SUB-SURFACE STATIC TUBE AERATION SYSTEMS

Aeration Systems For...

- The small wastewater plant
- Extended aeration lagoons
- Equalization & stormwater ponds
- Aerobic digesters
- Deep tanks
- Mixing

Aeration Systems = Aeration Solutions
Small wastewater treatment plants should be designed to minimize power consumption and operate unattended for long periods of time. Over 25 years of experience by Ventuse* brings the many advancements in equipment design learned in all sizes of installations, into an overall concept of design for the small wastewater treatment plant that:

- Provides the lowest installed-cost.
- Minimizes power and labor costs.
- Offers truly effective, long-term maintenance-free treatment.

The Static Tube

Static tube aerators (Fig. 1), developed in the 1970’s, provide the ideal combination of outstanding mixing, and good oxygen transfer of any device available today.

Fig. 1 – The Static tube aerator is the ideal mechanism for oxygen transfer and mixing in small lagoons and municipal wastewater treatment plants.

The Ventuse aeration system for small wastewater plants uses the static tube aerator because of its long-term, trouble-free operation. They simply work, without any maintenance whatsoever. Additionally, the static tube provides:

- Excellent oxygen transfer
- Maximum mixing from the “bottom-up”
- Clog-free operation
- Uniform mixing throughout the basin

With thousands of static tubes in operation, some of which date to the early 1980’s, they continue to perform in an enviable manner, without attention, without fanfare. Their monotony of operation is the accolade to their longevity of performance.

The Complete System

Today, convenience is the byword. In response, Ventuse has combined the many small components and revolutionized the aeration industry. Simplified design, sizing, and one-source responsibility make Ventuse aeration systems the solution to your aeration needs.

The cornerstone to the system is the System Module Sentinel™, a low-cost plug-in, fully replaceable system monitor that:

- Receives blower/system signals and provides warning or alarm on malfunction
- Starts stand-by blower upon malfunction
- Cycles blowers for equal wear
- Optimizes air flow to lagoon based on operator set matrix or dissolved oxygen
- Alerts operator on pending maintenance items

The complete system design and supply provided by Ventuse includes:

- Static tube aerators
- All underwater piping and appurtenances
- Air flow control valves
- System Module Sentinel
- Tattletale instruments
- Motor starters

Additionally, Ventuse can provide a pre-fabricated blower building, leaving only the steel main air header piping, earthwork, and installation by the contractor.

* Formally Semblex® Company  Semblex is a registered trademark of Capital Controls Co., Inc.
The Applications

Although static Tube aerators are widely used in extended aeration, several other applications are ideal for this device that combines good oxygen transfer with the best mixing, per horsepower, available today.

Aerobic digestion – The static tube aerator is the ideal device for mixing/aerating thick aerobic digesting sludge via the non-clog features and even spreading of mixing and aeration throughout the digester contents.

Stormwater runoff/equalization ponds – The use of 15” tall tubes provides widespread mixing and aeration down to about an 18” water level.

Deep tanks – The affect of maximizing pumping from the bottom-up, circulates over 1600 gpm per aerator (at 20 acfm per tube). No other static device can claim this pumping/mixing rate.
Fig. 7 – One of the world’s largest municipal static tube installations in Tijuana, Mexico. 1600 static tube aerators in three lagoons. 15’ sidewater depth.

The Solution
Design flexibility in oxygen transfer and mixing are the magic of the static tube aerator. And, another key component, the System Module Sentinel is the heart of the system, controlling blower operation for efficiency optimization and unattended plant operation.

A complete aeration system from Ventuse provides the end user with one-source supply, warranty, and expertise. Our “systems approach” means the lowest first cost, as well as the lowest operating cost for the small wastewater plant. Write for our complete design manual, or visit us online at www.Ventuse.com for complete sizing information.

For more information, please contact:

www.Ventuse.com
DESIGN GUIDE

Static Tube Aeration Systems for the Small Wastewater Treatment Plant, Aerobic Digesters, and Equalization Ponds

By Guy Mace - November 2001
Introduction

Static tube aeration systems possess an enviable record of longevity in operation and consistent performance. They are experiencing a renaissance in use, simply because they have been proven to work, but more especially they provide small cities and towns with the most economical installed aeration system, with virtually no operator attention. The beauty of lagoon aeration is its simplicity. Only a lagoon is required. No grit separation, no primary or secondary clarifiers, no sludge withdraw and disposal. And, the properly designed lagoon easily produces effluent meeting discharge standards of BOD5 and suspended solids.

Aerobic digesters and equalization ponds likewise benefit from installation of static tube aerators. The air-lift pumping action, combined with aeration and clog-free design are the ideal elements desired for these mixing limited processes.

Automated control and monitoring of the wastewater plant has been greatly enhanced by the development and availability of reliable and economical programmable logic controllers (PLC), which occurred in the mid 1990’s. Properly utilized, they provide alarms upon equipment malfunction and automatic start of standby equipment, allowing extended operation without operator attention. This same PLC can be used to reduce power consumption (operating costs). The PLC keeps air blowers operating at the lowest volume, to affect proper treatment of the wastewater.

The static tube aeration system, today, consists of the aeration blowers, blower starters, all underwater piping, static tubes, and system controls, furnished by the aeration systems manufacturer. The reason for this trend is manifested in one source responsibility for all components, keeping it simple, for both equipment purchase, and warranty of the entire system. This is the most economical means of purchasing equipment for the static tube aeration system.

History of Development

Static in-line mixing devices for mixing of two or more fluids were developed in the 1960’s for industrial process applications. In the late 1960’s, this concept was combined with the classic air-lift pump, thus significantly improving oxygen transfer from air to water, and creating a new aeration device, the static tube aerator. This type of aerator was found to not only provide good oxygen transfer, but it was (and is) the most effective aerator in existence for circulation of wastewater, combined with aeration.

Positive displacement blowers, most often used with static tube aerators, likewise, have an interesting history. They have evolved from being supplied as a simple blower, motor, and V-belt drive, with all accessories shipped loose, to complete assemblies, where all accessories of filters, silencers, valves, and instruments are factory pre-packaged on one skid. Why? Because the cost to engineer and the cost of field installation is less, with the pre-engineered factory package.

The third historical development occurred in the mid-1990’s when small and economical PLC’s became widely available. At the same time, manufacturers were collecting empirical data on how to operate a small wastewater plant, largely unattended. Of equal importance, the efficiency of aeration systems was improving by matching blower output with air demands of the wastewater aeration process.

These three developments have contributed to today’s exceedingly effective and economical extended lagoon aeration system for the small wastewater treatment plant.

Design Guide

This technical paper provides a detailed guide for the design of static tube aeration systems, how to size and lay-out the aerated lagoon, aerobic digester or equalization tank, and how to specify/purchase the components for installation by a contractor. There are four major components in the system:

- The static tube aerators
- Air piping and valves
- Aeration blowers (and blower buildings/enclosures)
- Instrumentation and controls

Aerator Construction and Operation

Static tube aerators are the ideal devices where both mixing and aeration are equally important (i.e., in extended aeration lagoons, equalization/raintroff detention, deep tank aeration, and aerobic digesters). Their use since the late 1970’s has proven their long lasting durability, without plugging or failure; a feat no other aeration device can claim.

The upward action of air bubbles through the tube serves as an air-lift pump, circulating large volumes of liquid and creating large mixing zones of influence (Figure 1). This ability to pump water upwards from the bottom of a lagoon or aeration tank is unique to static tube aeration.

Another design advantage, aside from their extended life, is cost. Because of the air-lift pumping characteristics, static tube aerators may be located further apart than other aeration devices, and yet, provide a greater degree of mixing. Thus, fewer static tube aerators and less underwater piping are required, offering the lowest installed cost of any other aeration device available.

A. Overall Configuration

The vertical tube is constructed of polyethylene, generally 12 inches diameter and 30 inch high (Figure 2).

Those applications using static tubes to aerate equalization/storm water run-off lagoons can be designed with 18-inch tall tubes to allow the lagoon to be drained to about 24 inches, before the aeration system is shut down. Similarly, a deep draw tube is available for sloping or irregular basin or lagoon bottoms.

Various internal devices are used to break large air bubbles into smaller bubbles and thereby increase oxygen transfer. Generally, three internal devices are used in a 30-inch tube and two in an 18-inch tube. These non-clog, static (non-moving) internal devices are specifically designed to
break-up the air bubbles discharged from the manifold piping, thereby increasing oxygen transfer and, at the same time, permitting large solid particles to pass upwards through the aerator.

B. Hold-Down and Level Adjustment Devices

The static tube aerator must employ a positive means of anchoring the tube in an earthen lagoon, or bolting onto a concrete floor. Leveling the aeration piping is of critical importance because the aeration piping (which contains the air orifice) must be level, not the static tube aerator, per se. The more precise the leveling of the piping, the better the uniform aeration throughout the lagoons and the better the system works. The advent of laser transits has greatly simplified leveling of aeration systems and allowed leveling to very precise limits of ±1/16 inch.

Sizing and Layout

A. Extended Aeration Lagoons

Static tube aeration systems are designed for the waste treatment lagoon process based on three criteria:

- Oxygen transfer required to satisfy the BOD₅ demand
- Circulation of the wastewater to provide adequate mixing at the water surface
- Operating flexibility of the lagoon system

1. Oxygen Required for BOD₅ Removal

A static tube lagoon aeration system is sized by first calculating the actual oxygen required (AOR) to satisfy the organic (biological) oxygen demand. The oxygen demand imparted by ammonia nitrogen should also be a consideration in overall design.

For lagoon treatment, an AOR to BOD₅ ratio of anywhere from 1.0 to 2.0 lb O₂/lb BOD₅ removed is used. Generally, an AOR to BOD₅ ratio of 1.5 lb O₂/lb BOD₅ removed is sufficient for design purposes. When incorporating ammonia demand, use a factor of 4.6 lb O₂/lb NH₃.

The design factor used to convert the AOR to SOR (standard oxygen required) is based on process operating conditions, which includes the alpha and beta factors to convert from process conditions to standard clean water design conditions. This AOR to SOR or the standard oxygen rate conversion factor is normally in the range of 0.5 to 0.75. A factor of 0.65 is used, today, for these calculations.

Hence, the total pounds of BOD₅ per day is multiplied by 1.5, the AOR to BOD₅ ratio, and divided by the standard oxygen rate conversion factor of 0.65. This results in the total standard pounds of oxygen required per day, or the SOR. Table I details a sample calculation.

Once the total oxygen demand is calculated, manufacturer’s test data is consulted to establish the quantity of static tube aerators required. This data is expressed as the oxygen transfer rate Q₀ per tube versus the air flow and/or sidewater depth (Figure 3).

The design air flow per static tube, today, is generally based on a rate between 5 and 25 SCFM per static tube, with extended aeration lagoon design conditions between 8-16 SCFM per static tube. The oxygen transfer rate per tube is determined from the vendor’s test data curves (Figure 3). This value is divided into the total oxygen requirement (SOR) to obtain the quantity of static tubes for the lagoon aeration system under consideration (Table II).

2. Mixing

Mixing in an extended aeration system is not a design limiting factor, except as related to uniform spacing to prevent short circuiting. Empirical experience by the Ventuse Company over 20 years and hundreds of installations, suggests layout rules of thumb, as described in the next section.

3. Static Tube Layout

Extended lagoon aeration systems generally consist of two or three cells, or three differentiated areas in one large lagoon. Sixty to seventy percent of the static tubes are placed in the first cell with the remainder in the second cell. The trend is generally to a three-cell system with the third cell designed for quiescent settling of suspended solids. Although static tube aerators are not generally required in the third cell (especially with long detention times), good engineering design suggests that a few tubes, perhaps up to five percent of the total, should be placed in the third cell for operator flexibility of providing some air for the third cell. This is especially desirable during the warm summer months when the oxygen demand is the highest. For the colder months of the year, the third cell static tube aerators may be shut down; however, placement of some tubes in the final lagoon increases overall operation flexibility and prevents short-circuiting. Likewise, creating some surface turbulence in the third quiescent lagoon significantly reduces algae bloom.

Considering that much of the biological activity occurs within the first 12 to 24 hours, a concentration of tubes is placed near the inlet of wastewater into the lagoon system. In very large lagoon systems where the detention time extends over 20 to 40 days or more, static tubes are placed on wider centers, increasing to the discharge end of the pond/lagoon system. The distance between static tube aerators may vary anywhere from 15 to 25 feet in the front part of the lagoon, where detention times are in the two to five day range, to as much as 150 to 200 feet at the discharge end of the lagoon, where the lagoon detention time is measured in weeks. Overall lagoon layout is entirely based on empirical data and only experienced manufacturers should be consulted to obtain recommendations on positioning of static tube aerators and air laterals in the lagoon.

The objective in laying out a static tube aeration system is to provide the necessary oxygen to satisfy the biological and chemical oxygen demand of the wastewater.
while providing adequate mixing to ensure complete treatment and prevent short circuiting. Inherent in the design of extended aeration systems is the provision for areas between the static tubes for sludge settling, with accumulation of solids on the lagoon bottom. This settled sludge is decomposed via both aerobic and anaerobic activity, gradually reducing sludge volume to a minimum.

Accordingly, as the wastewater passes through the lagoon aeration system, the distance between the static tubes increases, allowing more area for settling of suspended solids. Empirical design of equipment manufacturers should consider the factors of (a) oxygen transfer, (b) mixing to prevent short circuiting, and (c) design flexibility, to be of equal importance in providing a good engineered lagoon aeration system. Several elements of design include:

a. The “complete mix” zone of influence and vigorous pumping characteristics keep a zone around the bottom of the aerator clean of settled sludge, even if the system is shut down for long periods of time. It is, therefore, not necessary to “elevate” the entire aeration system to account for sludge settling.

b. The upward movement of water in the center of an aerated lagoon causes a circular rotation of water that sweeps outward towards the lagoon edge and back down the sloping sides, thereby “cleaning” the sloped sides. A row of static tubes, located one-third up the sloped side, is therefore, not required (Figure 4).

c. Locate static tubes 7-10 ft. away from the “toe” of the bottom, as illustrated in Figure 4. We have noticed some silting over of aerator installations where the end tubes are five feet or less from this “toe.” This has occurred in sandy soils where the side slope is less than 3:1.

d. Figures 5-8 illustrate four typical extended lagoon and aeration basin layouts.

B. Aerobic Digesters and Equalization (EQ) Tanks

Mixing is the design limiting criteria for these applications. The design engineer must determine the degree of mixing required. Generally, aerobic digesters require complete mixing with no settling of sludge on the tank bottom. EQ tanks may be completely mixed or partially mixed. The completely mixed EQ tank is expensive to install and operate, so, generally, a compromise of some sludge settling is acceptable.

1. Aerobic Digesters – Ventuse sizing criteria is 20 to 30 scfm of air per 1,000 cubic feet of sludge volume. Aerators are placed on a six-foot square grid with about 20 scfm per static tube aerator. This provides a completely mixed environment.

2. Partially mixed EQ tanks use static tubes on about 12 foot grids, 15 scfm per tube. This results in a partially mixed environment with a cone of sludge build-up between the grid. Aerators 18 inches in height, with two diffuser membranes are used, allowing the EQ tank level to be lowered to about two feet while still being mixed and aerated.

System Air Pressure Drop

The total pressure drop of the system, including the air orifice, laterals, and air headers should generally be in the 1 to 2 psi range. This aeration system pressure drop, added to the static water head and the pressure drop across the blower accessories, determines the total design pressure of the blower system. Small aeration systems with properly sized air headers and laterals (Table III), up to about 500 ft. for the largest run of piping, may be designed for 1.5 psig total system pressure drop, plus the sidewater depth (in psig). Larger lagoon aeration systems require pressure drop calculations of the piping system, as this is a major consideration in blower design. Pressure drop across the air orifice below each static tube should be in the range of 0.25 to 0.75 psi (0.3 psig typical) to ensure uniform distribution of air throughout the entire system to each static tube aerator.

Aeration Piping & Support

The main air header from the blowers to the aeration lagoon is generally the only major item supplied by the installing contractor. The main air header should be steel or cast iron to withstand the high blower discharge temperatures, which may approach 225 degrees in summer months. Table III may be used to size this air header pipe.

A. Underwater Air Pipe Laterals

The underwater polyethylene piping supplied by the equipment manufacturer should be a high density PE3408, which is ultraviolet stabilized. Recognizing that the differential pressure the pipe “feels” is 1 psi or less, the thickness or SDR rating of 21 is perfectly adequate (SDR 11 for 2 inch pipe). An SDR 21 pipe is capable of a sustained 80 psi pressure, thus having considerable safety factor for underwater aeration piping. The polyethylene pipe is supplied in 20 or 40 ft. random lengths. The piping is quite flexible, which eliminates elbows or flexible connections where the piping changes direction from the floor up the side of the lagoon, assuming the slope is 3:1.
where aerators are located more than 10 ft. apart, intermediate supports are required (Figure 10). We recommend supporting two-inch diameter pipe every eight feet. Do not use PVC underwater aeration piping, because joints require gluing. These joints will vibrate loose over time because of the piping vibration caused by air discharging from the air orifices. PVC is also quite brittle and can develop stress fractures. Polyethylene joints are heat fuse welded with the joint as strong as the piping, per se.

C. Equalization Tanks

Some EQ tanks are designed to be completely emptied, exposing the static tubes and aeration piping. A drawback of polyethylene pipe is that it expands and contracts with temperature changes. Therefore, in the situation where an EQ tank will be empty for periods of time, it is desirable to use thin wall stainless steel tubing for the aeration pipe lateral, in lieu of polyethylene.

Aeration Blowers

The most economical blowers for small wastewater plants are of the rotary positive displacement (PD) type. Today, they are supplied with all accessories factory pre-piped and skid mounted. These accessories include:

- Blower
- Motor
- V-belt drive
- Inlet air filter/silencer
- Inlet flex connector
- Outlet flex connector
- Outlet silencer
- Pressure relief valve
- Discharge check valve
- Discharge isolation valve

Because a PD blower vibrates, primary instruments are mounted on a gauge/instrument stand and located adjacent to the blower skid. Figures 11 and 12 are the typical configuration of the blower package, with air discharge near the floor for ready access to valves and simplified pipe support.

Wastewater plant design requires a standby blower of equivalent size to the largest operational unit. Thus, sizing is based on:

- Two 100% capacity blowers
- Three 50% capacity blowers
- Four 33% capacity blowers
- Five 25% capacity blowers

The smaller the plant, the fewer number of blowers.

A. Blower Variable Air Output

Optimization of air flow to match the air requirement in an aeration lagoon, presupposes that air can be varied by the blowers. Positive displacement blowers are “positive displacement”. That is, the rotating speed of the blower must change, to change the output. This is affected in three ways:

1. Change the sheaves (and V-Belts)
2. Two-speed motors
3. Variable frequency drivers (VFD)

They are listed in increasing expense. Option (1) is manually difficult to do; Option (3) may be more expensive than the blowers, per se. Thus, Option (2) provides a reasonable compromise. The two-speed motor allows step control of capacity. If, for example, three 50% blowers are used, with two on-line, the two-speed motors give four steps of air flow available to the operator or to the automated system described below. Merely using two-speed motors will offer significant power savings opportunities to the end user.

B. Blower Building

For small plants, a pre-fabricated one, or two-door garage provides an economical blower building. Heat generated by the motor/blower combination supplies sufficient heat for winter, even in the coldest climates. Weather resistant sound boxes can also be provided, in lieu of a building.

Instrumentation And Controls For Power Savings and Unattended Operation

The small wastewater treatment plant can now be instrumented for operator-free, long-term operation and designed to minimize power consumption, saving considerable power costs. This is affected by providing an instrumentation system, specifically adapted for small plant use, that is economical, yet effective.

Instrumentation and controls must be “bulletproof” in a small, unattended wastewater plant. That is, they must be:

- Foolproof
- Rugged
- Easy to understand and troubleshoot
- Easy to change-out
- Able to run in manual or automatic
- Economical

Advancements in the art have allowed manufacturers to provide just such a control system.

A. System Control Panel

The heart of the automated and complete system is the system control panel. This panel may be provided in a “plug-in” style, facilitating quick change-out and return to the manufacturer in the unlikely event of failure. This control panel performs all the functions of the “operator”, as follows:

1. Receives primary signals from blower instruments
2. Provides warning or alarms via phone, radio, or computer interlink with a remote alarm system
3. Shuts-down any failed blower and starts the standby blower
4. Alternates on-line blower operation for equal wear of all blowers
5. Optimizes air flow to the aeration lagoon, based on operator set time/air flow matrix
6. Instructs operator on next maintenance items (air filter change)
This control module may be operated in automatic, in manual, or the system control panel removed, and blowers operated from the starters, in manual.

B. Operator-Free, Long-Term Operation

This objective of design allows a small plant to be run for days, or even weeks, without operator attention. Three elements of instrumentation are required:

1. Switching of operating and stand-by blowers to provide equal wear, and running each blower every couple of days for proper lubrication to maximize life of the unit
2. Tattletale warning and shutdown instruments installed on the blower
3. Capability to switch on-line blowers automatically, if an operating blower is shut down upon alarm

Aeration blowers can be instrumented to provide “tattletale” alarms for both maintenance and alarm. These primary instruments are important if the plant is to be unattended for long periods of time. Not only can these instruments provide shutdown (failure) alarms, but they can provide maintenance status, a key ingredient for good operation of the plant. Recommended tattletale instruments are as follows (Figure 13):

1. Inlet air filter differential pressure switch – provides warning when the air filter needs changing
2. Vibration switch – mounted on the skid, or the blower, it detects vibration from a failing bearing
3. Discharge air temperature switch – as a bearing fails, heat is generated, and absorbed by the discharging air, raising the discharge air temperature
4. Discharge pressure switch – detects discharge air rising pressure, most commonly caused by inattentive operators closing-off air discharge valves. This switch is also a back-up to a failed pressure relief valve. Likewise, low or no pressure when the motor is energized is an alarm condition.
5. Motor starter overload contact
6. Motor winding temperature switch
7. Tachometer – Input of speed to the PLC allows computation of air volume. Also detects zero speed when power is on, a fault condition.
8. PLC failure

These devices input their primary signals into the PLC of the system monitor for alarm, shutdown of failed blower, and start-up of standby blower.

C. Power Savings

Large wastewater plants have advanced the art of controls and optimization over the past few years to reduce power consumption used for aeration by 20-30 percent. Now, micro PLC’s and manufacturer’s empirical operating experience combine to allow small wastewater plants equal access to this technology, in an economical, fool-proof system.

The controlled variable in an aeration system is generally dissolved oxygen (DO). Unfortunately, the present state of the art requires frequent cleaning and recalibration of DO probes. Empirical experience, regretfully, indicates DO probes receive marginal cleaning and maintenance, even in the well maintained and fully staffed plants! It is thus appropriate to avoid the use of an automated power savings system, based on using continuous reading DO probes in the largely unattended extended aeration lagoon.

Rather, blower capacity, i.e. power consumption, is controlled via a timer or diurnal wastewater flow.

Most of the biological activity (and oxygen demand) occurs in the first 12 hours. Accordingly, a highly variable diurnal flow affects the volume of air required. Ideally, a time/air flow matrix can be empirically determined over a period of weeks or months by the operator, optimizing air flow to a minimum rate sufficient to maintain slight positive dissolved oxygen at the lagoon surface.

A different matrix for summer and winter can easily be used or the blower capacity can be directly controlled, based on diurnal flow.

Starters

The motor starters for the aeration blowers are likewise, conveniently provided by the aeration systems supplier, each in their stand-alone box. This unitized construction is the lowest cost option, and allows easy change-out in the unlikely event of starter failure. Starters are provided with an on-off-auto selector switch on the door, with red stop and green run lights, and a non-resettable hourmeter. The starter is also provided with a relay contact for overload/malfunction alarm. Two-speed or variable frequency drivers are available for efficiency optimization.

Summary

The complete static tube aeration system, which minimizes power consumption and operator attention, is appropriately supplied by one manufacturer for one source responsibility, lowest cost, simplified design, and installation. By utilizing this systems approach, all the advancements of large plant design can now be incorporated into the small treatment system providing the lowest installed cost of any wastewater system available, and the lowest unattended operating costs.

Guy Mace is President of the Ventuse Company,
Springfield, MO
Table I
Example Of Static Tube Aerator Sizing For An Extended Aeration Lagoon

Design Basis:
Enter Values →
0.2 MGD Normal Flow
180 mg/l BOD₅ Influent Load @ Normal
30 mg/l NH₃-N Influent Load @ Normal
20 Day Retention Time

Constants:
1.5 lbs O₂/lb BOD₅
4.6 lbs O₂/lb NH₃-N
0.65 Oxygen Conversion Rate Factor (AOR to SOR)

Recommended:
3:1 Side Slope is Recommended (Normal for Lined or Earthen Lagoons is 3:1)
3:1 Lagoon Bottom Length to Width Ratio (Generally 2:1 or 3:1)
12 SCFM of air flow to each Static Tube (8, 10, 12, 15, or 18)
8 ft SWD (Generally 6-12 ft)

System Sizing & Comparison:

\[ \frac{0.2 \text{ MGD} \times 8.345 \text{ lb/gal.}}{1 \text{ MGD}} = \frac{x}{180 \text{ mg/l}} \]

\[ x = 300 \text{ lbs BOD}_5/\text{day} \]

\[ 300 ÷ 24 \text{ Hrs} \times 100\% \text{ removal} = 12.5 \text{ lbs BOD}_5/\text{hr removal required} \]

\[ \frac{0.2 \text{ MGD} \times 8.345 \text{ lb/gal.}}{1 \text{ MGD}} = \frac{x}{30 \text{ mg/l}} \]

\[ x = 50 \text{ lbs NH}_3-N/\text{day} \]

\[ 50 ÷ 24 \text{ Hrs} \times 100\% \text{ removal} = 2.1 \text{ lbs NH}_3-N/\text{hr removal required} \]

\[ \text{Total Combined O}_2 \text{ Required for BOD}_5 \text{ and NH}_3-N = 43.7 \text{ lbs O}_2/\text{hr} \]

Using static tube Model 12X30ST where O₂ transfer rate \( Q_0 = \text{lbs/hr per aerator @ 8 ft SWD} \)

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<th>Table II</th>
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Fig. 1 – Dynamic Flow of Air & Water Through Static Tube Aerator

Fig. 2 – Static Tube Aerator

- Polyethylene Internal Diffusion Membrane
- Polyethylene Tube Wall (Static Tube)
- Orifice Level Adjusting Stud
- 304 SS Clevis Saddle Support
- Polypropylene Clevis Saddle
- Lashing Tie
- Polyethylene Pipe—Air Manifold (Size Varies)
- 304 SS Leg
- Air Orifice (Size Varies)
  - 10 MM – 16 MM Dia.
  - 3/8” – 5/8” Dia.
- Tube Base (Concrete)
Fig. 3 - Static Tube Aerator
Oxygen Transfer per Tube

Fig. 4 - Water Circulation Pattern in Lagoon with Sloped Sides
EARTHEN LAGOON
POPULATION: 5000

AERATION SYSTEM PERFORMANCE

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<th>ACTUAL</th>
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<td>SS – IN, MG/L</td>
<td>—</td>
<td>240–280</td>
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<tr>
<td>SS – OUT, MG/L</td>
<td>—</td>
<td>15–30</td>
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LAGOON CONFIGURATION

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<tbody>
<tr>
<td>VOLUME, M³ (000)</td>
<td>5.7</td>
<td>28.4</td>
<td>14.2</td>
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<tr>
<td>MG</td>
<td>1.50</td>
<td>7.50</td>
<td>3.75</td>
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<td>2.10</td>
<td>10.70</td>
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<td>3.7</td>
<td>3.7</td>
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<tr>
<td>FT.</td>
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<td>12</td>
<td>12</td>
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<tr>
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<td>190</td>
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<td>3.8</td>
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<tr>
<td>FT.</td>
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<td>19.3</td>
<td>–</td>
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<td>669</td>
<td>–</td>
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<tr>
<td>SCFM/TUBE</td>
<td>22.5</td>
<td>23.6</td>
<td>–</td>
</tr>
</tbody>
</table>

COMMENT:

* OUTERMOST AERATORS AROUND THE TOE OF THE BERM WERE SITTED OVER: TUBES WERE LOCATED TOO CLOSE TO THE TOE.
FIGURE 6

NATURAL EARTHEN LAGOON

POPULATION: SUMMER 7500
WINTER 5000

STARTUP: 1983

AERATION SYSTEM PERFORMANCE

<table>
<thead>
<tr>
<th>DESIGN</th>
<th>ACTUAL</th>
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<tbody>
<tr>
<td>FLOW, m³/d (000)</td>
<td>6.6</td>
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<tr>
<td>MGD</td>
<td>1.75</td>
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<tr>
<td>BOD₅ – IN, mg/L</td>
<td>230</td>
</tr>
<tr>
<td>BOD₅ – OUT, mg/L</td>
<td>—</td>
</tr>
<tr>
<td>SS – IN, mg/L</td>
<td>—</td>
</tr>
<tr>
<td>SS – OUT, mg/L</td>
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</tr>
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</table>

LAGOON CONFIGURATION

<table>
<thead>
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<th>CELL NO.</th>
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<tbody>
<tr>
<td>VOLUME, m³ (000)</td>
<td>71.9–94.6</td>
<td>71.9–87.1</td>
<td>41.6–53.0</td>
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<tr>
<td>MG</td>
<td>19–25</td>
<td>19–23</td>
<td>11–14</td>
</tr>
<tr>
<td>ACT. DETENTION, DAYS</td>
<td>16</td>
<td>15</td>
<td>9</td>
</tr>
<tr>
<td>SIDEWATER, M</td>
<td>2.1–2.7</td>
<td>2.1–2.7</td>
<td>2.1–2.7</td>
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<tr>
<td>FT.</td>
<td>7–9</td>
<td>7–9</td>
<td>7–9</td>
</tr>
<tr>
<td>NO. OF TUBES</td>
<td>183</td>
<td>132</td>
<td>20</td>
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<td>SPACING, M</td>
<td>6.1–12.2</td>
<td>13.5–27.4</td>
<td>—</td>
</tr>
<tr>
<td>FT.</td>
<td>20–40</td>
<td>60–90</td>
<td>—</td>
</tr>
<tr>
<td>SLP/M/Tube – SUMMER</td>
<td>481</td>
<td>481</td>
<td>481</td>
</tr>
<tr>
<td>SCFM/Tube – SUMMER</td>
<td>17</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>SLP/M/Tube – WINTER</td>
<td>255</td>
<td>255</td>
<td>255</td>
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<tr>
<td>SCFM/Tube – WINTER</td>
<td>9</td>
<td>9</td>
<td>0</td>
</tr>
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</table>

COMMENTS:

• 3RD CELL HAS 20 STATIC TUBES AT OUTLET TO BOOST EXIT D.O. LEVEL.
• ALGAE BLOOM IN AUGUST – SEPTEMBER, REMOVED WITH TERTIARY SAND FILTERS.
• TREMENDOUS BUG PROBLEM INITIALLY CLOGGED
• BLOWER INLET FILTERS. PUT SCREENS ON WINDOWS OF BLOWER ROOM TO SOLVE PROBLEM.
• RUN TWO BLOWERS IN SUMMER, ONE IN WINTER

REV | DATE | BY | DESCRIPTION

VENTUSE

TITLE: AERATION SYSTEM PERFORMANCE
LAGOON CONFIGURATION

CUSTOMER: STANDARD DRAWING

DESIGNED BY: CHECKED BY:
DRAWN BY: M.L.P APPROVED BY:
DATE: 10/01/01 SCALE: NONE
DRAWING NO. 002
FIGURE 7

EARTHEEN LAGOONS
POPULATION: 17,000
STARTUP: 1987

AERATION SYSTEM PERFORMANCE

<table>
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<th>ACTUAL</th>
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<td>MGD</td>
<td>3.5–4.2</td>
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<td>BOD₅ – IN, mg/L</td>
<td>90–108</td>
</tr>
<tr>
<td>BOD₅ – OUT, mg/L</td>
<td>15–23</td>
</tr>
<tr>
<td>SS – IN, mg/L</td>
<td>80–112</td>
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<td>SS – OUT, mg/L</td>
<td>26–33</td>
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LAGOON CONFIGURATION

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<tbody>
<tr>
<td>VOLUME, m³ (000)</td>
<td>56.8</td>
<td>56.8</td>
<td>75.8</td>
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<tr>
<td>MG</td>
<td>15</td>
<td>15</td>
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<td>ACT. DETENTION, DAYS</td>
<td>3.8</td>
<td>3.8</td>
<td>5</td>
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<tr>
<td>SIDEWATER, m</td>
<td>2.7</td>
<td>2.7</td>
<td>2.7</td>
</tr>
<tr>
<td>FT.</td>
<td>9</td>
<td>9</td>
<td>9</td>
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<tr>
<td>NO. OF TUBES</td>
<td>281</td>
<td>157</td>
<td>7</td>
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<td>15.8</td>
<td>—</td>
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<tr>
<td>FT.</td>
<td>35</td>
<td>52</td>
<td>—</td>
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<td>SLPm/TUBE</td>
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<td>567</td>
<td>567</td>
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<td>SCFM/TUBE</td>
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COMMENT:

* 3RD CELL HAS 7 STATIC TUBES AT OUTLET TO BOOST D.O. LEVEL.

VENTUSE

<table>
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<th>DESCRIPTION</th>
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TITLE: AERATION SYSTEM PERFORMANCE
LAGOON CONFIGURATION
CUSTOMER: STANDARD DRAWING
DESIGNED BY: CHECKED BY:
DRAWN BY: MLP APPROVED BY:
DATE: 10/01/01 SCALE: NONE
DRAWING NO. 003
CONCRETE TANKS
POPULATION: 4500

AERATION SYSTEM PERFORMANCE

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<td>BOD₅ OUT, MG/L</td>
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<tr>
<td>SS IN, MG/L</td>
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<td>290</td>
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<td>SS OUT, MG/L</td>
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LAGOON CONFIGURATION

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<tbody>
<tr>
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<td>1.6</td>
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<tr>
<td>MG</td>
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<td>0.43</td>
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<td>ACT. DETENTION, HRS</td>
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<td>18</td>
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<td>3.7</td>
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<td>FT.</td>
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<td>NO. OF TUBES</td>
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<td>SPACING, M</td>
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<td>FT.</td>
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<td>SLPM/TUBE</td>
<td>1219</td>
<td>1219</td>
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<tr>
<td>SCFM/TUBE</td>
<td>43</td>
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REV | DATE | BY | DESCRIPTION
---|------|----|--------------

VENTUSE

TITLE: AEROBIC DIGESTOR AND EXTENDED AERATION CONCRETE BASINS WITH FINAL CLARIFIERS

CUSTOMER: STANDARD DRAWING

DESIGNED BY: CHECKED BY:
DRAWN BY: MLP APPROVED BY:
DATE: 10/01/01 SCALE: NONE
DRAWING NO. 004
Fig. 9 – Air Lateral Connections onto Main Air Header

Fig. 10 – Typical Lagoon & Aeration Tank Layout for Static Tube Aerators
FIGURE 11

<table>
<thead>
<tr>
<th>TYPE</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>J</th>
<th>DISCHARGE</th>
<th>WEIGHT (LBS)</th>
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<tbody>
<tr>
<td>BLW 65-1</td>
<td>27.2</td>
<td>36.4</td>
<td>9.3</td>
<td>14.6</td>
<td>21.6</td>
<td>33.5</td>
<td>5.1</td>
<td>12.6</td>
<td>3</td>
<td>585</td>
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<td>36.4</td>
<td>9.3</td>
<td>14.6</td>
<td>21.6</td>
<td>33.5</td>
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<td>12.6</td>
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<td>685</td>
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<td>BLW 80-2</td>
<td>35.0</td>
<td>50.6</td>
<td>13.4</td>
<td>20.9</td>
<td>26.9</td>
<td>40.4</td>
<td>5.5</td>
<td>16.5</td>
<td>4</td>
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<td>26.8</td>
<td>26.7</td>
<td>40.4</td>
<td>5.5</td>
<td>16.5</td>
<td>4</td>
<td>1200</td>
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<td>BLS 80</td>
<td>28.7</td>
<td>71.3</td>
<td>31.1</td>
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<td>32.4</td>
<td>41.3</td>
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<td>72.9</td>
<td>32.4</td>
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<td>42.3</td>
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<td>20.9</td>
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<tr>
<td>BLS 125</td>
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<td>90.9</td>
<td>38.8</td>
<td>38.4</td>
<td>41.3</td>
<td>47.4</td>
<td>11.0</td>
<td>31.5</td>
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<td>90.9</td>
<td>38.8</td>
<td>38.4</td>
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<td>54.1</td>
<td>11.0</td>
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<td>5</td>
<td>1852</td>
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<td>BLS 150</td>
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<td>47.0</td>
<td>62.2</td>
<td>11.0</td>
<td>31.5</td>
<td>6</td>
<td>2650</td>
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<tr>
<td>BLS 200</td>
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<td>94.9</td>
<td>42.7</td>
<td>38.4</td>
<td>53.3</td>
<td>63.2</td>
<td>11.0</td>
<td>31.5</td>
<td>8</td>
<td>3120</td>
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</tbody>
</table>

Dimensions in inches

NOTE:
DIMENSIONS ARE PROVIDED FOR PRELIMINARY DESIGN AND LAYOUT, SUBJECT TO CHANGE PER VENTUSE ENGINEERING AND "AS BUILT" DRAWINGS.
NOTE:
DIMENSIONS ARE PROVIDED FOR PRELIMINARY DESIGN AND LAYOUT, SUBJECT TO CHANGE PER VENTUSE ENGINEERING AND "AS BUILT" DRAWINGS.
LEGEND

RPM - Tachometer (scfm)/Zero Speed Alarm
ESF1 - Electrical Supply Fail (Starter)
ESF2 - Electrical Supply Fail (System Controls)

Fig. 13 - Process and Instrumentation Diagram  
Aeration System - Positive Displacement Blower
A complete aeration system from Ventuse provides the end user with one-source supply, warranty, and expertise.

Our “systems approach” means the lowest first cost, as well as the lowest operating cost for the small wastewater plant.

Write for our complete design manual, or visit us online at www.Ventuse.com for complete sizing information.
VENTUSE STATIC TUBE AERATORS

INSTALLATION INSTRUCTIONS

Introduction

The following suggested installation procedures are for Ventuse static tube aerators installed in a lagoon, steel, or concrete tank utilizing a concrete base for aerator mounting, or alternatively anchored directly to a concrete or steel floor.

Ventuse Static Tube Configuration

Ventuse static tube aerators are fitted with two (2) clevis saddle/adjusting stud mounting brackets, anchored to the bottom side of the static tube wall. This bracket allows the clevis saddle/adjusting stud assembly to be affixed directly to the static tube aerator. The adjusting stud allows six inches of vertical adjustment for leveling the underwater aeration piping.

Concrete Bases

Concrete bases under each static tube aerator are poured to size, as indicated on the drawings. The appropriate form is field fabricated. Each static tube aerator, with four stainless steel legs, is set inside the form and then concrete poured, embedding the legs in concrete. (Reference Drawing ________________ for base size.)

Intermediate supports are poured as indicated on the drawings, embedding the hairpin support. As aerator and intermediate bases are poured, locate in the lagoon or aeration basins as illustrated in the drawings. (Reference Drawing _______________ for base size.)

Alternate Anchoring

Static tube aerators may be affixed directly to a concrete or steel floor via alternate anchoring using anchor bolts. Legs are supplied with anchor bolt holes ½ inch for ¾ inch anchor bolts. Use the specified anchoring arrangement to affix the static tubes to the floor and follow the rest of these instructions for lateral leveling, orifice hole drilling, etc.

Air Lateral Installation

Polyethylene pipe is used with Ventuse aeration systems for ease of installation and longevity. The polyethylene pipe is heat fuse welded with a fusion welding machine (supplied by others) across the lagoon floor. The pipe arrives in 20 or 40 foot sections. Each lateral can be assembled by placing pipe together, heat fuse welding, and threading through the legs at each aerator, as well as through each of the intermediate support hairpins.
After heat fuse welding all piping, and attaching lateral to main air header, the piping under each aerator can now be leveled. This is the most critical step in installation. Ventuse recommends the use of an oscillating laser transit, set in the center of the lagoon or tank. Begin at the “near” end of each lateral (closest to the main air header), and level clevis saddles under each static tube. Accuracy with a laser transit is easily ± ¼ inch. The clevis saddle/adjusting studs are screwed upwards or downwards to level the piping. Piping between static tube aerators does not need leveling, but we suggest intermediate piping be higher than at aerators to facilitate drainage of water out of the pipe.

Once leveling is complete, installation and orifice drilling of each lateral can be done. Working with one lateral at a time, the air lateral piping can be installed onto the clevis saddles under each static tube by threading the lashing ties through the two buckles on the clevis saddle and around the aeration pipe, and snugly tighten the lashing ties to hold the pipe. After installing pipe, the orifice holes can be drilled. Drill orifices in bottom of air lateral, centered, underneath each static tube aerator. The size is as indicated on the drawings. Take care not to ream-out the hole; all holes should be exactly the same. (Reference Drawing _______________ for orifice hole sizing and location.)

**Final Checklist**

Just prior to filling the lagoon, basin, or tank, Ventuse should inspect the installation, checking that all lashing ties are properly tensioned, bolts are tight, and the aeration piping properly installed.

Check all static tube aerators, making sure all aerators are serviced by one (1) air discharge orifice. Check orifice for size and location.

Remove all debris and construction materials from basin(s).

The lagoon should be immediately filled, at least up to the top of the aeration piping, to preclude expansion and contraction of the aeration piping. Filling should be done as soon as possible after drilling the orifice holes and Ventuse’s inspection to reduce expansion and contraction of the polyethylene piping in exposure to sunlight.

**Summary**

The key to any static tube aeration installation method is achieving the vertical adjustment necessary to assure a level air lateral pipe under each static tube. It is strongly recommended that a Ventuse start-up engineer be on-site, especially during the initial installation for instruction and supervision of Contractor’s personnel. It is important to have close coordination between the Contractor’s personnel and Ventuse to ensure a smooth and trouble-free installation.
ENERGY SAVINGS CONTROL PHILOSOPHY
FOR THE SYSTEM MODULE SENTINEL™

By Ed Munsell, Chief Instrumentation Engineer, Turblex, Inc.

The System Module Sentinel (SMS) is the system control panel that controls the Ventuse static tube aeration system. This module is designed to house a small programmable logic controller (PLC), a door mounted operator interface monitor, and other appurtenances. Ventuse has designed this SMS to be a “plug-in” module, using a male/female connector to facilitate change-out, in the event that an internal component may need repair. The entire SMS can be unplugged and returned to the factory for repair or exchange. During this time, the plant may be operated on manual.

A key operating feature of the SMS is efficiency optimization of the blower, with blower output following the wastewater process air demand.

Operating Philosophy

Ventuse experience at tuning the process control of wastewater treatment plants show that all plants have a repeatable wastewater flow rate into the plant. These changes in flow are relatively consistent from day to day.

The operating philosophy is to develop a plant specific matrix of the wastewater flow. By monitoring the wastewater flow, time of day when the changes occur, and sampling the dissolved oxygen to determine the amount of air required by the aeration process, a matrix can be developed to cycle the blowers on and off, based on the time of day. The matrix would thus allow control of the air blowers based on the wastewater flow into the plant, with a minimum amount of hardware.

An optional alternative would be for the SMS to receive an analog signal, which would represent the total wastewater flow into the plant. Based on this flow signal, blowers would be started and stopped. The differences between the two methods are that the above method is a time based control system, and the optional method is a process controlled system.

The following is a graph showing the tracking of the daily process flow into a plant.
While gathering the data of the wastewater flow into the plant, the dissolved oxygen is monitored to determine the most efficient time to sequence the blowers. Examine the following example.

The optional control proposal of using actual process flow instead of a time based system would work similar.

Example, assuming two-speed motors on PD blowers:

1. If the wastewater flow is greater than a value “1”, but less than value “2” for “X” amount of time, operate the #1 blower at low speed.

2. If the wastewater flow is greater than a value “2”, but less than value “3” for “X” amount of time, operate the #1 blower at full speed.
3. If the wastewater flow is greater than a value “3”, but less than value “4” for “X” amount of time, operate the #1 blower at full speed, and #2 blower at low speed

4. If the wastewater flow is greater than a value “4”, but less than value “5” for “X” amount of time, operate the #1 and #2 blowers at full speed.

5. And so on.

6. If the wastewater flow is less than a value “4”, but greater than value “3” for “X” amount of time, and #2 is operating at full speed, switch #2 to low speed, and operate #1 blower at full speed.

7. If the wastewater flow is less than a value “3”, but greater than value “2” for “X” amount of time, and #2 is operating at low speed, shut-off #2, and operate #1 at full speed.

8. If the wastewater flow is less than a value “2”, but greater than value “1” for “X” amount of time, and #1 is operating at full speed, switch #1 to low speed.

The dissolved oxygen control is based on the blower size and the number of blowers used. When dealing with PD type blowers, the air flow will be in a step control. To understand the term *step control* consider the following:

A. PD blowers are either off or on, low or full speed.

B. If the blower is off, then the air flow is zero from that blower.

C. If the blower is on, then the air flow is at the maximum for that blower.

D. Low-speed will allow operation at reduced volume.

The larger the blower output rating, the larger the step, and consequently, the cruder the control. The smaller the blower output rating, the smaller the step, and consequently, the finer the control. Two-speed motors allow smaller, multiple steps, facilitating closer air control.

**Additional Features**

1. Programmable automatic cycling of the lead and lag blowers to average usage across all blowers.

2. Disregard blowers that are not in the auto mode of operation.

3. Automatically reassign the lead/lag order in case of an alarm condition.

4. Field wiring is to terminals. However, the system module can easily be unplugged and repaired without disconnecting any of the field wiring.

5. No process instruments means a reliable system.

6. User friendly operator interface for programming the plant specific operating information.

7. All alarms are displayed in an easy to understand text format, rather than a pilot light.
8. Expandable.

The Ventuse operating philosophy thus uses a time or a flow matrix to vary blower output, rather than dissolved oxygen. Empirical experience suggests that dissolved oxygen probes, requiring regular cleaning and calibration, are not suitable for the small wastewater treatment plant. The scheme used by Ventuse provides air flow control based on plant effluent flow, or a preset time cycle, neither of which rely on a maintenance intensive primary sensing element.
AIR PIPE LASHING INSTALLATION PROCEDURE

Step 1:
Insert strap into two buckles on clevis saddle, wrap around pipe, through lock cover and pull to desired tension.

Step 2:
Strap should be tightened snugly.

1"-8 (NYLON)
ADJUSTING STUD

LASHING TIE (2)

5/16" X 1"
304SS HHCS,
WASHER & NYLON
NUT (2)

CLEVIS SADDLE
(POLYPROPYLENE)

SADDLE
BUCKLE (4)

AIR PIPING

MOUNTING BRACKET
ON STATIC TUBE

LOCK COVER

LASHING

AIR MANIFOLD

VENTUSE

TITLE: CLEVIS SADDLE, ADJUSTING STUD AND TY-RAP LASHING DETAILS
CUSTOMER: STANDARD DRAWING

DESIGNED BY: CHECKED BY:
DRAWN BY: MLP APPROVED BY:
DATE: 10/01/01 SCALE: N.T.S.
DRAWING NO. 90106
MODEL 93000 SHOWN

12" I.D.

30"

"H"

"L"

"E"

MEMBRANE (3 PER TUBE)

POLYETHYLENE TUBE

304 SS LEG X 12 GA (4 PER TUBE)

ADJUSTING STUD (2 FOR TUBE)

304 SS CLEVIS SADDLE BRACKET (2 PER TUBE)

CLEVIS SADDLE (2 PER TUBE)

LASHING TIE (2 PER SADDLE)

POLYETHYLENE PIPE

* SIZE VARIES

SIZE VARIES *

*ORIFICE SIZE VARIES

| POLYETHYLENE PIPE SIZE-IN | BASE WT-LBS | SUGGESTED 1 SIZE-IN* | DIM "E" MIN-MAX 1 | "L" | "H"
<table>
<thead>
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<tbody>
<tr>
<td>6</td>
<td>500</td>
<td>34 X 34 X 5 1/2</td>
<td>10 5/8&quot;-15 3/4&quot;</td>
<td>20&quot;</td>
<td>50&quot;</td>
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<tr>
<td>4</td>
<td>325</td>
<td>34 X 34 X 3 1/2</td>
<td>7 3/4&quot;-10 3/4&quot;</td>
<td>14&quot;</td>
<td>44&quot;</td>
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<td>3</td>
<td>270</td>
<td>31 X 31 X 3 1/2</td>
<td>7 1/4&quot;-11 1/4&quot;</td>
<td>14&quot;</td>
<td>44&quot;</td>
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<td>2</td>
<td>220</td>
<td>28 X 28 X 3 1/2</td>
<td>7 3/4&quot;-11 3/4&quot;</td>
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<td>44&quot;</td>
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NOTE: CONCRETE BASE DIMENSIONS ASSUME 140 LBS./CU. FT. CONCRETE WITH 1.5 SAFETY FACTOR.

NOTE:

DIMENSIONS ARE PROVIDED FOR PRELIMINARY DESIGN AND LAYOUT, SUBJECT TO CHANGE PER VENTUSE ENGINEERING AND "AS BUILT" DRAWINGS.

1. Size and dimension varies per installation. Adjusting stud used to level aeration piping.

VENTUSE

10/01/01 SCALE: N.T.S. DRAWING NO. TUBE30

G:\VENTUSE\DWGS\TUBE30

TITLE: STATIC TUBE AERATOR (MODEL 12-30) WITH FIXED LEGS FOR CONCRETE BASE

CUSTOMER: STANDARD DRAWING

DESIGNED BY: CHECKED BY: DRAWN BY: MLP APPROVED BY:

REV  DATE  BY  DESCRIPTION

1.0
* Note

Size and dimension varies, per installation.
Adjusting stud used to level aeration piping.
See Ventuse installation instructions for details, or contact Ventuse for proper sizing.
POLYETHYLENE INTERNAL DIFFUSION MEMBRANE (3 PER TUBE)

304ss CLEVIS SADDLE BRACKET (2 PER TUBE)

CLEVIS SADDLE (2 PER TUBE)

LASHING TIE (2 PER SADDLE)

POLYETHYLENE PIPE

*ORIFICE VARIES

304 SS LEG X 12 GA (4 PER TUBE)
17" LONG

SIZE VARIES *

1. Size and dimension varies per installation. Adjusting stud used to level aeration piping.

NOTE:
DIMENSIONS ARE PROVIDED FOR PRELIMINARY DESIGN AND LAYOUT, SUBJECT TO CHANGE PER VENTUSE ENGINEERING AND "AS BUILT" DRAWINGS.
**INTERMEDIATE BASES**

<table>
<thead>
<tr>
<th>AIR MANIFOLD SIZE-IN.</th>
<th>BASE WT.-LBS.</th>
<th>SUGGESTED SIZE-IN.</th>
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<tr>
<td>6</td>
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<td>5</td>
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<td>2</td>
<td>75</td>
<td>15x15x4</td>
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**NOTE:** CONCRETE BASE DIMENSIONS ASSUME 140 LBS./CU. FT. CONCRETE + 1.5 SAFETY FACTOR.

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**VENTUSE**

**TITLE:** INTERMEDIATE BASE  
**DOUBLE HARPIN**  
**CUSTOMER:** STANDARD DRAWING

**DESIGNED BY:**  
**CHECKED BY:**  
**DRAWN BY:**  
**APPROVED BY:**  
**DATE:** 10/02/01  
**SCALE:** N.T.S.  
**DRAWING NO.:** 90223