

Air Diffuser

Instructions for Use

Let Nature Do Your Work



**Water treatment, Metals Oxidation,
Aquaculture, Pond Remediation/Eutrophication**

Typical applications

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

Dryden Diffuser Benefits

- Highly efficient oxygen transfer, up to 5kg/kW/h
- Self-ballasted to 3m, simply dropped into tanks or lagoons
- Easy installation and retrofits
- Easy to maintain, no need to drain tank
- Less than 65mbar differential pressure
- Stainless steel and plastic construction
- 10 year average life cycle
- Can be used with Air, N₂, CO₂

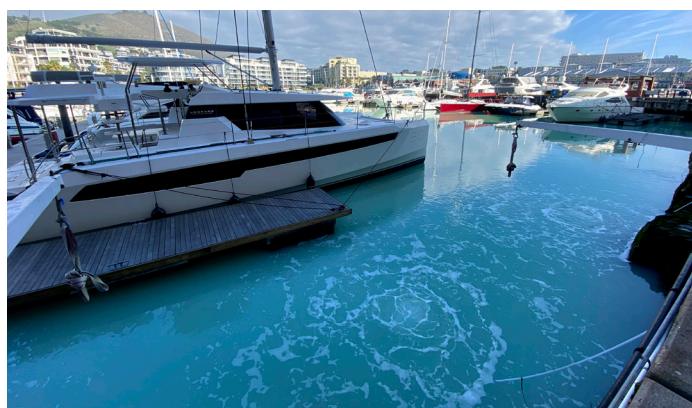


Table of Contents

1.	Introduction	5
1.1	Product Overview	5
1.2	Product codes & Specifications	5
1.3	Key Product Benefits	6
2.	Performance Data & How to Interpret It	6
2.1	Bubble Size	6
2.2	Oxygen transfer Coefficient (kLa):	6
2.3	Explanation of Key Performance Terms	7
2.4	Independent Test Results	7
3.	System Sizing Considerations	9
3.1	Typical Applications:	9
4.	System Design & Installation	9
4.1	System components:	9
4.2	Air blower selection:	9
4.3	Ring Main Piping	10
4.4	Step-by-Step Installation Procedure	10
4.5	Normal Operating Parameters	11
4.6	Start-up Procedure	11
4.7	Shutdown	12
5.	Maintenance	12
5.1	Maintenance Schedule	12
5.2	Standard Physical Clean	12
5.3	Chemical Clean (Scale Removal)	12

Dryden Diffuser Applications

1.	Sizing a system based on COD (BOD) & ammonium	14
2.	Gas stripping of THMs and Radon from drinking water	16
3.	Oxidation of ground water for the removal of ferric, arsenic & manganese	17
3.1	How to size a system	17
3.2	Filtration stage	17
4.	Thermal and chemical destratification of water bodies	18
4.1	Sizing and design of a system	18
4.2	Examples of Lake aeration configurations	18
5.	Biology and chemical stability of Lake aeration systems	19
5.1	Phosphates	19

5.2 Algal biodiversity	19
6. Sea Water Applications	21
7. Agricultural waste water	22
7.1 Design criteria	22
7.2 Air diffusers	22
7.3 Aeration in the shed	22
7.4 Treatment of the wastewater	22
8. Aeration of Aquaculture systems	23
8.1 Efficiency & sizing of system	24

1. Introduction

The Dryden Aqua fine bubble air diffuser is a high-performance, self-ballasted aeration device designed for use in tanks, lagoons, lakes, ponds, and open water bodies. This manual covers product specifications, independently verified performance data, installation, operation, maintenance, and application guidance across aquaculture, wastewater treatment, and water quality management sectors.

The diffuser generates fine to medium bubbles (1 to 3mm) that provide excellent oxygen transfer efficiency while maintaining strong vertical water movement. This combination distinguishes it from nanobubble generators, conventional membrane and disc diffusers.

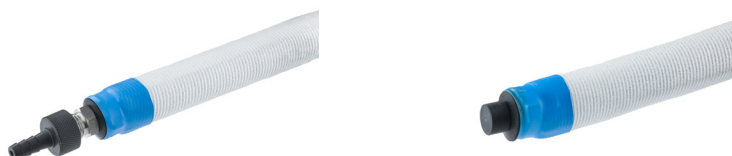
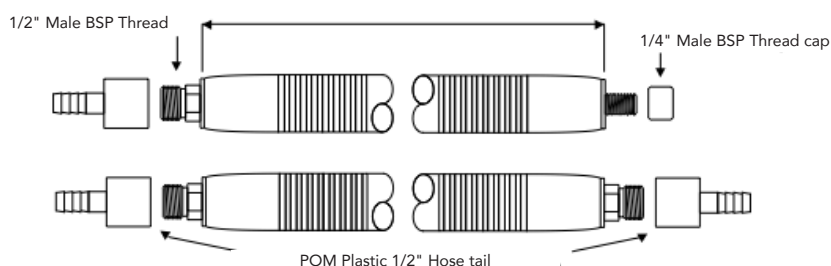
1.1 Product Overview

The diffusers are manufactured from a heavy-duty polyester fabric tube with internal nylon distributor hose. Glass bead ballast between the hose and outer tube ensures that the diffuser sinks and lies flat on the bottom without anchoring in water depths <4m. All metal components are 316L stainless steel and the inlet connection is a 1/2" POM acetal hose tail. The diffuser range covers 4 different size units as per the table below.

1.2 Product codes & Specifications

Product Code	Description	Diffuser Weight	Air Flow m ³ /hr (+/- 20 %)
70000	0.33 m Diffuser	0.5kg	1
70002	1.00 m Diffuser	1.5kg	3
70005	2.00 m Diffuser	3.0kg	6
70008	3.00 m Diffuser	4.5kg	9

Table 1: Standard product codes and specifications



1.3 Key Product Benefits

- Fine bubble output (between nano and course) — high SOTE with strong water movement
- Self-ballasted — no anchoring required at depths up to 3 m
- Less than 86 mbar pressure drop across diffuser (3 m unit)
- Can be removed and cleaned while blowers are running and tanks are full with water
- Compatible with air, N₂, and CO₂
- Suited for concrete, steel, clay-lined, and plastic-lined systems
- Independently verified to be 43% more efficient than comparable Japanese and US membrane diffusers
- 4× more efficient than surface paddle aerators in aquaculture applications
- >10 year service life with correct maintenance

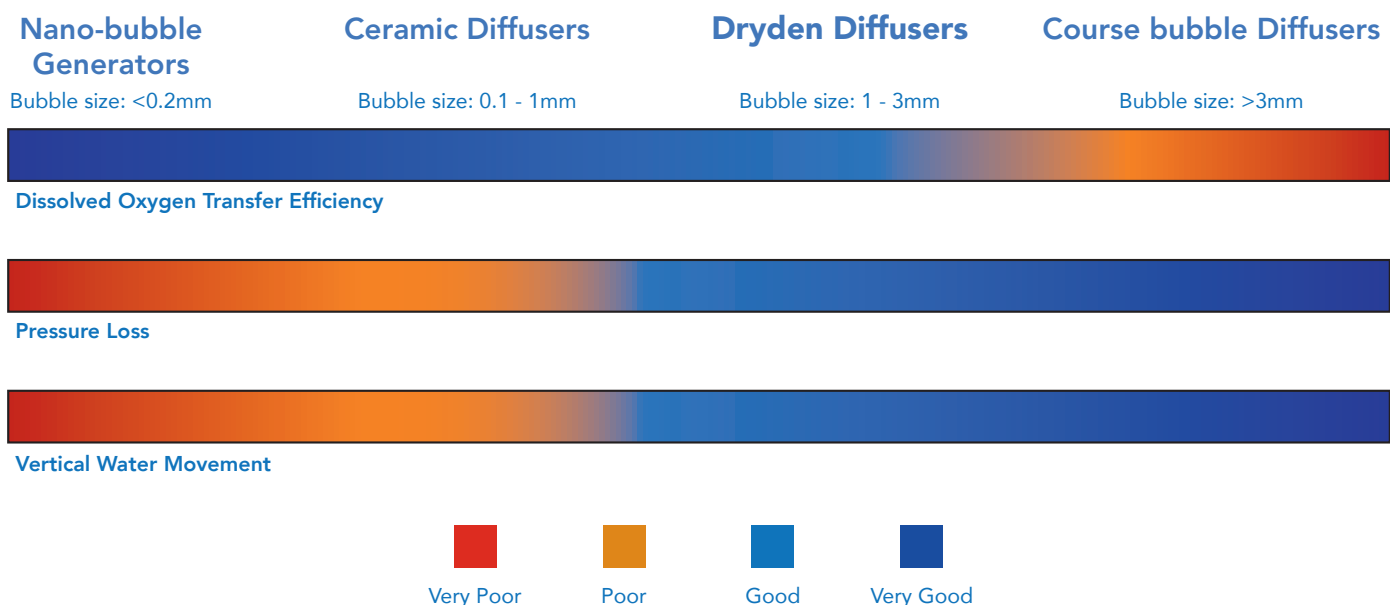
2. Performance Data & How to Interpret It

All performance values are presented as Standard Oxygen Transfer Rate (SOTR) and Standard Oxygen Transfer Efficiency (SOTE) measured under standard conditions: 20°C water temperature, zero dissolved oxygen, atmospheric pressure at sea level. Performance data was generated by independent laboratory testing using the clean water test methodology (ASCE 2-18).

The performance of any air diffusers depends on three linked factors: **bubble size, oxygen transfer coefficient and energy consumed**. Dryden Diffusers are engineered to optimise all simultaneously.

2.1 Bubble Size

The Dryden Aqua diffuser produces bubbles in the fine range (1 to 3mm) - intermediate between conventional course bubble aerators and dedicated nano-bubble generators. This intermediate zone is optimal as bubbles are small enough to achieve excellent oxygen transfer (large surface area-to-volume ratio, long residence time) while being large enough to create vigorous vertical water movement and mixing. Competing fine bubble membrane diffusers (EPDM) often sacrifice water movement for small bubbles and high pressure losses.



2.2 Oxygen transfer Coefficient (kLa):

kLa is a measure of how quickly oxygen transfers from the air bubble to water. It depends on bubble surface renewal rate, water turbulence and temperature. The Drydens Diffusers flexible fabric promotes continuous surface renewal and high turbulence.

2.3 Explanation of Key Performance Terms

Term	Definition
kLa_{20}	Volumetric oxygen transfer coefficient at 20°C (1/h). Measures how quickly oxygen dissolves from bubbles into water. Higher = faster transfer.
$SOTR_{20}$	Standard Oxygen Transfer Rate — mass of O_2 transferred per hour (kg/h or day) under standard conditions. The primary sizing parameter.
$SOTE_{20}$	Standard Oxygen Transfer Efficiency — percentage of injected O_2 that dissolves. Strongly depth-dependent. At 4 m: ~33.7%; at 8 m: ~67.9%.
$SSOTE_{20}$	Specific SOTE per metre of water depth (%/m). For this diffuser: 8.41–8.48 %/m. Multiply by any target depth to predict SOTE. Virtually independent of flow rate.
SAE_{20}	Standard Aeration Efficiency — kg O_2 transferred per kWh of blower energy. Tested value: 3.35–3.43 kg O_2 /kWh. Useful for operating cost comparisons.

Table 2: Definition of terms

2.4 Independent Test Results

Independent testing of the diffusers performance was carried out by **Clewatec, Germany**, a Competence Centre for Clean Water technology, in 2023.

Description Length of diffusers m	Diffuser Weight kg	Air Flow m ³ /hr (+/- 20 %)	SOTR @ 5m depth kg O_2 /day	SOTE @ 5m depth %
0.33 m Diffuser	0.5kg	1	3.2	42.5
1.00 m Diffuser	1.5kg	3	10	42
2.00 m Diffuser	3.0kg	6	22	42
3.00 m Diffuser	4.5kg	9	32	44

Table 3: Diffuser SOTR & SOTE rated performance at 5m water depths at STP and starting at a dissolve oxygen of zero.

Depth (m)	$SOTE_{20}$ (%)	Oxygen Transfer - kg O_2 /day @ STP			
		0.33m diffuser	1m diffuser	2m diffuser	3m diffuser
1	8.5	0.61	1.84	3.69	5.53
2	17	1.22	3.69	7.38	11.07
3	25.4	1.83	5.53	11.07	16.60
4	33.9	2.43	7.38	14.76	22.13
5	42.4	3.04	9.22	18.44	27.67
6	50.9	3.65	11.07	22.13	33.2
7	59.4	4.26	12.91	25.82	38.73
8	67.9	4.87	14.76	29.51	44.27

Table 4: Oxygen transfer of the different Dryden Diffuser models at different water depths.

Key Metric:

Independent testing confirms SAE of 5.56kg O_2 /kWh and SOTE of 42 - 44% at 5m depth - also verified to be 43% higher performance than equivalent Japanese and USA fine bubble membrane diffusers.

Performance Charts

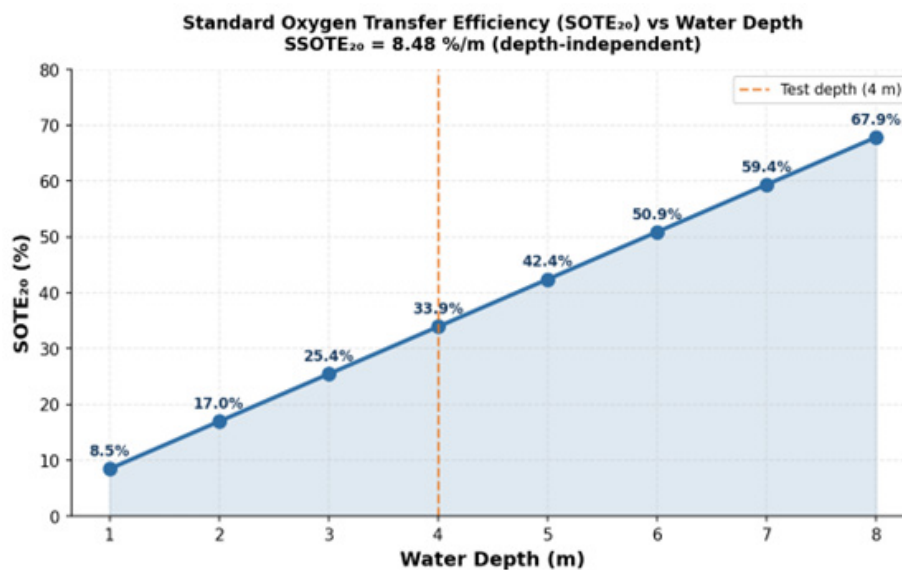


Figure 1: SOTE₂₀ vs depth, showing the linear relationship governed by SSOTE₂₀ = 8.48%/m. The dashed line marks the test depth.

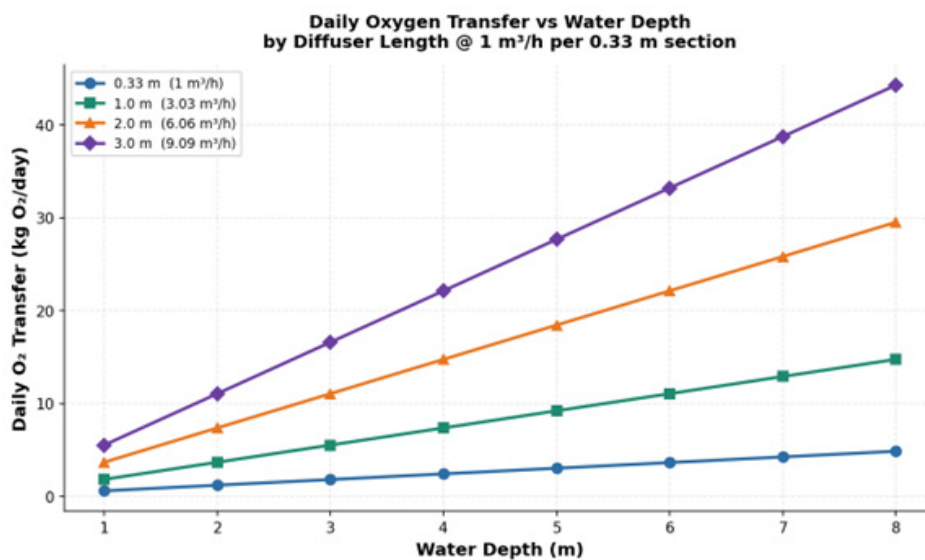


Figure 2: Daily O₂ transfer by diffuser length vs water depth for the different models

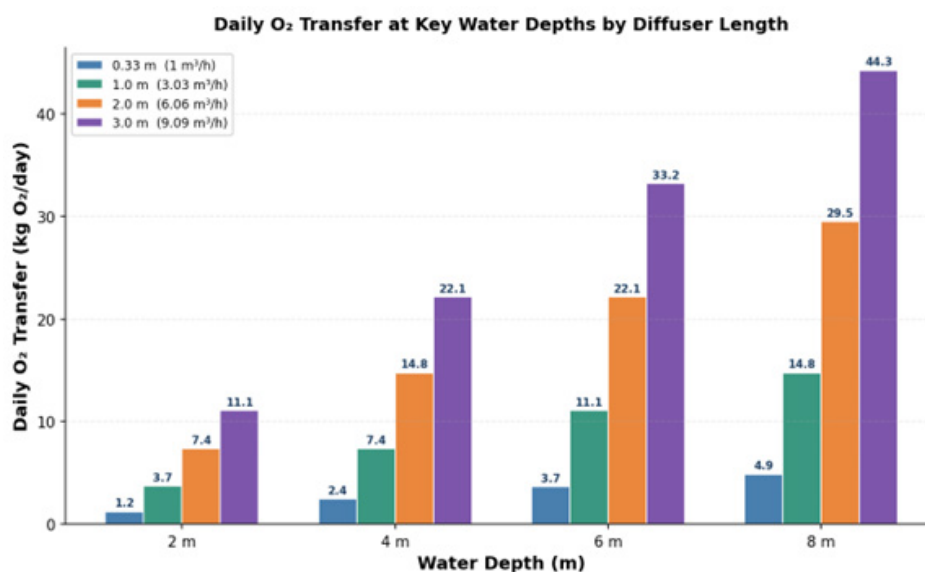


Figure 3: Clustered comparison at key depths - 0.33m, 1m, 2m and 3m diffusers

3. System Sizing Considerations

Clean water SOTR values must be corrected when designing for real-world applications. Using an alpha factor which is the ratio of kLa in the process water to the kLa of the clean water helps to adjust from test data to real-world applications.

3.1 Typical Applications:

Application	Alpha Factor (α)	Notes
Municipal wastewater	0.85 - 0.95	Apply to SOTR to get field O ₂ transfer rate
Industrial/high COD	0.6 - 0.8	Surfactants reduce bubble size
Landfill leachate	0.5 - 0.7	Use the conservative end for design
Aquaculture (freshwater)	0.9 - 1.0	Clean, low surfactant water
Seawater/saline	0.85 - 0.95	Smaller bubbles therefore high efficiency
Drinking water - pretreatment	0.95 - 1.0	

Table 5: Typical alpha factors per application type

The size of an aeration system depends on a number of variables; such as: water volume, depth, temperature, nutrient inputs (COD/BOD) and the required water quality outcomes of the system. For most applications it will be the provision of oxygen required to treat the COD/BOD, however in certain applications the diffusers are also sized on their ability to move and mix water very efficiently instead of COD/BOD reduction (i.e. stratification of lakes).

The below sections are recommendations, but a design engineer should always be consulted to ensure the requirements of the system are being met.

The solubility of oxygen in water decreases as the water temperature increases (See Appendix 1). Aeration systems are sized based on the oxygen demand, often referred to as the COD (Chemical Oxygen Demand) or BOD (Biochemical or Bacterial Oxygen Demand). The warmer the water, the more active the bacteria. This increases oxygen demand while reducing the water's ability to hold oxygen. Starting at a temperature of 5°C, for every additional 5°C, biochemical activity can increase by 100%, up to a temperature of 36°C, then it starts to slow down.



Dryden Aqua air diffusers are suitable for installation in tanks, plastic-lined lagoons, lakes, or reservoirs of virtually any size or configuration. More importantly, the diffusers can be installed without the need to drain tanks, lagoons, or systems. There is no practical limit to the size of the aeration system.

Refer to specific applications for system sizing recommendations/calculations.

4. System Design & Installation

4.1 System components:

A complete diffuser aeration system comprises four elements: 1) Air blower, 2) Air ring main pipework, 3) delivery hoses and fittings, 4) air diffusers. Each must be correctly sized and installed for the system to perform as designed.

4.2 Air blower selection:

Always specify oil-free positive displacement blowers. Oil contamination will immediately degrade diffuser performance and may be a food safety or environmental concern. The blower must be sized for the total airflow and hydrostatic head at different diffuser depths.

Water Depth	Required Pressure	Recommended Blower type
up to 3m	up to 700mBar	Side channel blowers
3 to 5m	up to 1bar	Rotary vane
5 to 10m	up to 1.5bar	Roots type
>10m	>1.5bar	Rotary screw compressor

Table 6: Blower type guidance by installation depth

Recommended blower specification:

- 100% oil-free positive displacement unit
- Blowers must be located near clean air sources (no air pollution)
- Fitted with pressure relief valves to prevent back-siphoning for units below the water level
- Non-return valves to prevent water ingress into the piping during blower shut-off periods

4.3 Ring Main Piping

Air flow range	Recommended Pipe Diameter
100-150 m ³ /h	90 mm
150-200 m ³ /h	125 mm
200-500 m ³ /h	150 mm
500-1000 m ³ /h	250 mm
1000-1500 m ³ /h	300 mm

Table 7: Pipe sizing requirements per flow rate

Fit condensation drain vents at the lowest points of the ring main. Air cooling in the piping condenses rapid - water build-up will result in system failures.

Air ring main installation

Locate the blower on a concrete pad and install at least 6m of metal discharge pipe. When air is compressed, its temperature increases; the metal pipe helps dissipate heat and protects the plastic pipework. 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 metal pipe is recommended.

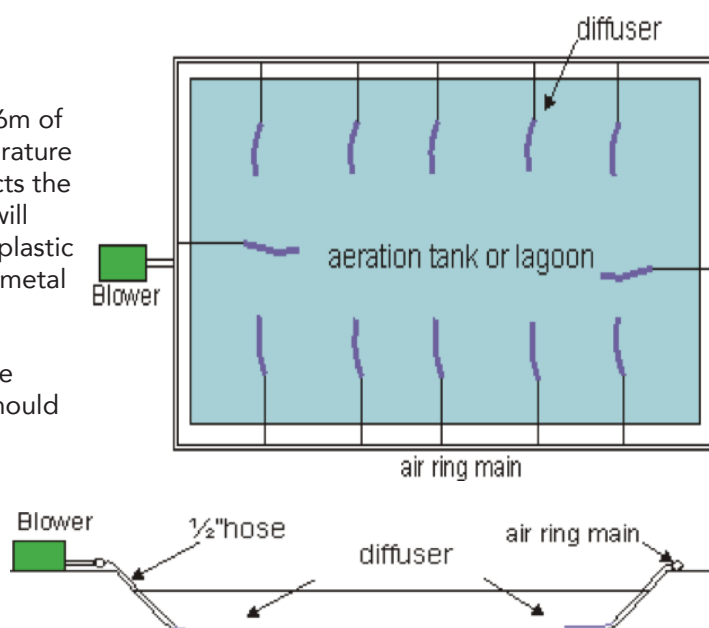
In tropical or hot climates, or if the water depth > 3m, the discharge pipe from the blowers and the full ring main should be in metal pipe.

When air is compressed it gets hot,

Example

Air temperature 30°C
Running pressure 0.8 bar = $8 \times 10 = 80^\circ\text{C}$ increase
Blower discharge temperature = $80 + 30 = 110^\circ\text{C}$

The diameter of the air ring main is a function of the air flow and perimeter of the lagoon.



4.4 Step-by-Step Installation Procedure

- Install the air ring main in HDPE or stainless steel around the perimeter of the tank or lagoon.
- Fit saddle clamps with 3/4" BSP female fittings at each diffuser drop point. Space equally for even flow distribution.
- Screw a 3/4" ball valve with 1/2" female BSP socket into each saddle clamp.
- Cut 1/2" urethane-reinforced braided hose (12 mm ID) to the required lengths.
- Push-fit and clip-secure the hose to each valve hose tail.
- Attach one diffuser to the free end of each hose.
- Lower the diffuser to the tank floor, ensuring the hose has no tight bends and the diffuser is not suspended.
- For depths >4 m: attach ballast weights before deployment.
- Commission blowers at low pressure first; increase to operating pressure once all diffusers are confirmed working.

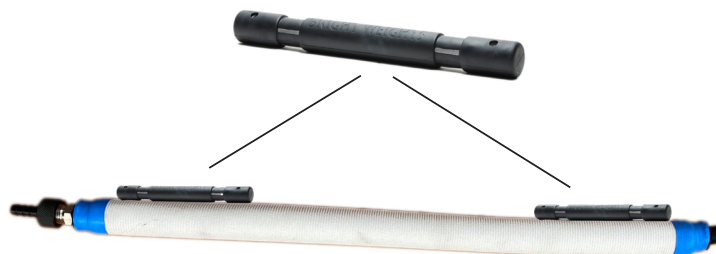


Extra ballast

If the application is in a depth of more than 4m, the diffusers will require extra ballast to ensure that they remain on the bottom and do not move around.

We offer a ballast that is produced from 1.5kg of lead, coated in a PVC jacket protecting it from the elements and also ensuring that there can be no leaching into the environment. The weights can be attached to the diffuser by cable tie, stainless steel strap clamp or tied on with synthetic cord depending on the submerged environment.

Each 3m diffuser will require 2 ballasts (one for either end of the diffuser).



Not to scale

4.5 Normal Operating Parameters

- Operating pressure: typically 0.5–0.8 bar (up to 1.0 bar for depths to 5 m; up to 1.5 bar for 5–10 m)
- Normal static pressure loss across diffuser: <1 psi (0.062 bar) without water head
- Differential pressure trigger for cleaning: >2 psi (0.15 bar) above baseline, or system pressure rise of >100 mbar
- Air flow per 0.33 m diffuser section: 1 m³/h nominal (±20%)

4.6 Start-up Procedure

- Confirm all delivery hose connections are secure and all ball valves are open. Start blower at minimum pressure; confirm air reaches all diffusers.
- Visually confirm bubble pattern from all diffusers (even coverage along the full diffuser length).
- Gradually increase to operating pressure.
- Record baseline blower discharge pressure — this is your fouling reference.

Agricultural shed systems only: Never turn on air diffusers in a shed containing animals for the first time. Allow 15–30 minutes for displacement of methane, CO₂, and H₂S before reintroducing stock. Once operating, diffusers must not be shut off for more than one hour without removing animals first.

4.7 Shutdown

For planned shutdowns: close delivery hose valves before stopping blowers to prevent water back-siphoning. Non-return valves are strongly recommended on all submerged delivery lines. Ensure blowers are located above water level.

5. Maintenance

The Dryden Aqua diffuser is designed to be maintained in situ with the tank full of water and blowers running. No plant downtime is required. The semi-flexible construction means scale deposits crack off during handling, and biofilm releases with minimal brushing.

5.1 Maintenance Schedule

Frequency	Task	By	Notes/triggers
Weekly	Visual check of bubble pattern across all diffusers	Operator	If uneven, check hose connections and blower pressure
Weekly	Record blower discharge pressure	Operator	Baseline +100 mbar = clean diffusers
Monthly/-6 Monthly	Physical clean: pull, shake, hose rinse	Operator	Frequency depends on water quality
As required	Acid clean (30% phosphoric acid, 1:5 dilution)	Operator	Soak 10–20 min; rinse thoroughly before redeployment
Annually	Full system inspection: hose condition, fittings, blower service	Operator	Check non-return valves and ring main condensate drains

Table 8: Recommended maintenance schedule. Cleaning frequency depends on water quality e.g. fouling in landfill leachate or high-COD wastewater will require more frequent attention than clean aquaculture water.

5.2 Standard Physical Clean

- Pull the diffuser from the water using the 1/2" delivery hose.
- Wearing heavy gloves, pull the diffuser through your clenched fist to remove loose scale and biofilm.
- Give the diffuser a firm shake to crack off rigid deposits.
- Rinse with a strong flow hose. High-pressure washing is not required and may damage the fabric.
- Reconnect and drop back into the water. The blowers can remain running throughout.

5.3 Chemical Clean (Scale Removal)

Chemical cleaning is required only when scale has formed, typically in hard water (high calcium/carbonate) or after the first 6–12 months of operation in wastewater systems.

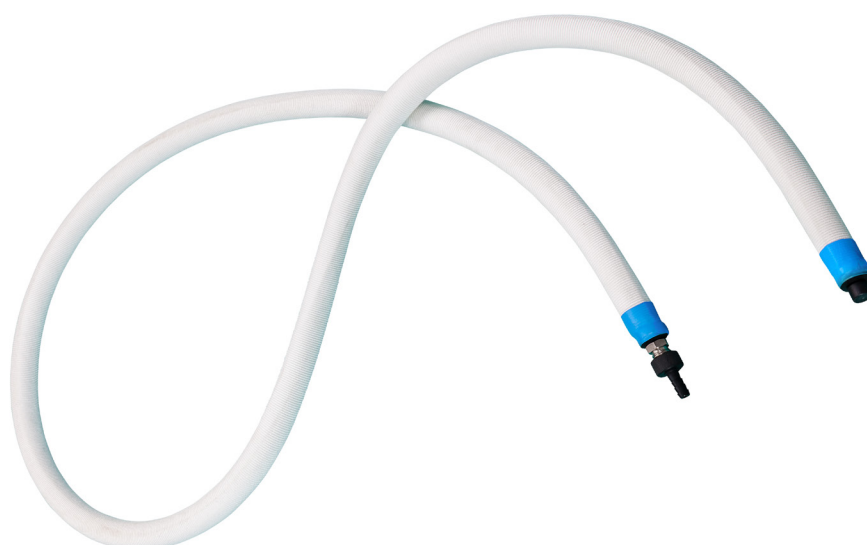
- Prepare a solution of 30% phosphoric acid diluted 1:5 with clean water.
- Submerge the diffuser in the solution. Soak for 10 minutes, or until fizzing stops.
- Do not soak for more than 20 minutes.
- Remove and rinse thoroughly with clean water.
- Reconnect to ring main and redeploy.

The acid is consumed during cleaning. Prepare fresh solution if cleaning multiple diffusers. Spent solution may be disposed of into the treatment system — it will have a minor, temporary effect on pH only.

6. Troubleshooting

Symptom	Likely Cause	Corrective Action
No bubbles from one or more diffusers	Blockage in delivery hose or diffuser; kinked hose; air valve closed	Check hose for kinks; open valve; pull diffuser and inspect; clean if fouled
Blower pressure rising steadily	Fouling / scaling on diffuser surface	Clean diffusers — mechanical then chemical if needed
Uneven bubble pattern across diffuser length	Partial internal blockage; hose lengths unequal	Ensure all delivery hose lengths equal; clean diffuser
Pressure >100 mbar above baseline	Significant fouling	Immediate clean required
Diffuser floating off bottom	Insufficient ballast (depth >4 m)	Add 500 g ballast weights (4–8 m) or 1.5 kg (>8 m)
Reduced O ₂ transfer despite correct flow	High water temperature; elevated existing DO; salinity; lipids in water	Apply α correction; check DO at diffuser depth; inspect for biofilm
Noise / vibration from pipework	Resonant frequency between blower and ring main	Fit elastomer-lined pipe clamps to absorb vibration

Table 9: Common troubleshooting items



Performance monitoring tip:

Track blower discharge pressure over time. A gradual pressure rise is the earliest and most reliable indicator of diffuser fouling. If pressure rises by more than 100 mbar above the commissioning baseline, schedule a clean. A sudden pressure spike may indicate a blocked hose or closed valve rather than diffuser fouling.

Dryden Diffuser Applications

1. Sizing a system based on COD (BOD) & ammonium

Aeration systems for activated sludge, extended diffused aeration, municipal, industrial, and agricultural wastewater are sized primarily on the oxygen demand created by the organic load (COD or BOD) and ammonium (nitrification).

Step-by-Step Sizing Procedure

1. Calculate the daily organic load

- Daily flow rate (m^3/day) = hourly flow (m^3/h) $\times$ 24
- Organic load (kg/day) = Daily flow (m^3/day) $\times$ Concentration (kg/m^3)

Example:

Flow = $100 \text{ m}^3/\text{h}$ Daily flow = $100 \times 24 = 2400 \text{ m}^3/\text{day}$

COD = $300 \text{ mg}/\text{L} = 0.3 \text{ kg}/\text{m}^3$

COD load = $2,400 \times 0.3 = 720 \text{ kg COD}/\text{day}$

If you only have BOD instead of COD, use the BOD value directly and apply a higher safety factor later (see step 4).

2. Calculate the ammonium ($\text{NH}_4\text{-N}$) oxygen demand

- Ammonium load ($\text{kg NH}_4\text{-N}/\text{day}$) = Daily flow $\times$ $\text{NH}_4\text{-N}$ concentration (kg/m^3)
- Theoretical oxygen demand for nitrification $\approx$ **4.6 kg O_2 per kg $\text{NH}_4\text{-N}$**

Example:

$\text{NH}_4\text{-N} = 40 \text{ mg}/\text{L} = 0.04 \text{ kg}/\text{m}^3$

Ammonium load = $2,400 \times 0.04 = 96 \text{ kg NH}_4\text{-N}/\text{day}$

Oxygen demand from ammonium = $96 \times 4.6 = 442 \text{ kg O}_2/\text{day}$

3. Adjust ammonium demand for assimilation by heterotrophic bacteria

(important when there is plenty of organic matter)

Use this simple adjustment:

Effective $\text{NH}_4\text{-N}$ for nitrification (kg/day) = $\text{NH}_4\text{-N}$ load – (COD load / 10)

(If the result is negative, set it to 0 — almost all ammonium will be assimilated into biomass.)

Example:

Effective $\text{NH}_4\text{-N} = 96 - (720 / 10) = 96 - 72 = 24 \text{ kg}/\text{day}$

Oxygen demand from nitrification = $24 \times 4.6 = 110 \text{ kg O}_2/\text{day}$

4. Calculate total oxygen demand and apply safety factor

Total oxygen demand ($\text{kg O}_2/\text{day}$) = COD load + Nitrification oxygen demand

Then apply an application/safety factor:

- Use 1.5 when using measured COD
- Use 2.0 – 2.5 when using BOD instead of COD (because BOD underestimates total oxidizable matter)

Example:

Total oxygen demand before factor = $720 + 110 = 830 \text{ kg O}_2/\text{day}$

With safety factor 1.5 - Required SOTR = $830 \times 1.5 = 1,245 \text{ kg O}_2/\text{day}$ (in clean water at 20°C)

5. Select diffusers and calculate number required

Look up the SOTR₂₀ (Standard Oxygen Transfer Rate in $\text{kg O}_2/\text{day}$ per diffuser) from the performance table for your chosen diffuser length and water depth.

Number of diffusers = Required SOTR ÷ SOTR20 per diffuser

Then determine the total air flow rate from the table (or manufacturer data) at the recommended operating flow per diffuser.

Worked Example

- Flow: 100 m³/h (2400 m³/day)
- COD: 300 mg/L = 720 kg COD/day
- NH₄-N: 40 mg/L = 96 kg NH₄-N/day

Step 3: Effective nitrification load = 96 – (720/10) = 24 kg/day = 24 × 4.6 = 110 kg O₂/day

Step 4: Total = 720 + 110 = 830 kg O₂/day × 1.5 = 1,245 kg O₂/day required

Assume you are using **3 m water depth** and the performance table shows that one diffuser (e.g. model 70008 or equivalent length) delivers **29 kg O₂/day** at standard conditions.

Number of diffusers = 1,245 / 29 ≈ 43 diffusers

Check the air flow requirement per diffuser in the table and multiply by 43 to get total blower airflow (m³/h).



2. Gas stripping of THMs and Radon from drinking water

Drinking water is usually filtered and then chlorinated. If the water originates from a granite aquifer, it may contain radioactive gas called radon. Dryden Aqua air diffusers are used for scrubbing drinking water in Norway.

In other situations, the chlorinated water will react with dissolved organic precursors such as humic and fulvic acid, forming THMs such as chloroform. The upper limit for THMs in drinking water is 100 µg/l, however, due to a high concentration of dissolved organics acids that act as precursors, it is very difficult to prevent the formation of THMs. Dryden Aqua air diffusers are used to strip excess dissolved gases. A small amount of aeration can provide a 25% to 50% reduction in THMs. 1 x diffuser delivering 10 m³/h of air for 10 to 20 m³/h of water treated will give a 50% reduction in dissolved gases. For precise calculation variables such as water depth, temperature and contact time must be taken into account.

Some water companies are now adding ammonium to drinking water to react with chlorine to form monochloramine. Monochloramine has an oxidation potential approximately 2'000 times lower than hypochlorous acid, but it still provides disinfection.

Monochloramine is non-toxic, but when water is consumed in the presence of stomach acids it will be converted to toxic trichloramine. At Dryden Aqua, we do not recommend the addition of ammonium to drinking water or the practice of chloramination. Gas stripping of THMs is a safer and more effective approach to reducing disinfection by-products. AFM® (activated filter media) manufactured by Dryden Aqua should also be used to treat the water. AFM® filters drinking water to a higher standard than sand and reduces the concentration of organic precursors that contribute to THM formation.



3. Oxidation of ground water for the removal of ferric, arsenic & manganese

The aeration and gas stripping of ground water makes it much easier to subsequently treat the water for the removal of heavy metals and metalloids. In addition, there are other benefits to be gained:

- Strong aeration to raise the dissolved oxygen concentration and oxidation potential will cause the zeta potential to drop and will initiate particle flocculation. This makes it easier to remove particles from the water using AFM® or sand filters.
- Iron in solution (Fe^{2+} , ferrous) is oxidised to ferric (Fe^{3+}). In the presence of oxygen, the ferric acts as a catalyst generating free radicals to oxidise and co-precipitate arsenic, manganese and other heavy metals.
- Aeration blows-off excess CO_2 and restores the proper alkalinity balance, the pH of the water will usually increase.
- Aeration blows-off volatile gases such as radon, organic solvents and other VOCs (Volatile Organic Compounds)

Aeration for pre-treatment of ground water is a very important step in water treatment, that is often ignored. Simple aeration for a period of 10 to 30 minutes or longer can have tremendous benefits that make it much easier to treat the water to a high standard using AFM® filtration.

3.1 How to size a system

The aeration water tank should ideally be 2 - 3m in depth, if the tank is less than 3m then additional aeration may be required. The dissolved oxygen content of ground water is often zero. The oxygen concentration needs to be increased to near saturation and maintained for 10 – 30 minutes (depending on the metal and the level of contamination) in order to ensure oxidation of metals.

If the water flow is $100\text{m}^3/\text{h}$, then 50 to $100\text{m}^3/\text{h}$ of air will be required for a period of 30 minutes to gas strip and oxidise the water.

3.2 Filtration stage

Application data sheets for AFM® Activated Filter Media are available from www.DrydenAqua.com the aeration is just the first stage of the process, the second stage is filtration by our AFM® filter media to remove the co-precipitated metal oxides from the water.



4. Thermal and chemical destratification of water bodies

To prevent thermal stratification, algal blooms and anoxic conditions, Dryden Aqua air diffusers are used to oxygenate and mix the lake or reservoir waters. Fine bubble diffused aeration is used to ensure water movement by airlift which is the most cost-effective mechanism of generating vertical motion of water. A small amount of air can move a massive amount 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.

Water depth in meters	Amount of water lifted by 1 m ³ /h of air passed through our diffuser
3	10 m ³ /h
4	15 m ³ /h
6	20 m ³ /h
10	40 m ³ /h
20	80 m ³ /h
30	120 m ³ /h
40	150 m ³ /h
60	200 m ³ /h

Table 10: Vertical water movement due to air input at different depths

The simple act of moving the water, will improve water quality, the productivity of the system will increase and, in the case of reservoir water treatment, the water becomes much more stable and predictable. The oxidation potential will increase which makes the water much easier to filter by media filtration such as sand or AFM[®] through conventional media filtration processes

Chemically stratified anaerobic water is very difficult to treat and often has a high dissolved organic content, high phosphate levels, bacterial count and heavy contamination of metals including iron and manganese. Thermal and chemical destratification can solve many of the water quality problems, often, it is possible to downsize the scale of water treatment systems that are used to draw and filter water from lakes or reservoirs. **An ecosystem-based catchment management approach to stabilising water quality is more effective than trying to control biological processes through heavy engineering.**

4.1 Sizing and design of a system

The topography of the lake bottom and its depth will have an influence on the design of the system. If the lake is shallow, with a depth from 1 to 2 m with a large surface area, then it is best to spread the air diffusers evenly over the lake. However, if the same lake has one point where it is 10 m or deeper, then the deep hole is the part of the lake that should be aerated. The depth profile will therefore dictate the configuration of the diffusers and amount of air required.

Using table 10, one can assess the amount of water being lifted compare with the air input. The volume of water in the lake should be estimated, once the volume is known the aeration system is then sized to move a minimum of the entire volume of water in the lake once every 7 days. As a rule of thumb in a typical 3m deep lake a minimum of 1 x 3 m diffusers or 10 m³ of air/h will be required for every 1,000 m² of water surface area. Turnover may have to be increased in the case of very shallow lakes or heavily stocked fishing lakes.

4.2 Examples of Lake aeration configurations

The following arrangements may be used for thermal and chemical destratification of lakes or reservoirs, the same approach may be used for Wetland watertreatment.

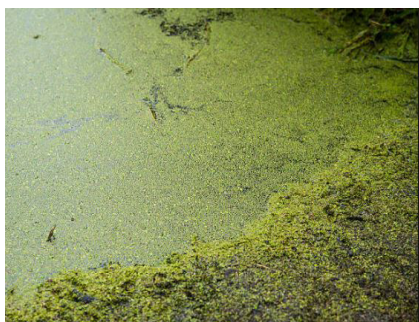
Example 1: A lake shaped like a bowl, with gradually sloping sides leading to a central area of uniform depth. The diffusers should be distributed evenly across the central zone of the lake.

Example 2: A deep zone is present in one part of the lake; aeration should be concentrated in this area.

Example 3: There is a dam at one end of the lake; this is usually the deepest area and the part that should be aerated. Avoid placing diffusers near the outlet to prevent air entrainment in the discharge. Air bubbles in the discharge can cause gas supersaturation, which is harmful to fish and the river ecosystem and may also damage turbines.

Example 4: A lake with step sides that drop down to the maximum depth of the lake. The lake will most likely have the same depth over the full area. The diffusers may be located around the perimeter, or even just around the island if system security is a concern.

5. Biology and chemical stability of Lake aeration systems



The first step in any pond/lake water treatment system is appropriate aeration for the thermal and chemical destratification of the lake. However, if the lake is subjected to high temperatures and has nutrient input from industry, domestic or agricultural sources, then the aeration system may require some additional help.

5.1 Phosphates

If the phosphate concentration in the water exceeds 0.1 mg/l, it will promote the growth of algae and bacteria. In such cases, the use of a phosphate precipitant such as NoPhos or lanthanum chloride-based products should be considered. These react with phosphate to form an inorganic precipitate, which is stable and no longer available as a nutrient for biological growth.

Careful dosing of NoPhos can clear a lake or a pond of all algae and bacteria, without the use of oxidising chemicals. The effect is achieved by removing access to the food source for the organisms. In natural ponds, phosphates should not be completely eliminated. However for fountains or chlorinated systems, the objective should be to reduce phosphates to below detectable levels then the use of NoPhos can reduce bacterial and algal loads by over 95%.

The following series of photos are taken over a six-week, showing the progression from dense algal growth to clear water. This result was achieved by controlling the phosphate concentrations using NoPhos.



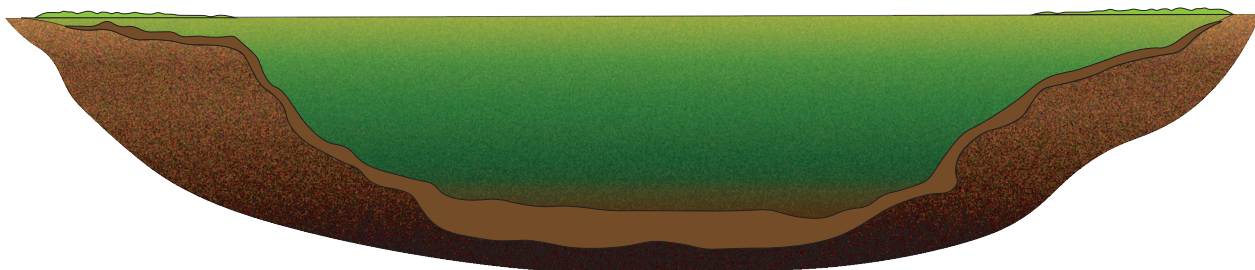
5.2 Algal biodiversity

It is generally more effective to work with natural processes rather than against them. This principle applies to natural ponds and lakes, as well as to chlorinated systems. Silicates and ferric are micro nutrients for algae, and by the addition of silicates can shift ecological balance in favour of diatoms. The Diatoms are larger organisms and serve as an excellent food source for crustaceans and fish. Water quality will initially deteriorate, but then a new equilibrium will be established.

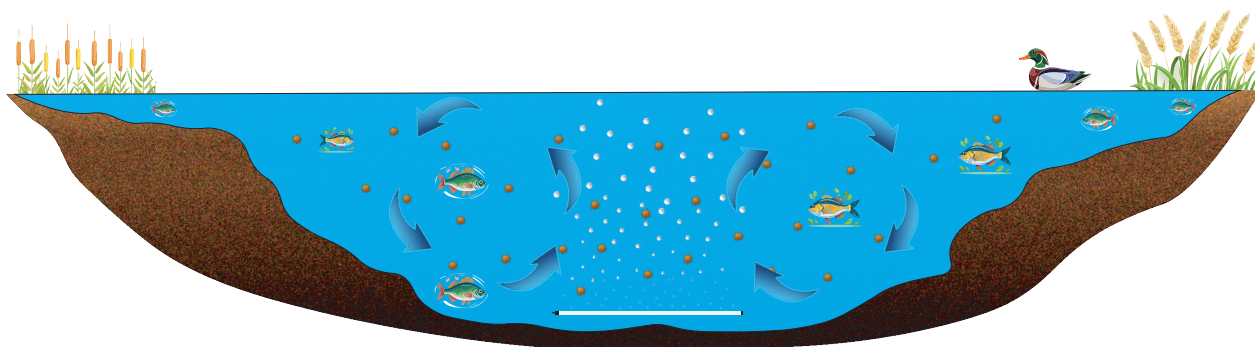
In some instances the addition of these micronutrients are encouraged and can provide a faster solution, but in

some cases, the addition of these micronutrients can accelerate the process; however, dosing must be carefully controlled, as overdosing may lead to unintended consequences.

The bottom line is that if you have time, the normal biological solution is always the best for sustainable long-term results.

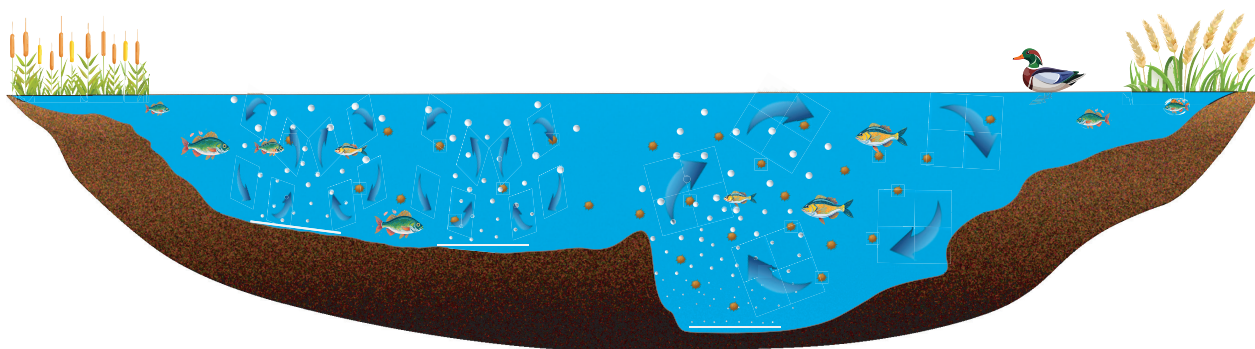


In many situations natural systems can restore water quality with the addition of air and water movement. The pond below shows the accumulation of sludge at the bottom of the pond, which has led to a eutrophic environment and the release of H_2S gas and has little or no life in the pond.



By placing diffusers into the pond to stimulate oxygenation and water movement the sludge is lifted off the bottom providing a healthy bacterial biome for the degradation of the organics, while also ensuring a healthy environment for plants and fish species to thrive.

As described above, diffuser placement is vital to achieve effective circulation and overall system performance. The below diagram shows how 1 diffuser placed at a deeper depth can create the same water movement as 2 diffusers placed at a shallower depth.



6. Sea Water Applications

The above process works equally well, if not better, in seawater, as the alkalinity is usually self buffering due to its salt content.

The following project was carried out in a marina where a large biomass of fish had accumulated, reducing oxygen levels to the point where mass mortality occurred. The resulting decomposition lead to an anaerobic environment and the release of hydrogen sulphide gas , causing odour issues and complaints from visitors and local residents. Dryden Aqua air diffusers were installed to increase oxygen levels and improve circulation. As a result, the entire marina basin was restored to aerobic conditions, allowing fish, crustaceans, and algae to return to a healthy and stable environment.

Project specification:

- 74 x 3m Dryden Air Diffusers
- 3 x aeration segments
- 666m³/h air flow
- 5m water depth
- Dissolved Oxygen increased from 1.5% to >80% at the 5m depth



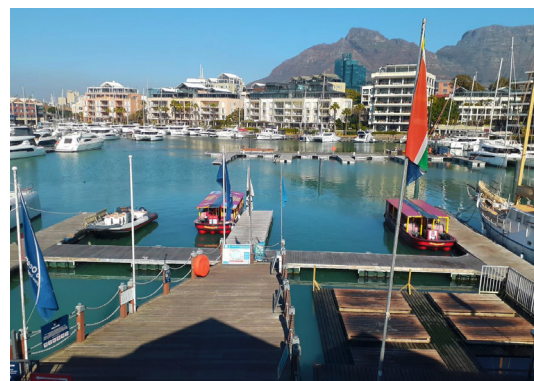
Before



Before



After



After

7. Agricultural waste water

Dryden Aqua air diffusers are used for the treatment of farm slurry waste; the systems are however applicable to any animal waste. In the UK the majority of the applications are for cattle, swine and chicken waste water.

Most farms have lagoons or large tanks that are used to collect the animal waste. The simplest system would be to use our drop-in air diffusers and aerate the tank containing all the solid as well as liquid waste. Aerobic bacteria will become established; the smell will be eliminated, and the effluent generated will be greatly improved. The system can be further optimised by following the design outline and sizing instructions presented in the following section.



7.1 Design criteria

Animals produce both solid and liquid waste. The solid waste should be separated from the liquid; however, in some cases this is not done, and all the waste is aerated using our diffusers.

7.2 Air diffusers

1 x air diffuser and 10 m³/h of air will mix the slurry from 20 cattle or 100 swine. If several diffusers are required a large diameter polyethylene pipe can be fitted around the perimeter of the tank with diffusers connected via ½" flexible hoses and dropped into the tank.

Parameter (the wastewater should be screened with a sludge pump or filtered down to 1,000 microns) the data presented is for screened wastewater	Typical values mg/l	Performance
COD	4000	>95%
BOD	3500	>99%
Ammonium, (the ammonium will be removed by assimilation as well as nitrification, so nitrate concentrations will increase)	1000	>99%
Suspended solids (If AFM® is installed on the system then performance is improved to 99%)	1000	>90%

Table 11: Removal performance

7.3 Aeration in the shed

Air diffusers can be used in the cattle shed to aerate and mix the slurry beneath the floor. This keeps the slurry aerobic and reduces the formation of noxious gases, improving animal health and well-being, reducing respiratory disease, and enhancing FCR (feed conversion ratio).

Note: that it is critically important that when the air diffusers are turned on for the first time, there must be no animals in the shed. Noxious fumes of methane, carbon dioxide and hydrogen sulphide may be discharged for a few minutes after turning on the air diffusers. Once the diffusers have been turned on they must never be turned off. If the diffusers are turned off for more than one hour, then the animals must be removed from the building before it is turned back on.

7.4 Treatment of the wastewater

Refer to Applications section 1 - Wastewater treatment section

8. Aeration of Aquaculture systems

Dryden Aqua diffusers have been used in fish farming for over 20 years across a wide range of species and system types. The fine bubble output provides efficient oxygen transfer, while the strong vertical water movement (airlift effect) is critical for maintaining water quality in deeper tank and cage systems.

Rule-of-thumb: Feed 20 kg/day → supply 20–40 kg O₂/day (1–2 kg O₂ per kg of feed). For systems above 20°C, apply the upper end of this range.

A list of some of the applications are included below;

- smolt production, fish transportation
- land based salmon farms, lobster holding units
- cage based salmon farms
- depuration systems
- trout ponds/raceways
- sea bass and bream
- shrimp tanks and ponds
- tilapia, milk fish
- barramundi, crayfish

Species	Temperature	Air per tonne	Diffuser guidance	Min DO
Salmonid smolts	<15 °C	10-20 m ³ /h	1 x 3m diffuser per tonne	>7 mg/l
Salmonid smolts	>15 °C	20-30 m ³ /h	1-2 x 3m diffuser per tonne	>7 mg/l
Rainbow trout	5-20 °C	10-20 m ³ /h	1 x 3m diffuser per tonne	>5 mg/l
Sea cage salmon	Sea temp	9 m ³ /h	1 x 3m diffuser per tonne @ 6-10m depth	>7 mg/l
Shrimp (temperate)	<25 °C	9 m ³ /h	1 x 3m diffuser per tonne	>4 mg/l
Shrimp (tropical)	>25 °C	36 m ³ /h	4 x 3m diffuser per tonne	>4 mg/l
Sea Bass / bream	>20 °C	18-27 m ³ /h	2-3 x 3m diffuser per tonne	>5 mg/l

Table 14: Aquaculture sizing guidance by species. These are indicative values - actual sizing should account for stocking density, feed rate, water temperature and target DO.



8.1 Efficiency & sizing of system

Dryden Aqua diffusers are about 5 times more efficient at moving water and transferring oxygen compared to mechanical surface aerator, because kinetic energy is not wasted in throwing the water up into the air or in moving mechanical machines.

Water depth, water temperature, salinity and lipid content of the water (as measured by DOC, BOD or COD) will all impact on O_2 transfer efficiency. Lipids make the bubble size much larger and reduce oxygen transfer. Oxygen tension is also important, at 100% saturation, oxygen transfer is zero, however as the partial pressure of oxygen drops, oxygen transfer increases exponentially.

The Dryden Aqua fine bubble air diffusers generate a mass vertical movement of water (refer to table 10, page 17), therefore oxygen transfer is not only from the microbubbles being released but also due to the residency time as the water rises.

With paddle wheel aerators or surface aerators, apart from the initial transfer of oxygen to the water, there is little transfer or vertical mixing of the water. For very large shallow ponds (<2m depth), a combination of paddle wheel aerators for horizontal flow and fine bubble air diffusers for vertical mixing can prove very effective. Whereas for depths greater than 2m, the vertical movement of water by the Dryden air diffusers are sufficient to provide the water movement required for the system. However, selective placement of the diffusers can be utilised to increase water movement efficiencies and therefore overall water turnover.



Important for aquaculture:

Dissolved oxygen should always be maintained above the minimum threshold for the target species (typically 7 mg/L for salmonids). Avoid gas supersaturation — if using oxygen concentrators, ensure output is diffused at atmospheric pressure to prevent gas bubble disease.

Appendix 1: Solubility of Oxygen in water at different temperatures

The solubility of oxygen in water in equilibrium with air at 760mm Hg pressure and 100% relative humidity. The data gives the mg/l of oxygen in solution that is equivalent to 100% saturation at the specified temperature.										
Temp °C	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	14.60	14.56	14.52	14.48	14.44	14.40	14.37	14.33	14.29	14.25
1	14.21	14.18	14.14	14.10	14.06	14.03	13.99	13.95	13.91	13.88
2	13.84	13.81	13.77	13.73	13.70	13.66	13.63	13.59	13.56	13.52
3	13.48	13.45	13.42	13.38	13.35	13.31	13.28	13.24	13.21	13.18
4	13.14	13.11	13.08	13.04	13.01	12.98	12.94	12.91	12.88	12.85
5	12.81	12.78	12.75	12.72	12.69	12.65	12.62	12.59	12.56	12.53
6	12.50	12.47	12.44	12.41	12.38	12.35	12.32	12.29	12.26	12.23
7	12.20	12.17	12.14	12.11	12.08	12.05	12.02	11.99	11.96	11.93
8	11.91	11.88	11.85	11.82	11.79	11.77	11.74	11.71	11.68	11.66
9	11.63	11.60	11.58	11.55	11.52	11.49	11.47	11.44	11.42	11.39
10	11.36	11.34	11.31	11.29	11.26	11.24	11.21	11.19	11.16	11.13
11	11.11	11.09	11.06	11.04	11.01	10.99	10.96	10.94	10.92	10.89
12	10.87	10.84	10.82	10.80	10.77	10.75	10.73	10.70	10.68	10.66
13	10.64	10.61	10.59	10.57	10.55	10.52	10.50	10.48	10.46	10.44
14	10.41	10.39	10.37	10.35	10.33	10.31	10.29	10.27	10.24	10.22
15	10.20	10.18	10.16	10.14	10.12	10.10	10.08	10.06	10.04	10.02
16	10.00	9.98	9.96	9.94	9.92	9.90	9.88	9.87	9.85	9.83
17	9.81	9.79	9.77	9.75	9.73	9.72	9.70	9.68	9.66	9.64
18	9.63	9.61	9.59	9.57	9.55	9.54	9.52	9.50	9.48	9.47
19	9.45	9.43	9.42	9.40	9.38	9.37	9.35	9.33	9.32	9.30
20	9.28	9.27	9.25	9.23	9.22	9.20	9.19	9.17	9.15	9.14
21	9.12	9.11	9.09	9.08	9.06	9.05	9.03	9.02	9.00	8.99
22	8.97	8.96	8.94	8.93	8.91	8.90	8.88	8.87	8.85	8.84
23	8.83	8.81	8.80	8.78	8.77	8.76	8.74	8.73	8.71	8.70
24	8.69	8.67	8.66	8.65	8.63	8.62	8.61	8.59	8.58	8.57
25	8.55	8.54	8.53	8.52	8.50	8.49	8.48	8.46	8.45	8.44
26	8.43	8.42	8.40	8.39	8.38	8.37	8.35	8.34	8.33	8.32
27	8.31	8.29	8.28	8.27	8.26	8.25	8.24	8.22	8.21	8.20
28	8.19	8.18	8.17	8.16	8.14	8.13	8.12	8.11	8.10	8.09
29	8.08	8.07	8.06	8.04	8.03	8.02	8.01	8.00	7.99	7.98
30	7.97	7.96	7.95	7.94	7.93	7.92	7.91	7.90	7.89	7.88