AIRGARD CYCLONE FUME SCRUBBER

Installation and Operation Manual

Ph. (408)-573-0701
U.S. Patent No. 4,986,838

AIRGARD
Cyclone Fume Scrubber
Installation and Operation

Table of Contents

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Features

>Automatic gas inlet plunger that reduces routine service to once every few months.
>Requires less city water than other available scrubbers - .5 to 3 gallons per minute is typical
>Tested by an Independent Lab to be 99.9997% efficient
>Water jet eductor (venturi) generates a nominal negative 1" of water with a 200SLM input of Hydrogen gas.
>2 speed thermoplastic pump with special corrosion resistant 2-speed ODP motor, or TEFC single speed motor.
>PLC based controller monitors and controls water level, pump flow, back pressure, plunger, make-up water flow, water leaks or spills, nitrogen flow, scrub and standby mode, and has auxiliary inputs and outputs easily programmed to customer's requirements

Environmental Limits

For indoor use. Altitude up to 2000m,
Temperature +5C to +40C.
Relative humidity up to 80% up to 31C decreasing to 50%at 40C.
Voltage variance: ±10%
Transient overvoltages: Category II
Ambient Pollution: Category 2
Please advise factory if unit will be used outside of these requirements

Material Flammability Ratings (UL94):

PVC (Scrubber body and piping): V-0
Polypropylene (spray nozzles): V-2
UHMW Polyethylene (inlet port): V-2

Noise Level:

<70dB, A-weighted at 1m from back of scrubber

Technical Data

>**Power Usage:**
1.5-2KW, depending on model
>**Electrical Rating**
208-480VAC, 50/60HZ
AIC Interrupt Rating: 50 KA
>**Nitrogen Usage:**
15SLM @ 60psig (Epi and Poly Etch/CVD)
40SLM @ 60psig (Heated Inlet)
>**Water Usage**:
-Scrub Mode
0.5 to 3gallons per minute-(will vary with process conditions.)
Standby Mode
1 to 2 gallons per hour.
>**Capacity**:
-Maximum total flow of gas:
600SLM (see page 4 for maximum safe flows of toxic/corrosive gasses)
>**Facilities Requirements**:
-Electrical
208-480VAC, 2KW, 1 or 3φ depending on configuration customer requested. Check nameplate for details.
-Scrubber Exhaust
0 to –4" H_2O

>**Plumbing**:
-Exhaust gas input connection:
Epi: 2" PVC Pipe.
Poly Etch/CVD: 4" ASA Flange
Heated Inlet: NW 40
-Scrubber gas output connection: 2" FPT.
-City water input connection: ½" FPT.
-Effluent drain connection: 2" FPT.
-Scrubber drain connection: ½" FPT.
-Tray drain connection: ½" FPT
-Nitrogen Connection: ¼" Tube Fitting
>**Overall Dimensions**
-Footprint: 28.5" x 32.5" (standard Motor only)
-Height: Epi, Poly Etch/CVD: 90"
Heated Inlet: 80.5"
-Weight Dry: 260 lbs.
-Weight Wet: 276 lbs.

Ph. (408)-573-0701
U.S. Patent No. 4,986,838

GAS FLOW CAPACITIES

The total gas flow capacity of the Airgard scrubber line is 600 liters/min. At higher flows, a loss of efficiency and/or backpressure may result, depending on the process and carrier gasses being used. Please consult the factory if you intend to exceed 600SLM total flow.

For each known type of chemical gases and vapors likely to be scrubbed, the theoretical maximum air concentrations of hazardous fumes at the nose of a man of average height standing 1m from a large leak from the gas inlet port have been calculated assuming a maximum gas inlet flow rate, a carrier gas flow of 100slm (except for H2 which is a carrier gas), a large leak rate of 0.2 liters/min (the inlet of the scrubber typically runs at a pressure less than atmospheric due to the eductor, so this leak rate is a high estimate) at the scrubber inlet before any scrubbing occurs, and an air change rate of 2ft/min, and shown to be less than 0.25% OEL.

The maximum safe flow rates for some commonly used gasses are shown below. For different carrier flow rates, the maxim input gas flows should be raised or lowered proportionately with the carrier flow.

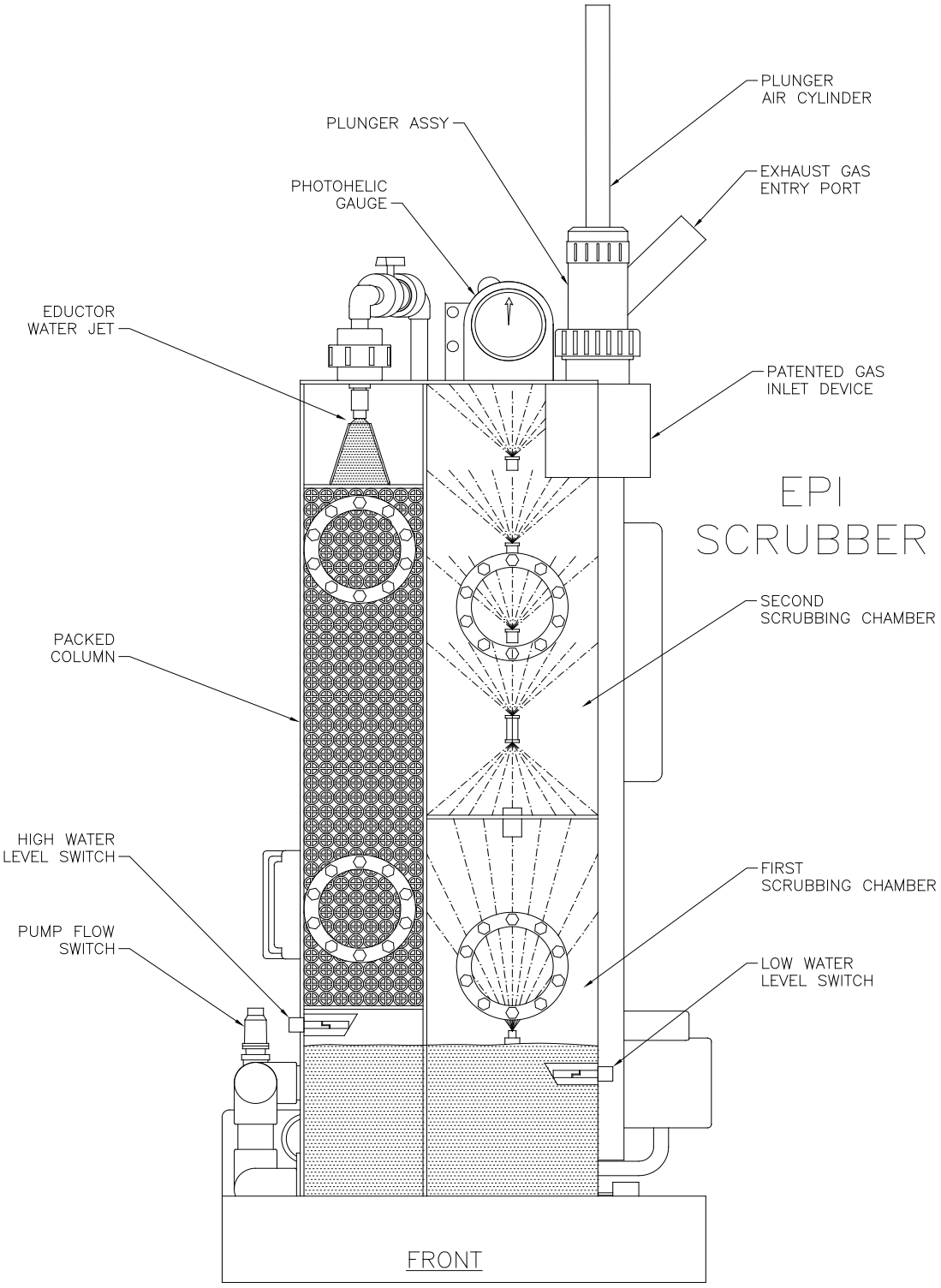
Keep in mind that these are concentrations for pure gasses. If the gasses are diluted at the source, the maximum flows are proportionately higher.

Gasses bubbled from liquid sources, such as $SiHCl_3$ and $SiCl_4$ are typically delivered at concentrations of less than 25%, so the measured flow rate at the process tool can be four or more times higher than listed here. Please consult the factory if you are not sure about your particular application.

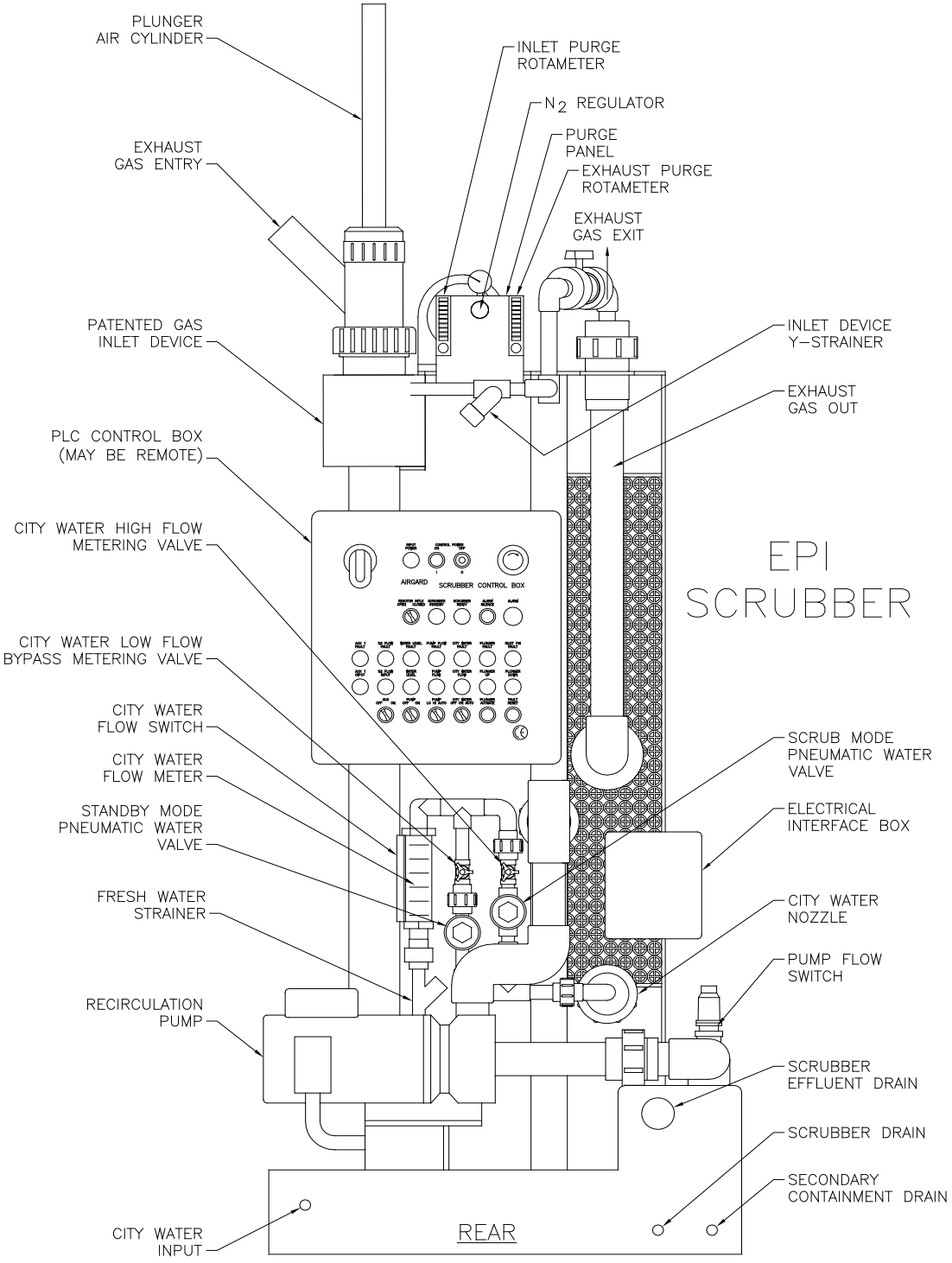
Input Gas	Input Gas Flow, l/m	Concentration at 1m (ppm)	TLV, ppm	25% TLV, ppm	IDLH, ppm	Concentration at 1m, %	25% LEL, %
HCl	5	1.171	5	1.25	50	0.0001171	
$SiHCl_3$	2	0.482	1.7	0.425	100	0.0000482	
$SiCl_4$	5	1.171	5	1.25	100	0.0001171	
SiH_2Cl_2	5	1.171	5	1.25	100	0.0001171	
NH_3	30	5.676	35	8.75	300	0.0005676	
HBr	3	0.716	3	0.75	30	0.0000716	
F_2	1	0.244	1	0.25	25	0.0000244	
BCl_3	2	0.482	2	0.5	50	0.0000482	
SiF_4	3	0.716	3	0.75	38	0.0000716	
HF	3	0.716	3	0.75	30	0.0000716	
Cl2	1	0.244	1	0.25	30	0.0000244	
H_2	200	24.6	3	0.75	30	0.0024594	1.0

Pyrophoric gasses such a silane that are not removed in water scrubbers should be diluted to ¼ LFL before entering the scrubber. Silane (LFL=1%), therefore must be diluted with N_2 to less than .25% (400:1).

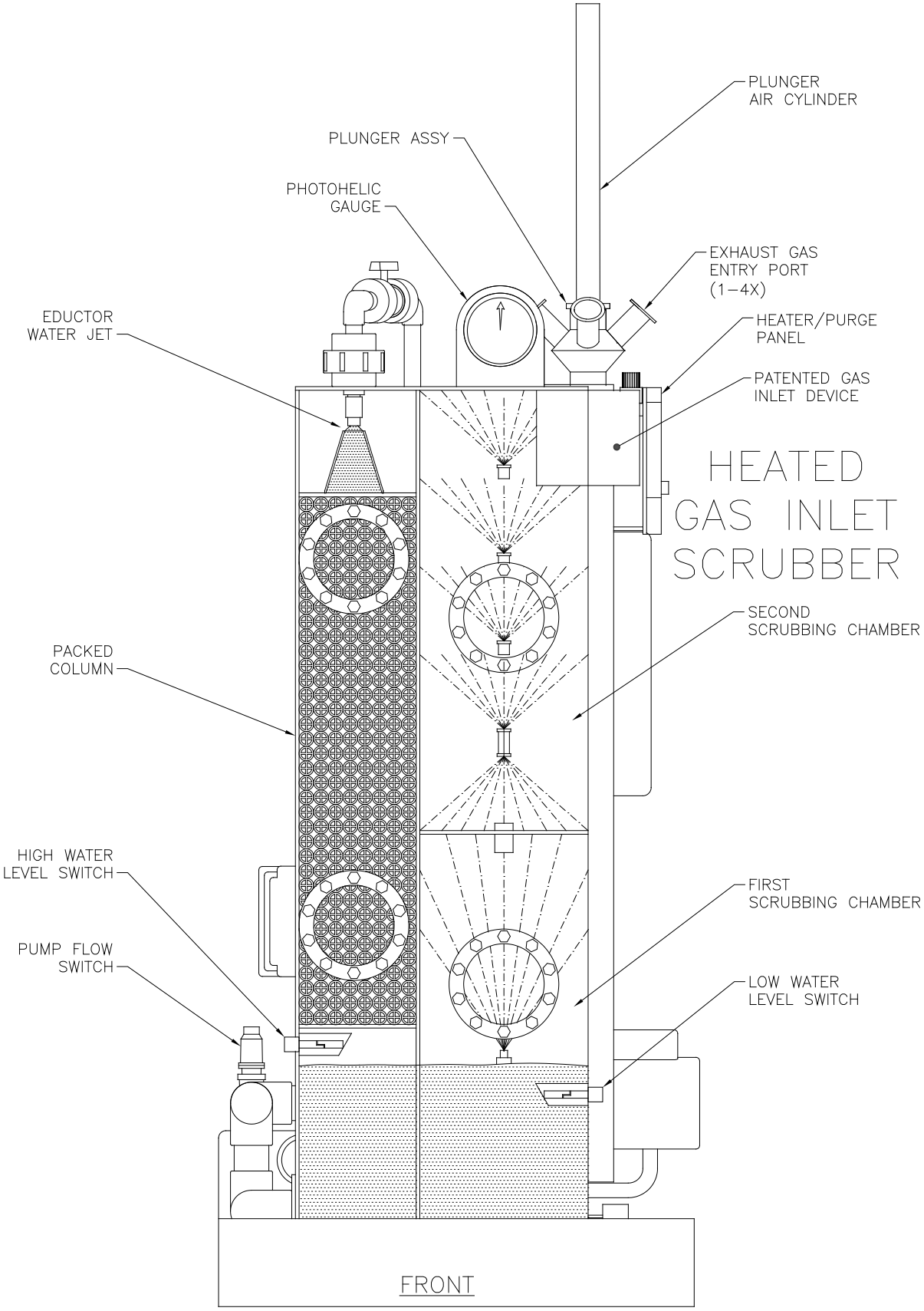
AIRGARD CYCLONE FUME SCRUBBER VIEWS

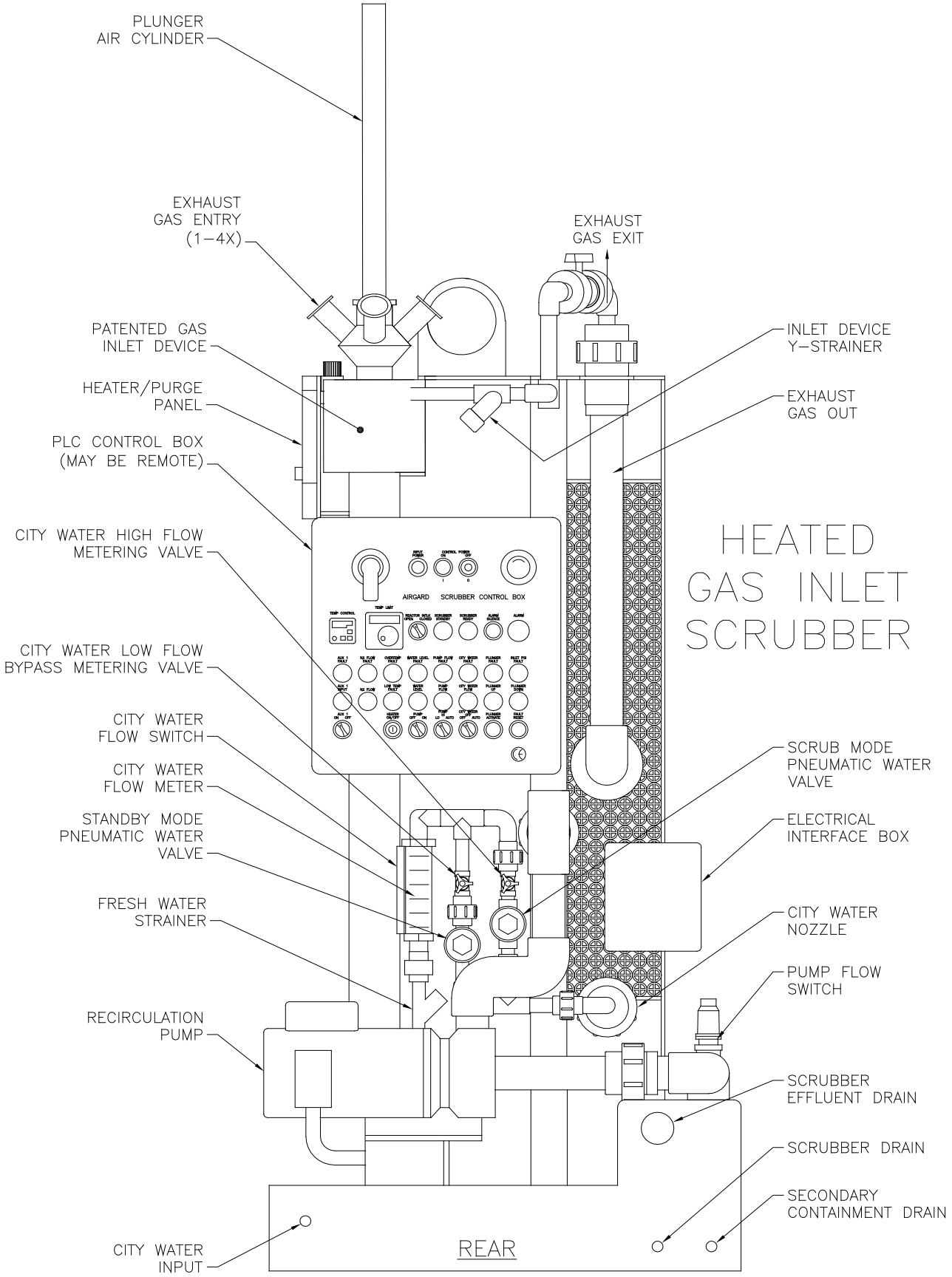


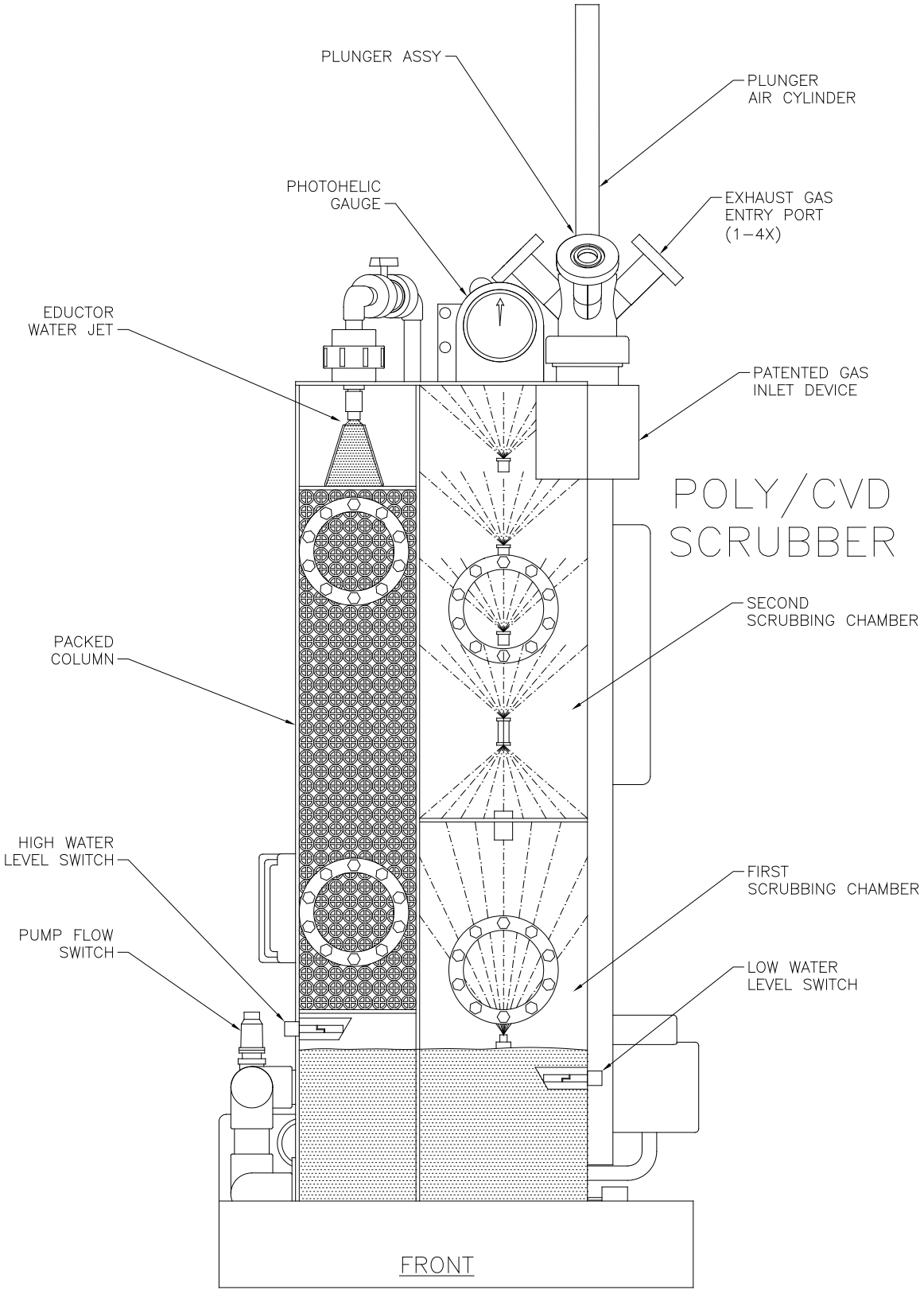
Ph. (408)-573-0701
U.S. Patent No. 4,986,838



Ph. (408)-573-0701
U.S. Patent No. 4,986,838







Ph. (408)-573-0701
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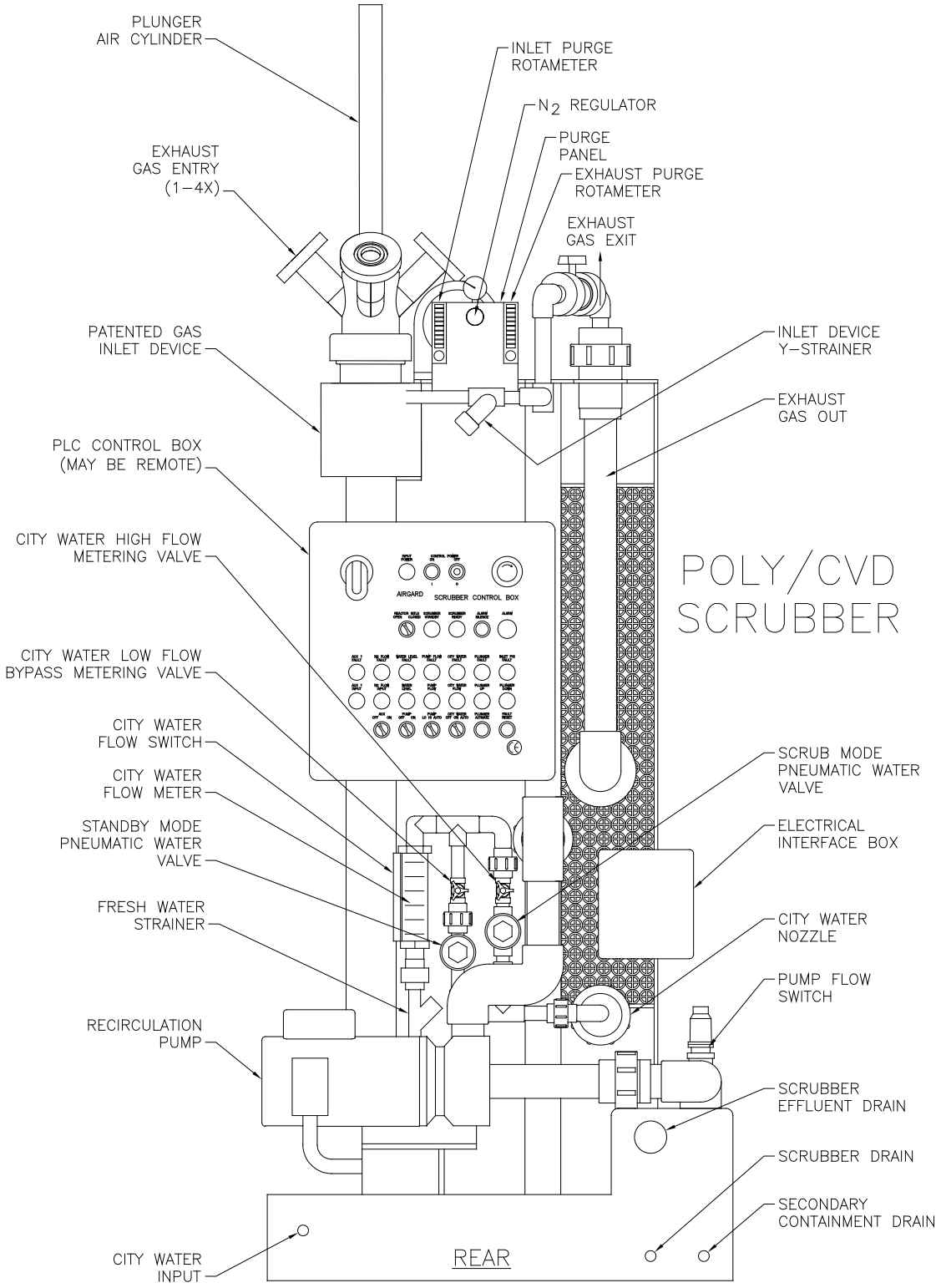


Installation

The scrubber should be located on a flat, level surface near the reactor and the required facilities (city water, acid drain and power). Care should be taken to select a site away from workstations and areas of heavy traffic.

The scrubber should be installed into an area whose temperature range is always Maintained between the temperature of 35 F and 111 F (2 C and 44 C).

For safety in the event of an earthquake, the scrubber must me fastened to the mounting surface with the supplied tie down brackets.

Use fasteners as follows:

The Cyclone Fume Scrubber must be anchored in to the floor, sub-floor or rooftop. The unit base must be properly leveled. The supporting location must be strong to support the additional weight of the of the Cyclone Fume Scrubber module.

1. Anchorage to the concrete slabs

a. Use four (4), 3/8" diameter HILTI Kwik carbon steel expansion anchor or equivalent with a minimum embedment in concrete of 1 5/8" at the 4 support locations are required. Bolts to be properly torqued.

2. Anchorage to the Plastic Plates

a. Use four (4), 5/16" diameter carbon bolts steel with nuts and washers. Bolts to be properly torqued.

Gas Connections

(Reference Figures 1 and 2, pages 13-15)

The gas input connection is a 2-inch PVC pipe stub located on the side of the plunger assembly and should be plumbed as shown in Figure 2. Care should be taken to support the exhaust piping in order to avoid any stress on the gas inlet or outlet connections. It is highly recommended that the gas inlet line is plumbed per the configuration shown in Figure 2. This configuration will give sufficient support and allows easy access to the removable gas inlet port when service is needed.

The gas exhaust connection is a 2-inch FPT located on top of the scrubber. Plumb the exhaust with 2-inch PVC pipe to an appropriate emission point away from any possible sources of ignition or ventilation intakes. A one-foot length of metal pipe is recommended at the upper end of the exhaust line.

Do not run flammable or hazardous gasses through the scrubber until all plumbing connections are made and the scrubber has been filled with water until it runs out the drain.

City Water Connection

(Reference Figure 3 and 4, page 16)

The City Water connection is a ½ inch FPT fitting. It is located on the back left side of the scrubber base and is to be connected to a fresh water source with an inlet pressure of 40-100 psig. (The scrubber can be modified to run at lower supply pressures). A shut off valve, as shown in Figure 4, should be installed for ease of component maintenance.

Recycled water from other sources such as cooling tower blow off or neutralized acid wastewater can be used in place of fresh water. Be sure to consult the factory before using recycled water.

Drain Connections

(Reference Figures 3 and 4, page 16)

The scrubber effluent drain, the scrubber drain, and the secondary containment drain connections are shown in Figure 3.

The secondary containment drain should be plumbed to an acid waste drain through a ½" PVC ball valve. This valve is used to drain the secondary containment around the base of the scrubber.

The scrubber drain should be plumbed to an acid waste drain with a lockable (the lockable valve is required to comply with CE and S2 safety standards) ½" PVC ball valve. This valve is used to drain the entire scrubber during servicing and should never be opened during operation. A lockable valve may be used to prevent inadvertently opening this valve.

The scrubber effluent drain should be connected to an appropriate acid drain line (2" inch minimum). This line should not be valved or obstructed in any way. A vent line as shown in Figure 4 is recommended to avoid siphoning. Be sure that the drain line is properly sloped.

DO NOT install a trap downstream of the scrubber
DO NOT allow any part of the drain line to go above the level of the scrubber's drain connection.

If the drain line is connected to a sump or pumping station, be sure that there is a provision for the scrubber to drain in case of a pump failure. If water cannot escape out of the drain, the water level in the scrubber will rise until the water blocks the gas exit path – this will cause the reactor and exhaust line to over pressure.

Nitrogen Connection

(Reference Figure 1, page 13)

Connect Nitrogen to the input of the pressure regulator on the purge panel (see Figure 1, pages 13-14). Connection is ¼" poly tube fitting. For the Heated Gas Inlet Model, see Figure 1, page 13), the purge panel is on the side of the unit rather than the top.

USE NITROGEN ONLY!
DO NOT USE COMPRESSED AIR, OR A SEVERE EXPLOSION HAZARD WILL RESULT!

Electrical Connection

NOTE: ELECTRICAL COMPONENTS SHOULD ONLY BE ACCESSED BY QUALIFIED PERSONEL.

See instructions and control box interface diagram in control box section.
Be sure to follow all local electrical codes and use strain relief glands on flexible cables that meet NEMA 4 standards. Main power cables in the EU must be <HAR> approved. Conduit and fittings must be NEMA 4 watertight.

Ph. (408)-573-0701
U.S. Patent No. 4,986,838

FIGURE 1 EPI

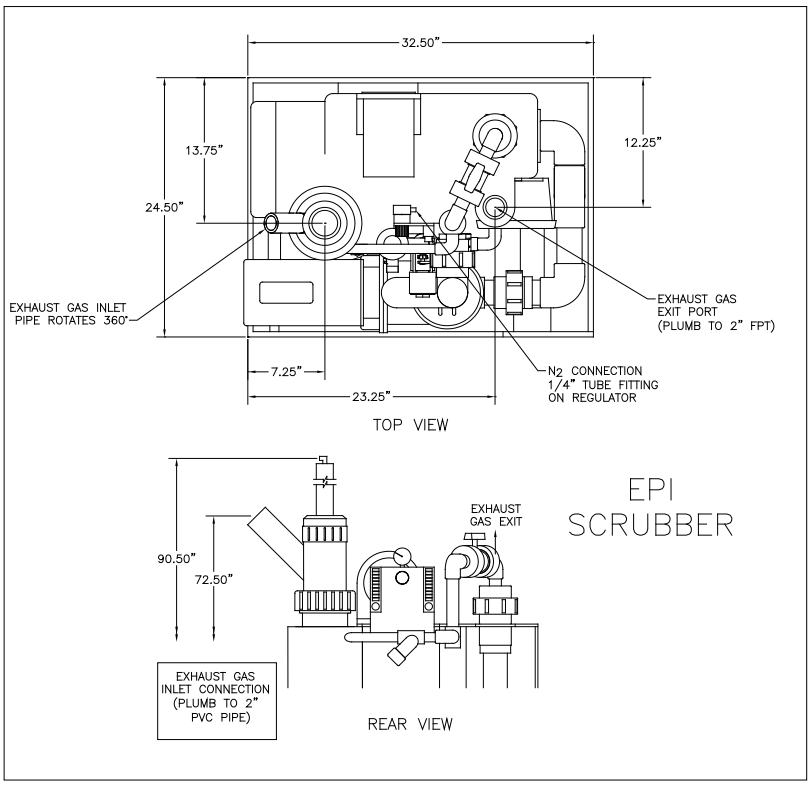


FIGURE 1 HEATED INLET

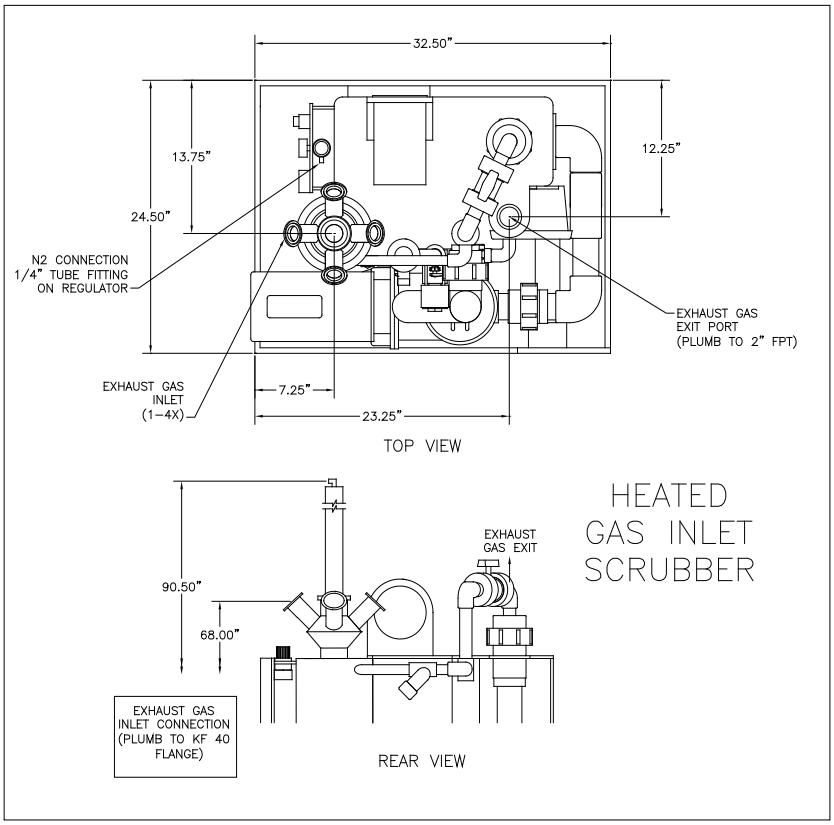


FIGURE 1 POLY/CVD

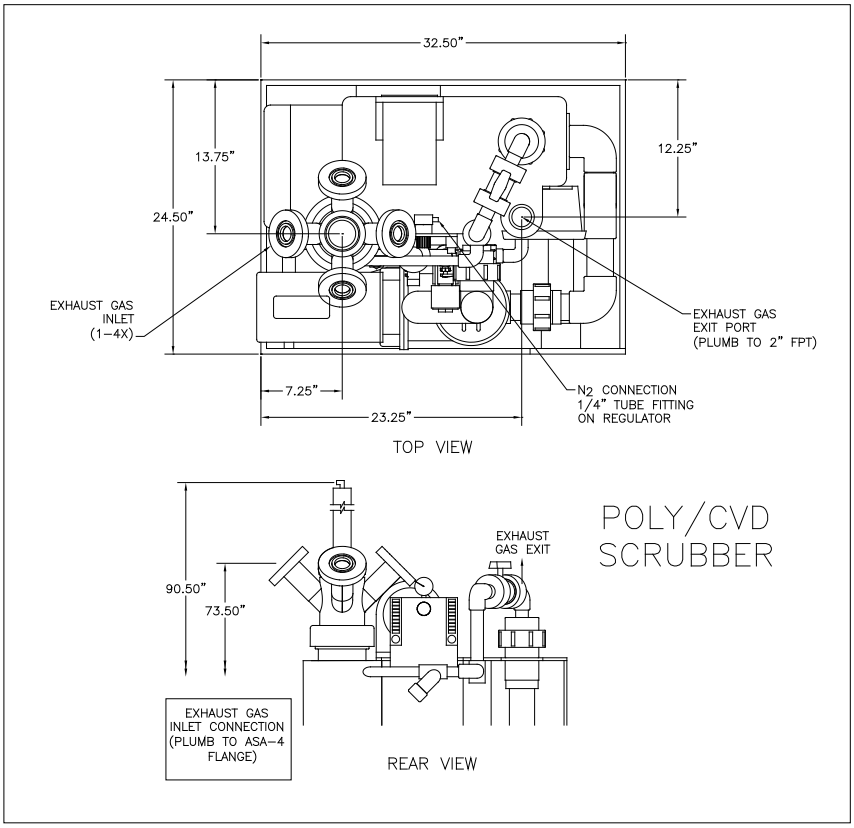


FIGURE 2 EPI

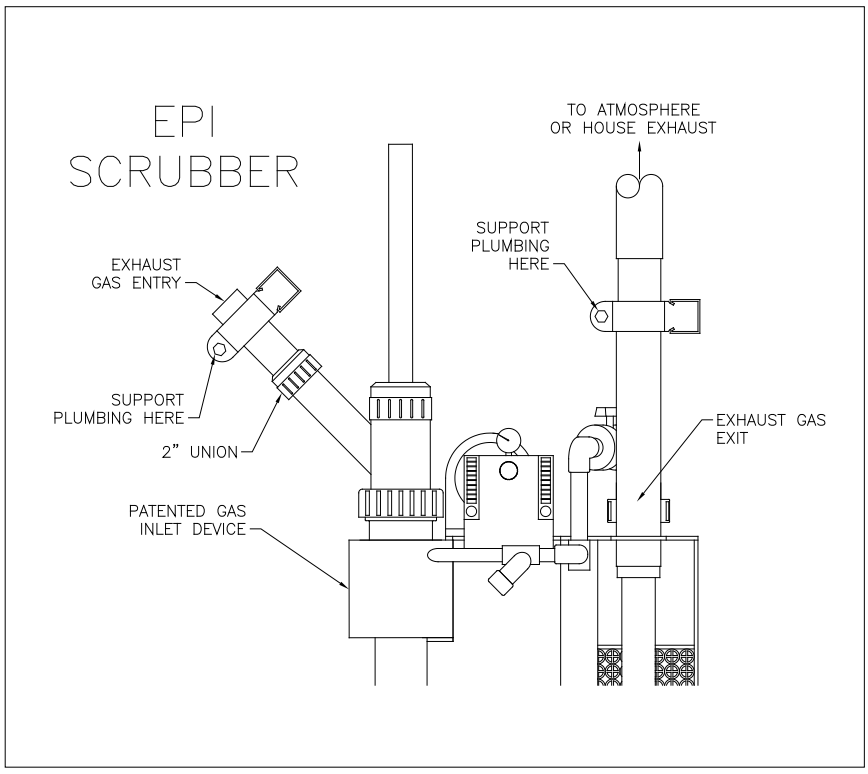


FIGURE 2 HEATED INLET

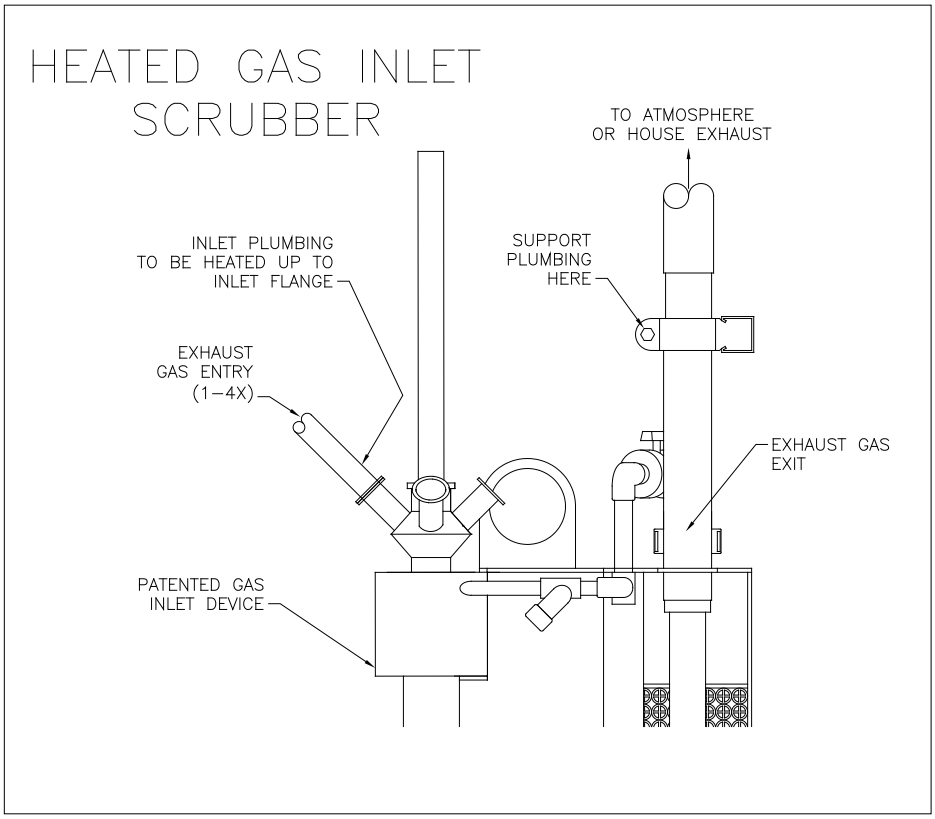


FIGURE 2 POLY/CVD

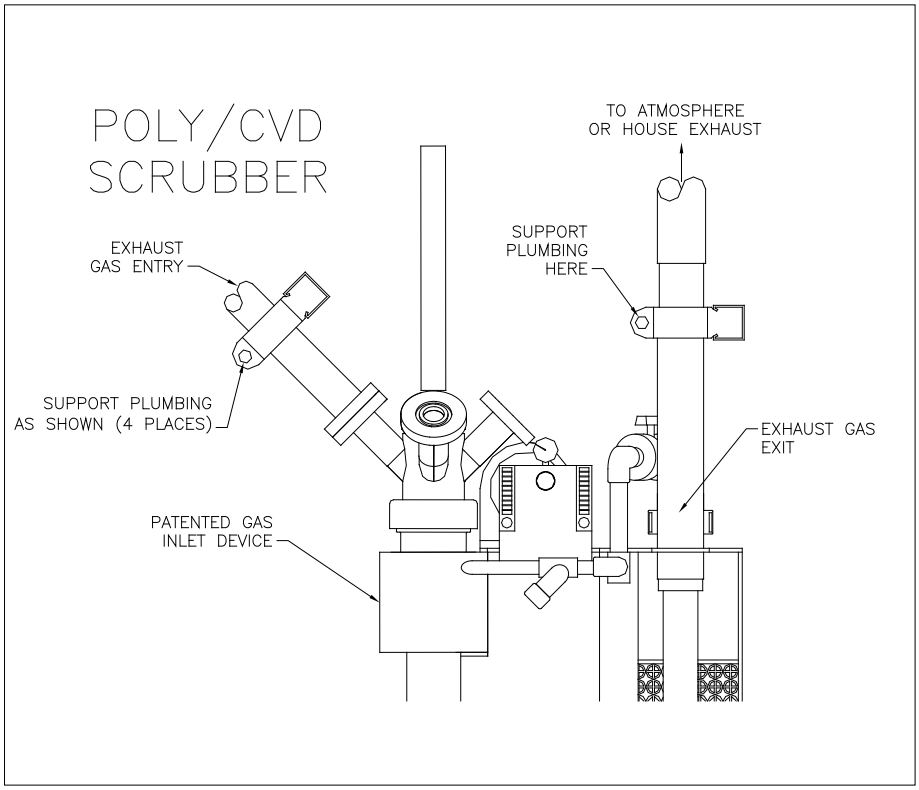


FIGURE 3 ALL MODELS

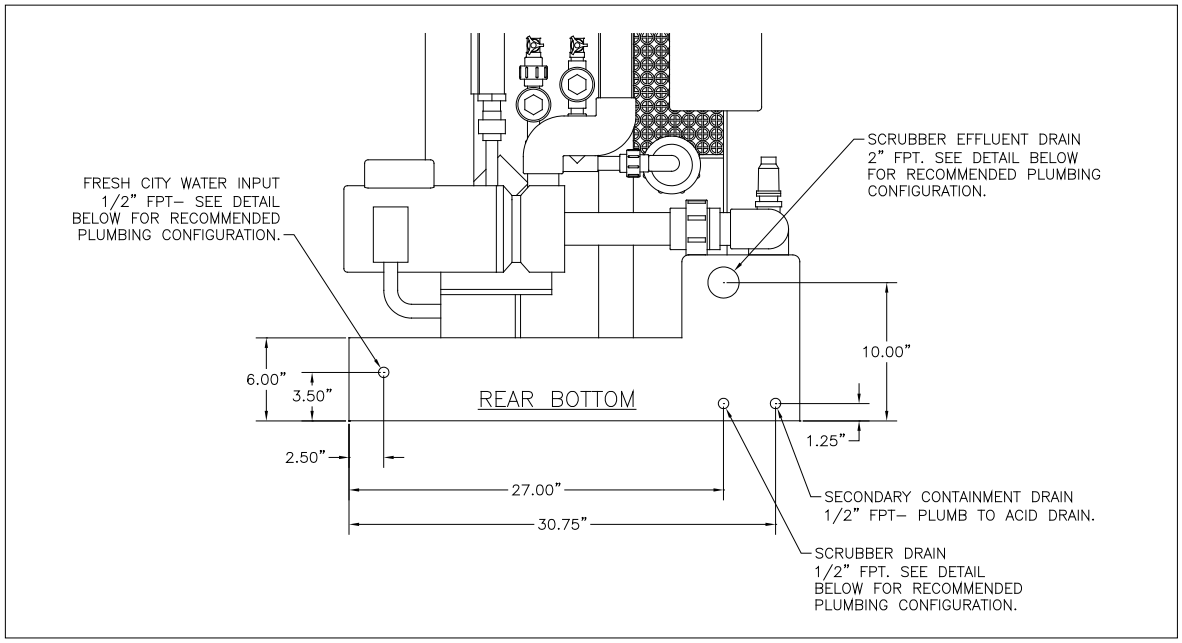
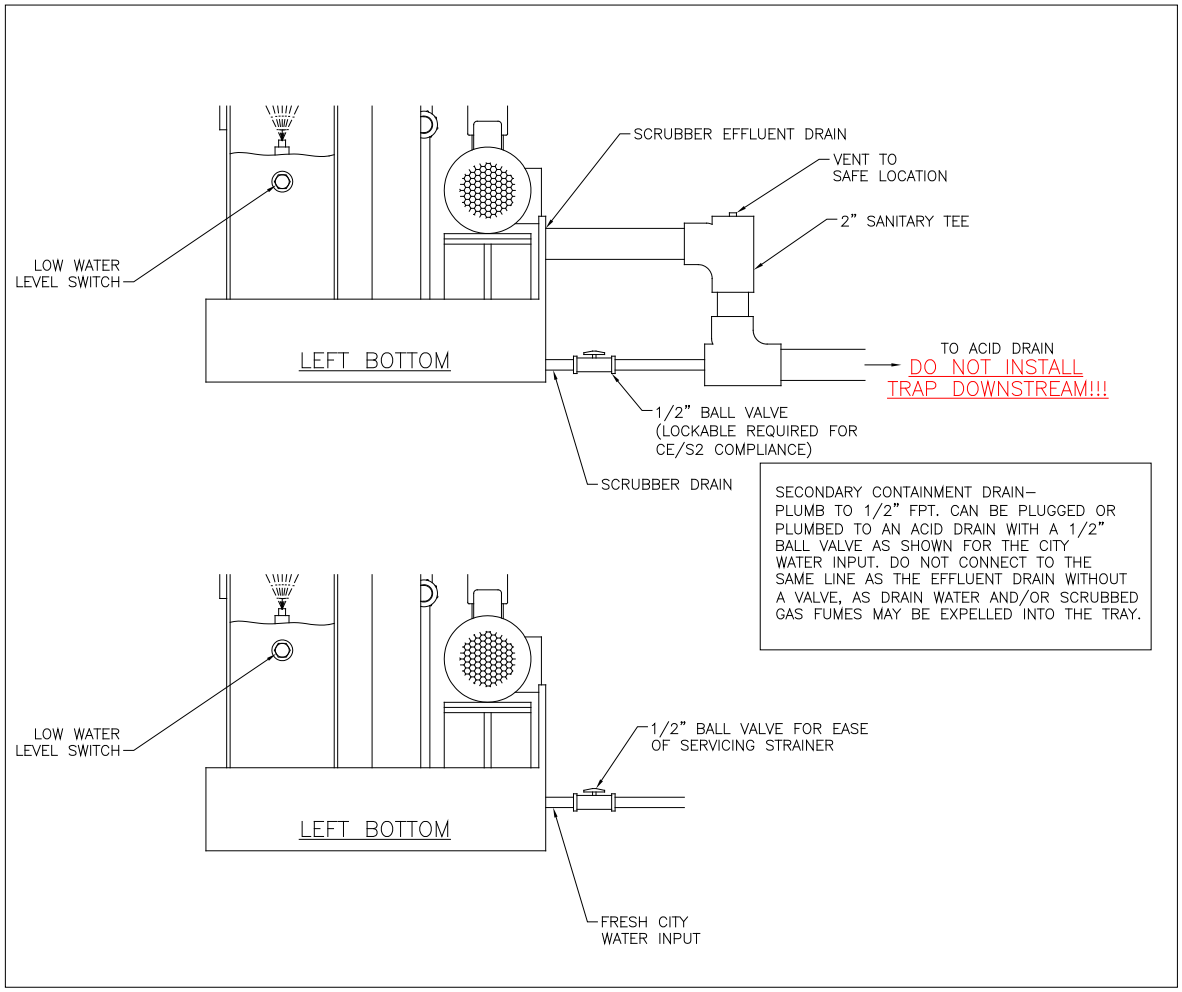


FIGURE 4 ALL MODELS



Airgard Plunger System

The Airgard Plunger System is an alternative to opening the scrubber for routine inlet port changes.

The regulator on the purge panel should be connected to house nitrogen, 60-150psig.

When installing the plunger assembly, be sure all sealing surfaces are clean, and apply a light coat of vacuum grease to all 3 o-rings. Slowly and evenly tighten the thumbnuts until the plunger body and top are all the way down against their respective sealing surfaces.

Be sure that the incoming gas plumbing is properly supported, and that the weight of the plumbing is not supported by the plunger housing.

Use N_2 only! Do not use compressed air, or there will be a severe explosion hazard!

The regulator should be set to ~50psig. Set the rotameter to at least 10slm for proper purging of the plunger assembly. **For units equipped with a Magnehelic of Photohelic, See pneumatic diagram.**
The plunger speed can be adjusted with the small screw on the speed controllers/fittings on the air cylinder. It should be adjusted to ~ 2 seconds in each direction.

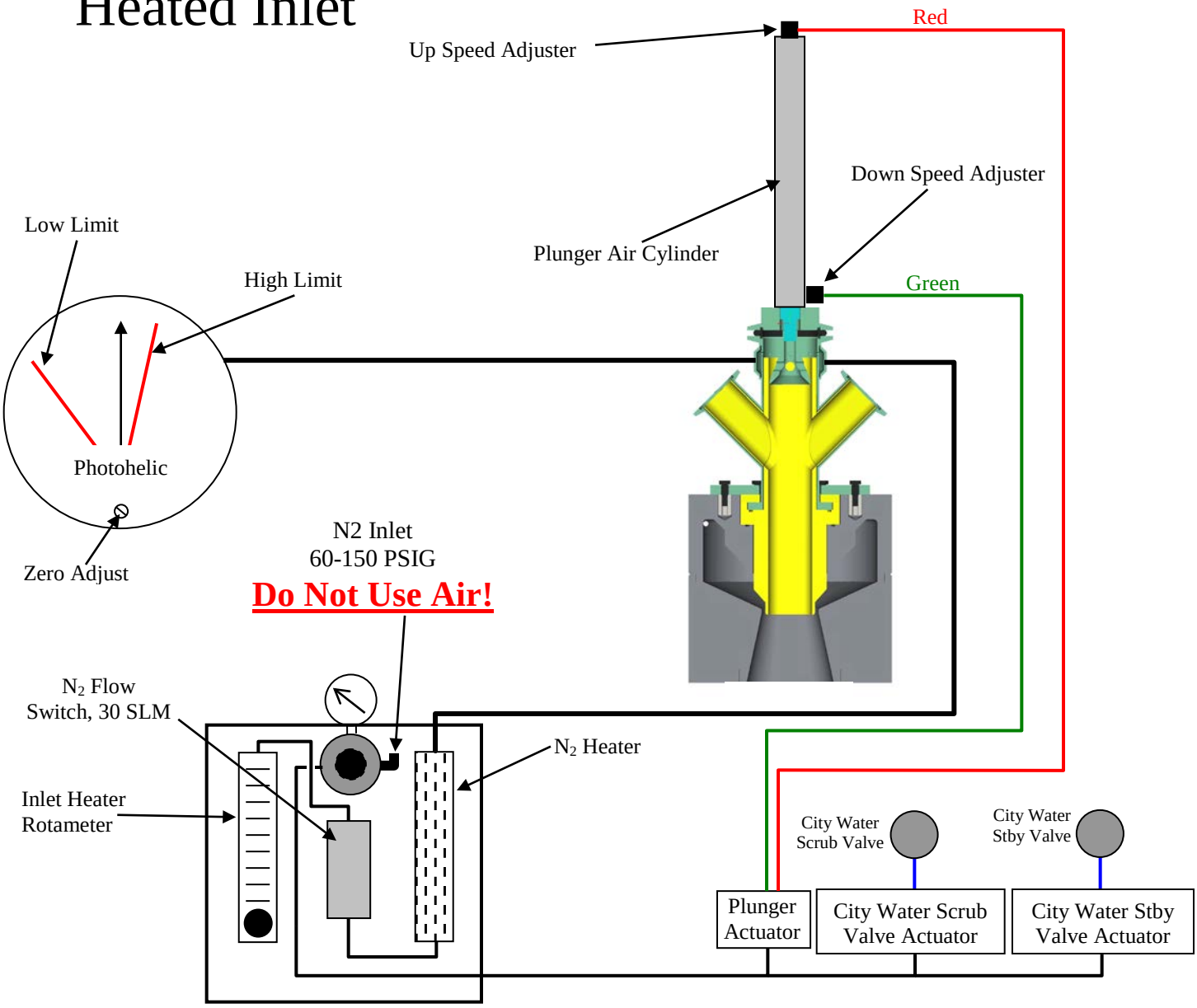
Be sure to wear all appropriate safety gear when working on or operating the plunger or scrubber (gloves, safety glasses, face shield, etc.)

Pressing the button on the Scrubber Control Box front operates the plunger. There are several other automatic modes available that can be used to operate the plunger- consult the control box manual or the factory for more information.

The plunger should only be operated with the system closed and completely purged of atmosphere. The build-up in the inlet can cause sparks when it is moved.
Although the plunger head is perforated to allow gas flow through it while it is in the down position, we recommend plunging only when the process tool is idle and in nitrogen.
Overuse of the plunger will shorten the required service interval. Depending on the process, plunging will be required anywhere from daily to weekly. Watch the buildup on the inlet, and plunge only when necessary. Generally there will be no backpressure seen at the tool until the inlet is at least half obstructed.
The entire plunger assembly should be taken apart and cleaned approximately every 6 months. This interval will vary depending on the type of process, plunging interval, etc. Be extremely cautious cleaning these parts, as the material that builds up can be flammable, or even pyrophoric. It is a good idea to clean them while they are completely immersed in water.

Ph. (408)-573-0701
U.S. Patent No. 4,986,838

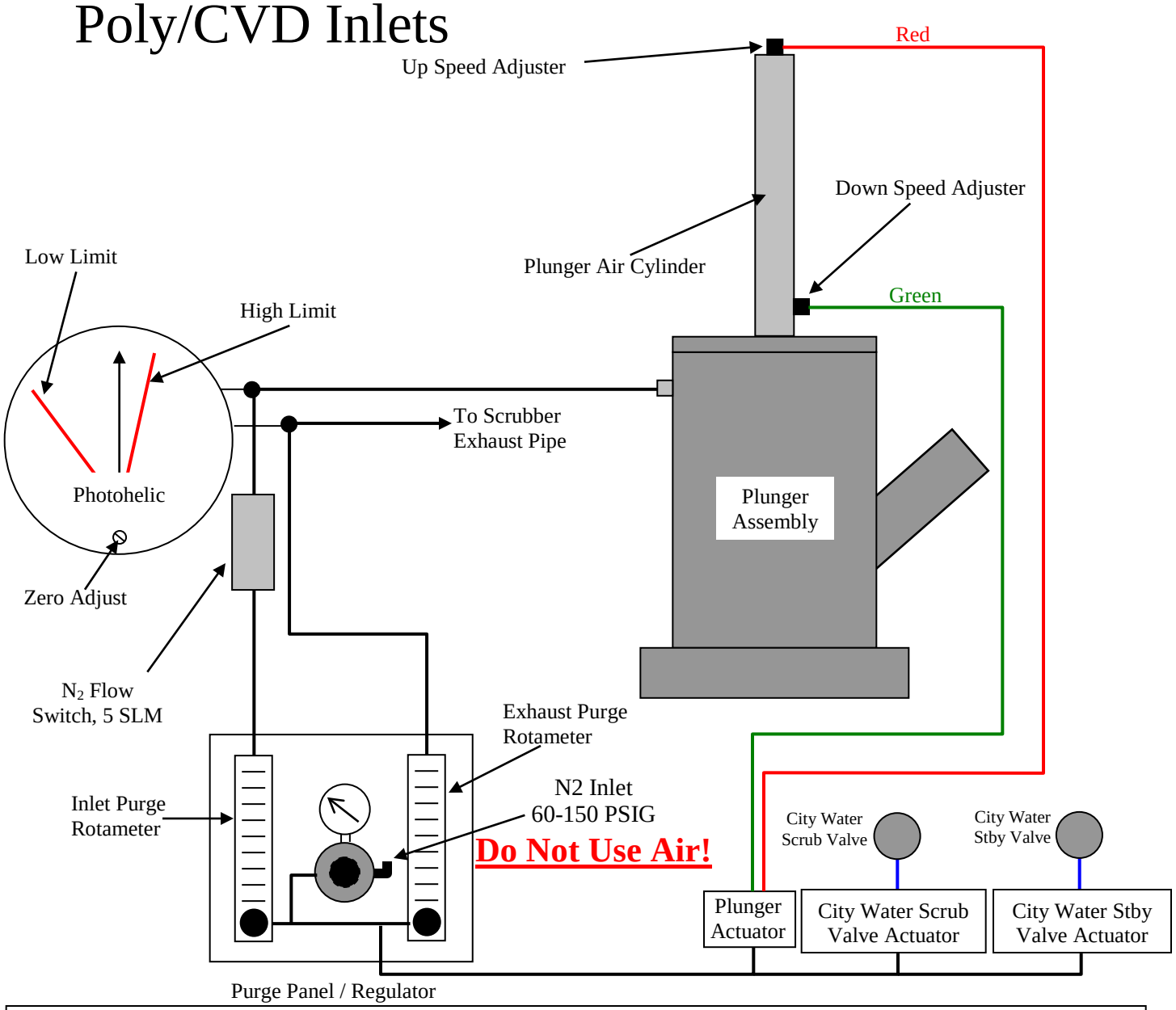
Figure 5 - Pneumatic Diagram, Heated Inlet



The N_2 Pressure regulator should be set to 50 PSI.
Set the inlet heater rotameter flow to 40SLM. Then, with the recirculation pump off and low flow (<100SLM) from the reactor through the scrubber, turn the zero adjust screw on the Photohelic gauge until it reads zero.
The Photohelic now reads the pressure drop at the inlet, relative to atmospheric pressure. Positive readings indicate backpressure; negative readings indicate "negative pressure" generated by the eductor.

The Photohelic high limit should be set at the desired fault level, usually about +1" of water. The low limit switch is not used, and should be set all the way to the left.

Figure 5 - Pneumatic Diagram, Poly/CVD Inlets



The N_2 Pressure regulator should be set to 50 PSI.
Set the inlet purge rotameter flow to 10SLM, and the exhaust purge rotameter flow to 5SLM. Then, with the recirculation pump off and low flow (<100SLM) from the reactor through the scrubber, turn the zero adjust screw on the Photohelic gauge until it reads zero. If you are unable to zero the Photohelic, or are close to the limit of adjustment, the exhaust purge rotameter may be adjusted, as long as the flow is not completely turned off.
The Photohelic now reads the pressure drop across the scrubber, *not* relative to atmospheric pressure. Positive readings indicate backpressure; negative readings indicate "negative pressure" generated by the eductor. The absolute pressure seen by the reactor chamber is the sum of atmospheric pressure, the Photohelic reading, and the pressure (relative to atmosphere) in any house exhaust system that the scrubber exhaust is tied into.
The Photohelic high limit should be set at the desired fault level, usually about +1" of water. The low limit switch is not used, and should be set all the way to the left.

Pump Start–Up and City Water Flow

Fill the scrubber with water (**for pumps with strainers, loosen the strainer lid until the basket is full of water, then re-tighten**) and then start the recirculating pump. Anytime the pump is running, the city water flow should be kept to at least a trickle to allow for evaporative losses. City water flow during actual scrubbing is a function of process conditions- please consult the factory for recommended fresh water flow settings.

ANYTIME FOAMING OCCURS, THE CITY WATER FLOW IS TOO LOW

The pump should be left running at low speed during inlet port servicing and also during shut down periods of less than a few days. Frequent pump shutdowns can cause nozzle clogging, premature plugging of the inlet port, and reduce pump life. For longer shutdown periods, replace the inlet port with a clean one and turn off the pump and the city water.

Removable Gas Inlet Port

(Epi and Poly Etch/CVD only)

The only routine maintenance required on the STS scrubber is the periodic removal and cleaning of the gas inlet port and plunger assembly. We recommend disassembly and cleaning of the plunger assembly every 6 months, depending upon the process gasses, growth rates and deposition times. The scrubber comes with a spare inlet port to minimize downtime during inlet port servicing.

As long as it is not allowed to dry out, the buildup in the inlet port will stay soft and dense. Frequently the build up will fall off by itself before backpressure is ever observed at the reactor. At 200 SLM of hydrogen gas, no noticeable backpressure will be observed until the restriction in the inlet reduces the inlet's opening down to a diameter of about 2 centimeters.

Cleanout Tool

(Heated Inlet Only)

All heated inlet systems are shipped with an inlet cleanout tool. If the plunger is unable to clear the inlet restriction due to excessive buildup, this tool can be used to quickly clean the inlet and get the system back into production.

To clean the inlet, turn off the heater and **purge the scrubber with at least 700 liters of N_2** and set the Photohelic high limit switch all the way to the right to avoid automatic plunging. Remove the clamp from the NW50, and set the plunger assembly aside. Insert the clean-out tool into the inlet assembly, and turn the tool clockwise by hand while applying gentle downward pressure until the obstruction is removed. Reverse the procedure to reassemble, being sure the o-ring and sealing surfaces are clean. Replace any o-rings that are damaged oar compressed. Don't forget to reset the Photohelic setting.

Ph. (408)-573-0701
U.S. Patent No. 4,986,838

Procedure, Heated Inlet Cleanout Tool

Airgard heated inlet systems can be easily serviced using the inlet cleanout tool. If the plunger is unable to clear the inlet restriction due to excessive buildup, this tool can be used to quickly clean the inlet and get the system back into production.

1. To clean the inlet, be sure all hazardous gasses to the scrubber are shut off.
2. Turn off the heater and **purge the scrubber with at least 700 liters of N_2** (20 minutes at 35slm…this should be enough to cool the heater as well)
3. Remove the clamp from the NW50 on top of the inlet assembly, disconnect the air lines and sensors, remove the plunger assembly (including the o-ring) and set it aside.
4. Insert the clean-out tool into the inlet assembly, making sure that the plastic bushing slides down into the inlet assembly until the shoulder is on top of the NW50 flange. (See photo below)
5. Turn the tool clockwise by hand while applying gentle downward pressure until the obstruction is removed. You may want to stop and run some water down the inlet occasionally if the build-up is particularly hard.
6. Reverse the procedure to reassemble, being sure the o-ring and sealing surfaces are clean. Replace any o-rings that are damaged or compressed.
7. Turn the heater on and purge the scrubber for at least 15 minutes at 35 slm before flowing any process gasses.

Ph. (408)-573-0701
U.S. Patent No. 4,986,838

Procedure, Acid Clean, Silicon Nitride Systems

In some processes, such as silicon nitride deposition, there will be some coating of the scrubber's internal surfaces from non water-soluble deposits. Carefully adding a small amount of hydrochloric acid during routine services will prevent excessive build-up.

Safety gear: Safety glasses, acid/base gloves, face shield
Pump remains on, eductor valve wide open, city water on

1) Be sure all hazardous gasses to the scrubber are shut off.
2) Turn off the heater and **purge the scrubber with at least 700 liters of N_2** (20 minutes at 35slm…this should be enough to cool the heater as well).
3) The water in the sump must be purged as well. While the system is N_2 purging, set the input (city) water flow to at least 2gpm and let it flow for at least 20 minutes. This will help avoid a vigorous reaction between the acid and any chemicals left in the scrubber water.
4) Set the Photohelic high limit switch all the way to the right to avoid automatic plunging.
5) Remove the clamp from the NW50 on top of the inlet assembly (or the plastic nut for non-heated inlets), remove the plunger assembly (including the o-ring) and set it aside.
6) Set the heater N_2 flow to 10slm
7) Place a large funnel on top of the plunger/inlet assembly, making sure the end is centered, and the funnel is in a stable position, centered in the inlet.
8) **Slowly** pour HCl (muriatic acid from a pool supply will do, purity is not an issue) into the funnel.
9) Let the acid solution recirculated through the scrubber until the build-up is removed. If it is not gone in 10-15 minutes, repeat step 8.
10) Reverse the procedure to reassemble, being sure the o-ring and sealing surfaces are clean. Replace any o-rings that are damaged or compressed. Don't forget to reset the Photohelic setting.
11) Set the heater N_2 rotameter back to it's previous setting (35-50slm). Turn the heater on and let the scrubber purge for at least 15 minutes before flowing any process gasses.

Replacing Dirty Inlet Port

BE SURE SCRUBBER HAS BEEN PURGED WITH A MINIMUM OF 700LITERS OF NITROGEN GAS BEFORE SERVICING!

WEAR PROPER SAFETY EQUIPMENT WHEN SERVICING INLET PORT-A MINIMUM BEING ACID RESISTANT GLOVES AND SAFETY GLASSES!

NOTE: Leave pump on during inlet port servicing

1.) Remove the plunger assembly by removing the 3" union nut at the plunger base.

2.) Use water spray from the city water auxiliary water outlet to remove the bulk of the buildup with the inlet in place.

DO NOT POUR HYDROFLOURIC ACID OR ANY OTHER CHEMICALS INTO THE INLET TO CLEAN IT !!

3.) Remove the inlet port by pulling up while twisting.

4.) To install the entry port, first rinse all of the sealing surfaces on the device and apply a light coating of grease the to the inlet port o-ring. Then, insert the dry, clean, spare inlet port supplied with the unit. Once inserted, push down on the inlet port while twisting it back and fourth. Push and twist until the port seats firmly. This should leave approximately ¼" of the inlet port showing above the 3" union.

Clean the o-ring and sealing surface on both the 2" inch union and plunger base. Apply a light coating of vacuum grease to the o-rings on both unions.Reinstall the gas input section of plumbing and tighten the union nuts. Once Hydrogen gas is flowing, these union joints should be leak checked with a portable Hydrogen detector.

AFTER SERVICING THE INLET PORT, BE SURE THAT THE SCRUBBER HAS BEEN PURGED WITH A MINIMUN OF 700 LITERS OF NITROGEN GAS BEFORE REINTRODUCING HYDROGEN OR ANY OTHER PROCESS GASES !

Cleaning Dirty Inlet Port and Plunger Assembly

1.) Handle the dirty inlet port and plunger assembly with care. The build-up that forms in the inlet port can be pyrophoric and will react violently with concentrated HF (Hydrofluoric acid). When ever handling or cleaning a dirty inlet port be sure to wear the proper safety equipment – a minimum being gloves, eye protection, face shield, and a plastic apron with arm guards.

2.) Remove the o-ring from inlet port and wipe it clean using Isopropyl Alcohol and a clean, lint free towel.

3.) Remove as much buildup from the inlet port as possible with water and gentle wiping with a paper towel. Never use a hard object to remove buildup from the inlet as it could scratch or damage the inner surface of the inlet port.

4.) Once the heavy buildup has been removed, immerse the dirty parts in a container of water only. This must be done in an appropriate acid fume hood. Operator must follow all appropriate safety procedures, and use all safety gear for safe handling of acid (acid gloves, safety glasses, face shield, arm guards, apron, etc.) **Slowly** add about 500ml of 10% HF* to the water in the container. The reaction can cause sparks, and may be violent. Be patient, and don't add too much acid too fast. When the parts are clean, **rinse the parts thoroughly with fresh water**, allow them to dry, reinstall clean o-rings and store the clean port for the next use. **Do not use acid to clean the metal air cylinder.**
*A safer, but slower method is to soak the inlet port in a weak (20% or less) NaOH or KOH solution overnight. This will soften the build-up enough to remove it easily. Be sure to rinse the part thoroughly after soaking.
Do not ever mix HF and NaOH or KOH!!! They will react with great violence!
Be sure to handle all chemicals with care, and use the proper safety equipment.

Y–Strainers

There are two clear Y–strainers on the back of the scrubber. One is in the inlet device supply line and one is in the city water supply line. They will rarely plug, but they should be checked weekly, and cleaned when necessary.

Ph. (408)-573-0701
U.S. Patent No. 4,986,838

Spray Nozzles

If a spray nozzle stops flowing or has an uneven spray pattern, it should be removed and cleaned.

It is strongly recommended that you disconnect the scrubber from the reactor exhaust line at the scrubber before opening the scrubber to atmosphere.

BE SURE THAT THE SCRUBBER HAS BEEN PURGED WITH A MINIMUM OF 700 LITERS OF NITROGEN GAS, AND AT LEAST 30 GALLONS OF FRESH WATER BEFORE SERVICING! WEAR PROPER SAFETY EQUIPMENT WHEN SERVICING SPRAY NOZZLES- A MINIMUM BEING ACID RESISTANT GLOVES AND SAFETY GLASSES!

NOTE: The pump must be turned off prior to removing the access port or any Spray nozzles for cleaning.

Upper Main Stack Spray Nozzles

BE SURE THAT THE SCRUBBER HAS BEEN PURGED WITH A MINIMUM OF 700 LITERS OF NITROGEN GAS, AND AT LEAST 30 GALLONS OF FRESH WATER BEFORE SERVICING! WEAR PROPER SAFETY EQUIPMENT WHEN SERVICING SPRAY NOZZLES- A MINIMUM BEING ACID RESISTANT GLOVES AND SAFETY GLASSES!

Scrubber will remain efficient with one or two upper main stack nozzles plugged.

1.) Turn of pump.
2.) Remove the access port on the rear of the upper main scrubbing chamber.
3.) Unscrew the restricted nozzle and remove the blockage.
4.) Reinstall the clean nozzle and the access port.
5.) Once the pump is turned back on, visually check for water leaks.
6.) Purge the unit with at least 500 liters of N_2
7.) After the scrubber is flowing Hydrogen gas it should be leak checked with a hand held Hydrogen detector.

Upper Packed Column Spray Nozzle

BE SURE THAT THE SCRUBBER HAS BEEN PURGED WITH A MINIMUM OF 700 LITERS OF NITROGEN GAS, AND AT LEAST 30 GALLONS OF FRESH WATER BEFORE SERVICING! WEAR PROPER SAFETY EQUIPMENT WHEN SERVICING SPRAY NOZZLES- A MINIMUM BEING ACID RESISTANT GLOVES AND SAFETY GLASSES!

1.) Turn off pump.
2.) Unscrew both the union nut on the nozzle side of the packed column water supply valve, and the union nut on the packed column nozzle itself.
3.) Remove the section of pipe and unscrew the packed column nozzle from it's assembly.
4.) Note the number of turns necessary to unscrew the packed column nozzle and remove the nozzle. Take care to reinstall the nozzle with the same number of turns This will insure that the nozzle will be reinstalled at it's original height.
5.) Remove the restriction from the nozzle (the internal baffle can be pulled out for cleaning) and reinstall the clean nozzle. Remember to tighten the nozzle with the same number of turns used to unscrew it. If the nozzle doesn't feel tight with that number of turns, Teflon tape should be added to the threads.

6.) Clean the o-ring and the sealing surface on both of the plumbing unions, reinstall the pipe segment and tighten both union nuts.
7.) Purge the unit with at least 500 liters of N_2
8.) After the scrubber is flowing Hydrogen gas it should be leak checked with a hand held Hydrogen detector.

Lower Main Stack Spray Nozzle

BE SURE THAT THE SCRUBBER HAS BEEN PURGED WITH A MINIMUM OF 700 LITERS OF NITROGEN GAS, AND AT LEAST 30 GALLONS OF FRESH WATER BEFORE SERVICING! WEAR PROPER SAFETY EQUIPMENT WHEN SERVICING SPRAY NOZZLES- A MINIMUM BEING ACID RESISTANT GLOVES AND SAFETY GLASSES!

1. Turn off pump
2. Remove the lower chamber access port.
3. Unscrew the nozzle.
4. Remove the blockage from the nozzle (the internal baffle can be pulled out for cleaning) and reassemble in the reverse order.
5. Purge the unit with at least 500 liters of N_2
6. After the scrubber is flowing Hydrogen the access port should be leak checked with a hand held Hydrogen detector.

Lower Packed Column Spray Nozzle

(FRESH CITY WATER)

BE SURE THAT THE SCRUBBER HAS BEEN PURGED WITH A MINIMUM OF 700 LITERS OF NITROGEN GAS, AND AT LEAST 30 GALLONS OF FRESH WATER BEFORE SERVICING! WEAR PROPER SAFETY EQUIPMENT WHEN SERVICING SPRAY NOZZLES- A MINIMUM BEING ACID RESISTANT GLOVES AND SAFETY GLASSES!

1.) Turn off pump.
2.) Turn off city water input to the scrubber.
3.) Unscrew the 2” inch union nut on the city water nozzle assembly. The nozzle assembly is located on the lower backside of the packed column.
4.) Unscrew the ½” inch union on the city water supply line, remove the small section of plumbing and unscrew the city water nozzle from it’s assembly.
5.) Remove the restriction from the nozzle and reinstall the clean nozzle.
6.) Purge the unit with at least 500 liters of N_2
7.) Clean the o-ring and the sealing surface on both the plumbing unions, reinstall the pipe segment and tighten both union nuts.

Recirculation Pump

The water recirculation pumps used on the Airgard STS–06 Series Fume Scrubber are outfitted with high durability corrosion resistant seals. However, extended use in a highly corrosive environment will eventually lead to pump seal failure.

Pump seal failure is indicated when fluids visibly start to leak around the recirculation pump shaft. In this event, the scrubber should be scheduled at once for preventive seal maintenance.

This step will require partial disassembly of the recirculation pump, and replacement of the defective seal with a new seal. Use only pump seals supplied by Airgard. Most commercial seals are made of materials that will not withstand the scrubber's chemical environment.

If you have questions concerning this procedure, or if you require additional spare seals, contact the factory for technical support.

The American Products model pump will not be available from our manufacturer forever, so please do not throw away your old pumps when you replace them. Unless the parts are actually broken, the pumps can be rebuilt to be as good as new. Airgard will buy back any old pumps, or issue credit against new pumps if the old pumps are returned to Airgard.

PUMP OR MOTOR FAILURE DUE TO NON-REPLACMENT OF LEAKING SEALS WILL NOT BE CONSIDERED A COVERED DEFECT UNDER WARRANTY TERMS.

SAFETY CONSIDERATIONS

PURGING

NEVER ALLOW EXPLOSIVE GASSES TO MIX WITH ATMOSPHERE IN THE SCRUBBER. THE SCRUBBER SHOULD BE PURGED WITH AT LEAST 700 LITERS OF NITROGEN BEFORE AND AFTER INTRODUCING HYDROGEN OR ANY OTHER PROCESS GASSES. PLEASE CONSULT FACTORY IF THERE ARE ANY QUESTIONS. IT IS THE CUSTOMER'S RESPONSIBILITY TO SEE THAT THE SCRUBBER IS PROPERLY PURGED AT ALL TIMES. PYROPHOURIC GASSES SUCH AS SILANE MAY REQUIRE ADDITIONAL SAFEGUARDS. PLEASE CONSULT FACTORY FOR ASSISTANCE.

PLUMBING

DO NOT PUT VALVES IN THE REACTOR OR SCRUBBER EXHAUST LINES OR THE SCRUBBER DRAIN LINE – ANY OBSTRUCTIONS IN THESE LINES COULD CAUSE THE PROCESS CHAMBER AND/OR THE SCRUBBER TO OVER PRESSURE.

ELECTRICAL

ELECTRICAL COMPONENTS SHOULD BE ACCESSED ONLY BY QUALIFIED PERSONNEL.

Ph. (408)-573-0701
U.S. Patent No. 4,986,838

Airgard Fume Scrubber Safety

Airgard fume scrubbers, when properly installed, operated and maintained will function safely for many years. They are designed to be as safe as possible, but the primary responsibility for safe operation rests with the user.

The scrubber is, in the simplest terms, a plastic box filled with water spray. If it is filled with an explosive mixture and ignited, it will explode. Airgard has no control over what gas mixtures are introduced into the scrubber.

Great care must be taken by the owner to keep potentially explosive gas mixtures from accumulating in the scrubber.

- The scrubber generates a negative pressure, so the line from the process tool and the tool itself must be leak tight or atmosphere will be drawn into the system creating a hazard.
- The scrubber must always be filled with water to keep the drain trap full, or it will draw in air through the drain line.
- Exhaust line integrity must be maintained. All lines must be leak checked regularly.
- The scrubber should be regularly checked for leaks. All scrubbers are checked before leaving the factory, but handling during shipping and installation may cause leaks. The customer should inspect the units for water leaks, and a H2 sniffer should be used to check for gas leaks. Do not attempt to pump down the scrubber and use a He leak tester.
- Do not attempt to pressurize the scrubber for leak testing. It is not designed to withstand any significant pressure. Severe damage may result.
- Care must be taken in the installation to avoid any “dead legs” in the plumbing where air or process gasses may accumulate. Reduced pressure systems often have a separate line from the pump, which may not be purged when the pump is not running. An N_2 purge should be added at the end (away from the scrubber) of any line feeding the scrubber.
- When the scrubber is installed onto existing installations, be absolutely sure all lines are purged and clean. The scrubber should be filled with water until it runs out the effluent drain before any lines are connected, or gasses are introduced.
- Flow must be maintained through the scrubber at all times to prevent air from diffusing back through the exhaust line. If the process tool can under *any* circumstances (fault, power failure, etc.) stop all flow completely, a nitrogen purge separate from the tool should be installed in the tool exhaust line between the tool and the scrubber.
- Anytime the scrubber or the exhaust piping is to be opened for servicing, the entire system (tool, exhaust lines, scrubber), *must* be purged completely with nitrogen. Three volume changes is the minimum purge volume for safety—700 liters for the scrubber, plus three times the volume of the tool’s process chamber plus the exhaust plumbing volume.

Ph. (408)-573-0701
U.S. Patent No. 4,986,838

Epi reactor exhaust lines, and some other process tools as well, develop a buildup that is flammable and often pyrophoric when exposed to air. This buildup often develops on the dry portion of the scrubber's inlet device as well. It is wise to assume that there is always an ignition source for any flammable gas mixture that is allowed to accumulate. *Used exhaust lines must be handled with extreme care.* We recommend that you consult your tool's manufacturer for proper handling procedures.

Anytime the scrubber is opened to the atmosphere for servicing, the exhaust line from the reactor should be disconnected and kept purged. Atmosphere introduced from the scrubber can diffuse back into the exhaust line and ignite the deposits.

Although Airgard has a good safety record, there have been some scrubber explosions. In some cases it is difficult to determine the cause after the fact, the following are the most common causes, in order:

1. Exhaust line leaks: Plumbing between the tool and the scrubber is not properly installed and/or leak checked after installation or servicing. Usually this causes an explosion in the exhaust line itself. The low pressure in the line draws in air, and the resultant flammable mixture is ignited by the deposits in the exhaust line. The high pressure generated will normally blow a section out of the scrubber. However, if the leak is large enough, and the ignition happens after the flammable mixture has filled the scrubber as well, a more violent explosion can result. The scrubber has large flat surfaces and is not designed to be a pressure vessel, and therefore gives out much more easily than piping.
2. Leaks or explosions in the tool itself will generate a pressure wave down the exhaust line that may damage the scrubber.
3. Pyrophoric gasses: pyrophoric gasses such as silane require special care and precautions. Silane is not water soluble and can ignite when it hits the air, even after passing through the scrubber. Please consult us if you intend to use any pyrophoric gasses.
4. Re-used wastewater: Effluent water from the scrubber contains entrained and dissolved hydrogen. If the scrubber effluent water is neutralized and pumped back into the scrubber, it provides a hydrogen source that can be hazardous when the scrubber is opened for servicing.

Scrubbers should not be installed where there are many people present, and should be far enough apart that an explosion in one will not cause damage to an adjacent unit. If this is not possible, scrubbers should be separated from foot traffic and each other by a steel mesh or expanded metal screen.

Explosions are uncommon, and almost all of our scrubbers made over the last 15 years are still in service. However appropriate care must be taken to install, service and operate them safely. We are happy to assist our customers in any way possible, but once the scrubber leaves our dock, we cannot control what gasses are introduced and the responsibility for safe operation rests with the user.

Ph. (408)-573-0701
U.S. Patent No. 4,986,838

Operation of Multiple Systems on a Single Scrubber

Airgard does not recommend using a single scrubber for more than one process tool.

More than one process tool can be connected to a single scrubber only if all of the following conditions are met:

1.) All gasses from all tools are compatible with each other. Be sure to include atmosphere if it is ever introduced into the exhaust stream. *Never allow an explosive mixture to accumulate, in or flow through the scrubber!*

2.) The sum of the maximum gas flows does not exceed the capacity of the scrubber (600 SLM for the Airgard STS-06).

1.) Connecting more than one Epi Reactor chamber to a single scrubber is not recommended, because in many epi systems atmosphere is introduced during the load cycle, which could mix with hydrogen from another system causing an explosion hazard.

Other considerations:

1.) Increased downtime – servicing one tool's exhaust line will probably require shutting down the other tool(s) as well.

2.) Exhaust line pressure is a function of flow – the exhaust pressure one tool sees will change as the other tool's flow rate changes – some processes may be adversely affected by these pressure changes.

3.) Back streaming – each tool must be isolated from the common exhaust line whenever the process chamber is opened to the atmosphere.

4.) Safety – All lines must be marked so that maintenance personnel know that the line is fed from multiple sources.

If you choose to connect more than one tool to a scrubber, please carefully consider all of these concerns, particularly safety. You **must** thoroughly understand all of the possible combinations of gasses that may occur in the exhaust system in any situation, including power failures, leaks, aborts and emergency shutdowns. **Be especially careful when using flammable, explosive, and/or pyrophoric gasses!**

AIRGARD, INC. WILL NOT BE HELD RESPONSIBLE FOR ANY DAMAGES, ACCIDENTS, OR INJURIES CAUSED BY MIXING IMCOMPATIBLE GASSES

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U.S. Patent No. 4,986,838

Lockout Tag-Out Procedures

The Airgard Cyclone scrubber control box has 2 Lock-Out Tag-Out locations:

Main Power Disconnect: This should be locked and tagged in the off position whenever working on the scrubber with it powered down, or changing or maintaining electrical components.

Reactor Interlock Switch: This should be switched to the “Open” position and locked whenever maintenance procedures necessitate working on or opening the scrubber with the power on. Provided that the interlock circuit is properly connected to the process tool, this will not allow the process to flow dangerous gasses that could be a hazard to maintenance personnel.
This is especially important when the scrubber is to be opened in any way that exposes the technician to the inside of the scrubber.
The maintenance person must be sure that the scrubber is properly sealed, purged and leak checked before unlocking the switch and turning it to the “Closed” position.
Note: The interlock supplied in the control box must be connected to the process gas source (process tool) in such a way that all hazardous gasses are turned off in the event of the scrubber interlock opening, otherwise the interlock circuit (and switch) will have no effect on safety.

CE/S2 Compliance Recommendations

Secondary containment leak detector option.

Airgard offers an optical liquid sensor for the secondary containment that can be factory wired into one of the auxiliary inputs in the control box, and tied to the scrubber alarm, scrubber ready contact, and/or an auxiliary contact that can be used to notify the facility monitoring system (if present in your fab).

Safety Cage Option:

Airgard recommends a safety cage or explosion shield in applications where the scrubber will be handling potentially flammable or explosive gasses. Airgard offers a perforated stainless steel safety enclosure that does not increase the footprint of the unit, and allows easy access to all controls, displays and adjustments.

If and Airgard approved safety cage or shield is not used when scrubbing flammable and/or explosive gasses, Airgard cannot be held responsible for damage or injury to personnel or equipment.

Airgard scrubbers are not inherently unsafe, but safe operation is dependent on proper installation, application, and maintenance. Any fume scrubber can be a hazard if the user allows air and flammable gas to mix in the scrubber, exhaust lines, or in the tool connected to it.

Ph. (408)-573-0701
U.S. Patent No. 4,986,838

Figure 6 - **SAFETY WARNING LABELS**

Indicates Hazardous Voltage Present

Indicates Hazardous Explosive Chemicals or Fumes may be present

Indicates Hazardous Flammable Chemicals or Fumes may be present

Indicates Hazardous Toxic Chemicals or Fumes may be present

Indicates Hazardous Corrosive Chemicals or Fumes may be present

Indicates Eye Protection must be worn around scrubber

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U.S. Patent No. 4,986,838

AIRGARD SCRUBBER "NEGATIVE DRAW" SYSTEM

The STS-06 series fume scrubber features a spray nozzle and eductor that reduces exhaust line pressure by up to four inches of water. A high flow, full cone spray nozzle pushes gas through a cone mounted above the packed column, reducing the pressure in the scrubber and piping upstream.

The pressure drop depends upon the water flow (which is adjustable), the flow rate of the gas being scrubbed, and the type of gas being scrubbed. The higher the water flow, the lower the gas flow, and the more viscous the gas, the more pressure drop will be produced.

Too much draw during the low or no flow conditions that exist while opening and closing the process chamber can cause particle problems, so we have built in a feature that limits the pressure drop to about 4" of water (see attached Figures 7and 8).

The cone is about 4" tall and is mounted on a perforated plate. The pressure drop generated by the water spray causes gas and water to flow upward through the holes in the plate. Within a few seconds, the area above the plate will fill with enough water to stop the upward flow (see Figure 7). The water level above the plate actually acts as a manometer – if the water is 1" deep, then you know that the venturi is generating a pressure drop of 1" of water.

When the gas flow gets low enough so that the pressure exceeds the height of the cone, water spills over the top of the cone, limiting the depth of the water to 4". Gas will continue to bubble up through the plate, "short circuiting" the venturi and limiting the pressure drop to $\leq$4 inches of water (see Figure 8).

Try to keep in mind the magnitude of the pressures involved here. Atmospheric pressure is ~35 feet (420 inches) of water. A pressure change of 1" of water is about .002 bar, 2T or .035 psi. This will change the pressure in your exhaust lines and process chamber by only about 0.25%, which is unlikely to cause any measurable change in your process. A barometric change of 0.5" Hg due to the normal variation in weather conditions is over 6 times more significant than the pressure change in your process chamber due to the venturi cone draw.

The benefit of "negative draw" lies in reducing the chance of particulate back flow during the opening and closing of the process chamber or exhaust valve for loading and unloading wafers.

Ph. (408)-573-0701
U.S. Patent No. 4,986,838

FIGURE 7- HIGH GAS FLOW CONDITION

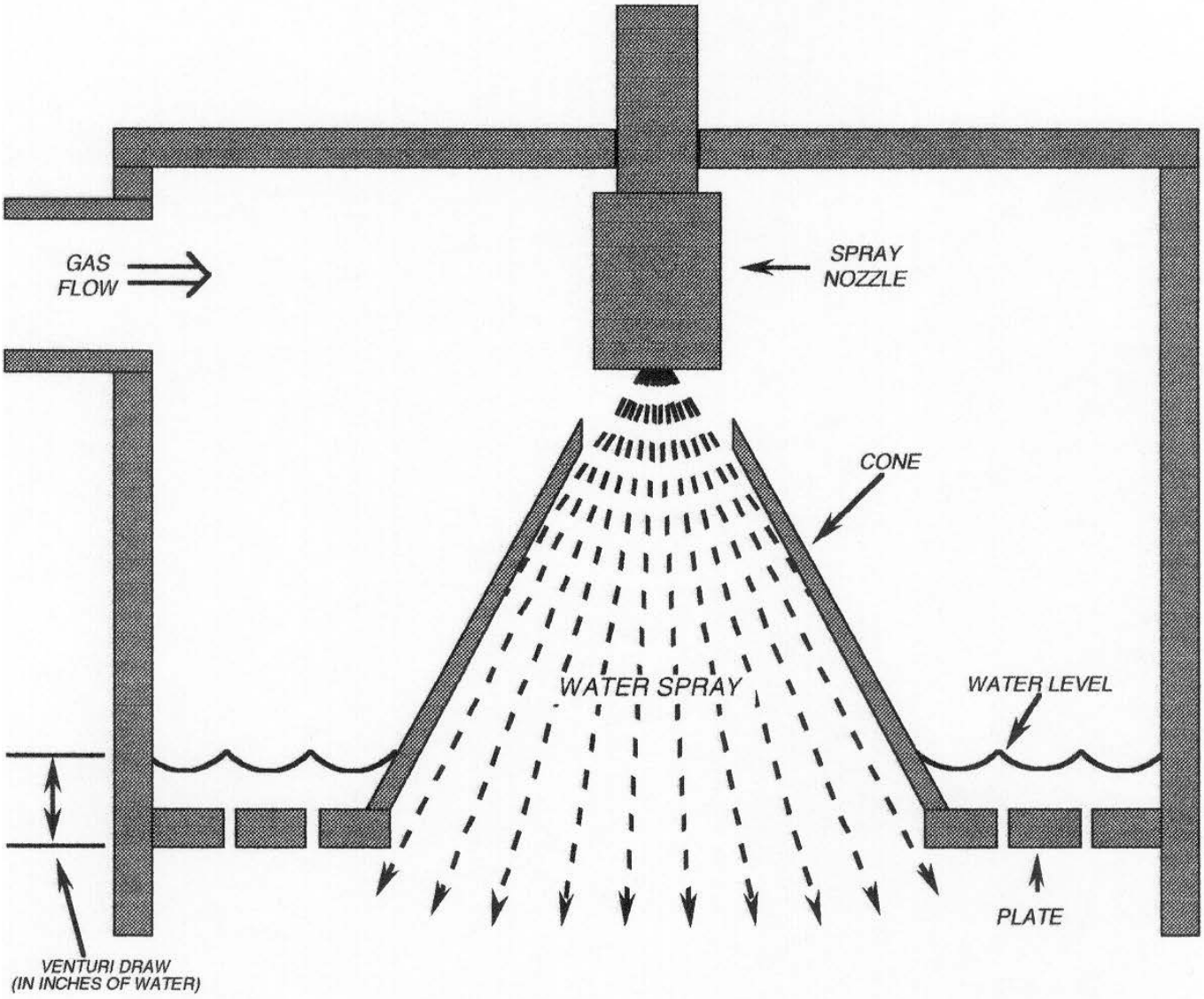
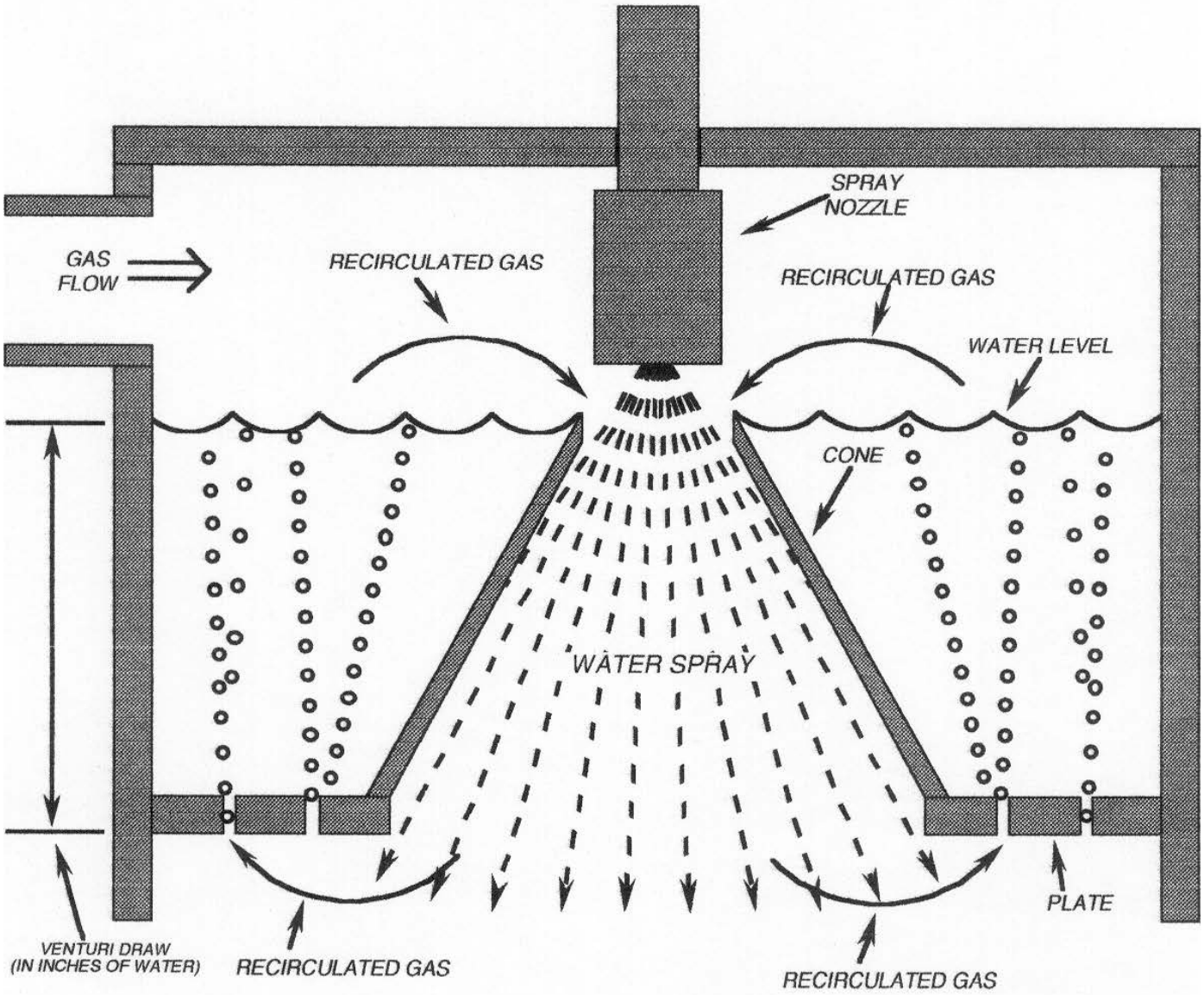


FIGURE 8- LOW GAS FLOW CONDITION



AIRGARD CHEMICAL INJECT SYSTEM OPTION

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FEATURES AND BENEFITS

FEATURES:

- Constructed of corrosion-resistant materials:
    - 316 stainless steel or Hastelloy C-276 tubing and fittings
    - PVC and polypropylene pipe and fittings
    - Teflon and polyethylene tubing
    - Viton or EPDM seals and o-rings.

- Pulls cleaning chemicals directly from the 1 gallon bottle using a water powered eductor, and injects them into the scrubber's recirculating system.

BENEFITS:

- Allows cleaning chemicals to be added to the scrubber without stopping production, greatly reducing cost of ownership, and increases process tool uptime compared to manually dosing.

- Does not allow air into the scrubber, or let hazardous gasses escape from the scrubber during chemical dosing.

- Reduces chemical exposure to technicians compared to traditional manual dosing methods.

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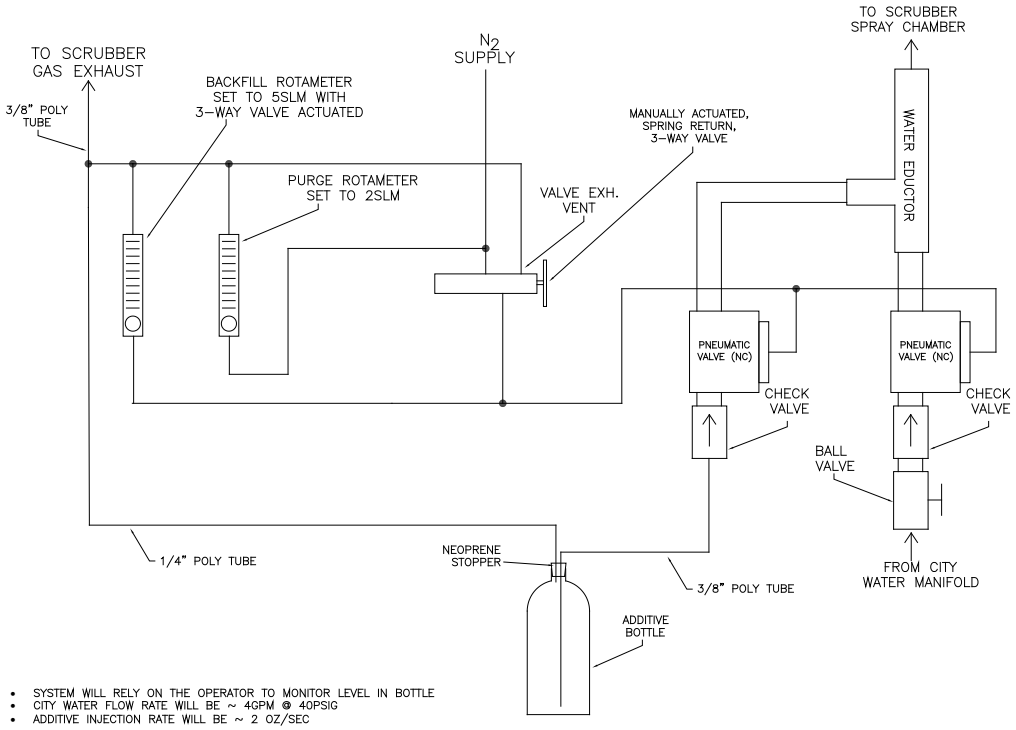
U.S. Patent No. 4,986,838

SET-UP AND OPERATION

Set-up:

1. Be sure that the scrubber is installed according to the installation manual.
2. For the system to work properly, adequate city water pressure is essential. The facility plumbing must be at least ½' pipe, and supply pressure at least 40psig.
3. The purge rotameter (right side) should be set to 2slm, and the bottle backfill rotameter (left side) should be set to 5slm (this rotameter only flows when the actuator button is pressed).
4. Place a full bottle of the chemical to be injected in the spill tray (BE SURE TO DOUBLE CHECK THAT THE CORRECT TYPE OF CHEMICAL BOTTLE IS INSTALLED!), and firmly insert the dip-tube assembly into the bottle. Be sure that whatever chemical is used is compatible with the scrubber materials, and any gasses or liquids that are in the scrubber. A review by your company's safety committee is strongly recommended. Airgard is not responsible for damages, losses, or injuries caused by using, mixing, or spilling dangerous or incompatible chemicals.
5. Put appropriate chemical identification warning labels on the scrubber, splash shield and bottle that are appropriate to the chemical being injected.



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Operation:

1. It is important that the system not be operated without the chemical bottle installed, or with the chemical bottle empty. Many processes use flammable and/or pyrophoric gasses that may burn or explode if air is injected into the scrubber. The dip tube assembly must be well sealed onto the bottle before operating the system. Different manufacturers use different design bottles, and it is the responsibility of the user to effect a good connection to the bottle. Airgard can supply different sizes of stoppers, depending on the requirement.
2. Be sure that the city water valve is turned on, and that the scrubber recirculation pump is running before pressing the inject button. Visually check to see that there is enough chemical in the bottle.
3. Press the inject button to activate the eductor. Depending upon the city water pressure, and the viscosity of the chemical being injected, the injection rate will be approximately 1-2 ounces per second. The required dose will depend on many variables (process, time between cleans, cleaning chemical and concentration, etc.) and is up to the user to determine.

Maintenance:

1. Visually check for leaks at each bottle change.
2. Thoroughly rinse any leaks or spills.
3. Check all flexible tubing weekly for wear, cracks, or leaks, and replace if necessary.
4. Before disassembling for component servicing, install a bottle of water and suck it through the system into the scrubber. DO NOT assume that this will remove all hazardous chemicals from inside the plumbing. The unit should only be taken apart in fume hood. Assume that any liquid in the components is hazardous.

Safety:

1. It is essential that the user fully understands the chemistry involved. The dissolved gasses in the scrubber my react violently with some chemical additives, so great care must be taken to avoid unwanted chemical reactions. Airgard cannot possibly know or control all of the chemical mixture possibilities in a given installation, and therefore cannot be responsible for the safe operation of this system.
2. Some chemical reactions will cause foaming. New chemistries should be approached with caution—try low concentrations and low doses to start. Foam could be pushed out of the scrubber exhaust and into facility ductwork, causing damage and hazards. Dosing during processing (gasses flowing from the tool) will be much more likely to cause a vigorous reaction and should be avoided.
3. Dosing with corrosive chemicals may cause corrosive fumes to be emitted into the facility ductwork, causing corrosion, damage, and safety hazards.
4. Any chemicals to be added must be compatible with the materials of construction of the scrubber. Airgard can supply you with a list of materials.
5. All chemicals must be handled and stored safely, and any technicians handling chemicals must be fully qualified and use appropriate protective gear.
6. Do not operate without the splash shield in place.
7. Do not use 100% concentrations that will yield large amounts of heat when mixed with water, such as glacial Sulfuric Acid.
8. Do not switch between incompatible chemicals without thoroughly rinsing the system with water first.

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U.S. Patent No. 4,986,838

AIRGARD CYCLONE SPARE PARTS LIST

STANDARD SPARE PARTS KIT-INCLUDED WITH EACH SYSTEM

ITEM	Part No.	QTY
Gas Inlet Port	300008****	1ea.
5/16”-18X1”, Nylon bolt	800001	4ea.
5/16” Nylon washer	800000	4ea.
Nitrogen Heater, 500W	400041*	1ea.
O-ring, Gas Inlet Port	700007****	6ea.
O-ring, Jet Access Port	700008	1ea.
O-ring, 2” Union, NW50 (HI Plunger Top)	700012	2ea.
O-ring, 1 1/2” Union, NW40 (HI Inlets)	700004	2ea.
O-ring, ½” Union	700000	2ea.
O-ring, Teflon Inlet Insert Upper	700009*	2ea.
O-ring, Teflon Inlet Insert Lower	700021*	2ea.
O-ring, Poly/CVD Inlet Flange (4” ASA)	700018**	2ea.
O-ring, Plunger Air Cylinder Face	700023	2ea.
O-ring, Plunger Base (3” Union)	700010****	2ea.
O-ring, Plunger Top	700009****	2ea.
Pump seal-Viton for MDM Pump	500003***	1ea.
Fuse, 30A (Incoming power disconnect)	400123	3ea.
Fuse, 15A (24VDC distribution)	400129	2ea.
LED, Siemens, White	400126	1ea.
LED, Siemens, Green	400125	1ea.
LED, Siemens, Yellow	400124	1ea.
LED, Siemens, Red	400127	1ea.
LED, Siemens, Blue	400128	1ea.

Additional Recommended Spare Parts:

Pump, 2 speed, 2HP, 1Φ, 208V MDM	500012
Pump, Mag Drive, 1HP, 1Φ, 208V	500010
Water Level Switch	400026
Pump Flow Switch, Paddle Style	400069
City Water Flowmeter/Switch	400003
Solenoid, 4-way, 24VDC	600001

* Heated Inlet Scrubber Only
**Poly/CVD Scrubber Only
***Epi Scrubber Only
****Epi and Poly/CVD Only

Ph. (408)-573-0701
U.S. Patent No. 4,986,838