INSTALLATION, OPERATION AND MAINTENANCE MANUAL

VERTICAL BIOLOGICAL SCRUBBER

Serial Number:_____

Date Manufactured:_____

Drawing Number:_____

Tag_____

Reference_____

Project_____

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INTRODUCTION

This Scrubber Installation, Operation and Maintenance manual has been written for you, the Installer, Operator and Maintenance Personnel. Although we have attempted to include each component on your scrubber, each scrubber system is unique and built on a custom basis. Furthermore, there are hundreds of different chemicals that can be scrubbed and your chemical scrubbing process is unique. Therefore, it is impossible to cover all components, operating conditions and chemical processes. In addition to this manual, separate manuals are available for accessory items such as pH controllers, flowmeters, heater controllers, etc. Do not hesitate to contact HEE Environmental Engineering or your Sales Representative for additional manuals or for any further assistance.

1.1 General Information

1. All parts of the scrubber equipment have been thoroughly inspected and pre-tested at the factory. Upon receipt of shipment, a complete inspection of the equipment is recommended to determine if any damage was sustained during shipment or parts have vibrated loose. If any damage is found, a claim should be immediately filed against the freight carrier.

2. It is advisable to have equipment installed by personnel familiar with the installation of air handling equipment. In most cases, your sales person can recommend a qualified contractor.

3. Check the nameplates and tags on equipment for special instructions.

4. The scrubber should be mounted on a solid surface which completely supports the bottom of the scrubber. When the scrubber is to be mounted on a platform, the platform should be thoroughly braced. If the scrubber is roof mounted, consult a structural engineer to prevent overloading the roof structure. Refer to the scrubber drawing for the operating weight. Finally we recommend the scrubber be mounted on a six-(6) inch housekeeping pad. This will simplify the drain connection and assist in drainage. A six-inch high structural steel scrubber base can be provided by HEE Environmental Engineering as part of the scrubber system.

5. Air temperatures at the inlet to the scrubber should never exceed 160ºF unless the material on construction has been designed at a higher temperature. The water temperature of the recirculating liquid should not exceed 120ºF for Schedule 80 PVC construction (180ºF for CPVC and 200ºF for polypropylene). Consult the factory if unsure of operating conditions.

6. Equipment is constructed of fiberglass reinforced plastic (FRP) and thermoplastic materials. Care must be taken during handling and installation to prevent damage, which may be caused by external stress or shock.

7. Certain accessory items such as pressure gauges, solenoid valves, controls and instrumentation may have been shipped loose to prevent damage in transit. Install these items to the scrubber system as required.

8. Refer to Appendix B for a check list for start-up procedures.

INSTALLATION

2.01 Unloading and Rigging

Utilize nylon straps when lifting the scrubber from the truck bed to the final position. If lifting lugs are incorporated, use them. If there are no lifting lugs, place nylon straps around the scrubber flanges for lifting. These flanges are strong and will support the dry weight of the scrubber.

2.02 Packing Installation Procedure

1. Remove the top mist eliminator section of the scrubber tower. Remove the mist eliminator modules from the upper portion of the tower as well. Next remove any support components of the mist eliminator assembly. Remove any plumbing which will interfere with the installation of the packing at the provided unions.

2. Lower the sacks of packing into the scrubber through the top of the scrubber. Once the packing has been lowered, the bottom of the sack should be opened. Next the sack should be slowly lifted to allow the media to release from the sack. This process should be repeated until the vessel has been filled to the specified height.

3. Workmen can walk on the media during the installation process to facilitate the leveling process. Workers should not be in the tower while the sacks are being lowered or released. Once all media is in the tower, the media should be leveled.

4. Be careful not to leave any foreign materials in the packed bed section. Make sure all plywood, boxes and bags are removed.

5. Reverse the procedure in step 1 to re-install associated components.

2.03 Packing inspection

Inspect the packing material to determine if damage, shifting or settling has occurred during shipment. Inspection can be made by looking in the access door or through the polypropylene access ports. The packing should be even across the top surface to prevent dry spots in the packing and prevent any air from passing over the top of the packing. Adjust as required. Should you require additional packing due to excessive settling, please contact HEE Environmental Engineering.

2.04 Mist Eliminator Section

Inspect the mist eliminator section. The scrubbers usually have mist eliminators in block form, which can be inspected by looking into the top of the scrubber.

2.05 Inlet Connection

Connect incoming duct to the inlet transition using a flexible connector. The inlet is generally connected to a HEE Environmental Engineering centrifugal fan to provide motive for air movement.

HINT: Be sure to slope the transition into scrubber to allow proper drainage of any liquid from the inlet duct and to prevent the scrubber recirculating liquid from running into the inlet duct.

2.06 Outlet Connections

Usually the bio-tower will discharge directly to the atmosphere; as such outlet connections are not required.

2.07 Hold Down Lugs

Seismic holds down lugs are provided on the scrubber bottom. Use suitable hardware to secure these lugs.

CAUTION: HEE Environmental Engineering does not recommend cast-in-place concrete anchors. Set the scrubber in place, mark the location of each hole, and either core drill the cement or use expansion hardware.

2.08 Water Supply Connections

Install a one (1) inch secondary effluent supply pipe per project drawings. A gate valve, solenoid and flowmeter should be utilized as shown for the water make-up control. If these parts are not included, HEE Environmental Engineering can provide these parts for your scrubber system. – Systems which require a nutrient system will have a slightly different configuration.

2.09 Water Make-up Piping System

The electric solenoid can be connected to the pump starter auxiliary contact. This will shut off the water make-up system when the pumps are not operating. The gate valve is used to regulate the amount of flow and the inline flow meter provides a visible means of adjusting the flow to the desired amount. – Systems which require a nutrient system will have a slightly different configuration.

2.10 Nutrient Feed System

In situations where secondary effluent is not available to provide essential nutrients to the bacteria within the tower a nutrient feed system will be required. The nutrient solution is injected to the tower through a two stage dilution system. The concentrated nutrient is diluted and held in a day tank. The diluted nutrient solution is added to the scrubber as the pH of the tower solution drops. Once the pH falls below a pH of 2 the nutrient system will add solution until the pH reaches 3. The filling of the diluted nutrient is done automatically once the liquid in the storage tank drops to the low level point.

The pH controller is mounted in a convenient location and a submersible pH probe is located in the sump. Refer to the manuals provided with the pH controller system for installation and wiring instructions. When wired properly, the pH controller signals the nutrient system to transfer solution from the storage tank into the tower.

Project drawings will usually include detailed information of the nutrient system components.

2.11 Overflow and Drain Fitting

Install drainage piping to the overflow and drain fitting as shown per project drawings. IMPORTANT: Since the scrubber pump box is operating under positive pressure, be sure to include a vent on the drain line as shown.

The over flow has a built in trap system to ensure that foul air is not expelled through the overflow piping.

2.12 Valve Position

Check all valves to ensure proper position. All spray header valves should be in the open position with the handles in line with the flow. The drain valve should be closed, with the handle in a line across the fluid flow.

2.13 Sump Heater System

If a sump heater system has been included, it will consist of a heater controller, RTD temperature sensor mounted in the sump, a screw plug heating element located in the sump, a heat sensitive fuse link located in the heating element and a low sump level switch mounted on the tower exterior. The low sump level switch and heat sensitive fuse link MUST be properly wired to the heater controller to prevent heater burnout in the event of a low sump level condition or detection of an excessive temperature in the heating elements.

2.14 Electrical Connections

Make the necessary electrical connections as required using qualified personnel. All electrical work should be done according to the National Electrical Code. Also, check with the city for the proper codes.

2.15 Pressure Gauge Assembly

If an optional pressure gauge assembly has been included in the scrubber system, it will consist of an isolation valve, gauge guard filled with glycerin and a liquid filled pressure gauge. The assembly has been shipped loose for field installation. Prior to installation, check the level of glycerin in the gauge guard. Remove the pressure gauge and bleed screw and fill with glycerin to remove all air. This can be achieved by pouring the oil into the upper gauge cavity and tilting the gauge guard in several positions to be sure that no air is trapped within. After filling completely, turn the gauge guard over quickly and screw in the pressure gauge. Any excess oil will come out of the bleed screw. Install the bleed screw and assemble the pressure gauge assembly to the recirculating line. If a pressure gauge was not included in your system, Harrington Industrial Plastics can offer one to suit your needs.

2.16 Removal of Debris

The scrubber should be thoroughly cleaned after installation is complete to remove any construction debris and foreign objects. Spray water on the packed bed, mist eliminator section, scrubber body, and

transition with a hose spray nozzle and wash the material out of the scrubber. This process should be repeated a number of time until water flows through the media without appearing “muddy”.

2.17 Pump Rotation

In most applications, horizontal sump pumps are used for the recirculating system. Prior to adding water to the scrubber sump, check the pump rotation. The motor should operate in a clockwise direction when viewed from the end. The label on the motor also indicates the proper rotation.

2.18 Pump Motor Rotation-Three Phase

If the pump motor is rotating in a clockwise rotation when looking at motor fan, rotation is correct. If rotation is not correct, interchange any two main power leads to obtain the correct rotation.

2.19 Water addition to the Scrubber Sump

After the above has been completed, water can be added to the scrubber sump by selecting “Hand” on the make up water selector switch located on the control Panel.

2.20 Check for Leaks and Loose Fittings

Start the scrubber pump(s) and check for loose ball valves, check valves and union. Use a strap wrench to tighten any fittings that may have vibrated loose during shipment. Also check all piping, flange connections and access doors for leaks.

OPERATION

3.01 Principles of Operation

The biotrickling scrubber utilizes naturally occurring bacteria to oxidize reduced sulfides to sulfuric acid. The aerobic reaction occurs within a bio-film, which propagates on the surface of the media within the tower. Under normal operating conditions the population of bacteria is sustained by cycling secondary effluent through the tower. This enables the bacteria to survive through irregular loading of sulfide to the scrubber.

Due to the sulfuric acid generated by the reaction the tower liquor is driven to a low pH. To counter the negative affects of extremely low pH on the performance of the bacteria, the liquor pH is controlled via dilution with secondary effluent. As such once the pH drops to 2pH, the sump is diluted until the pH reaches 3 pH.

The biotrickling scrubber was designed using the following aerobic biological reaction:

$$H_2S + 2O_2 \xrightarrow{\text{Sulfur Oxidizing Bacteria}} H_2SO_4$$

3.02 Mist Eliminator

The most common type of vertical mist eliminator utilized is a polypropylene blade type mist eliminator in the shape of a chevron. The mist eliminator is capable of removing droplets down to 45 microns at a velocity of 650 FPM.

3.03 Water Make Up

Fresh water must be intermittently added to the scrubber recirculation system to: 1) Maintain the quality of the recirculating liquid, 2) Provide a source of water for humidifying the incoming air, and 3) Minimize concentration of sulfuric acid inside the scrubber.

Normally, the addition of fresh water is controlled by using a solenoid valve, gate valve and an inline flow meter. The solenoid can be connected to the pump starter auxiliary contact. The gate valve is used to regulate the amount of flow and the inline flow meter provides a visible means of adjusting the flow to the desired amount.

As fresh water is added to the scrubber recirculation system, excess contaminated water will flow out through the overflow fitting located on the pump box. The rate at which this water flows out is commonly called the blow down rate.

A nutrient system will be required if secondary effluent is not available for the scrubber.

3.04 Make up Water Rate

The amount of make up water required will depend upon 1) the amount of air contaminant being processed through the scrubber and 2) the humidity of the incoming air.

If the inlet loading of the air contaminant is known, the make up water rate can be calculated. Usually, enough fresh water should be added to the scrubber sump to maintain the pH of the sump between.

A small amount of water make up is also used to fully humidify the incoming air. Since the air is being washed by water, the relative humidity of the air will increase to about 100 percent (about 2 percent by weight). The amount of water used will depend upon the relative humidity of the incoming air.

Since most water supplies contain various minerals, and only pure water will evaporate from the scrubber recirculating liquid, the concentration of these minerals in the scrubber recirculating system will increase over time. To avoid this gradual buildup, the scrubber system is completely shut down, thoroughly cleaned and fresh water is added. This procedure should be performed at least once per year.

3.05 Pumps

In most applications, horizontal sump pumps are used for recirculating scrubbing liquid.

Always make sure there is enough liquid in the reservoir and the level is high enough considering the capacity of the pump unit. Inadequate liquid will cause a vortex in the pump box. A vortex occurs when air mixes from the surface into the fluid, which can disturb the flow and also prevent the pump from priming.

After operating the pumps, check the running amps versus the full load amps. If they exceed the full load amps, gradually close the spray line valves until the running amps are within the full load amps.

An Operation and Maintenance manual specific for the pump provided will be appended to this manual. Please reference that manual for more specific information.

3.06 Liquid Level

During start up or priming of the pump, the pump impeller housing must be covered with water. Once the pump is primed, the sump water level will drop since the water is being pumped into the plumbing lines and packing area. The float valve will make up for the drop in water level. Each time the pump is turned off, the extra water added will flow out of the overflow fitting.

3.07 Float Valve

Some systems are provided with a float valve. The float valve acts as a control for a low water level condition. The float valve is used only to fill the scrubber sump initially, add water for evaporation control and act as a back-up in case the make up water supply has been turned off. It should not be used in place of make-up control.

3.08 pH Control

The scrubber uses pH to control the makeup water flow. When the pH of the liquor drops to 2 the makeup water solenoid will energize and add water. Once the pH rises to 3 the make up water will cease.

3.09 Neutralization System

The neutralization system is used is secondary effluent is not available at the facility. The primary effluent provides the essential nutrients that the bacteria need to survive. In situations where secondary effluent in not available the nutrient system is required to provide the nutrients that the bacteria require.

The nutrient system consists of a two stage tank system. The fist tank contains a concentrated nutrient solution. The second tank acts as a dilution vessel intermediate to the scrubber. The dilution tank is controlled by a two point level system. When a low level condition is met a solenoid is energized to initial the transfer of concentrated nutrient and additional potable water to the dilution tank. The dilution is controlled by a device called a Dosatron which accurately controls the dilution and mixing process.

3.10 Flow Meter

If an optional flow meter has been included in the scrubber system, they are either a vertical inline flow meter with a float, or a paddle wheel design with an analog or digital display. The flow meter will indicate the total water recirculation rate. If a flow meter was not included in your system, Harrington Industrial Plastics can offer one to suit your needs.

3.11 Pressure Gauge

If a pressure gauge has been included in the scrubber system, it will consist of an isolation valve, gauge guard filled with glycerin and a liquid filled pressure gauge. The pressure reading is unique for each system and will measure the hydraulic pressure at the installation point, not the pump discharge pressure. If a pressure gauge was not included in your system, HEE Environmental Engineering can offer one to suit your needs.

3.12 Pressure Differential Gauge

If an optional scrubber pressure drop gauge has been included in your scrubber system, it will provide a reading of the total scrubber pressure drop in inches of water column. If a pressure drop indicator was not included in your system, HEE Environmental Engineering can offer one to suit your needs.

3.13 Sump Heater

A sump heater system is designed to prevent the sump liquid from freezing. If an optional sump heater system has been included in the scrubber system, it will consist of a heater controller, RTD temperature sensor located in the pump box, a screw plug heating element, a heat sensitive fuse link and a low sump level switch. The low sump level switch and heat sensitive fuse, when properly wired to the heater controller, will prevent heater burnout in the event of a low sump level condition or detection of an excessive temperature in the heating elements.

The heater controller will indicate the sump liquid temperature, and a temperature control point can be entered in the heater controller. Our initial suggested setting is 45 degrees Fahrenheit, and can be adjusted to suit your requirements.

CAUTION: The level of solution must be kept above the hot zone at all times. Allowing solution to fall below this level will cause excessive temperature which will pose a significant fire hazard.

MAINTENANCE

4.01 General Maintenance Instructions

Adequate access has been engineered into the unit to create a minimum of work when cleaning or servicing is required. Reference to the project drawings will help to identify the scrubber components.

Appendix A contains the recommended maintenance frequency for the various scrubber components and devices.

4.02 Mist Eliminator Access

Access to the mist eliminator is available by removing the top outlet transition of the unit. The transition is bolted to the main body and can be easily removed. The mist eliminator is in modular form, and can be lifted out by hand. We recommend periodic inspections during shut down periods. The maintenance should include:

1. Visual check of internal blade elements for solids build-up.

2. Clean all areas with high pressure hoses as required.

When re-installing the transition, use butyl caulking on the flanges for proper sealing.

4.03 Pumps - Removal and

For information on pump maintenance, request the installation, operation and maintenance manual for the specific pump.

HINT: If a change in flow reading is observed, it probably indicates the presence of debris or foreign material in the pump inlet housing. This condition can also cause pump cavitations as indicated by excessive pump noise. This condition must be corrected to prevent pump impeller damage. Finally, the debris may also have lodged in another part of the recirculating system.

4.04 Pump Motor Maintenance

Cleaning and Inspection: A clean motor runs cooler. The motor should be cleaned and inspected at regular intervals. Operating conditions involving continuous running, hot, dirty or dusty surrounding, etc., require frequent attention. Always check motor shaft bearings when any unusual noise or vibration develops in the motor.

4.05 Float Valve

The operation of the float valve should be checked weekly. A scale deposit could develop allowing the float valve to stick. Open up the access door to the float valve located in the still well, and push down on it to verify operation.

4.06 pH System

A pH system will require regular maintenance. A pH probe needs to be calibrated once per month. Also check for buildup on the pH glass membrane. Finally, a pH electrode degrades with time and usage. The first indication of a depleted electrode is a reading that constantly drifts or takes a long time to stabilize (>10 seconds) while in the pH solution. The same symptoms can indicate a problem in the meter. Refer to the pH manuals provided with your pH system for additional information

4.07 Flowmeter

Check the operation of the flow meter and clean as required. If the flow meter is a paddle wheel sensor with an analog or digital display, remove the flow sensor from the recirculating line and check the O-rings and replace them when necessary. The paddle wheel must always turn freely. Be sure the connections to the indicator and additional cable are still intact. Lubricate the barrel and O-rings with G.E. Silicone Compound #G660 every three months. Keep the paddlewheel and pin free of any lubricant. A Spare Rotor Kit consisting of a paddlewheel, O-rings, and a pin is available. It is suggested that you check your flowsensor periodically until some history of your specific application can be created.

The paddlewheel is designed to rotate on the shaft; the shaft should not rotate with respect to the housing. The paddlewheel must turn freely. If it does not, clean the paddlewheel assembly as follows:

1. Remove the flowsensor from the pipe and insert a plug into the pipe fitting. Clean any external debris from the paddlewheel.

2. For the MK 515, using a small flat-bladed screwdriver, gently pry one of the paddlewheel mounting ears away from the pin.

3. When one end of the pin if free, gently work the paddlewheel and pin out of the remaining mounting ear.

4. Thoroughly clean the pin, paddle, and pin holes with a wire brush and/or toothpick along with alcohol and/or soap and water.

5. To reinstall the paddlewheel and pin, reverse steps 1, 2, and 3.

6. After cleaning, the paddlewheel should spin freely without binding or sticking.

4.08 Pressure Gauge

The pressure reading should be checked weekly and recorded. An increase in pressure indicates a gradual plugging of the recirculating system. Usually, the spray nozzles should be inspected for debris and possible scale buildup.

4.09 Pressure Differential Gauge

Check the scrubber pressure drop on a monthly basis, and record the reading. An increase in pressure drop indicates a gradual fouling of the packing media and scrubber interior. When the pressure drop increases by 50%, it is time to perform maintenance. Refer to the packing maintenance section.

The differential gauge requires no lubrication or periodic servicing. The interior should be protected from dust, dirt, corrosive gases and fluids. Zero adjustments should be checked and reset occasionally to maintain accuracy. Use the zero adjusting screw located at the bottom of the front cover, while the high and low pressure taps are both open to atmosphere.

4.10 Sump Heater System

Once a month, verify the proper operation of the low sump level switch by pressing down on it and simulating a low sump level condition. The sump heater should not energize in the event of a low sump condition.

Tank sludge, if allowed to build up around the heaters, will reduce heater life substantially. Inspect for and remove all sediment and sludge BEFORE they contact the heater surfaces.

Inspect heater surfaces regularly and chemically remove any materials that build up on the surfaces. Scraping heater surfaces can shorten the life of the metal heaters.

4.11 Draining the Recirculating

Some systems may use include check valves on the pump discharge piping. If this valve is included in your system, the line must be drained prior to disassembly of the piping.

4.12 Pump Inlet Strainer

The pump inlet is protected by an inlet strainer. This is generally a passive device. If large debris, such as plastic, enters that scrubber it is possible that it will be

become trapped against the strainer by the suction generated by the pump. If this occurs the debris bust be removed via the sump access door.

4.13 Sump Access

The larger vertical units have an access door into the packing area, and into the scrubber sump. the sump access consists of a 24" diameter manway. It must not be opened during operation because of the positive pressure of the system. The door gives access to the sump for periodic cleaning.

4.14 Packing Access

Another access door is located in the packed section area, and is a bolted access door. The door should not be opened during unit operation. The door is for removal of the packing material, if it becomes necessary to clean the packing.

4.15 View Ports

Round clear viewing ports are located in areas to allow observance of the spray nozzles. Inspect the nozzles once a month for proper spray patterns.

4.16 Spray Nozzle Access

The spray nozzles are accessible through the top access door.

4.17 Spray Nozzles

If required, the spray nozzles can be removed for cleaning. A scale buildup can usually be removed by soaking the spray nozzles in a dilute solution of muriatic acid. A small stainless steel wire brush can also be used.

HINT: It is always a good idea to keep some spare nozzles in stock. This will allow you to thoroughly soak and clean the plugged up spray nozzles, and continue normal scrubber operation.

4.18 Ball Valve

To prevent the buildup of scale and maintain free operation of the valves, operate them at least once per week.

4.19 System Cleaning

The entire scrubber system should be completely cleaned at least once a year. During this process, the liquid should be drained and the entire scrubber interior be cleaned.

4.20 Recommended Spare Part List

The following is our recommended spare parts list for a standard scrubber:

<u>Standard Parts List</u>
Pump
Pump inlet strainer
Spray nozzles (one complete set)
True union ball valve (one of each diameter)

The following is our recommended spare parts list based on accessories that may be on the scrubber:

<u>Parts List based on Scrubber Accessories</u>

Flow meter (main recirculating line):
Inline direct reading flow meter
or
Signet flow sensor (paddle wheel)
Inline flow meter (water make-up)
Low level switch
pH probe (can be refrigerated up to 1 year)
Pressure differential gauge
Pressure gauge assembly

Refer to the scrubber drawing for additional accessories or features no included above.

APPENDIX A

MAINTENANCE FREQUENCY*

	Weekly	Monthly	Semi Annual	Annual
Record flow meter reading				
Inspect and Y Strainer				
Verify Operation of Float Valve				
Operate Ball Valves				
Calibrate pH Probe				
Inspect Spray Nozzle Pattern				
Record Pressure Drop Reading				
Inspect Sump Heater Operation				
Verify low sump level switch operation				
Check Water Make-up Rate				
System Cleaning				
Inspect Flowmeter paddlewheel assembly				
Check Pump Motor Amps				
Clean and Inspect Pump Motor				
Inspect Packing Face for Build Up				
Inspect Packing for Build Up				
Inspect Mist Eliminator for Build Up				

* Suggested frequency until some history of your specific application can be created.

Appendix B

CHECK LIST FOR START-UP PROCEDURES

- ☐ Check for packing settling or shifting
- ☐ Missing Items
- ☐ Piping cracks/breakage or leaking
- ☐ Caulking on Flanges
- ☐ Clean Scrubber Sump and Pump Box
- ☐ Water Supply to Float Valve
- ☐ Water Supply to Water Make-up
- ☐ Drain and Overflow Connection
- ☐ Drain Installed with a Vent
- ☐ Check Pump Motor Rotation
- ☐ Electrical Connections
- ☐ Check Spray Nozzle Pattern
- ☐ Adjust Water Make-up Rate
- ☐ Check Pump Motor Amps

pH System

- ☐ Calibrate at pH of 7 and 4
- ☐ Enter Alarm and Operating Points

Sump Heater System

- ☐ Test Low Sump Level Switch
- ☐ Enter Temperature Operating Point

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