Subject **«Biochemical engineering»**

Final lecture on module 1

Lecture 5 – press-conference
Aeration and Agitation

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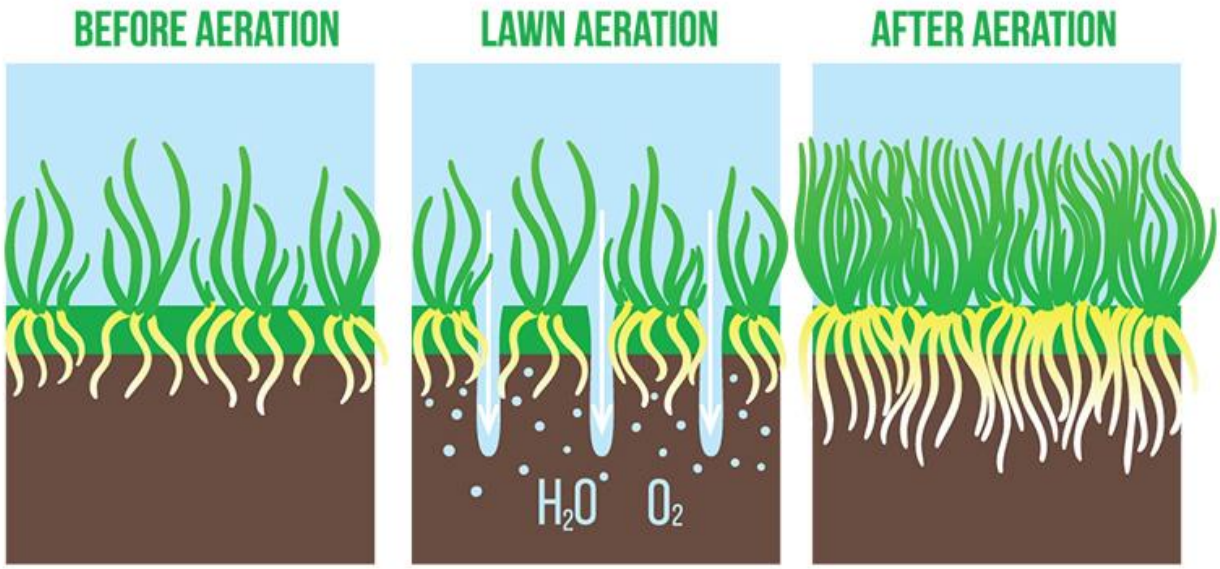
WHAT IS *AERATION*?



Aeration is the process of bringing water and air into close contact in order to remove dissolved gases, such as carbon dioxide, and to oxidize dissolved metals such as iron. It can also be used to remove volatile organic chemicals (VOC) in the water. Aeration is often the first major process at the treatment plant. During aeration, constituents are removed or modified before they can interfere with the treatment processes.

WHY DO WE USE AERATION?

- Oxidation of organic matter;
- To increase dissolved oxygen content;
- To reduce the concentration of taste and odor causing substances, such as hydrogen sulfide and various organic compounds, by volatilization / stripping or oxidation;
- To oxidize iron and manganese, rendering them insoluble;
- Flocculation of colloids in sewage influent;
- To remove those compounds that may in some way interfere with or add to the cost of subsequent water treatment.

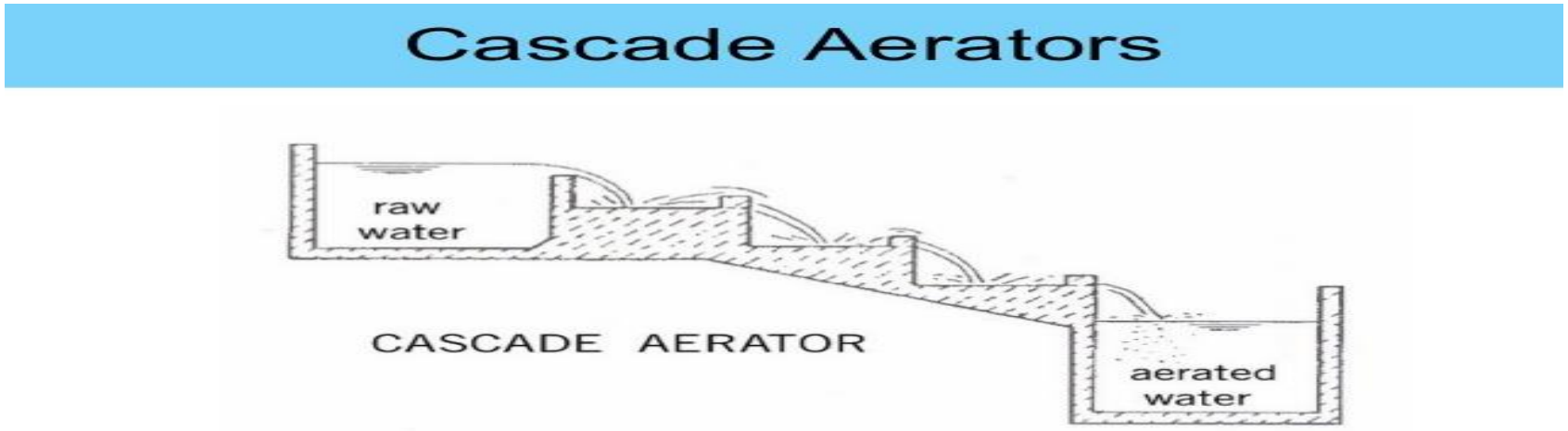
DISCUSSION OF CHEMICAL SUBSTANCES AFFECTED BY AERATION

- Volatile organic chemicals, such as benzene, found in gasoline, or trichloroethylene, dichloroethylene, etc.
- Carbon dioxide;
- Hydrogen sulfide (rotten-egg odor);
- Methane (flammable);
- Iron (will stain clothes and fixtures);
- Manganese (black stains);
- Various chemicals causing taste and odor.

METHODS OF AERATION

- Passing water through air
- Passing air through water
- Water can be exposed to air by spraying or by distributing it in such a way that small particles or thin sheets of water come in contact with the air.
- Water can also aerated by pumping large volumes of air through the water.

Water into air



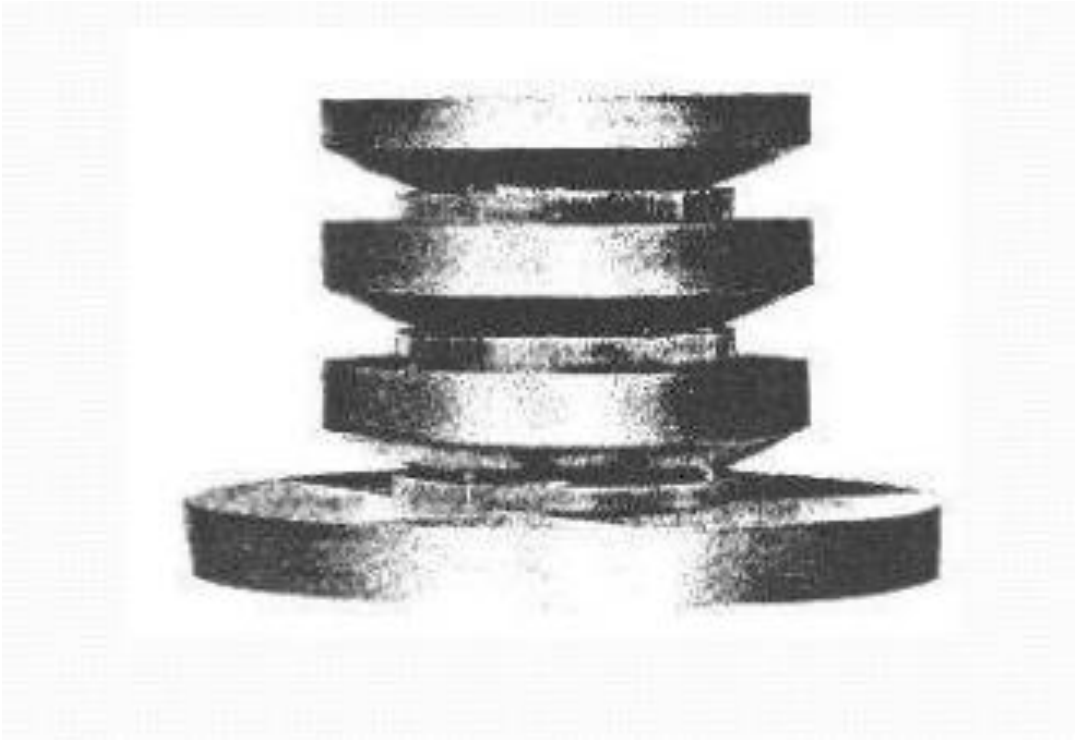
Cascade Aerators

A cascade aerator consists of a series of steps that the water flows over. In all cascade aerators, aeration is accomplished in the splash zones.

Cascade aerators can be used to oxidize iron and to partially reduce dissolved gases.

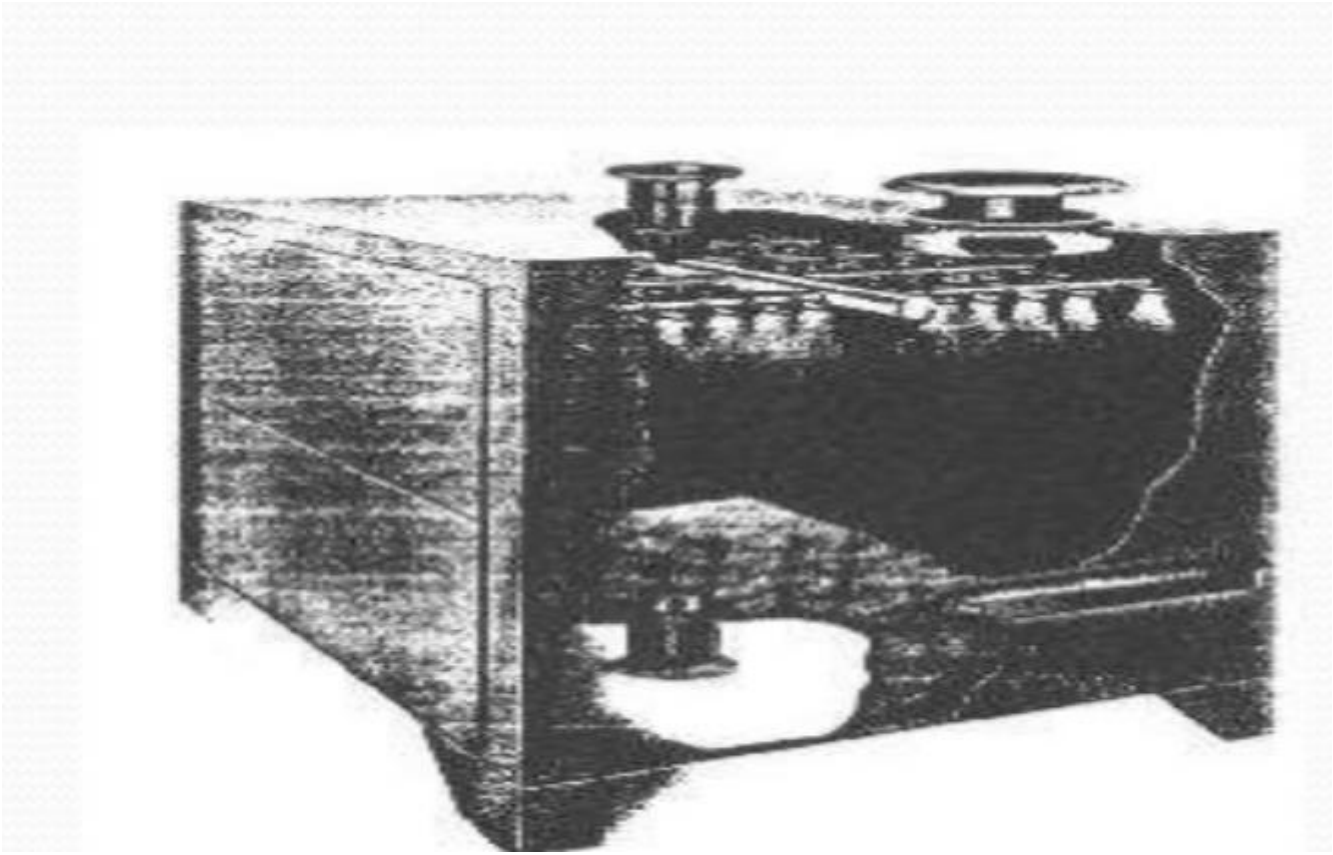
Cone Aerators

Cone aerators are used primarily to oxidize iron and manganese from the ferrous state to the ferric state prior to filtration. The water being pumped to the top of the cones and then being allowed to cascade down through the aerator.



Spray Aerators

This type of aerator has one or more spray nozzles connected to a pipe manifold. Moving through the pipe under pressure, the water leaves each nozzle in a fine spray and falls through the surrounding air, creating a fountain affect . In general, spray aeration is successful in oxidizing iron and manganese.

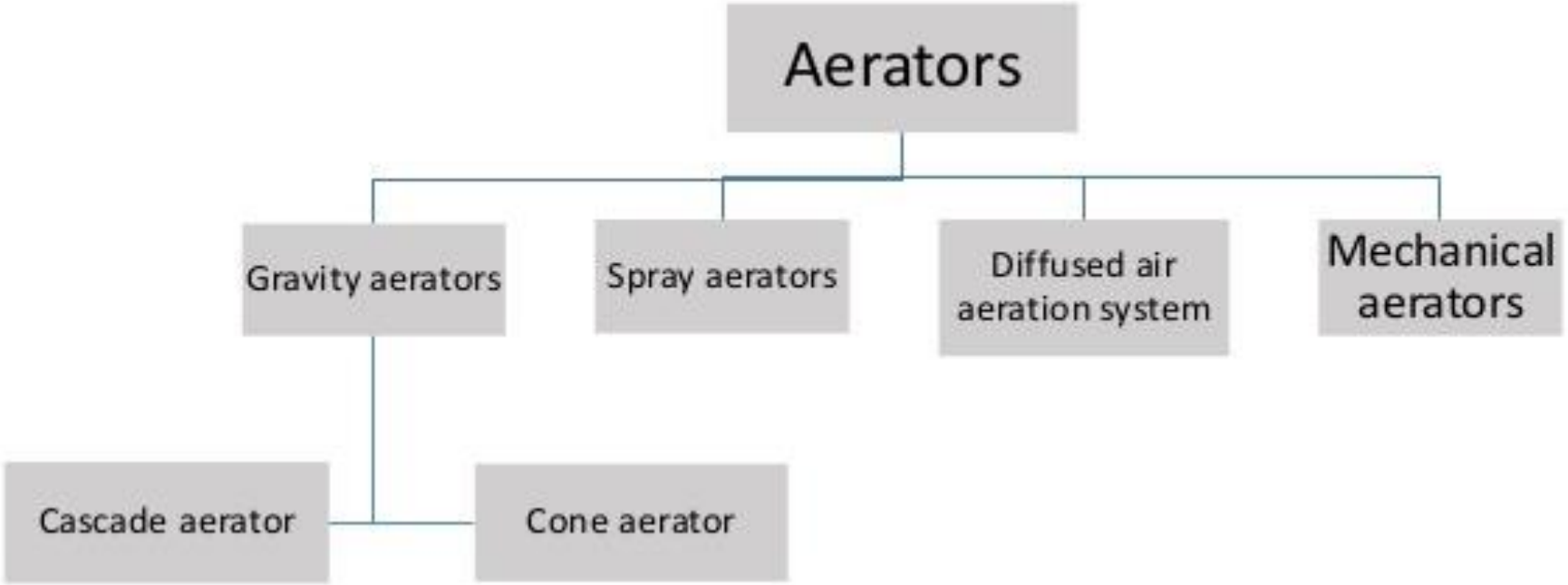


AIR INTO WATER

AIR STRIPPING

- It is quite effective in removing volatile organic chemicals (VOCs) from water.
- VOCs may be carcinogens. (eg of VOCs are benzene from gasoline and trichloroethylene from dry cleaning establishments)
- It can be accomplished by letting the water flow over cascade aerators or in specially designed air-stripping towers. In these, water is allowed to flow down over a support medium or packing contained in the tower, while air is being pumped into the bottom of the tower.

Types of Aerators



Diffused – Air Aeration Systems

→air is introduced into liquid being aerated in the form of bubbles which typically rise through the liquid

→common device for ;

transferring oxygen in aerobic biological treatment systems

air stripping of volatile organics

E:http://www.brightwaterfli.com/diffused_aeration_systems.htm

FINE BUBBLE

→the size of bubbles varies from coarse to fine

- fine-bubble diffusers
- coarse bubble diffusers

MECHANICAL AERATORS

- By producing a large air-water interface the transfer of oxygen from atmosphere is enhanced

- Can be VERTICAL SHAFT or HORIZONTAL SHAFT

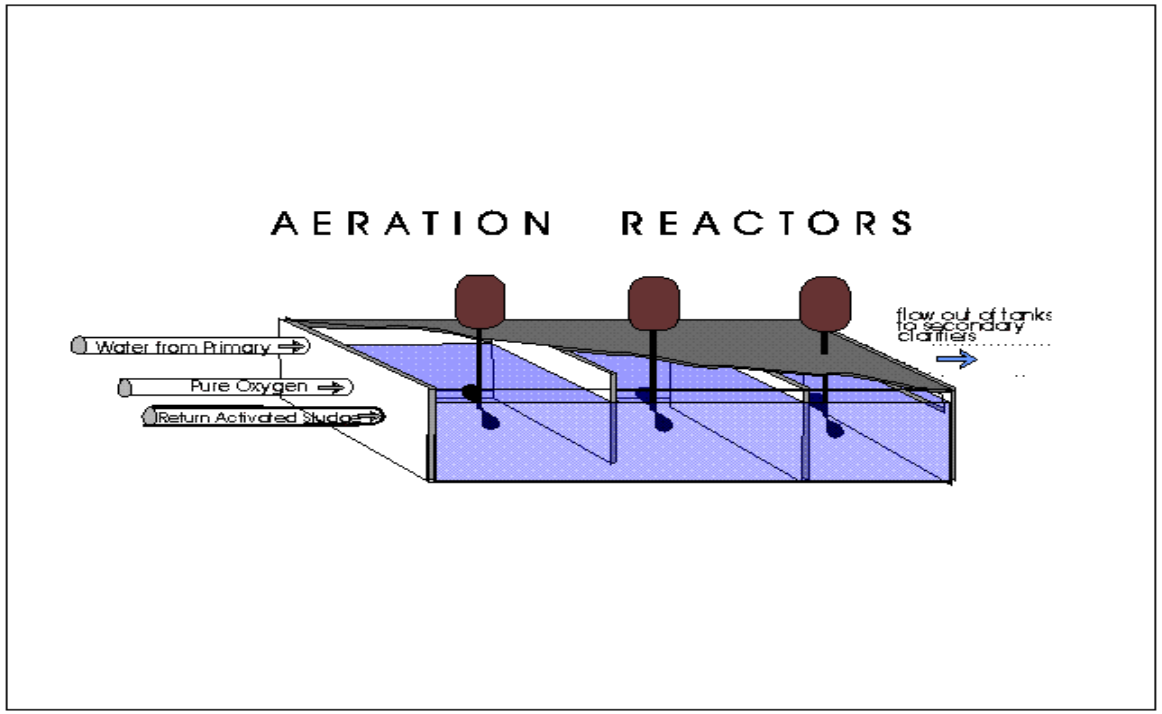
DIFFUSED AERATION	MECHANICAL AERATION
1. Superior Mixing a) full dept mixing for any depth b) full basin utilization	Limited mixing depth Limited energy location- poor distribution
2. Major Energy Saving Approx 40% energy saving vs. splash type surface aerators Low energy demand	High energy cost High energy demand
3. Possible Flexibility Can turn down or throttle entire system	Loss of air when unit are turn off No throttling possible
4. Capital Cost If used in deep basin very economical Short payback period	If used in deep basin very costly Comparatively high payback period

ADVANTAGES OF EXTENDED AERATION SYSTEM:

- Plants are easy to operate, as the management of operation is for a maximum of two or three hours per day.
- Extended aeration processes are often better at handling organic loading and flow fluctuations, as there is a greater detention time for the nutrients to be assimilated by microbes.
- Systems are odor free, can be installed in most locations, have a relatively small footprint, and can be landscaped to match the surrounding area.
- Extended aeration systems have a relatively low sludge yield due to long sludge ages, can be designed to provide nitrification, and do not require a primary clarifier.

DISADVANTAGES OF EXTENDED AERATION SYSTEM:

- Extended aeration plants do not achieve denitrification or phosphorus removal without additional unit processes.
- Flexibility is limited to adapt to changing effluent requirements resulting from regulatory changes.
- Longer aeration period and hence requires more energy.



Two kinds of agitation

- Agitation based on **vertical deviance** occurs when the agitators subscribe to the value system of the establishment, but dispute the distribution of benefits or power with that value system.
- Agitation based on **lateral deviance** occurs when the agitators dispute the value system itself.

VI. AGITATE AND SOLVE

- This is a persuasion theme that works as an overall approach to making your case. First, you identify the problem and qualify your audience. Then you agitate the reader's pain before offering your solution as the answer that will make it all better.
- The agitation phase is not about being sadistic; it's about empathy. You want the reader to know unequivocally that you understand his problem because you've dealt with it and/or are experienced at eliminating it. The credibility of your solution goes way up if you demonstrate that you truly feel the prospect's pain

@FOAMpodcast

AGITATION

INCREASING LIKELIHOOD OF DANGEROUS CONDITION

COOPERATIVE

ORAL SOMETHING

(Lorazepam, Olanzapine)

DISRUPTIVE WITHOUT DANGER

HALDOL 5mg + LORAZEPAM 2 mg IM

DROPERIDOL or MIDAZOLAM 5-10 mg IM

DROPERIDOL or MIDAZOLAM 10-20 mg IM

INCREASING AGITATION

EXCITED DELIRIUM

ADEQUATE # OF PEOPLE

PERSONAL PROTECTIVE EQUIPMENT

RELIEVE DANGEROUS HOLDS

FACE MASK OXYGEN

KETAMINE IM 4-6 mg/kg

HEAD OF BED UP, LOOSEN RESTRAINTS

VITAL SIGNS (TEMPERATURE, GLUCOSE, O2)

IV, CRYSTALLOID BOLUS + RESUSICTATION

WHY AGITATED?

hypoxia, hyperthermia, hypoglycemia, hypoperfusion
hyperkalemia, ICH, CNS infection, acidemia
rhabdomyolysis

Aeration and Agitation

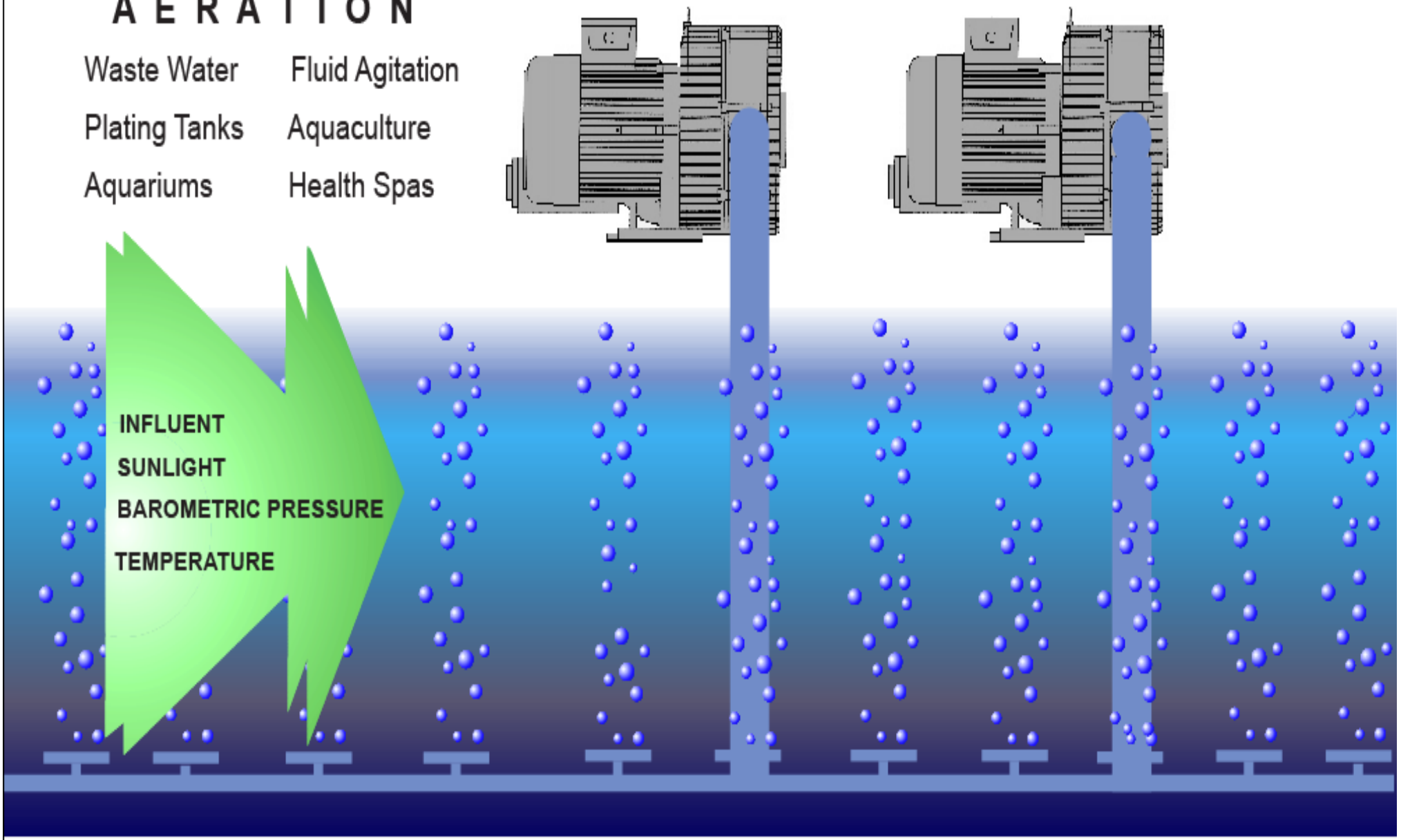
- Primary purpose of aeration is to provide microorganisms in submerged culture with sufficient oxygen for metabolic requirements, while agitation should ensure that a uniform suspension of microbial cells is achieved in a homogeneous nutrient medium.
- The of aeration-agitation system used in a particular fermenter depends on the characteristics of the fermentation process under consideration
- The structural components of the fermenter involved in aeration and agitation are:

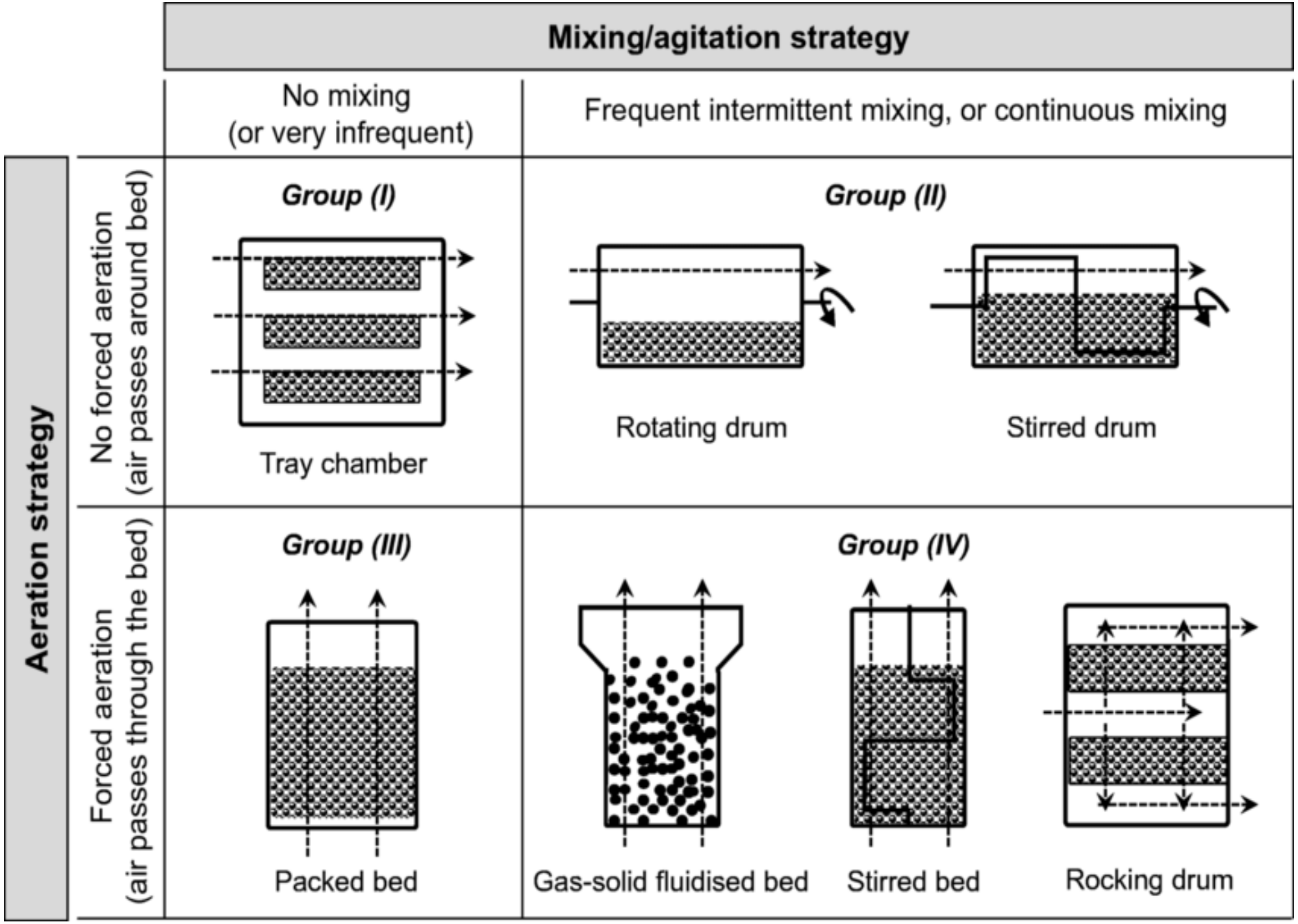
1. The agitator (impeller)
2. Stirrer glands and bearings
3. Baffles
4. The aeration system (sparger)

AERATION

Waste Water
Plating Tanks
Aquariums

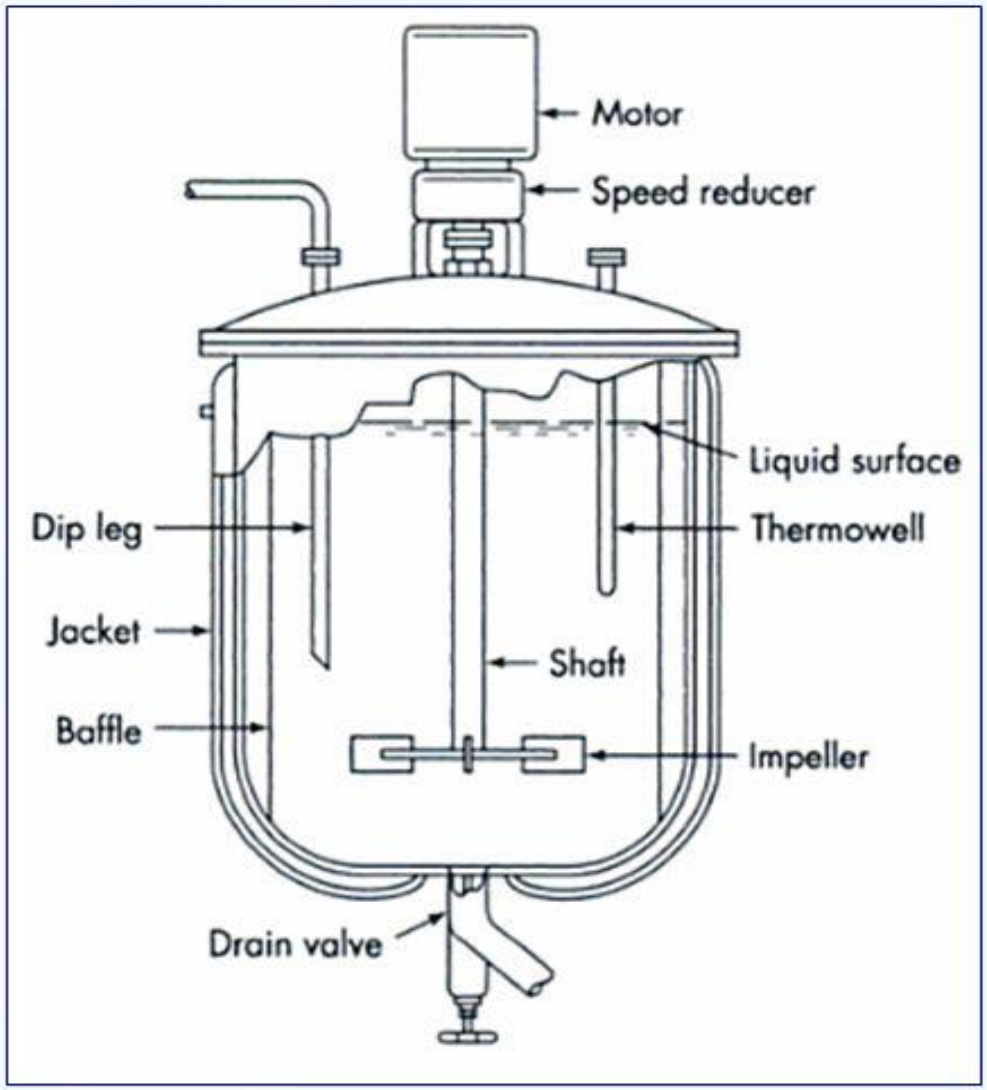
Fluid Agitation
Aquaculture
Health Spas




Mixing/agitation strategy
No mixing (or very infrequent)
Frequent intermittent mixing, or continuous mixing
Aeration strategy
No forced aeration (air passes around bed)
Forced aeration (air passes through the bed)
Group (I)
Tray chamber
Group (II)
Rotating drum
Stirred drum
Group (III)
Packed bed
Group (IV)
Gas-solid fluidised bed
Stirred bed
Rocking drum

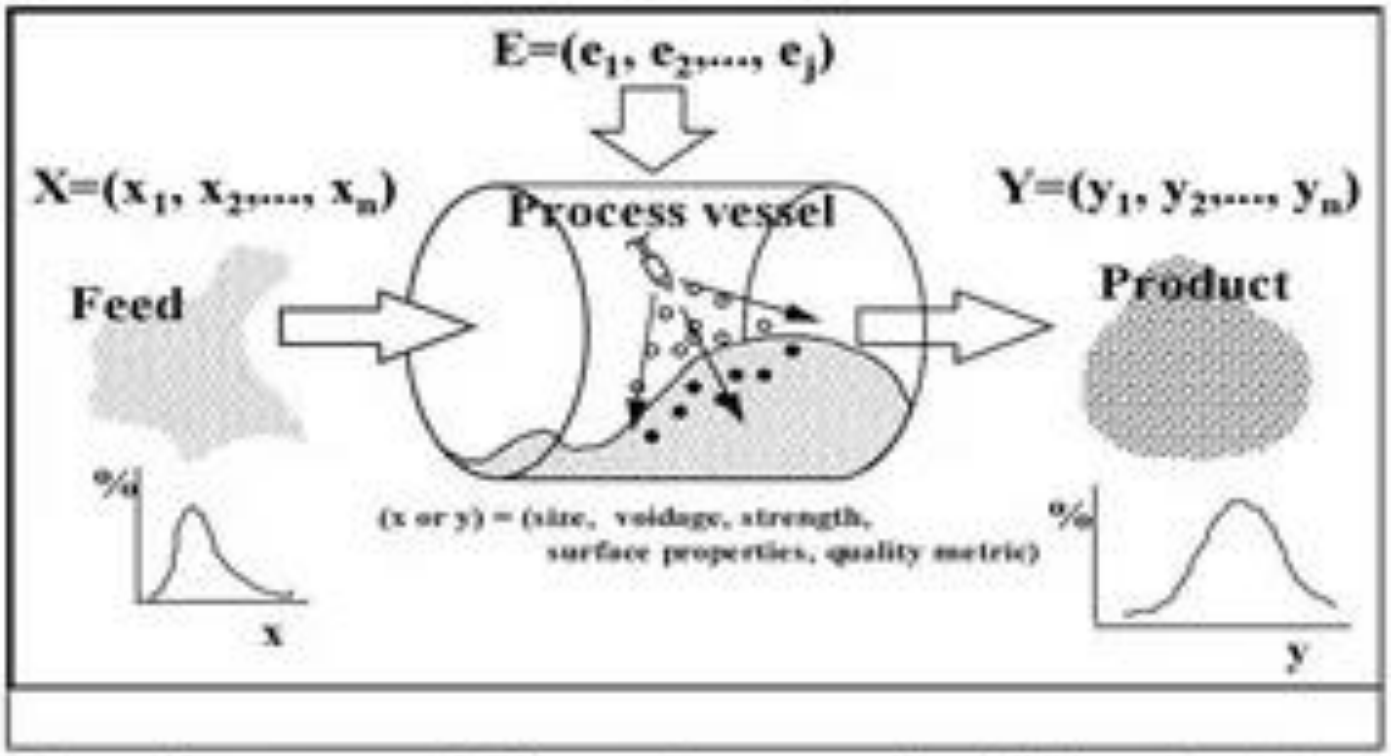
Agitation vessel

- Liquids are agitated in a tank
- Bottom of the tank is rounded
- Impeller creates a flow pattern.
- Small scale tank (< 10 litres) are constructed using Pyrex glass.
- For larger reactors/tank, stainless steel is used.
- Speed reduction devices are used to control the agitation speed.
- Mixing Flow : 3 patterns (axial, radial, tangential flow)
- Three main types of impellers :
  - (i) propellers
  - (ii) paddles
  - (iii) turbines



Typical agitation process tank

1) Agglomeration by Agitation Methods



- Will be referred to as **granulation**, where a particulate feed is introduced to a process vessel and is agglomerated to form a granulated product
- Liquid binder used to form interparticle bonds
- Agitation of "wet mass" to promote liquid binder dispersion and granule growth

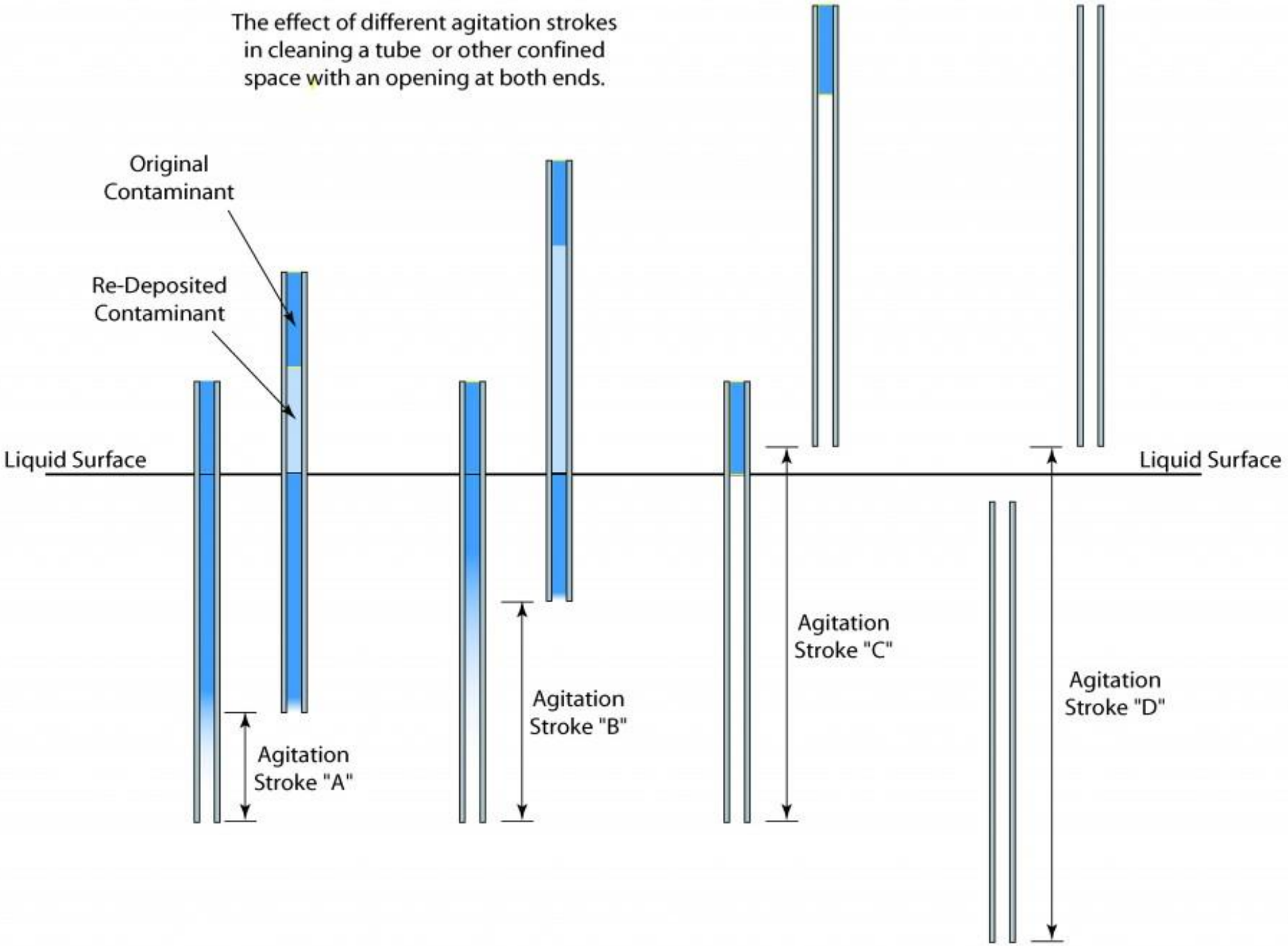
Causes of Agitation

Medical/Neurologic

-Delirium
-Acute Psychosis
-Substance Abuse/Dependence
-Any "Brain" Disease

Psychiatric

-Schizophrenia and other psychotic illnesses
-Bipolar illness
-Major depressive disorder
-Anxiety disorder
- Personality disorders


The effect of different agitation strokes in cleaning a tube or other confined space with an opening at both ends.
Original Contaminant
Re-Deposited Contaminant
Liquid Surface
Liquid Surface
Agitation Stroke "A"
Agitation Stroke "B"
Agitation Stroke "C"
Agitation Stroke "D"

Aeration and agitation

- Aeartion provides oxygen to culture.
- Removes unwanted volatile products of metabolis.
- Agitation either by stirring or as a side effect of aeration.

Importance of agitation

- 1. To increase the rate of oxygen transfer from the air bubble to the liquid medium.
- 2. To increase the rate of oxygen and nutrients transfer from the medium to cells.
- 3. To prevent formation of clumps of cells, aggregates of mycelium.
- 4. To increase the rate of transfer of product of metabolism from cell to medium.
- 5. To increase the rate or efficiency of heat transfer between the medium and the cooling surfaces of the fermenters.

Effect of agitation upon aeration

- 1. by dispersing the air in smaller bubble.
- 2.by causing the bubbles to follow a more tortuous path and dalaying their escape from the culture.
- 3. by preventing the coalescence of bubbles.
- 4. by decreasing the rate-limiting thickness of the liquid film at the gas/liquid interface.

Oxygen supply affected by following:

1. Type of agitation:

The shape, number and arrangement of impellers and baffles.

Either 2 or 3 impellers for large fermenters at suitable level on the stirrer shaft or 3 or 4 baffles on the wall of the vessel.

2. Speed of agitation:

1000 or more for lab. Fermenters.

But this is not possible for large vessels. For penicillin fermentation requires 50rpm needs high input of energy and uneconomical.

3. Depth of liquid in the fermenters:

Bubble remain longer in the medium of a tall, deep fermenter. Greater hydrostatic pressure at the sparger improves solution of oxygen.

Height : diameter ratio of 3:1 or 4:1 is common.

4. Type of sparger:

One single opening preferred to produce large bubble.

5. Air flow:

Aeration – increased by air flow rate, expressed in vvm (Vol. of air/vol. of medium/min.). Large fermenters cannot be supplied with air at greater rates than 0.5 to 1.0vvm.

6. Physical properties of the medium:

Temp., viscosity, surface tension and nature of organism , all affects solubility of oxygen directly or by bubble size and turbulence.

The agitator

- Agitator is required to mix the following objectives:
- bulk fulid and gas-phase mixing, air dispersion, oxygen transfer, hear transfer, suspension of solid particles and maintaining uniform environment.
- Types: Disc turbines, vaned dics, open turbines of variable pitch and propellers.

Disc turbine:

- It is with a series of rectangular vanes set in a vertical plane around the circumference .
- Vane disc: It is a series of rectangular vanes attached vertically to the underside. Air from the sparger hits the underside ot the disc and is displaced towards the vanes where the air bubbles are broken into smaller bubbles.

Application	Typical examples
Maintain Media Homogeneous	Milk storage tanks, cream tanks, mixed product tanks, UHT product storage tanks, etc.
Mixing and Solutions (dissolve)	Fluid and fluid mixing, i.e. drinking yoghurt and fruit mix tanks, flavoured milk mix tanks, syrup mix tanks, etc.
Solid Dispersion	Powder protein + oil mix tanks, micro salt + milk product mix tanks, etc.
Suspension	Fluids with particles, i.e. juice tanks, crystallising tanks etc.
Heat transmission	Circulation of media in tanks with dimple jacket (cooling or heating)
Dairy Fermentation (break coagula + mixing)	Yoghurt tanks, cheese culture tanks, crème fraîche, etc.

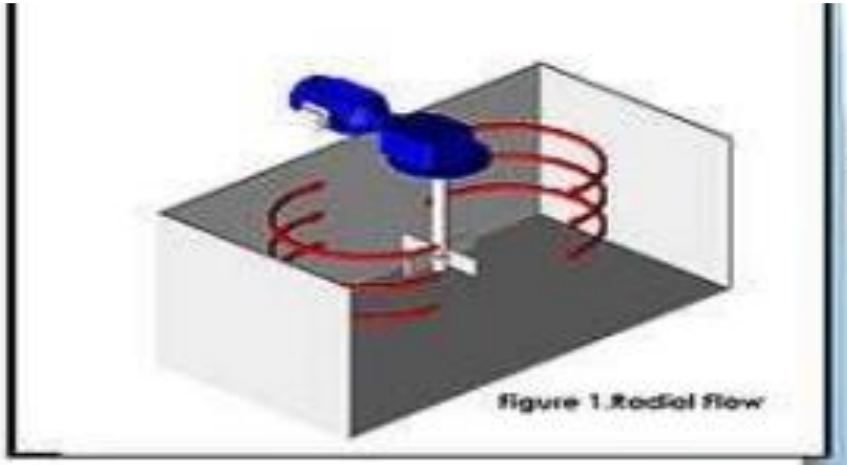


figure 1.Radial flow

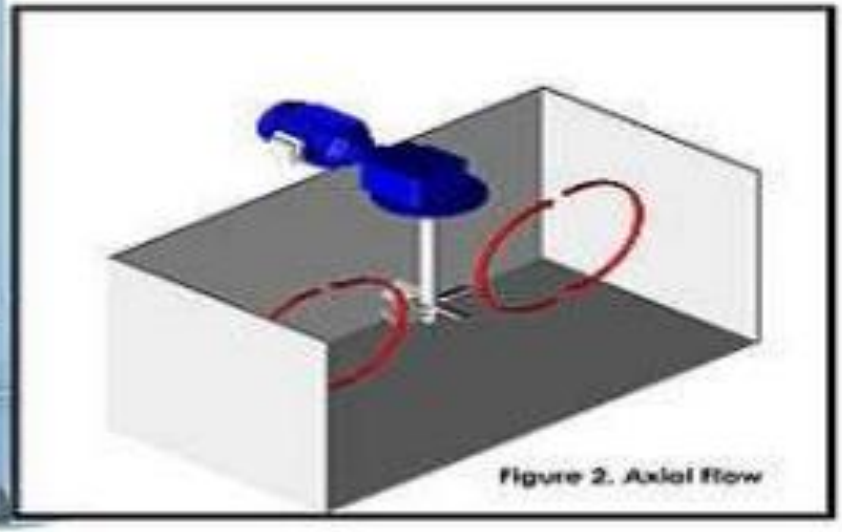


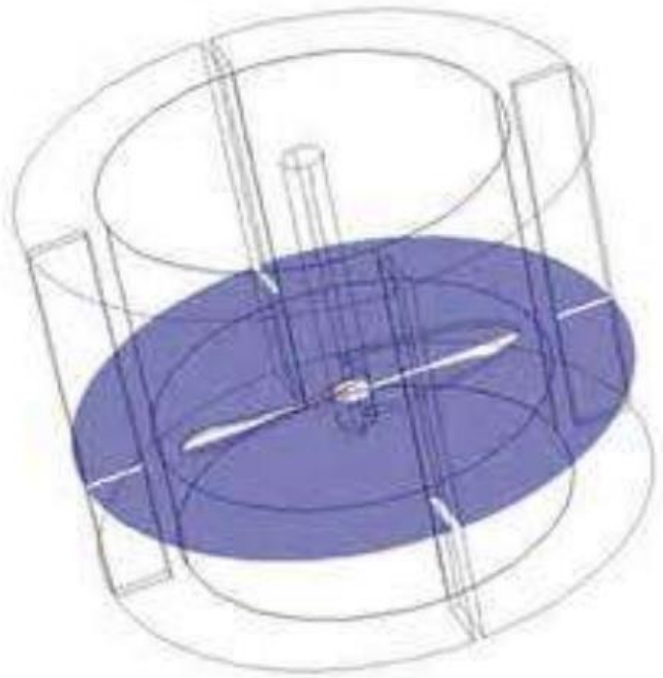
Figure 2. Axial flow

Stirrer glands and bearings

- Sealing of stirrer shaft – difficult problem in the construction of fermentation equip.
- Entry of stirrer shaft – top, side or bottom
- Basic type of seal assambly:
- 1. the stuffing box (packed gland seal)
- 2. the simple bush seal
- 3. the mechanical seal
- 4. the magnetic drive.

Baffles

- Four baffles to prevent vortex and to improve aeration efficiency.
- Vessel with3dm3 – six to eight baffles.
- They are metal strips, one-tenth of vessel dia. And attached radially to the wall.
- Increased agitation with wider baffles; drop in agitation with narrower baffles.



The aeration system (Sparger)

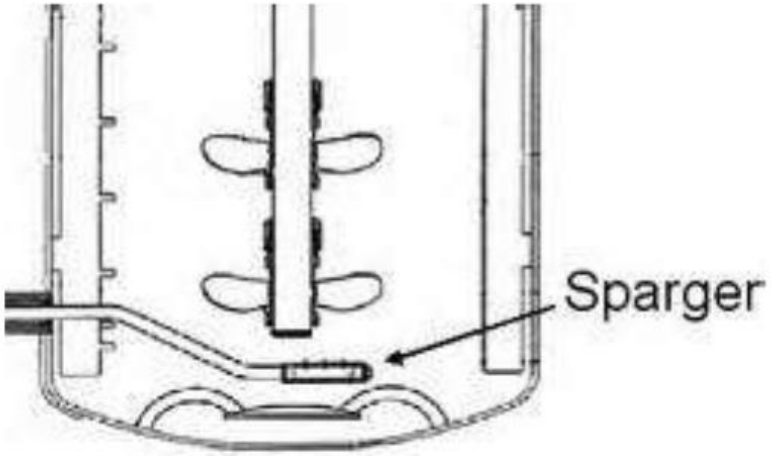
- A sparger is a device for introducing air into the liquid in a fermenter.
- Types:
- Porous sparger
- The orifice sparger (a perforated pipe)
- The nozzle sparger (an open or partially closed pipe)

Porous sparger and Orifice sparger

- Made of Sintered glass, ceramics or metal.
- The bubble size produced from spargers is always 10 to 100 times larger than the pore size of the aerator block.
- Orifice sparger:
- In small stirred fermenters the perforated pipes were arranged below the impeller in the form of crosses or rings.
- Orifice spargers without agitation used in yeast manufacturing, effluent treatment and in SCP production.

Nozzle sparger

- It’s a single open or partially closed pipe, provides stream of air bubbles.
- The single nozzle sparger causes a lower pressure loss than any other sparger and normally does not get blocked.


Sparger

Primary Use

Aeration is to provide microorganism in submerged culture with sufficient oxygen for metabolic requirements.

Agitation ensures that a uniform suspension of microbial cells is achieved in a homogenous nutrient medium.

Aeration and agitation depends on fermentation.

Purposes of Agitation

- Blending of two miscible liquids, such as ethanol and water.
- Dissolving solids in liquids, such as salt in water.
- Dispersing a gas in a liquid as fine bubbles, such as oxygen from air in a suspension of microorganisms for fermentation or for the activated sludge process in waste water treatment.
- Suspending of fine solid particles in a liquid, such as in the catalytic hydrogenation of a liquid where solid catalyst particles and hydrogen bubbles are dispersed in the liquid.
- Agitation of the fluid to increase heat transfer between the fluid and a coil or jacket in the vessel wall.

THANK YOU
for your
ATTENTION!