chapter-3-

Prof. Dr. Samir Afifi

Conventional wastewater treatment processes

Main goals of WW Treatment

1. **Prevention of pollution to:**
   - **Ground water**
   - **Soil**
   - **marine life (aquatic life)**
   - **Water bodies**
   - **air**

cont== Main goals

2. Protection of the public health
3. Solving asocial problems caused by the acumen of wastewater
4. Saving of water for reuse purpose such as:
   - **Agriculture**
   - **Recharge**
   - **Industrial recycle**

Technical goals of wastewater

1. **Separation of solids from liquid**
2. **Solid stabilization**
3. **Proper reuse and or disposal of liquid and solids**
4. **Destroy pathogenic microorganism**

How to a chive the technical goals?

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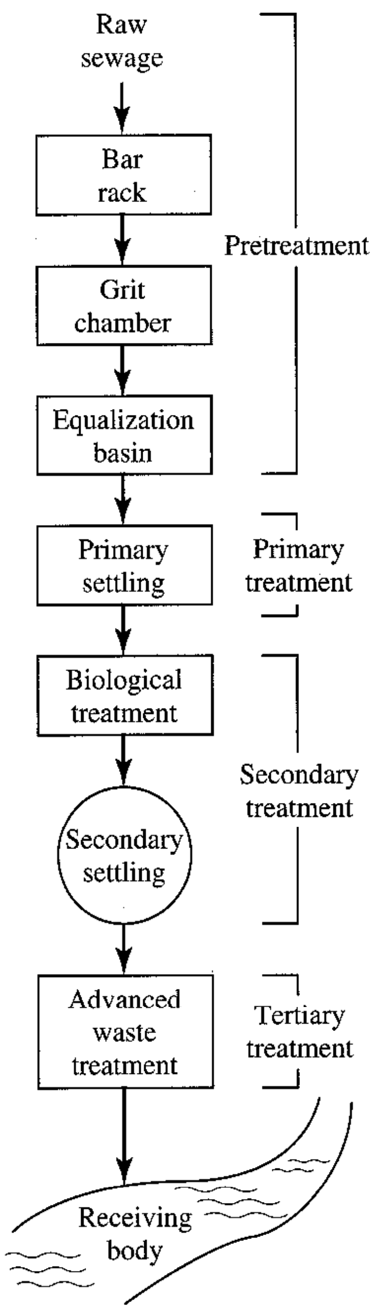
Goals?

How to achieve the technical goals?

- **Preliminary treatment**
- **Primary treatment**
- **Secondary treatment**
- **Physical- chemical treatment**
- **Advanced wastewater treatment**
- **Des-infection**
- **Effluent discharge**



Municipal Wastewater Treatment Systems

- Pretreatment – removes materials that can cause operational problems, equalization optional
- Primary treatment – remove ~60% of solids and ~35% of BOD
- Secondary treatment – remove ~85% of BOD and solids
- Advanced treatment – varies: 95+ % of BOD and solids, N, P

Preliminary treatment

Remove solids by screening and settling

- The sewage is passed through a screen to remove large pieces of debris (e.g. sticks, stones, rags, and plastic bags).
- Next, the sewage enters a grit chamber, where the water flow is slowed just enough to allow coarse sand and gravel to settle out on the bottom.

Preliminary treatment

Screening:

- **Manual bar screen**
- **Mechanical bar screen**
- **comminutors**

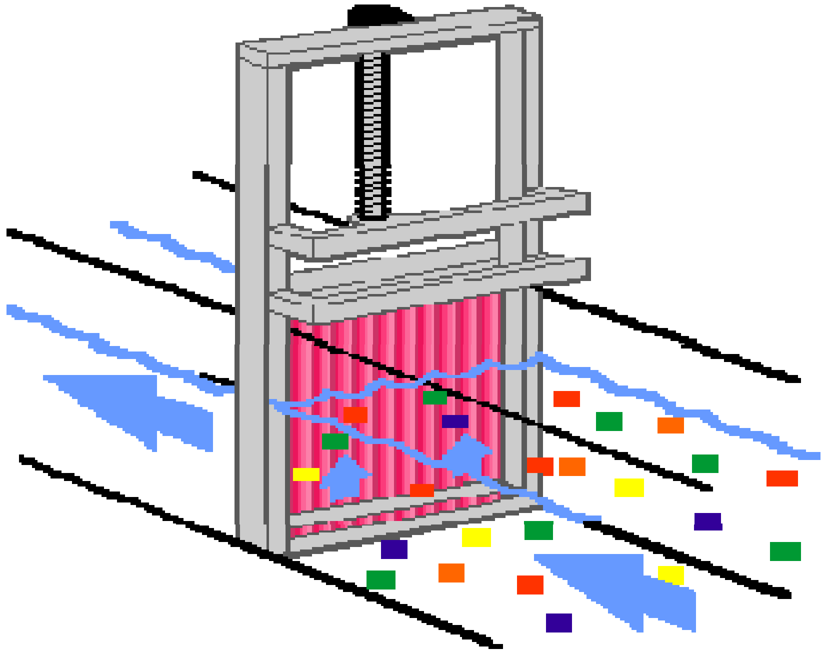
Aim

- To remove floating materials
- To prevent damage to mechanical equipment such as pumps& aerators
- To prevent blockage of pipes

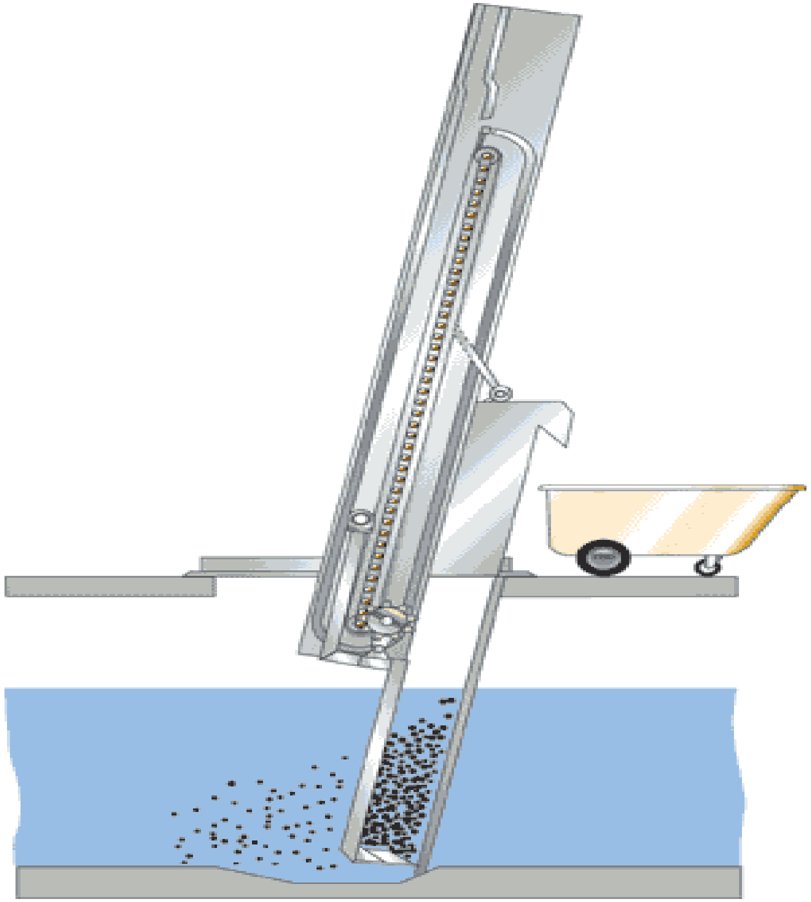
Channel width (W):

$$W = (Q/VD) * \begin{cases} 2 & \text{---12mm} \\ 1.67 & \text{--- 18mm} \\ 1.5 & \text{---24mm} \end{cases}$$

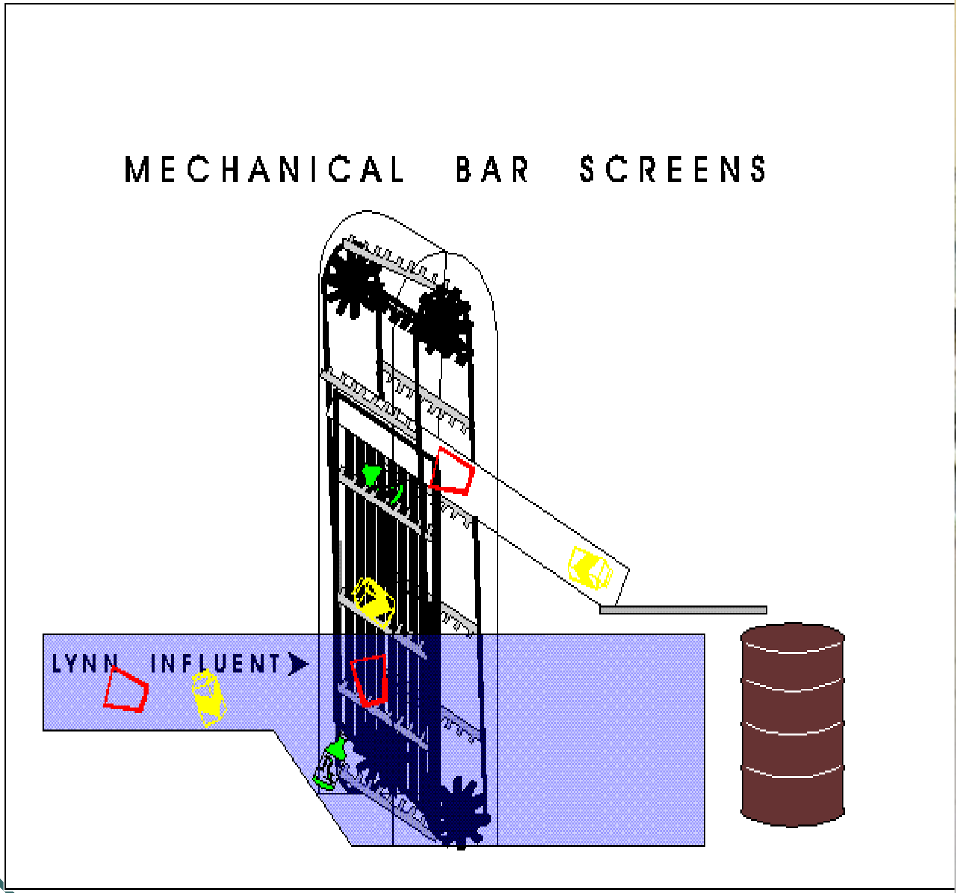
Manual bar screen



Mechanical bar screen



Mechanical bar screen



Grit removal

Aim

- **To prevent abrasion & wear of mechanical equipment**
- **To prevent deposition of grit in pipes / channels**

((It is important to remove particle with diameter >0.2 mm and to prevent organic material sedimentation))

Grit Basin

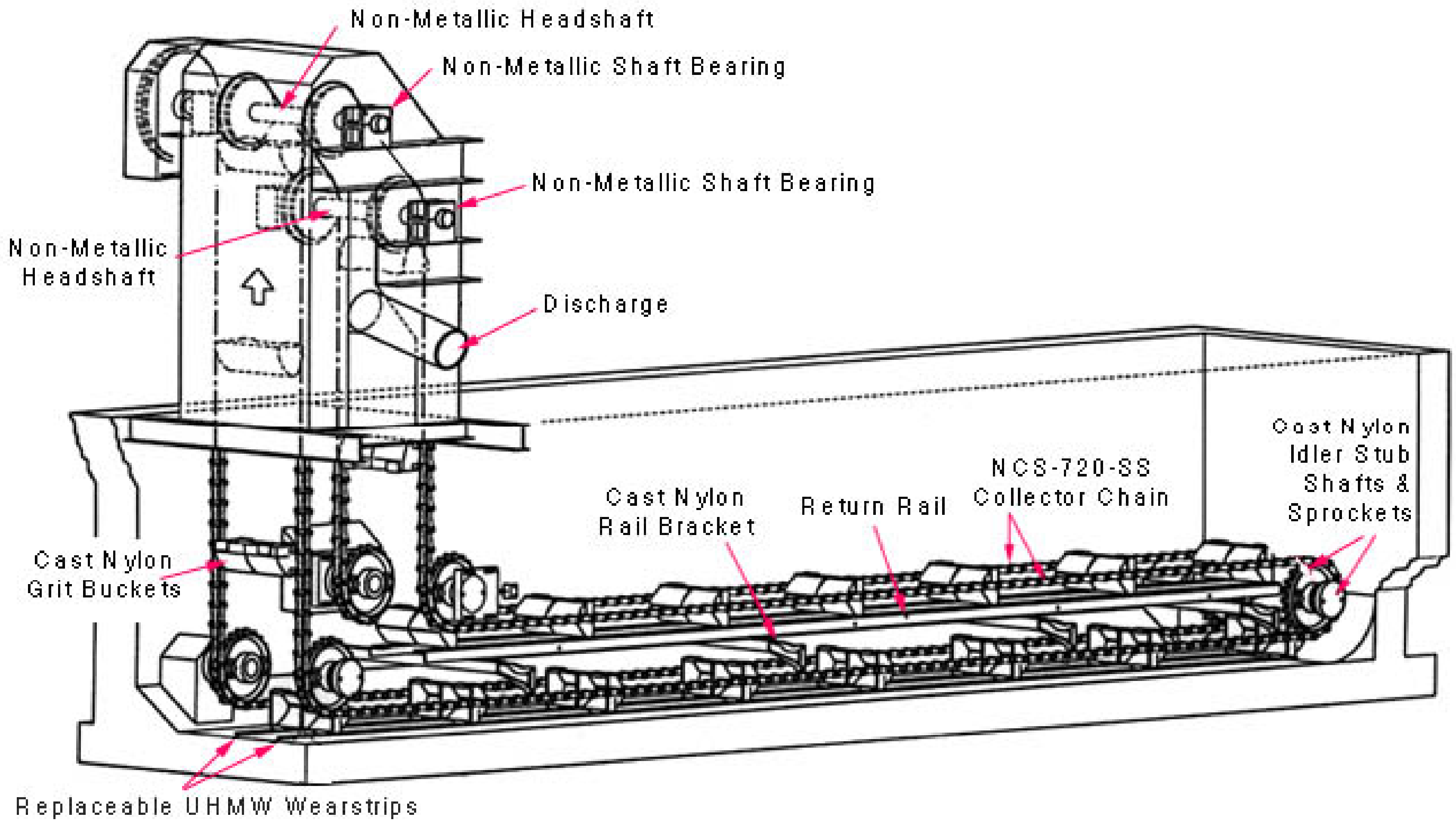
Removal grit

1. **Grit channel:**

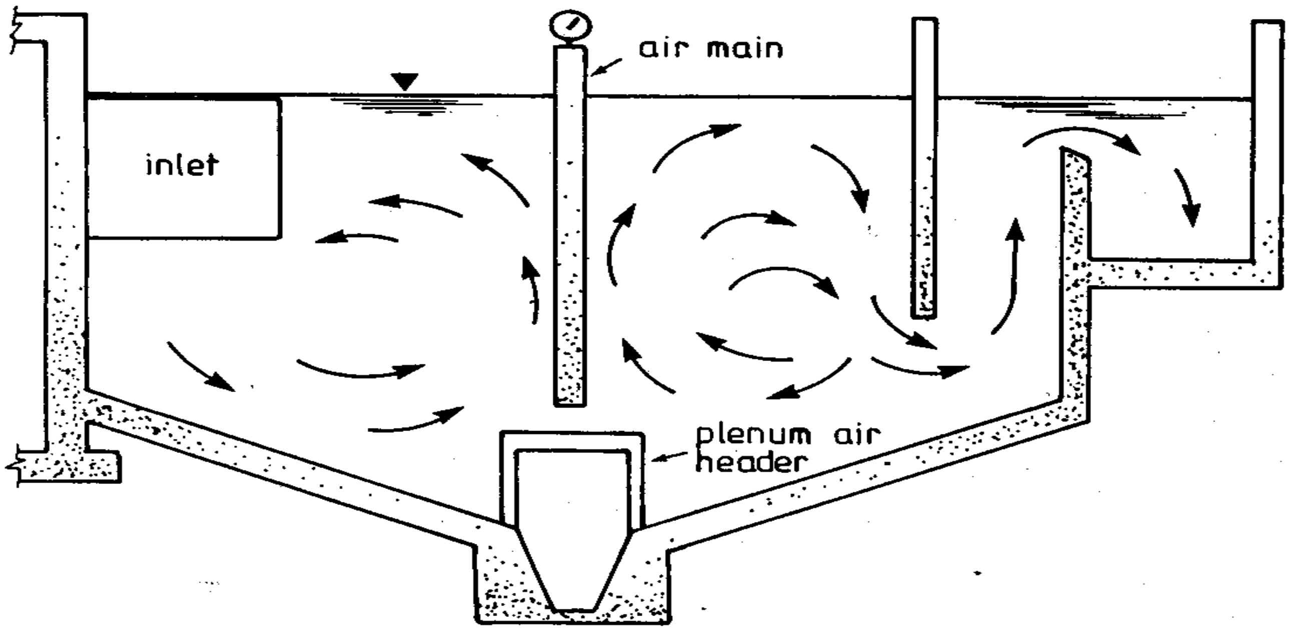
- **Channel width = 1.5A/H**
- **Velocity of 0.03m/s is needed for grit settling.**
- **Channel length = 20 * channel depth**

Grit removal

Grit Chambers: Velocity Controlled

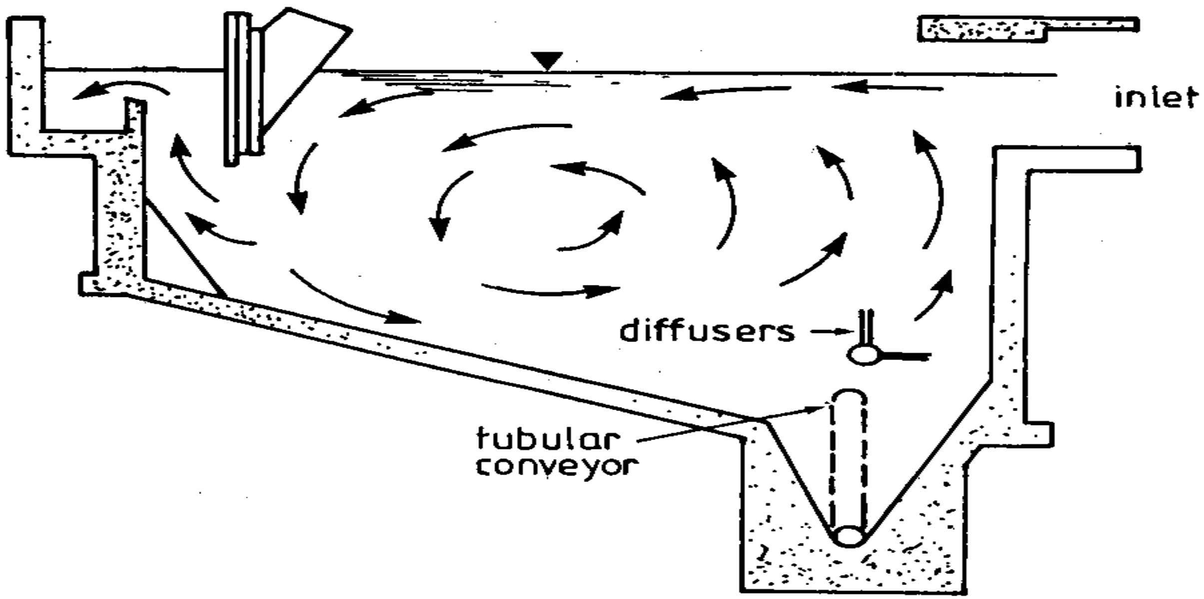


2.Aerated grit chambers



(a)

2.Aerated grit chambers



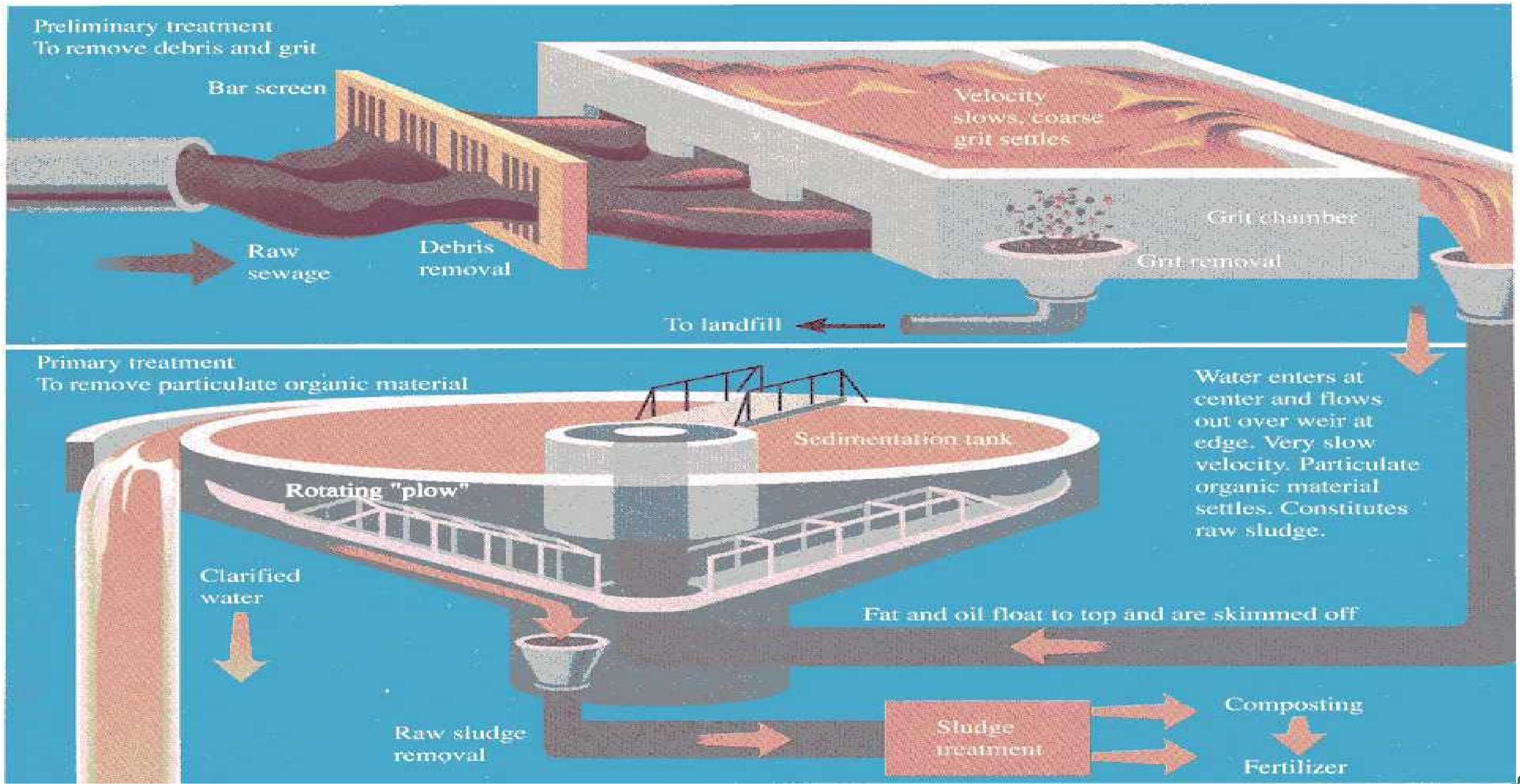
(b)

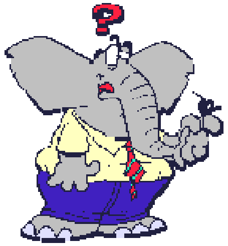
Primary (Treatment) sedimentation

Aim:

- **Removal of settable solids.**
- **<u>Removal of 40% of BOD5</u>:**

Primary (Treatment) sedimentation





Proper Primary Treatment will

reduce reactor size

(construction cost)

and

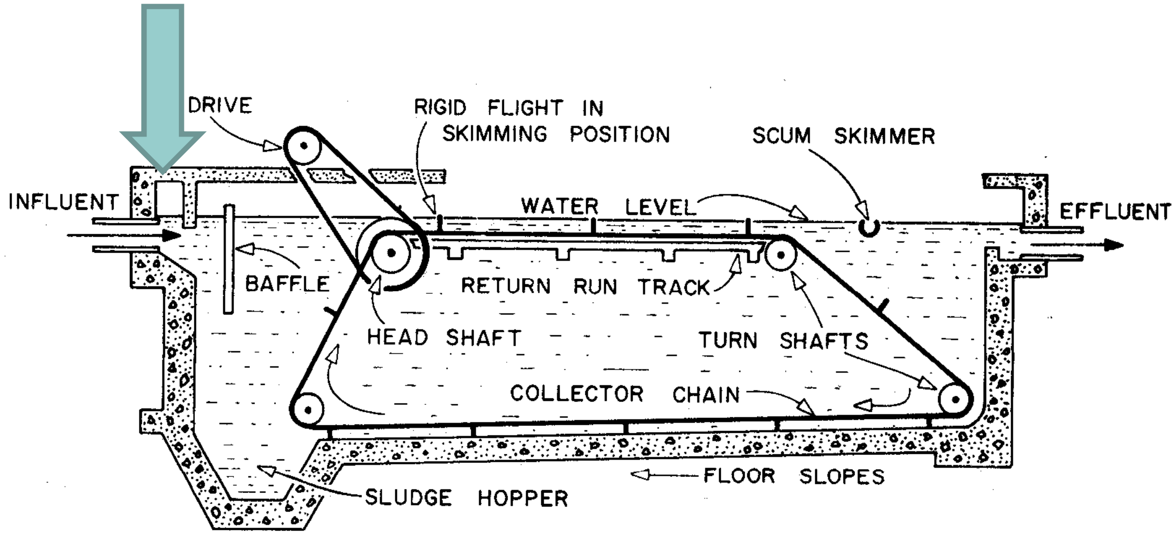
Reduce power consumption

(operational cost)

Sedimentation tank consist of four zones:

1. **Inlet zone:**

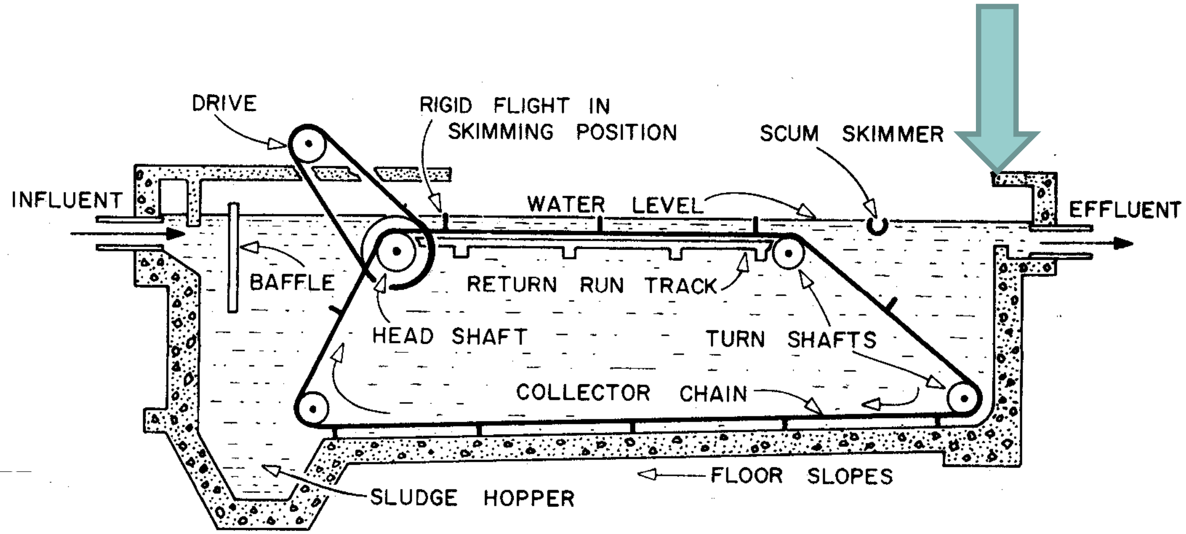
reduce the sewage velocity in a minimum space



2. **Outline weir :**

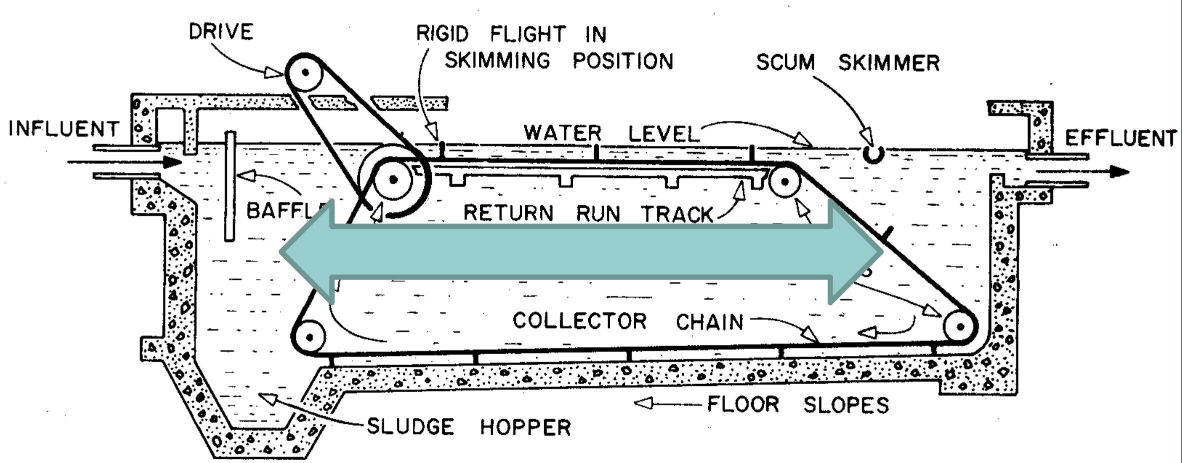
- **Collect and withdraw the settled sewage**

- **Prevent floating material to pass over outlet weir.**



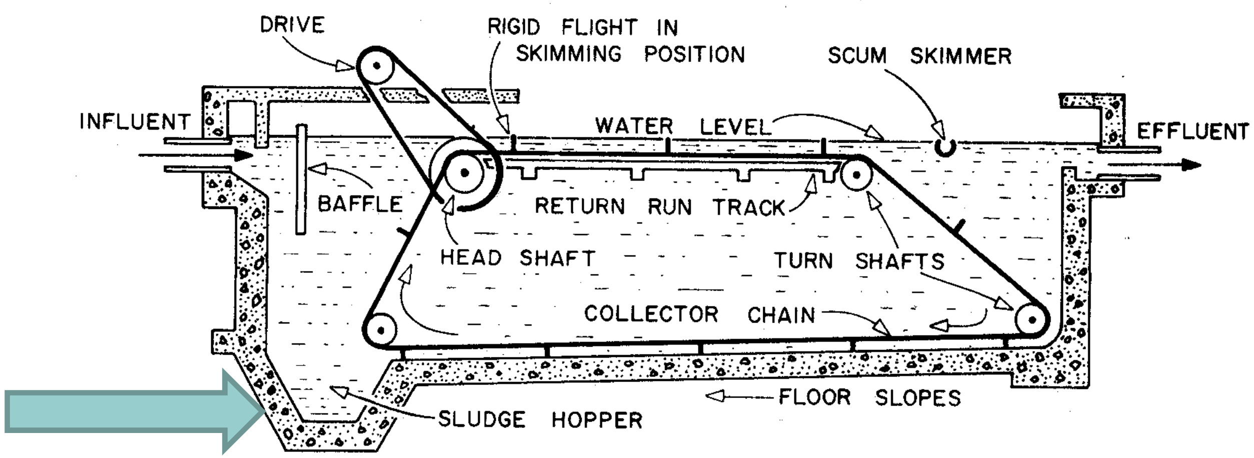
3. Settlement zone:

- Area for settlir
- Should free from:
  - Short-circuiting
  - Stagnant areas

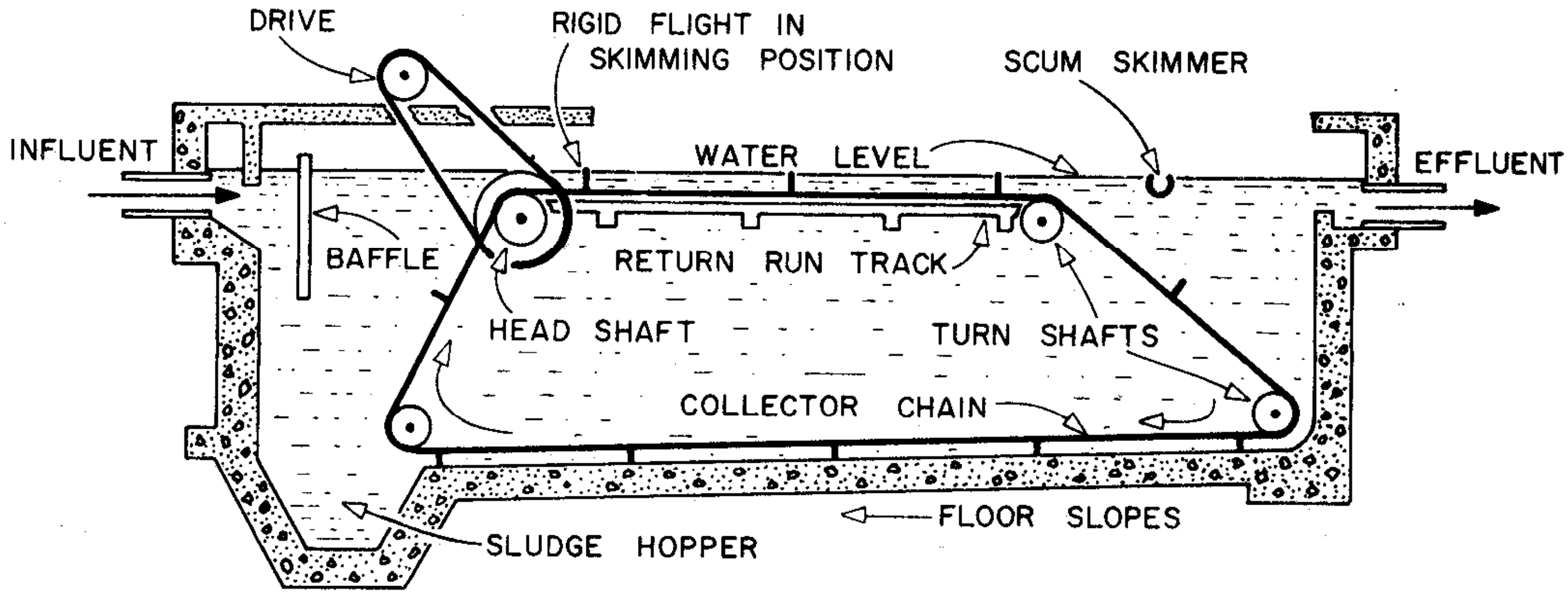


4.Storage , collection and withdraw of sediment solids (desludging):

- Manual
- mechanical



Primary Settling



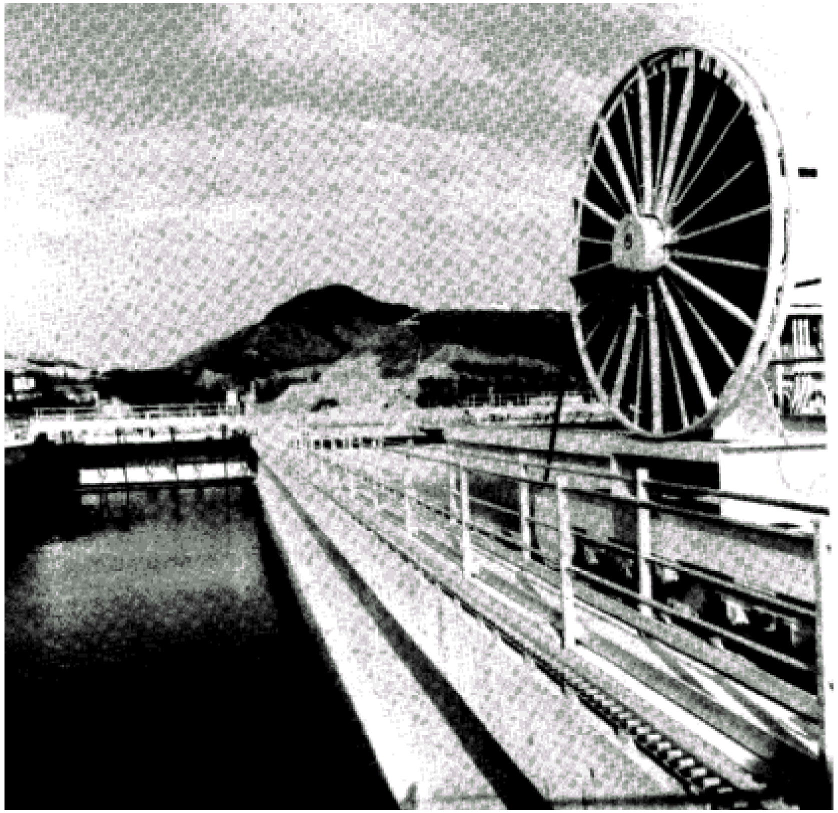
ST type

1. **Horizontal flow tanks:**

   Rectangular

   Length / Breadth ratio 4:1

Horizontal flow tanks



ST type

2. **Radial flow tanks:**

- **circular with slope down floor.**
- **Inlet of the center and flows up and out**
- **Outlet is around the tank.**

2. Radial flow tanks:

ST type

3. Upward-flow tanks:

- **Circular or square.**
- **Inlet at tank center and flow initially downwards.**
- **Outlet is around the tank.**

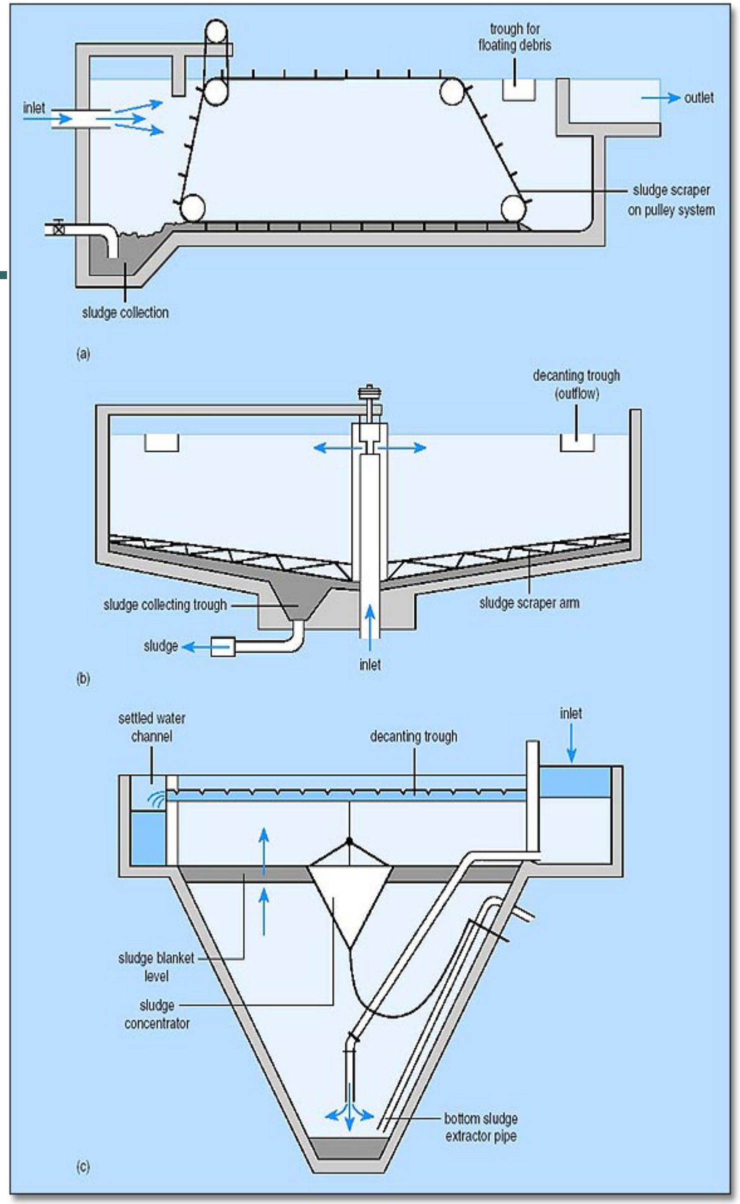
Upward-flow tanks

Typical sedimentation tanks:

(a) rectangular horizontal flow tank

(b) circular, radial-flow tank

(c) hopper-bottomed, upward flow tank



Primary Settling Tank Design

- Size
  - rectangular: 3-24 m wide x 15-100 m long
  - circular: 3-90 m diameter
- Detention time: 1.5-2.5 hours
- Overflow rate: 25-60 $m^3/m^2 \cdot day$
- Typical removal efficiencies
  - solids: 50-60%
  - BOD_5: 30-35%

Secondary Treatment

Secondary Treatment

The main Aim of Conventional Secondary Treatment (Biological Unit) is to:

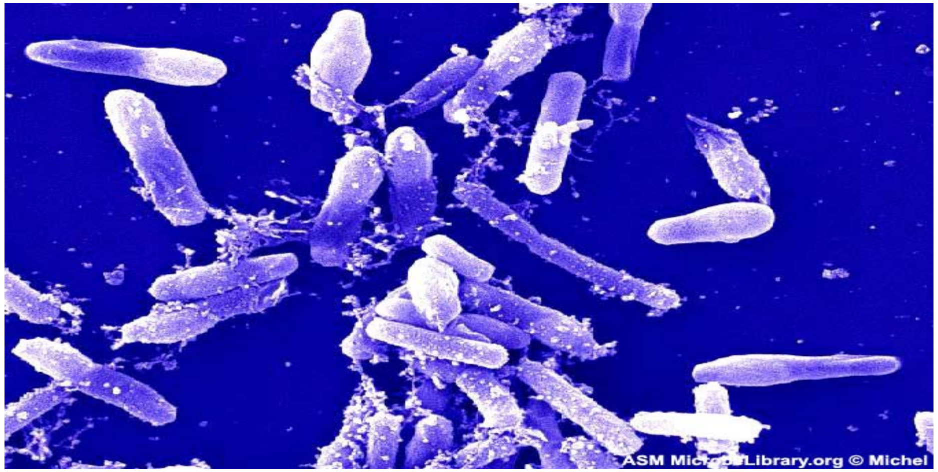
Reduce the Biological Oxygen Demand (BOD) through Aerobic Oxidation.

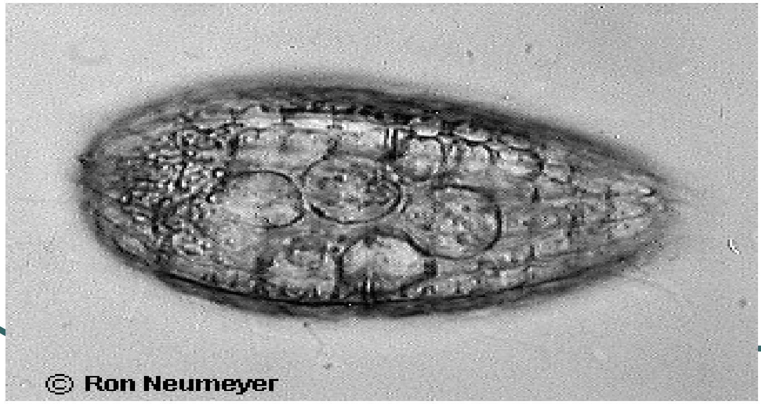
The process needs:

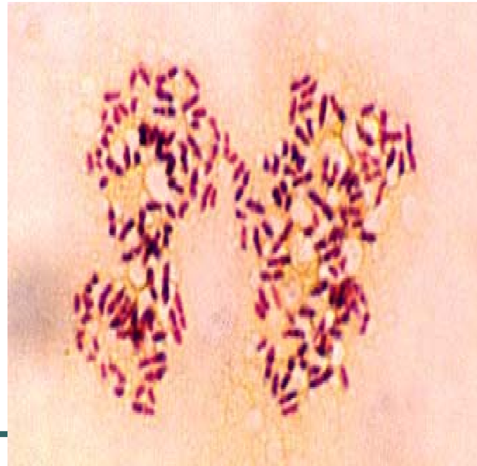
- organisms
- oxygen

How is this accomplished?

- Create a very rich environment for growth of a diverse microbial community







Secondary Treatment

- Provide BOD removal beyond what is achieved in primary treatment
  - removal of soluble BOD
  - additional removal of suspended solids
- Basic approach is to use *aerobic* biological degradation:

  organic carbon + $O_2 \rightarrow CO_2$

- Objective is to allow the BOD to be exerted in the treatment plant rather than in the stream

Basic Ingredients

- High density of microorganisms (keep organisms in system)
- Good contact between organisms and wastes (provide mixing)
- Provide high levels of oxygen (aeration)
- Favorable temperature, pH, nutrients (design and operation)
- No toxic chemicals present (control industrial inputs)

Process Classification based on form of microbial population:

- **fixed film processes (Microorganisms are attached)**
- **dispersed growth processes (Microorganisms are immobilized)**

Dispersed growth vs Fixed Growth

- Dispersed Growth – suspended organisms
  - Activated sludge
  - Oxidation ditches/ponds
  - Aerated lagoons, stabilization ponds
- Fixed Growth – attached organisms
  - Trickling filters
  - Rotating Biological Contactors (RBCs)

Fixed film processes:

- "Fixed film processes represent the oldest form of wastewater treatment system and includes":

cont==Fixed film processes:

- **Land application of sewage**
- **Trickling or Percolating filter**
- **Rotating Biological Contractor (RRC)**

Trickling filter

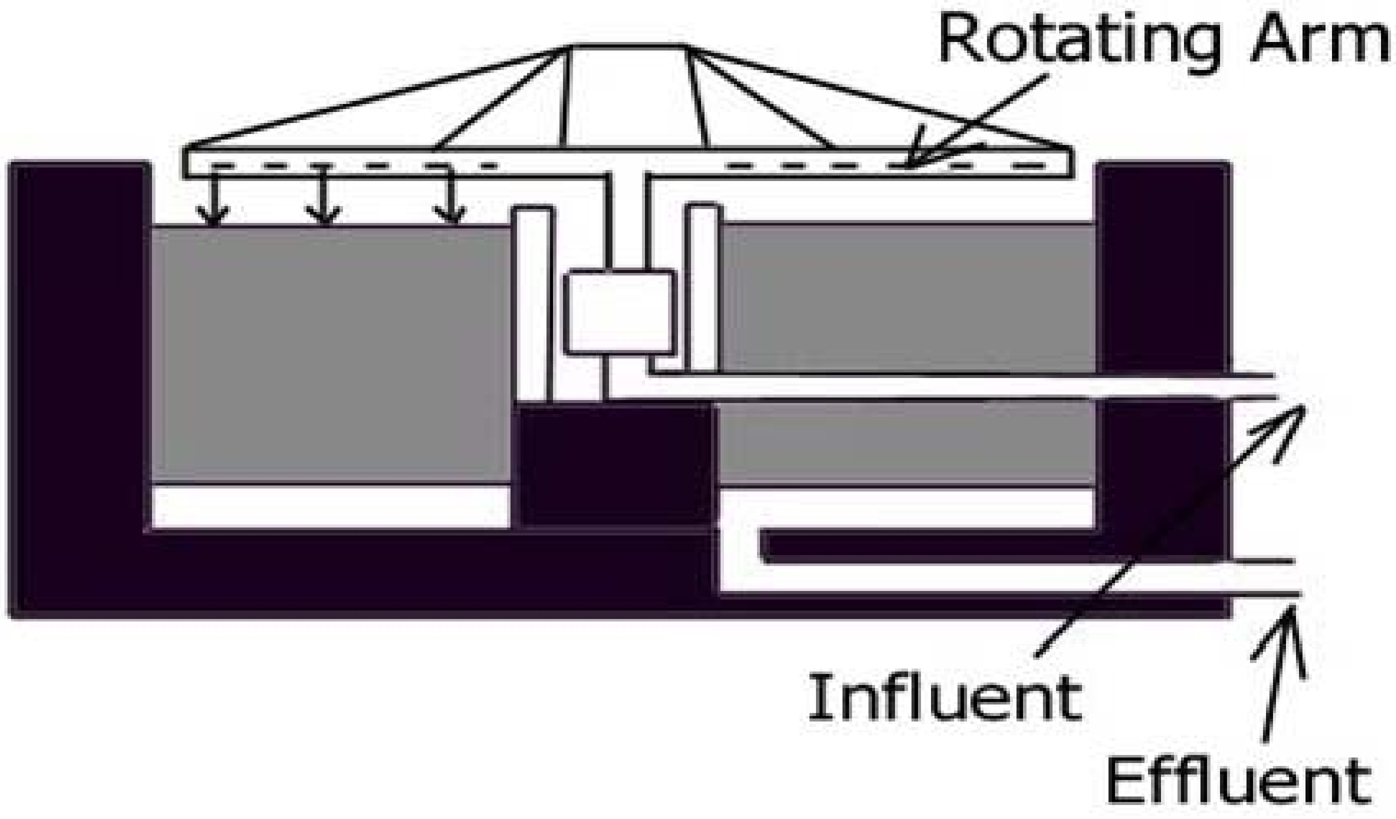
<u>Trickling filter</u>

“Bio-filter, bacteria bed

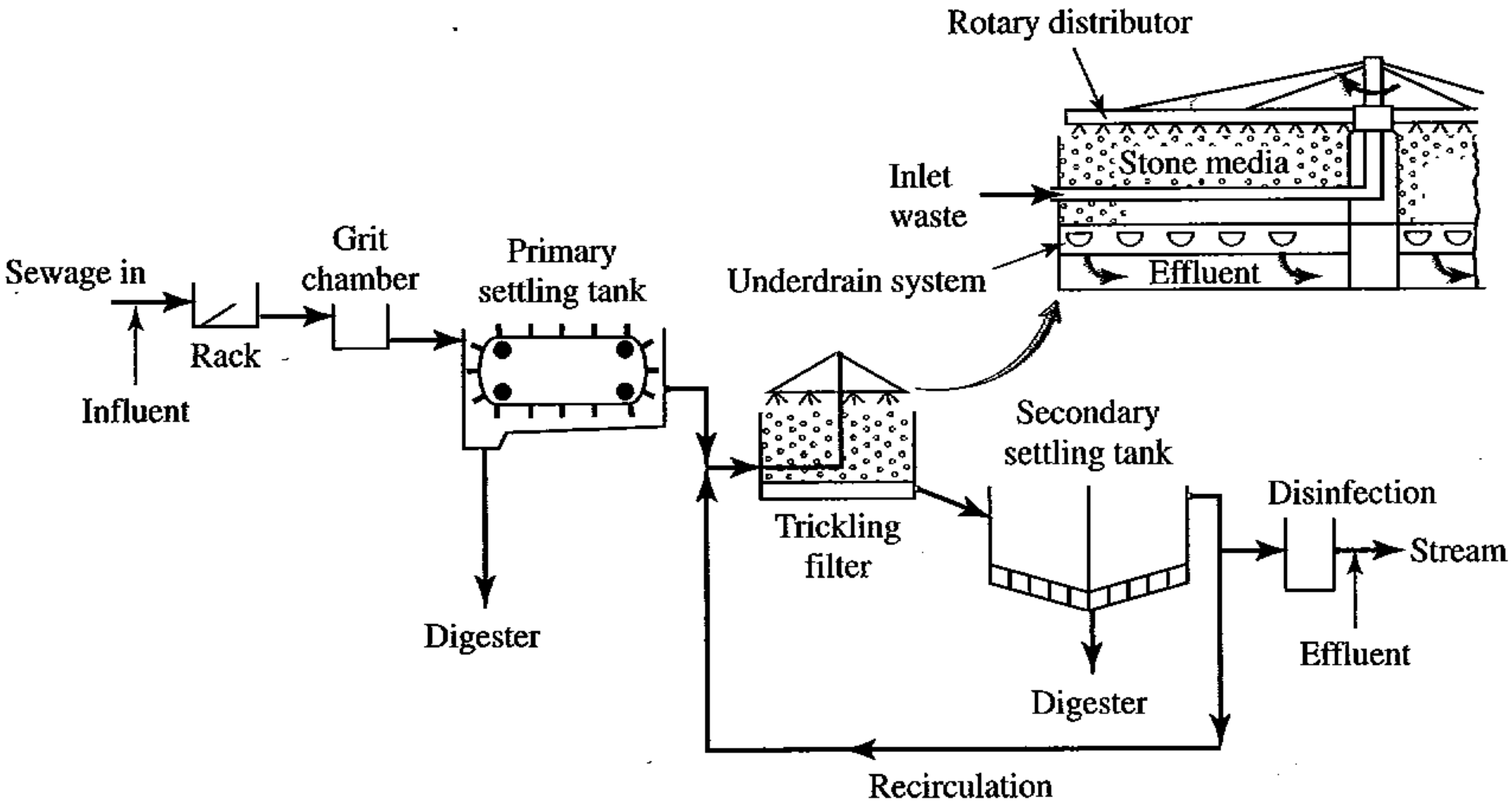
or

percolating filter”

Trickling Filters



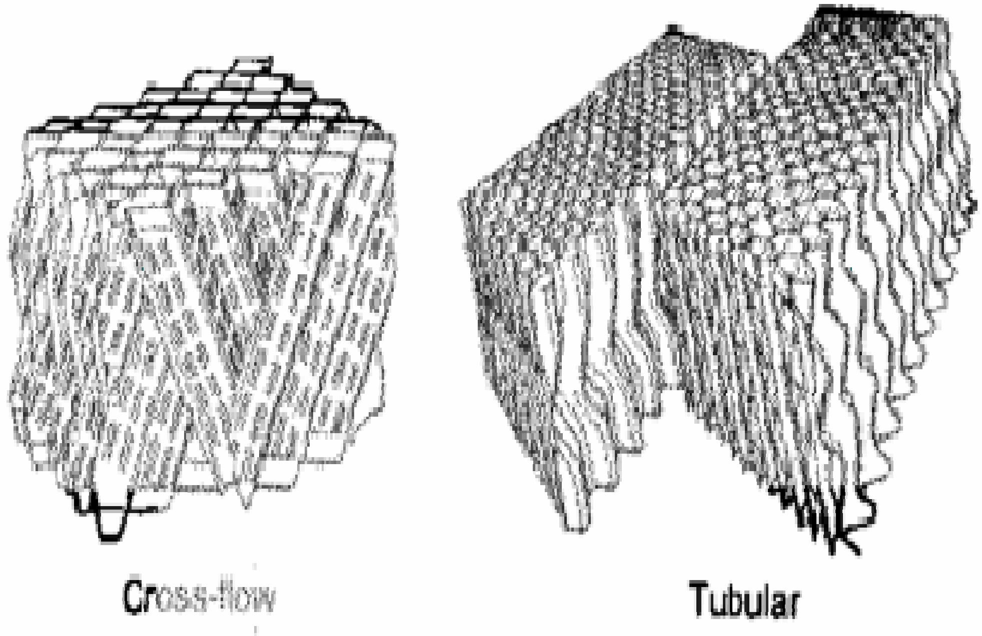
Trickling Filter Plant Layout



Trickling filter:

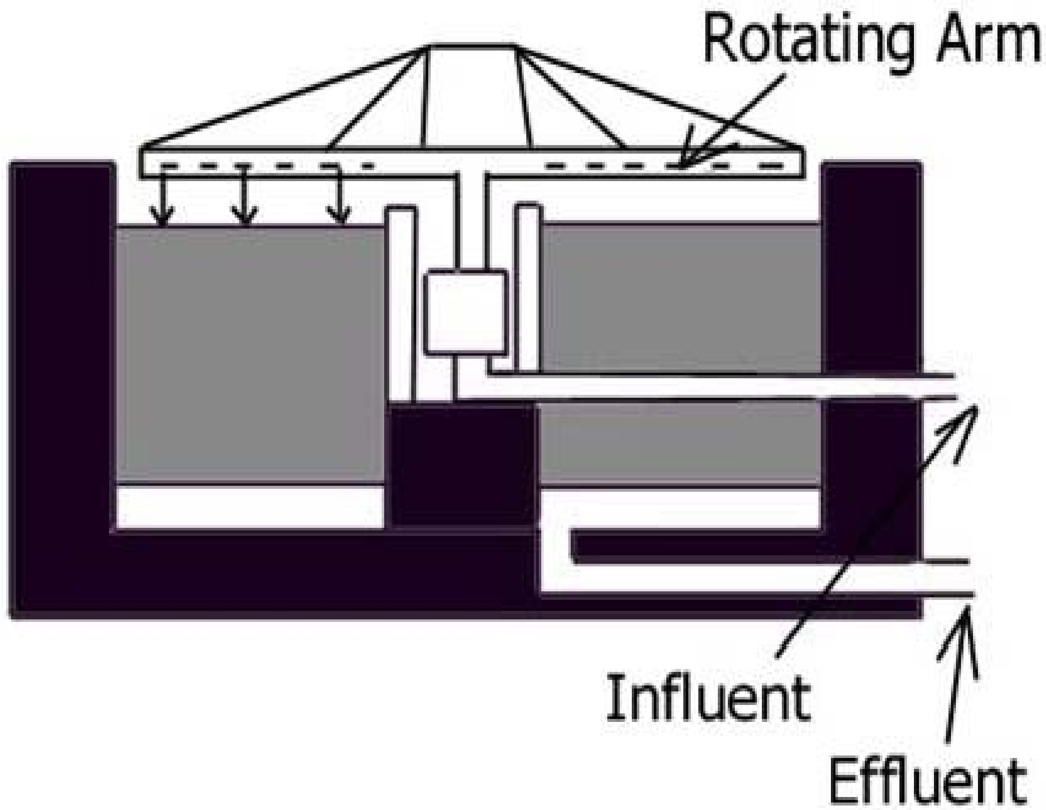
- **Form: Rectangular or Circular Plan**
- **Inside: A permeable Media (crushed rock or blast-furnace slag of diameter 25-100mm)**
- **Depth: 3.0m to 12m (depends of the filter media)**

Trickling Filt

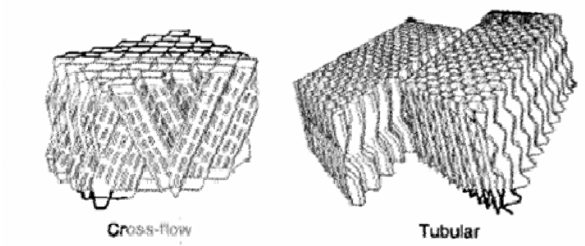


Trickling filter:

- **Wastewater distributed mechanically over the media**
- **Effluent collected at the filter base**



Trickling Filters



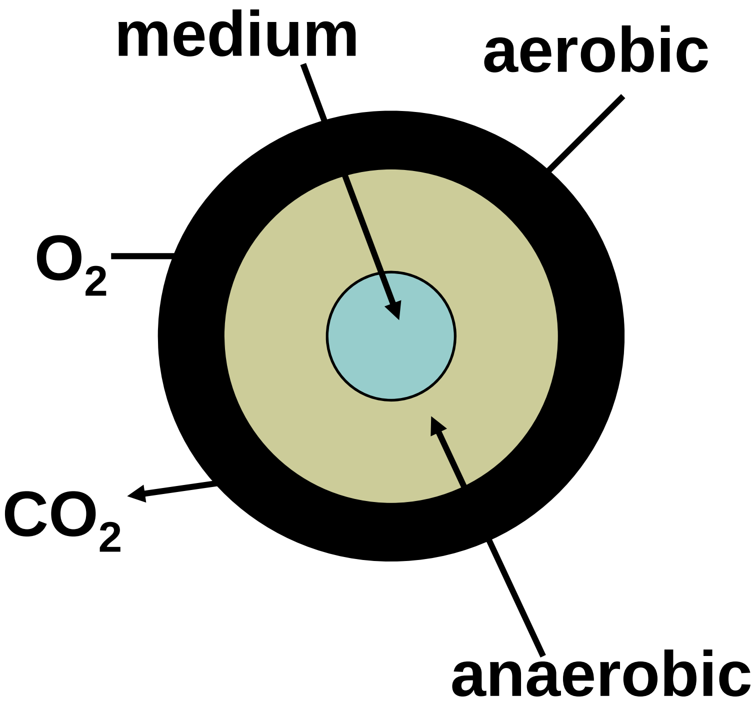
Treatment Process:

- Influent entering at the center of the bed and passing into radial distributor arms above the bed surface

cont== Treatment Process

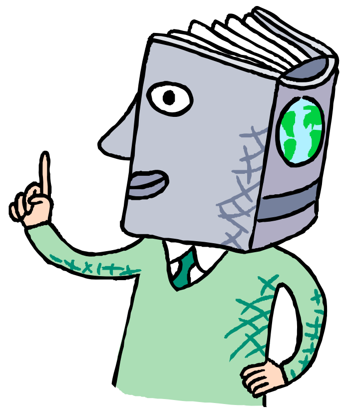
- A microbial film develops over the surface of the media and this is responsible for removal of BOD during passage of sewage through the bed.

Treatment Process



cont== Treatment Process

- **The distribution of air through a filter occurs by circulation through void spaces in the filter media.**



cont== Treatment Process

- Filtration, in the traditional sense of straining out of large particles, does not occur and the process is solely a biological one

The efficiency of the system depends upon:

- Distribution of settled sewage over the surface of the filter
- Circulation of air throughout the filter media

Factors Effected Filters Loading Rates:

1. **Effluent quality required**
2. **Media employed**
3. **Type of wastewater (Influent quality)**

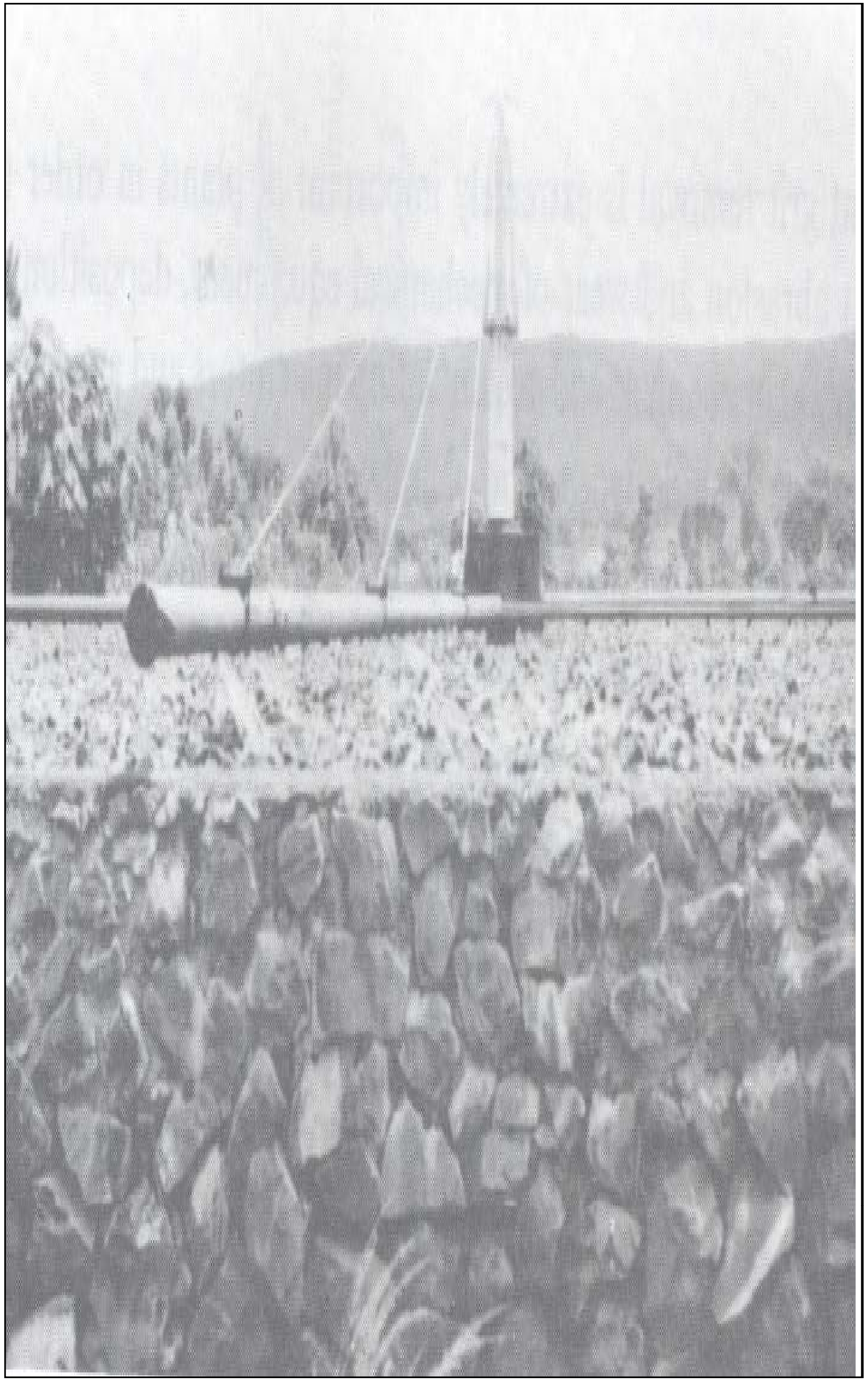
PONDED Problem:

- **Over Loading cause excessive growth of the slime layer resulting in the voids between the media and it becoming blocked.**

PONDED Problem:

This prevents sewage percolating through the filter and thus it collects on the surface of the media

<u>'Ponded Cause'</u>



Sloughing off':

- **In a well operated filter there is a continual cycle of film growth followed by death and detachment from the media. This is known as 'Sloughing Off'.**

Cont==Sloughing off':

- The resultant sludge is carried away with the filter effluent. Periodic sloughing off the slime layer is a feature of filter operation (change of seasons). During this period treatment will be severely reduced.

Trickling Filters

- Not a true filtering or sieving process
- Material only provides surface on which bacteria to grow
- Can use plastic media
  - lighter - can get deeper beds (up to 12 m)
  - reduced space requirement
  - larger surface area for growth
  - greater void ratios (better air flow)
  - less prone to plugging by accumulating slime

Advantage of trickling filters:

- **Simple technique to design and operate**
- **Have very low running costs**
- **Tolerate shock and toxic loads (short contact time)**

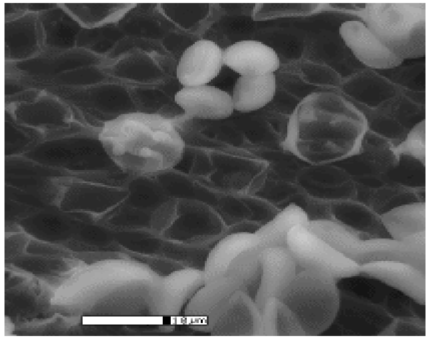
Disadvantages:

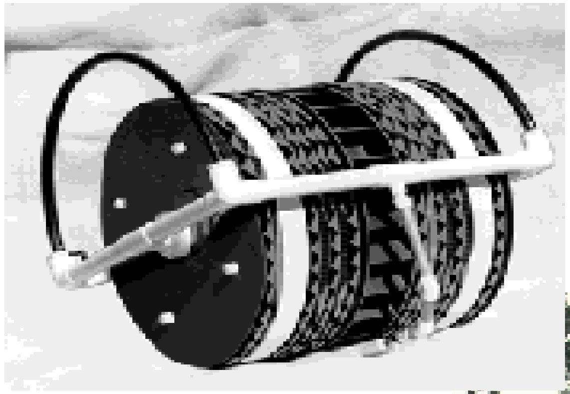
- Land requirements high
- Provide a limited treatment efficiency
- Associated with odorous and fly nuisance (In hot countries)

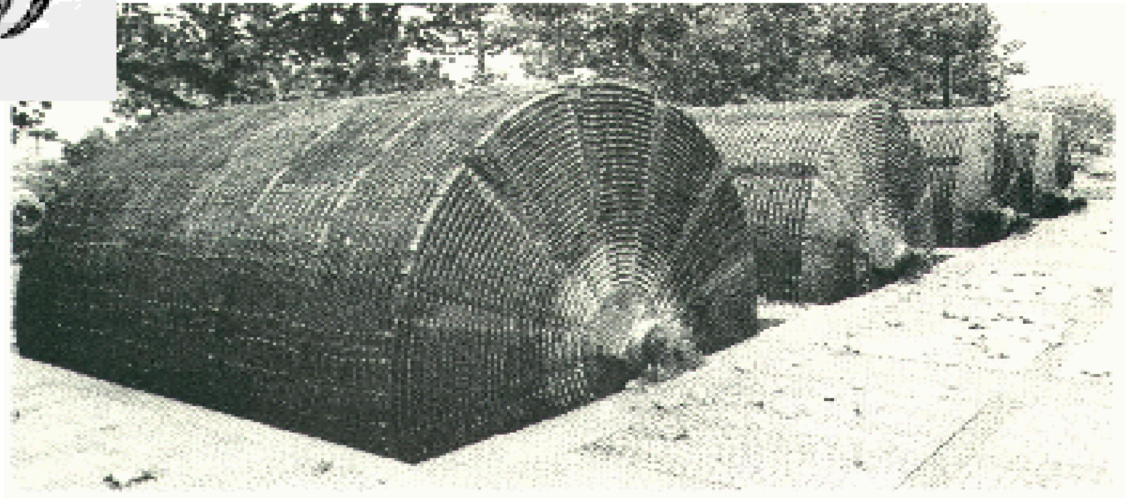
Rotating biological contactor (RBC) (Biodisc):

- **A rotating disc (bed) has attached bacteria**
- **The disc immersed in awastewater tank**

Rotating Biological Contactors



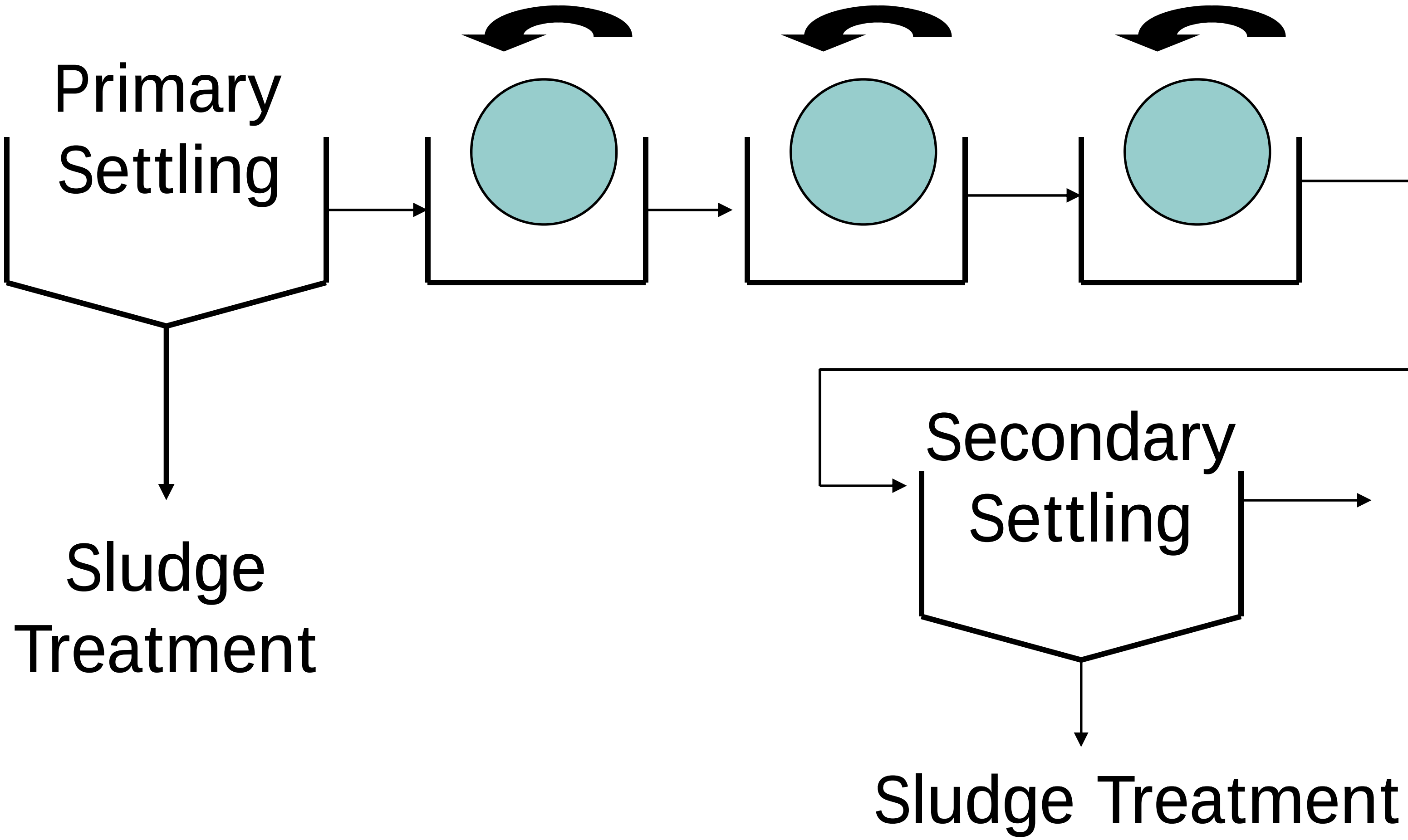




Rotating Biological Contactors

- Called RBCs
- Consists of series of closely spaced discs mounted on a horizontal shaft and rotated while ~40% of each disc is submerged in wastewater
- Discs: light-weight plastic
- Slime is 1-3 mm in thickness on disc

Rotating Biological Contactors



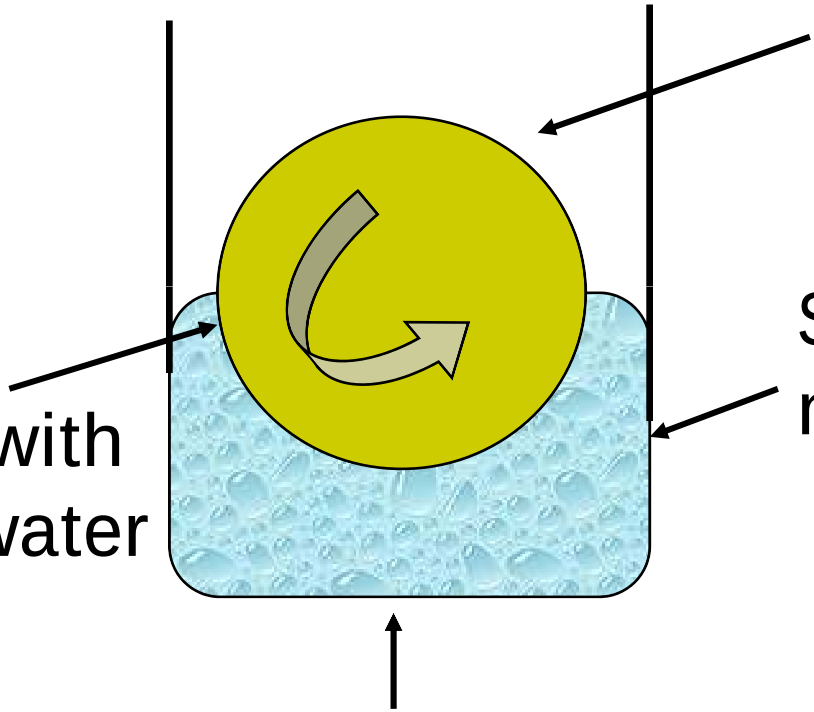
Cont==Rotating biological contactor (RBC) ,(Biodisc):

- **Rotation of disk will permitting the aeration as disc expose to the atmosphere**

Cont==Rotating biological contactor (RBC) ,(Biodisc):

- **A microbial community will be developed at the disk (from of biofilm = 3mm) which is responsible for BOD removal**

Rotating biological contactor (RBC), (Biodisc)



Rotating Biological Contactors

Advantages:

- Ease to operate
- Low land requirement
- Application in rural areas
- Can be marketed as package
- Reduced power and maintenance cost
- Elimination of pounding and clogging

Disadvantages:

- **New process**
- **Breaking and craking of discs**
- **Shaft bearing failure**
- **Rain and wind protection faultily**

Rotating Biological Contactors

Dispersed Growth Processes

Activated Sludge Process:

The process is a suspended growth system comprising a mass of microorganisms constantly supplied with organic matter and oxygen.

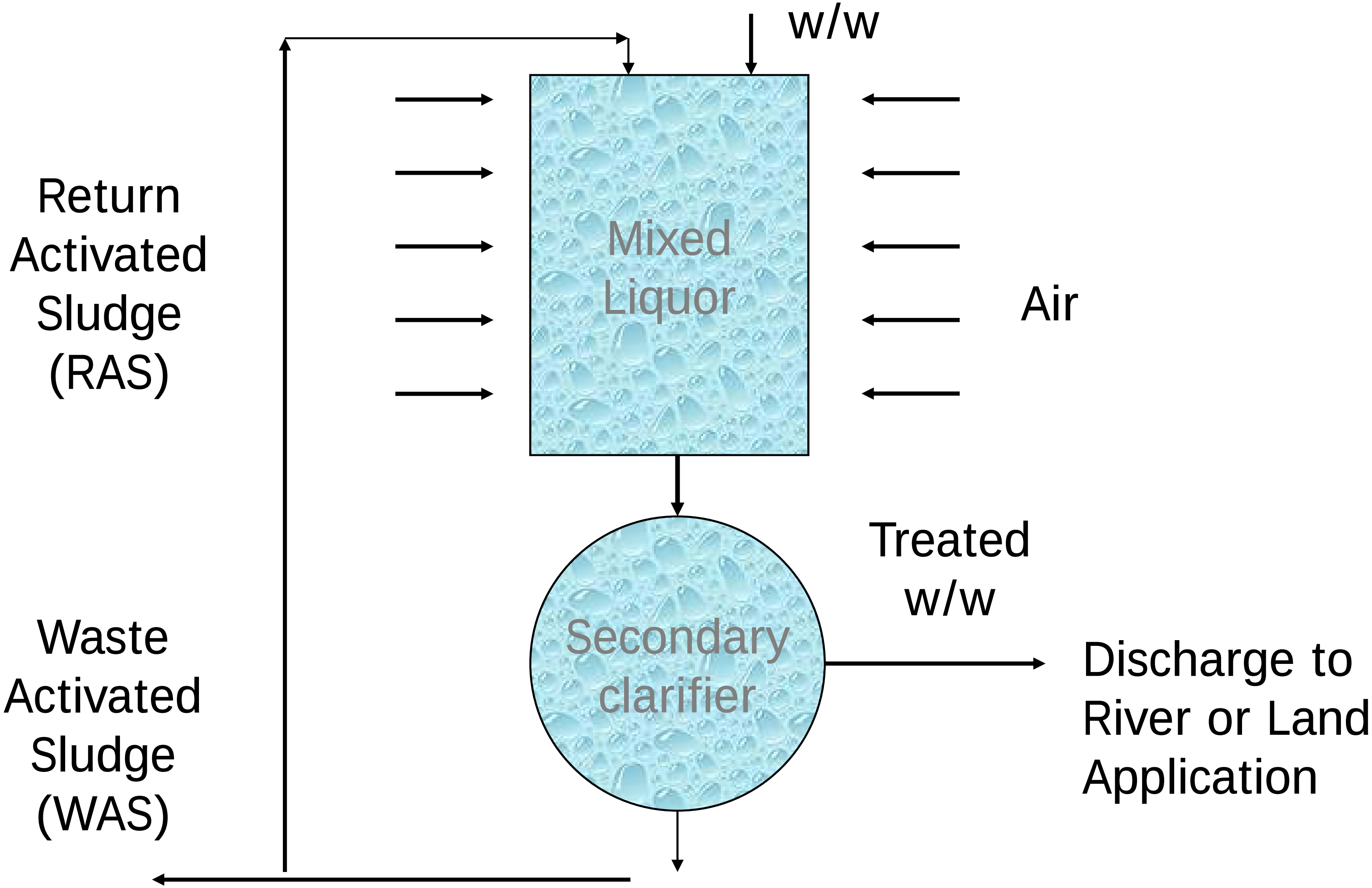
Cont==Activated Sludge Process:

The microorganisms grow in flocs, and these flocs are responsible for the transformation of the organic material into new bacteria, carbon dioxide and water.

Cont==Activated Sludge Process:

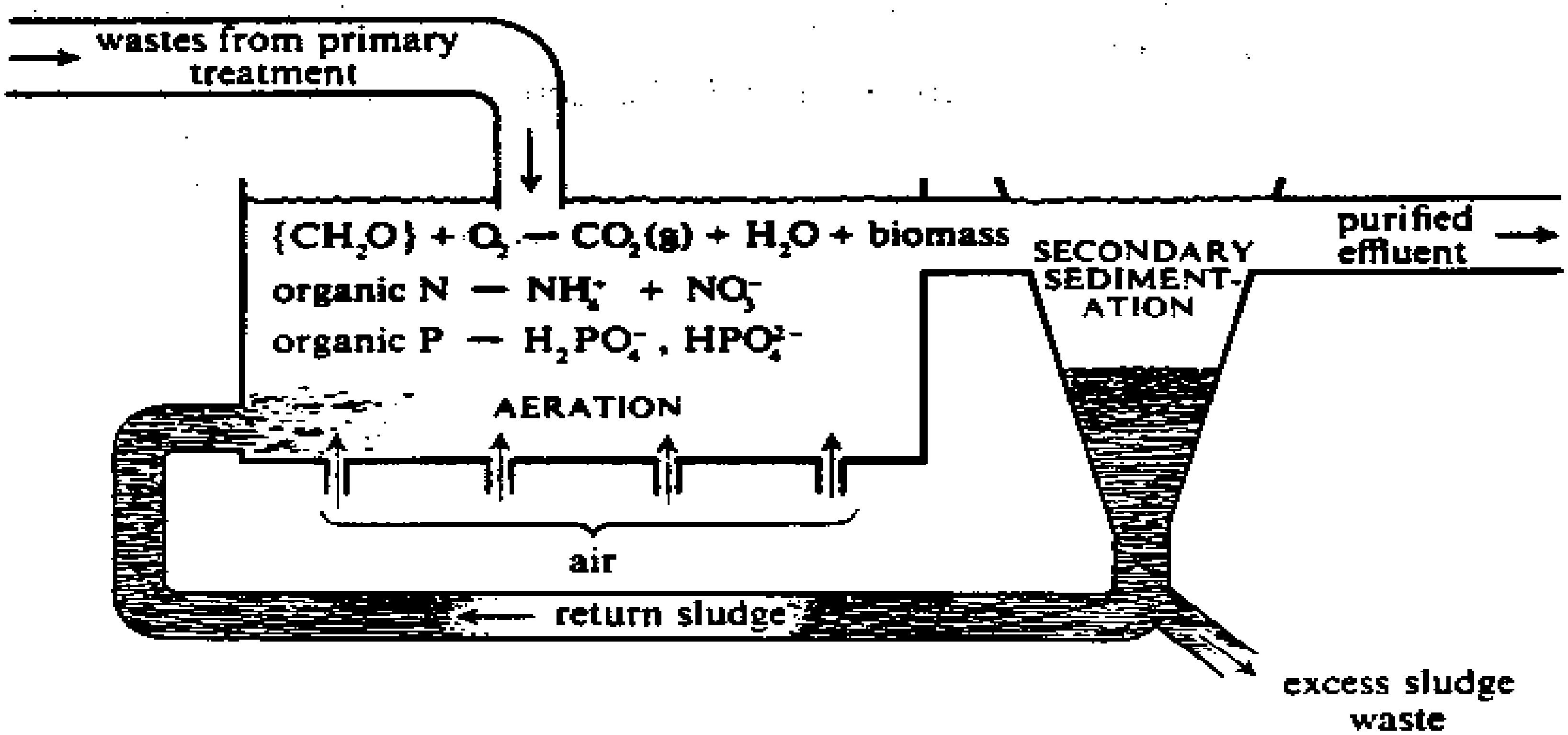
- Process in which a mixture of wastewater and microorganisms (biological sludge) is agitated and aerated
- Leads to oxidation of dissolved organics
- After oxidation, separate sludge from wastewater

Activated Sludge



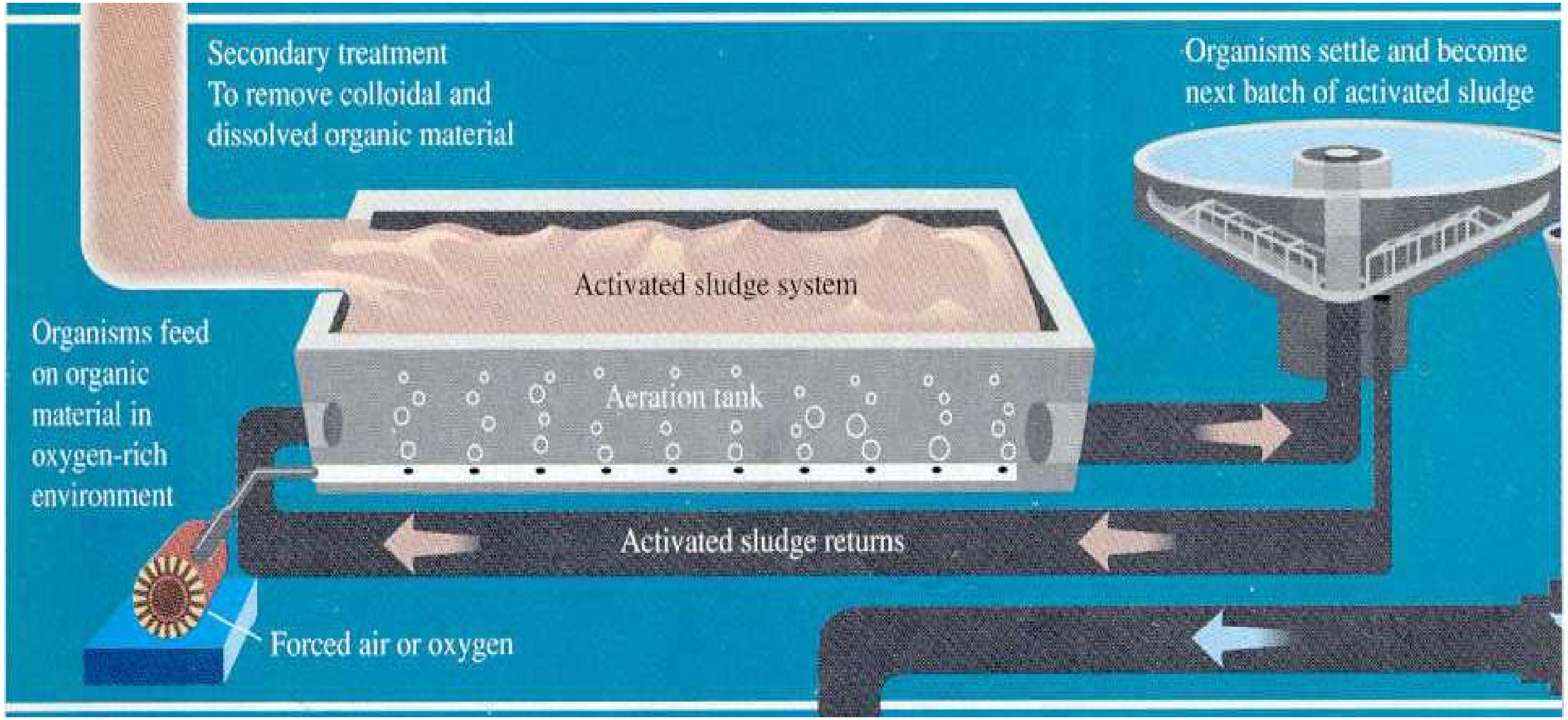
Dispersed Growth Processes

Activated Sludge Process:



Dispersed Growth Processes

Activated Sludge Process:



Activated Sludge Process

Actieved Sludge Process

Organic Mater (BOD)

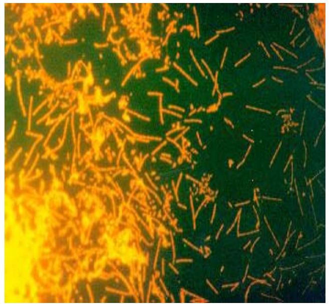
+

Oxygen

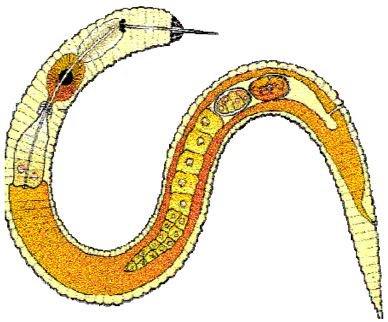
+

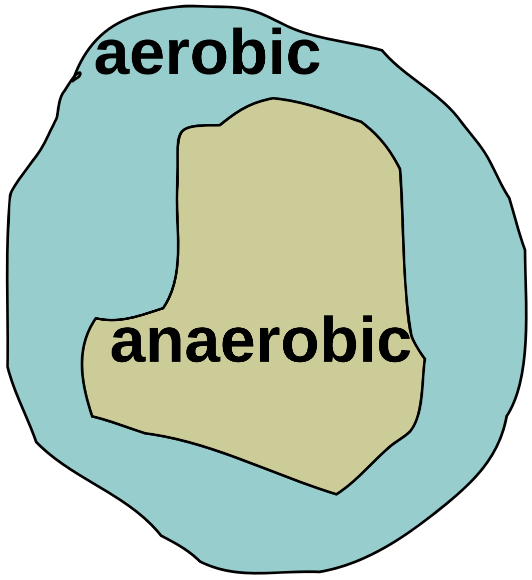
Microorganism

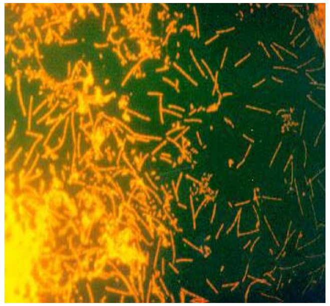
Growth (Flocs)



Sludge floc







Cont==Activated Sludge Process

2.Flocs washing out to the secondary sedimentation tank

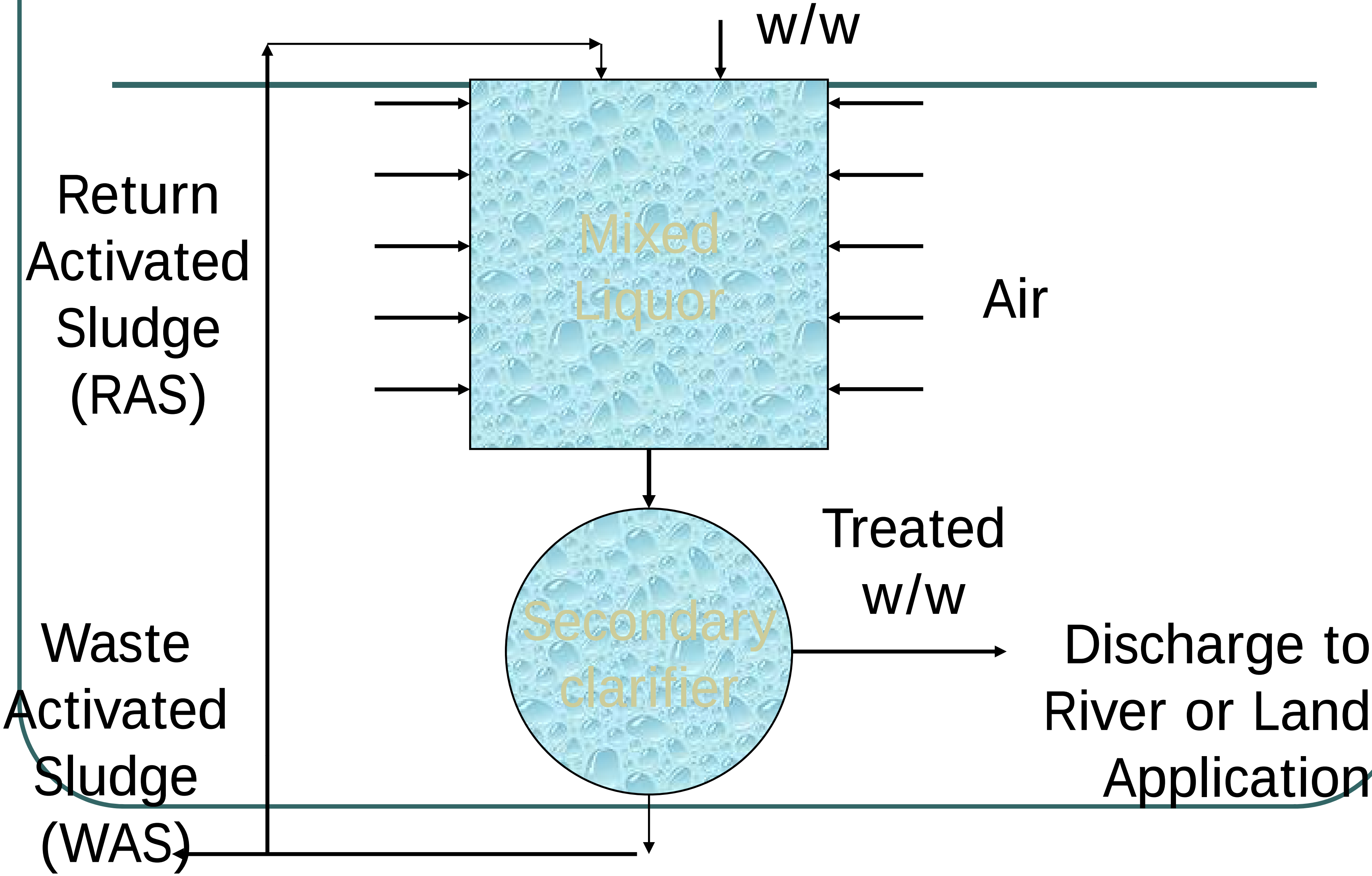
3.Settling of flocs (SLUDGE)

Cont==Activated Sludge Process

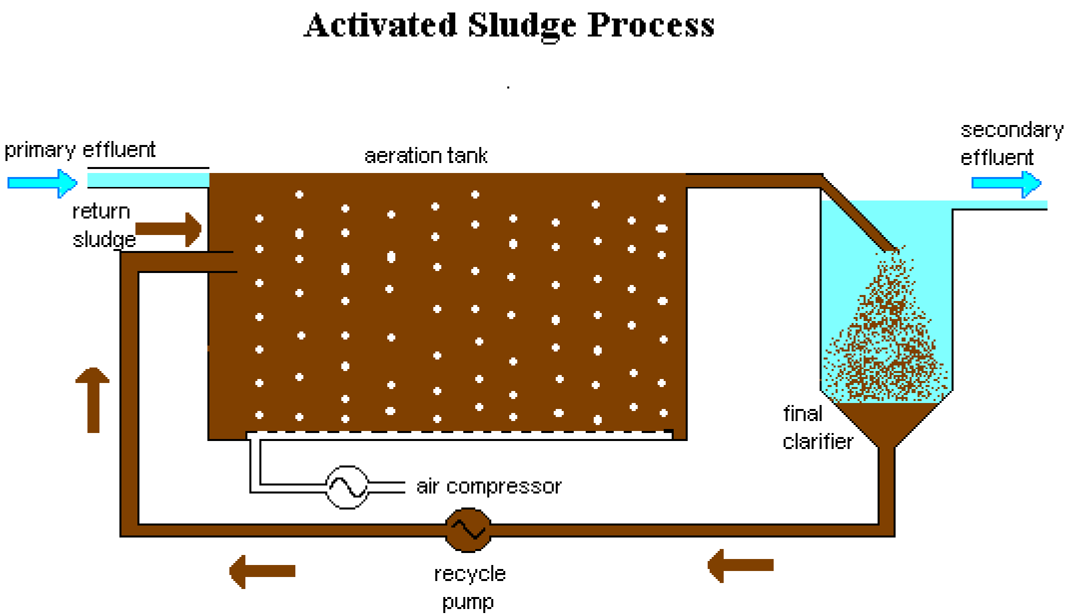
4. A fraction of settled sludge recycled back to the aeration tank (Returned Sludge)

5. Remainder sludge will be wasted

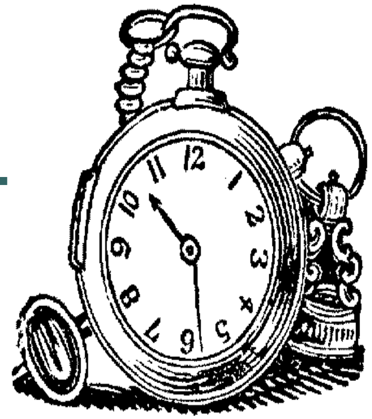
Activated Sludge



Activated Sludge Process



Sludge Age



The average time, which

A microorganism (fraction of the solids, which are wasted) will spend in the reactor is known sludge age

Sludge Age

- and is defined as:

$$\text{Sludge age (d)} = \frac{\text{Total solids in reactor (Kg)}}{\text{Total solids wasted (Kg/d)}}$$

Variation principals of activated sludge process

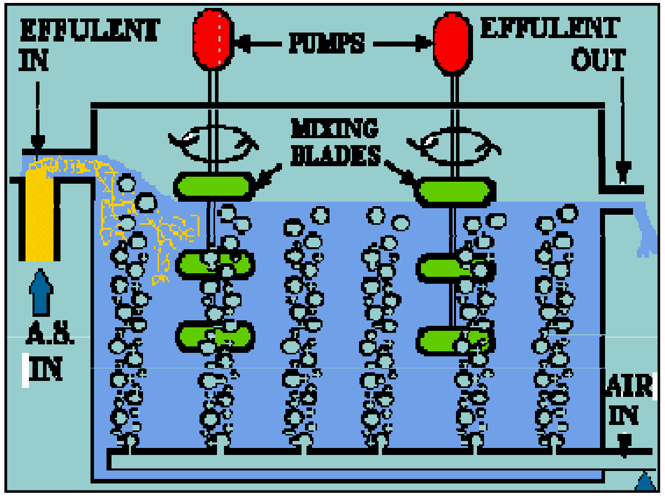
1. The method of oxygen supply
2. Aeration tank configuration
3. Loading rate

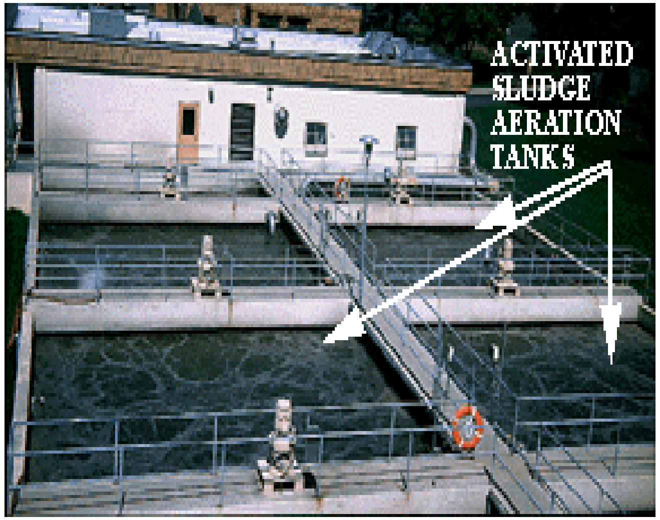
Methods of oxygen supply for activated sludge:

1. **Mechanical surface aeration.**
2. **Diffused air aeration.**

Methods of oxygen supply for activated sludge:

Diffused air aeration. **Mechanical surface aeration.**





Mechanical surface aeration:

1. **Transfer O2 from atmosphere to the MIXED LIQUOR by agitation of the liquid surface**

cont==Mechanical surface aeration:

2. Agitation helps to keep the sludge (flocs) in suspension and prevents it settling:

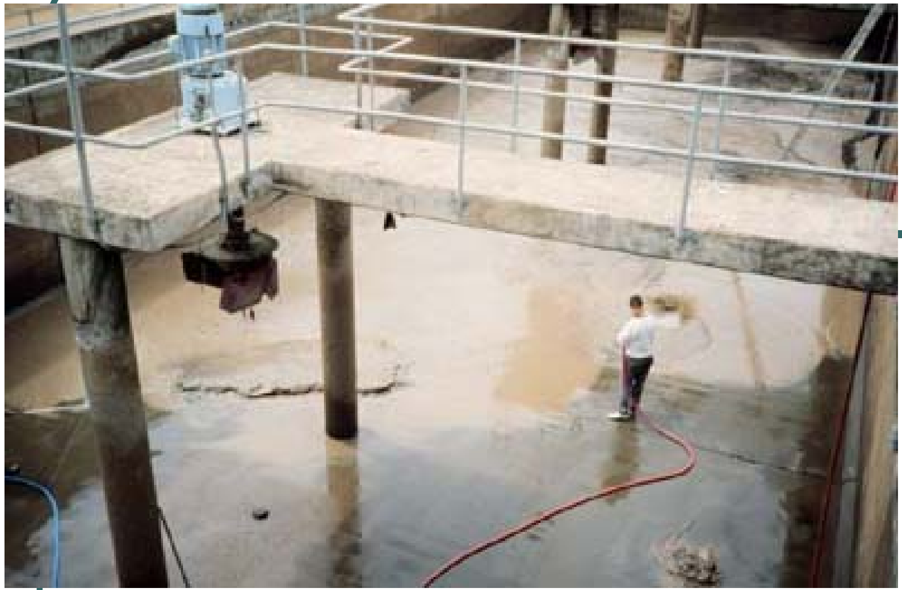
- Vertical A
- Horizontal A

Cont==Mechanical surface aeration:

The immersion depth of the aerator is very important and affect the oxygenation capacity

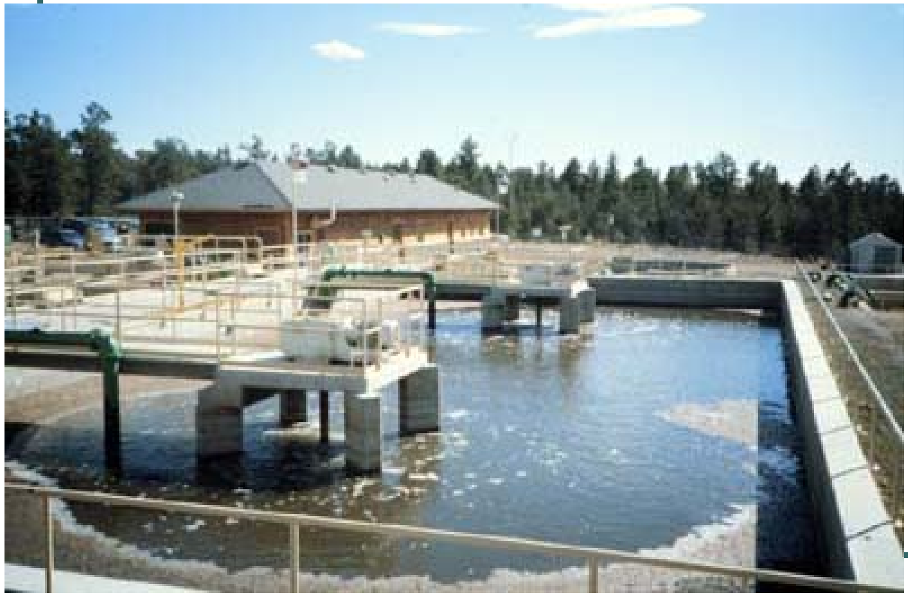
❖ Vertical A

Mechanical Aerators



Fixed aerator

Floating aerator



Turbine aerator

Diffused air aeration:

1. **Located at the floor of the reactor and release air stream into mixed liquor in form of bubbles**

2. **As bubbles rise to tank surface, this will keep the mixed liquor solids in suspension form**

Diffused air aeration:

Ceramic Disc Air Diffuser

Diffusers

Type of air diffusers

1.Fine bubble diffused air:

- Tiles made of ceramic
- Bubbles diameter up to 2mm
- Provide large air/liquid interface with high oxygen transfer efficiency

Blockage problem

- attached biomass
- particles in air

2. Coarse bubble diffused air

- **Bubbles diameter in range 3-5 mm**
- **Reduced oxygen transfer**

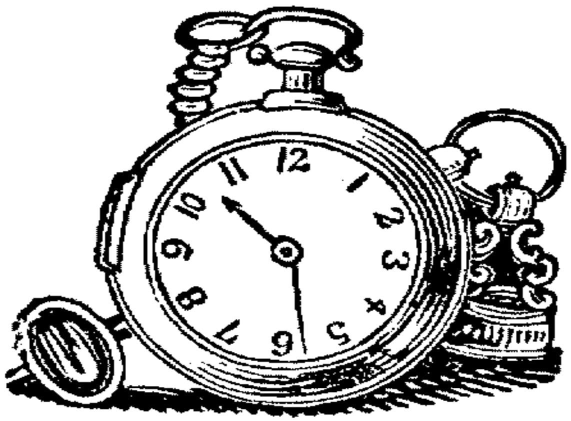
Loading rate

The parameter describe the rate of applying of sewage in the AS reactor

1. **Volumetric loading**
2. **Organic loading**
3. **Food: microorganism ratio (f/m-ratio)**
4. **Floc loading**

1.Volumetric loading:

Determined the time ,which the sewage will undergo aeration in reactor



Retention Time (d) [Hydraulic RT]

= **Reactor volume (m3)/total daily flow (m3/d)**

In cause of absence of sludge Recycle

RT= sludge age

- **Contact time (6-10)hs**
- **Aeration Tank magnitude**

2.Organic loading:

The amount of organic (BOD) applied per unit volume of aeration tank

2.Organic loading:

$$\text{Organic Loading (Kg BOD/m3.d)} = \frac{\{\text{ influent flow (m3/d) * BOD (kg/m3)}\}}{\text{Reactor volume(m3)}}$$

3.Food-Microorganism Ratio (F/M-Ratio):

- **Sludge loading**

F/M-Ratio=

$$\frac{\text{BOD of sewage (Kg/m3) * influent flow (m3/d)}}{\text{Reactor volume (m3) * Reactor Sludge (Kg/m3)}}$$

F/M Parameter

- Low F/M (low rate of wasting)
  - starved organisms
  - more complete degradation
  - larger, more costly aeration tanks
  - more O_2 required
  - higher power costs (to supply O_2)
  - less sludge to handle
- High F/M (high rate of wasting)
  - organisms are saturated with food
  - low treatment efficiency

4.Floc Loading:

Give an indication about BOD concentration available to sludge microorganism at a given time

Floc loading (kg BOD/kg MLSS)=

$$\frac{\text{Mass of BOD at time of mixing}}{\text{Mass of MLSS at time of mixing}}$$

Used where sludge settlement in secondary sedimentation tank is poor

FL >100 kg BOD/ kg MLSS results improvement in sludge settling

Effluent of loading rate on plant performance:

BOD loading in influent will have the following effluent

- **Effluent Quality – sludge settling properties**
- **Efficiency of plant performance**

$$1/\Theta = Yq - ka$$

Θ :Sludge age

Y: Sludge Yield (kg/kg BOD)

Q: organic loading rate (kg BOD/kg MLSS)

Aeration tank configuration:

- **The configuration of selected Activated Sludge reactors (aeration Tank) will have effects on many aspects of plant performance and economy (running and construction costs)**

Secondary Treatment
Aeration Tank "Reactor"

Batch Reactor (BR):

Activated sludge known as the fill and draw process:

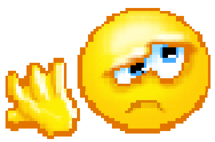
- A reactor filled with settled sewage
- Aeration for sufficient time (generally 8-12 hours)
- Settling the reactor contents

Cont==Batch Reactor (BR):

- Discharge the treated supernatant to a watercourse
- Portion of the settled sludge will be wasted
- The process repeated again

Cont==Batch Reactor (BR):

The process (BR) Lost fervor because of the amount of operator control required



Sequencing Batch Reactor (SBR):

- A recent modification of BR process know as a sequencing batch reactor (SBR) is gaining increased popularity.

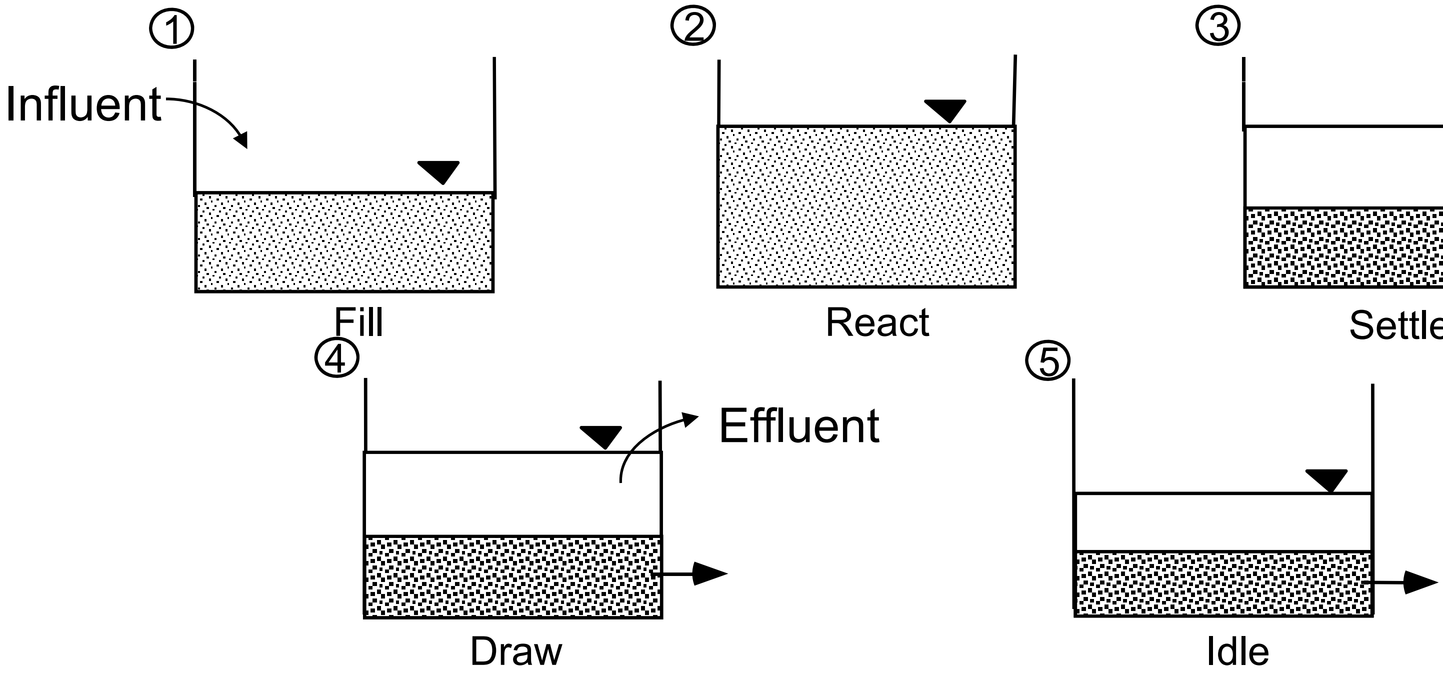
Cont==Sequencing Batch Reactor (SBR):

SBR allows different removal processes to be performed in the same reactor :

- **Carbonaceous oxidation**
- **Nitrification , Denitrification**
- **Phosphate removal**

Sequencing Batch Reactor (SBR)

- Suspended growth system
- Completely mixed mode; batch mode with discontinuous flow
- Typical F/M = 0.05~0.1 (comparable to an extended aeration type process)



Causes suitable to apply RBC technology:

- **Highly variable hydraulic and organic loads**
- **Small communities**
- **Vacation resorts and institutional facilities**

Complete Mix Reactors (CMR):

1. **Rapidly distributed of settled sewage and return activated sludge**

2. **MLSS, BOD and O2 concentration should have the same values in any point in the reactor**

Cont==Complete Mix Reactors (CMR):

Advantage: 

- **Large dilution of influent provides a buffer against any toxic substances**

- **Uniform distribution of load ensure an efficient use of aerators**

Cont==Complete Mix Reactors (CMR):

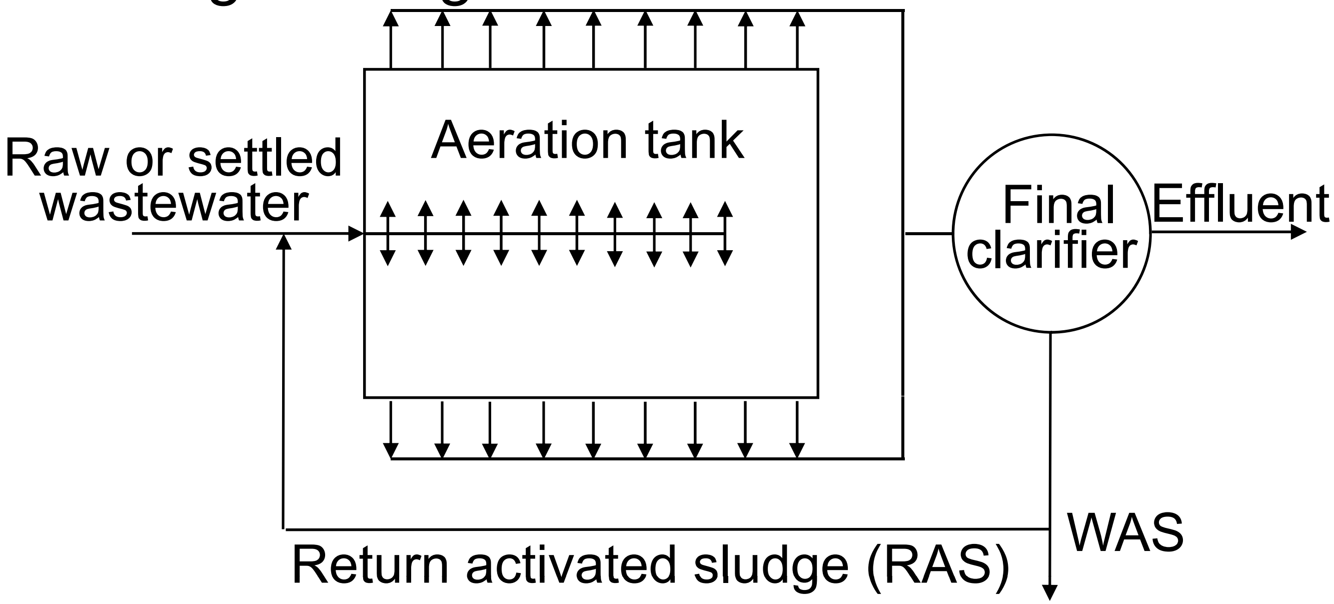
Disadvantages: 

- **Short-circuiting , leads to not adequate treatment.**

- **Low floc loading , leads to sludge settlement problems.**

Completely-Mixed Activated Sludge (CMAS)

- Objective is to mix aeration basin completely.
- CMAS is inflexible (one basin); also CMAS systems tend to bulk more than conventional systems at low F/M; CMAS is useful to disperse toxic or shock loads and even out DO demand for high strength wastewater.



Oxidation Ditches:

Originally designed as:

- **Inexpensive treatment system for small rural communities**
- **Shallow (1m) continuous oval ditches**
- **Excavated directly or with simple lining for certain soil types**

Cont==Oxidation Ditches:

- Operated at very low loading rates
- No need for primary sedimentation
- A horizontal paddle aerator provided mixing and aeration

Cont==Oxidation Ditches:

- **Mixed liquor keep in circulation around the ditch**

- **After a suitable period of aeration , the aerator turned off and the ditch served as secondary sedimentation tank**

Cont==Oxidation Ditches:

- **Low loading rates sludge ages result:**

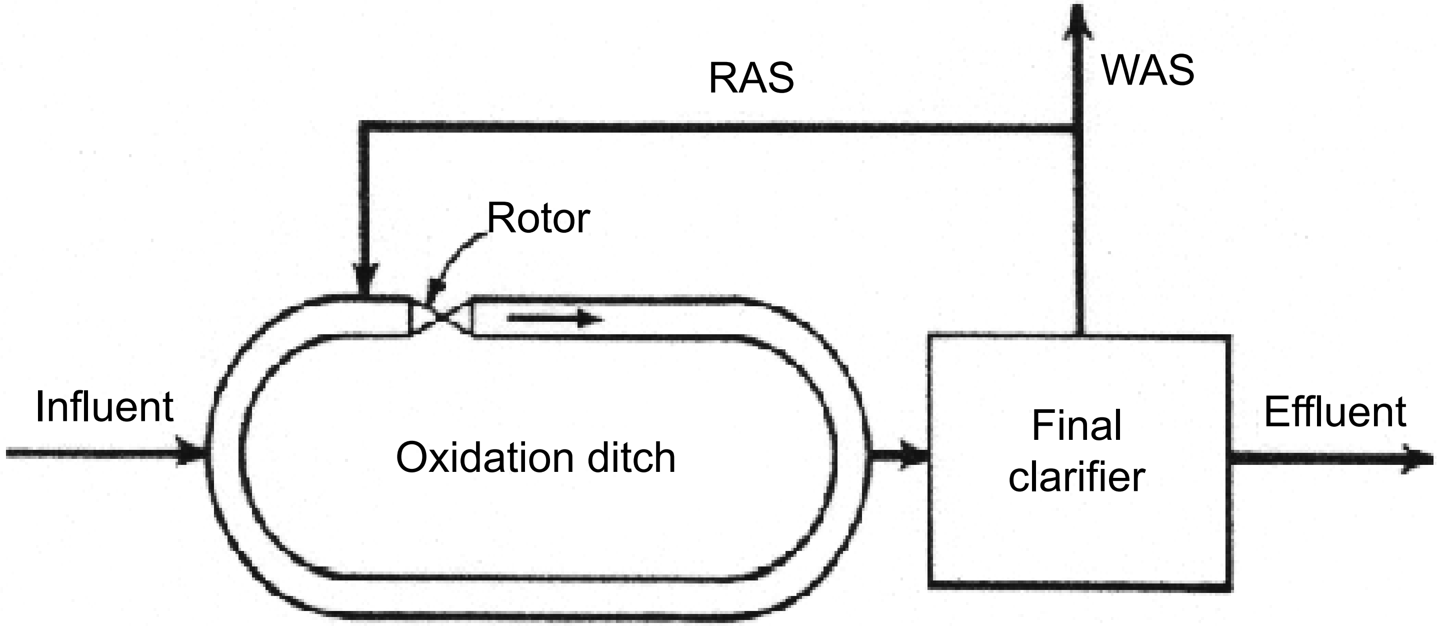
1. **Low sludge production (as result of endogenous respiration)**
2. **Effluent completely nitrified**

Oxidation Ditches:

Low Rate Activated Sludge

Oxidation Ditch

- Low rate, suspended growth system
- Can be operated intermittently or continuously. Continuous operation requires secondary clarifiers.
- Loading rates = 10~15 lb BOD_5/1000 $ft^3 \cdot$day
- Useful for small communities; but large space required.

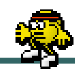


Modified oxidation ditches:

- Represent high wastewater treatment technology
- Separation secondary settlement tanks
- The ditch is invariably constructed using concrete

Cont==Modified oxidation ditches:

- **Vertical shaft cone aerators employed**
- **Carrousel process types for large populations**



on

Ditch

Plug-Flow Reactors:

1. Tanks with a high length to breadth ratio
2. The reactor consists of a number of tanks or pockets in series , each equipped with its own aerator (pocket behaves a complete mix reactor)

Cont==Plug-Flow Reactors:

3) **Settled sewage and return sludge introduced at one end and remove at the other**

4) **Samples along the tank show a gradient of decreasing BOD , increasing MLSS and decreasing oxygen demand**

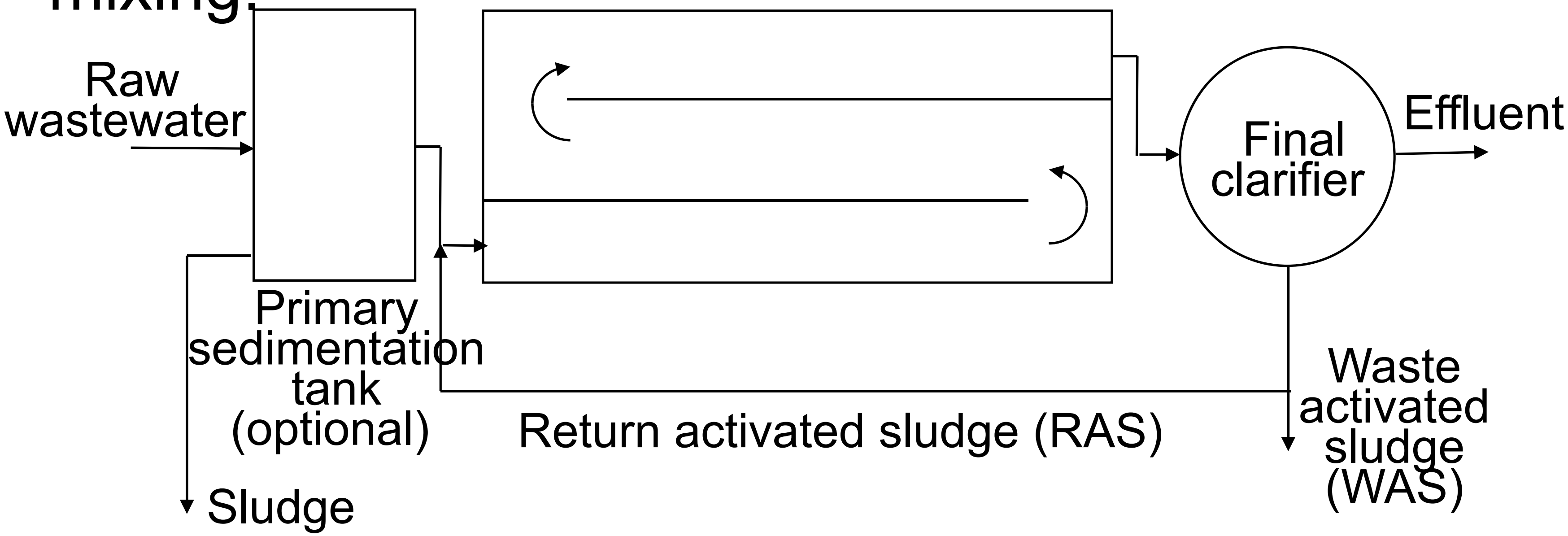
Cont==Plug-Flow Reactors:

5) **As load and oxygen demand not evenly distributed along , step aeration is apply**

6) **This modification of air supply matches the BOD demand and is utilized more efficiently**

Plug-Flow

- RAS and sewage are fed at one and the same point in aeration basin.
- The basin configuration will determine degree of mixing.



Cont==Plug-Flow Reactors:

7) **Advantages : reducing total plant running costs up to 50%**

8) **Floc loading problem of sludge settlement traditionally reduced**

Step Feeding:

1) The technique is employed only on plug-Flow reactors with the aim of :

- Distributing the load more evenly
- Avoiding oxygen deficiency at the inlet

Cont==Step Feeding:

2) **All return sludge recycled to the reactor inlet**

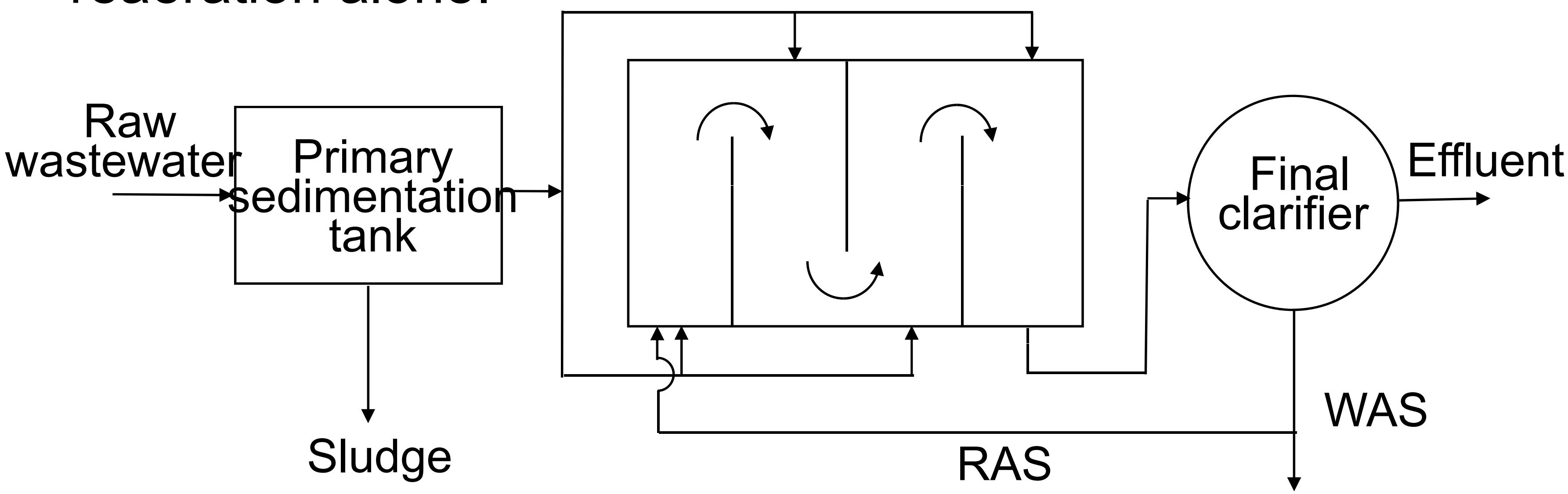
3) **The flow of the incoming settled sewage spilt and fed to a number of pockets**

Cont==Step Feeding:

4) **If too many increments of feed are employed , reactor will resemble in CMR**

Step Aeration

- Tank size for aeration may be reduced to about the half the size of CAS.
- More efficient use of oxygen.
- Can have some part of aeration basin devoted to RAS reaeration alone.



Modifications of conventional sludge process:

Variations are possible , based on :

- Differing reactor configuration – modes of aeration
- Modification haves generally a specific function

Cont==

Modifications of conventional sludge process:

- **Reduce construction and operation costs**
- **Modification to existing conventional plants**

Completely new plant

{Understanding the philosophy behind the modification is important}

(A/B) process:

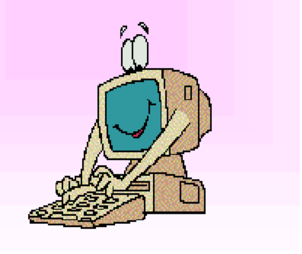
The
absorption-bio-oxidation
(A/B) process

Cont==**(A/B) process:**

- **Two stage process in series**
- **The aim to maximize the production of sludge in two reactor**

Cont==(A/B) process:

- Oxygen is required for oxidative process which produced energy and carbon dioxide



Cont==(A/B) process:

- The process operates without primary sedimentation

- A separation of the first-stage sludge from that of the second stage

Cont==(A/B) process:

- **Two secondary clarifiers are required**

A. **The first has a very high sludge loading rate:**

Cont==(A/B) process:

- **3-7 kg BOD/kg MLSS d . (operating in facultative anaerobic mode) 50% of the influent BOD is achieved**

Cont==(A/B) process:

- **Reducing energy required to remove 1 kg of BOD from 0.3 kwh to 0.15 kwh .**

- **Exploiting the gut microorganism in raw sewage.**

Cont==(A/B) process:

B. The B stage completes the oxidation of the sewage :

- Loading rate 0.5kg BOD/kg MLSS d.

Cont==(A/B) process:

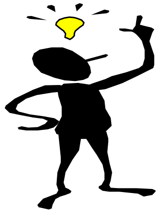
- Operates aerobically with high solids retention time, with nitrification of ammonia

- Efflent ammonia concentration 5-10mg/1.

Cont==

(A/B) process:

- **A/B process can have a loading rate 50% more than conventional single stage activated sludge plant with the same effluent quality**



Contact stabilization :

- Process to solve the sludge settlement in CMR
- The process provides zone with high floc loading in a small tank

Cont== **Contact stabilization :**

Screened sewage + return sludge 30 min in AT (contact zone)

Cont== **Contact stabilization :**

Settling → **effluent to wc**

↓

sludge

↓

transfer to stabilization zone
(aeration up to 12 hours)

Cont== **Contact stabilization :**

- **Sludge returned to contact zone**
- **Sludge absorbed BOD to floc**

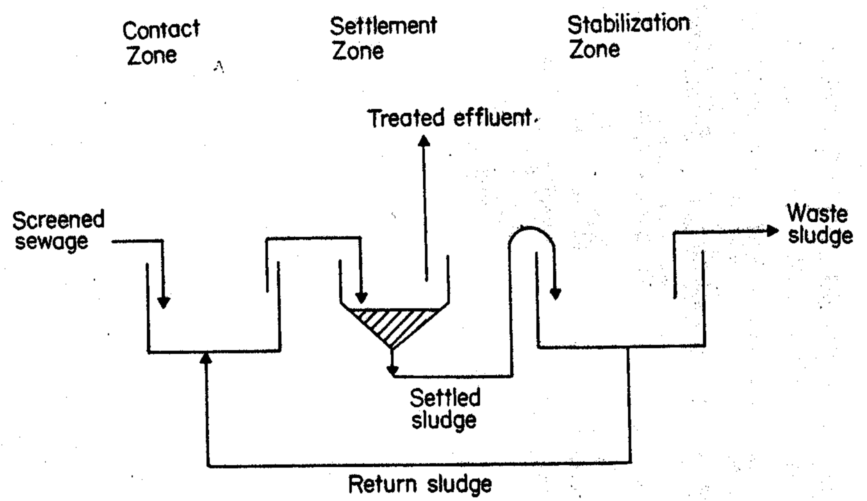
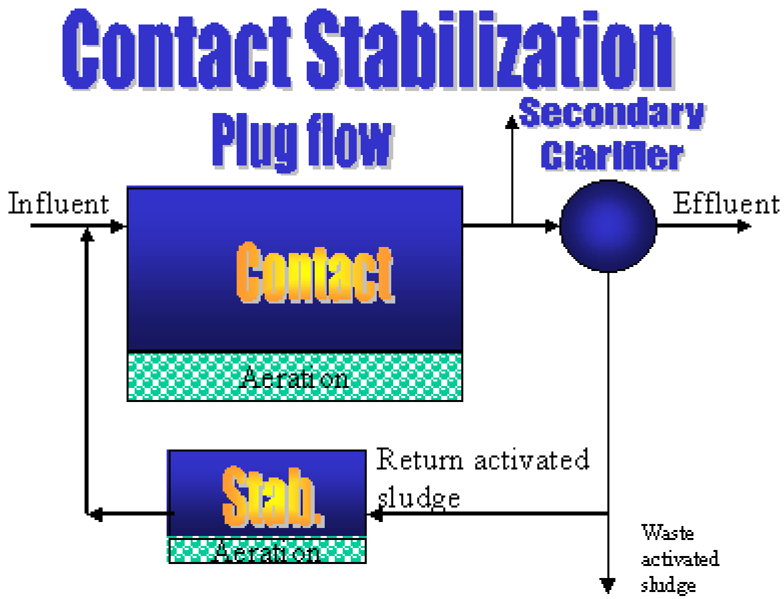


Figure 2.14 Schematic diagram of a contact stabilisation plant suitable for use in a small community.

Cont==**Contact stabilization :**



Cont==**Contact stabilization :**

Advantages :

large reduction of AT Sludge for a package plant for small communities

The absorption-Bio-oxidation (A/B) process:

- **The aim is to maximize sludge production**
- **Has two stage AS**
- **The process operates without primary sedimentation**

Cont==The absorption-Bio-oxidation (A/B) process:

- Two secondary clarifiers are required
- First stage (A-stage):
  - Has very high sludge loading rate (3-7kg BOD/kg MLSS/d)
  - Facultative anaerobic

Cont==The absorption-Bio-oxidation (A/B) process:

- **Treatment efficiency is low**
- **Rabid BOD removed (50%)**
- **Energy required low (0.15kwh/1kg BOD)**
- **BOD removed mechanism is absorption**

Cont== The absorption-Bio-oxidation (A/B) process:

- **B-stage:**
  - **Has low sludge loading (0.3kgBOD/kg MLSS)**
  - **Aerobic with high solids R.T**
  - **Nitrification is occur**

Cont==The absorption-Bio-oxidation (A/B) process:

- **This system save in aeration cost**
- **Sludge (organic mater) used CH_4 produced (anaerobic Digestion)**

QUIZ

True or false:

1. **The aim of primary treatment To prevent blockage of pipes**
2. **The aim of Grit removal is to prevent organic material sedimentation**
3. **40% of BOD5 remove in primary sedimentation**

True or false:

4. **Settlement zone Should free from Short-circuiting**
5. **Fixed film processes represent the oldest form of wastewater treatment system**
6. **trickling filters Simple technique to design ,operate and high running costs**

True or false:

7. **RBC elimination of pounding and clogging**
8. **The average time, which a microorganism will spend in the reactor is known sludge age**
9. **Coarse bubble diffused air Reduced oxygen transfer**

True or false:

10. **CMR rapidly distributed of settled sewage and return activated sludge**


Thanks