DRYDEN AQUA TECHNOLOGY
SUSTAINABLE WATER QUALITY

Fine Bubble Air Diffusers
for
Water Aeration, Oxidation & Mixing

Typical applications

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

Key features

- Semi-flexible, tubular construction
- Self ballasted
- Available in 9 lengths from 0.3 - 3m.
- Air handling capacity from 1 - 10m^3/hr
- Less than 0.2 Bar (3 psi) pressure differential
- Oxygen transfer efficiency up to 5 kg/kwhr
- Resistant to calcification
- Easy to clean and maintain
- Robust and long-lasting (typical lifespan in chemically aggressive landfill leachate plants is more than 10 yrs)

Air Diffusers : Simple, efficient and sustainable water treatment without chemicals

About Dryden Aqua

Founder of Dryden Aqua, Dr Howard Dryden is a marine biologist with a unique knowledge combination of biology, chemistry and technology. He is the inventor and developer of the activated, bio-resistant filter media AFM® as well as a range of niche products for use in the water treatment industry.

Dryden Aqua was founded in 1980 primarily to serve the aquaculture industry. The company's unique knowledge combination and detailed understanding of biological as well as physio-chemical processes has since enabled it to develop into other markets where sustainable water treatment processes can make a difference. Dryden Aqua provides innovative and simple, solutions for treatment of drinking water, food and beverage processing, industrial process water as well as municipal and industrial waste water worldwide. Dryden Aqua processes use nature rather than fighting against it!

Comparative Advantages of Dryden Aqua Fine Bubble Air Diffusers

Maintenance

- Solid diffusers suffer from problems of blockage from carbonate and iron deposition and are therefore very difficult to clean and maintain.
- Flexible membrane type diffusers stay largely free of fouling but, need a heavy frame or, must be anchored to the base of the aeration tank.
- Dryden Aqua diffusers are hybrid units. As they are semi flexible, carbonates and metal oxides simply crack off the unit.

Efficiency

- Surface aerators waste a huge amount of kinetic energy with an O_2 transfer coefficient of 1 - 2 kg of O_2 per kW.
- Membrane diffusers are more efficient at 2 kg to 3 kg of oxygen per kW.
- Dryden Aqua fine bubble air diffusers have an average bubble size of 1mm with Oxygen transfer coefficient of over 5 kg of O_2 per kW.

DA fine bubble air diffusers are therefore the most efficient available and are ideal for retrofit applications as a simple drop-in product, for lakes, tanks, lagoons and aeration channels, for both clean water and waste water treatment.

Diffuser Performance

Oxygen Transfer Efficiency

Dryden Aqua fine bubble diffusers deliver up to10m³/h of air and 1 kg of O_2/hr with an oxygen transfer efficiency of up to 5 kg/kwhr. Diffuser efficiency will however depend on bubble size and headloss. O_2 Transfer efficiency will also vary with temperature, water depth and salinity.

The table (right) shows oxygen transfer efficiency in kg of O_2 per day of different lengths of diffusers in freshwater at 20°C. At lower temperature and in seawater O_2 transfer efficiency will be further improved.

As a general design guideline and with a generous safety margin to account for temperature variation etc. 10 m³/hr of air will provide 1 to 2 kg of oxygen transfer per hour per diffuser. For more accurate dimensioning guidelines please refer to the diffusers IFU that is available on the Dryden Aqua website via via the following link https://www.drydenaqua.com/water-treatment/products/air-diffusers.

Description	Air Flow m³/hr (+/- 20 %)	Oxygen Transfer kg of O_2/day per diffuser at different depths		
		2 m	3 m	4 m
0.33 m Diffuser	1	2 kg O_2	2.5 kg O_2	3 kg O_2
0.66 m Diffuser	2	4 kg O_2	5.0 kg O_2	6 kg O_2
1.00 m Diffuser	3	6 kg O_2	7.5 kg O_2	9 kg O_2
1.33 m Diffuser	4	8 kg O_2	10 kg O_2	12 kg O_2
1.66 m Diffuser	5	10 kg O_2	12 kg O_2	15 kg O_2
2.00 m Diffuser	6	12 kg O_2	15 kg O_2	18 kg O_2
2.33 m Diffuser	7	14 kg O_2	17 kg O_2	21 kg O_2
2.66 m Diffuser	8	16 kg O_2	20 kg O_2	24 kg O_2
3.0 m Diffuser with NRV	9	18 kg O_2	22 kg O_2	27 kg O_2

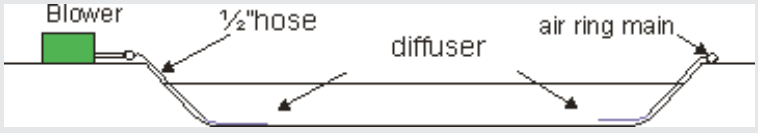
In independent tests carried out by Dr. Shigetaka Wada of Chulalongkorn University, Dryden Aqua diffusers were found to be 29% efficient compared to 14% efficient for good quality membrane diffusers and 10% for standard coarse bubble diffusers.

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.

Water Depth in metres	Water lifted by 1m³/hr of air passed through a diffuser
3	10 m³/hr
4	15 m³/hr
8	20 m³/hr
10	40 m³/hr
20	80 m³/hr
30	120 m³/hr
40	160 m³/hr
60	200 m³/hr

Fine bubble diffused aeration is the most cost-effective means of generating mass vertical motion of water. A small volume of air can move a massive quantity of water for a relatively low energy expenditure. For example, 1m³ of air, diffused at a depth of 60m will lift in the region of 200m³/hr of water.

The table (left) gives the volume of water moved per m³/hr of air by Dryden Aqua Fine bubble diffusers at different depths.



Installation

In lakes and lagoons and in most industrial applications an air distribution ring main is the best way to supply air to large numbers of diffusers. ½" flexible hoses are used to link the diffusers to the ring main (see images above and left). Diffusers are fitted to the hoses via the hose tail connectors supplied, and then simply dropped into the tank. No further fixings are needed. Maintenance and cleaning are carried out by simply pulling on the flexible hoses to recover the diffusers. Maintenance can be carried out with the tank can be full of water and the air blowers running.

The diffusers require a positive displacement, 100% oil free blower to drive the system. The blower should ideally be located adjacent to the air diffusers but can be many 1000`s of metres away if the pipework is sized accordingly. If plastic distribution pipe is used, the first 6 metres of pipe work should be metal in order to reduce the air temperature to <90 °C max in any plastic pipe.

Pressure loss across the diffusers is 0.2 Bar (3psi). The air pressure required is therefore equal to :

- diffuser headloss + water head + systems losses.

This can be calculated as :

- 0.2 Bar + 0.1 Bar per metre head of water + pipework head losses (normally max 0.2 Bar).

Diffusers in Water Treatment

Biological treatment of waste water

Municipal wastewater or industrial wastewater from the food industry which have a high BOD:COD ratio are relatively easy to treat. Examples like the pharmaceutical industry or textile industry with a high 'hard COD' quotient are more difficult.
The fine bubble size, low pressure loss and durability of the Dryden Aqua diffusers make them ideally suited even to the most extreme cases although in more difficult 'hard COD' cases, residence time in reservoirs may need to be increased and nutrients added.
In landfill leachate sites and applications with a high hard COD quotient, requiring residence times of > 10 days, (see table right) Sequencing Batch Reactors (SBR) are used to ensure best fit of bacterial flora to the biological loads at each stage of the treatment process. With increased residence time, the mass of sludge generated also decreases due to endogenous respiration.
See the diffusers IFU document https://www.drydenaqua.com/water-treatment/products/air-diffusers for more details.

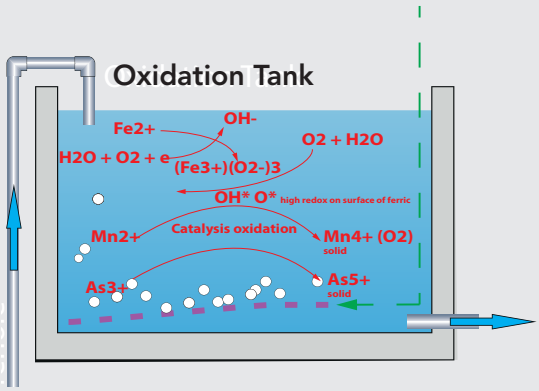
Gas stripping of THMs and Radon from drinking water

Dryden Aqua air diffusers are used to blow-off excess dissolved gases.

If drinking water originates from a granite aquifer it may contain radio-active Radon. In countries like Norway where Radon is a problem Dryden Aqua air diffusers are used for scrubbing drinking water.

Chlorinated water will react with dissolved organic precursors such as humic and fulvic acid and to form THMs such as chloroform. A small amount of aeration can provide a 25% to 50% reduction in THM's. 1 x 3m DA diffuser delivering 10m^3/hr of air for every 10 to 20m^3/hr of water treated will give a 50% reduction in dissolved gases. For precise calculation variables such as water depth, temperature and contact time must also be taken into account.

Oxidation of Ferric, Manganese and Arsenic



Dryden Aqua air diffusers are commonly used for oxidation and precipitation of dissolved metal contaminants from the water. They are particularly effective for ferric removal and also for manganese or Arsenic in cases where Mn:Fe or or As:Fe ratios are less than 1:5 or 1:10 respectively. If necessary additional ferric can be added to redress the balance and to facilitate oxidation and co-precipitation. Contaminated water is usually ground water which must be strongly aerated for at least 30 minutes prior to filtration after which it should be AFM® filtered to complete the process.

Destratification of Lakes and Reservoirs

Thermal and nutrient stratification in lakes can lead to cyclic seasonal toxic algal blooms, high concentrations of bacteria, legionella risk and general deterioration of water quality. Simple aeration at the deepest part of the lake is a very effective means of de-stratification, thereby improving productivity and stability of the entire body of water. As little as a 7 day airlift driven turnover can have a dramatic effect in lakes containing several million m^3 of water..

Aeration of Aquaculture systems

Dryden Aqua diffusers were originally developed for Aquaculture and we have been supplying diffusers and aeration systems to the Fish Farming Industry for many years. Aeration greatly improves the environmental conditions for fish and reduces disease riusk while also improving the quality of the water discharged from the farm.

Aeration systems are normally sized to meet 100% of the oxygen requirements of the fish and to maintain the dissolved oxygen concentration at approximately 70% saturation with no influent water to the tanks..

For further detailed information and instruction on use of diffusers please consult the Diffusers IFU (Information For Use) document which can be downloaded from the Dryden Aqua website www.drydenaqua.com via the following link: https://www.drydenaqua.com/water-treatment/products/air-diffusers

Diffuser Applications

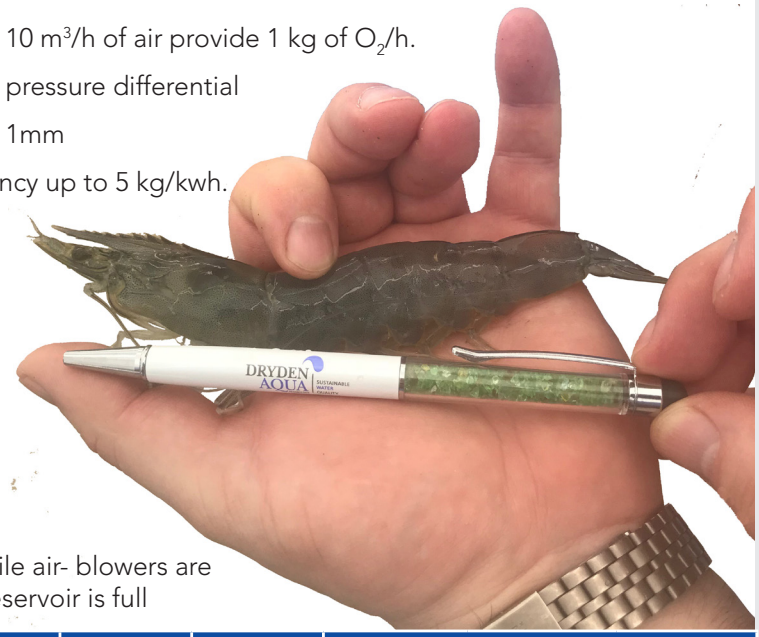
Application Guidelines for Dryden Aqua Fine Bubble Diffusers

Application Type	Residence time	Dimensioning Guidelines	
Biological treatment of waste water			
Municipal waste water	1 - 5 days	1 x 3m diffuser for 50 - 100 PE Population Equivalent	For Oxygen demand, determine the COD loading in kg/day Oxygen demand = water flow (m^3/hr) x COD (kg/m^3) x 24 *(kg/m^3 = mg/l x 100)* An application factor of 1.5 should also be added e.g. If water flow is 100m^3/hr and COD is 300mg/l. 100 x 0.3 = 30kg/hr x 24 = 720kg of O_2/day At 4m depth a 3m DA diffuser will deliver 27kg/day of O_2. see table p3 You therefore need 720/27 x 1.5 = 40 diffusers x 10 m^3/hr = 400 m^3/hr of air
Industrial waste water	3 - 15 days	See right	
Textile waste water	3 - 5 days	See right	
Agricultural waste water (pigs, cows)	5 - 50 days	1 x 3m diffuser for 10 cows / 20 pigs	
Pharmaceutical waste	30 - 60 days	See right	
Landfill Leachate	5 - 45 days	See right	
If there is also an Ammonium load then 5kg of oxygen should be added for each kg of ammonium. See Diffusers IFU for full details.			
Gas Stripping			
Radon or THM's in drinking water	60 mins	1m^3/hr of air per 1 - 2m^3/hr of water flow	
CO_2, VOC's and pH balance	30 mins	0.5 - 1m^3/hr of air per m^3/hr of water flow	
Oxidation of Groundwater for Iron, Manganese & Arsenic			
Iron removal Mn removal As removal	30 mins " "	0.5 - 1m^3/hr of air per m^3/hr of water flow • Mn:Fe ratio must be < 1:5 • As: Fe ratio must be < 1:10 AFM® is used for metals removal post oxidation.	
Destratification of Lakes and Reservoirs			
Thermal & Nutrient Destratification	Turnover 7 days 3 days < 3 days	Nominal - Use 1 x 3 m diffuser (10 m^3hr of air) per 1,000 m^2 of lake surface area or:- For lakes with deep central area For shallower lakes with compromised circulation For lakes with high load e.g. agricultural run-off or bio-load	
Airlift circulation is cheap. Circulation must be 24/7/360.....Always overdimension! NoPhos can be added for Phosphate control See Diffusers IFU for full details			
Aeration of Aquaculture systems			
General	Each 20kg of feed/day, needs 30kg to 40kg of O_2 day to metabolise the feed.		
Salmonids (smolts, trout farms, RAS systems etc.)	In shallow tanks at 20°C 10m^3/hr of air will deliver 250 to 500g/ hr of O^2 (seawater 350 - 600g/hr). - 1000kg of smolts below 15°C, require = 10 - 20m^3/hr of air (2 x 3m diffusers) - 1000kg of smolts above 15°C, require = 20 - 30m^3/hr of air (3 x 3m diffusers)		
Salmon Cages	For cage de-stratification - 1 x 3m diffuser per 10 tonnes of salmonids		
Tropical spp, shrimps, Tilapia.....	At temperatures above 25°C - 1000kg of shrimps above 25°C, require = 40m^3/hr of air (4 x 3m diffusers)		
N.B. In all cases tank depth and salinity have an enormous influence on diffuser efficiency. Optimum depth 2.4 - 3m.			

Summary

Summary Specification

- Semi flexible tubular construction up to 3 m in length
- Outer polyester jacket with Internal glass bead ballast
- Plastic & stainless fittings
- Self ballasted. No secondary anchorage required
- Air flow from 1 to 10 m^3/h
- 1 x 3 m air diffuser and 10 m^3/h of air provide 1 kg of O_2/h.
- Less than 0.2 Bar (3psi) pressure differential
- Average Bubble size < 1mm
- Oxygen transfer efficiency up to 5 kg/kwh.



- Can be maintained while air- blowers are operating and water reservoir is full

Article	Description	Diffuser Weight kg	Air Flow m^3/hr (+/- 20 %)	Oxygen Transfer kg of O_2/ day per diffuser at different depths		
				2 m	3 m	4 m
70000	0.33 m Diffuser	0.5	1	2 kg O_2	2.5 kg O_2	3 kg O_2
70001	0.66 m Diffuser	1.0	2	4 kg O_2	5.0 kg O_2	6 kg O_2
70002	1.00 m Diffuser	1.5	3	6 kg O_2	7.5 kg O_2	9 kg O_2
70003	1.33 m Diffuser	2.0	4	8 kg O_2	10 kg O_2	12 kg O_2
70004	1.66 m Diffuser	2.5	5	10 kg O_2	12 kg O_2	15 kg O_2
70005	2.00 m Diffuser	3.0	6	12 kg O_2	15 kg O_2	18 kg O_2
70006	2.33 m Diffuser	3.5	7	14 kg O_2	17 kg O_2	21 kg O_2
70007	2.66 m Diffuser	4.0	8	16 kg O_2	20 kg O_2	24 kg O_2
70008	3.0 m Diffuser with NRV	4.5	9	18 kg O_2	22 kg O_2	27 kg O_2
70020	75 x 75mm weight with 2 x ½" connectors for installations > 5m depth					
70021	75 x 75mm weight with 5 x ½" connectors for multiple diffuser connections