Wastewater Operator Certification Training

Module 4: Fundamentals of Wastewater Treatment

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Topical Outline

Unit 1 – Preliminary Treatment: Screening & Degritting

Learning Objectives

- Explain the general purpose of the Preliminary Treatment Process.
- Explain the purpose of Screening, Grit Removal and Pre-aeration.
- Indicate the differences between manually and mechanically cleaned racks and screens.
- Define differences between screening and comminution.
- Describe safe disposal of screenings and grit.

The Preliminary Treatment Processes

Almost everything finds its way into sewers. Preliminary treatment is normally the first step in processing wastewater. It protects pumps and other equipment by removing harmful matter. Plants may or may not utilize all of the preliminary equipment discussed in this section.

General Overview

Screening is one of the first methods of wastewater treatment.

- Removes or reduces size of solids which may interfere with downstream processes.
- Designed to remove floating material and larger suspended solids.
- Generates head loss.

Bar Screens & Racks

Manually Cleaned

- Vertical or inclined bars spaced at equal intervals across influent channel.
- Bar spacing ranges from ½" to 1 ½", widely used.
- Usually incorporates horizontal area at top for draining.
- Cleaned with a rake with tines that fit between bars.
    - Debris raked to top of rack.
    - Placed in container, for proper disposal, after draining.
- Requires frequent attention.
    - As debris collects on bars it blocks channel.

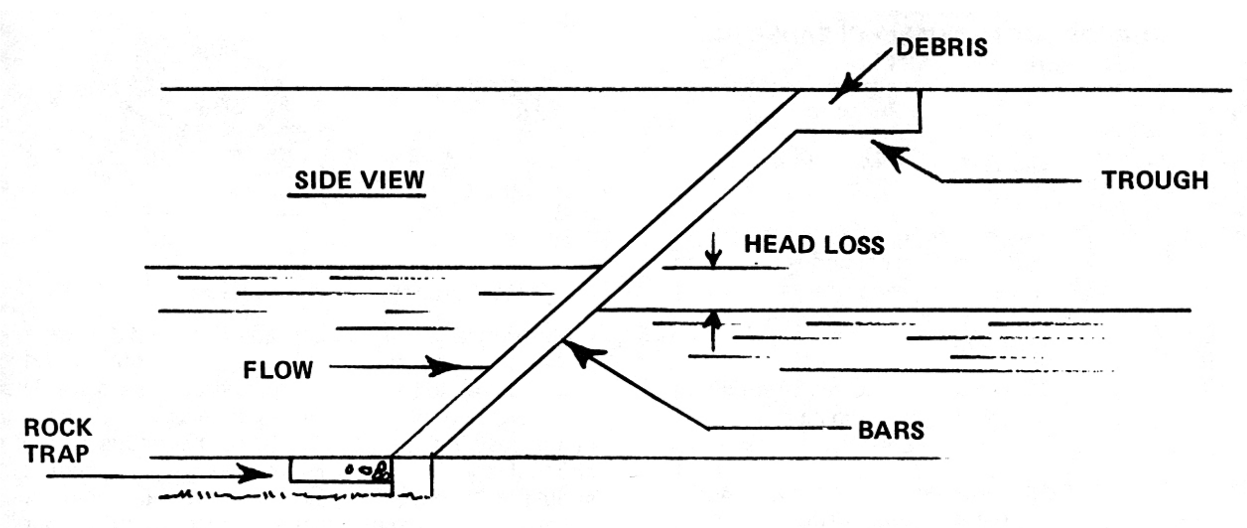

Figure 1.1 Manually cleaned bar screen[1]

Mechanically Cleaned

- Uses mechanically driven rake to traverse rack.
  - o Intermittent or continuous operation.
- Requires less operator attention than those manually cleaned.
- Screenings usually discharged directly to container.

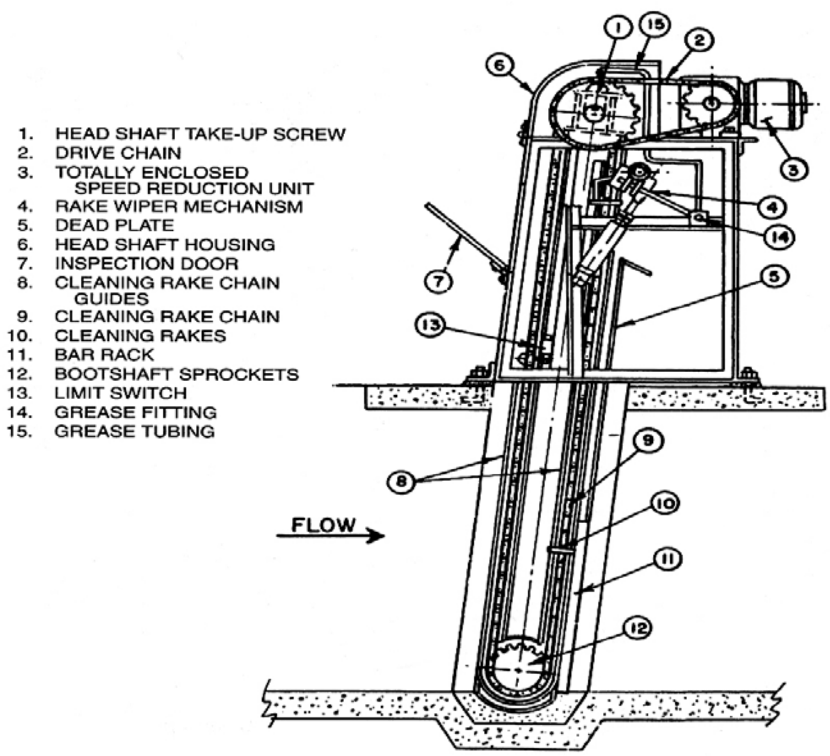

Figure 1.2 Mechanically cleaned bar screen[2]

Screenings Disposal

- Screenings material is very offensive.
  - o Stinks.
  - o Attracts vermin and flies.
  - o May contain organic material.
- Disposal in accordance with environmental regulations or permit requirements.
- Generally landfilled.

General Overview

Grit

- "Grit" is the heavier mineral matter found in wastewater.
- Sand, cinders, eggshells, etc.
- Will not decompose.
- Causes excessive wear on pumps and other mechanical equipment.
- Can clog pipes or accumulate in tanks and digesters.
- Should be removed as soon as possible after reaching plant.
- Should remove grit but only a minimum of organic suspended solids.

Grit Removal Devices

Grit Channels

- Velocity controlled at approximately 1.0 foot per second (fps) regardless of flow to allow grit to settle.
- Cleaning the grit form the channel is important to maintain grit removal efficiency. Cleaning the channel helps to keep the flow velocity of wastewater low. As more grit builds up, the velocity of wastewater increases and removal efficiency decreases.
- Velocity control devices:
    - Device usually located above channel invert to provide for grit storage.
    - Length of chamber sufficient to allow settlement of the smallest particle desired to be removed.
- Manually cleaned—usually only small plants or as a by-pass for mechanically cleaned channel.
- Mechanically cleaned—chain and flight scrapers.
- Grit removed on a daily basis.

Aerated Grit Chamber

- Tank with sloping bottom and hopper.
- Injected air lowers specific gravity of fluid resulting in better grit settlement.
- Lighter organic particles are suspended by the air and pass through tank.
- Grit moves along bottom to hopper by rolling action created by air addition.
- Most frequently found at activated sludge plants where air is available.

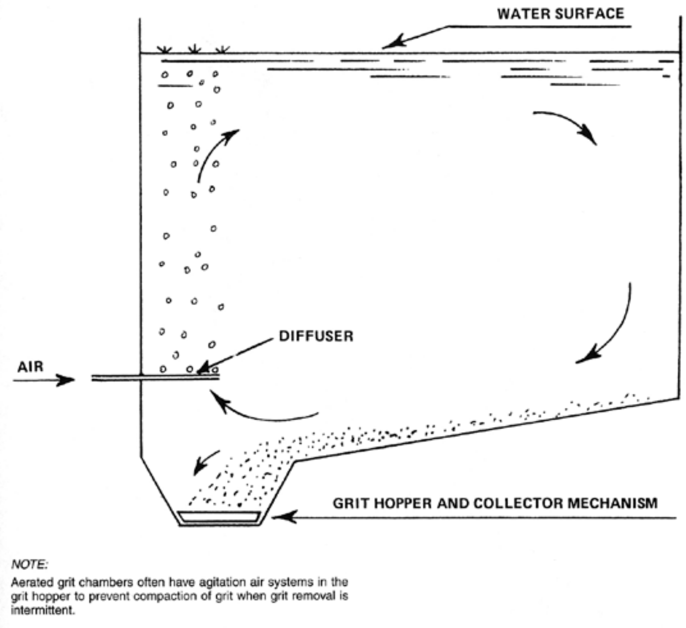

Figure 1.3 Aerated grit chamber[3]

Cyclone Separators

- Commonly used for grit washing.
- May be used as a grit removal device.

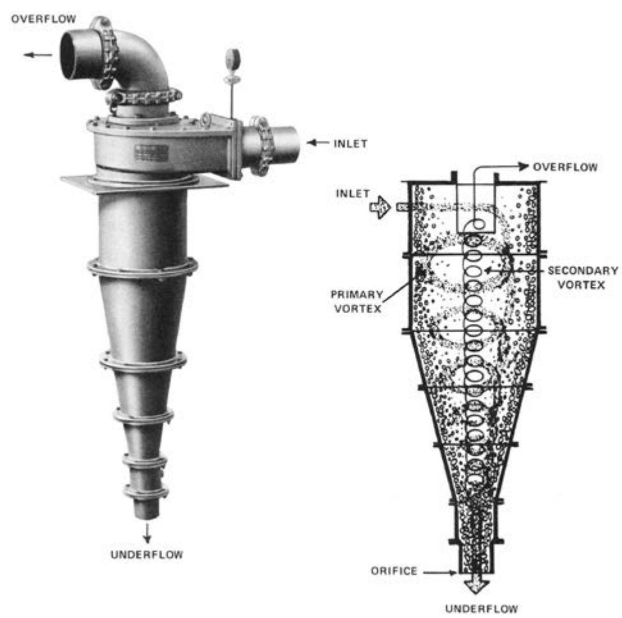

Figure 1.4 Cyclone Separator[4]

Grit Washing

- Removes excess organic material from the grit and returns it to process stream.
- Grit removal generally by screw conveyor to storage container.

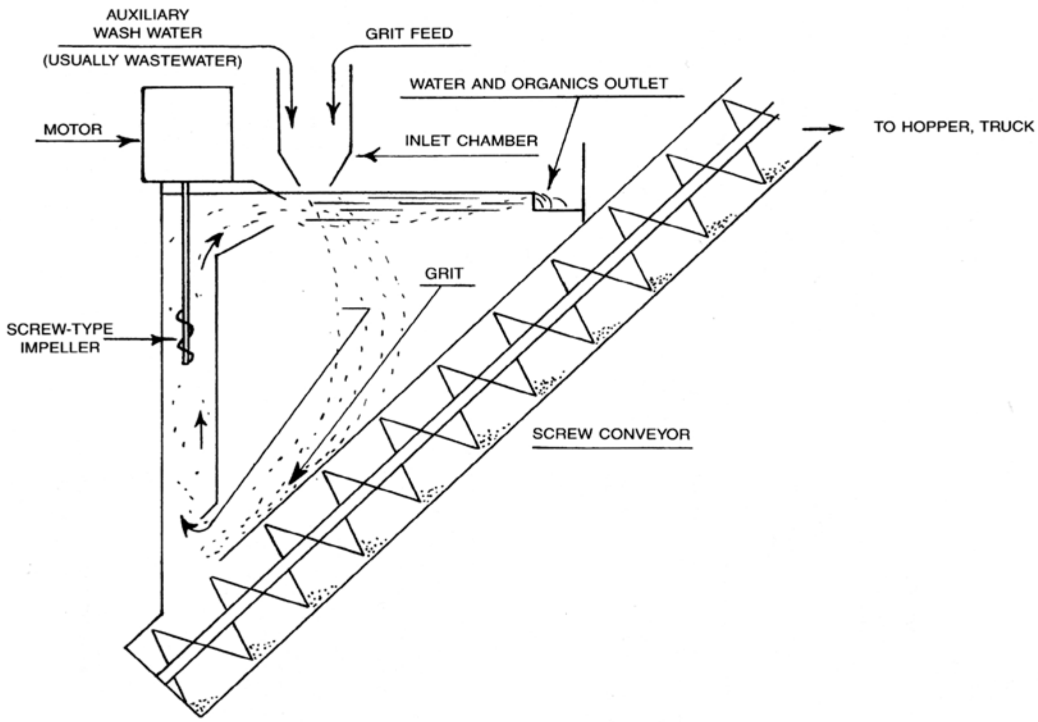

Figure 1.5 Grit Washer[5]

Grit Disposal

- Disposal in accordance with environmental regulations or permit requirements.
- Generally landfilled; however, other options include incineration and land application.

General Overview

During the Comminution Process

- Cuts and shreds retained material to approximately ¼” size.
- Material not removed from flow.
- Material removed by sedimentation later in the treatment process.
- Hard materials, such as wood and plastic, are not shredded and must be removed periodically, either mechanically or manually.
- Rags, cloth and other fibrous material may clog the comminution device.

Comminutors

Cut and Shred Materials

- Consist of revolving cutter blades mounted in a slotted screen.
  - o Solids too large to pass through the screen slots are cut into pieces by rotating blades.
- Installed directly in flow channel.
- Usually provided with by-pass barscreen.

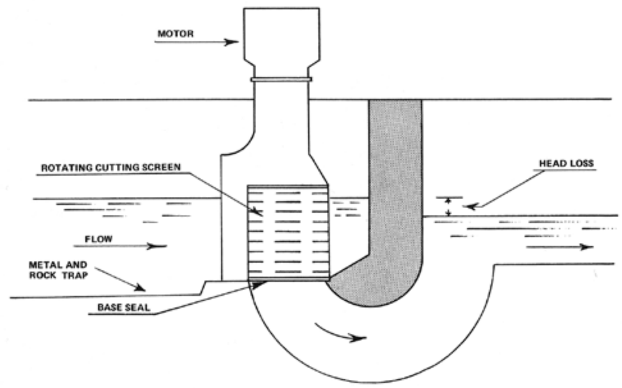

Figure 1.6 Comminutor[6]

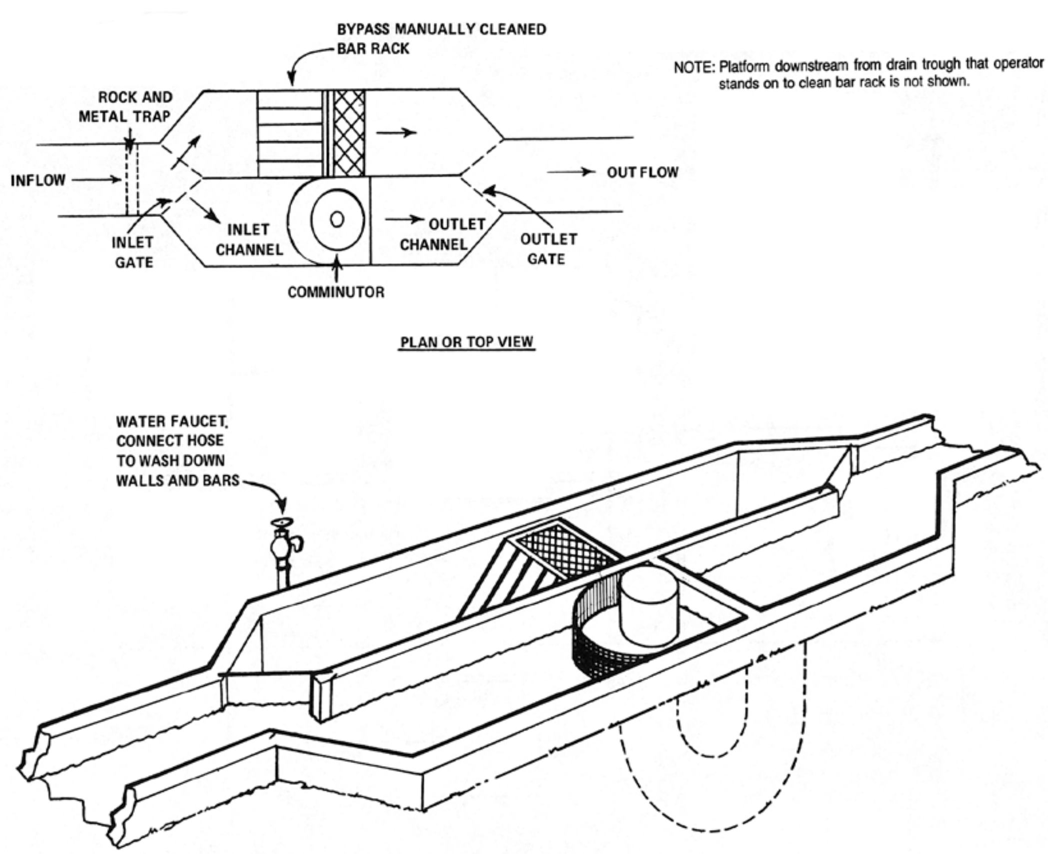

Figure 1.7 Comminutor with by-pass screen[7]

What is the purpose of preliminary treatment as it relates to screening and comminution?

List at least two differences between screening and comminution.

Purposes

- Improve grit removal efficiency.
- Freshen wastewater.
- Remove gases and add oxygen.
- Promote grease flotation.
- Aid coagulation.

Key Points

- Preliminary treatment is normally the first step in processing wastewater and protects pumps and other equipment by removing harmful matter.
- Preliminary treatment includes screening/comminution, grit removal and pre-aeration.
- Screening designed to remove floating material and larger suspended solids.
- Grit is the heavier mineral matter found in wastewater.
- Grit channel velocity controlled at approximately 1.0 foot per second (fps) regardless of flow to allow grit to settle.
- Screenings and grit are generally landfilled, however, grit may also be incinerated or land applied.
- Pre-aeration tends to increase the overall efficiency of solids and BOD removal.

References

[1]Larry Bristow, "Chapter 4: Racks, Screens, Comminutors and Grit Removal." In *Operation of Wastewater Treatment Plants Volume I*, *(*Sacramento, CA: California State University, Sacramento Foundation, 1998), p. 69.

[2]Bristow, p.69.

[3]Bristow, p.89.

[4] Bristow, p.92.

[5] Bristow, p.94.

[6] Bristow, p.76.

[7] Bristow, p.75

[8] Bristow, p.81.

Unit 2 – Primary Treatment: Sedimentation and Flotation

Learning Objectives

- Explain sedimentation and flotation principles.
- List factors that indicate when a clarifier is not performing properly.
- Use mathematical formulas to solve for detention time, weir overflow, surface loading, and solids loading.

Sedimentation

Sedimentation is the removal of heavier solids and grit.

Flotation

Flotation is the removal of lighter solids and grease.

Types of Units

There are Three Types of Units in the Primary Treatment Process

Primary Clarifiers

- Flotation units.
- Combined Sedimentation-Digestion units.

In your own words, define sedimentation.

In your own words, define flotation.

Clarifiers

Settling Characteristics

- Settling characteristics are dependent on three factors:
  - Specific Gravity.
    - Weight of particle in relation to weight of equal volume of water.
  - Particle size and shape.
  - Relationship of downward movement of particle to forward flow velocity.

Factors Which Influence Settling Characteristics

Temperature, detention time, short circuits, weir overflow rate, surface settling rate, and solids loading rate all influence the settling characteristics of wastewater.

- Temperature.
  - Water expands, or becomes less dense, as temperature increases (above 4˚ C) and contracts, or becomes denser, as temperature decreases.
    - Opposite is true below 4˚ C.
  - Generally, as water temperature increases settling rate increases; as temperature decreases so does settling rate.
    - As water becomes denser, density differential between water and solid particles becomes less and particles settle slower.

- Detention Time.
  - o Wastewater must remain in sedimentation basin long enough for solid particles to fall to sludge layer.
  - o Generally 2 to 3 hours.
  - o Detention time calculation based on flow and tank dimensions.

If the flow is less than or exceeds that for which the sedimentation basin was designed, the basin will not perform properly.

Formulas

Detention Time, hr. = $\frac{\text{Tank Volume, cu ft} \times 7.5 \text{ gal/cu ft} \times 24 \text{ hr/day}}{\text{Flow, gal/day}}$

Rectangular Tank Volume, cu ft = Length, ft x Width, ft x Height (Depth), ft

Area of Circle, ft^2 = (0.785) ($Diameter^2$) or (π) ($Radius^2$)
Note: π = 3.14

Circular Tank Volume, cu ft = Area x Height (Depth), ft

so,

Circular Tank Volume, cu ft = (0.785 x $(Diameter, ft)^2$ x Height (Depth), ft) or ((3.14) x $(Radius, ft)^2$ x Height (Depth), ft)

Sample 2.1: What is the detention time when the flow is 3.0 million gallons per day (MGD), or 3,000,000 gal/day and Tank dimensions are 60 feet long by 30 feet wide by 10 feet deep?

Sample 2.2: What is the detention time when the flow is 2.5 million gallons per day (MGD), and Circular clarifier dimensions are 60 ft in diameter by 12 ft deep?

- Short Circuits.
  - o Higher forward flow velocity in some areas decreases detention time in those areas.
  - o Also caused by turbulence.
  - o Even dispersal of influent flow across entire tank cross section promotes even flow velocity in all sections of tank.

- Weir Overflow Rate.
  - o Proper WOR is necessary to prevent high velocities at discharge.
    - ♦ Generally 10,000 to 20,000 gallons per day per foot of weir (gpd/ft).
  - o Calculation is based on flow and length of the weir and is expressed as gallons per day per square foot as indicated in the formula below.

Formulas

$$\text{Weir Overflow, GPD/ft} = \frac{\text{Flow Rate, GPD}}{\text{Length of Weir, ft}}$$

$$\text{Length of Circular Weir} = 3.14 \times \text{Weir Diameter, ft}$$

Problem 2.1: Compute the weir overflow rate for a circular clarifier with a 75 foot diameter overflow weir when 3.5 MGD is the flow rate into the unit.

- Surface Loading Rate (or Surface Settling Rate).
  - o Directly relates to solids removal efficiency.
    - ♦ Generally 300 to 1200 gallons per day per tank surface area (gpd/sq ft).
  - o Calculation based on flow and liquid surface area.

Formula

$$\text{Surface Loading Rate, GPD/sq ft} = \frac{\text{Flow Rate, GPD}}{\text{Area, sq ft}}$$

Problem 2.2: Compute the Surface Loading Rate when flow into a rectangular clarifier 40 feet wide by 110 feet long by 12 feet deep is 5.0 MGD.

- Solids Loading.
  - The amount of solids, which can be removed for each unit of clarifier surface area.
  - Typical solids loadings:
    - Primary clarifiers – generally not a consideration.
    - Secondary clarifiers – 12 to 30 lbs/day/sq ft.
    - Dissolved air flotation – 5 to 40 lbs/day/sq ft.
    - Sludge thickening – 5 to 20 lbs/day/sq ft.
  - Calculation based on flow, suspended solids concentration, and liquid surface area.

Formulas

Solids Applied, lbs/day = Flow, MGD x Conc., mg/*L* x 8.34 lbs/gal

$$\textbf{Solids Loading, lbs/day/sq ft} = \frac{\text{Solids Applied, lbs/day}}{\text{Surface Area, sq ft}}$$

Problem 2.3: Compute the solids loading at which the clarifier is operating when a circular clarifier with a diameter of 125 feet is operating with a forward flow of 6.0 MGD and a return sludge flow of 2.0 MGD. The MLSS is 4.000 mg/L.

Indicators of Clarifier Operating Problems

- Floating Sludge (Bulking).
- Black, odorous septic wastewater entering clarifier.
- Black, odorous septic wastewater leaving clarifier.
- Scum in clarifier effluent.
- Sludge hard to remove from hopper.
- Low sludge solids.
- Miscellaneous problems:
  - Surging flow.
  - Slime growth.
  - Excessive corrosion.
  - Mechanical problems:
    - Chain/drive problems.
    - Seal problems.
    - Bearing problems

☑ There are several factors that affect proper clarifier operation. List as many as you can below.

What are some indicators of clarifier problems? List several below.

Flotation

General

- Wastewater always contains some suspended solids that have neutral buoyancy—they neither settle nor float.
- Particles can be flocculated with air or chemical coagulants and either settled (if heavy) or floated using small air bubbles.

Vacuum Flotation

- Aerated to saturation with dissolved air.
- Flows into vacuum chamber, which pulls out the air in the form of small bubbles.

Pressure Flotation

- Aerated under pressure.
- Pressure released—dissolved air released in the form of small bubbles.

Specialized Processes

Combined Sedimentation-Digestion Units

- Sedimentation occurs in upper unit.
- Solids (sludge) fall to lower unit for digestion.

Septic Tanks

- Usually for individual homes or small contributing population.
- Operation similar to combined sedimentation-digestion units.
- Solids must be removed periodically and disposed of at a wastewater treatment plant or septage processing facility or land applied.
- Liquid effluent usually disposed of underground by leaching through soil.

Key Points

- Primary treatment consists of sedimentation and flotation.
- Sedimentation is the removal of heavier solids (and any remaining grit not previously removed) and generally takes place in clarifiers or combined sedimentation-digestion units.
- Flotation is the removal of grease and other lighter solids which will not settle.
- The most important function of a clarifier is to remove as much settleable and floatable material as possible.
- Detention time based on flow and tank volume; generally 2 to 3 hours.
- Most common factors influencing settling characteristics are temperature, detention time, short circuits, weir overflow rate, surface settling rate and solids loading.
- Indicators of clarifier operating problems include bulking sludge, scum in the clarifier effluent, sludge hard to remove from hopper and low sludge solids just to name a few.

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Unit 3 – General Overview of Biological Secondary Treatment

Learning Objectives

- List four biological secondary treatment processes.
- Explain the principles of the trickling filter process.
- Identify the different types of trickling filters.
- Explain the principles of the rotating biological contactor (RBC) process.
- Explain the principles of the activated sludge process.
- List the three waste treatment pond classifications and explain the principles of each.

Process Description

Biological Process - Fixed Film System (Trickling Filter)

- Wastewater sprinkled over a fixed media produces a slime (biological film) that coat media surface.
    - o Film consists of bacteria, protozoa, and fungi that feed on waste organics.

- Film requires continuous supply of dissolved oxygen.
    - o Adequate ventilation required.
        - ▪ Natural ventilation.
        - ▪ Forced air.
    - o Media voids must be kept open.
    - o Flow is usually intermittent.

- Quantity of film produced is controlled by the available food.
    - o Increases as organic load increases until maximum effective thickness.
        - ▪ During operation, film will slough off.

- Effluent recirculation increases treatment efficiency.

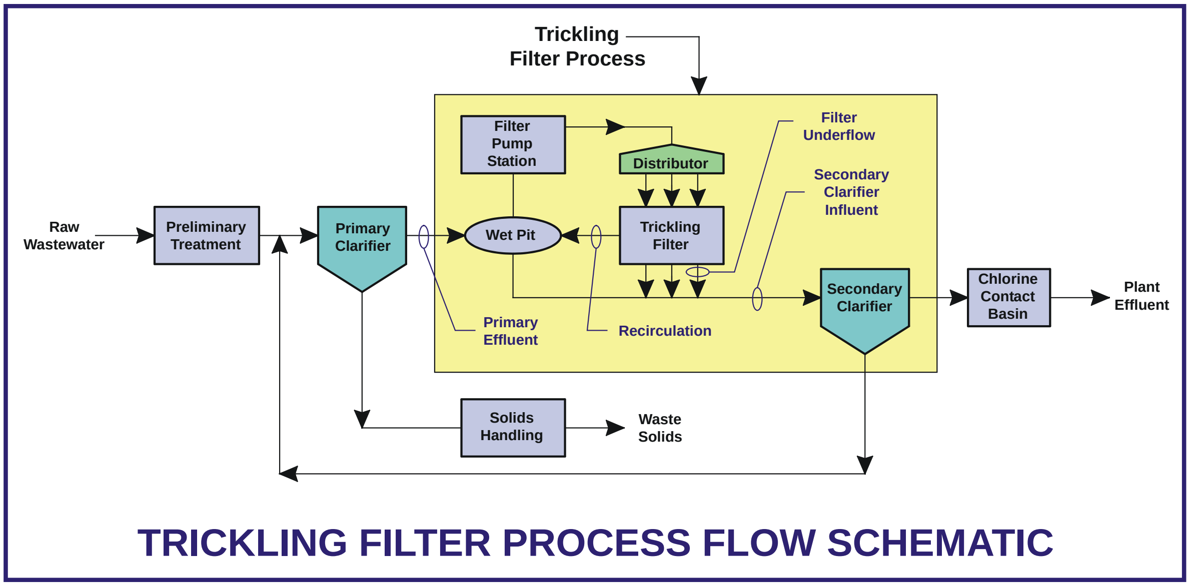

Figure 3.1 Trickling filter process flow schematic

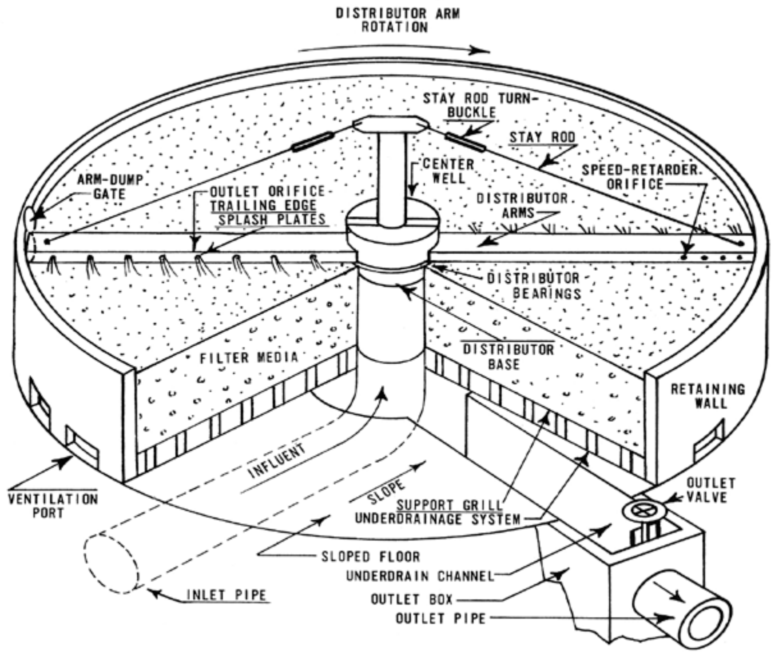

Figure 3.2 Trickling filter[1]

Major Components

Distribution system

- Distributes wastewater to top of media.
  - Fixed distribution system.
    - Intermittent liquid dosing to provide rest periods.
  - Rotating distributor.

Media

- Rock.
  - Approximately 35% void space.
- Plastic media.
  - Approximately 95% void space.

Underdrain

- Collects filtered water.
- Provides ventilation.

Classification of Filters

Standard Rate

- Media.
  - Usually rock media – 6 to 8 foot depth.
- Hydraulic loading of 25 to 100 gal/day/sq ft.
- Organic loading of 5 to 25 lbs/day/1000 cu ft.

High Rate

- Media.
  - Rock – 6 to 8 foot depth.
  - Synthetic – 15 to 30 foot depth.
- Hydraulic loading.
  - Rock media - 100 to 1000 gal/day/sq ft.
  - Synthetic media – 350 to 2100 gal/day/sq ft.
- Organic loading.
  - Rock Media - 25 to 100 lbs/day/1000 cu ft.
  - Synthetic Media - 50 to 300 lbs/day/1000 cu ft.
- Generally all high rate trickling filters use recirculation.

Roughing Filters

- High rate filter with very high organic loading.
  - 100 to over 300 lbs/day/1000 cu ft.
  - Used to reduce organic loading to subsequent oxidation processes.

Abnormal Conditions

Ponding

- Results from a loss of open area in media bed.
- Causes
    - Excessive organic loading.
    - Lack of primary clarification.
    - Improper media selection.
    - Accumulated fibrous material filling media voids.

Odors

- Aerobic process – no serious odors should exist.
- Foul odors indicate anaerobic conditions.

Filter Fly

- Tiny, gnat-sized fly (psychoda).
- Most frequently found in low-rate filters.
- Control
    - Increase recirculation rate.
    - Apply approved insecticides.
    - Flood filter.
        - Results in poor effluent quality.
        - Should be carefully monitored.
    - Apply chlorine dose.

Sloughing

- Excessive film loss is an indication that there are problems with the biological activity within the filter media.

What are the operating principles of the Trickling Filter Process? Explain them below.

Note: Trickling Filters are discussed in further detail in Module 20.

Figure 3.3 Rotating biological contactor[2]

Process Description

Biological Process - Fixed Film System (Rotating Biological Contactor)

A fixed film system similar to trickling filters.

Media

Media is moved through wastewater.

- Rotating shaft surrounded by plastic discs called media.
- Slime grows on plastic media.
- As media drum rotates, media is alternately submerged in wastewater and exposed to air.

Covered

Generally covered for reasons relating to weather conditions.

- Protect slime from freezing.
- Prevent rain from washing slime from media.
- Avoid exposure to sunlight
  - Prevents growth of algae.
  - Prevents deterioration of media.
- Provides some protection for operators from sun, rain, snow, wind, etc... during maintenance.

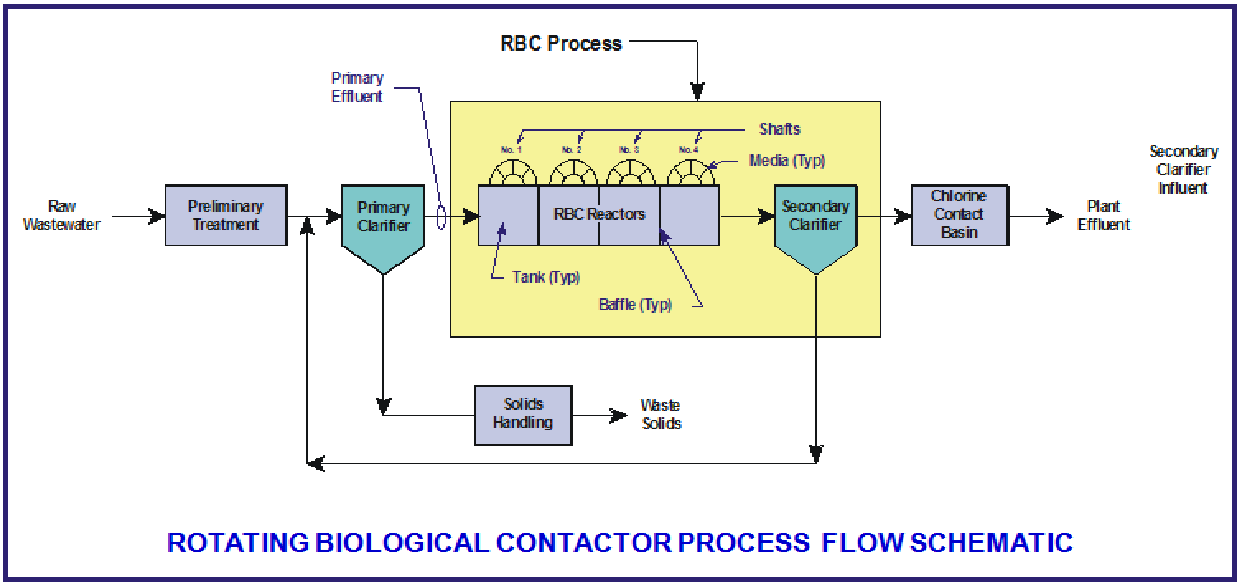

Figure 3.4 Rotating biological contactor process flow schematic

Principles of Operation

Process Operating Conditions

- Performance is affected by hydraulic loadings and temperatures below 55˚ F.
- Typical operating and performance characteristics.
  - Hydraulic loading.
    - BOD removal – 1.5 to 6 gpd/sq ft of media.
    - Nitrogen removal - 1.5 to 1.8 gpd/sq ft of media.
  - Organic loading.
    - Soluble BOD – 2.5 to 4 lbs BOD/day/1000 sq ft.
    - BOD removal – 80 to 95 percent.
    - Effluent Total BOD – 10 to 30 mg/l.
    - Effluent Soluble BOD – 5 to 15 mg/l.
    - Effluent NH_3-N – 1 to 10 mg/l.
    - Effluent NO_3-N – 2 to 7 mg/l.

Pretreatment Requirements

- Usually proceeded by screening, grit removal, and primary settling.

Abnormal Conditions

Decreased Treatment Efficiency

- Possible causes.
  - Temperature below 55˚ F.
  - Large variations in flow or BOD loadings.
  - Unusually high or low pH.

Biomass Sloughing

- Possible causes.
  - Influent containing toxic or inhibitory substances.
  - Unusual variation in flow and/or organic loading.

Snails

- Not a problem in RBCs used for BOD removal.
- Generally occur in plants providing nitrogen removal.
- Snail shells may clog pipes and pumps.
- Snail control
  - Chlorination.
  - Increase pH to 10—kills snails without harm to microbial growth.

<u>Note</u>: Rotating Biological Contactors (RBCs) are discussed in further detail in Module 21.

Process Description

Activated Sludge Process

- Uses microorganisms to speed up decomposition of wastes.
    - o Microorganisms feed and grow on waste particles in the wastewater.
    - o As organisms grow and reproduce, more and more waste is removed.
    - o Mass of organisms needs a steady balance of food and oxygen.

Principles of Operation

Process Description

- Oxidation and removal of soluble or finely divided suspended materials.
- Aerobic organisms stabilize material by partial oxidation.
    - o Process forms carbon dioxide, water, and sulfate and nitrate compounds.
- Remaining solids changed to a form that can be settled and removed during sedimentation.

Process Objectives

- Conversion of dissolved and suspended material to settleable solids.
- Oxidation of organic waste.

Classification of Processes

Complete Mix

- Contents of aeration tank are completely mixed.

- Organic loading.
    - o Mixed Liquor Suspended Solids (MLSS) – 2000 to 5000 mg/l.

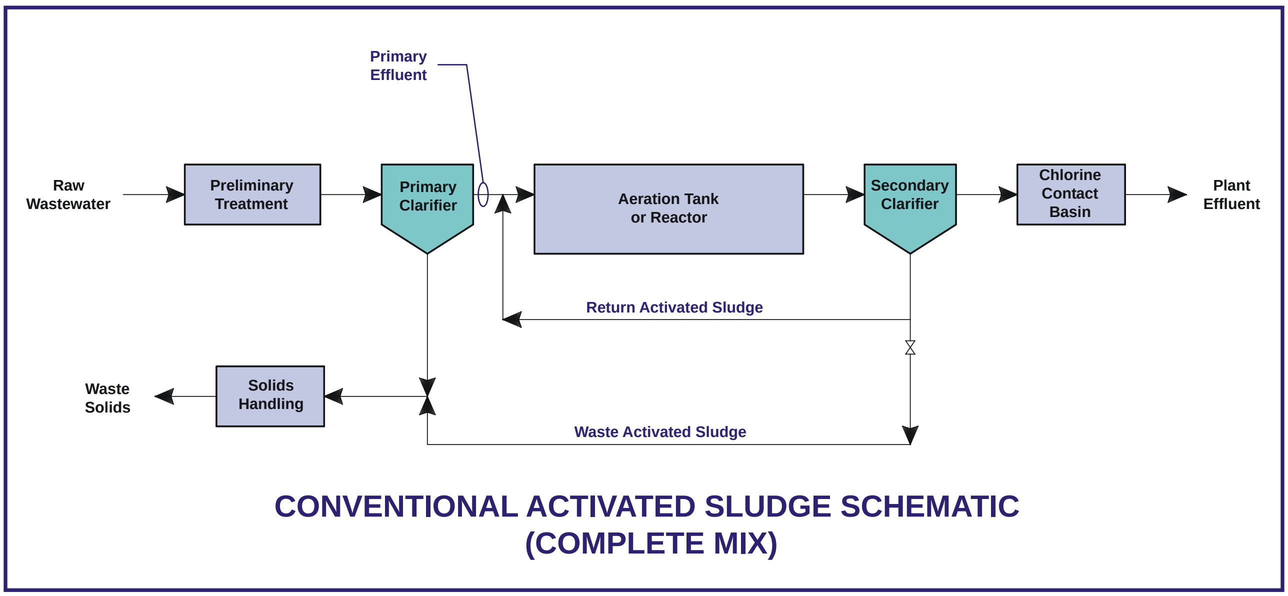

Figure 3.5 Complete Mix Activated Sludge Schematic

Contact Stabilization

- Capture of waste material and digestion of that material is done in different aeration tanks.
- Organisms capture waste material in the contact tank or reactor.
- Settled organisms are returned to the reaeration tank to digest the captured material.
- Organic loading.
  - Mixed Liquor Suspended Solids (MLSS) – 1500 to 2000 mg/l.
- Sludge wasted to maintain proper process control.

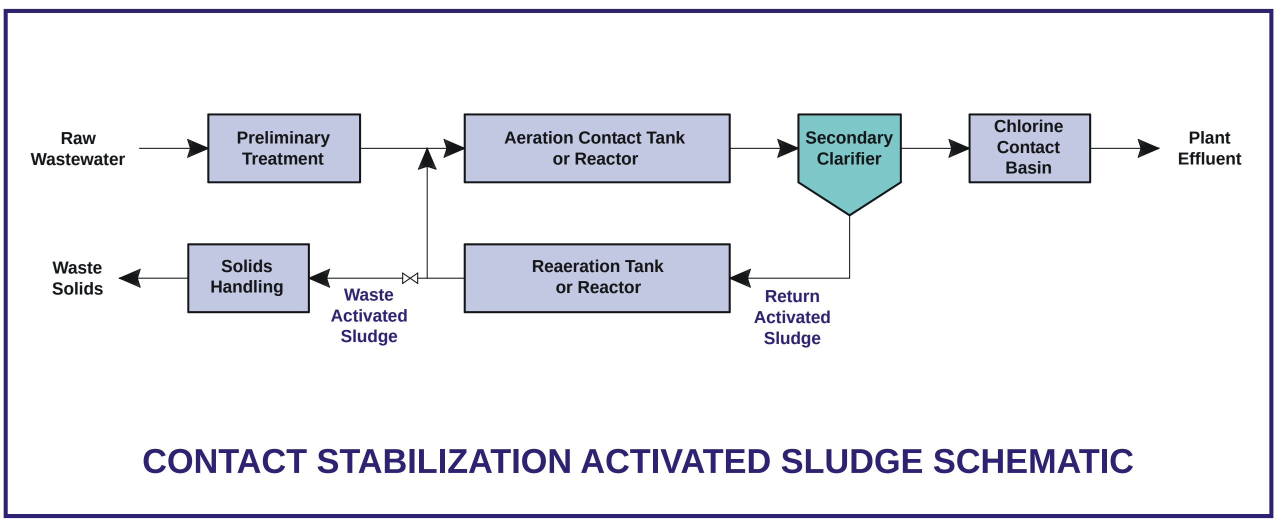

Figure 3.6 Contact stabilization activated sludge schematic

Extended Aeration

- Consists of aeration and sedimentation.

- Usually no primary settling.

- Organic loading.
  - o Mixed Liquor Suspended Solids (MLSS) - 2000 to 5000 mg/l.

- Produces less sludge than other processes.
  - o Sludge wasting is still necessary to maintain proper process control.

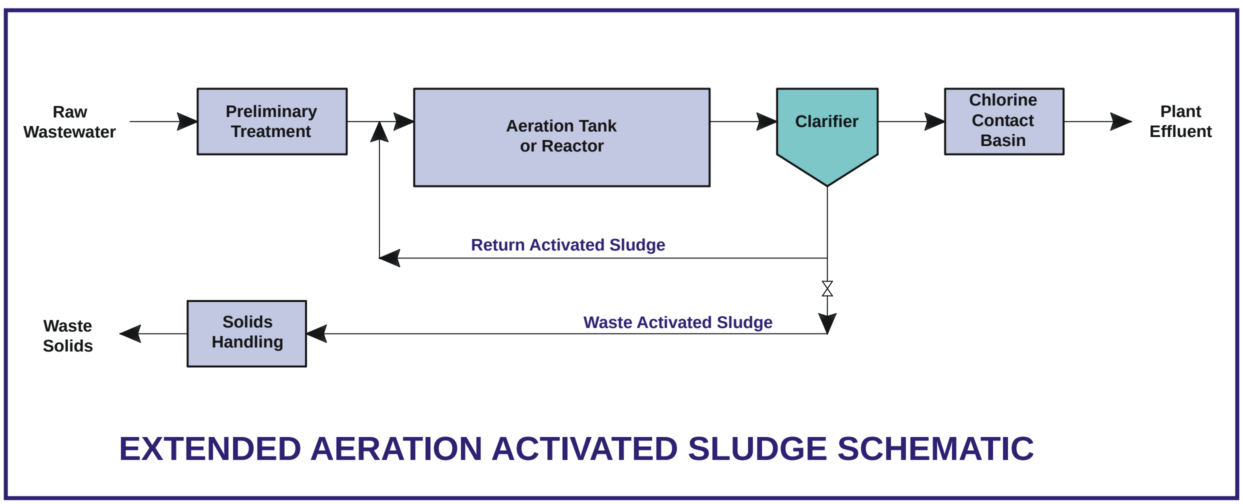

Figure 3.7 Extended aeration activated sludge schematic

Sequencing Batch Reactors

- An activated sludge treatment arrangement where aeration and secondary clarification are performed in a single tank on the basis of time.
  - Sequential control stages.
    - Fill – wastewater is introduced into the tank.
    - Aeration - the contents of the tank are aerated.
    - Settle – the aeration is discontinued and the tank contents are allowed to settle.
    - Draw – the clarified supernatant is removed.

Oxidation Ditches

- Continuous channel extended aeration process.
- Usually no primary settling.
- Mixing and aeration provided by brush rotor assemblies.
- Organic loading.
  - Mixed Liquor Suspended Solids (MLSS) – 2000 to 6000 mg/L.

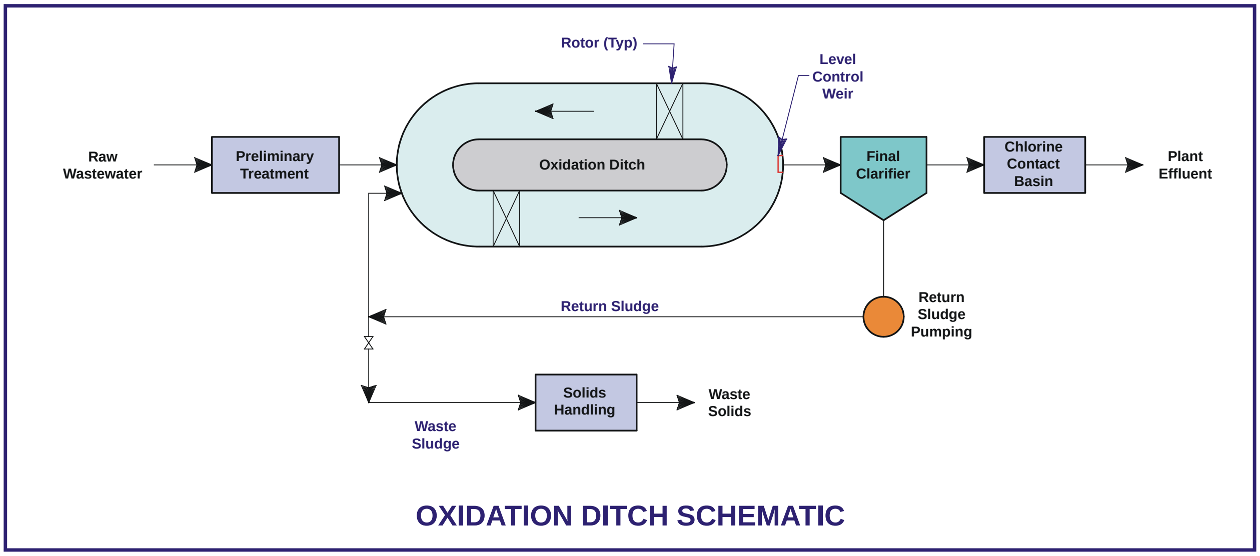

Figure 3.8 Oxidation ditch schematic

Aeration Methods

Mechanical Aeration

- Mechanical aeration devices agitate the water surface to cause spray and waves so that oxygen can be absorbed from the air.
  - o Types of mechanical aeration devices
    - ♦ Paddle wheels
    - ♦ Mixers
    - ♦ Rotating brushes
    - ♦ Floating aerators

Figure 3.9 Mechanical aeration device[3]

Diffused Aeration

- Air from a blower system is discharged into the wastewater.
  - o Diffusers break up the air stream into fine bubbles.
  - o The smaller the bubbles the **greater** the oxygen transfer.

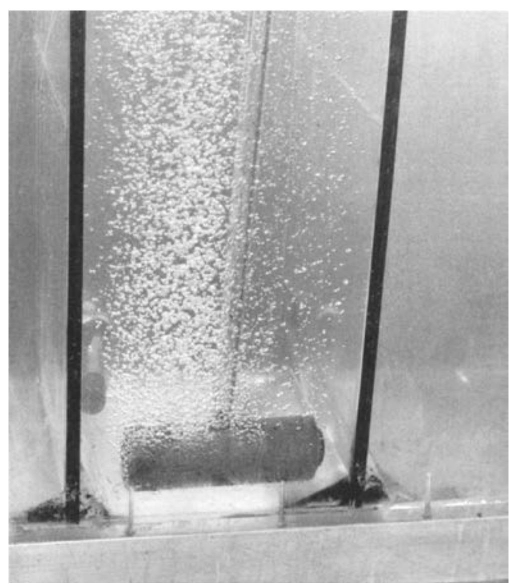

Figure 3.10 Air diffuser[4]

Abnormal Conditions

Solids Carryover in Effluent

- Return sludge rate out of balance with process requirements.
- Sludge not settling in clarifier (bulking).
    - Low solids level.
    - Low dissolved oxygen.
    - Strong, stale, septic influent.
    - Clarifier sludge blanket level too high.
    - Aeration rate too high or too low.

Odors

- Aeration rate too low.
- Return sludge rate too low.
- Poor housekeeping.

Foaming/Frothing

- Foaming usually caused by too low a solids level.
- Frothing usually caused by too long a solids retention time.

List 5 forms of the activated sludge treatment process.

What two aeration methods are used to provide oxygen to the activated sludge treatment process?

Why might solids be found in the secondary clarifier effluent of an activated sludge treatment plant?

Note: Activated Sludge Processes are discussed in further detail in Modules 15-18 and 8.

Process Description

Ponds & Lagoons

- Heavy solids settle.
  - o Decomposed by bacteria.
- Lighter suspended material broken down by suspended bacteria.
- Dissolved nutrient material (nitrogen and phosphorus) used by green algae.
- Some wastewater liquid evaporated from pond surface.

Advantages for Smaller Systems

- Expensive equipment not required.
- Economical to construct.
- Treatment is equal or superior to some conventional processes.
- Adaptable to changing loadings.
- Consumes little energy.
- Serves as wildlife habitat.
- Poses few sludge handling and disposal problems.
- Most trouble-free of any treatment process—provided a consistently high quality effluent is not required.

Pond Limitations

- Odors.
- Large land area required.
- Treatment efficiency is dependent on climatic conditions.
- May contaminate groundwater.
- High effluent suspended solids levels.

Pond Classifications

Aerobic

- Have dissolved oxygen distributed throughout the contents practically all the time.
- Usually require supplemental oxygen source.
  - Mechanical aeration.
  - Diffused aeration.

Anaerobic

- Without dissolved oxygen.
- Treatment depends on fermentation of sludge at the pond bottom.
- Highly efficient in stabilizing organic waste.
- Odor problems.

Facultative

- Most common type in use because it is almost impossible to maintain completely aerobic or anaerobic conditions throughout the pond all of the time.
- Upper portion (supernatant) is aerobic.
- Bottom layer is anaerobic.
- Algae supply most oxygen to upper portion.

Abnormal Conditions

Scum

- Common characteristic of ponds.
- Usually greatest in spring.
    - o Water temperature warms.
    - o Biological activity resumes.
- Usually wind action dissipates scum.
    - o In absence of wind or in sheltered areas, scum must be broken up by other means.
        - ♦ Hand rakes.
        - ♦ Water jets.
        - ♦ Outboard motors.
    - o If not, will dry on top and become crusted.
        - ♦ Reduces sunlight.
            - o Oxygen production by algae is reduced.
                - ♦ Odor problems result.

Odors

- Generally caused by overloading resulting in anaerobic conditions.
- At times caused by process upsets.
- Remedy is to increase dissolved oxygen.
    - o Recirculation from aerobic units.
    - o Use of aerators.
    - o Chlorination.

Weeds and Insects

- Weed Control
  - o Essential part of pond housekeeping.
    - ♦ Modern herbicides and soil sterilants make task easier.
  - o Edge weeds promote mosquito breeding and scum accumulation.
  - o Weed growth hinders pond circulation.

- Weed Control Methods
  - o Water depth greater than 3 feet.
  - o Remove first year growth by hand.
  - o Drown weeds by raising water level.
  - o Lower water level and cut or burn weeds.
  - o Use riprap along bank.
  - o Lime pond.
  - o Use herbicides as last resort.

- Insect Control
  - o Types of insects:
    - ♦ Mosquitoes.
    - ♦ Shrimp-like animals.
    - ♦ Chironomid midges.
  - o Control with pesticide applications.

What are the three types of waste treatment ponds? List them below.

Note: Ponds and Lagoons are discussed in further detail in Module 19.

Key Points

- Four biological secondary treatment processes include activated sludge, trickling filters, RBC's and Ponds and Lagoons.
- Trickling filters and rotating biological contactors (RBCs) are fixed-film processes
- Activated sludge is a suspended growth process
- Ponds and Lagoons are classified as aerobic, anaerobic and facultative.
- Facultative ponds and lagoons are the most common type in use due to the difficulty of maintaining completely aerobic or anaerobic conditions throughout the pond at all times.

References

[1] Larry Bristow, "Chapter 6: Trickling Filters." In *Operators of Wastewater Treatment Plants Volume I*, *(*Sacramento, CA: California State University, Sacramento Foundation, 1998), p.172.

[2]Richard Wick, Chapter 7: Rotating Biological Contactors. In *Operators of Wastewater Treatment Plants Volume I,* (Sacramento, CA: California State University, Sacramento Foundation, 1998) p.216.

[3]John Brady and Ross H. Gudgel, "Chapter 8: Activated Sludge." In *Operators of Wastewater Treatment Plants Volume I, (*Sacramento, CA: California State University, Sacramento Foundation, 1998), p.216.

[4]Brady, p.216.