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A review: waste water treatment

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Abstract: Génération of industriel waste water, is one of the burning issue with all of the chemical industries because it is required to discharge directly to the river because of which it is required to do the treatment of waste water and discharge it in given specification by pollution control board. Here in this paper the review of all treatments related to waste water is described in detail which is very important to all of the chemical industries.

Keywords: Waste water, chemical industry, primary treatment, secondary treatment, tertiary treatment.

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I. INTRODUCTION

The quality of water is vital concern for mankind since it is directly linked with human health. It is a matter of history that pollution of drinking water cause water born dieses which wipe out the entire population of cities. Polluted water is one of the issue with all of the chemical industries because it is discharge directly to the river and sea. So it is required to do the treatment of waste water which is generated in chemical industry and discharge it in specification given by pollution control board. One of the major aspects in the treated water is necessity of oxygen. The concentration of oxygen in water should be optimum. For this major oxygen demand is divided in to biological oxygen demand and chemical oxygen demand. For maintaining the oxygen content in water as well as some other nutrient and elements, the waste water treatment is required. Waste water treatment is divided in the three distinguished treatments. (1) Primary treatments (2) Secondary treatments (3). Tertiary treatments.

1. Primary treatment: These treatments make the effluent suitable for secondary and tertiary treatment. It mainly included removal of solid matters by sedimentation and floatation.
2. Secondary treatment: This treatment is concerned with biological treatments. This consisted with different biological processes where the microorganisms degrade ths sludge and water is cleared. Example: activated sludge, aerated lagoon, trickling filters and membrane separation.
3. Tertiary treatments: Biological treated water is subjected to tertiary physiological processes in specially designed sludge blanket clarifiers followed by removal of light metals, organic phosphate and chlorine ions. The method has mainly principal of chlorination, disinfection and ammonia- stripping etc.

II. PRIMARY TREATMENTS OF WASTE WATER

Waste water contains different types of organic and inorganic solids both in dissolve and suspended form depending on the sources. Physical chemical processes are used to remove specific dissolve matters in waste water, emulsified oils, precipitated toxic chemicals, suspended matters etc. These processes included sedimentation and floatation etc.

1. Clarification by sedimentation:

Clarification by sedimentation is process of gravitational settling. Clarification by sedimentation is consists of primary settling basins. Here with this process two products are formed. One is clarified water product and another is slurry. Two distinct form of vessels are generally used as a clarifier.

- Clarifier
- Thickeners

Clarifier is used as the name suggested, for the dilute suspension, to obtained water containing mineral and suspended solid. While thickeners are used to thicken the suspension which produce the underflow and clarified water at overflow.

1.1. Form of solid in waste water:

Total suspended solids are defined by Environmental Protection Agency (EPA) as those dry solids which are retained in the 0.45 micro. Meter. Filter from the total water sample in unit mg/lit or percentage dry solid in the weight. Dissolve solids are solids which are pass through this filter. TSS are additionally divided in two additional category settle able and non- settle able solids. Non-settle able solids are that solid which are not settled by gravitational force. Clarification process is remove only settle able solids while for removal of non-settle able solids chemical conditioning (means coagulant and flocculent) are used for removal of colloidal solid.

1.2. Types of settling

There are four classes of sedimentation processes take place on the bases of particle concentration and degree of particle interaction. All these classes are:

- Discrete particle settling
- Flocculent settling
- Hindered settling
- Compression settling

More than one class of settling can happens at any one time and it is common to have three occurring in the clarification of dilute solution. Table 1 shows the description of these classes:

Table: 1 Description and application of different classes of settling phenomenon.

Type of settling	Description	Application
Discrete particle settling Class I	Particles at low concentration and behave as a individual particle not interact with each other	Removal of grit, sand and inorganic particles such as slag in steel mill
Flocculants Class II	A dilute suspension of particles that coalesce or flocculate during sedimentation. The particles increase in size and mass by agglomeration, thereby increasing the settling rate.	Most solids are flocculent type in waste water including paper and pulp, food processing, municipal and biological treatment, chemically treated solids are shows class II type sedimentation.
Hindered settling Class III	Suspension of intermediate concentration in which force between particles are sufficient to hinder the settling of adjesunt particles. The particles adhere together and mass settle as a blanket, forming a discrete interface between the floc and supernatant. Settling rate are start to decrease.	Hindered is characterizes by biological solids and flocculated chemical suspension when the concentration exceeds the 500-1000 mg/L depending on the type of particles.
Compression settling Class IV	The particle concentration is reached at one stage where a structure is formed and further settling can happens because of only by the compression of that structure. The weight of the particles being constantly added to the top of the structure by sedimentation, which provide this compression. The settling process of this zone is very low.	It occurs in the lower layers of the deep sludge masses such as in the bottom of deep clarifiers and in the sludge thickening facilities.

1.3. Flocculants in sedimentation:

Chemical treatment can be used for the removal of suspended solids by flocculating the colloidal non settling solids to convert them in settling solids. Chemical used is depending on the effluent and chemical industry from which waste water is generated. The coagulant is either inorganic of iron or aluminum, polymers having various formulations or blends of inorganic and organic chemicals. Anionic and nonionic or cationic flocculants are used alone or with a coagulant. Chemical dosage is deciding how much clarity of liquid could be achieve. Flocculants are added outside or through feed well to the clarifier.

1.4. Types of sedimentation clarifiers:

There are five types of clarifiers :

- Circular clarifier
- Rectangular clarifier
- Plate and tube clarifier
- Drag saparator
- Oid/ water saparator

1.4.1. <u>Circular clarifier:</u>

Circular clarifier is shown in following figure:

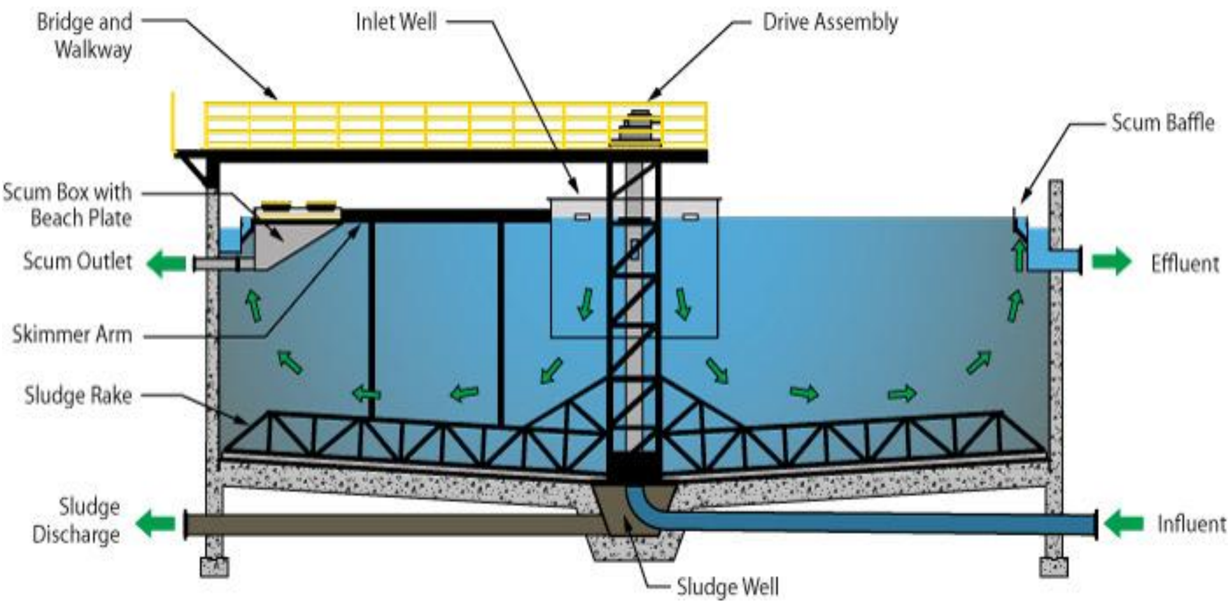

Figure 1 Central feed circular clarifier for primary treatment

Fig 1 shows the circular clarifier which is used commonly in primary treatment. This is generally in the range of 15 m in diameter. The centre feed clarifier is divided in the four section which have their own work.

Section I

This section is inlet zone, which provide required velocity to feed water by which settling is done.

Section II

This is a quiescent settling zone which should be in the required size which provide large space to settling. As well as it should large enough to meet the overflow rate.

Section III

This is a outlet zone which provide the transition from the low velocity of settling zone to higher outlet velocity. The treated water is topically discharge over V-notched weir plate which provides equal removal of water from 360 deg of the periphery of the circular clarifier.

Section IV

This zone is sludge zone. It must effectively collect the sludge without disturbing to the settling zone.

1.4.2. Peripheral feed circular clarifier

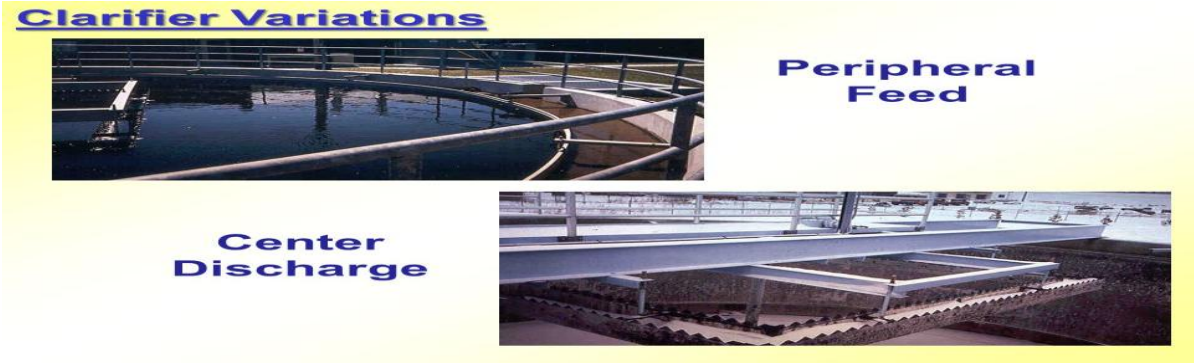

Figure 2 Peripheral feed and center discharge circular clarifier.

This type of clarifier is used to occupy all the volume of sedimentation vessel. The influent through width decreases from influent location to 180 deg away, and it has orifice at the floor space to distribute the flow equally around the tank periphery. Water enters at lower section and immediate sedimentation of large particle can be achieved. Velocity accelerated towards the centre and decrease as flow is reversed and redirected to the over flow weir. This type of clarifier is sensitive to temperature change and hydraulic load fluctuations since the flow pattern is entirely depend on inlet hydraulic.

1.4.3. Rectangular clarifier

The rectangular clarifier is like circular clarifier but it is rectangle and it has inlet at one end and outlet at another end. Flow through rectangular clarifiers enters at one end and passes through inlet baffles and travels through the length of tank to the effluent weir. Sludge is removed by dual purpose flight system. The settled solids move towards the sludge hopper which is located at the influent end of the basin. Flights on their return travel to the effluent end serve as a skimmer to remove floating materials. The rotating scum trough removes floating materials. Trough may be work manually or automatically to remove the floating materials.

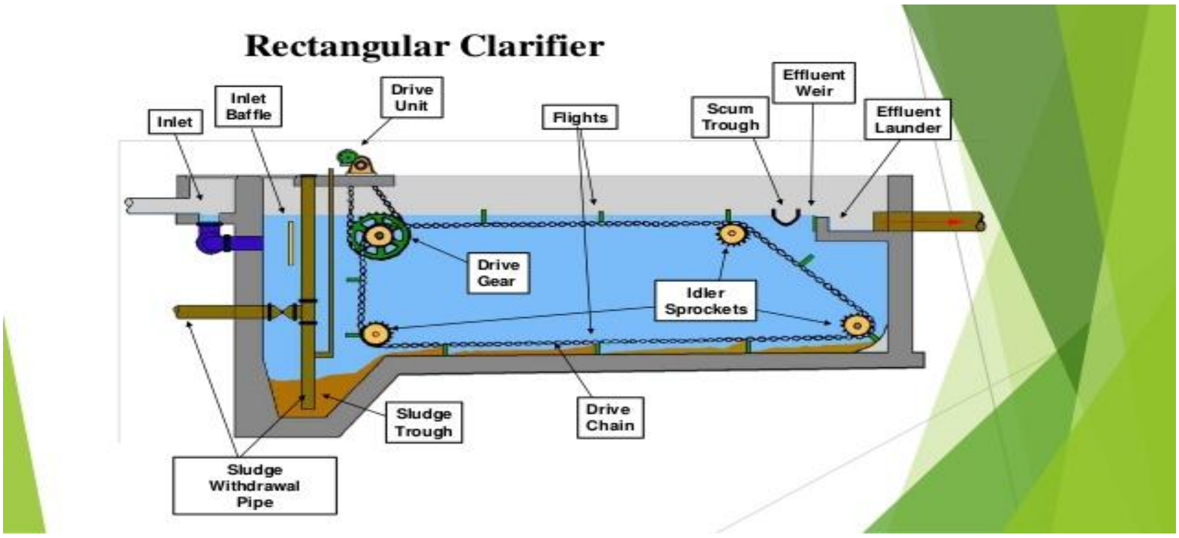

Figure 3 Rectangular clarifier

1.4.4. Traveling bridge clarifier

The single sludge scraper supported by a travelling bridge is used to move the sludge in wide rectangular basin. The bridge moves on rails mounted on the tank wall. The bridge may scrape the sludge first third of the basin, two or three times and then scrape the total basin length, then returning to the opposite side and resting for a period before starting the cycle again. The best traveling cycle time is depend on the type of waste water and characteristics of it.

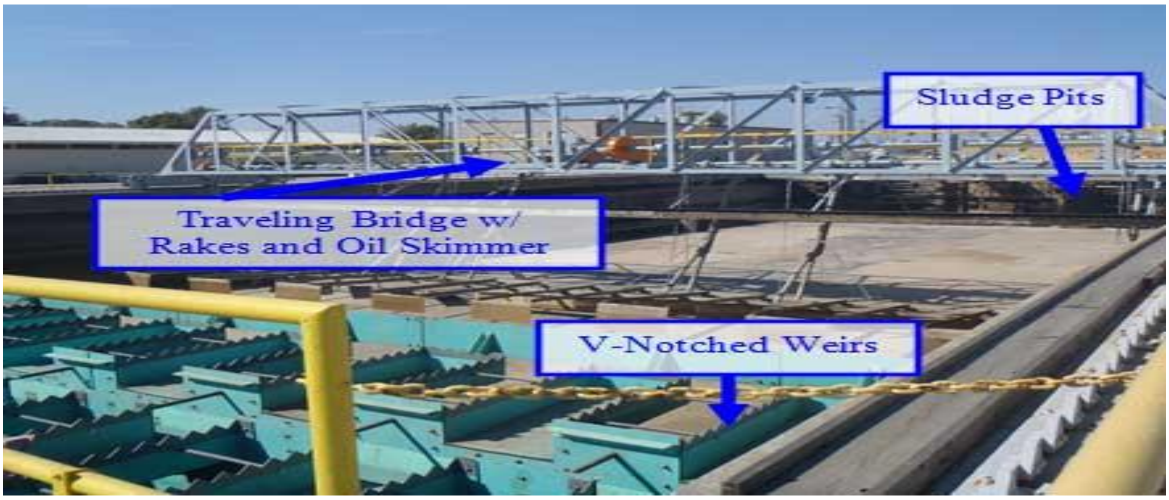

Figure 3 Travelling bridge clarifier

1.4.5. Plate and tube type clarifier

The feed is introduce through feed duct from the flocculation tank to clarifier feed box which is a bottomless section of the plate sections. The flow is then directed toward the individual sides of entry plates in downward direction. The feed is distributed across the width of the plate and flow upward under laminar flow condition. The solids settled on the plate surfaces and clarified water is exits on the top of the plates through orifice holes. The solid slide down the plate surfaces into the sludge hopper from which sludge is removed. Flocculation is induced as the solids roll down the inclined surfaces.

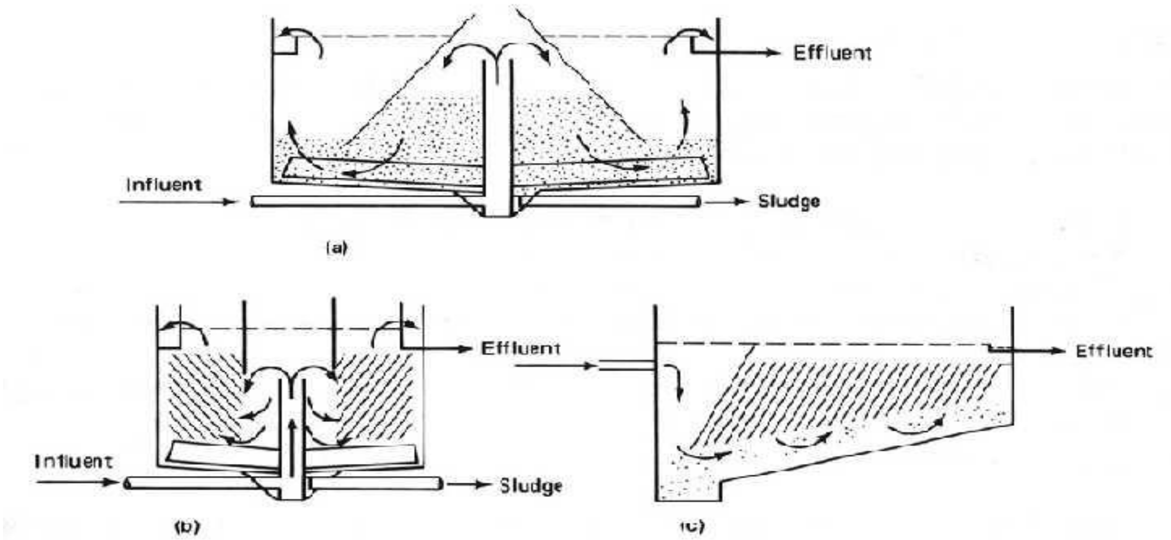

Figure 5 Plate and tube type clarifier

1.4.6. Actiflo clarifier:

Actiflo clarifier is use micro-sand for fast settling of flocs by adding the weight. The sand added as a coagulants and water is added to the settling chamber. Coagulation process is happens on the surface of sand. And when the size of particle increases the settling rate will also be increases. The clarifier has provided with some provision by which the micro-sand will be separated from flocs and reused. The clarifier section is provided with the inclined plates. This clarifier is used where the high flocs waster water is generated.

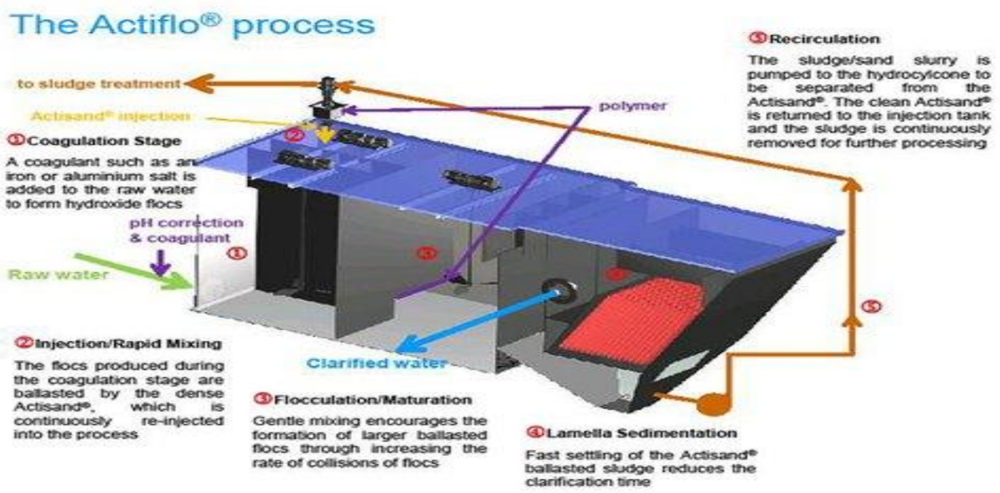

Figure 6 Actiflo clarifier

1.4.7 <u>API separator</u>

American petroleum Institute (API) separator is rectangular clarifier with chain and flight oil skimmer, designed in accordance with procedure and specification developed by API. The removal of oil globule is a function of the over flow rate in a ideal separator with no short circuiting or turbulence. Any oil globule with a rate of rise equal to or greater than the over flow rate is removed from the separator. Any globule having a rate of rise equal to or greater than the water depth divided by the retention time will reach the surface even though it is at the bottom of the basin. A manually rotatable slotted pipe skimmer is typically used for removal of oil. The drum skimmer pick up a thin film of oil as it rotate, which is scrape and drain in to a collection sump. The drum can be made of stainless steel or aluminum or plastic.

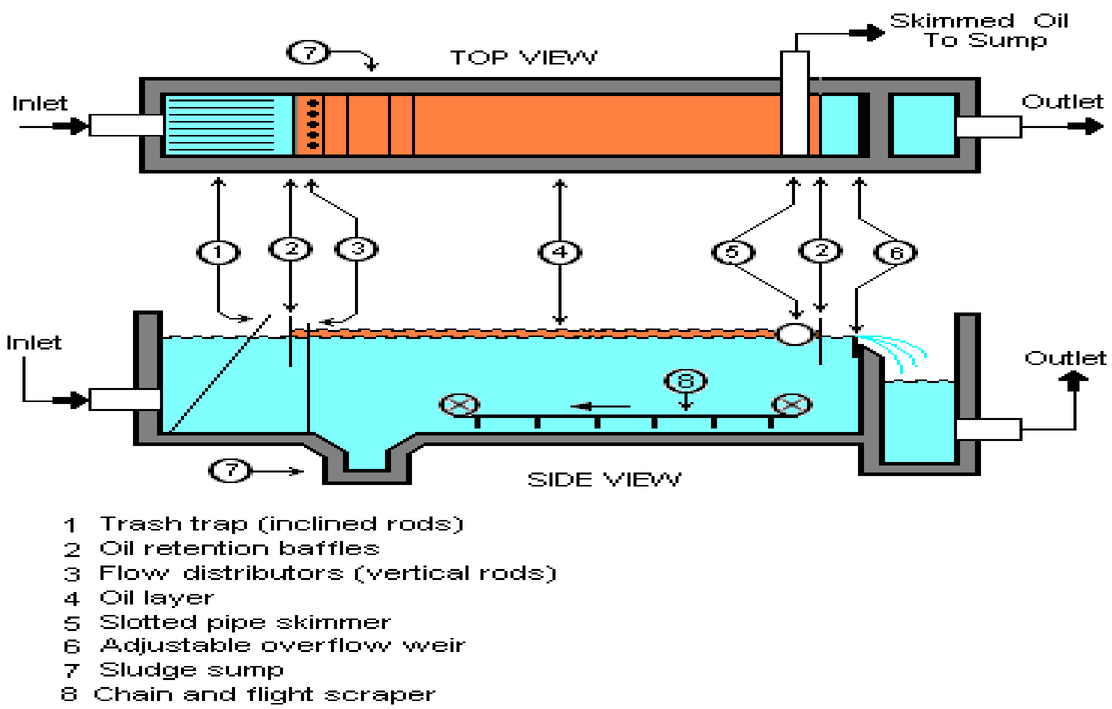

Figure 8 API separator

1.5. **Flotation clarification**

The dissolve air floatation (DAF) clarification process is used to separate suspended solids or liquor from water that are lighter than or only slightly higher than the water. This water includes fats, oil, greases, bio-solids, algae and matel hydroxides etc. DAF is therefore used in petroleum refinery, chemical industries, steel industries, paper and pulp industries etc. Oily waste may coat the solid particles and giving them to tendancy to float rather than settle. An API separator is used for these types of waste waters.

1.5.1. **Dissolve Air Floatation (DAF) system:**

A schematic diagram is shown in figure. Part of effluent is saturated with air at the elevated pressure in the air saturation tank and it is recycle to the influent. The back pressure valve at the indicated pressure release point in the floatation reduces the pressure on the recycle flow where it mixes with the influent. The influent is mixed with recycle flow. The excess dissolve air then come out of the solution, the small air bubbles attached to the particles in the waste water and rise to the surface of the waste water. The floated material is skimmed of the cell for further handling or recovery. The clarified water is discharge or reclaimed or receivers for further treatment which depending on the discharge requirement. The floatation unit is either rectangular or circular. Circular unit is more economical then rectangular unit.

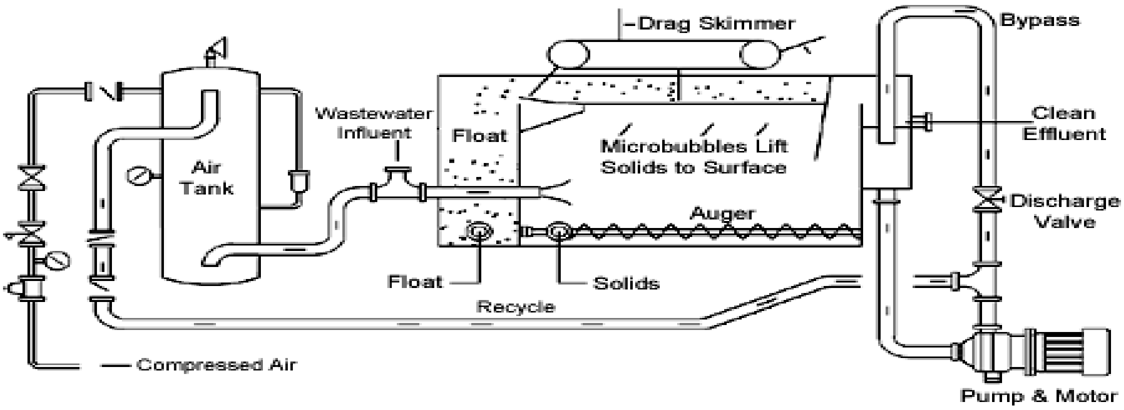

Figure 9 Dissolve air floatation system (DAF system)

III. SECONDARY TREATMENT OF WASTE WATER

The secondary waste water systems are biological streatment for the purpose of soluble pollutants of waste water which are remained in that after primary treatment. During secondary waste water treatment consideration must be given to the handling of sludge, where microbial organisms are at proper environmental condition, to perform a waste water contamination.

3.1 **Major purpose of this system:**

1. Biological oxidation of soluble organic matter that remains after primary treatment.
2. Adsorption of suspended solids carried over from primary treatment.
3. Biological removal of some of the nutrients like ammonia, nitrates and phosphates which are dissolved in waste water.

3.2. **Different secondary treatments:**

Type	**Common name**	**Use**
	Aerobic processes	
Suspended growth	Activated Sludge	
	Conventional (Plug flow) Continuous flow stired tank Step aeration Pure oxygen Modified aeration Contact stabilization Extended aeration Oxidation ditch	Carbonaceous BOD removal (nitrification)
	Suspended growth nitrification	Nitrification

	Aerated lagoon	Carbonaceous BOD removal
	Aerobic digestion	
	Conventional Air pure oxygen	Stabilization Carbonaceous BOD removal
	High rate aerobic algal pond	Carbonaceous BOD removal
Attached growth	Trickling filter	
	Low rate High rate	Carbonaceous BOD removal (nitrification)
	Roughing filter	Carbonaceous BOD removal
	Rotating Biological contactor	Carbonaceous BOD removal (nitrification)
	Packed bed reactor	Nitrification
Combined processes	Trickling filter, activated sludge Activated sludge, trickling filter	Carbonaceous BOD removal (nitrification)

Type	**Common name**	**Use**
	Anoxic processes	
Suspended growth	Denitrification	Denitrification
Attached growth	Denitrification	Denitrification
	Anaerobic processes	
Suspended growth	Anaerobic digestion	
	Standard rate single stage High rate single stage Two stage	Stabilization, Carbonaceous BOD Removal
	Anaerobic contact process	Carbonaceous BOD Removal
Attached growth	Anaerobic filter	Carbonaceous BOD Removal, Stabilization (denitrification)
	Anaerobic lagoon (Pond)	Carbonaceous BOD removal, stabilization
	Anerobic/Anoxic or Anaerobic processes	
Suspended growth	Single stage	Carbonaceous BOD removal nitrification, denitrification
Attached growth	Nitrification/denitrification	Nitrification/denitrification
Combined process	Facultative lagoon (Pond)	Carbonaceous BOD removal
	Mturation or tertiary pond	Carbonaceous BOD removal (nitrification)
	Anaerobic facultative lagoon	Carbonaceous BOD removal
	Anaerobic facultative aerobic lagoon	Carbonaceous BOD removal

3.3. Basic methods of secondary treatment:

3.3.1. Activated sludge process:

The activated sludge process is secondary biological treatment in which waste water is agitated with biological mass and aerated. The biological mass is separated from treated waste water in clarifier and return to aerated process to maintain a balance of biological solids and waste water being treated. Activated sludge process was developed in England in 1914, and was so named because it involves production of an activated mass of microorganisms capable of stabilizing organic content of waste in the presence of dissolve oxygen. Activated sludge process is biological contact process where bacteria, protozoa and small organisms like rotifer is generally found. All type of bacteria make up activated sludge. The predominant type is determined by the nature of organic substance in waste water, made of operation of the plant and environment conditions present for organism in process.

The biological treatments have certain parameters on which the process works. Figure 9 shows the different parameters

Biological treatment control parameters							
PH and Alkalinity	temperature	Oxygen requirement	Nutrient requirement	Solids Separation	Aeration capacity	Mixing energy	Solids Retention time

Figure 9 The biological treatment control parameters.

3.3.2. <u>Process</u>

The conventional activated sludge process consists of an aeration tank, secondary clarifier, method of returning sludge to the aeration tank and means of wasting excess sludge from system. Sludge wasting is accomplished from the recycle or mixed liquor line. Both inflow settled waste water and recycled sludge are settled the tank at the head end and are aerated for the period of 4 to 12 hr. Influent waste water and recycled sludge are mixed by action of diffused or mechanical aeration. During this period absorption, flocculation and oxidation of organic matter occurs. Mixed liquor is settled in the activated sludge clarifier/ thickner and sludge is returned at the rate of approximately 25 to 100% of the influent flow rate.

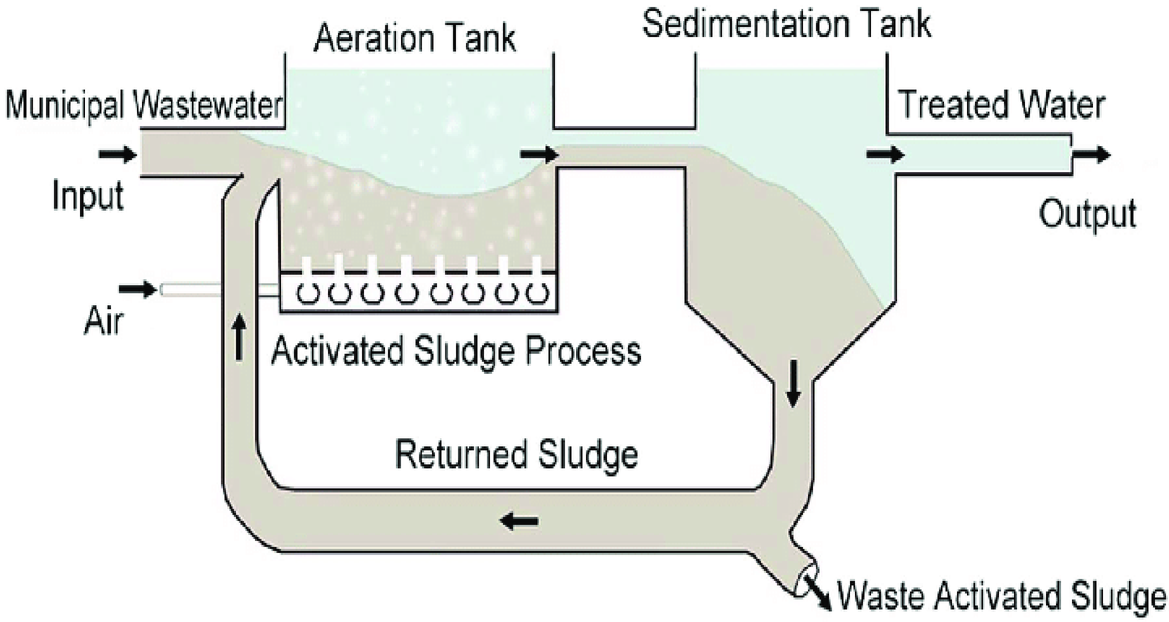

Figure 9 Activated sludge system

Important microorganisms:
Microorganisms consisted important in biological treatment are:

1. Bacteria
2. Fungi
3. Algae
4. Protozoa
5. Rotifer
6. Worms

Bacteria growth:
The growth pattern based on the number of cell has four distinct phases:

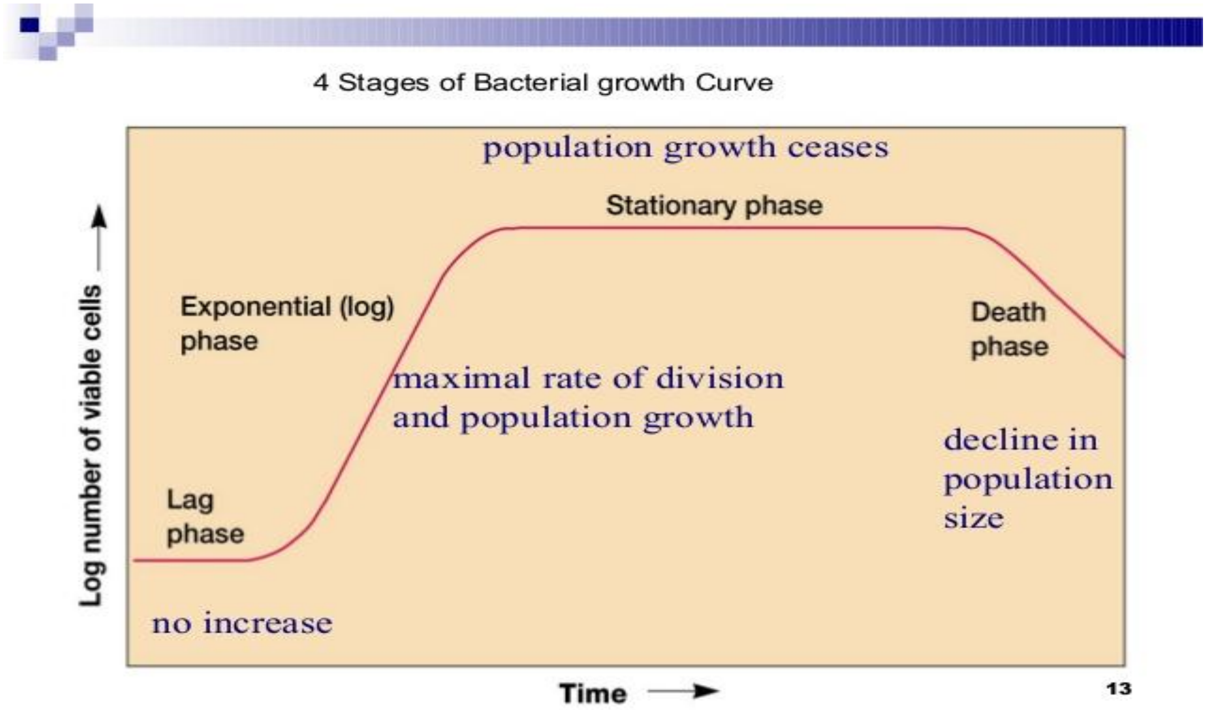

Figure 10 Bacteria growth pattern based on number of cell.

3.3.3 Aerated lagoon

Aerated lagoon is a basin in which wastewater is treated on a flow through basin. The oxygen is usually supplied by surface aerators or submersed aeration devices. In aerated lagoon all solids are in the form of suspension. Aerated lagoons are operated as flow through activated sludge system without recyle, usually followed by large settling pond.

Lagoons are out of favour for new construction because of following reasons:

- Odour from algae blooms.
- Ground water contamination.
- Large land area requirements.

BOD removal

Aerated lagoon that are properly designed, operated and maintained, can produce effluent that is low in solids and with the effluent BOD of less than 30 mg/l. Solid concentration in effluent are variable (20 to 100 mg/l) and are affected by secondary changes.

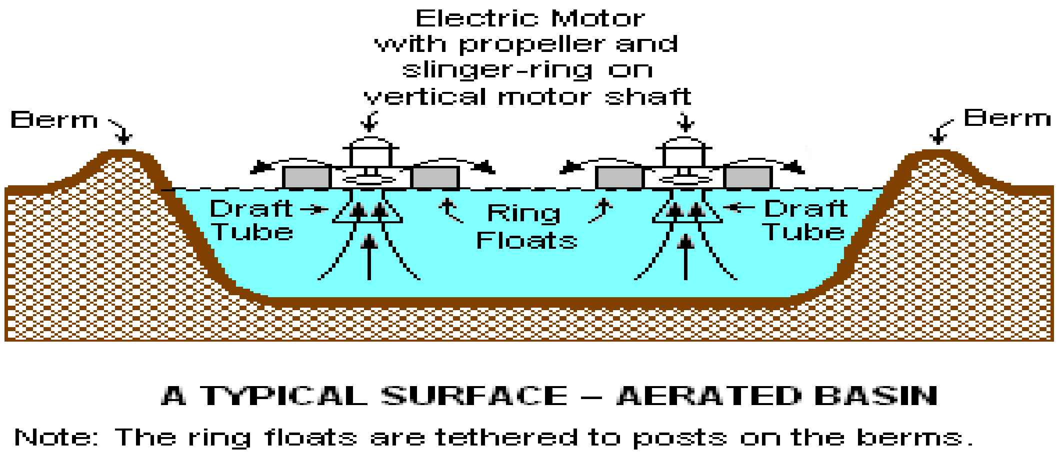

Figure 13 Aerated lagoon

3.3.4 Stabilization ponds

A stabilization pond (also called an oxidation pond) is relatively shallow body of water contained in an earthen basin of control shape designed for waste water. Stabilization ponds are used for industrial as well as mixture of industrial and domestic waste water. Installation is new surviving such industries as oil refinery, dairies, poultry processing plants.

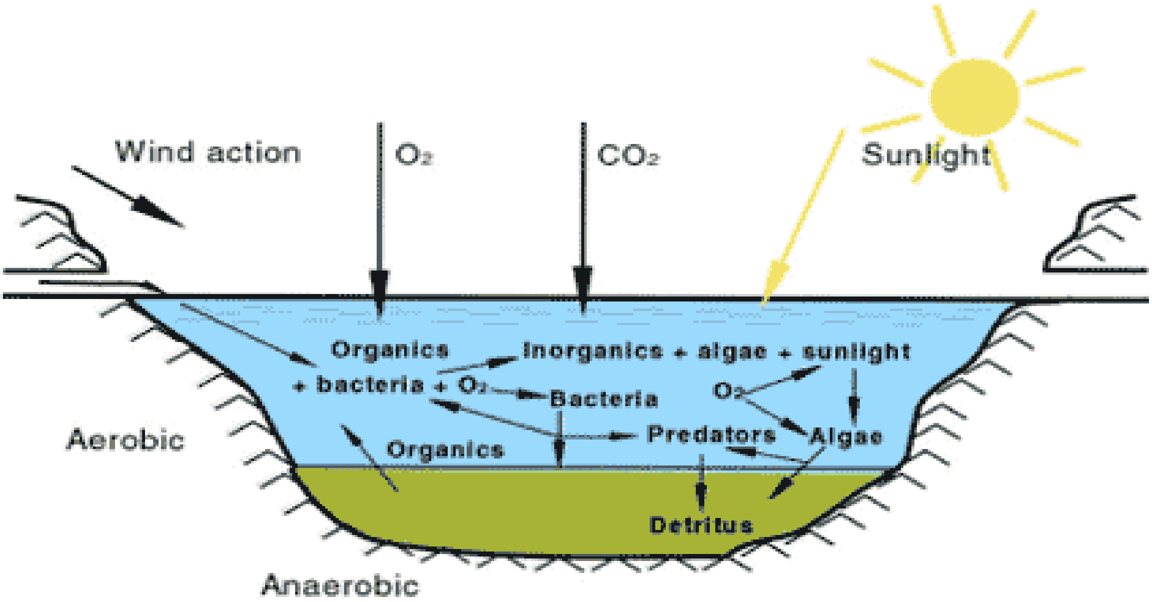

Figure 11 Stabilization pond.

Table 1 Types of stabilized ponds.

Type of pond or pond system	Common name	Identifying Characteristics	Application
Aerobic (0.5-2 ft) (0.2-0.6m)	High rate aerobic pond		Nutrient removal, treatment of soluble organic wastes, conversion of wastes
Aerobic (2-5 ft) (0.6-1.5m)	Low rate aerobic pond	Designed to maintain aerobic conditions throughout the liquid depth.	Treatment of soluble organic wastes and secondary effluents.
	Maturation or Tertiary pond	Similar to low rate aerobic ponds but very lightly loaded.	Use for polishing (upgrading) effluents from conventional secondary treatment processes, such as trickling filter or activated sludge.
Aerobic Anaerobic	Facultative pond	Deeper than a high rate pond. Photosynthesis and surface reaeration provide oxygen for aerobic stabilization in upper layers. Lower layer is facultative. Bottom layer of solids undergoes anaerobic digestion.	Treatment of primery or secondary settled wastewater and industrial wastes. Secondary waste polishing.
Aerobic Anaerrobic	Facultative pond with mechanical surface aeration	As above but small mechanical aerators are use to provide oxygen for aerobic stabilization.	Treatment of primery or secondary settled waste water and industrial wastes. Secondary waste polishing

3.3.5 Trickle filters

The trickling filter process is a fixed film biological process that used slag, rock, stones, plastic or wood as medium on which microorganism grow. Waste water is typically applied as a spray from moving liquid distributors. As waste water is trickles through the bad, microorganisms grow on the surface of the packing in a fixed film. Wastewater passes over and through the medium to provide needed contact between microorganism and organics. Biological growth is slow down when inner biological area is not receiving the oxygen. The clarifier is used after trickling filter to remove this biological material before discharging. Sometimes effluent from the clarifier is recycle back to the trickling filter to increase BOD removal efficiency and maintain the hydraulic load on the filter. Figure shows trickling filter and its important components.

Figure 12 Trickling filter

3.3.5 Sludge reduction process

Biological waste water treatment is always result in considerable amount of excess sludge that has to be wasted. In general 0.5 to 0.6 kg of dry sludge is produced when 1 kg BOD is treated. Sludge reduction is achieved by inserting sludge digestion devises in biological waste water treatment as shown in fig.

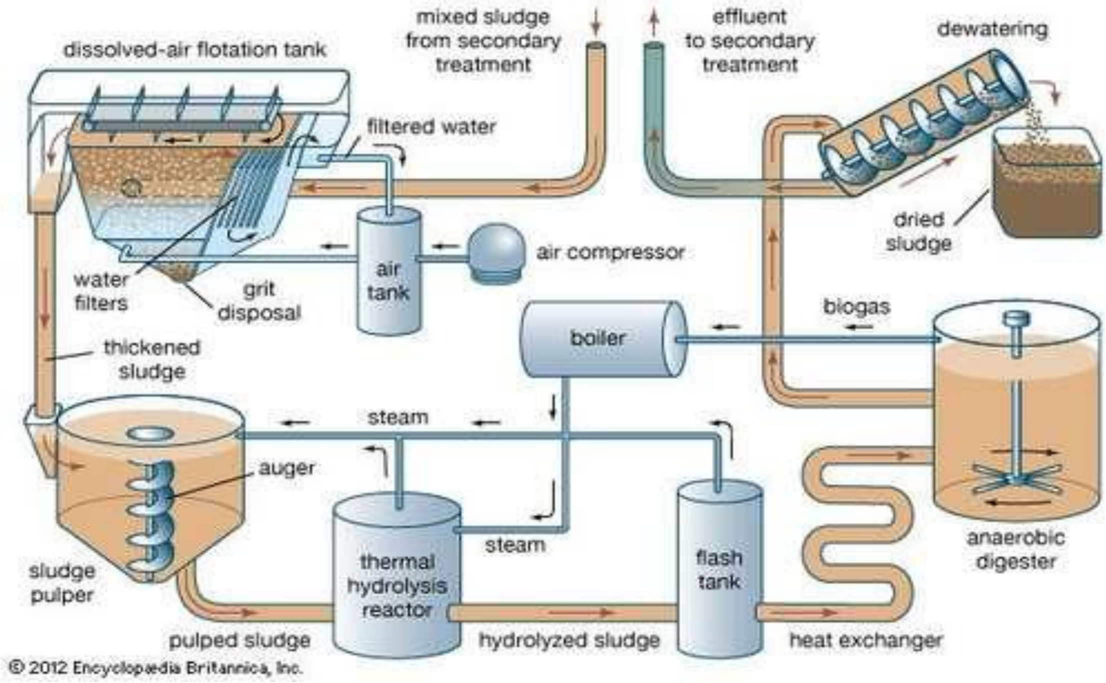

Figure 13 Sludge digestion devises.

In this process, some part of return sludge is thickened in a clarifier is sent to the sludge digester to solubilize the sludge. Solubilize sludge that contains soluble BOD and cell debris that sent back to bio reactors, where microorganisms are consume BOD and cell debris since about 60% of carbon contains in disintegrated sludge is converted to new microorganisms while about 40% turns to carbon dioxide, net sludge reduction can readily achieved.

3.3.6 <u>Anaerobic digestion</u>

Anaerobic digestion is one of the oldest processes used for stabilization and reduction of domestic primery and biological sludge. In the process, organic material in sludge is converted biologically to a variety of end products like methane and carbon dioxide under anaerobic condition. The process is carried out in air tight reactor with sludge removed and introduce at intermittent basis.

The anaerobic treatment process involves decomposition of organics in waste water to methane and carbon dioxide in absence of oxygen. The conversion of organics in methane and carbon dioxide required little energy so that the quantity of cell growth is slow and quantity of organic removal is low. This process is used for removal of high quantity of organics of waste water about 75% to 95 % removal can be achieved by this process which depend on design and application. Table illustrate the BOD/COD characteristics from anaerobic treatment of various waste waters.

Table 3 BOD/COD in anaerobic treatment effluent.

Waste water sourse	BOD mg/L	COD mg/L
Sugar	50-500	250-1500
Dairy	150-500	250-1200
Miaze Starch	-	500-1500
Potato	200-300	250-1500
Vegetable	100	700
Wine	3500	-
Pulp	350-900	1400-8000
Fiber board	2500-5500	8800-14900
Paper mill	100-200	280-300
Landfill leachate	-	500-4000
Brewery	-	200-350
Distillery	-	320-400

3.3.7 <u>Process</u>

1. Four group of micro organisms sequentially degrade organic matter into anaerobic fermentation. Microorganisms degrade polymer type of material to monomer. No COD removal is observed.
2. Monomer is then converted into fatty acids by acid forming bacteria with H_2.

All acids higher than acitic acid are converted to acetic and H_2 by acetogenic microorganisms. The conversion of propionic acid is:

$$C_3H_6O_2 + H_2O \longrightarrow C_2H_4O_2 + CO_2 + 3H_2$$

3. Acitic acid and H_2 are converted to methane by methanogenic organisms

$$C_2H_4O_2 \longrightarrow CO_2 + CH_4$$

$$CH3COO^- + H_2O \longrightarrow CH_4 + HCO_3^-$$

Hydrogen:

$$HCO_3^- + 4H_2 \longrightarrow CH_4 + OH^- + H_2O$$

3.3.8. <u>Membrane Bioreactor:</u>

In this system ultrafiltration (UF) or microfilteration (MF) membrane replace sedimentation basins for separation of biomass from water.

MBR process

Since solid liquid separation is performed by a membrane, lower effluent TDS can be achieved compared to a conventional settling basin. Membrane is serves as a separation device for solid liquid separation instead of clarifier or dissolve air floatation unit. Membrane are used in a submersed configuration and operated under vacuum or they are used external to the aeration basin. In a submerged MBR a suction pump is used to pull the clean water, through the membrane, while excluding passage of particles.

In a external MBR, a re-circulating pump is used to deliver a mixed liquor under pressure to membranes and then back to the aeration basin.

The membrane surface continuous is continuous to be sourced by water and air, and solid debris is loosed and removed. Membranes are configurated of polymeric or ceramic material. The most majority of membrane system are made from polymeric materials such as polyvenylidine diflouride, polyethelyne and chlorinated polyethelyne. Membranes are generally hollow fiber or flat sheet.

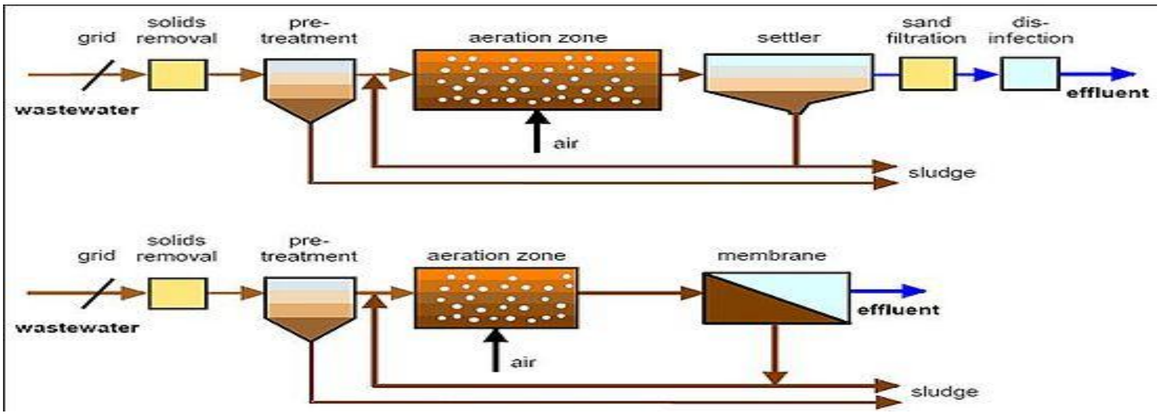

Fig 12 Membrane bioreactor process

IV. TERTIARY WASTE WATER TREATMENT

The main objective of tertiary waste water treatment is to remove ammonia, phosphate and suspended solids, and purification of secondary waste water treated water to sufficient level to discharge it in

environment. Secondary waste water treatment is removes about 90% of biological oxygen demand (BOD), suspended solids and pollutants. Sometimes additional removal of ammonia, phosphorous and organics are required to meet discharge permit. Thus tertiary treatment processes are specifically designed to follow a secondary waste treatment system and ensure reduction of ammonia and phosphate and other pollutants to meet permit requirement and ensure protection of environment. Specific operation and processes applicable to tertiary treatments can be classified in the table given bellow.

Table 4 Classification of tertiary waste water treatments

Sr. No	Tertiary waste water treatments
1.	Disinfection
2.	Dechlorination
3.	Ammonia reduction
4.	Phosphate reduction
5.	Organic removal

4.1 <u>Chlorination: (Disinaction)</u>

In biological treatment process, chlorination is probably a most widely used unit operation encountered involving the chemical addition. Effluent from a treatment plant flows in to a mixing tank and contact with chlorine solution or gas. Chlorine react with water as two step reactions.

1. Hydrolysis

$$Cl_2 + H_2O \longrightarrow HCl + HOCl$$

2. Dissociation

$$HOCl \longrightarrow H^+ + OCl^-$$

Generation of hydrogen ion [H^+] can lower the PH of water with gaseous chlorine when water alkalinity is too low to buffer with acidity created. In case were removal of ammonia is intended (break point chlorination), the dosage of gaseous chlorine is usually high enough to require some form of caustic addition.

4.2 <u>Dechlorination</u>

Dechlorination of chlorinated water is sometimes required to protect aquatic biota in receiving streams. Dechlorination is very fast process and accomplished by using:

- Activated carbon
- Sodium metabisulfite
- Sodium thiosulphate
- Sulfur dioxide

- Sodium sulphite

Sulphite is most common dechlorination agent used for reducing the chlorine of waste water effluent. The reducing agent is also work for destroying other oxidizers like peroxide. Disinfaction by product is formed from the reaction of and oxidant such as chlorine with organic maters in water. Several chlorinated organic have been identified because of chlorinating water: Chloroform and trihelomethane.

4.3 <u>Ammonia reduction:</u>

During the conventional secondary treatment all most all of the nitrogen is converted in to Ammonia. Although ammonia has little toxicity to human it has to be removed from water because of following features:

- Ammonia can be toxic to fish life
- Ammonia consumes dissolve oxygen in receiving water.
- Ammonia increase the amount of chlorine required for disinfection.

Ammonia nitrogen level can be reduced by biological or physical-chemical processes. The physical-chemical processes is further divided in selective ion exchange, ammonia stripping and breakpoint chlorination.

4.3.1 <u>Ammonia stripping</u>

Alkaline waste water can be pump to the top of cooling tower and distributed over the fill. Air is drawn through media to extract ammonia from water. During warm weather, air stripping can achieve 95% of ammonia removal at PH 11.5 by using 400 ft^3 of air per gallon of waste water. Scale formation if serious problem observed in ammonia stripping towers. If soft scale formation is anticipated then, a water spray system can be installed to remove the soft scale accumulated.

4.3.2 <u>Selective ion exchange</u>

In this process, ammonia ions in solution are exchange for calcium or sodium ions displaced from an insoluble exchange material. It removes 95% to 97% of ammonia. The process operation is resembles that a water softener, except that material to be removed is ammonium ion rather than water hardness**.**

4.3.3 <u>Breakpoint chlorination</u>

In this process chlorine is added to waste water to satisfy the chlorine demand, so that further addition of chlorine results in directly proportional chlorine residual. Breakpoint chlorination is used to do the ammonia removal because chlorine, when added to waste water containing ammonia, reacts to form compounds that are oxidized to nitrogen gas. Overall reaction is as bellow:

$$3Cl_2 + 2NH_3 \longrightarrow N_2 + 6HCl$$

Reducing organics and solids in waste water reduces the amount of chlorine needed to reach breakpoint. The breakpoint process can result in overall 99% removal of ammonia, reducing the concentration to less than 0.1 mg/L as N. Breakpoint process is expensive process so that biologically treatment process is used.

4.3.4 <u>Phosphate removal</u>

Phosphate is required in secondary waste water treatment plants to maintain healthy biomass for efficient BOD reduction. Partially treatment for phosphate removal involves precipitation of orthophosphate with metallic ions like aluminum, iron and calcium polyphosphate and organic phosphate do not readily react with metallic ions and are removed only after conversion to orthophosphate by biological treatment and hydrolysis followed by chemical precipitation.

4.3.5 <u>Iron treatment</u>

Both Ferrous (Fe^{+2}) and Ferric (Fe^{+3}) ions can be used in precipitation of orthophosphate. Common sources are $FeCl_3$, $FeCl_2$, $Fe(SO_4)_3$, $FeSO_4$ and pickle liquor. Ferric is typical most effective in removing orthophosphate when PH range from 4.5 to 6, while ferrous is effective in range of 7-10. Iron precipitates phosphate as follow:

$$Fe^{+3} + PO_4^{-3} \longrightarrow FePO_4$$

$$3Fe^{+2} + 2PO_4^{-3} \longrightarrow Fe_3(PO_4)_2$$

4.3.6 Organic removal

The principal uses of activated carbon as a tertiary treatment process are removal of objectionable organics and removal of residual chlorine. Both granular activated carbon and powdered activated carbon can be used. Activated carbon removes the organics which are not removed during conventional secondary treatment. These refractory organics can be herbicides, lignins, tannins, ether or other such compounds.

One approach is to use granular activated carbon in tertiary treatment sequence following primery and secondary biological treatment. This involves treating secondary effluent by contacting with granular activated carbon in fixed beds. Adsorption of residual organics and further BOD and COD removal take place.

The second approach is to utilize powdered activated carbon which is added directly to secondary treatment unit. It absorbs toxic substances and concentrates feeding sites for bacteria thus retention time is increases there by effectively reducing treatment costs. The dewatered powdered activated carbon and biomass mixture is disposed of by land filling or incineration.

V. CONCLUSION

Proper water treatment can reduce the demand of nature resources, deliver improvements to system efficiency and improve the company's financial performance, while providing many environmental benefits:

- Cleaner water to use and air to breath
- Reducing fuel use
- Improved the water recycling
- More fresh water
- Reduction in solid waste and liquid emission
- Sustainable development of site operation

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