection from air ingress if the purge valves were open during an unattended power failure situation.

**VP9:** Diaphragm valve. Used to purge the second hot water heat exchanger on the 20G direct fired unit. The same rules apply as VP6.

**VP10:** Diaphragm valve. Used to isolate the purge tank pressure transducer on units with SmartPurge™.

**VP11:** Spindle valve. This valve controls the supply of solution to the nozzle of the purge eductor. Normally it is set for full open (4 turns) but in some cases where solution flow is more critical, it can be set for two turns open or 50 %.

**VP12:** Diaphragm valve. This valve is meant to be used as a connection point for an auxiliary vacuum pump for evacuation purposes. It connects to the evaporator section of the smaller S series units *VP12 was formally called VP11 on S series units.*

**VP13:** Diaphragm valve. Both this valve and VP14 are used on the 21G unit to select either end of the condenser to purge from. In most cases both VP13 and VP14 are left in the open position. If it appears that the solution eductor is not adequately removing non-condensables from the condenser, it may be necessary to purge from only one end or the other by selectively closing one of the valves. Normally more non-condensables will be

at the water leaving end of the condenser due to the lower pressure.

**VP14:** Diaphragm valve. Both this valve and VP13 are used on the 21G unit to select which end of the condenser to purge from. In most cases both VP13 and VP14 are left in the open position so that both ends of the condenser are purged simultaneously. If it appears that the solution eductor is not adequately removing non-condensables from the condenser, it may be necessary to purge from only one end or the other by selectively closing one of the valves. Normally more non-condensables will be at the water inlet end of the condenser due to the lower temperature.

**VP15:** Globe valve. This valve is used to allow non-condensables trapped in the tube side of the high temperature solution to solution heat exchanger on the 22G and 22GL to be flushed back into the absorber where they can be removed in the conventional manner. The valve is normally opened partially during solution circulation at initial start-up or after the unit has been pressurized for some reason. After hot purging the unit, the valve should be closed and left closed.

**VP16:** Globe valve. This valve is used to allow non-condensables trapped in the tube side of the intermediate temperature solution to solution heat exchanger on the 22G and 22GL to be flushed back into the absorber where they can be removed in the conventional manner. The valve is normally opened partially during solution circulation at initial start-up or after the unit has been pressurized for some reason. After hot purging the unit, the valve should be closed and left closed.

**VP17:** Globe valve. This valve is used to allow non-condensables trapped in the shell side of the intermediate temperature solution to solution heat exchanger on the 22G and 22GL to be flushed back into the absorber where they can be removed in the conventional manner. The valve is normally opened partially during solution circulation at initial start-up or after the unit has been pres-

surized for some reason. After hot purging the unit, the valve should be closed and left closed.

**VP18:** Globe valve. This valve is used to allow non-condensables trapped in the shell side of the low temperature solution to solution heat exchanger on the 22G and 22GL to be flushed back into the absorber where they can be removed in the conventional manner. The valve is normally opened partially during solution circulation at initial start-up or after the unit has been pressurized for some reason. After hot purging the unit, the valve should be closed and left closed.

**VP19(2 SOL)** : Automatic valve. Used on units equipped with *SmartPurge™*. This valve is controlled by the Micro Panel and automatically opens when purging is required. VP19 opens first in the purge sequence after the purge pump starts. Pressure transducer PT-3 then monitors the pressure in the line. When the pressure is reduced to 15 mm Hg, VP20 is permitted to open which allows non-condensables to be removed from the purge tank.

**VP20(1 SOL):** Automatic valve. Used on units equipped with *SmartPurge™*. This valve is controlled by the Micro Panel and automatically opens during the purging sequence. VP20 opens after the purge pump operation is proven by pressure transducer PT-3.

**VP21:** Spindle Valve. Used on larger S series units. This valve is in series with VP4. It should be left full open when the unit is in the cooling mode and closed in the heating mode.

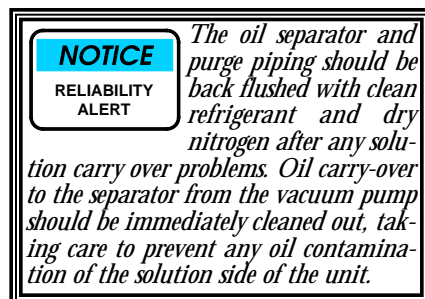
**VP22:** Spindle Valve. Used on larger S series units. This valve is in series with VP2. It should be left full open when the unit is in the cooling mode and closed in the heating mode.

## Oil Separator

The oil separator is located in the suction line of the purge pump. It is constructed so that oil from the vacuum pump cannot get drawn into the unit

should a power failure occur during purging. The separator is sized to hold twice the volume of the purge pump oil charge.

The oil separator also serves as a trap in the unlikely event that solution gets



drawn into the purge piping and helps prevent contamination of the purge pump.

## Absolute Pressure Gauge

The gauge is very important for reading the extra low system pressures throughout the unit. It can be used to read absorber pressure, purge tank pressure, purge pump pressure and on S series units, condenser pressure.

The standard absolute pressure gauge is a mercury manometer. An optional dial-type absolute pressure gauge may be provided where mercury is prohibited. In either case, the gauge will read in mm Hg absolute. *Hg* is the chemical symbol for mercury and *mm* is the abbreviation for millimeter. If exposed to the atmosphere, the gauge will be at the top of its range.

Care should be taken to prevent lithium bromide solution from contaminating the gauge. It will cause inaccuracies in the pressure reading on the mercury manometer and it will damage the dial-type gauges.

To read the mercury manometer, allow the pressure to stabilize and then read the *difference* between the two columns of mercury. The columns will be at an equal height only in a perfect vacuum. If one column is 1 mm below the zero point and the other column is 1 mm

above the zero point, the pressure is 2 mm Hg absolute.

## Purging Frequency

The purge tank evacuation frequency will be dependent on several factors such as unit size, operational parameters, running time, solution chemistry, and of course, leak tightness of the unit. Some units may only need to have their purge tank evacuated a few times per year. Others may require more frequent evacuation. Although very frequent purge tank evacuation is a matter of concern, a change in the frequency is also an indicator of a unit problem. For instance, a unit may routinely accumulate 60 mm Hg of pressure in the purge tank over 200 hours of operation (approximately one month). If, all of a sudden, the purge tank accumulates 60 mm Hg pressure in 100 hours of operation (approximately two weeks), there is a strong indication that either a leak is developing or there is a problem with the solution chemistry or both. Therefore, if a unit is manually purged, it is important to keep track of the purging history. If the unit is equipped with *SmartPurge™*, the micro processor keeps track of the purging frequency and alerts you if it has become excessive.

## When to Purge the Purge Tank

The old philosophy of purging an absorption unit was to have the plant room operator manually purge the unit once per day whether it was needed or not. In addition to purging from the purge tank, most operators preferred to purge from the absorber with the purge pump for a given period of time. Although some users may still prefer this method, it should not be necessary, providing the unit is in good health.

Since the ParaFlow™ unit's internal purge system is automatically and continuously (while the unit is operational)

moving any non-condensables from critical areas of the unit such as the absorber or condenser to the purge tank, it is only necessary to monitor the purge tank pressure and evacuate it periodically. It should not be necessary to purge the absorber with the purge pump on a properly operating unit.

Although the purge tank can adequately maintain 100 mm Hg pressure, *SmartPurge™* will evacuate the tank if the pressure exceeds 60 mm Hg. The purge tank will be evacuated until the tank pressure is reduced to 30 mm Hg. It is recommended that units without *SmartPurge™* be purged the same way.

Open the purge tank to the vacuum indicator and check the purge tank pressure. If it is above 60 mm Hg, use the purge pump to evacuate the tank until the vacuum indicator shows that the tank pressure is 30 mm Hg. **Do not evacuate the purge tank to a pressure lower than 30 mm Hg.** There is nothing to be gained by lowering the pressure of the tank below 30 mm Hg; plus solution may be pulled into the tank and purge pump if the absorber pressure is high enough.

Operations personnel should be shown how to keep a history log of when the purge tank was evacuated, what its “before purging” and “after purging” pressures were.

### When to Purge the Absorber

Although non-condensables are automatically removed from the absorber by the solution vortex, under certain circumstances the absorber must be manually purged with the purge pump. This is normally only necessary under the following conditions:

1. Unit is being started for the first time and is full of residual non-condensables from the nitrogen or argon holding charge.

2. Unit was pressurized for maintenance purposes and has residual non-condensables from a nitrogen or argon pressurization charge.

3. Just after changing the unit from the heating to the cooling mode. This is especially true on S Series units with Low Temperature Heating (using evaporator for heating).

4. Unit is producing non-condensables in the low side of the system either due to a low side leak or lack of inhibitor.

If any of the above conditions are true, the purge pump should be used to purge from the absorber. It must be remembered however, that the purge pump is not nearly as effective in removing non-condensables from the absorber as the solution vortex. Therefore, whenever possible, if non-condensables are present in the absorber, artificially lower the level in the absorber, if necessary, so that the vortex can form and remove the non-condensables in a more thorough manner.

### When to Purge From the Condenser

On G series units it is possible to purge from the condenser with the purge pump, however it should never be done during unit operation. This is because the condenser will be filled with hot refrigerant vapor during unit operation which will condense to liquid refrigerant in the purge piping and fill the purge pump with liquid refrigerant. Purging from the condenser connection on the purge tree should only be done under the following conditions:

1. Unit is new and is full of nitrogen or argon holding charge.
2. Unit was pressurized for maintenance purposes and has residual non-

condensables from a nitrogen or argon pressurization charge.

After the unit has been operated for the first time the condenser purge valve (VP3) should not be opened again on the G unit.

On the S series unit, the VP3 may be opened to read the condenser pressure using the vacuum indicator during operation in the cooling mode. Any liquid condensation will drain into the purge tank. Do not leave the valve open for long periods.

### When to Purge the Hot Water Heater

Direct Fired units with the optional hot water heat exchanger have a purge connection which allows the user to vent non-condensables should they build up during the heating cycle. The non-condensables will then be vented to the purge tank on the G series units or to the condenser on the S series units.

It is necessary to vent non-condensables from the hot water heat exchanger only when the High Temperature Generator pressure is excessive.

Only open the purge valve (VP6 or VP9) for a maximum of three minutes during heating operation in a given one month period.

This procedure should not be done on a routine basis—only as needed, otherwise, too much refrigerant vapor will escape from the High Temperature Generator causing abnormally high solution concentration to occur.

### SmartPurge™

*SmartPurge™* consists of hardware and software that monitors the purge tank pressure, purges it when needed and records the event. *SmartPurge™* will also alert the user if purging is excessive.

# PURGING

## How it Works

By utilizing two pressure transducers, *SmartPurge™* continuously watches the purge pump performance and stops the purging process if a problem occurs.

If *SmartPurge™* is installed, it will be necessary to make it active by removing the I/O Expansion board jumper *JP-1*. It will also be necessary to enable *SmartPurge™* by selecting it using the Micro Panel keypad

*SmartPurge™* must be turned off to perform manual purge procedures.

For more specific information on *SmartPurge™*, see the Micro Panel Operation Manual (155.17-O2).

### Purging at Start-Up

*For units shipped under pressure with solution and refrigerant pre-charged, begin here.*

*For factory tested units shipped under pressure where most of the solution charge was removed and shipped separately, begin here, but prior to Hot Purging, charge the shipped-loose solution and refrigerant. Then proceed to the Hot Purging Section and continue the purging process (providing unit pressure falls within gray area of Figure PC-1)*

*For units shipped under vacuum with no charge, charge unit first (see Solution Charging Section of this manual) and proceed to the Hot Purging Section (providing unit pressure falls within gray area of Figure PC-1)*

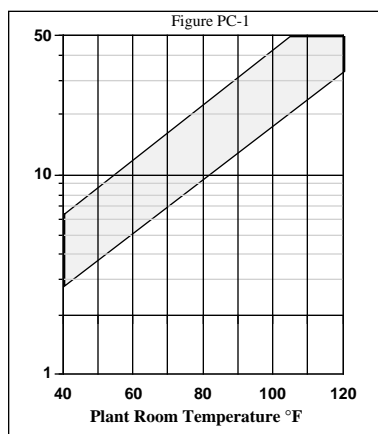
Refer to the ParaFlow™ Start Up Procedure Manual (Form 155.17-SU2) for more specific details on tasks other than purging.

Check vacuum indicator connections. (Install mercury manometer or optional absolute pressure gauge if one has not already been installed). A separat-

ed valved connection can also be installed near the vacuum indicator for use in pulling samples and for other maintenance procedures.

Check the installation and operation of the purge pump. Check oil level, rotation and belt tension (between 1/4 and 1/2 inch of belt deflection at mid point of belt). Check pump's capacity to draw vacuum. Acceptable performance is below 3 mm Hg within 2 minutes.

Install the necessary auxiliary piping to the purge pump in order to perform a bubble test.



Install the full flow ball valve on the purge pump gas ballast.

Check purge system piping for air leakage. No air leakage is acceptable.

Vent residual holding charge from unit. **Do not allow air to enter unit at any time.**

After warming the purge pump up for approximately 20 minutes, begin evacuation of the unit.

*Note: The following purging instructions apply to evacuation during start-up or evacuation after pressurization for other reasons. Insure all purge valves are placed back in their proper positions after evacuation.*

*During all purging procedures, unless performing a bubble test procedure, the purge*

*pump gas ballast should be wide open. A cold trap may be temporarily installed in the purge pump suction to prevent purge pump oil contamination. Change purge pump oil as necessary. Do not allow LiBr or free water to remain in the purge pump if accidentally ingested. Flush pump immediately.*

### Cold Purging

Open VP2, VP3, VP4, VP5, VP6 and VP9 and purge from all sections simultaneously. (If unit has no hot water heat exchanger there will be no VP6 or VP9—only 20G direct fired units will have VP9). If the unit is equipped with *SmartPurge™*, the Manual Purge mode must be selected on the Micro Panel so that the automatic valves will open.

Solution may be circulated during this cold purging process to expedite the removal of dissolved non-condensables. **Do not run the refrigerant pump.**

Continue cold purging the unit until the internal unit pressure is close to the saturation pressure equivalent to the plant room temperature. Use the absolute pressure gauge to check the absorber pressure and compare the results to Figure PC-1. If the measured pressure is in the shaded area of the chart, continue on to the next step, otherwise continue the cold purge procedure.

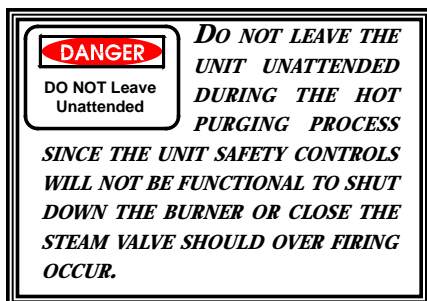
### Hot Purging

Close all purge valves. Allow the purge pump to continue running with the gas ballast fully open.

Continue circulating solution by running all the applicable solution pumps. Tower water may be circulated through the unit during this process so that refrigerant is generated, however more heat will be required to maintain the solution temperature and the unit pressure may be reduced which will slow the purging process somewhat. It is recommended that if additional refrigerant is needed to start the unit, that the tower water is circulated through the unit at the

end of the hot purging process until a sufficient refrigerant level is visible in the refrigerant tank. **The refrigerant pump should not be running during this step.**

On steam fired units, jumper the automatic shut-off valve and condensate drain valve. Place the unit in Service Mode and open the steam control valve slightly using the Load and Unload keys on the Micro panel. Do not allow the solution temperature in the HTG to exceed 200°F (93.3°C) Regulate the steam control valve using the Load and Unload keys on the Micro panel to maintain this temperature.



On direct fired units, operate the burner periodically by jumpering the start terminals in the burner control panel (terminals 4 & 5). Do not allow the solution temperature in the HTG to exceed 200°F (93.3°C)

Purge the unit from the absorber only. (VP4 and VP5 open)(VP19 and VP20 open also on units with SmartPurge™).

Periodically check the purge tank pressure. If the purge tank pressure exceeds 60 mm Hg, evacuate it to 30 mm Hg. **Do not evacuate the purge tank below 30 mm Hg.**

Periodically check the bubble rate of the purge pump when purging from the absorber. To do this, close the purge pump gas ballast completely. Close the ball valve on the purge pump discharge so that all flow goes through the clear plastic tube on the tee upstream of the discharge ball valve. Put the end of the clear plastic hose just so that it is sub-

merged in a bucket of water. Be sure that the pump is not leaking by closing VP4 and observing that all bubbles stop. If bubbles still occur after several minutes there is a leak in the purge pump suction piping somewhere. Find and repair the leak.

When the bubble rate from the absorber drops below 30 bubbles per minute, the unit is ready for initial operation, otherwise continue hot purging.

### Purging during initial operation

Remove all electrical jumpers used during the hot purging operation.

Insure that all water flows through the unit are within design specifications.

Start the unit and hold the heat input at minimum.

Purge the unit from the absorber only. (VP4 and VP5 open)(VP19 and VP20 open also on units with SmartPurge™).

Periodically check the purge tank pressure. If the purge tank pressure exceeds 60 mm Hg, evacuate it to 30 mm Hg. **Do not evacuate the purge tank below 30 mm Hg.**

Gradually increase the firing rate of the unit keeping watch on the HTG pressure.

- 1.Run the unit at the highest firing rate possible for 20 minutes.
- 2.Blow down the refrigerant.
- 3.Shut down the unit and allow it to go through a dilution cycle, keeping watch on the purge tank pressure.
- 4.Restart the unit after the dilution cycle ends.

Repeat the above steps until the unit can be run at a sustained high fire rate without encountering a high pressure condition.

The unit should be thoroughly purged at this point., however absorber purging and purge tank purging may

need to done on a frequent basis in a manual fashion for the first 40 hours or so of operation. After that, the unit should only need to be purged from the purge tank when the purge tank pressure exceeds 60 mm Hg. If the unit is equipped with *SmartPurge™*, that will be done automatically providing *SmartPurge™* is selected from the Micro panel.

### Force Purging the Absorber

If, troubleshooting procedures indicate full fire performance problems are being caused by non-condensables in the absorber, the ability of the continuous integral absorber purge system may be hampered by too high of a solution level in the absorber.

If the solution level is too high in the absorber a vortex will not form as the solution drains out of the main shell into the solution tank. Then, instead of being drawn out of the absorber via the solution vortex, non-condensables will be trapped above the liquid level in the absorber. As non-condensables accumulate, unit performance will suffer.

Many times in this situation, the purge pump is not effective at removing the non-condensables due to their location. Only the swirling solution vortex can remove the final pockets of non-condensables hovering just above the liquid level in the absorber. If the absorber solution level stays high enough so that the vortex cannot form, performance will continue to suffer.

Vortex formation is more sensitive to high solution level in G units than it is to high absorber solution level in S series units. In many cases too much solution has been charged at start-up. Occasionally the high solution level is caused by the inability of the unit to fire at high fire because of high temperature or pressure in the HTG.

To rid the absorber of accumulated non-condensables, it is necessary to *force*

# PURGING

## How It Works

the solution level lower in the absorber so that a vortex will form in the outlet of the absorber main shell. The non-condensables will then be drawn into the vortex and get carried to the HTG and LTG by the solution flow.

The absorber can be *force purged* several different ways.

If the solution level is only slightly high and the unit is a direct fired type, it may only be necessary to shut the unit off, putting it into a dilution cycle. The instant the burner shuts off, the bubbles in the solution boiling in the HTG collapse. This causes the level to drop which in turn makes the HTG solution float valve open wide. When the float valve opens, the solution pump pumps at a higher flow rate, and in many cases the solution level in the absorber shell drops enough to produce a vortex.

This procedure can be repeated several times.

*During the initial phase of the dilution cycle, the absorber will purge just as well as it would during fired operation, provided the vortex has formed.*

If the unit is steam fired or if the level is too high in the absorber to take advantage of simply putting the direct fired unit into a dilution cycle, it may be possible to temporarily stack solution in the HTG or LTG. Stacking or raising the level of solution in the HTG or LTG allows the solution level in the absorber to drop which allow a vortex to form and the non-condensables to be drawn out.

To stack solution in the HTG, put the unit into a dilution cycle and quickly close valve VC or VS1. Slowly open the valve slightly as the level drops in the absorber so that the level in the solution tank is visible in the top sight glass. **Do not allow the solution pump to run dry or attempt this procedure with the burner on.** Watch the purge tank pressure. As the vortex forms, the non-condensables will be transported through the unit and be removed from the condenser by the purge eductor system. The purge tank pressure will go up as the non-condensables are pumped there by the purge

eductor system. An increase in purge tank pressure indicates a successful *force purge*. After the absorber has purged itself, readjust valve VC or VS1 to its normal setting.

To stack solution in the LTG, put the unit into a dilution cycle and quickly open valve VS2. Throttle the valve as the level drops in the absorber so that the solution level in the solution tank is visible in the top sight glass. **Do not allow the solution pump to run dry or attempt this procedure with the burner on.** Watch the purge tank pressure. As the vortex forms, the non-condensables will be transported through the unit and be removed from the condenser by the purge eductor system. The purge tank pressure will go up as the non-condensables are pumped there by the purge eductor system. An increase in purge tank pressure indicates a successful *force purge*. After the absorber has purged itself, readjust valve VS2 to its normal setting.

Do not *over stack* solution into either the HTG or LTG as severe refrigerant contamination will occur.

If the solution level is so high so that solution cannot be safely stacked in either the HTG or LTG the unit is probably overcharged. If that is the case, there is no alternative but to remove solution from the unit. into a plastic container until the absorber level drops into the top sight glass of the solution tank.

A properly charged unit with normal non-condensable accumulation will seldom, if ever, require force purging of the absorber. after its first week or so of operation The need for constant force purging on a mature unit indicates the unit is leaking, has a solution chemistry imbalance, or both.

### Leak Rate Test Procedure

This test can be used to check the rate at which non-condensables are collecting in the unit.

It involves making two checks with a minimum of 4 hours of operation between tests.

In the first test, the non-condensables are purged to a known minimum amount.

In the second test, the non-condensables are purged to the same known minimum amount, but this time the amount of non-condensables are collected and measured. The total amount of non-condensables are divided by the total number of minutes the unit ran between tests. The result will be compared against an allowable leak rate table or can be compared against previous readings to determine if the unit leak rate is stable.

*Note: Purge pump must have leak rate kit installed (part of unit accessories).*

### Pre-Test Procedure (must be performed before both Part One and Part Two of Leak Rate Test):

*Purge pump oil must be clean and the pump must be capable of pulling down to less than 3 mm Hg absolute. Start purge pump. After a few seconds of operation, open gas ballast ball valve to full open. Let pump run for at least 10 minutes before performing leak rate test to warm up and rid purge pump oil of any non-condensables. Leave purge pump running with unit purge system valved off and purge gas ballast open.*

*Unit should be operating at relatively stable conditions in the cooling mode.*

### Part One—Leak Test Procedure

1. Close leak test ball valve on discharge of purge pump so that all discharge flow will be through the clear plastic flexible hose on discharge tee branch. Insure that the purge pump discharge flow is passing through the hose and no obstructions

## How It Works

# PURGING

2. Purge pump gas ballast must now be tightly closed.

3. Fill both a 2.5 gallon bucket and the 500 cc clear plastic cylinder with water (part of leak test kit). Invert the cylinder in water of bucket taking care to prevent as much air as possible from entering cylinder (open mouth of cylinder will now be under water level of bucket).

4. Secure cylinder in inverted vertical position with the mouth of the cylinder under the level of the water in the cylinder using string or tape.

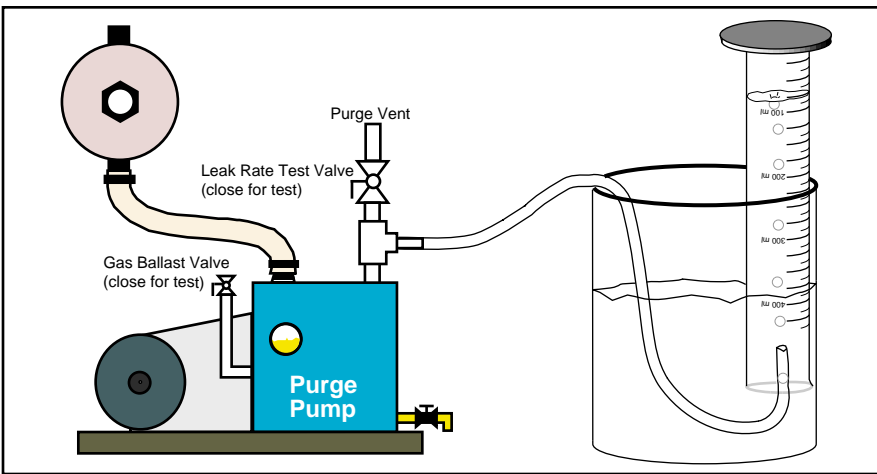
5. Insert the clear plastic hose from the purge pump discharge so that any flow

Figure PC-2

Unit Model	Leak Rate (cc/min)
12SC, 13SC	2
14SC, 15SL, 16S, 16SL, 16G	2.5
17S, 17G, 18S, 18G	3.5
19S, 19G, 19GL	4
20G, 21G, 22G, 22GL	5

interface of trapped air and water) for reference.

8. Slowly open valve VP5 and VP4 (Units with SmartPurge™ must have Manual Purge selected on Micro Panel so that automatic valves are open) and purge from Absorber until bubble rate is less than 5 cc/min. Watch the water level



from the hose will flow into the open end of the cylinder.

6. Observe end of hose for one minute. Since the purge pump is valved off at the unit and the gas ballast is closed, no bubbles should be observed. Many bubbles indicate leaking purge piping, valves or gas ballast. Repair leaks if necessary. A few bubbles may mean that there are gases coming out of the purge pump oil or a small leak is present. Replace oil if questionable.

7. After purge pump integrity has been checked, mark cylinder at water level (at

in the inverted cylinder to determine this. When the collection rate of non-condensables is equal to or less than 5 cc/min., close valve VP4.

9. Remove hose from bucket.

10. While observing vacuum gauge, slowly open valve VP2 and purge the Purge Tank until Purge Tank pressure drops to 30 mm Hg absolute. Immediately close VP2. If purge tank is purged to a lower pressure than 30 mm HG absolute, note the actual pressure for later.

11. Record the time. Instruct operations personnel (if you are leaving the site) not to purge the unit until Part 2 of the leak rate procedure can be performed. A minimum of 4 hours between the tests is required to obtain accurate numbers. Longer times are better, but the unit should not be shut down or purged between the two tests.

## Part Two—Leak Test Procedure

1. Close the *leak test ball valve* on the discharge of the purge pump so that all discharge flow will be through the clear plastic flexible hose on the purge discharge tee branch. Insure that the purge pump discharge flow is passing through the hose and no obstructions or kinks exist.

2. Purge pump gas ballast must now be tightly closed.

3. Fill both a 2.5 gallon bucket and the 500 cc clear plastic graduated cylinder (part of leak test kit) with water. Invert the cylinder in water of bucket taking care to prevent as much air as possible from entering cylinder (open mouth of cylinder will now be under the water level of the bucket).

4. Secure or hold the cylinder in the inverted vertical position with the mouth of the cylinder under the level of the water in the cylinder using string or tape.

5. Insert the clear plastic hose from the purge pump discharge so that any flow from the hose will flow into the open end of the cylinder.

6. Observe end of hose for one minute. Since the purge pump is valved off at the unit and the gas ballast is closed, no bubbles should be observed. Many bubbles indicate leaking purge piping, valves or gas ballast. Repair leaks if necessary. A few bubbles may mean that there are gases coming out of the purge pump oil or a small leak is present. Replace oil if questionable.

7. After purge pump integrity has been checked, mark cylinder at water level (at interface of trapped air and water) for reference.

8. Slowly open valve VP5 and VP4 (Units with *SmartPurge™* must have Manual Purge selected on Micro Panel so that automatic valves are open) and purge from the absorber until the bubble rate is less than 5 cc/min. Watch the water level in the inverted cylinder to determine this. When the collection rate of non-condensables is equal to or less than 5 cc/min., close valve VP4.

9. Record total amount of cc's of water displaced in the cylinder. Refill the cylinder with water if necessary prior to the next step and note level mark again.

10. While observing the vacuum gauge, very slowly open valve VP2 and purge the Purge Tank until Purge Tank pressure drops to 30 mm Hg absolute or whatever pressure the tank was purged to in Part One of the test. Observe the level in the inverted cylinder. If the level drops too low, close valve VP2 and record total amount of non-condensables collected so far. Refill cylinder and open valve VP2 again and resume test until purge tank pressure is lowered to the level it was in Part One of test. Record the total amount of non-condensables collected from the Purge Tank.

11. Add the amount of non-condensables removed from the absorber in step 9 of this part of the test to the total amount of non-condensables removed from the purge tank in the last step.

12. Calculate the total running time in minutes since the unit was purged in Part One of this test.

13. Divide the total amount of non-condensables collected in Part Two of this test by the number of minutes calculated in Step 12. The result will be the unit leak rate in cc's per minute (cc/min.).

The lower the number, the better. The table in Figure PC-2 shows the allowable leak rate for individual model units.

### For Example:

You arrive at the job in the morning. The unit is a YPC-FN-16G. The unit is running. You check out the purge pump. The purge pump is properly piped up with the necessary leak check kit equipment. The oil looks good and the pump can pull less than 1 mm Hg absolute. You set up the bucket and graduated cylinder and purge out both the absorber and purge tank per the instructions. You check the time and it is 9:44 AM. Since you have another job in the area to go to, you tag the purge valves with "*Do not Open*" signs and tag the Micro Panel with a "*Do not Operate Purge Pump*" tag. You instruct the operations personnel to refrain from purging the unit and to leave the unit operate at the current load until you return. You leave the site.

At 2:30 you return to the site. Operations personnel inform you that the unit has been running steadily since you left. You set up the equipment to perform Part Two of the Leak Test Procedure. You warm the purge pump up and prepare to begin collecting non-condensables in the water filled cylinder. Checking the time, you see it is 2:54 PM.

You collect 125 cc's of non-condensables out of the absorber before the rate drops below 5 cc/min. You close off VP4 and log the amount of collected non-condensables on paper.

You refill the cylinder with water so that there is enough room to collect the non-condensables from the purge tank.

You then check the purge tank pressure. It is 45 mm Hg absolute as read on the vacuum gauge. You collect 257 cc's of non-condensables from the purge tank before the purge tank pressure is reduced to 30 mm Hg absolute. You close of VP2 and log that amount on paper. Adding the amount of non-condensables from both the absorber and the purge tank

results in a total of 82 cc's (125 +257=382).

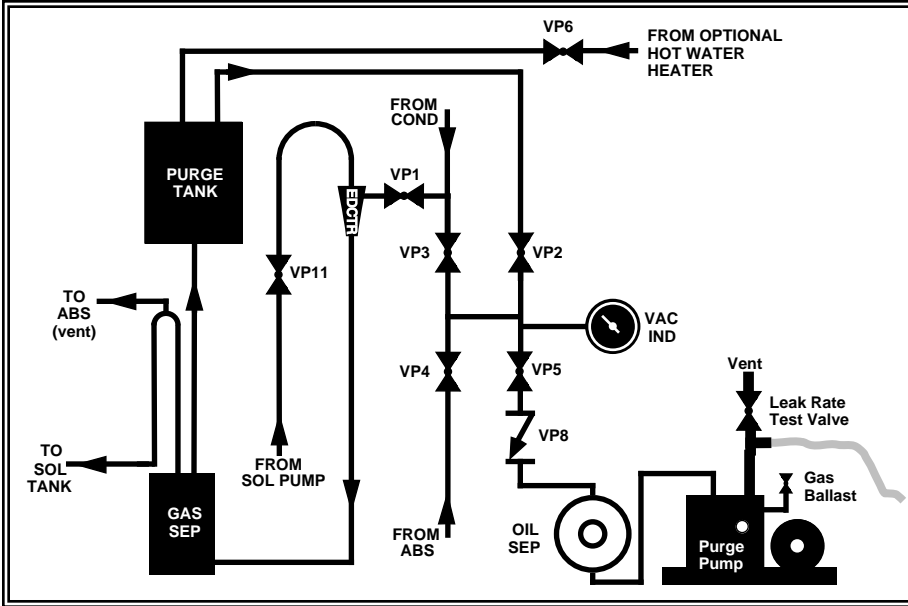
You calculate the total unit running time in minutes between the purging in Part One and the purging in Part Two by subtracting the two recorded times. The result is 5 hours and 10 minutes or 310 minutes. (2:54 PM - 9:44 AM = 5 hours 10 minutes or 310 minutes)

You divide the total amount of non-condensables collected by the total number of running minutes between the purging tests and find that the unit leak rate is 1.23 cc/min. (382 cc/310 minutes = 1.23 cc/min).

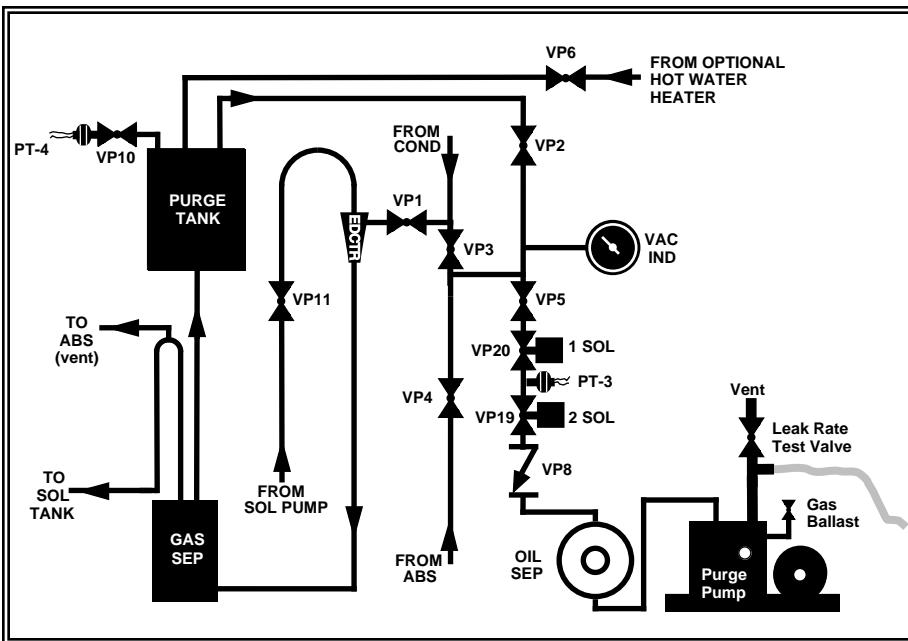
You check the chart and find that this model unit could have a maximum leak rate of 2.5 cc/min. Since 1.23 cc/min is less than that, the unit leak rate is in the acceptable range.

Looking back at the history record of this unit, you see that the same test performed last year resulted in a leak rate of 1.05 cc/min. The year's leak rate test results show a 15 % increase over last year. This may not be cause for alarm, but if the next test shows a similar increase, the rate of non-condensables being generated by the unit indicates a small leak is developing or the inhibitor may be close to depletion. If a solution analysis show the inhibitor level to be within limits, then a small leak is most likely. The unit should be leak checked at the next opportunity.

# PURGING



G Series Unit Purge System (without SmartPurge™)

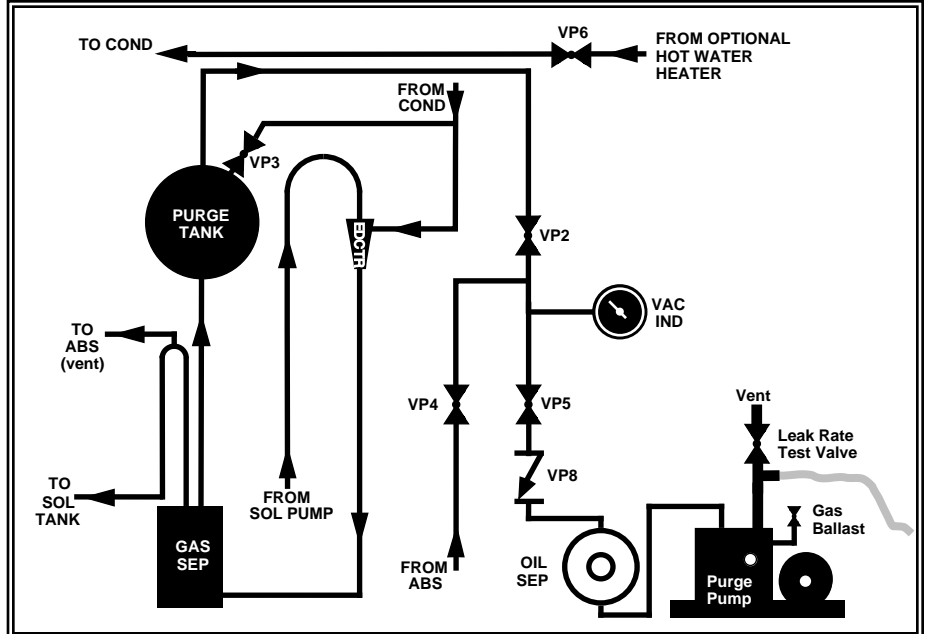


G Series Unit Purge System With SmartPurge™

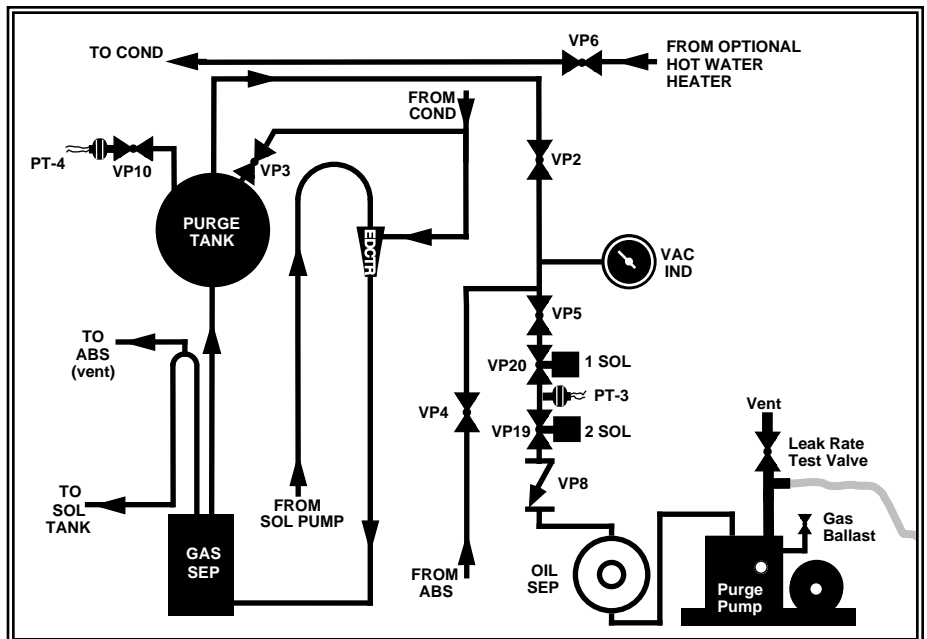
# PURGING

## How It Works

**S Series Unit Purge System  
(without SmartPurge™)**



**S Series Unit Purge System  
With SmartPurge™**



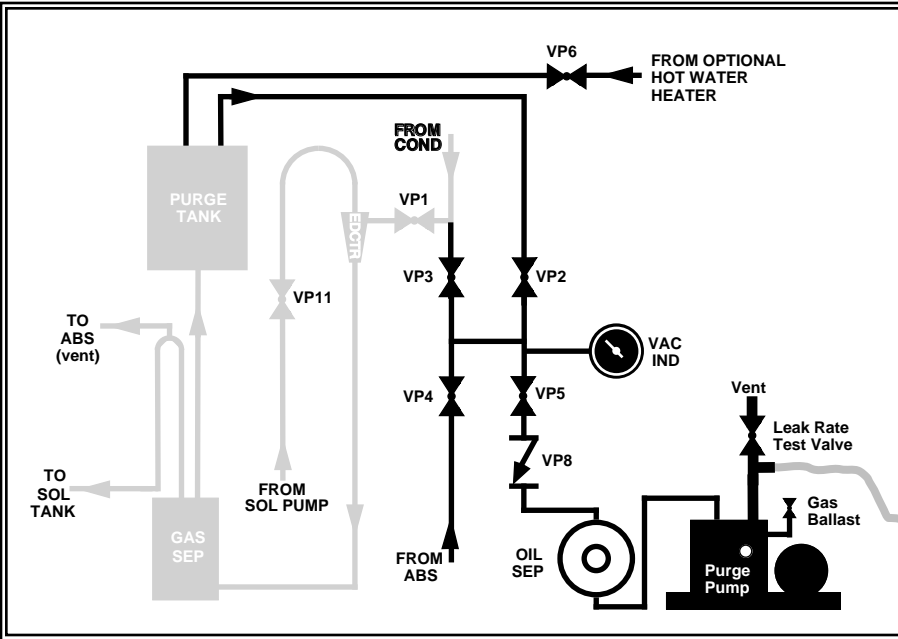
## G Series Continuous Purge Cycle

Solution from the solution pump discharge flows through valve VP11 to the nozzle of the purge eductor which induces non-condensable laden refrigerant vapor to flow from the condenser through VP1.

The combined flow of solution and non-condensables leaves the purge eductor and flows to the gas separator where the non-condensables separate and flow to the purge tank where they are stored.

The solution flows back to the absorber through a liquid U-trap seal.

When the solution eductor is working properly, the eductor outlet temperature is at a higher than the solution inlet to the eductor.



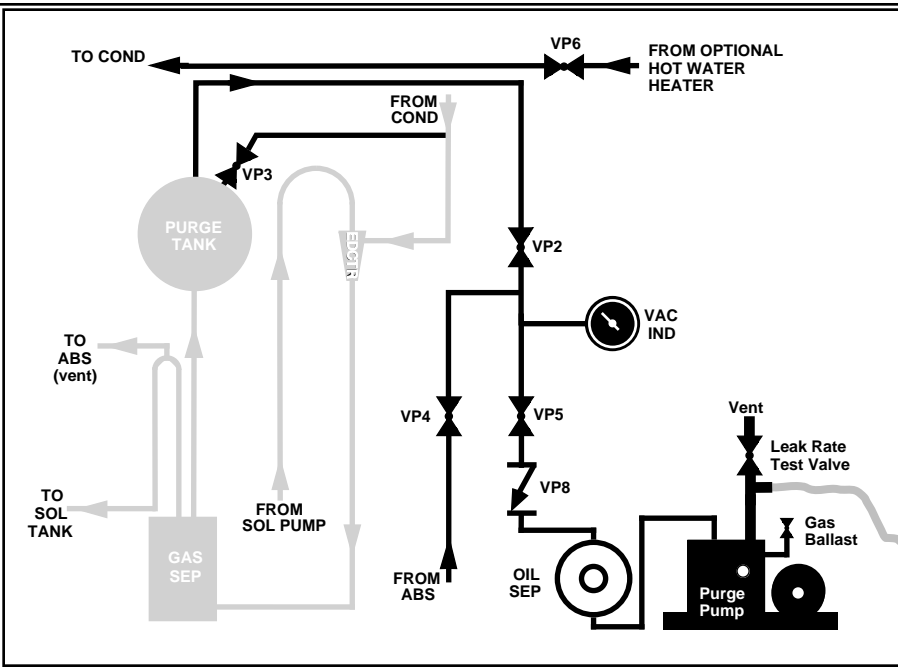
## S Series Continuous Purge Cycle

Solution from the solution pump discharge flows to the nozzle of the purge eductor which induces non-condensable laden refrigerant vapor to flow from the condenser through VP3.

The combined flow of solution and non-condensables leave the purge eductor and flow to the gas separator where the non-condensables separate and flow to the purge tank where they are stored.

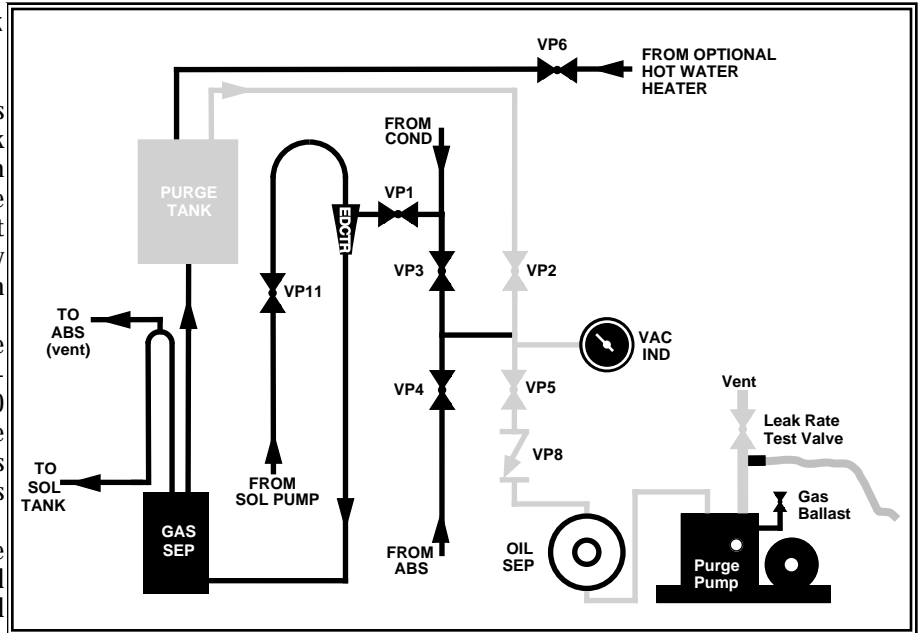
The solution flows back to the absorber through a liquid U-trap seal.

When the solution eductor is working properly, the eductor outlet is at a higher temperature than the solution inlet to the eductor.



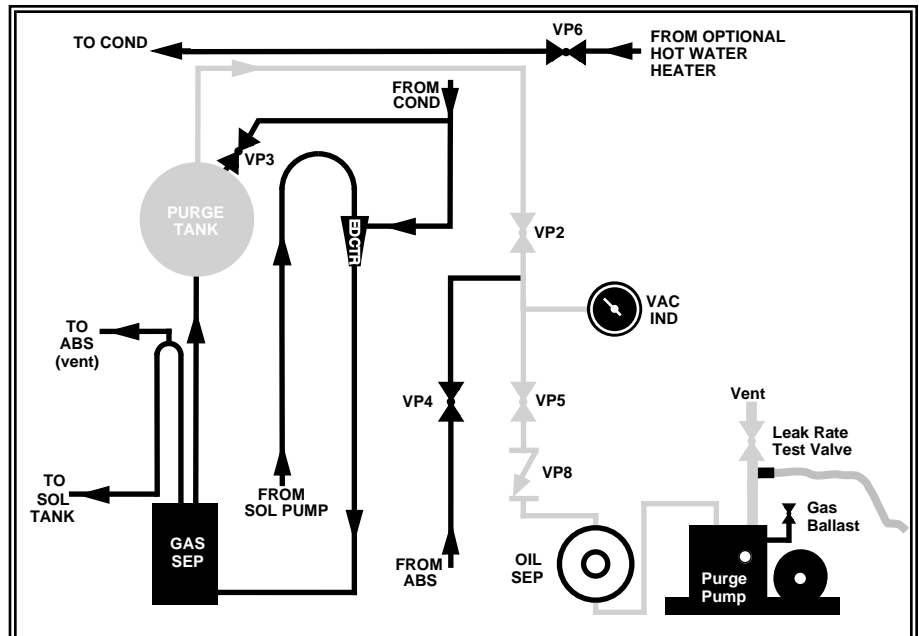
### Manually Purging the Purge Tank on G Series Unit

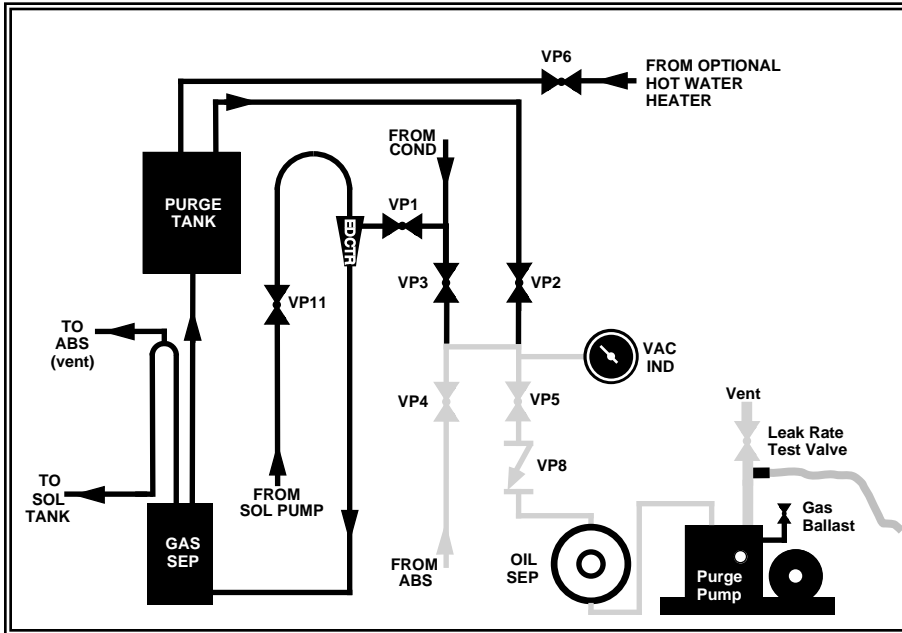
1. Operate purge pump for 10 minutes to warm up oil with gas ballast open, leak rate valve open and all purge system valves closed. Check that the purge pump is capable of pulling down to at least 3 mm Hg by opening VP5 briefly and reading the purge pump pressure on the vacuum indicator gauge.
2. Slowly open valve VP2 to read the purge tank pressure on the vacuum indicator gauge. If the pressure exceeds 30 mm Hg absolute, the purge tank may be purged although it is not necessary unless the tank pressure is equal to or exceeds 60 mm Hg absolute.
3. Slowly open valve VP5. Watch the purge tank pressure. When it is lowered to 30 mm Hg absolute, close VP5 and VP2.
4. Run purge pump for 10 minutes more to clean up oil.



### Manually Purging the Purge Tank on S Series Unit

1. Operate purge pump for 10 minutes to warm up oil with gas ballast open, leak rate valve open and all purge system valves closed. Check that the purge pump is capable of pulling down to at least 3 mm Hg by opening VP5 briefly and reading the purge pump pressure on the vacuum indicator gauge.
2. Slowly open valve VP2 to read the purge tank pressure on the vacuum indicator gauge. If the pressure exceeds 30 mm Hg absolute, the purge tank may be purged although it is not necessary unless the tank pressure is equal to or exceeds 60 mm Hg absolute.
3. Slowly open valve VP5. Watch the purge tank pressure. When it is lowered to 30 mm Hg absolute, close VP5 and VP2.
4. Run purge pump for 10 minutes more to clean up oil.

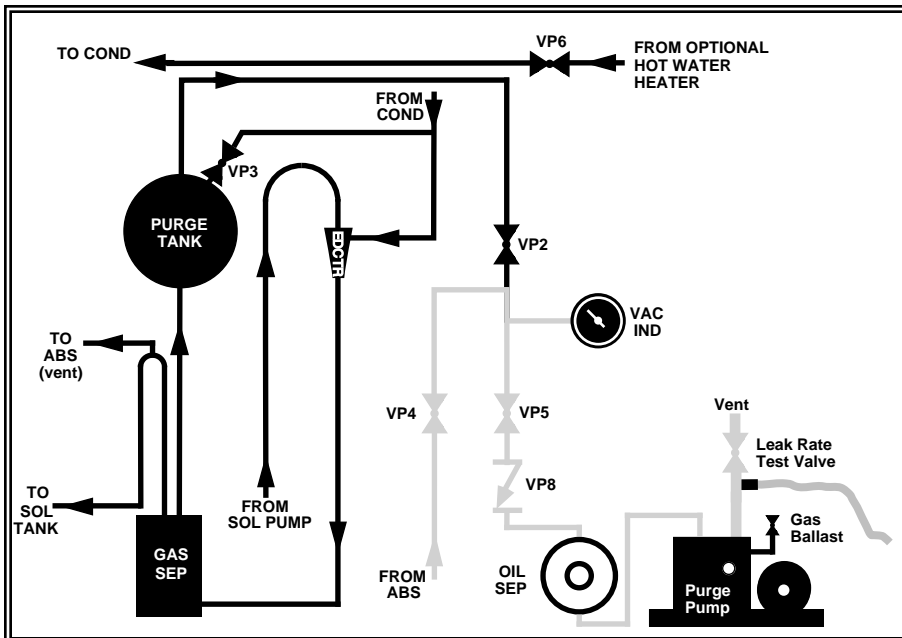




### Manually Purging the Absorber on G Series Unit

Should it be necessary to purge the absorber, first assure that the solution level is no higher than the center absorber main shell sight glass.

1. Operate purge pump for 10 minutes to warm up oil with gas ballast open, leak rate valve open and all purge system valves closed. Check that the purge pump is capable of pulling down to at least 3 mm Hg by opening VP5 briefly and reading the purge pump pressure on the vacuum indicator gauge.
2. Open VP4 and then VP5.
3. Purge as necessary with the purge gas ballast fully open and the leak rate test valve open, except when checking bubble rate.
4. After purging is complete, close VP4 and VP5.
5. Run purge pump for 10 minutes more to clean up oil.



### Manually Purging the Absorber on S Series Unit

1. Operate purge pump for 10 minutes to warm up oil with gas ballast open, leak rate valve open and all purge system valves closed. Check that the purge pump is capable of pulling down to at least 3 mm Hg by opening VP5 briefly and reading the purge pump pressure on the vacuum indicator gauge.
2. Open VP4 and then VP5.
3. Purge as necessary with the purge gas ballast fully open and the leak rate test valve open, except when checking bubble rate.
4. After purging is complete, close VP4 and VP5.
5. Run purge pump for an additional 10 minutes to clean up the oil.



**1. Why is it when I purge from the purge tank, solution sometimes is drawn into the oil separator and the purge pump?**

Solution being drawn into the purge tank during purging is a result of pulling the purge tank pressure too low for a given absorber pressure. Since the purge tank is isolated from the absorber by a fairly high U-trap liquid seal, and during normal operation the absorber pressure is 6 mm Hg absolute, it should not be possible for solution to get sucked into the purge tank no matter how low the tank pressure is reduced.

However, if the absorber pressure is high, for instance during initial commissioning, it may be possible to suck solution into the purge tank. When there is a known high pressure in the absorber, you should not purge from the purge tank alone.

During normal operation, it is recommended that the purge tank pressure is not pulled below 30 mm Hg absolute. If this practice is adhered to, it should not be possible for solution to enter the purge tank during purging.

Always clean the lines and purge pump thoroughly after solution contamination.

**2. Sometimes when I go to perform a Leak Rate Test, I find that the purge tank pressure has been reduced below 30 mm Hg. The instructions for the Leak Rate Test say that we should only pull the purge tank down to 30 mm Hg. What should I do?**

If you attempt to perform Step One of the Leak Rate test and you find that the customer has pulled the purge tank below 30 mm Hg, record the actual pressure of the purge tank and then purge the tank to that same level in Step Two.

The 30 mm Hg purge tank minimum is a guideline to help prevent solution being drawn into the tank. In most

cases the tank pressure can be lower than 30 mm Hg without a problem.

**3. Where do I find the straight thread adapter fittings that screw into the purge pump discharge and gas ballast ports?**

The adapter fittings are shipped with the unit in the ship loose container. They are not a York manufactured item and must be procured from the purge pump manufacturer.

**4. Sometimes I see a yellow vapor coming out of the purge pump discharge. What is that?**

The yellow vapor (or sometimes reddish brown) is an oxide of nitrogen and is a result of nitrate inhibitor being consumed. Normally inhibitor consumption is caused by air leaks or high generator temperature situations.

Avoid breathing the yellow vapor as it is considered harmful when ingested.

**5. The purge pump will not pull down to 3 mm Hg. Should I replace the pump?**

Usually the purge pump only requires a *special oil flush* when this problem occurs. Failure to pull down to rated vacuum is normally a result of free water laying in the pump cavities. Simply draining and replacing the oil will not rid the pump of this free water.

Performing an oil flush per the instructions in this manual under the purge pump section will normal bring the pump back to good performance.

**6. What is the normal bubble rate when I purge the unit?**

The bubble rate will vary depending on where you are purging from and at what load the unit is at. The best way to determine if a unit has an acceptable leak rate is to perform a Leak Rate Test. The Leak Rate test will enable you to measure

the amount of non-condensables that a unit produces over a given time period.

**7. How often should I purge the unit?**

Providing the unit is past its originally break in period and is operating normally, you only need to purge it when the purge tank pressure goes above 60 mm Hg absolute. Purge the purge tank until the tank pressure is reduced to 30 mm Hg absolute.

**8. The unit performance is poor. It looks like I have non-condensables in the absorber, but despite purging the absorber for a long time with the purge pump, I don't seem to be getting anywhere. What is wrong?**

If the absorber solution level is high enough to prevent a vortex from forming in the outlet, non-condensables may collect above the liquid level in the absorber causing unit performance degradation. The purge pump may not be able to effectively remove the non-condensables when these conditions occur.

You may need to *Force Purge* the absorber which involves artificially reducing the absorber main shell level so that a vortex forms and the non-condensables are drawn out of the absorber.

Follow the instructions in this manual under the Force Purging section.