OPERATING PROCEDURES
FOR
PRD TECH's BIOFILTER
WITHOUT LIQUID RECYCLE

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Innovative Technologies for a Cleaner Environment

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PROBLEM & SOLUTIONS

- Emission of odors and volatile organics from wastewater treatment plants and sludge handling facilities poses a major nuisance to communities and a health hazard to plant personnel
- Possible treatment approaches includes:

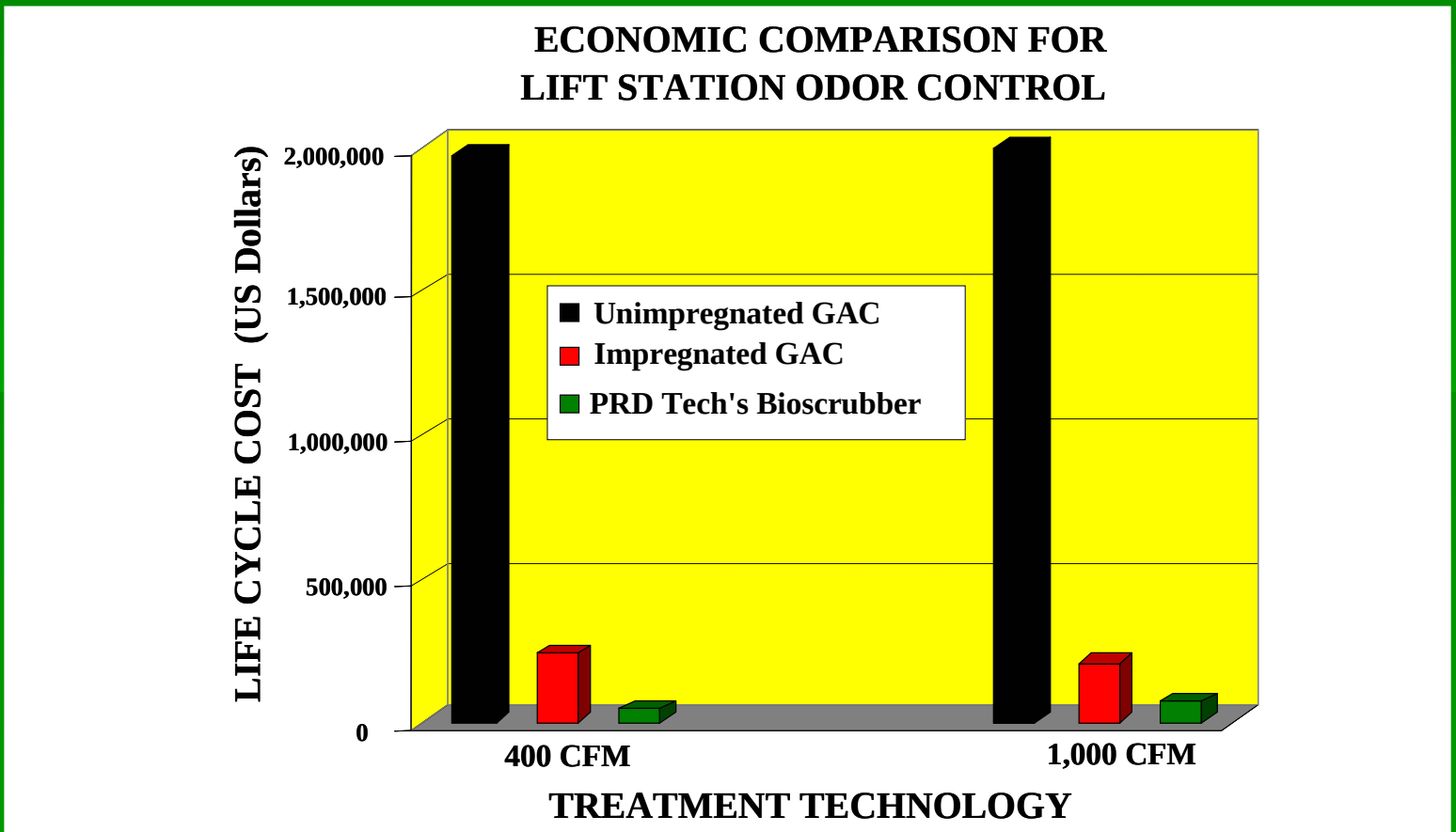
1. Chemical oxidation
2. Activated carbon adsorption
3. Catalytic oxidation
4. Biofiltration

CHEMICAL OXIDATION

- Uses an oxidizing agent, such as ozone, Hypochlorite, permanganate, peroxide, etc.
- Chemicals are expensive and pose hazards to plant personnel during storage and handling
- In the case of hypochlorite, oxidation of BOD in wastewater produces halocarbons – carcinogen chemicals, which are volatile
- Capable of only treating water soluble compounds

ACTIVATED CARBON ADSORPTION

- Carbon needs to be regenerated
- Even with reactive carbons, life cycle cost is high



CATALYTIC OXIDATION

- Generates by-products, such as nitrogen oxides
- Very energy intensive – high operating cost
- Periodic catalyst replacement – investment cost
- Hydrogen sulfide produces sulfur dioxide
- High destruction efficiency at high temperature
- Not suitable for high moisture streams, typical for wastewater treatment plants

TYPES OF BIOFILTERS

Natural Media (soil, peat, compost)

- Lower biodegradation rates
- Eventual replacement required
- Significant pressure drop
- Pre-humidification necessary
- Very large footprint
- Can only handle low inlet concentrations (< 10 ppmv)
- Compost settling – major issue
- Low gas velocity (5- 20 ft/minute)

Synthetic Media (foam, pellets, fibers…)

- Higher degradation rates
- No replacement needed
- Low pressure drop
- No pre-humidification
- Small footprint
- Can handle high inlet conc.
- No settling
- High gas velocity (50 – 200 ft/minute)

ARE ALL SYNTHETIC MEDIA ALIKE ?

PRD Tech's Synthetic Media is special:

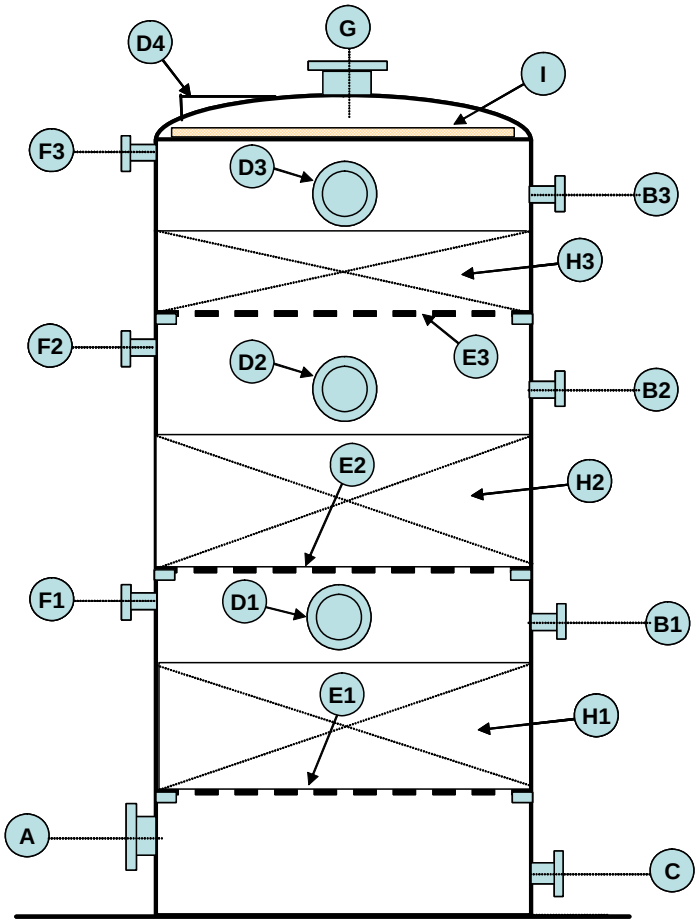
1. **High surface area (> 100 ft^2/ft^3)**
2. **High void fraction (>90%)**
3. **Low bulk density (minimizes weight)**
4. **Engineered surface to maximize biofilm attachment and growth**

COMPONENTS OF BIOFILTER

1. FRP Vessel
2. PRD Tech's Biomedia
3. Liquid spray nozzles
4. Mist eliminator
5. Biocatalyst solution
6. Sludge Mixer; and
7. Automation and Controls

FRP VESSEL

1. No liquid recycle; and
2. With liquid recycle



LEGEND

A	GAS INLET
B1 B2 B3	BIOMASS + WATER MIXTURE INLET
C	LIQUID OVERFLOW
D1 D2 D3 D4	MANWAYS
E1 E2 E3	FRP GRATING FOR SUPPORTING BIOMEDIA
F1 F2 F3	WATER WASH NOZZLES
G	TREATED GAS OUTLET
H1 H2 H3	BIOMEDIA BEDS
I	MIST ELIMINATOR

PRD TECH' BIOMEDIA

1. Provide high surface area biofilms to the gas stream, containing the contaminants;
2. Allow biomass attachment to the biomedia surface;
3. Allow gas and liquid to be distributed evenly within the biofilter bed; and
4. Allow excess biomass growth to slough-off and exit the bed, without plugging the biomedia.

PRD TECH'S SYNTHETIC BIOMEDIA
General Considerations

1. Designed specifically for biofilters
2. Surface modified to allow accelerated attachment and growth of biofilms
3. Low bulk density; easily supported (2.5 – 7.0 lb/ft^3)
4. High biologically-active surface area (30 – 110 ft^2/ft^3)
5. Designed for good distribution of high gas flows and low liquid flow rates
6. Randomly packed or Structured, depending on application

PRD TECH'S SYNTHETIC BIOMEDIA

1. **Randomly Packed Media (1", 2", 3", 3.5" in size)**

   - For very large biotrickling filters
   - Surface modified to allow biofilm attachment and growth
   - Size depends on gas BOD; High BOD – large size Low BOD – small size; Different sizes are used within the same biofilter
   - Low gas pressure drop and low bulk density

2. **Fibrous Media**

   - Used in final stages for polishing of low BOD gas
   - Acts as a mist eliminator also
   - Surface tailored for each application

PRD TECH'S SYNTHETIC BIOMEDIA

3. **Structured Media**

- Used for very high gas BOD applications
- Acts like a support structure also for other media types
- low bulk density; has to be cut to size
- low gas pressure drop
- Surface modified for each application to enable good attachment and growth of biofilm

Anyone or all three types of biomedia may be used in a single PRD Tech's Biotrickling filter system, depending on gas BOD, flow rate, types of contaminants and operating conditions.

LIQUID SPRAY NOZZLES

Biomass + Water

- Seed the biomedia
- Overcome biomass decay
- Maintain pH
- Supply water to biofilms
- Supply biocatalyst to biofilms

Water Wash

- Wash the media to remove excess biomass, cell debris
- Maintain pressure drop

Non-clogging design, when used with Sludge mixer and strainer

MIST ELIMINATOR

1. Remove entrained water in gas stream
2. Handle biomass growth
3. Structured Media design (low ΔP)

BIOCATALYST SOLUTION

General Biocatalyst

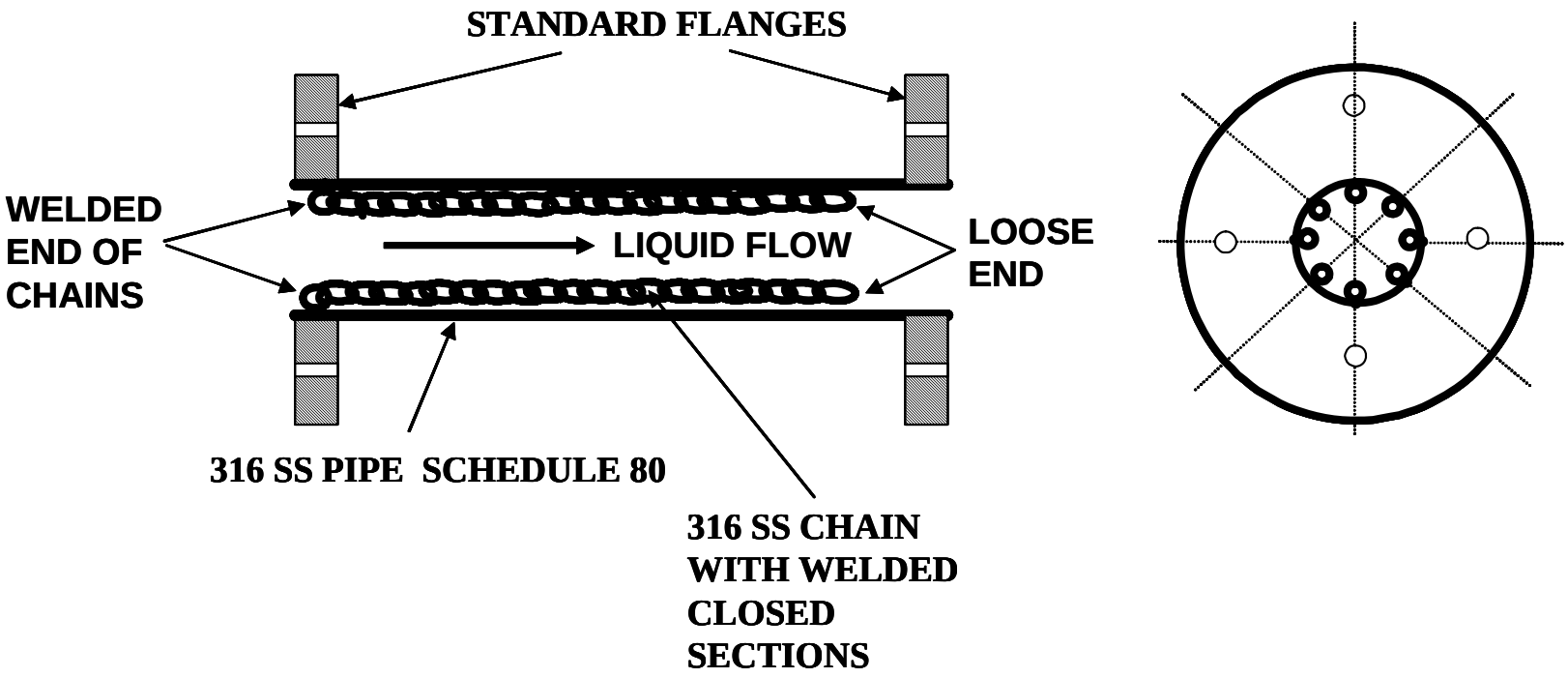
- Enzymes, mineral nutrients, Biosurfactants and fatty acids to accelerate biodegradation rates
- Manufactured by PRD Tech
- PRD-BIOSPEEDUP
- Variety of applications – Wastewater treatment plant, Aeration basin, Biofilters, Bioremediation in soils, etc.

Contaminant-Specific

- Designed for specific contaminants
- Will assist specific bacteria

SLUDGE MIXER

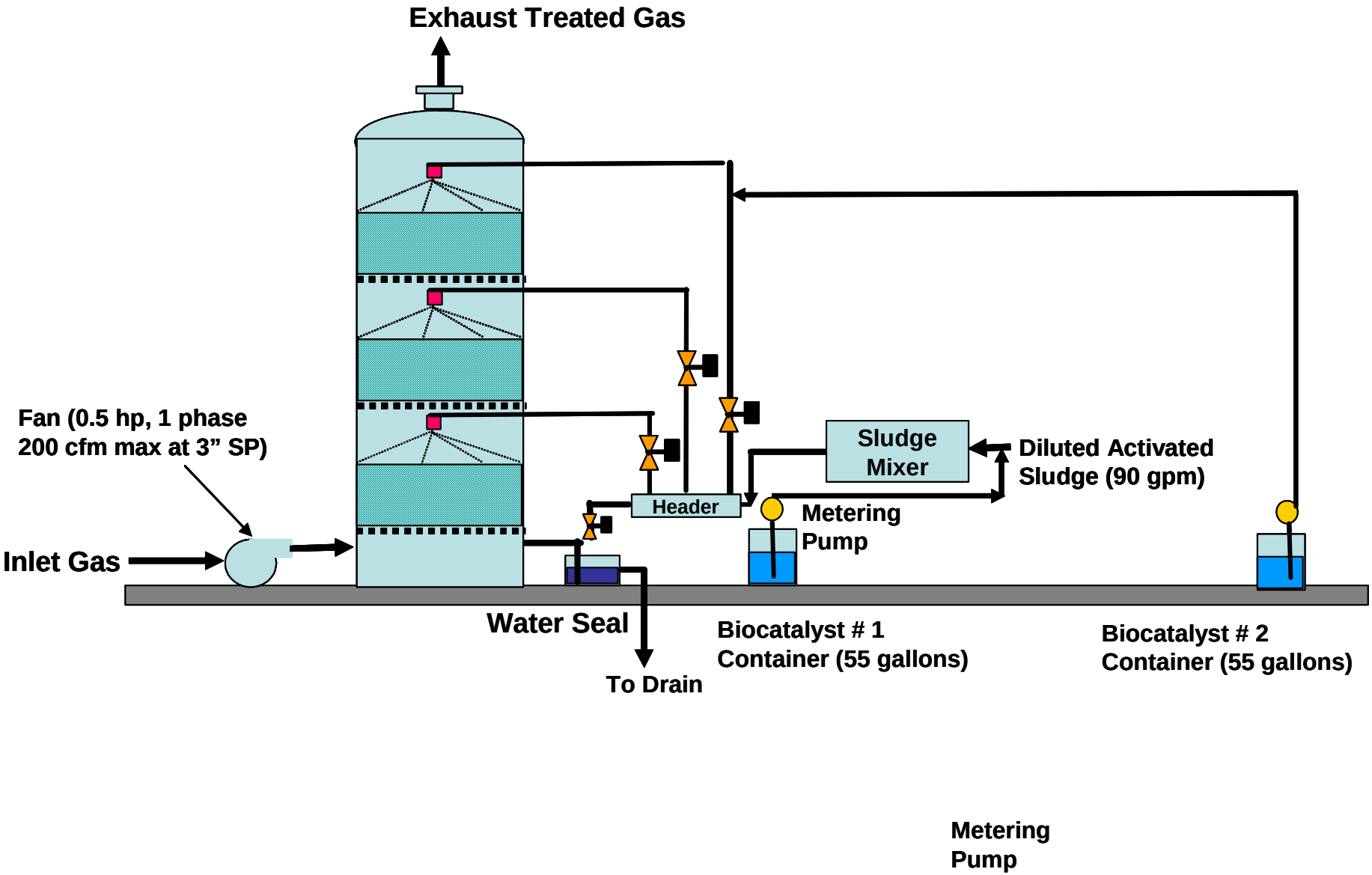
To breakdown sludge particles and mix Sludge (biomass) with water



AUTOMATION AND CONTROLS

1. Maintain “optimum” operating conditions
2. Data collection;
3. Alarms; and
4. Diagnostics, inform operator, etc.

PRD Tech can supply fully automated computer-controlled biofilters, as well as PLC controlled systems


Exhaust Treated Gas
Fan (0.5 hp, 1 phase
200 cfm max at 3" SP)
Inlet Gas
Sludge
Mixer
Diluted Activated
Sludge (90 gpm)
Header
Metering
Pump
Water Seal
To Drain
Biocatalyst # 1
Container (55 gallons)
Biocatalyst # 2
Container (55 gallons)
Metering
Pump

STARTUP PROCEDURE

1. Check all connecting lines (gas, water, drain)
2. Allow only water (no sludge) to flow into system for 2 hours
3. Check nozzles to ensure full coverage of each bed by spray
4. If spray is not uniform, check liquid pressure, spray head position
5. Stop water flow to lower beds (close valves) and allow water to flow down onto the lower two beds from the top bed
6. Check whether the water is flowing down evenly; uneven flow indicates that the biofilter is not “plumb”
7. Open sludge valve slowly to maintain inlet biomass conc. Into sludge mixer in the range of 600 – 1,000 mg/L (determined by dry weight procedure)

STARTUP PROCEDURE

continued

8. Switch on metering pump for biocatalyst solutions
   Initial flowrate of biocatalyst solutions: 0.06 GPH (0.23 Liters/hr; 3.79 mL/minute) for 2 weeks; then reduce to ½ flowrate for the next 2 weeks; eventual flowrate: 0.006 GPH (0.02 Liters/hr or 0.4 mL/minute)

9. Check whether solution is being injected and calibrate using graduated cylinder (60 mL in 15 minutes at maximum rate of injection)

10. Introduce gas flow after biomass+water has been flowing for 2 hours; start with ½ maximum gas flow and gradually increase to maximum flow rate

11. Air flow cannot be shutoff after biomass addition has begun (anaerobic condition, methane production)

STARTUP PROCEDURE

continued

12. Check for vessel vibrations by touching the vessel sides; All inlet and outlet pipes should be supported independently; check installation bolts)

13. Check pressure drop across each bed (should be less than 1”)

14. Check overflow of biofilter (no gas bubbling through vent)

STEADY-STATE OPERATION

1. Check drain line (no gas bubbling, liquid seal operating)
2. Check gas pressure drop across each bed
3. Check nozzle sprays for each bed
4. Check level of biocatalyst solution in each drum
5. Check inlet concentration of biomass into nozzles (less than 1,000 mg/L)
6. Periodically open flush valve on header to clean the header of accumulated biomass
7. Check inlet gas temperature (should not exceed 110 F)

SHUTDOWN PROCEDURE

1. Do not shutoff air supply unless complete shutdown is desired
2. If gas supply is shut due to blower failure, open all manways and operate with only water sprays (no biomass addition)
3. Shutdown air supply first, then close sludge flow valve; Turn off biocatalyst metering pumps. Increase water flow rate of water to wash down the biomedia for at least 2 hours.
4. Open all manways
5. Pump out liquid below drain line using external pump
6. Wash the sump to remove biomass
7. Remove mist eliminator before moving system