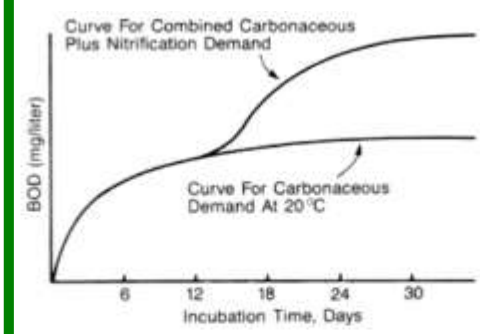
October 2017

The Wastewater Insight

Environmental Leverage Inc.

Turning Liabilities into Leverage



GENERAL OXYGEN TRANSFER EFFICIENCIES[1]

	#/Hp hr	Kg/KWH
Mechanical Aeration Systems		
Rotors (brush aerators) surface aeration	2.5 to 3.5	1.52 to 2.13
Slow speed surface	3.0 to 3.5	1.82 to 2.13
High speed splash surface aeration	2.5 to 3.25	1.52 to 1.98
Induced surface aeration (Aire O2 type)	1.0 to 1.5	0.61 to 0.91
Combination Systems		
Submerged Turbine (turbine mixer and compressors)	1.5 to 2.5	0.91 to 1.52
Jets (pumps with compressors)	2.0 to 3.5	1.22 to 2.13
Diffused Aeration		
Coarse bubble system		
Static tubes	2.0 to 3.0	1.22 to 2.13
Wide band grid	2.5 to 3.5	1.52 to 2.13
Misc. coarse bubble	2.0 to 3.0	1.22 to 2.13
Traditional Fine Pore Aeration		
Ceramic disc or ceramic dome grid	5 to 7	3.04 to 4.26
Flexible Membrane Disc or Tubes Grid at Conventional Flow Rates	4 to 7	2.43 to 4.26
Advanced Technology Membrane Fine Pore Aeration	up to 12	7.30

Why is D.O. or Dissolved Oxygen so important in the Wastewater Treatment plant?

Oxygen Requirements

Oxygen in aerobic biological treatment is a basic part of the growth cycle. Oxygen is required both for the development of new cells and to meet their continuing energy requirements in order to degrade organics and nutrients. The classical biochemical oxygen demand exerted by a waste flow consists of two oxygen demand curves known as carbonaceous demand and nitrification. Oxygen consumption to assimilate the carbonaceous organic material begins almost immediately, while oxygen consumption for conversion of organic nitrogen compounds does not begin until the carbonaceous material in the waste has been oxidized. At this point the carbon reducing microorganisms present have begun to die off (endogenous respiration), allowing the less competitive nitrification micro-organisms to grow using ammonia as an energy source. "Nitrification" also exerts an oxygen demand on the system. The combined total oxygen demand is the sum of the two demand curves. Realistically both processes occur in the aeration basin at the same time as long as there is free oxygen, a sufficient food source and the correct biological parameters, such as the Critical 5 plus One.

Theoretically, an oxygen demand of 1.42 grams is exerted by each gram of biological solids produced during carbonaceous degradation. Nitrification can have a much higher demand for oxygen. 4.5 parts of O2 per part of NH3.

Aeration is a major cost at any plant. A typical wastewater plant's electricity can be the most expensive part of the process. One way to optimize oxygen usage, is to make sure the solids are not held too long anywhere. Solids that are held too long generate septic conditions. Primaries, secondaries, sludge dewatering tanks or EQ tanks that are allowed to turn septic and then have water that is sent to the aeration basin that is septic will require a large amount of oxygen. This not only deprives the bacteria that need the oxygen for biodegradation, but increases the need and therefore the cost of electricity for pumps and aerators.

Make sure if you have dissolved oxygen, that you do not have broken diffusers. This also can lessen the oxygen transfer and force you to run the pumps longer and use more electricity.

We started this month out with a new **Mystery Bug of the month!**

Check out our website for more photos of our new mystery bug!!!!

EnvironmentalLeverage.com

Many times when we troubleshoot a wastewater treatment plant we tell customers after looking under the microscope that they have low Dissolved Oxygen (D.O.) filaments or issues at their plant. Usually the response we first get back is" my D.O. in my aeration basins in 2-3 ppm all the time, it's not possible!

Technically many times D.O. is not an issue in the aeration basin; it is usually in another part of the plant that is causing the problem. Whether in the collection system, influent wet wells, primary, clarifier, and digester or dewatering, somewhere there is a point with low dissolved oxygen. Water or solids from this area is returned or recycled to the system and is causing the growth of pin floc, high TSS, poor floc formation or filaments.

Typical aeration requirements

5 lbs. oxygen oxidizes 1 lb. nitrogen

3 lbs. oxygen oxidizes 1 lb. carbon

1-1.5 lbs. oxygen oxidizes 1 lb. B.O.D.

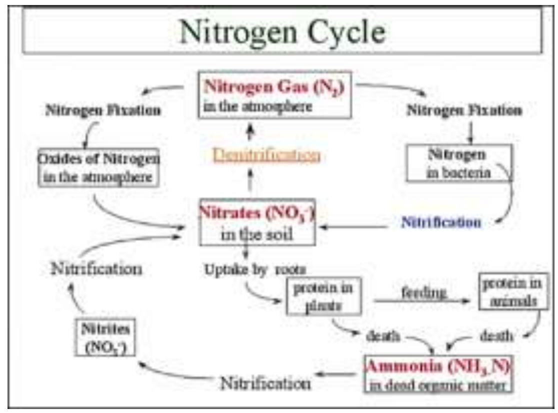
1 lb. oxygen oxidizes 1 lb. hydrogen sulfide

.67 lb. oxygen oxidizes 1 lb. manganese

.4 lb. oxygen oxidizes 1 lb. iron

Aeration Equipment- For Mixing and Aeration
Keep in mind you are doing two things with aeration, keeping the biology in suspension as well as providing dissolved oxygen in suspended growth systems. In fixed film system, aeration or dissolved oxygen is still required for proper biological growth.
Some typical considerations when choosing aeration include:

- Energy efficiency
- Long term reliability
- Low maintenance requirements
- Capital cost
- Ease of installation



Aeration Tanks
Aeration tanks used in activated sludge processes are usually constructed of reinforced concrete and left open to the atmosphere.

The rectangular shape permits common-wall construction for multiple tanks. If the total capacity exceeds 5000 ft (140 m3), the total aeration tank volume required should be divided among two or more units capable of independent operation. The total capacity required is determined from the biological process design.

If the wastewater is to be aerated with diffused air, the geometry of the tank may significantly affect the aeration efficiency and the amount of mixing obtained. The depth of wastewater in the tank should be between 10 and 16 feet (3 and 4.9 m) so that the diffusers can work efficiently. Freeboard should be from 1 to 2 feet (0.3 to 0.6 m) above the waterline. The width of the tank in relation to its depth is important if spiral-flow mixing is used. The width-to-depth ratio for such tanks may vary from 1.0:1 to 2.2:1. This limits the width of a tank channel to 20-36 feet (6.1-11 m).

Mixed Liquor Dissolved Oxygen - The mixed liquor D.O. level in activated sludge aeration basins is controlled by:

1. Organic loading - directly influences oxygen uptake rate, which indirectly affects D.O. level
2. Aeration source and level - directly influences D.O. level
3. Mixed liquor solids inventory - indirectly influences oxygen uptake rate and F/M ratio, which in turn indirectly affects the mixed liquor D.O. level

The dissolved oxygen levels in the effluent from the aeration tank are generally maintained between 1.0 and 2.0 as a target depending upon whether you have clarifier or other types of settling and dewatering afterwards.

What type of aeration is best?

The two basic methods of aerating wastewater are:

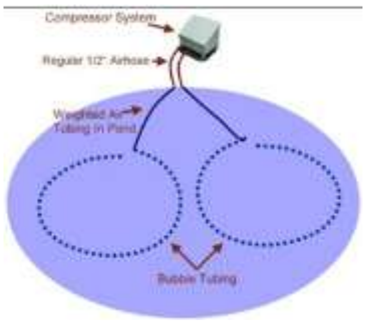
- Introduce air or oxygen into the wastewater with submerged porous diffusers or air nozzles
- Agitate the wastewater mechanically to promote solution of air (or oxygen) from the atmosphere above the liquid being aerated

The amount of air used per pound of BOD removed varies greatly from one plant to another. Comparing the air use at different plants is risky because of different loading rates, control criteria, and operating procedures.

Diffused Aeration - A diffused-air system consists of diffusers that are submerged in the wastewater, header pipes, air mains, and the blowers and appurtenances through which the air is generated. The diffusers most commonly used in aeration systems are designed to produce fine, medium, or coarse (relatively large) bubbles.

Bubble-Line Aeration

Bubble Tubing is the ideal air diffuser for shallow lakes and ponds. Bubble Tubing, being flexible and self sinking, is easier to get into a pond than discs or multi-disc assemblies which need weights or have plastic bases that must be filled with stones. Bubble Tubing can be tossed into smaller ponds or fed off the back of a boat in larger ponds or even hooked to guide ropes and pulled into position making it one of the most trouble-free diffuser systems available.



This graphic shows a typical setup of a properly designed linear aeration system. In shallow ponds, or even in any pond for that matter, using lengths of Bubble Tubing will allow you to add gentle rising bubbles over a larger area or in specific patterns or shapes due to the flexibility.

While disc diffusers or air stones can be very desirable in deeper ponds and lakes there is often a misconception as to the effectiveness of discs, especially the various multiple-disc assemblies on the market. In shallow conditions, discs and air stones act like a coarse bubbler sputtering large foaming splashes on the surface.

Using Bubble Tubing allows for quick and easy application of aeration and circulation into any pond, especially shallow basins.

Solar Aeration

Solar (DC) powered aeration systems are similar to electrical (AC) powered systems. A DC powered system allows power to be generated at a site that does not have access to the AC grid. What sets them apart is that solar panels generate electrical power (DC) needed to run the compressor, while storing excess energy in batteries. Batteries keep the system running during cloudy days and at night.

A solar aeration system consists of:

- solar panels (sized to supply enough power for calculated consumption)
- deep cycle batteries to store excess power
- a control board with regulator (charge controller)
- compressor
- weighted feeder hose
- air diffuser.

This type of system can be placed on the dugout bank or mounted on a small trailer for mobility.

Windmill Aeration

Windmill Aeration, sometimes referred to as *pond aeration*, keeps water clean while using an environmentally friendly source of energy - the free power of the wind - saving thousands of dollars in energy costs.

No electric is needed, but no mixing when there is no wind either.

The windmill is a direct drive system without gears and few moving parts. It is efficient and easy to maintain. Twelve galvanized steel blades catch the wind turning the crankshaft which is attached to the diaphragm. This acts like a piston, forcing air out on the down stroke, 1.2 cubic feet a minute and 30 P.S.I. of air is produced as a result.

The windmill package consists of a 12' tower and a 5 ' diameter turbine with 12 blades and 100' of 3/8" weighted tubing and two pond diffusers. All parts are galvanized for years of service. The only service ever required is a yearly greasing of one fitting and a diaphragm replacement as needed. The windmill can be located hundreds of feet from the pond if necessary to catch the wind. The windmill can also operate to a depth of 50 feet if necessary.

Mechanical Aerators - The most commonly used types of mechanical aerators are surface and submerged turbine aerators. With surface aerators, oxygen is entrained both from the atmosphere and from air or pure oxygen introduced in the tank bottom. In either case, the pumping action of the aerator and that of the turbine help to keep the contents of the aeration tank mixed. Both types are described here, along with aerator performance and the energy required for mixing.

Surface Aerators - Mechanical surface aerators are the simplest type of aerators. They are available in sizes from 0.75 to 75 kW (1 to 100 hp). They consist of submerged or partially submerged impellers that are attached to motors, which are mounted on floats or on fixed structures. The impellers are fabricated from steel, cast iron, non-corrosive alloys, and fiberglass-reinforced plastic and are used to agitate the wastewater vigorously, entraining air in the wastewater and causing a rapid change in the air-water interface to facilitate solution of the air. Surface aerators may be classified according to the speed of rotation of the impeller as low or high speed. In low-speed aerators, the impeller is driven through a reduction gear by an electric motor. The motor and gearbox are usually mounted on a platform that is supported either by piers extending to the bottom of the tank or by beams that span the tank. They have also been mounted on floats.

Submerged Turbine Aerators - Most mechanical surface aerators are up flow types that rely on violent agitation of the surface and air entrainment for their efficiency. With turbine aerators, however, air or pure oxygen may also be introduced by diffusion into the wastewater beneath the impeller of down flow or radial aerators. The impeller is used to disperse the air bubbles and mix the tank contents. A draft tube may be used with either up flow or down flow models to control the flow pattern of the circulating liquid within the aeration tank. The draft tube is a cylinder with flared ends mounted concentrically with the impeller, and extending from just above the floor of the aeration tank to just beneath the impeller.

Mechanical Aerator Performance - Surface aerators are rated in terms of their oxygen-transfer rate expressed as kilograms of oxygen per kilowatt-hour (pounds (kg) of oxygen per horsepower-hour) at standard conditions. Standard conditions exist when the temperature is 20°C, the initial dissolved oxygen is 0.0 mg/l, and the test liquid is tap water. Commercial-size surface aerators now available range in efficiency from 2 to 4 lb (0.9 to 1.8 kg) O2/hp-hr.

Energy Requirement for Mixing - As with diffused air systems, the size and shape of the aeration tank are very important if good mixing is to be achieved. Aeration tanks may be square or rectangular and may contain one or more units. Water depth may vary from 4 to 12 feet (1.2-3.7 m) when using surface aerators. Depths up to 35 feet (10.7 m) have been used with draft-tube mixers.

In diffused-air systems, the air requirement to ensure good mixing varies from 20 to 30 ft3 (0.56 to 0.84 m3) per 1000 ft3 (28 m3) of tank volume.

Typical power requirements for maintaining a completely mixed flow regime with mechanical aerators vary from 0.6 to 1.15 hp per 1000 ft3 (28 m3), depending on the design of the aerator and the geometry of the tank, lagoon, or basin. In the design of aerated lagoons for the treatment of domestic wastes, it is extremely important that the mixing power requirement be checked because in most instances it will be the controlling factor. With both the diffused-air systems and mechanical aerators, the power required for the liquid alone is usually less than that required for a liquid containing suspended solids.

Typical SOTR mechanical aerator = 2.0 to 4.0 lb/HP-Hr depending on aerator design and manufacturer; lower values for high speed & brush and higher for low speed with draft tube.

Typical SOTR diffusers – 10 to 40% depending on type and manufacturer at 15 feet submergence; lower values for coarse bubble, higher for fine bubble ceramic discs. Air flow per diffuser varies by type and manufacturer.

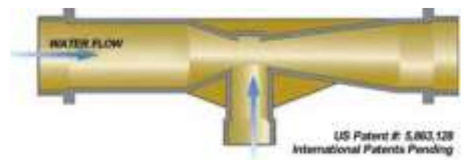
Standard Aeration Efficiency is usually expressed as Lbs of oxygen per BHP-hr or per kW-hr

Standard aeration efficiency Fine Bubble (full floor coverage) 6.6 – 10.8 lbs.O_2/BHP-hr

- Fine Bubble (spiral roll) 3.3 – 6.6 lbs.O_2/BHP-hr
- Jet Aeration 3.6 – 5.7 lbs.O_2/BHP-hr
- Mechanical Aerators 1.8 – 3.4 lbs.O_2/BHP-hr
- Coarse Bubble 2.1 – 3.1 lbs.O_2/BHP-hr
- Aspirating Aerators 0.8 – 1.3 lbs.O_2/BHP-hr

Data from ASCE WEF Manual of Practice 8: Design of Municipal Wastewater Treatment Plants.

Course bubble has roughly 0.75% SOTE per foot submergence, 3 - 4 lbs oxygen/BHP/hr and typically requires 50 - 60% more power than fine bubble fixed floor



Alternative Oxygen Equipment

There are two pure oxygen generator designs: the traditional cryogenic air-separation process for large applications, and a pressure-swing adsorption (PSA) system for the somewhat smaller and more common plant sizes.

Cryogenic Air Separation - The cryogenic air-separation process involves the liquefaction of air, followed by fractional distillation to separate it into its components (mainly nitrogen and oxygen).

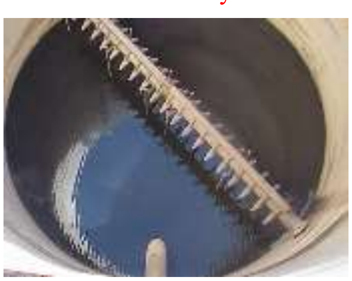
Pressure-Swing Adsorption - The PSA system uses a multi-bed adsorption process to provide a continuous flow of oxygen gas. The feed air is compressed and passed through one of the absorbers. The adsorbent removes the carbon dioxide, water, and nitrogen gas, and produces relatively high-purity oxygen. While one bed is adsorbing, the others are in various stages of regeneration.

The concept of the PSA generator is that the oxygen is separated from the feed air by adsorption at high pressure, and the adsorbent is regenerated by "blowdown" to low pressure. The process operates on a repeated cycle having two basic steps, adsorption and regeneration.

Venturi or Mazzei Injectors are an updated way on an old technology to give your aeration/mixing at your plant an extra boost also for a very small cost.

Mazzei® Injectors are high-efficiency, Venturi-type, differential pressure injectors with internal mixing vanes. When a sufficient pressure difference exists between the inlet and outlet ports of the injector, a vacuum is created inside the injector body, which initiates suction through the suction port.

***Oxygen equipment is constantly updated, mechanical parts change, new technology comes out, transfer efficiency is compared. Check out the internet for more information on aeration. Typically though, diffused aeration has the highest transfer rate lately for the cheapest amount.



Jet Aerators and Jet Mixers

PURE Oxygen Or UNOX

Regardless of which type of aeration you have, make sure you have proper mixing as well as dissolved oxygen concentration levels necessary for your system.

2017 Class Schedule

We still have some spots open in our upcoming hands-on Training class.

If you cannot travel, we also now have more courses on our ELearning. These courses have been pre-approved for CEU credits.

Please check our website or email us for a registration form. Please let us know if you would like to host a class in your area.

2 Day Biological Wastewater Process Control Seminar

This 2-day (16 hours) course is pre-approved in California as Training for Wastewater Operators, Engineers, and Laboratory personnel.

Each attendee will receive complete class notes and a Wastewater Microscopic Training CD… *valued at $250.00.*

October

San Francisco, CA Area

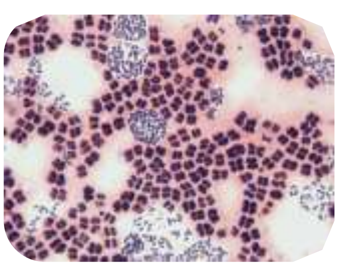
Oct. 17th & 18th, Tues. & Wed., 2017

8am - 4:30pm both days

West County Wastewater District
2377 Garden Tract Road
Richmond, CA 94801 USA

Lunch will be provided both days for class

Please be sure to bring a 100ml - MLSS sample from your own facility for analysis



Did you guess what this was? **These are tetrads, They typically are found in industrial facilities when they are limited with nitrogen. Check your N values. 100 parts of Carbon-5 parts of nitrogen. Nitrates in the influent don't count, they are already converted and not available to the bacteria as a nutrient source.**

September 2017- Tetrads

Check out our website for more photos of our new mystery bug!!!!

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