LAGOON WATER TREATMENT

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WATER TREATMENT NEEDS

- Good mixing of liquid
- Dissolved Oxygen in water
- Active bacteria
- Ability to remove inorganics, such as ammonium-nitrogen, phosphorus, metals, etc.

DISSOLVED OXYGEN IN WATER

OXYGEN TRANSFER BASICS

- There are various wastewater characteristics that affect the amount of Oxygen that gets dissolved in wastewater:

- Soluble salts (TDS), particulate (TSS), surface active substances (algae, O&G), temperature, atm pressure, et. al.

OXYGEN TRANSFER BASICS

continued

- Additionally, the solubility of oxygen is also impacted by other mechanical and kinetic properties:
- Tank geometry (circular, rectangular, square, etc.; rounded corners, conical bottom, height of tank, material of construction, in-ground, above ground, etc.
- Type of aeration device,
- Intensity of mixing (Reynolds Number)

OXYGEN TRANSFER BASICS

continued

- The Standard Oxygen Transfer Rating (SOTR) is a unit of measurement that quantifies the “oxygen” transfer efficiency of a specific type of aeration device using either a “Buoyancy” or “Kinetic” oxygen transfer model.
- The Standard is maintained by the ASCE and all testing is done in “Clear Water.”

Oxygen Saturation Values (C_s) for Distilled Water at Standard Conditions (1 atm) [7]

Temperature (°C)	Temperature (°F)	O_2 (mg/liter)
0	32.0	14.6
5	41.0	12.8
10	50.0	11.3
15	59.0	10.2
20	68.0	9.2
25	77.0	8.4
30	86.0	7.6
35	95.0	7.1
40	104.0	6.6
45	113.0	6.1
50	122.0	5.6

OXYGEN TRANSFER BASICS

continued

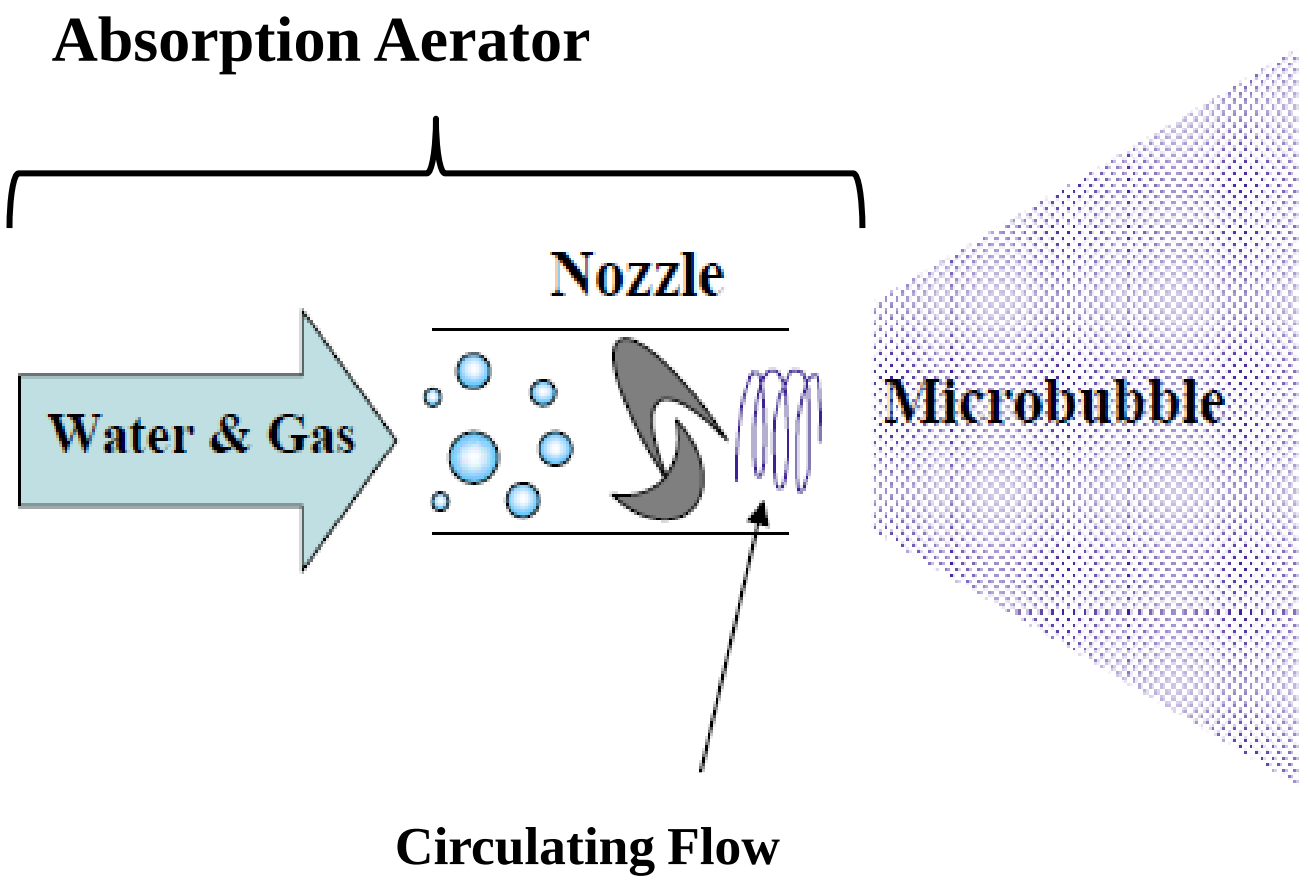
- Because the ASCE testing is done in clear water (low TDS, TSS, etc.) there are three (3) values that are used to correct for the wastewater characteristics to develop an AOTR (Actual O2 Transfer Rating):
- The ***alpha*** **(α)** value corrects for the type of aeration device, tank geometry, intensity of mixing.

OXYGEN TRANSFER BASICS

continued

- The ***beta (β)*** value corrects for soluble salts (TDS), particulate (TSS), surface active substances, etc.
- The ***theta*** (φ) value adjusts for the solubility of oxygen at specific temperatures.
- All aeration devices have a standard SOTE however, their values must be adjusted for the above three values for an AOTR.

ABSORPTION AERATOR MECHANISM



VARIOUS KINETIC TRANSFER MODEL MECHANICAL AERATION DEVICES' SOTE

- Following are various AOTR's for mechanical aeration devices: lbs. O_2/hp/hr
- **Absorption Aerator** **2.73 -3.06**
- Surface aerator w/draft tube 1.2 - 2.1
- Surface high speed 1.2 - 2.0
- Submerged turbine 1.0 - 2.0
- Submerged turbine/sparger 1.2 - 1.8
- Surface brush and blade 0.8 - 1.8
- Fine Bubble Diffusers 0.5 - 1.5

ABSORPTION AERATOR

- The Absorption Aerator process has a high oxygen transfer efficiency because of the following factors:
- High Gas / Liquid ratio: 2.2 : 1.0
- Intensity of mixing is internal in the device's mixing & oxidizing zone.
- Constant supply of an oxygen-deficient film to overcome the resistance of a partially oxygenated liquid (Two film theory).

ABSORPTION AERATOR

continued

- Kinetic force of the discharge is used for mixing and equalization (2 fps). The best use of this feature is in a circular tank.
- Stripping substances with weak Henry's constants, e.g. CO_2 and VOCs.
- Oxidizing sulfur-containing molecules, e.g. hydrogen sulfide and -mercaptans for effective odor and corrosion control.

ABSORPTION AERATOR

continued

- Degassing of gases imbedded in organic materials enhances settling of solids in clarifiers.
- Large amounts of induced DO cause fats, oils, and grease to hydrolyze and float for skimming.
- By stripping CO_2 pH is raised allowing for nitrification (pH >6.8) to begin.

INTERDEPENDENCE OF pH, ALKALINITY AND CO2

- A formula for pH showing the interdependence of pH, alkalinity and carbon dioxide:

- pH = 6.35 + log(alkalinity/carbon dioxide)

ABSORPTION AERATOR

continued

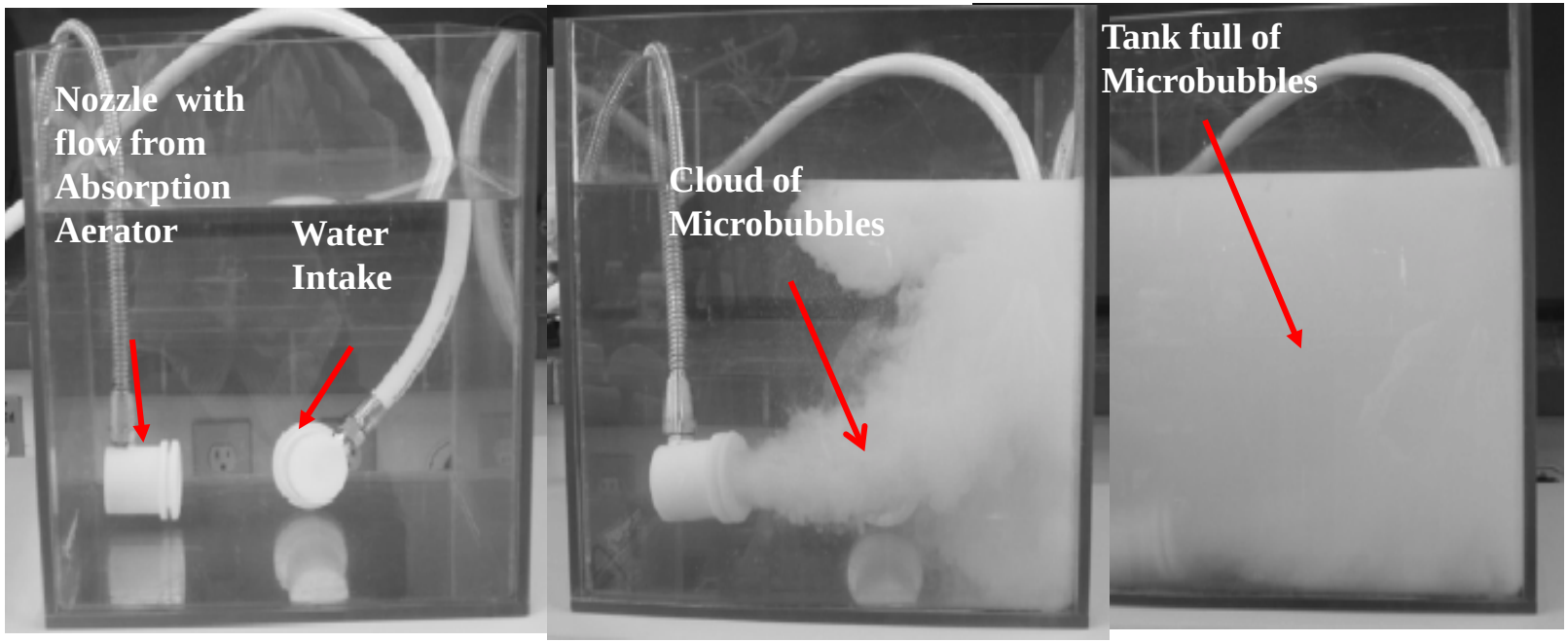
- BOD Reduction, the large amounts of DO immediately allow BOD reduction begin.
- The water nozzle has a pressure differential that causes organic materials to break apart (implosion) which increases their surface area making them more readily available for microbial digestion.

APPLICATIONS OF ABSORPTION AERATOR

continued

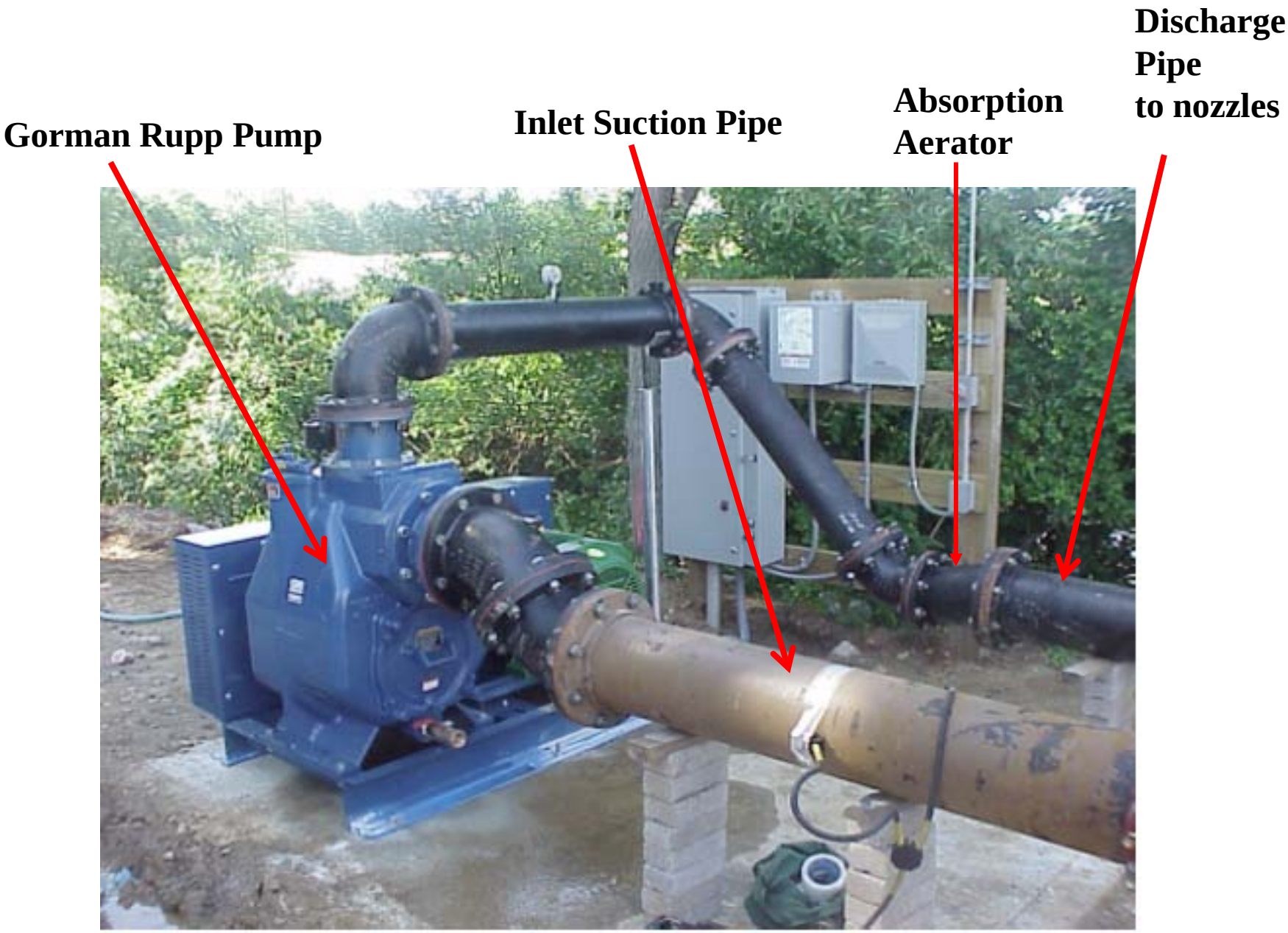
- Mixing and Equalization
- Supernatant aeration from digesters
- Landfill leachate aeration prior to headworks.
- Oil & Grease Recovery.
- Effluent aeration to streams or wetlands.
- Stripping PCE, TCE, etc. from industrial wastestreams and groundwater.
- Lagoon aeration with two zones.

PHOTOGRAPHS OF MICROBUBBLES GENERATED BY THE ABSORPTION AERATOR SYSTEM

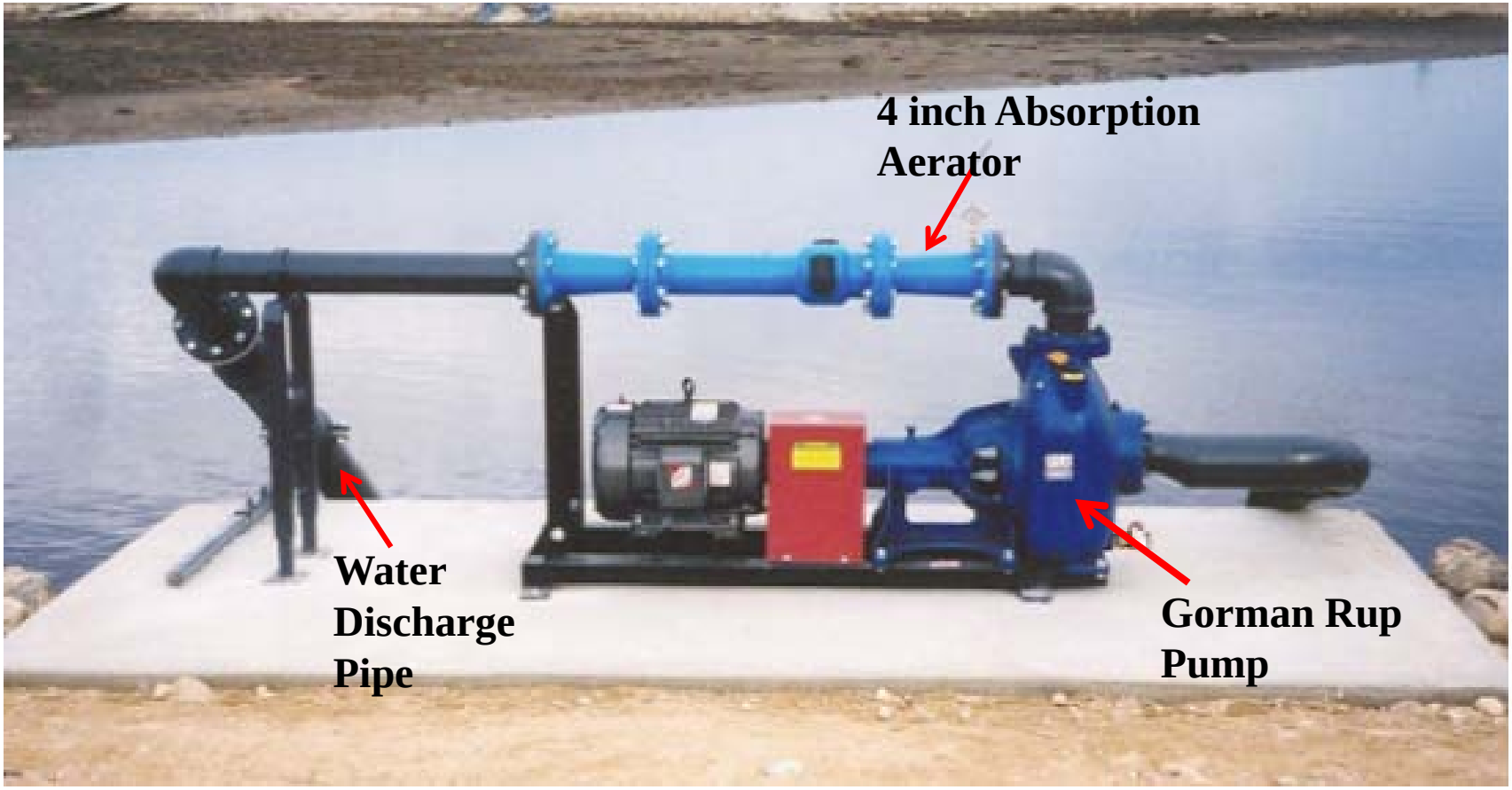


WATER INTAKE RISERS AT THE BOTOM OF LAKE

Risers are off the bottom to prevent turbidity increase and sediment re-suspension


Gorman Rupp Pump
Inlet Suction Pipe
Absorption Aerator
Discharge Pipe to nozzles

POND AERATION SYSTEM



DESIGN CONSIDERATIONS

- Start with total oxygen demand required for desired reductions and sizing unit(s).
- Determine what features need to be factored into the design.
- Flooded or lift suction.
- Location of equipment.
- Use of Gorman-Rupp self-priming pumps.

MIXING OF THE WATER IN THE LAGOON

USE OF NOZZLES

Mixing Nozzles provide dynamic mixing under pressure, which results in great mass transfer. PRD Tech, Inc.’s nozzles allow the delivery of treatment gases to any depth — all within a compact design, with trouble-free operation and easy installation. Various models are available for different applications.

ADVANTAGES OF USING NOZZLES

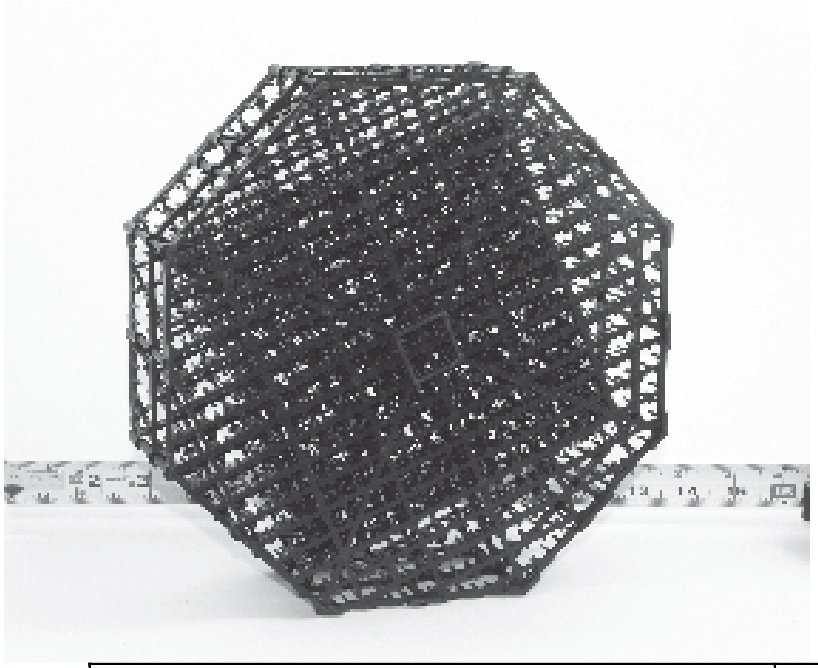
- Enhanced Gas/Liquid Interface Renewal
- Dynamic mixing under pressure yields greater mass transfer
- Desired back pressure to the Aerator
- Delivery of treatment gases to any depth
- Compact design for trouble free operation and ease of installation
- Highly durable PVDF thermoplastic construction
- Various models designed to match your application

ACTIVE BACTERIA IN THE LAGOON

USE OF BIOMEDIA IN LAGOON

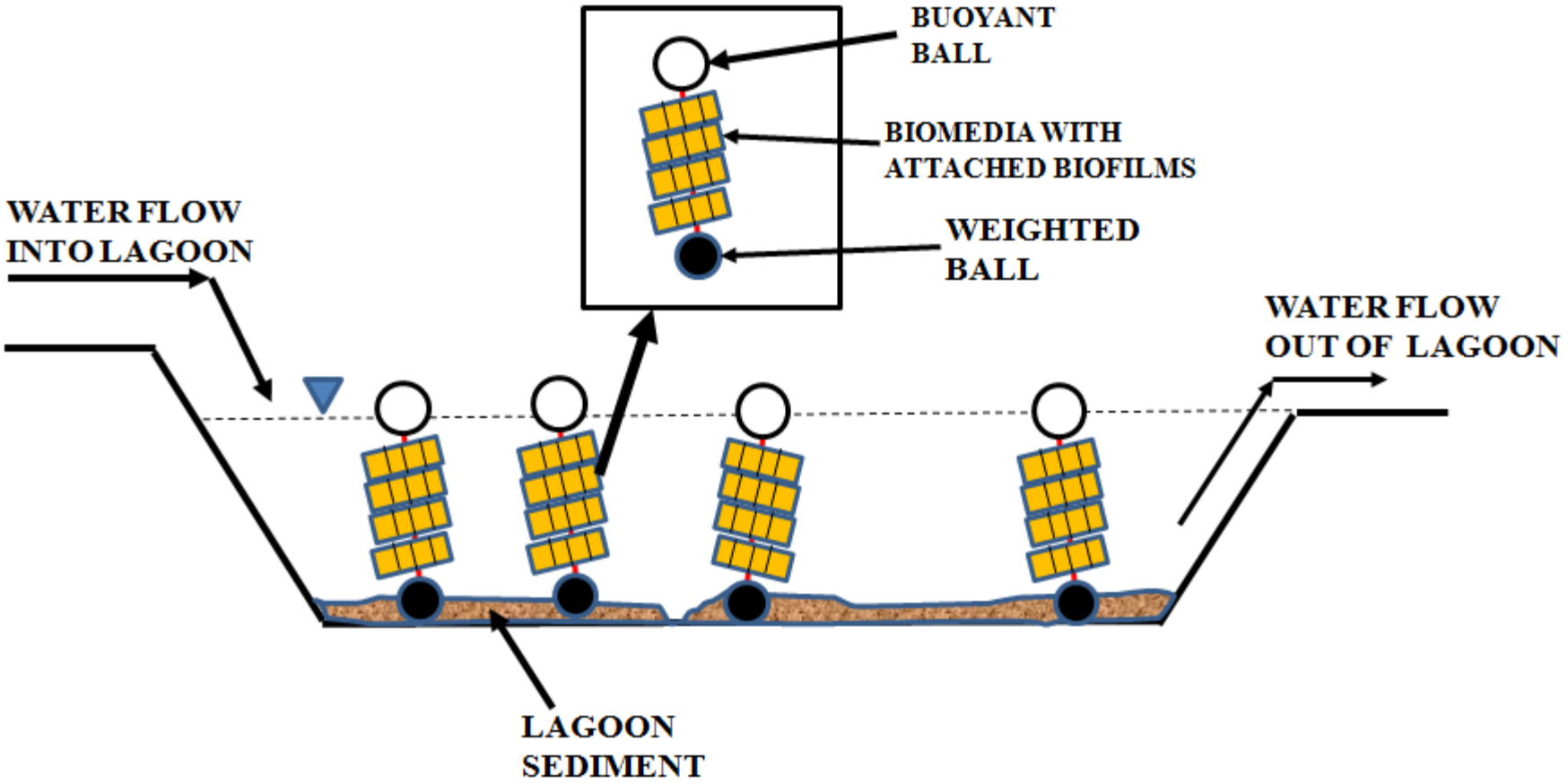
- Biomedia allows active bacteria to grow on its surface and form active biofilms;
- Biofilms allows conversion of nitrates/nitrites to nitrogen gas (denitrification);
- Biofilms allows biological removal of phosphorus from the water;
- Biomedia increases the concentration of active biomass in the water by several fold when compared to suspended cultures, such as in activated sludge

BIOMEDIA USED IN LAGOONS



NewGen Biomedia Characteristics	Value
Shape	Hexagonal
Material	Plastic, Ceramic
Dimension	11.5 in hexagon, 3 in thick
Void fraction (vol %)	96
Density (lb/ft^3)	3.2
Surface Area (ft^2/ft^3)	187

USE OF BIOMEDIA IN LAGOON



Even in lagoons with no water flow in and out of the Lagoon, this type of treatment can treat the water in-place (*in-situ)* with no water being pumped in and out of the lagoon.

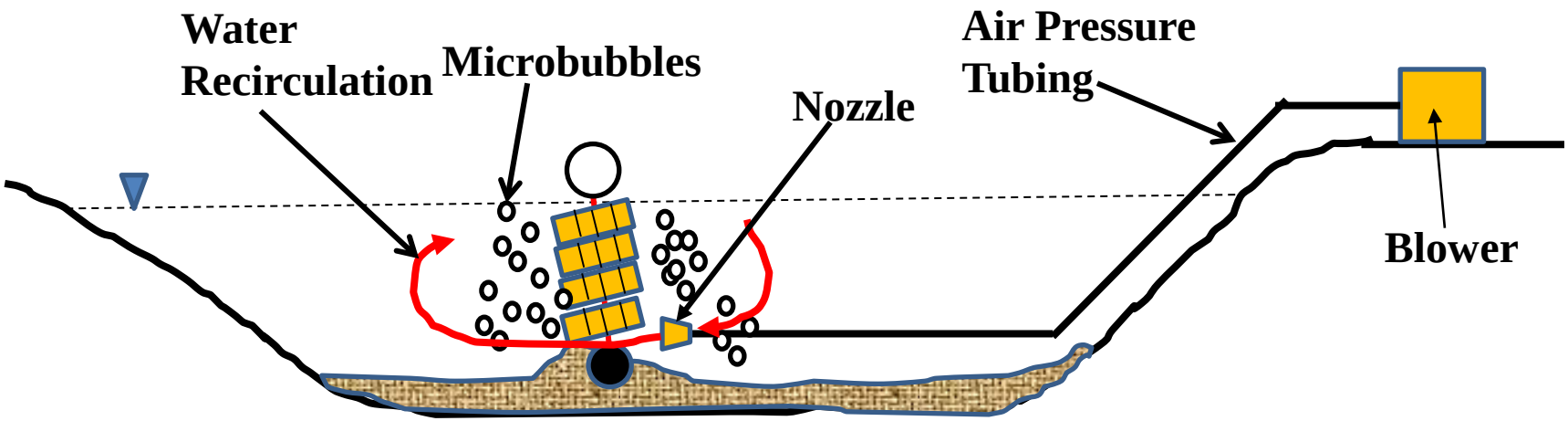
ADVANTAGES OF *IN-SITU* LAGOON WATER TREATMENT

- Does not require an external water treatment system, with water being pumped in and out of the lagoon;

- Very cost effective compared with an external water treatment system with water pump around;

- Removes Biological Oxygen Demand (BOD), Nitrates, Nitrites, Phosphorus, Metals, Total Suspended Solids (TSS), Organics, etc.

IN-SITU LAGOON WATER TREATMENT



In-Situ **Water Treatment is achieved with no water pump around system.**

Media stack waves around in the water, but stays in place, as the water moves around it, and gets treated by the active biofilms on the surface of the biomedia

The air is injected in the form of microbubbles at the bottom of the Biomedia stack, and provides dissolved oxygen in the recirculating water

Several Biomedia stacks in one lagoon can effectively treat the water

The air blower is kept outside the water for easy access.

SUMMARY

- The *in-situ* lagoon water treatment system is simple, easy to install and has few moving parts;
- The Absorption Aerator process is simple, easy to install into existing systems, has no moving parts.
- The mechanical energy is derived from the pump accelerating the liquid through the Absorption nozzle creating the vacuum to aspirate ambient air into process liquid.
- The Absorption Aerator process provides many enhancements to existing wastewater treatment systems and their performance.