



SANITAIRE

a xylem brand

Sanitaire Aeration in Wastewater Treatment



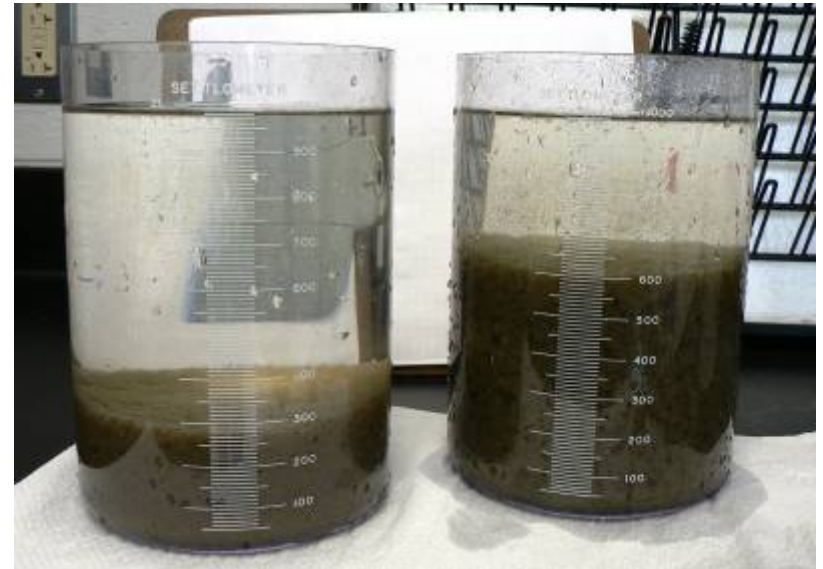
Wastewater Pollutants to Remove

- Inorganic Solids: Plastic bags, Grit, sand etc.
- Other Solids (includes micro-organisms)
- Organic material (BOD, COD)
- Nitrogen
- Phosphorus
- Others (pathogens, micro-pollutants, pharmaceutical rest products)



Activated Sludge – what is it?

Bacteria eat dissolved materials and grow more bacteria. Then the bacteria are removed from the water by settling or filtration, leaving clean water



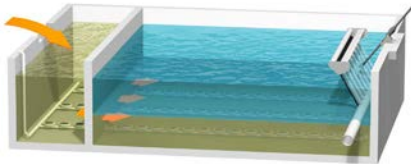
Activated Sludge Processes

Suspended Growth (free floating bacteria)

- Conventional Activated Sludge (CAS)



- Sequencing Batch Reactor (SBR)



- Membrane Bioreactor (MBR)

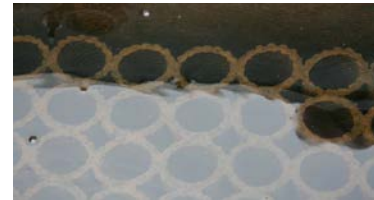


Fixed Film (bacteria attached to media)

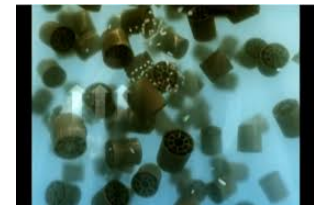
- Trickling Filter & RBC



- Submerged Aerated Filter (SAF)



- Moving Bed Bioreactor (MBBR) and Integrated Fixed Film Activated Sludge (IFAS)



Activated Sludge – The Essentials

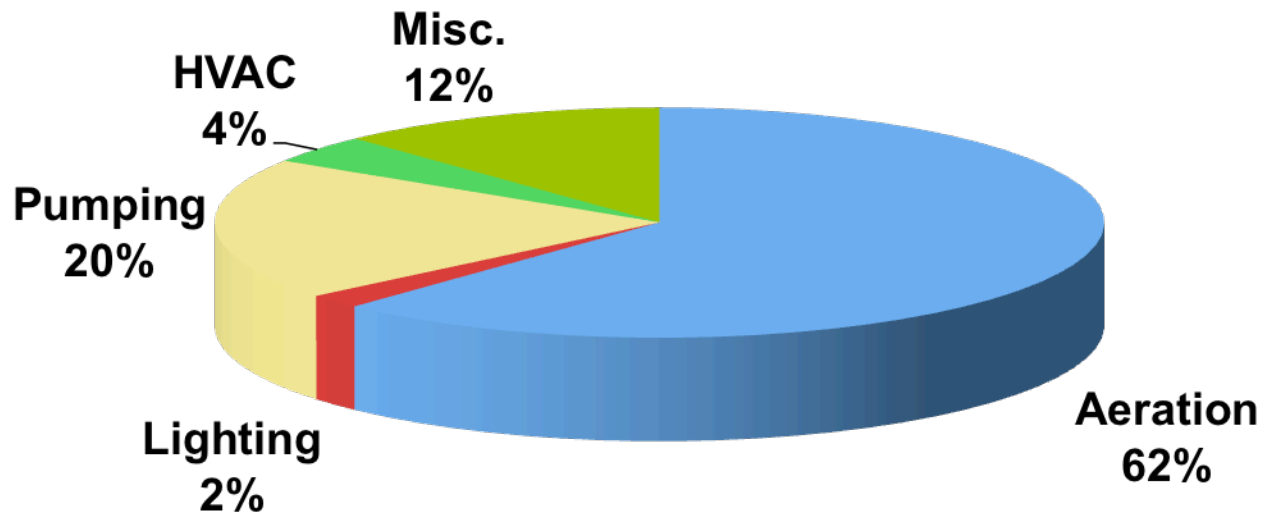
- Dissolved Oxygen
- Nutrients
- Temperature
- Selecting Floc formation
- Contact time
- pH & Alkalinity
- Mixing
- Settling



A perfect science with imperfect and dynamic conditions !

Energy Usage Typical WWTP

Aeration System can account for 50-75% of Plant Energy Usage

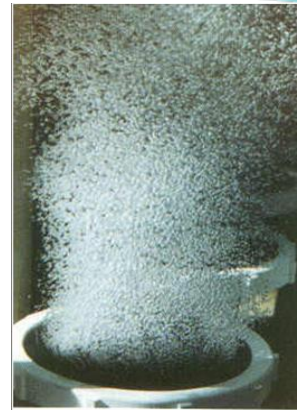


Aeration in a wastewater treatment plant

1. Grit/Grease channel
2. Retention basin (Storm)
3. Biological treatment
4. Storage of primary & external sludge
5. Storage of waste-activated sludge
6. Aerobic Digester



Biological Systems



Diffused Aeration Systems
Conventional A/S Plants
Oxidation Ditches
Sequencing Batch Reactors



Types of Aeration Systems



Mechanical Aeration

- Low Efficiency
- High Maintenance



Jet Aeration

- High SOTE
- Low to Moderate SAE
- Moderate Maintenance



Coarse Bubble Diffused Aeration

- Low Efficiency
- Low Maintenance



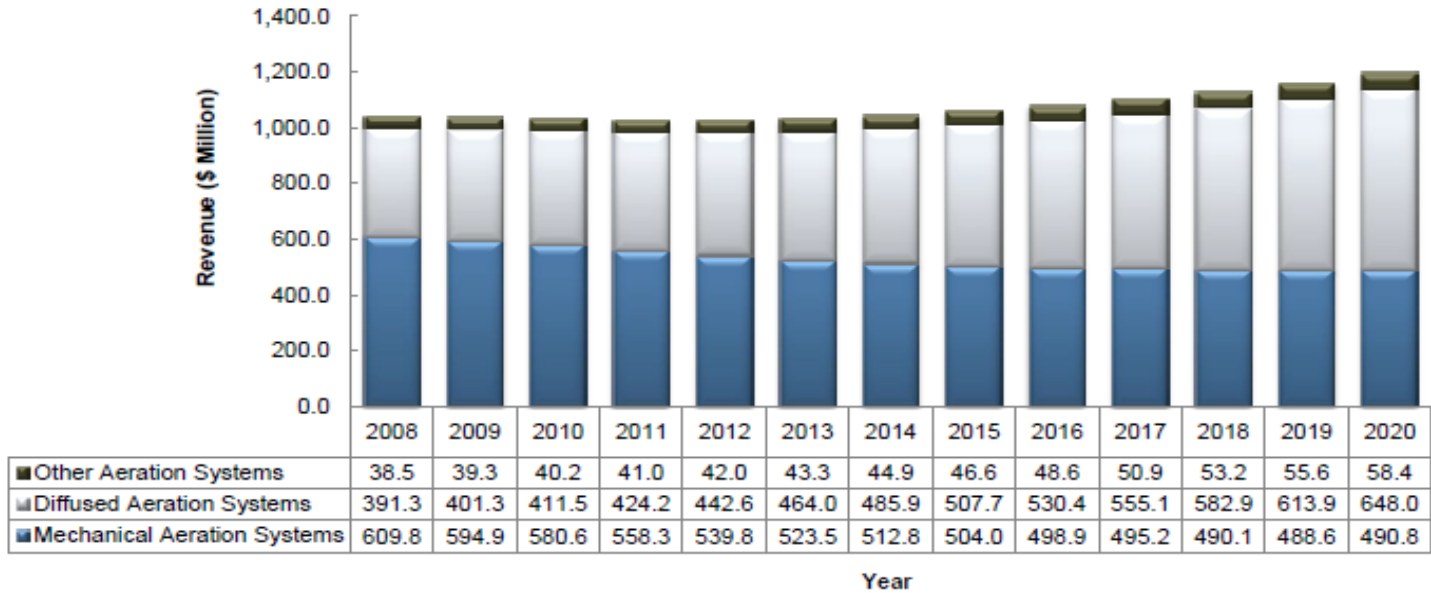
Fine Bubble Diffused Aeration

- High Efficiency
- Low Maintenance

Historical Development of Aeration Systems

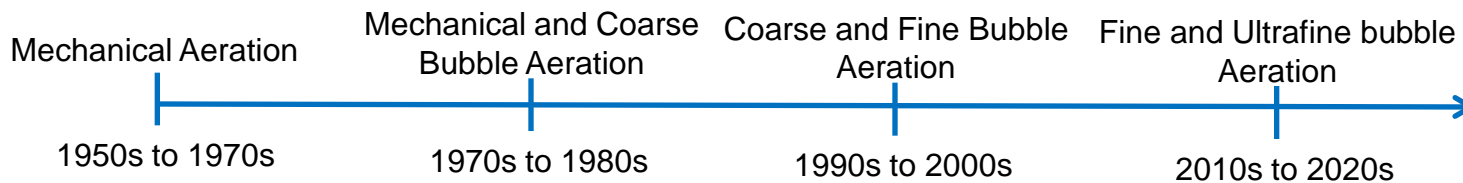
Key Takeaway: Mechanical systems are predicted to become less prominent

Wastewater Aeration Systems Market: Revenue Forecast by Technology Type, North America, 2008-2020



Note: Revenue Forecast based on Predicted Scenario

Note: All figures are rounded. The base year is 2011. Source: Frost & Sullivan analysis.



Aeration Efficiencies

Standard Conditions

- Fine Bubble (full floor coverage) 4.0 - 6.6 kgO₂/kW-h
- Fine Bubble (spiral roll) 2.0 - 4.0 kgO₂/kW-h
- Jet Aeration 2.2 - 3.5 kgO₂/kW-h
- Mechanical Aerators 1.1 - 2.1 kgO₂/kW-h
- Coarse Bubble 1.3 - 1.9 kgO₂/kW-h
- Aspirating Aerators 0.5 - 0.8 kgO₂/kW-h



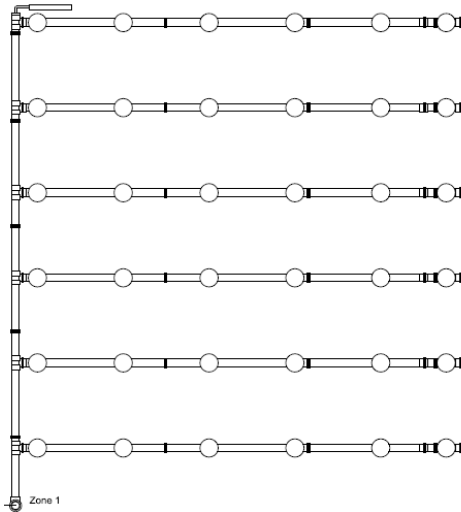
Data from ASCE WEF Manual of Practice 8: Design of Municipal Wastewater Treatment Plants.



Low investment cost vs. high performance

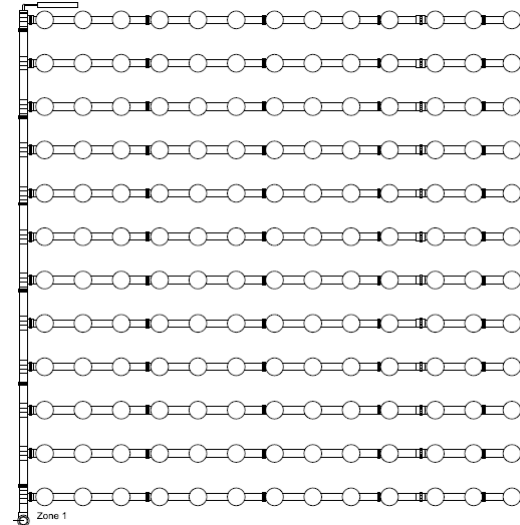
Low investment cost

- Low number of diffuser
- Max spacing between diffuser
- High air flow per diffuser
- Low SOTE for the system
- Higher air flow requirement!!!



Low operation cost

- High number of diffusers
- Min spacing between diffusers
- Low air flow per diffuser
- High SOTE for the system
- Lower air flow requirement



Designing for Energy Efficiency

Aeration grid design

Increased SAE →

Low density installations

Medium density installations

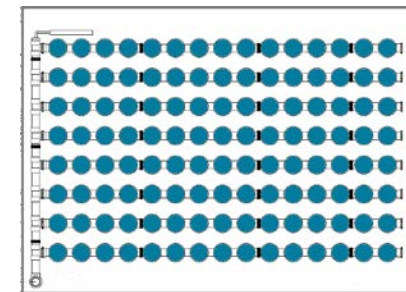
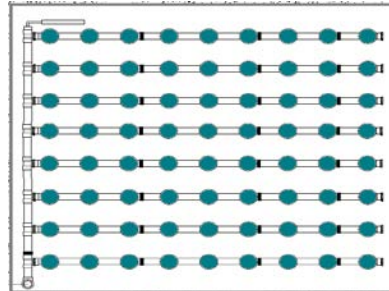
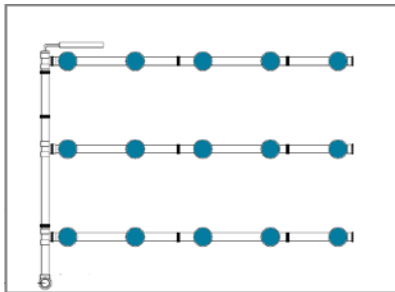
High density installations

High airflow per area of membrane

Low airflow per area of membrane

Low Equipment Cost

High Equipment Cost



What affects Aeration Efficiency?

- Diffuser type (bubble size)
- Submergence of the diffusers
- Airflow per diffuser
- Diffuser Density (A_t/A_d)



System Pressure and Blower Considerations

System Pressure:

- It is the total of piping losses, head of water on top of diffusers and DWP

$$SP = PL + DWP + \text{Head}$$

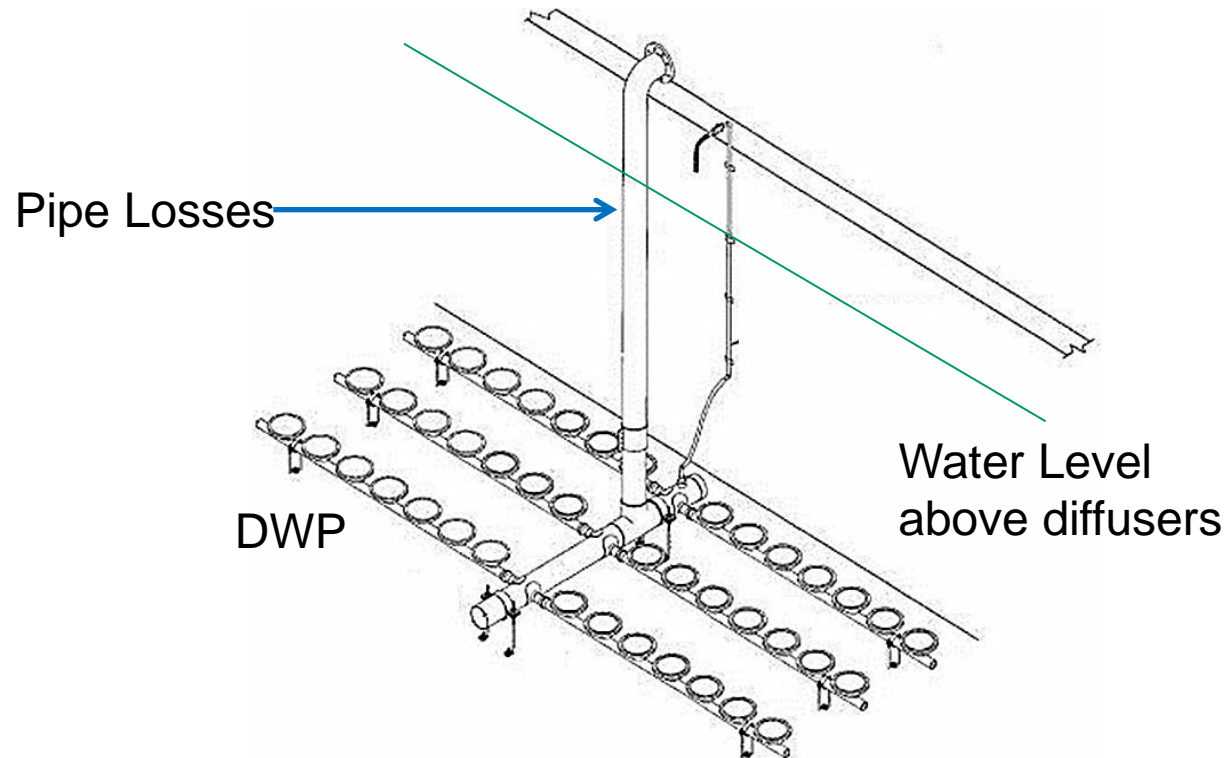
Example:

Submergence = 5 m

DWP = 40 cm

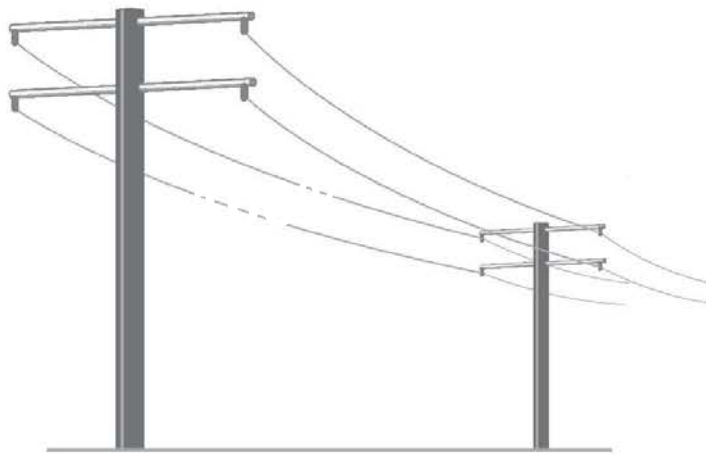
Pipe Losses = 0.5 m

SP = 5.54 m or 54 kPa

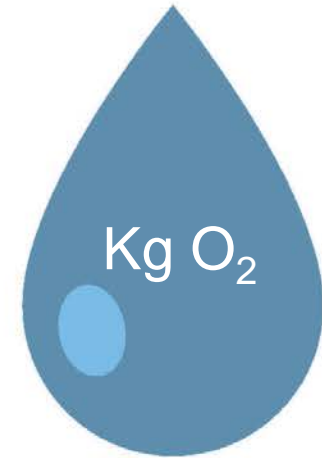


SAE – Standard Aeration Efficiency

Taking into account both SOTE & system headloss



1 kW-hr



SAE = amount of oxygen transferred to the water
per kilowatt hour



Energy Calculation and Blower Power

Adiabatic Power Equation

$$P_w = \frac{WRT_1}{550 \otimes n \otimes \epsilon} \left[\left(\frac{P_2}{P_1} \right)^{0.283} - 1 \right]$$

P_w = power requirement of each blower (hp)

W = mass flowrate of air (lb/s)

R = engineering gas constant for air 53.3 (ft-lb/(lb air)⊗°R)

T_1 = absolute inlet temperature (°R = 460 + °F)

p_1 = absolute inlet pressure (lb_f/in²)

p_2 = absolute outlet pressure (lb_f/in²)

n = 0.283 for air

550= ft-lb/s-hp

ϵ = efficiency

- We use this formula to estimate power usage or sizing blowers.
- Not 100% accurate but close enough to make comparative arguments.
- For exact power outputs, contact a blower manufacturer.



Sanitaire Performance Test Facility

- State-of-the-art test facility for advanced performance testing difuser life-cycle testing

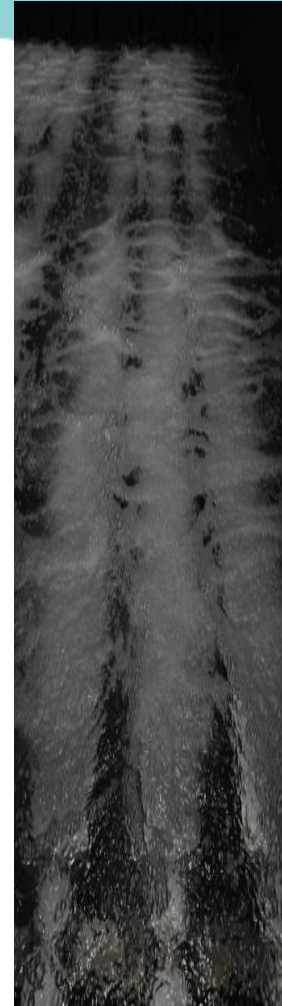


- Facility in operation since May 2010
- Tank Dim: 3.25m wide x 6.55m L X 8.5m deep.
- Test to 8.2m Submergence.
- Tank volume: 240 m³
- Time to fill: 2.5 hours
- Time to drain: 45 minutes
- Blower 1: 22 kW PD Blower
- Blower 2: 45 kW Screw Blower
- 14 Droplegs
- 19 Diffusers per drop
- Automated SCADA Control System



Test facility includes/featuring:

- Tank
- Aeration Droplegs and Control Valves
- Aeration Grids
- Control Station & Testing Laboratory
- Blower Room
- Boiler & Heat Exchanger
- Sodium Sulfite Mixing Tanks
- Dissolved Oxygen Probes
- Airflow Meters

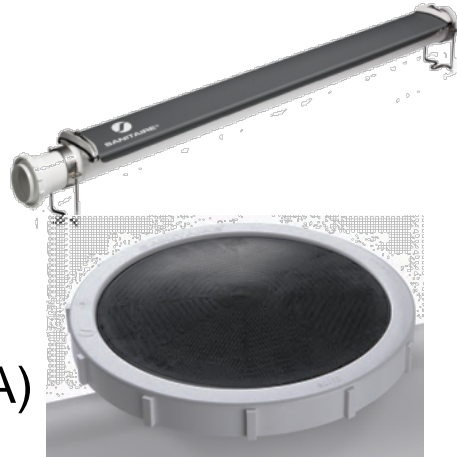


Certified performance testing and PERFORMANCE GUARANTEES!

Existing Xylem Portfolio

Sanitaire Diffused Aeration

- Gold Series (FBDA)
- Silver Series II (FBDA)
- Silver Series LP (FB/CBDA)
- Ceramic Disk (FBDA)
- D24 (CBDA)



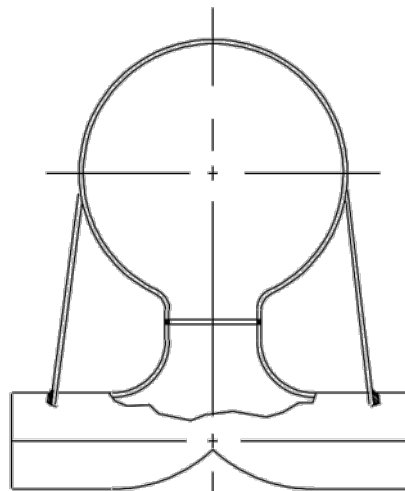
Mechanical aerators

- Jet aerators



Sanitaire Coarse Bubble Systems

- Low maintenance
- Low oxygen transfer rates
- Primary purpose is **mixing**
- Stainless Steel (304L or 316L)
- Lift Out / Fixed options
- Tender Support for design



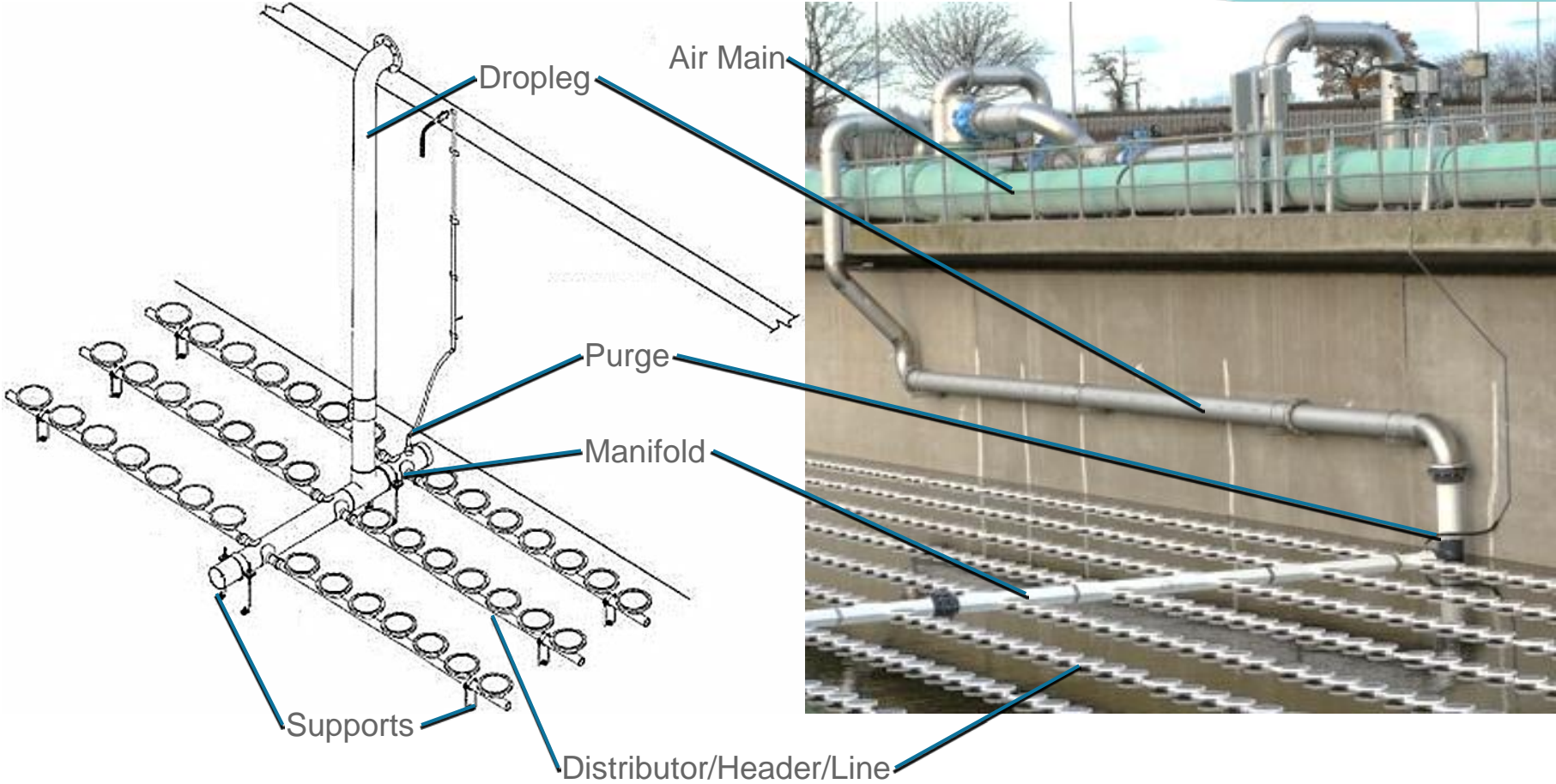
Sanitaire Fine Bubble Systems

The leading fine bubble diffused aeration systems

- High oxygen transfer efficiency for low power consumption
- Time-proven, robust systems with unparalleled diffuser longevity and minimal maintenance requirements.
- Wide selection of diffusers including membrane, ceramic and coarse bubble.
- High level design capability to ensure the right product selection and optimized design for best cost and energy efficiency.



Fine Bubble System Components



Fine Bubble System Components / Materials

Pipework

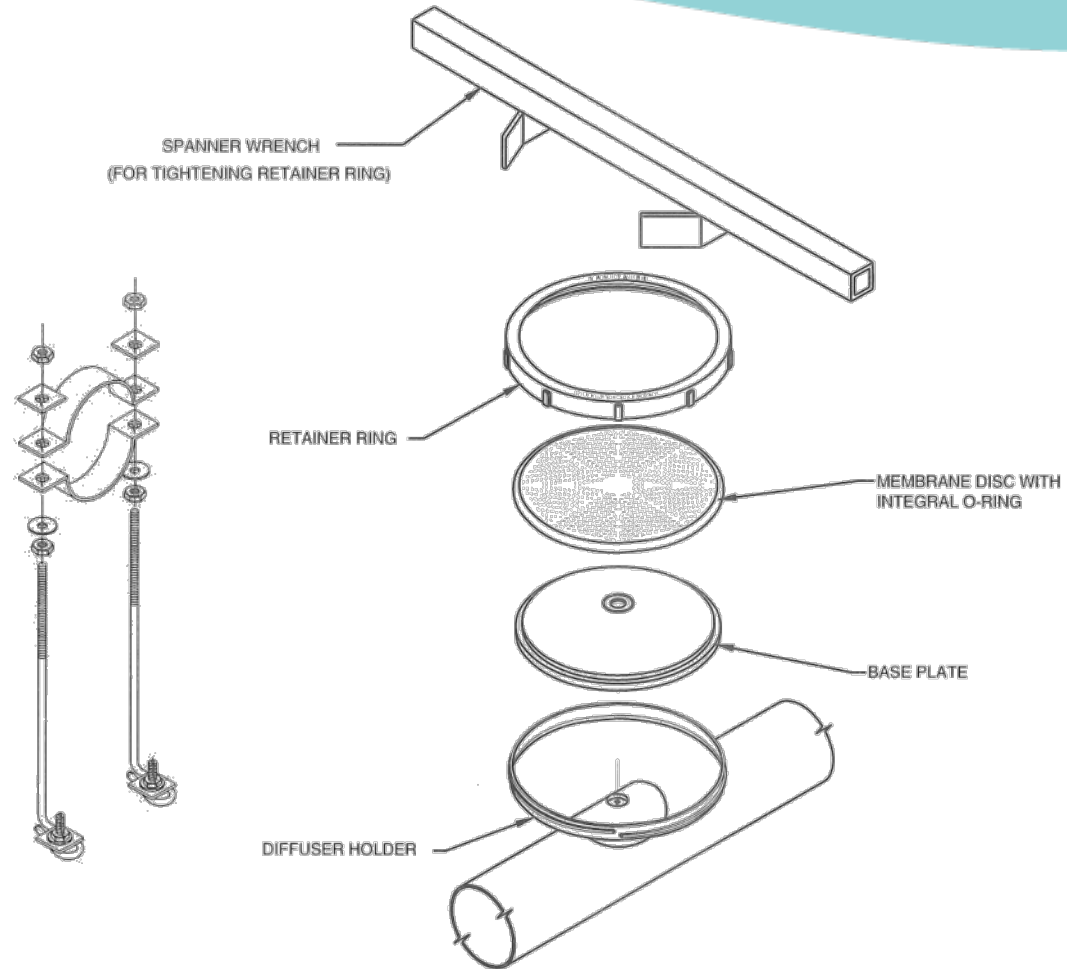
- uPVC (Standard)
- cPVC (High Temperature)
- 304L Stainless Steel
- 316L Stainless Steel

Supports

- 304 Stainless Steel
- 316 Stainless Steel

Diffuser Assembly

- uPVC
- cPVC
- Polypropylene



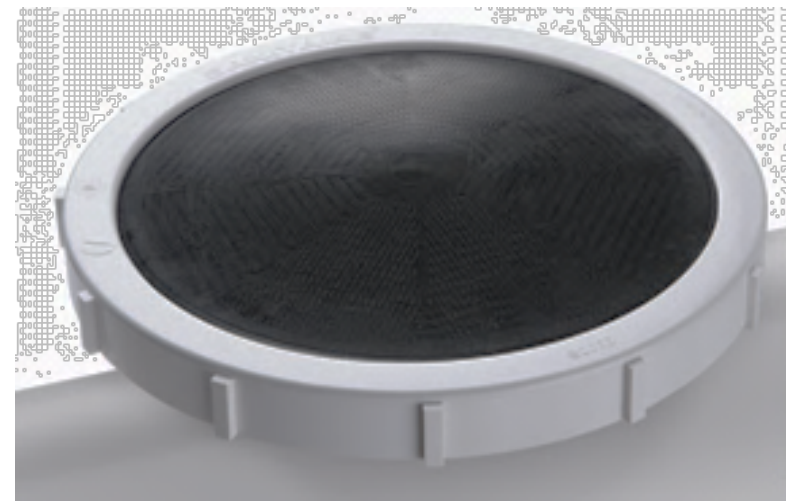
Ceramic disc diffuser

- Introduced in 1978
- Over 8,000,000 diffusers in operation worldwide
- 20 year diffuser life
- Proven piping and support system
- Pressure monitoring and cleaning options available



Membrane disc diffuser

- Introduced in 1986
- Over 15,000,000 diffusers in operation worldwide
- Resistant to fouling
- On/off applications
- Proven piping and support system
- Pressure monitoring and cleaning options available



Sanitaire® membrane development

1986

- Original material – EPDM
- Anticipated life: ~ 5 years

1993 “Silver Series”

- Improved chemical resistance
- Anticipated life >10 years

2000 “Silver Series II”

- Improved design/shape
- SOTE enhancement

2002 “Silver Series II LP”

- Change in slit pattern
- Fewer and larger slits
- Wider operating range



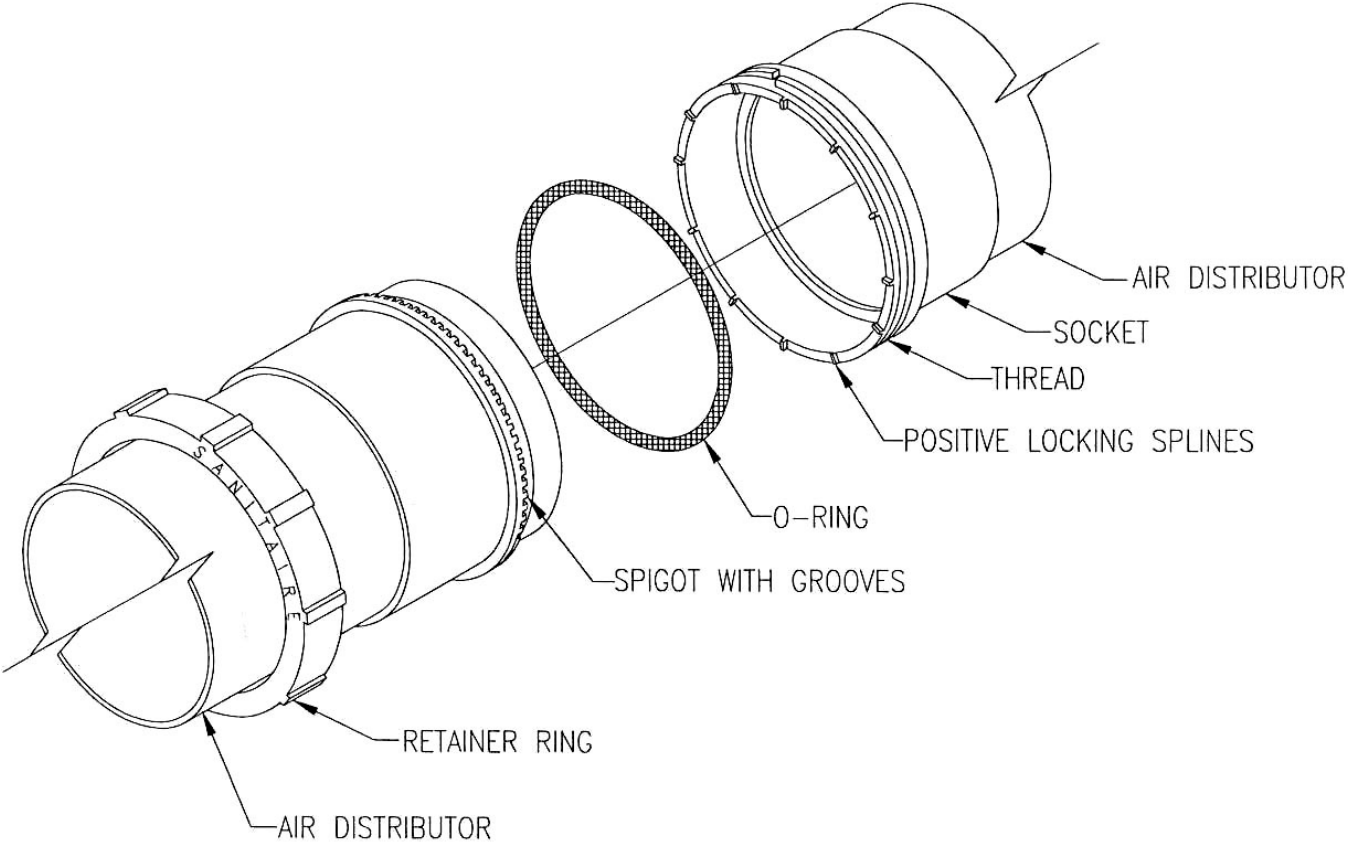
Fine Bubble Aeration

Stainless Steel Supports



Fine Bubble Aeration

Fixed, anti-rotational joints



Purge Assemblies

All Purges

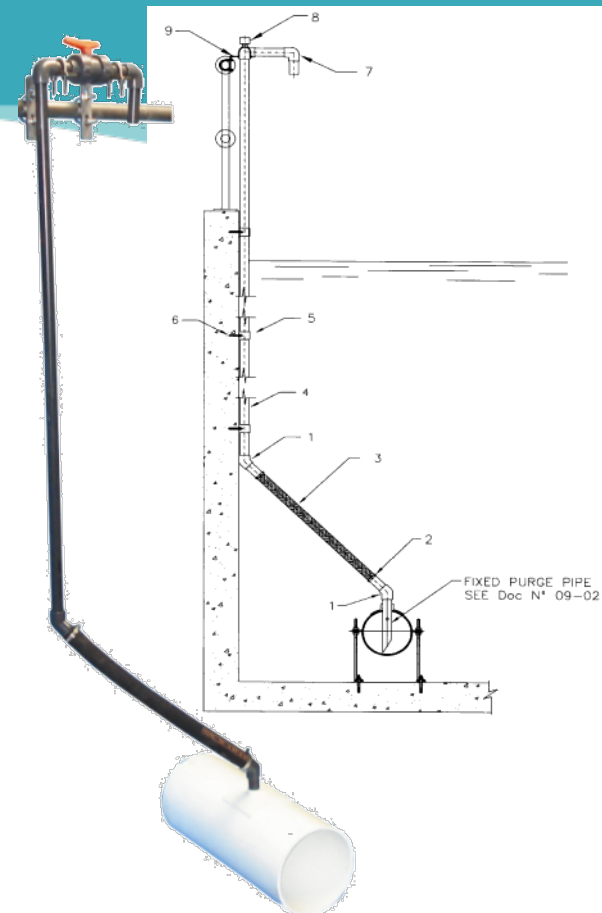
- Installed on every manifold
- Installed at lowest point
- Required to remove moisture build up

Manual Purge

- Simple ball valve & purge pipe
- Standard & heavy duty options
- Operators required to purge weekly

Continuous Purge

- EPDM tube diffuser
- Automatic – not dependent on operators

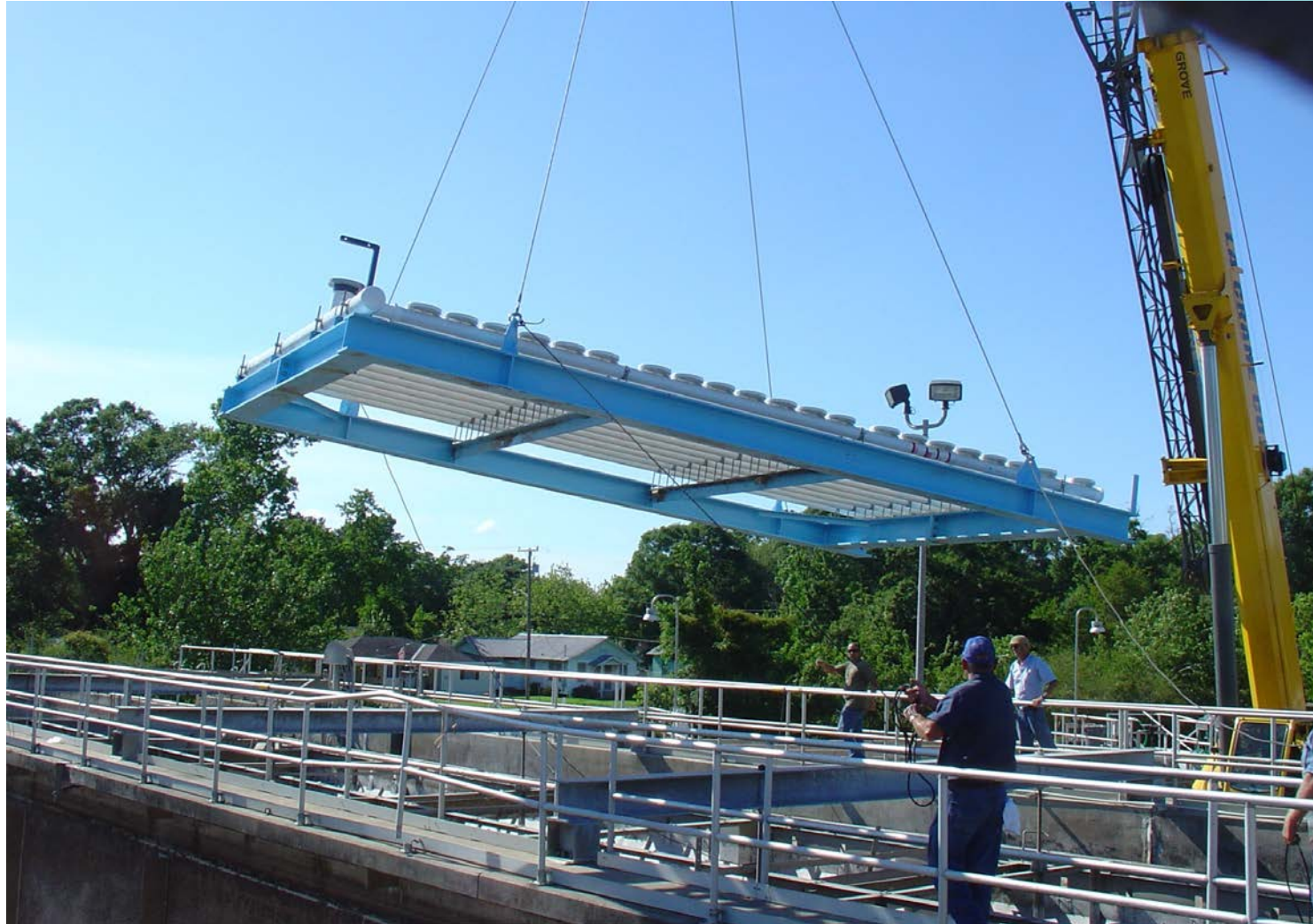


Membrane Strip Diffuser

- Introduced in Q4 2010 to meet rising energy costs
- Using Sanitaire proven pipework and supports
- Able to achieve high diffuser density
- Operates at low flux (low airflow per membrane area)
- Can be retrofitted into existing Sanitaire installations
- New membrane material



Retrievable Grid Systems and Eco-Lift



Typical Retrievable Aeration Grid System

A retrievable aeration grid is a type of Fine Bubble Diffused Aeration system that can be put in and removed from a aeration basin multiple times while the rest of the system is still in operation.

Lifting Mechanism with stainless steel cables and pole



Retrievable Grid uses CS or SS Base Frame as Ballast

Aeration Grid is installed on top of this base frame



Typical Applications – Why retrievable Grids?

- Industrial Plants with limited space
 - Mechanical aerators cannot provide enough O₂ to the system
 - They are maintenance intensive
- All of the single basin designs
- Oxidation Ditches
- No redundancy in the system
- Customer Preference



Sanitaire RG Aeration & Flygt Mixers for Oxidation Ditch Application

Liquid Cleaning System

Diffuser Fouling Types

1. Biofouling on the surface (rare)

How and Why?

- Bacteria attaches to the surface
- Grows 1" to 2" thick layer causing coalescences of bubbles
- Typically, mixing issues, too low air flow rates.
- Air bumping is the solution

2. Calcium Hardness fouling in the on the surface

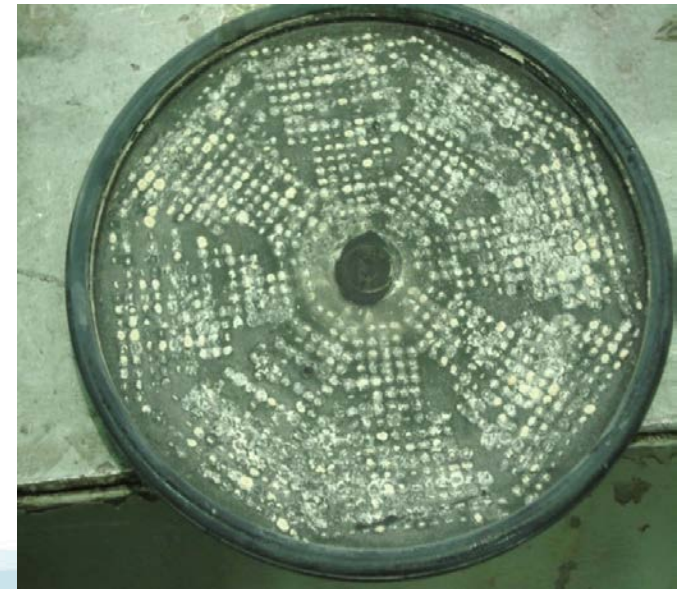
How and Why?

- Water Hardness, temperature, excessive heat
- Doesn't affect operation

3. Calcium Hardness fouling in the slits and backside

How and Why?

- Water Hardness, temperature, excessive polymer and heat
- On/Off operation
- Will increase Headloss



Advantages of LCS

- Extends the operating life of diffusers
- Resets the diffusers to like-new conditions
- Works well and is evenly distributed over grid.
- Cheaper chemical and equipment cost.
- Low investment – High Return
- Safer than gas cleaning and high pressure cleaning systems
- Automation is possible
- Different from other liquid cleaning systems;
 - They utilize high concentration, low quantity cleaning agents vs. we utilize low concentration, high quantity
 - This ensures equal distribution of the cleaning agent and cleans 100% of the diffusers



Sanitaire Performance Test Facility

- State-of-the-art test facility for advanced performance testing difuser life-cycle testing

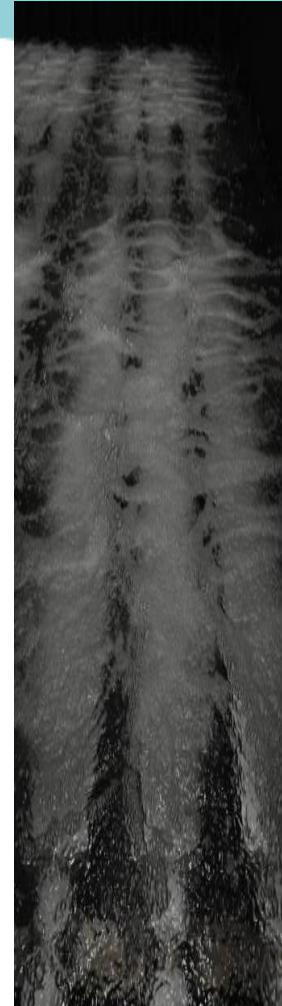


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- Boiler & Heat Exchanger
- Sodium Sulfite Mixing Tanks
- Dissolved Oxygen Probes
- Airflow Meters



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Beckton STP, London, UK



Doha South STO, Qatar



Cardiff STP, UK





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Case Stories

Fine Bubble replacing Mechanical Aerators

Moore Co. WWTP, NC - USA



New Aeration Equipment

- Sanitaire 9" Ceramic Disc Diffusers
- Pressure monitoring system
- Gas Cleaning System
- (1) 150 Hp blower operating at 60%

Original Aeration Equipment

- Submerged Turbine Aerators
- (12) 25 Hp + (12) 30 Hp
- (1) 150 Hp blower operating at 100%

Operating Power Comparison

480 HP vs. 150 HP

Annual Savings: ~\$50,000USD



Gold Series replacing Mechanical Aerators

Calco Toffo WWTP - Italy



Plant Size: 440m³/h

New Aeration Equipment:

- Sanitaire Gold Series
- PD Blower with VFDs and DO Control

Existing Aeration Equipment:

- Six (6) 22kwh (30 BHP) Flo-Get Surface Aerators

Annual Savings: ~120,000USD



Gold Series replacing Tube Diffusers

Columbus, WI - USA

General Info:

- **Plant Type:** Conventional Activated Sludge
- **Plant Size:** ~5000 m³/day
- **Lay-out:** Three (3) Parallel Tanks
- **SOR:** 250 to 400 kg/h O₂



Equipment Upgrade in 2013

	Existing	New
Aeration Equipment	Wyss Tube Diffusers	Sanitaire Gold Series
Blowers	Hoffman Multi-Stage Centrifugal (125 HP)	Aerzen Positive Displacement (75 HP)
Controls	Constant Speed	VFD Hand Adjusted with DO Probe

Results: **30.16% Savings**

	Existing	New
Cost of Gallon of treated waste water	0.0346 US Cents	0.0241 US Cents



Silver Series replacing Tube Diffusers RWZI Maarsen - Holland

General Info:

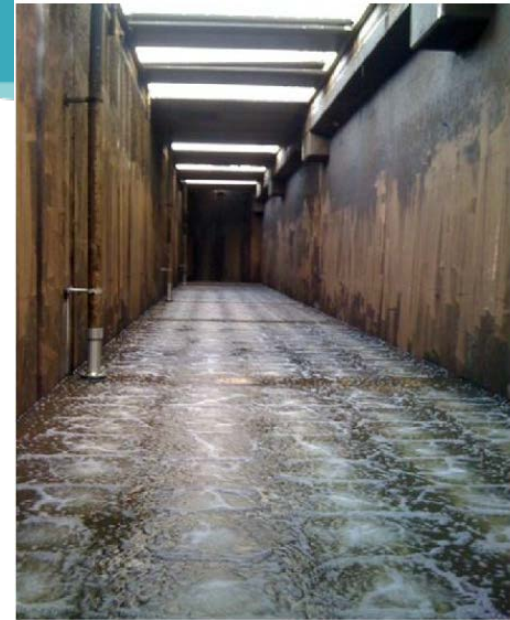
- **Plant Type:** Oxidation Ditch
- **SOR:** 81 kg kg/h O₂

Equipment Upgrade in 2011

- **Plant Type:** Tube Diffusers to Silver Series II 9"
- **No. of Diffusers:** 330 per tank

Results:

- **Project was awarded to Xylem based on 15 years of LCC analysis. Customer is very happy with Xylem equipment.**
- **Xylem was the main contractor dismantling existing system, cleaning tanks and installing new equipment.**



Silver Series replacing Tube Diffusers

Croda Gouda, Holland

General Info:

- **Plant Type:** Oxidation Ditch
- High Calcium Content in WW
- Causing Scaling and failure of tube diffusers

Equipment Upgrade in 2007

- **Plant Type:** Tube Diffusers to Silver Series II 9"
- **No. of Diffusers:** 4460 diffusers per tank

Results:

- **The graph shows the diffuser received after 2 years of operation.**
- **There was no significant increase in diffuser pressure.**
- **End user is upgrading their second system using Sanitaire SSII in 2014.**

