Dryden Aqua

Air Diffuser

Instructions for use

Typical applications

- Activated sludge, wastewater
- Landfill leachate waste water
- Extended diffused aeration systems
- Destratification of lakes or reservoirs
- Industrial wastewater treatment
- Reduction of THMs by air stripping
- Agricultural waste water
- Wetland water treatment systems
- Aquaculture for fish & shrimps

Specifications

- Highly efficient oxygen transfer, up to 5kg/kw/hr
- Self-ballast, simply dropped into tanks or lagoons
- Very easy installation and retrofits
- Very easy to maintain, no need to drain tank
- Less than 2 psi differential pressure
- Built in non-return valve
- Stainless steel and plastic construction
- 10 year average life cycle
- Can be used with Air, N_2, CO_2

CONTENTS

1. Introduction

Product order codes & oxygen transfer data

Product code	Description Length of diffusers m	Diffuser Weight kg	Air Flow m^3/hr (+/- 20 %)	Oxygen Transfer kg of O_2/day per diffuser at different depths at 20 °C and 50% O_2 saturation		
				2m depth	3m depth	4m depth
70000	0.33 m	0.5 kg	1	2 kg O_2	2.5 kg O_2	3 kg O_2
70001	0.66 m	1.0 kg	2	4 kg O_2	5 kg O_2	6 kg O_2
70002	1.00 m	1.5 kg	3	6 kg O_2	7.5 kg O_2	9 kg O_2
70003	1.33 m	2.0 kg	4	8 kg O_2	10 kg O_2	12 kg O_2
70004	1.66 m	2.5 kg	5	12 kg O_2	12 kg O_2	15 kg O_2
70005	2.0 m	3.0 kg	6	14 kg O_2	15 kg O_2	18 kg O_2
70006	2.33 m	3.5 kg	7	16 kg O_2	17 kg O_2	21 kg O_2
70007	2.66 m	4.0 kg	8	18 kg O_2	20 kg O_2	24 kg O_2
70008	3.0 m	4.5 kg	9	20 kg O_2	22 kg O_2	27 kg O_2

Unique product features and benefits

Dryden Aqua air diffusers are of semi-flexible construction of 32 mm in diameter and of variable length up to 3 metres depending on the air, oxygen or carbon dioxide throughput required. The diffusers have their own internal ballast and will stay on the bottom of the aeration tank without the requirement to secure them to the base. This makes our diffusers easy and quick to install. The diffusers can also be maintained while the tank is full of water, and even while the air blowers are running,

The Dryden Aqua Air Diffusers are among the most robust, versatile and efficient fine bubble diffusers. Fine bubble diffusion is inherently more effective than coarse bubble diffusion in providing a greater mixing action and gas transfer efficiency (up to 5 times more efficient). The diffuser has been independently verified to have 40% higher performance than equivalent fine bubble membrane diffusers manufactured in Japan and the USA

Installation

The diffusers are ideally suited for clay or plastic lined lagoons, but they are also perfect for steel and concrete tanks, lakes and aeration ditches. Installation in a lagoon or tank is very simple; fit an air ring main pipe (usually in HDPE or steel) around the perimeter of the lagoon, fit a ½" hose on to the air ring main using saddle clamps, cut the hose to a length that will take it to the base of the lagoon, fit one diffuser on the end of the hose and throw it into the lagoon. An Installation with 100 diffusers to cater for a PE (Population Equivalent) of 10,000 can be completed in 5 days.

Maintenance

The air diffusers require virtually no maintenance. DA air diffusers are used to treat landfill leachate and compost/ anaerobic wastewater digesters. The COD can be over 10,000mg/l with an alkalinity of 2000 mg/l. Under these conditions, some degree of scaling can occur. However, because the diffusers are semi flexible, a simple flexing of the diffuser will crack off any rigid scale deposits.

It is very easy to clean the diffusers, just pull on the ½" hose to recover the diffuser, give it a quick shake and brush, and then throw back into the water. Cleaning of 100 diffusers takes about 4 hours. Frequency of cleaning depends upon the quality and temperature of the water, but it is usually between once very 4 weeks to every 6 months. The diffusers can be maintained while the air blowers are running and whilst the lagoon or tanks are full of water.

Landfill leachate treatment
Scotland

Oxygen transfer rate

The performance of an air diffuser is related to bubble size, oxygen transfer coefficient and energy consumed. The Dryden Aqua fine bubble air diffuser efficiency has been measured at 5kg of O_2 transfer per kw. One diffuser and 10 m^3/hr of air will provide sufficient mixing and oxygen for 50 to 100 PE people in a municipal treatment plant. This equates to 1 to 2 kg of oxygen transfer per hour per diffuser.

The Dryden Aqua diffusers are usually twice as efficient as any other diffuser on the market and up to 4 times more efficient than surface aerators.

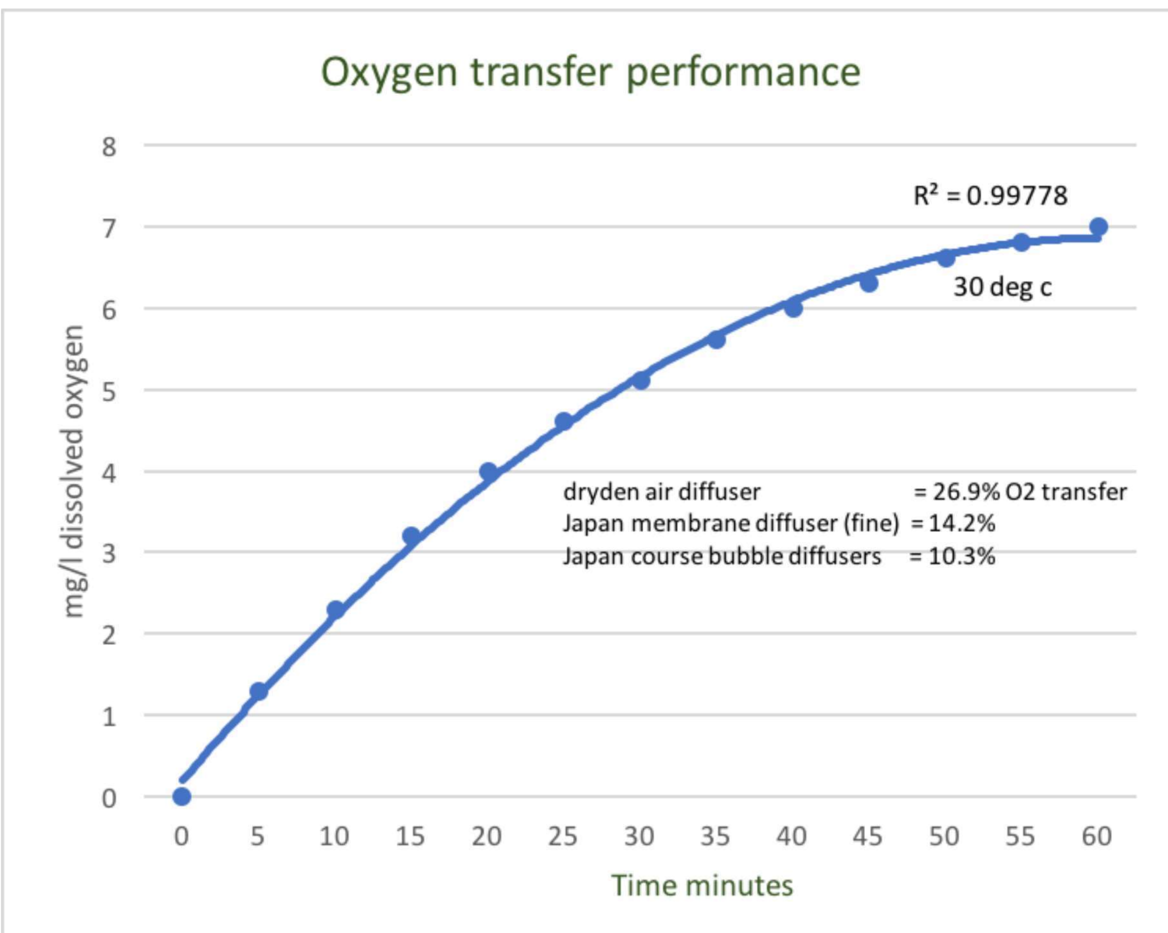
Independent verification of diffuser performance

A comparative analysis of air diffuser performance was conducted in 2016 by;

Dr. Shigetaka Wada
Chulalongkorn University, Thailand

Test Procedure

1. Water tank: diameter 1.0m, height 4.0m, water depth 3.5m.
2. Coarse diffuser tested for comparison (943-made in Japan, 013-made in USA, 0225 &0226- made in Japan)
3. Membrane diffuser tested for comparison (836, 046-ceramic diffuser, made in Japan)
4. Oxygen content is dropped to nearly zero by adding $CoCl_2 6H_2O$ as a catalyser and Na_2SO_3 as an oxygen absorber.
5. Air is blown in through the aerator in the bottom of the tank and the oxygen content measured until near 100% oxygen saturation is reached.



2. Sizing a system for different applications

The size of an aeration system depends on a number of variables and the objectives of the system, for most applications it will be the provision of oxygen, however the diffusers are also sized on their ability to move and mix water very efficiently.

The size of a system is also a function of the physical conditions, including the size and depth of water in the tank / lagoon to be aerated. The temperature of the water as well as the chemistry will also impact on oxygen transfer and oxygen solubility.

Solubility of Oxygen in water

The solubility of oxygen in water in equilibrium with air at 760mm Hg pressure and 100% relative humidity Units:mg/l.
The data gives the mg/l of oxygen in solution that is equivalent to 100% saturation at the specified temperature.

T ºC	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	14.60	14.65	14.52	14.48	14.44	14.40	14.36	14.33	14.29	14.25
1	14.21	14.17	14.13	14.09	14.05	14.02	13.98	13.94	13.90	13.87
2	13.83	13.79	13.75	13.72	13.68	13.64	13.61	13.57	13.54	13.50
3	13.46	13.43	13.39	13.36	13.32	13.29	13.25	13.22	13.18	13.15
4	13.11	13.08	13.04	13.01	12.98	12.94	12.91	12.88	12.84	12.81
5	12.78	12.74	12.71	12.68	12.64	12.61	12.58	12.55	12.52	12.48
6	12.45	12.45	12.39	12.36	12.33	12.29	12.26	12.23	12.20	12.17
7	12.14	12.11	12.08	12.05	12.02	11.99	11.96	11.93	11.90	11.87
8	11.84	11.81	11.78	11.76	11.73	11.70	11.67	11.64	11.61	11.58
9	11.56	11.53	11.50	11.47	11.44	11.42	11.39	11.36	11.34	11.31
10	11.28	11.25	11.23	11.20	11.17	11.15	11.12	11.10	11.07	11.04
11	11.02	10.99	10.97	10.94	10.91	10.89	10.86	10.84	10.81	10.79
12	10.76	10.74	10.72	10.69	10.67	10.64	10.62	10.59	10.57	10.55
13	10.54	10.50	10.47	10.45	10.43	10.40	10.38	10.36	10.34	10.31
14	10.29	10.27	10.24	10.22	10.20	10.18	10.15	10.13	10.11	10.09
15	10.07	10.04	10.02	10.00	9.98	9.96	9.94	9.92	9.89	9.87
16	9.85	9.83	9.81	9.79	9.77	9.75	9.73	9.71	9.69	9.67
17	9.65	9.63	9.61	9.59	9.57	9.55	9.53	9.51	9.49	9.47
18	9.45	9.43	9.41	9.39	9.37	9.36	9.34	9.32	9.30	9.28
19	9.26	9.24	9.23	9.21	9.19	9.17	9.15	9.13	9.12	9.10
20	9.08	9.06	9.05	9.03	9.01	8.99	8.89	8.96	8.94	8.92
21	8.91	8.89	8.87	8.86	8.84	8.82	8.81	8.79	8.77	8.76
22	8.74	8.72	8.71	8.69	8.67	8.66	8.64	8.63	8.61	8.59
23	8.58	8.56	8.55	8.53	8.51	8.50	8.48	8.47	8.45	8.44
24	8.42	8.41	8.39	8.38	8.36	8.35	8.33	8.32	8.30	8.29
25	8.27	8.26	8.24	8.23	8.21	8.20	8.18	8.17	8.16	8.14
26	8.13	8.11	8.10	8.08	8.07	8.06	8.04	8.03	8.01	8.00
27	7.99	7.97	7.96	7.94	7.93	7.92	7.90	7.89	7.88	7.86
28	7.85	7.84	7.82	7.81	7.80	7.78	7.77	7.76	7.74	7.73
29	7.72	7.70	7.69	7.68	7.66	7.65	7.64	7.63	7.61	7.60
30	7.59	7.57	7.56	7.55	7.54	7.52	7.51	7.50	7.49	7.47

The solubility of oxygen in water decreases as the water temperature increases. Aeration systems are sized based on the oxygen demand, often referred to as the BOD (Biochemical or Bacterial Oxygen Demand). The warmer the water, the more active the bacteria. Starting at a temperature of 5ºC, for every additional 5ºC, biochemical activity will increase by 100%, up to a temperature of 36ºC, then it starts to slow down.

Examples of applications & sizing of a system

	Number of diffusers code 70008	Air flow, m³/hr	Diffuser depth m	Capacity of system to deliver oxygen kg/day	Water flow m³/day	COD mg/l	COD loading per kg/day	Water minimum residence time days	
Municipal waste water	1	10	2 to 3m	20	15	400	6	1-5	50- 100 people
Industrial waste water	1	10	3 to 5m	27	4	4500	18	3 to 15	
Textile waste water								3-5	
Pharma waste								30 to 60	
Agriculture, cows	1	10						5-50	10 cattle
Agriculture, swine	1	10						5 - 50	20 swine
Degassing application THMs drinking water	1	10	3 to 5m	n/a	240 to 480	n/a	n/a	60 minutes	3000 people

Notes.

- COD = refers to the Chemical Oxidation demand of the water. COD is always higher than the BOD, however BOD laboratory analysis always gives an underestimate. We therefore recommend that sizing is based on COD.
- Application factor = a factor of 1.5 should be applied, COD loading per day x 1.5 = capacity of system to deliver oxygen. The system may be over-sized, but under-sizing should be avoided.
- Capacity of system to deliver oxygen is just an estimate, this figure could vary depending upon water chemistry and physical conditions, it should therefore only be considered as a guideline.

3. Sizing a system based on COD (BOD) & ammonium (all waste water applications)

- All activated sludge system
- Municipal waste water
- Industrial process waste water
- Agricultural waste water
- Extended diffused aeration system

The aeration activated sludge systems are sized on the basis of the COD and ammonium concentration with application factor of 1.5. If you do not know the COD and only have BOD, then substitute BOD for COD and apply an application factor of 2.5. To size an installation for wastewater treatment, determine the COD loading in kg/day. For example, if the water flow is 100m^3/hr at 300mg/l of COD,

COD = 100 x 0.3 = 30 kg/hr = 30kg of oxygen per hour = 720 kg per day.
If the water depth is 3m, then from the performance table;
1 x diffuser code 70008 will deliver 27kg/day.
Number of diffusers required = 720 /27 x application factor 1.5 = 40 diffusers and an air flow of 400 m^3/hr
Ammonium will exert an autotrophic nitrification BOD on the system, which is not measured as COD.
1 kg of ammonium = 5 kg of oxygen demand or (COD equivalent)
If the ammonium concentration is 40mg/l in 100m^3/hr water flow, then mass of ammonium = 4kg/hr = 96kg/day.
If 1 kg of ammonium = 5 kg of COD, then the COD equivalent = 96 x 5 = 480kg
480kg / 27 x 1.5 = 27 diffusers. This figure assumes that the ammonium reduction is by nitrification which will not be the case if there is organic matter in the water.

Heterotrophic bacterial metabolism requires 1 kg of ammonium nitrogen per 10kg of organic matter, if the COD is 10 times the ammonium concentration, then all the ammonium will be assimilated as heterotrophic bacterium respiration. If the COD is at a lower concentration, then extra oxygen may be required to provide sufficient oxygen to complete the autotrophic bacterial nitrification metabolism of the system.

Example to determine the ammonium, COD equivalent factor

Ammonium = 40mg/l
COD = 300mg/l
Water flow = 100m^3/hr

Mass of ammonium kg/day = 0.04 x 100 x 24 = 96kg
Mass of COD kg/day = 0.3 x 100 x 24 = 720kg
Equation = (Ammonium - (COD / 10)) x 5 = COD factor
(96 – (720/10)) x 5 = 120 as COD factor

If the COD component is 720 kg day, and the ammonium contributes 120kg, the total number is 840 kg/day The number of diffusers = 840/27 x 1.5 = 47 diffusers and 470 m^3/hr of air.

4. Air Diffuser Installation

Detailed instructions

Installation of aeration systems

Dryden Aqua air diffusers are suited for installation in tanks, plastic lined lagoons, lakes or reservoirs of virtually any size or configuration. There is no limit to the size of the aeration system.

The systems comprise 4 basic components.

- Air blower
- Air ring main
- Air delivery hose / fittings
- Air diffusers

Typical roots blower specification

- 1 bar discharge pressure
- fitted with an acoustic environmental enclosure
- no load valve
- pressure relief valve
- temperature transmitter alarmed for over temperature
- filter restriction indicator and switch for connection to alarm system
- pressure transmitter connected to alarm system

Air blower installation

The air blower should be a 100% oil free positive displacement blower; for small systems, up to 150m^3/hr of air, rotary sliding vane compressors are the most economic and appropriate. For greater air flowrates, progress on to rotary lobe / roots type air blowers for air flows up to 2000m^3/hr. The blower should be able to deliver air at 1 bar pressure for installations where the diffusers are located at a depth up to 5m.

The blowers should be sized to deliver air at 1 bar discharge pressure, even if the water depth is only 3m. The blowers will always deliver the same air flow. If the pressure is lower however, then the work done by the blower and power absorbed will be reduced.

If the diffusers are located at a water depth greater than 5 metres, a rotary vane or roots type blower will be required that can deliver air of up to 1.5 bar pressure to compensate for the increased hydrostatic head and to make sure that the blower is relaxed and not running at its upper limit.

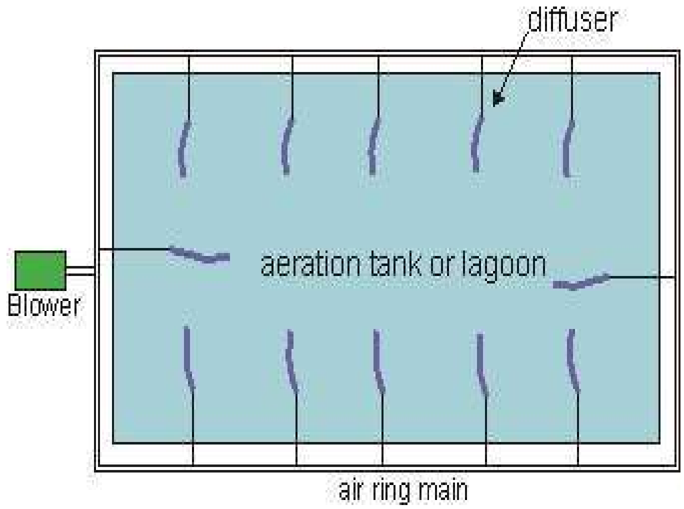
If water depth is greater than 10m, the pressure will need to be increased even further and rotary screw compressors will be better suited.

Blower location

The blowers must be located away from any air pollution, such as a diesel generator or source of any atmospheric contamination from dust, fines or solvents. The air blowers should be fitted inside an acoustic enclosure or installed under cover and protected from the elements. Ensure that the blower location is well ventilated to avoid the equipment over-heating. If the blower is located under cover in a room, then it is essential that the room has forced fan ventilation, otherwise the cooling air will be recycled in the room and the blowers will overheat.

The blowers must be located above the water level in the aeration system to avoid back siphoning of water through the pipework.

Air ring main



Locate the blower on a concrete pad and fit at least 6m of metal discharge pipe. When air is compressed the temperature increases, the metal pipe will help to dissipate some of the heat energy to protect the plastic pipework.

In tropical or hot climates, or if the water depth is over 3m, the discharge pipe from the blowers and the full ring main should be in metal pipe.

When air is compressed it gets hot, for every 0.1 bar, the air temperature will increase by 10°C. The maximum upper temperature for plastic pipe is 90°C. If the temperature is likely to exceed 80°C then metal pipe is recommended.

Example

Air temperature 30°C
Running pressure 0.8 bar = 8 x 10 = 80°C increase
Blower discharge temperature = 80 + 30 = 110°C
The diameter of the air ring main is a function of the air flow and perimeter of the lagoon. As a guide,

100 to 150m³/hr of air 90mm diameter pipe
150 to 200m³/hr of air 125mm diameter pipe
200 to 500m³/hr of air 150mm diameter pipe
500 to 1000m³/hr of air 250mm diameter pipe
1000 to 1500m³/hr of air 300mm diameter pipe

Condensate

The air in the air ring main will cool down as it progresses around the network. As the air cools a water condensate will collect in the pipe. The accumulation of water can be very rapid. If the outlet connection for the air is connected to the side of the pipe, then the air ring main pipe may half fill with water over the first few weeks of operation. It is therefore important to fit water vents around the air ring main.

Noise

Occasionally a resonant frequency may be achieved between the blower and the pipework. To attenuate the sound and prevent a resonant frequency, metal clamps with an elastomer lining should be used to absorb pipe vibration.

Delivery hose and fittings

A high quality ½" flexible hose connects the air ring main to the air diffuser. Urethane reinforced braided hose is recommended. The mechanism by which hoses are connected to the air ring main will depend if it is plastic or metal pipe.

If plastic pipe is used then HDPE (high density polyethylene) is recommended, if metal pipe is used then stainless steel is recommended. If mild steel pipe is used, it should be hot dipped galvanised to help with corrosion.

1. Fit the saddle clamp around the HDPE air ring main pipe with the 3/4* female BSP threaded fitting pointing toward the tank or lagoon. If metal pipe is installed, then a clamp may be used or a ¾" female BSP threaded socket welded onto the pipe. If the pipe is installed over the water, the air connection should be on the under-side of the pipe.
2. Through the ¾" BSP threaded fitting drill a ½" hole into the air ring main pipe
3. Screw into the ¾" female connection, a ¾" valve with a ½" female BSP socket, screw into the socket a ½" male threaded x ½" fluted hose tail
4. Cut the flexible ½" hose to a length that will take it to the base of the tank, make sure the diffuser is not hanging from the hose. For lagoons cut the hose at a point 0.5m above the base of the lagoon.
5. Push fit the hose onto the valve hose tail and secure with a screw clip.
6. Fit the diffuser on to the other end of the hose and drop the diffuser into the tank.
7. Repeat this process for all the air diffusers.

Extra ballast

If the tank or lagoon has a water depth over 5m, with diffusers spaced less than 5m apart, then there may be a tendency for the diffusers to lift. Under these conditions, we can provide additional ballast for the diffusers. The ballast fits onto the end of the hose, and the diffuser screws onto the ballast.

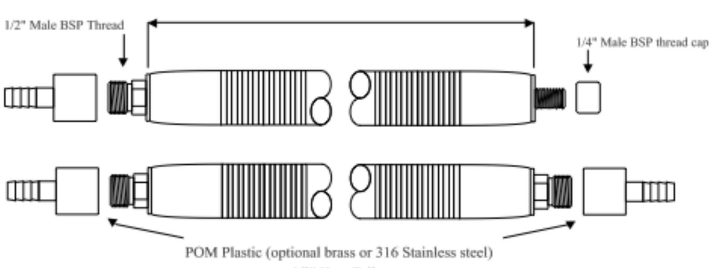
The ballast is manufactured in 316L grade stainless steel and measures 75mm x 75mm x 75mm. Ballasts are available with an air connection on the top with either 1 or 4 diffuser outlets, one on each side.

Diffuser Construction

The diffusers are manufactured from a very heavy-duty polyester fabric tube, a nylon distributor hose runs down the centre of the tube. Between the nylon hose and polyester tube there is a ballast comprising spherical glass beads.

The diffuser is banded using 316 stainless steel compressed on to the nylon inner tube with a nitrile rubber bush.

The metal end fittings are 316L grade stainless steel. As standard, each diffuser is fitted with a ½" acetyl plastic hose tail for connection of the diffuser to a ½" flexible hose. The plastic hose tail is screwed into the stainless-steel fitting on the end of diffuser.



5. Air Diffuser Maintenance

Solid diffusers are more efficient than membrane diffusers, however they experience problems due to carbonate and iron deposition which blocks the diffusers. For this reason, the water industry has moved to membrane type diffusers.

Membrane or elastomer diffusers do not block; however, they must be installed on frames or modules and secured to the base of the tanks. This makes them unsuitable for lagoons and makes them difficult to service. The modules must either be recovered using a crane, or the tank must be emptied every 1 to 5 years to repair or replace the diffusers. Typically, on any installation with 10 aeration lanes, one will be decommissioned for servicing at any one time.

The Dryden Aqua fine bubble, self-ballasted air diffuser will also experience both mineral and biofouling. They are however very easy and quick process to clean and, by using Dryden Aqua diffusers, the aeration lanes will never be out of service. A second major advantage is the very high performance of Dryden Aqua diffusers, 26.9% Oxygen Transfer Efficiency against only 14.2% for membrane type diffusers. This means that the blowers are much smaller with Dryden diffusers and 30% less energy is consumed. The waste water industry in Europe uses 2% of all power generated, and most of this energy is expended on driving the aeration systems.

The Dryden Aqua diffuser is a hybrid unit. Because it is semi flexible, carbonates and metal oxide precipitates simply crack and fall off the flexible surface, and biofilm comes off with an occasional brush. Also, because the diffuser has its own internal ballast, it does not need to be anchored to the base of the tank. When cleaning or, if maintenance is required, the diffuser is simple pulled out of the tank using the air hose. The tank can be full of water and the air blowers running when diffusers are removed. This makes the diffusers very easy and efficient to maintain.

The frequency of cleaning depends upon the quality of the water. Usually, the cleaning frequency will be once every 4 weeks to 6 months. If the diffuser starts to become fouled, the air blower pressure will start to increase. If the discharge pressure increases by any more than 2 psi (0.15 Bar), then it is recommended that the diffusers are cleaned. Normal static pressure loss, without taking account of water depth, will be 3 psi (0.2 Bar).

Standard cleaning procedure

1. Remove the diffuser for the tank or lagoon using the ½" flexible hose to recover the diffuser
2. Wearing a pair of strong gloves, simply pull the diffuser through your clenched hand, give it a shake and then drop back in the tank

The above basic cleaning process is all that is required. Once every 1 to 6 months however, they may require a more aggressive chemical clean once a year, especially during the first year of operation, or if the water has a high alkalinity and hardness.

Chemical Cleaning of the diffusers

Any surface in contact with biologically active water, will develop a biofilm. If the water has a high calcium and carbonate concentration, then there may also be scale formation.

Most of the scale formation will take place during the first 12 months. During this period, the diffusers will be working hard to reduce the concentration of organics in the water and any sludge in the system. It also takes around 6 months for the bacterial cell biomass to develop.

If scale forms on the diffuser this will happen very slowly, because it is difficult for scale to form on a flexible air diffuser. However, if the water is very hard then scale is a possibility. To remove the scale, make up a solution of 30% phosphoric acid, diluted with 5 parts water. Soak the diffuser in the solution for 10 minutes or until it stops fizzing. Do not soak for more than 20 minutes. After acid treatment wash with freshwater and immediately connect back onto the air ring main and throw back into the water.

The acid will be consumed during the cleaning process, so if cleaning multiple diffusers some fresh acid solution will be required. Any waste acid solution may be added to the aeration system. If the diffusers are cleaned and looked after, they can be expected to give up to 10 years of useful life.

6. System Performance

Extended diffused aeration system and system performance

Wastewater, extended aeration systems can be operated as serial tanks or SBR Sequencing Batch Reactors. SBR performance is usually superior to serial-based systems but they are technically more complex and require more space. If the residence time of waste water in the system is under 10 days then we recommend serial flow systems, if more than 10 days then SBR is better.

The systems should be as large as possible, the greater the volume of water in the lagoons/tanks, the longer the waste water residence time. Most heterotrophic bacteria that digest organic matter grow very quickly, they may have a doubling time as short as 15 minutes. However, if the organics are hard for the bacteria to oxidise, then the time required may be substantially longer and extend into days. Bacterial activity follows the 80:20 rule, it is easy for a bacterium to metabolise the first 80% to 90% of the organics, it is the remaining 10% to 20% that is difficult. If systems are aiming to achieve the best possible discharge standards, or even zero discharge, then use of extended diffused aeration, activated sludge systems as part of the main process is the perfect choice.

Natural selection

If a system is stable, then through a process of natural selection bacteria will develop that will be able to oxidise most organics, even toxic PCBs can eventually be metabolised or removed. If the organic load is low, then autotrophic bacteria will predominate in the system, especially towards the end of the process. Heterotrophic bacteria and COD/BOD reduction will often take place at the beginning of the system, and as the organics are reduced in concentration, autotrophic bacteria start to colonise the latter parts of the aeration system.

Autotrophic bacteria such as the nitrifiers Nitrosomonas and Nitrobacter are responsible for oxidising ammonium to nitrite and nitrate and can take up to 30 days to double in biomass at a temperature of $10^{o}C$. Long residence time and/ or fluidised bed bioreactors or fixed film systems should be used to optimise the process.

Caution must be exercised when running systems close to $36^{o}C$ because this is the temperature of human blood, and as such there is a greater risk of incubating human pathogens in the effluent treatment system. Dryden Aqua fine bubble air diffusers are much more efficient than surface aerators because they do not waste kinetic energy by throwing the water in to the air. Fine bubble air diffusers are also safer, because they do not generate an aerosol, so there is less risk of spreading potentially pathogenic bacteria in the air.

We do not recommend the use of venturi type injectors or forced propeller injectors for activate sludge or extended biological treatment systems. Injectors tend to cause gas supersaturation with nitrogen, bulking of the sludge and foam formation. The injectors also smash up the bacterial floc and reduce the performance of the bacteria.

Aeration and biological system performance

The performance of an extended diffused aeration system is inherently better, more stable and more reliable than a standard activated sludge aeration system, and when combined with Dryden Aqua air diffusers in an optimised process the performance is excellent.

The following table compares performance data for a Dryden Aqua extended diffused aeration system with a standard activated sludge system using membrane diffusers. Examples and literature are cited to verify the performance statements.

	Type of system	Residence time days	AFM tertiary treatment	Typical performance Suspended solids	Typical performance BOD	Typical performance COD	Typical performance ammonium
Municipal waste water treatment	Typical Activated sludge with decantation	0.5 days	no	90%	95%	85%	50%
municipal waste water	Dryden Activated sludge with decantation, tertiary treatment	3 days	yes	>99%	>99%	>95%	>99%
industrial waste water	Dryden Activated sludge with decantation, tertiary treatment	3 to 15 days	yes	>95%	>95%	>90%	>95%
landfill leachate	Dryden Activated sludge, SBR	5 to 45 days	no	>95%	>95%	>90%	>95%

The performance of a Typical activated sludge system using membrane diffusers.
Water 2015, 7, 855-867; doi:10.3390/w7030855

Parameter		**Source Effluent Concentration mg/l**	**Range Removal Efficiency Range**
TSS (mg/L)	literature	20 to 40	87 to 93
	actual	22 to 33	90 to 93
BOD	literature	10 to 40	85 to 97
	actual	21 to 30	77 to 85
COD	literature	30 to120	80 to 93
	actual	41 to 55	76 to 82
TN	literature	>15	<60
	actual	16 to 26	43 to 53

- Arceivala, S.J. Wastewater Treatment and Disposal: Engineering and Ecology in Pollution Control; Marcel Dekker Inc.: New York, NY, USA, 1981.
  Water 2015, 7 867
- Qasim, S.R. Wastewater Treatment Plants: Planning, Design and Operation; Holt, Rinehart and Winston: New York, NY, USA, 1985.
- Design of Municipal Wastewater Treatment Plants; Water Environment Federation/American Society of Civil Engineers: Alexandria, VA, USA, 1982.
- Mara, D. Domestic Wastewater Treatment in Developing Countries; Earthscan: London, UK, 2003.
- Metcalf & Eddy. Wastewater Engineering: Treatment and Reuse, 4th ed.; Metcalf & Eddy, Inc.: New York, NY, USA, 2003.
- Von Sperling, M.V.; Chernicharo, C.A.L. Biological Wastewater Treatment in Warm Climate Regions; IWA Publishing: London, UK, 2005; Volume 1.

7. Applications

- Annex 1: Extended diffused aeration biological wastewater treatment
  - Textile waste water
  - Landfill leachate
  - Municipal wastewater
  - Industrial
- Annex 2: Gas stripping of THMs and Radon from drinking water
- Annex 3: Oxidation of metals such as ferric, manganese and arsenic
- Annex 4: Thermal and chemical destratification of lakes
- Annex 5: Agricultural waste water
- Annex 6: Aquaculture systems