TRAINING PROGRAMME FOR ETP OPERATORS IN TEXTILE INDUSTRY

Promotion of Sustainability in the Textile and Garment Industry in Asia - FABRIC

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

FABRIC Asia

Aeration systems for biological treatment

GIZ FABRIC – ETP Operator Course

Contents

- Basic concept
- Types of aerators
- Selecting adequate aeration system

Basic concept

Basic concept

Purpose

Aerobic biological treatment systems **need continuous oxygen** supply

Approach

Artificial aeration

- Aeration provided by set of mechanical units **(‘aerators’).**
- Consumption of electric power and provision of mechanical action resulting in aeration of water
- Different designs depending on process

Basic concept

Options

- Different types of diffusers based on bubble size (e.g. coarse, medium and fine)
- Also natural aeration systems (e.g. reed beds) and cascade aerators

Typical aeration types:

- **Surface** aerators
- **Submerged** aerators
- Differences in **oxygen transfer rates**:
  - fluctuation between 0.7 and 1.4 kg of oxygen per Kilowatt-Hour.

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Basic concept

Purpose:

1. Increasing **dissolved oxygen in treatment unit:**
   - by dispersing air in water
     - splashing water in air to enable entrapment of air in water
     - bubbling air through water
2. Provide **sufficient mixing in tank** to
   - ensure contact of organic particles with bacteria;
   - prevent settling

.

Types of aerators

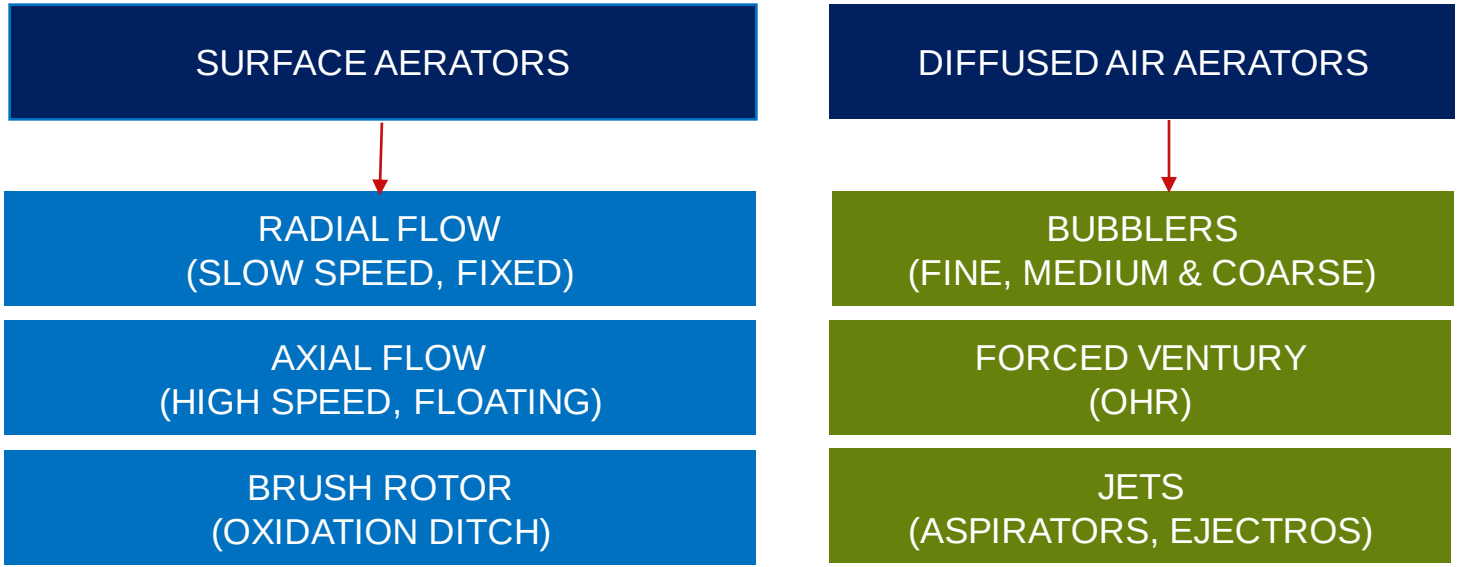
Types of aerators

Two basic ways to reach dispersion of air in water:

1. **Surface aerators:**
   - Installed and operated at surface
2. **Submerged aerators:**
   - Bubbling air from bottom of tank through orifices/diffusers
   - Ejecting water with force through channel through which air sucked into wastewater

Types of aerators

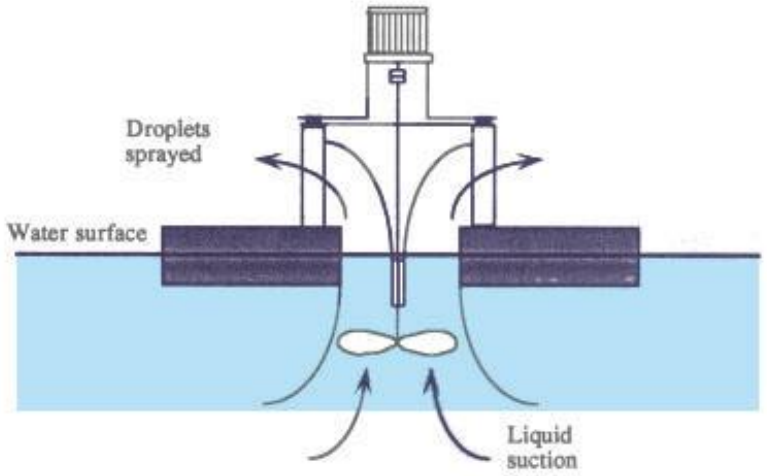
Common aeration units:



Surface aerators

Floating aerators - Design

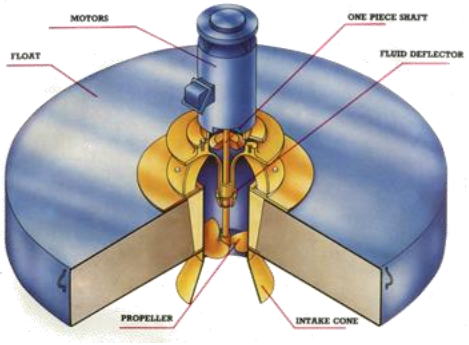
- Popular surface aeration unit
- Mounted on a float
- Consisting of propeller installed inside rising tube and driven by non-immersed motor



Surface aerators

Floating aerators – Concept

- Propeller drawing liquid from beneath unit and spraying above surface of tank
- Oxygen transferred through air on sprayed droplets and turbulent surface of the liquid
- Mixing in tank by creation of convectional water currents



Surface aerators

Floating aerators

Surface aerators

Fixed aerators – Design

- Similar to agitator, except blades designed to splash water around.
- Blades installed at surface
  - Maximum amount of water thrown around.
- Immersion of blades important factor

Surface aerators

Fixed aerators – Concept

- Splashing of water into air
- Creation of powerful waves through out tank
- Entrainment of air into water through splashed water drops

Surface aerators

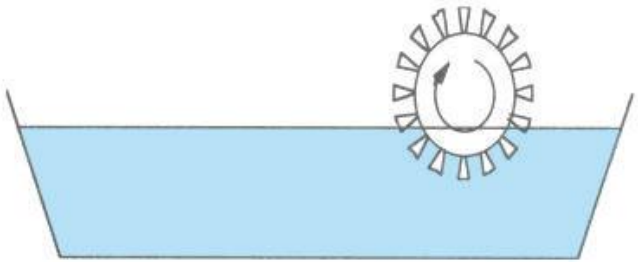
Fixed aerators – Challenges

- **Too low immersion:**
  - Less water being sprayed
  - Reduction of aeration effect
- **Too deep immersion**
  - No throw of water
  - Effect more similar to agitator
  - Increase of load

Surface aerators

Cage rotors/ brush aerators

- Used in oxidation ditches
  - blades mounted on cylinder rotating through liquid
  - baffles to direct flow and ensure turbulent velocity



Surface aerators

Cage rotors/ brush aerators

- Some oxidation ditches employing other aeration systems like:
  - Surface aerator
  - Set aerator
  - Diffused aeration
  - → often provided with flow boosters
- Apart from water spray, turbulent flow through ditches encouraging better aeration

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Surface aerators

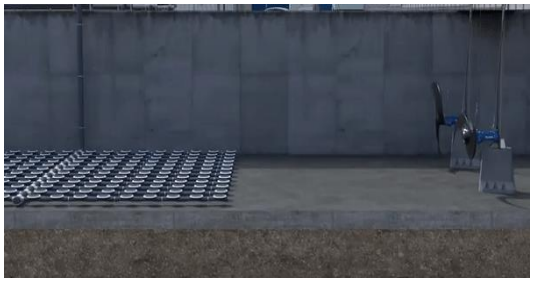
Cage rotors

- Aeration by creating turbulence
- promoting flow through ditches

Surface aerators

Special case

- Bottom diffusers in addition to rotating brushes on surface
  - improve aeration and oxygen transfer.



Bottom diffusers in the oxidation ditch and ABS flow boosters

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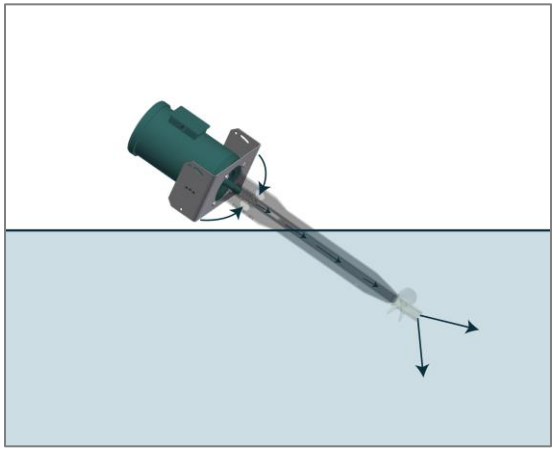
Surface aerators

Jet aerator mounted on floats

- Generally used for low aeration requirements (e.g. aqua culture)
- Used in oxidation ditch because of unidirectional flow
- Multiple units sometimes used for rectangular tanks.
- Used for shallow aeration tanks
- Common in small ETPs



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Surface aerators

Jet aerator mounted on floats – Concept

- Mounted on floats on both sides with hollow shaft extended into water
- Rotating impellers at end of shaft
  - Water jet sucking in air and discharging air-water mixture.

Jet aerator mounted on floats (Blowtac)

Surface aerators

Concept

- Bubbling of from bottom
  - Air bubbles rising to top, passing through water column and getting dissolved in water
- **Efficiency** of air dissolution **depending on contact time between air and water**
  - Longer contact time with water => more air dissolved

Surface aerators

Improving contact time of air and water

(1) Increasing depth of the tank

(2) Reducing size of air bubbles

(3) Deflecting horizontal movement of air

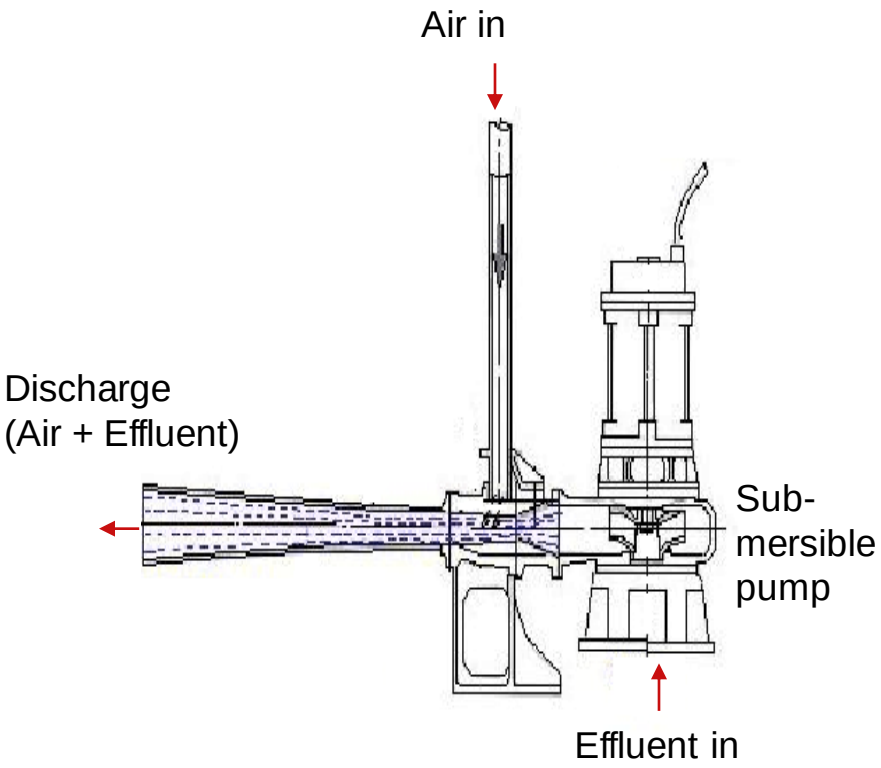
Remember

- **Fine bubble diffusers more efficient** than coarse bubble aeration!

Surface aerators

Ejectors

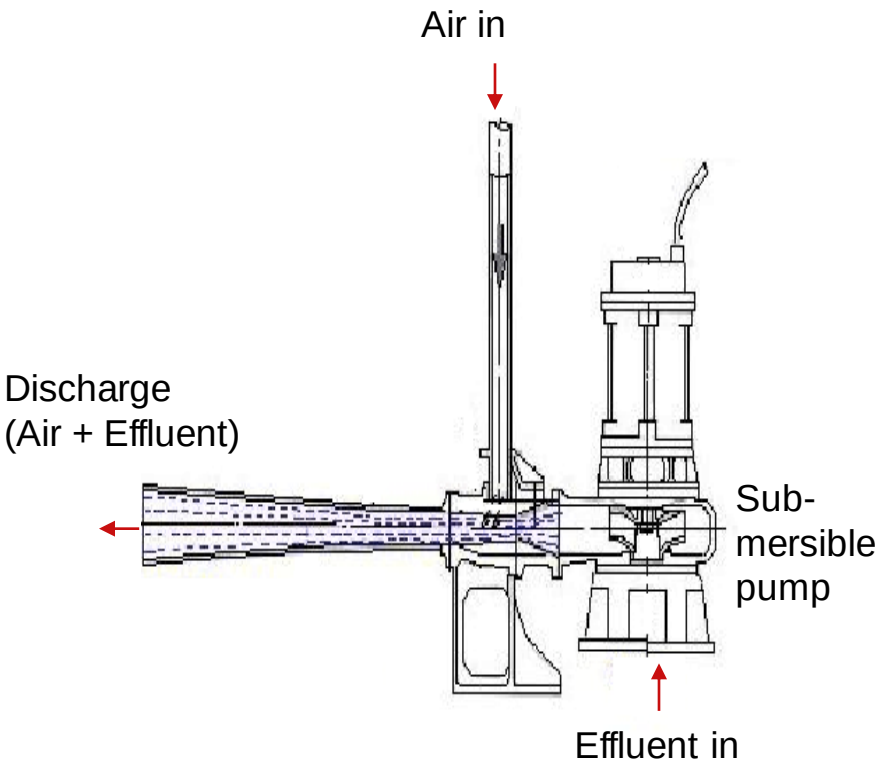
- Submersible pumps with air inlet line attached to outlet
  - Water suction from bottom and discharge towards side
  - Vent pipe attached to discharge line
  - Air being sucked into system and mixed with effluent due to force of water pumped



Submerged aerators

Ejectors

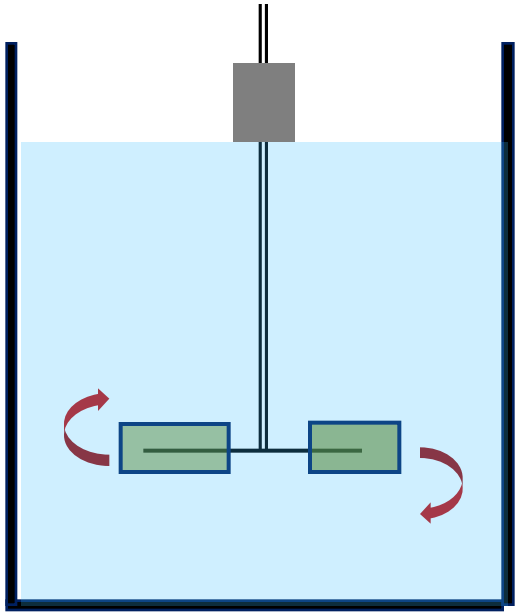
- Venturi arrangement after point of air joining water leads to sufficient air diffusion
- Mixing power of system relatively high
- Aeration power relatively low



Submerged aerators

Turbine aerators

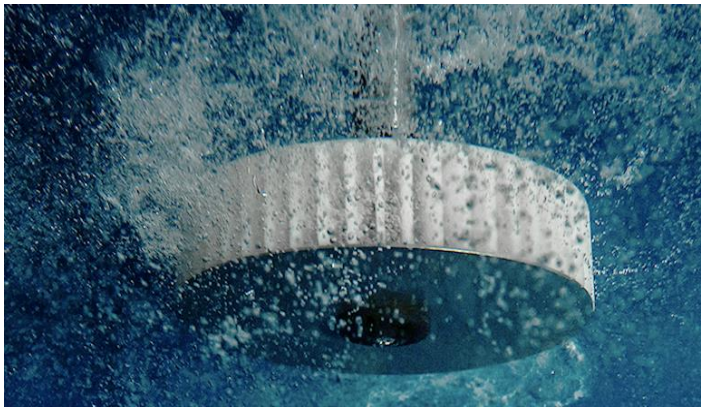
- Simple aeration devices used in ponds, aqua culture, etc.
- Increasing acceptability in wastewater treatment
  - relatively high oxygenation capacity



Submerged aerators

Turbine aerators – Design

- Electric motor-driven turbine impeller rotating at high speed
- Impeller either integrated
  - with air line, or
  - installed above pipe or sparging ring discharging compressed air
- Use of more than one impeller in same axis depending on depth of aeration basin



Submerged aerators

Turbine aerators – Concept

- Air bubbles discharged from pipes and dispersed by rotation of turbine.
- Power drawn by turbine systems used for
  - Maintaining mixing and
  - Breaking down and dispersing air bubbles (the latter demanding most of power).

Submerged aerators

Deflected air bubblers

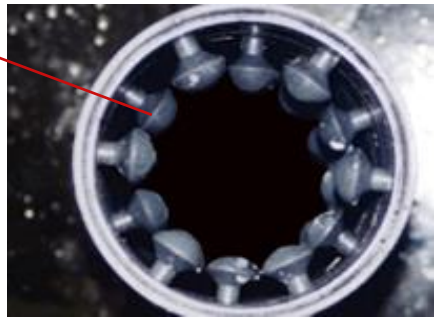
- Air introduced into tube
  - No direct release into wastewater
  - Collision with multiple deflectors, creating finer bubbles and reducing speed of upward rise
- Common deflected air bubbler:
  - **OHR aerator**

Submerged aerators

Deflected air bubblers – OHR aerator

- Air introduced to polypropylene or steel tube with mushroom-shaped projections inside
- Air introduced together with water hits projections and creating smaller bubbles
  - Zig-Zag movement

Mushroom like projections within the tube



Submerged aerators

Deflected air bubblers

- **Advantages:**
  - Long lifespan
  - Absence of clogging
  - Easiness of maintenance
- **Disadvantages:**
  - Low efficiency due to higher amount of diffused air and hence power consumption

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Submerged aerators

Deflected air bubblers – OHR in operation

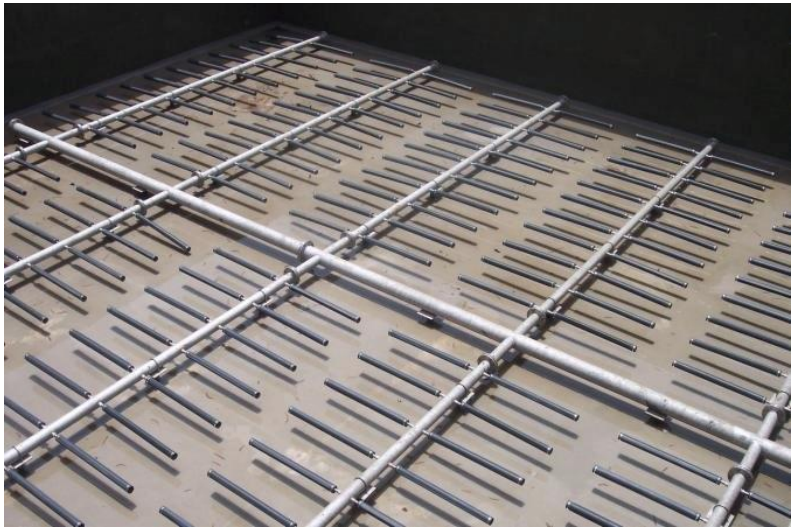
Special design of OHR system

- air bubbles breaking into finer bubbles
- creating fine-medium bubbles

Submerged aerators

Diffused aeration systems

- Diffusers divided into:
  - Fine bubble
  - Medium bubble
  - Coarse bubble
  - Large bubble diffusers
- Placed along air manifolds, close to bottom of aeration tanks

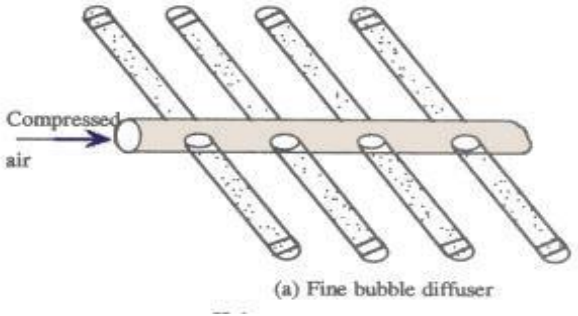


Submerged aerators

Diffused aeration systems - Examples

Fine bubbles

- Different materials (EPDM rubber, ceramic or steel) with fine pores
- Mostly **EPDM rubber**, covering either pipe or disc made of plastic
- Installed in **grid of pipes** (fixed or flexible) **located at bottom**
- Very small bubbles with high surface for good oxygen transfer from air to wastewater



(a) Fine bubble diffuser

Submerged aerators

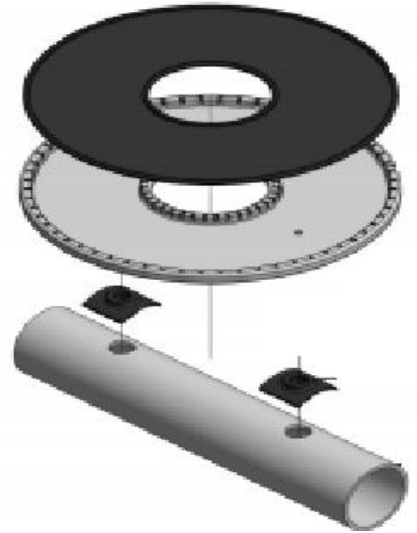
Diffused aeration systems - Examples

Medium bubbles

- Mostly perforated pipes or tubes wrapped with plastic or woven fabric

Large bubbles

- Orifice devices of various types,
- Some designed to be non-clogging.



Submerged aerators

Diffused aeration systems - Examples

Coarse bubbles

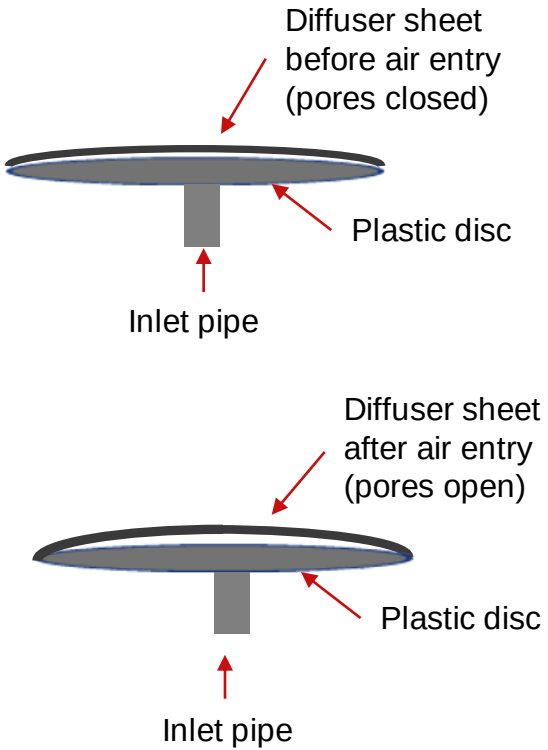
- Mostly porous pipes with nozzles
- Orifice devices of various types
  - some designed to be non-clogging.
- Less efficient for oxygen transfer
- Presence of particles in air no problem
- Lower cost and maintenance requirements

Submerged aerators

Diffused aeration systems

Non-clogging effect

- Fine pores in rubber diffusers open only when inflated.
- When air withdrawn, contracting and closing pores.
  - Closed pores preventing sludge getting into diffuser tubes and air lines.



Submerged aerators

Bottom bottle diffusers

Submerged aerators

To remember

“Bubblers” working by

- Letting in air at bottom of tank
- Allowing bubbles to pass through the water
- Allowing air to get mixed in water
- Preventing settling of solids in tank through release of air at bottom

Submerged aerators

To remember

Fine bubble diffused aeration

- only showing very **gentle agitation at top**
- high turbulence (like **coarse bubble**) indicator for **broken diffuser sheet**
- EPDM **diffuser sheets** becoming **brittle** after some time
  - need of **replacement after 2-4 years**
  - consider lifting systems

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Selecting adequate aeration system

Selecting adequate aeration system

Main factors for selection

- Capital and operating cost
- Efficiency of aeration
- Maintenance requirement
- Lifespan of system

Choice of adeaquate aeration system

Additional factors for selection:

- type of ETP and its capacity
- application area (e.g. aeration tank or equalization tank)
- Diffused aeration systems most common in medium and large ETPs

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