UNIT-1

1. Explain the various water quantity and quality requirements for the food processing industry?

Water is an essential resource in the food processing industry, playing a crucial role in various stages of production. The quantity and quality of water required in food processing depend on several factors, including the specific industry sector, the nature of the food product, and regulatory standards. Here are the key considerations for water quantity and quality in the food processing industry:

Water Quantity:

1. Process Water: Process water refers to water used directly in food production processes, such as washing, rinsing, cooking, and cooling. The quantity of process water needed depends on the production volume, equipment, and specific operations involved.

2. Cleaning and Sanitation: Water is essential for cleaning and sanitizing equipment, utensils, and production areas. Sufficient water supply is necessary to ensure proper cleaning and maintain hygienic conditions in the facility.

3. Steam Generation: Many food processing operations require steam for heating, cooking, and sterilization. Water quantity requirements include both the direct use of water for steam generation and the subsequent condensate that may be recycled.

4. Cooling Systems: Water is often used for cooling purposes in food processing, such as in refrigeration units or as a coolant for heat-generating equipment. The quantity of water needed depends on the specific cooling requirements of the equipment and processes involved.

Water Quality:

1. Potable Water: The food processing industry typically requires potable or drinking water for various applications, including direct product contact, formulation, and personnel consumption. Potable water should meet specific quality standards to ensure it is safe and free from contaminants that could affect product quality or pose health risks.

2. Microbial Standards: To prevent microbial contamination and ensure food safety, water used in food processing should meet microbiological quality standards. These standards may include limits for total coliforms, Escherichia coli (E. coli), and other indicator organisms.

3. Chemical Contaminants: Water quality standards also address chemical contaminants that may be present in the water supply or result from the food production processes. Common chemical parameters of concern include heavy metals, pesticides, residual cleaning agents, and organic compounds.

4. Food Additives: Some food processing operations may require the addition of chemicals or additives to water for specific purposes, such as pH adjustment or disinfection. In such cases, the quality of the water used and the suitability of additives must be carefully considered to ensure compliance with regulatory standards and prevent any adverse effects on food quality or safety.

2. Explain the various water quantity and quality requirements for the textile industry?

Water plays a significant role in the textile industry, where it is used for various processes, such as fiber production, dyeing, printing, finishing, and fabric washing. Both water quantity and quality are critical considerations in the textile industry due to environmental concerns, water scarcity, and regulatory requirements. Here are the key factors to consider regarding water quantity and quality in the textile industry:

Water Quantity:

1. Fiber Production: Water is used in the production of natural fibers like cotton and wool. It is required for cleaning, scouring, and rinsing processes during fiber preparation.

2. Wet Processing: Wet processing operations, such as dyeing, printing, and finishing, require substantial amounts of water. The quantity of water needed depends on factors like the fabric type, dyeing method, color intensity, and desired process efficiency.

3. Washing and Rinsing: After various textile treatments, washing and rinsing processes remove excess chemicals, dyes, and finishing agents. These processes require an adequate water supply to achieve thorough cleaning and ensure the quality of the final product.

4. Cooling Systems: Textile machinery often requires water for cooling purposes. This includes cooling water for dyeing machines, heat exchangers, and other equipment involved in the textile manufacturing processes.

Water Quality:

1. Impurities and Contaminants: Water used in the textile industry must meet specific quality standards to prevent the presence of impurities and contaminants that could adversely affect the textile production processes or the quality of the final products. Common impurities include suspended solids, organic matter, dissolved salts, and microbiological contaminants.

2. pH and Hardness: The pH level and hardness of water can influence dyeing and finishing processes. Textile manufacturers often adjust the pH and hardness of water to optimize the dye uptake and ensure consistent color fastness and fabric properties.

3. Chemical Composition: The presence of certain chemicals in water can impact textile processes. For instance, high levels of iron, copper, or chlorine in the water supply may interfere with dyeing processes and cause color variations or fabric damage. It is important to monitor and control the chemical composition of water used in textile operations.

4. Wastewater Treatment: Given the potential for water pollution from textile processing, it is crucial for the industry to implement appropriate wastewater treatment measures. This ensures that the discharged effluents meet local environmental regulations, minimizing the environmental impact of textile manufacturing activities.

3. Explain the various water quantity and quality requirements for the power plants?

Power Plant Water Treatment:

In energy production water is used for producing steam, heat and electricity. It is integral part of technological process. Water quality affects lifetime and performance of equipment used in technological processes

Turbidity

Turbidity is the cloudiness or haziness of a fluid caused by large numbers of individual particles that are generally invisible to the naked eye, similar to smoke in air. The measurement of turbidity is a key test of water quality

Clarifier

A clarifier is a settling tank used to remove solid waste particles from water. When the clarifier separates the concentrated impurities, the sludge formed by the process discharges from the bottom of the tank.

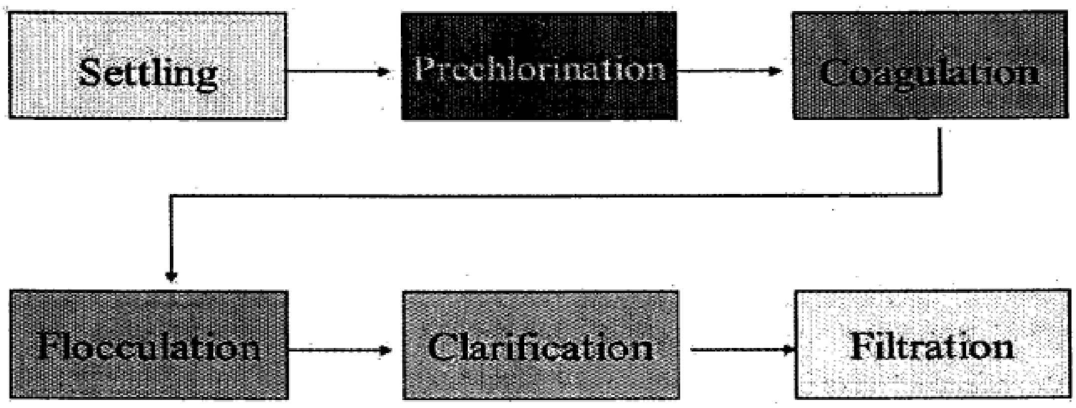
Thickener

An apparatus for the sedimentation of solids from suspension in a liquid.

Decanter Centrifuge

A centrifuge is a device, which employs a high rotational speed to separate components of different densities. A decanter centrifuge separates solid materials from liquids in slurry and therefore plays an important role in wastewater treatment.

Operations involved in removal of un-dissolved Impurities

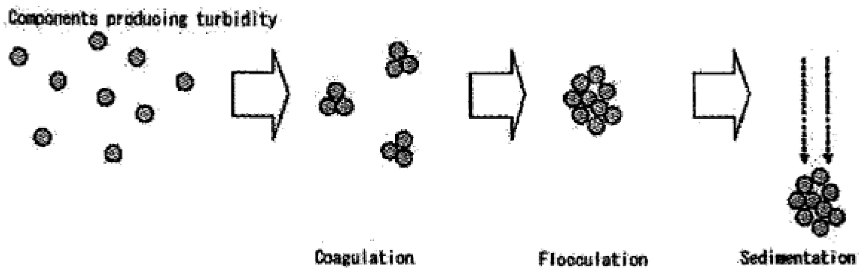


Coagulation

Coagulation is a process to neutralize charges and then to form a gelatinous mass to trap particles thus forming a mass large enough to settle or be trapped in the filter.

Flocculation

Flocculation is gentle stirring or agitation to encourage the particles thus formed to agglomerate into masses large enough to settle or be filtered from solution.



4. Explain the various water quantity and quality requirements for the fertilizers?

The production of fertilizers, which are essential for enhancing agricultural productivity, requires water for various processes. The water quantity and quality requirements in the fertilizer industry depend on the specific fertilizer production methods and the types of fertilizers being manufactured. Here are the key considerations for water quantity and quality in the fertilizer industry:

Water Quantity:

1. Feedstock Preparation: Water is required for preparing the raw materials used in fertilizer production, such as phosphate rock or natural gas. This includes processes like washing, grinding, and beneficiation of raw materials, which may require significant amounts of water depending on the production scale and technology used.

2. Reaction and Synthesis: Water is often used as a medium for chemical reactions and synthesis processes in fertilizer production. For example, in the production of ammonium-based fertilizers like ammonium nitrate or urea, water is a crucial component in the synthesis reactions.

3. Cooling and Condensation: Some fertilizer production processes generate heat and require cooling. Water is used for cooling purposes, such as in condensers or heat exchangers, to maintain optimal operating temperatures and prevent equipment damage.

4. Dust Suppression and Equipment Cleaning: Water may be required for dust suppression during handling, storage, and transportation of fertilizers. Additionally, water is used for equipment cleaning to maintain cleanliness and prevent contamination.

Water Quality:

1. Chemical Impurities: Water used in fertilizer production must be free from chemical impurities that can interfere with the chemical reactions or affect the quality of the final product. Impurities such as heavy metals, organic compounds, and contaminants from water sources should be minimized to ensure the desired fertilizer quality.

2. Microbial Contaminants: Microbial control is crucial in fertilizer production to prevent the growth of bacteria or other microorganisms that may adversely affect product quality or safety. Water used in fertilizer production should meet microbiological quality standards to avoid contamination.

3. pH and Salinity: The pH level and salinity of water can affect the solubility and reaction rates during fertilizer production. Water with appropriate pH and low salinity levels is preferred to ensure optimal conditions for chemical reactions and avoid undesirable effects on fertilizer properties.

4. Water Treatment Residues: If water used in fertilizer production undergoes treatment processes like filtration, ion exchange, or reverse osmosis, the residues or byproducts of those treatments should be properly managed to prevent any negative impact on the environment or the quality of the final product.

5. Explain the types of water used in industry.

In industrial settings, various types of water are used for different purposes based on their quality and specific requirements. Here are the common types of water used in industry:

1. Potable Water: Potable water, also known as drinking water, is typically sourced from municipal supplies or wells and meets the drinking water standards set by regulatory authorities. It is used in industries for activities like employee consumption, food and beverage production, and sanitary purposes.

2. Process Water: Process water refers to water used directly in industrial processes, excluding utility functions like heating and cooling. It can come from various sources, such as groundwater, surface water, or recycled water. Process water is used in manufacturing, cleaning, rinsing, dilution, and other production-related activities. Its quality requirements depend on the specific process and application.

3. Cooling Water: Cooling water is used in industrial cooling systems, such as cooling towers or heat exchangers, to remove excess heat generated by machinery or processes. It helps maintain optimal operating temperatures and prevents equipment overheating. Cooling water can be sourced from freshwater supplies or treated wastewater, and its quality requirements focus on preventing scaling, fouling, and corrosion.

4. Boiler Feedwater: Boiler feedwater is high-quality water used in steam generation systems, such as boilers or steam turbines. It requires stringent quality control to prevent scaling, corrosion, and damage to the boiler components. Feedwater is typically demineralized or deionized through processes like reverse osmosis or ion exchange to remove impurities.

5. Wastewater: Wastewater refers to water that has been used in industrial processes and contains varying levels of impurities or contaminants. It includes process effluents, cooling tower blowdown, boiler blowdown, and other wastewater streams. Wastewater must be treated to meet environmental regulations before discharge or undergo further treatment for reuse purposes.

6. Recycled or Reclaimed Water: Recycled or reclaimed water is treated wastewater that has undergone various treatment processes to meet specific quality standards. It can be used in industrial applications that do not require potable water quality, such as irrigation, process water supplementation, or cooling tower makeup.

7. Deionized Water: Deionized water, also known as demineralized water, undergoes an extensive purification process to remove dissolved minerals, salts, and ions. It is used in industries that require ultrapure water, such as electronics manufacturing, laboratory processes, or certain pharmaceutical applications.

8. Ultrapure Water: Ultrapure water is water that has been further treated to achieve an extremely high level of purity, often through advanced purification technologies like ultraviolet (UV) irradiation,

microfiltration, or distillation. It is used in industries with stringent quality requirements, such as semiconductor manufacturing, pharmaceutical production, or precision cleaning.

Each type of water used in industry has specific quality characteristics and applications. The selection of water type depends on the industry sector, the specific processes involved, regulatory requirements, and the desired quality standards for the intended application.

UNIT-2

1. Discuss the use of Municipal waste water in industries

Use of Muncipal waste water in Industries:-

- Muncipal waste water Reuse has been increasing particularly in countries where shortage of water Resources is severe.
- A sucessful reuse application of waste water depends on many factors of which quality and quantity very useful.
- The presence of Heavy metals, pollutants and other Toxic organics can effect health without treatment.
- For direct and Indirect distribution systems, the muncipal waste water used in Industries is 7-8%.

2. Explain the following advanced water treatment methods with neat sketch

i) Adsorption, ii) Reverse Osmosis iii) Ion Exchange iv) Ultra filtration

Defination :- Adsorption is a natural process by which molecules of a dissolved substance collect on and adhere to the surface of an Adsorbent solid.

- The Adsorbent is the solid material on which the adsorbate accumulates
- The Adsorbate is the dissolved substance that is being removed from Liquid phase to the solid surface of the adsorbent.
- Adsorption may occur at the outer surface of the adsorbent and in the Macropores, Mesopores and micropores in the inner cracks of the adsorbent.

Macropores > 25 nm
Meso pores > 1 nm and < 25 nm
Micro pores < 1 nm

($1 nm = 10^{-6} mm$)

- Forces affecting adsorption :-
  The principal forces leading to sticking the adsorbate to the surface of the adsorbent solid are : (i) Vander Waals forces
  (ii) Hydrogen bonding
  (iii) Dipole - dipole Interactions.

- The following are main materials that are used as adsorbents.
  - Activated carbon
  - Silica
  - Synthetic polymers

  Activated carbon is mostly used adsorbent in water treatment.

- Activated carbon is a specially treated carbon, which possesses the property of absorbing and attracting impurities, such as gases, Liquids and Finely divided solids.

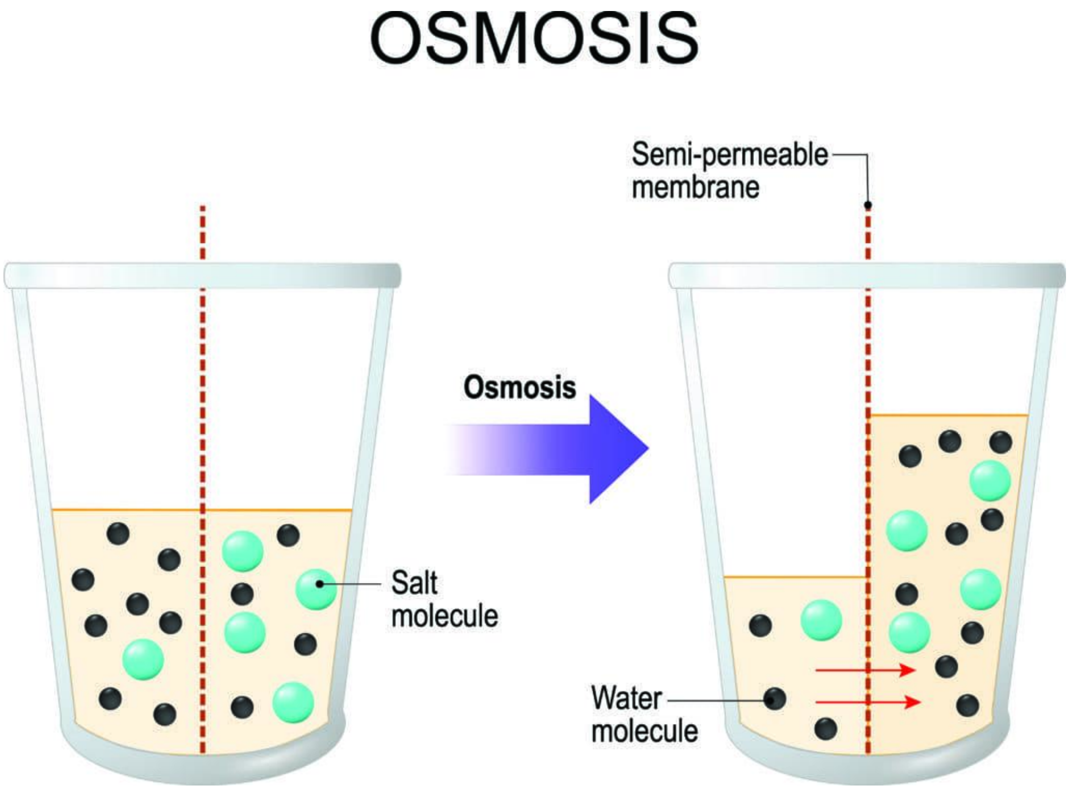
- It is available in granular as well as powder forms. It is highly porous, and Absorptive and thus very useful for removing phenol type impurities.
- Activated carbon is mostly used in powdered form, and may be added to the water either before or after the coagulation, but before Filteration.
- The most common method adopted is to add a portion in the mixing tank, and to add the remaining portion in water Just before it enters the filter.
- This method of using activated carbon at two stages is called split method. Activated carbon may be applied at a constant rate or at varying rate.
- It may be applied either in a dry form or as a suspension or as a slurry. It use as a suspension in water and then fed into the water to be treated as slurry, is generally preferred.
- It use in powdered form may create problems, such as blown off due to winds. Nevertheless, in both the cases, the feeding equipment are similar to those used for adding coagulants.
- The usual dose of activated carbon varies from 5 to 20 mg/lt and optimum dose may be determined first in the laboratory and then in the field.

What is Reverse Osmosis?

Reverse osmosis is a water purification process that uses a semi-permeable membrane (synthetic lining) to filter out unwanted molecules and large particles such as contaminants and sediments like chlorine, salt, and dirt from drinking water. In addition to removing contaminants and sediments, reverse osmosis can also remove microorganisms – which you certainly do not want to drink. It gets water clean down to a molecular level, leaving only pure H2O behind.

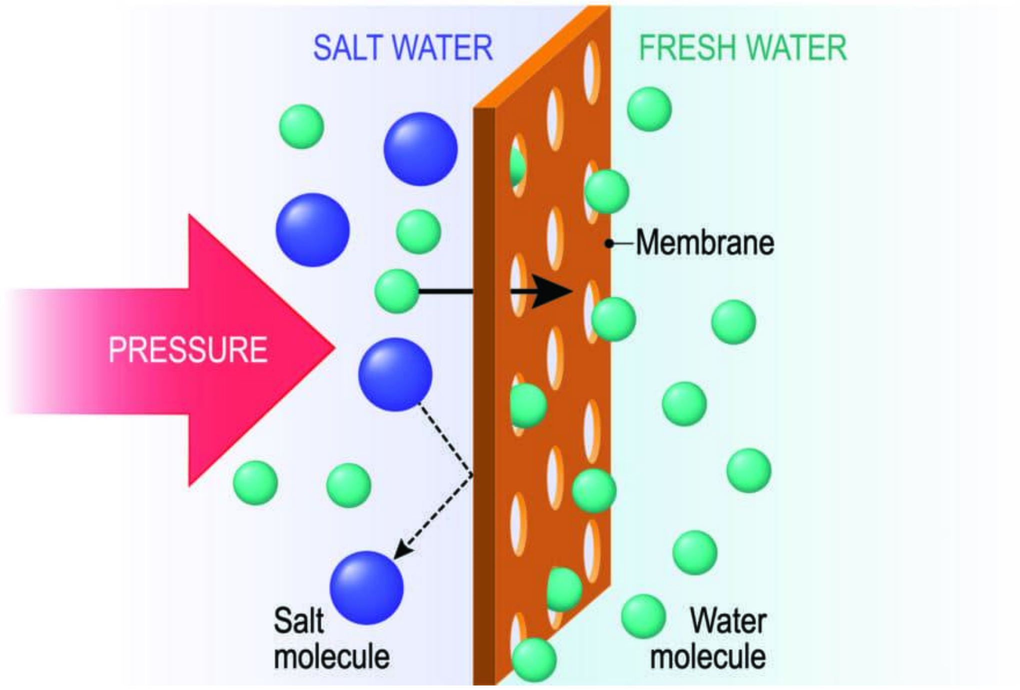
How Does Reverse Osmosis Work?

Before we go into the details of how reverse osmosis works, we should start by explaining how osmosis works. As you may remember from your high school chemistry class, osmosis is the process by which water passes through a semi-permeable membrane from a less concentrated solution into a more concentrated one. In other words, the pure water passes through the filter to the contaminated water in order to equalize the concentrations – which is not what we want our drinking water to do. This movement generates osmotic pressure.[1]



In reverse osmosis, an applied pressure is used to overcome the osmotic pressure and push the water from high concentration of contaminants to low concentration of contaminants. This means it's being forced in reverse and the contaminated water is trying to move into the pure water, but because it must pass through a filter first, the contaminants get trapped and only the pure water passes through; resulting in the cleanest possible drinking water – which is exactly what we want![2]

REVERSE OSMOSIS



Ion Exchange:-

principle:- Reversible exchange of ions between the ions present in the solution and those present in the ion exchange resin.

- Ion exchange is an adsorption phenomenon where the mechanism of adsorption is electrostatic. Electrostatic forces hold ions to charged functional groups on the surface of the ion exchange resin.
- The adsorbed ions replace ions that are on the resin surface on 1:1 charge basis.

Example: $R-H^+ + Na^+ \longrightarrow R-Na^+ + H^+$

- Examples of Ion exchanger materials are: proteins, soils, coal metal oxides and Alumino silicates (zeolites)

process:-

- The process here, however, uses a strong base anion exchange resin (zeolite) in the chloride form.
- As the water passes through the bed of the resin contained in a pressure vessel, Flourides and other anions like Arsenic, nitrates etc. present in the water are exchanged with the chloride ions of the resin, thus releasing chlorides into water and adsorbing flurides, nitrates, Arsenic ions into the resin.
- When the resin gets saturated with anions like Fluoride, nitrate, Arsenic etc. as indicated by their increased Concentration in the out flowing water, the same can be cleaned and regenerated with 5-10% Sodium chloride solution (brine) and the bed is returned to service.

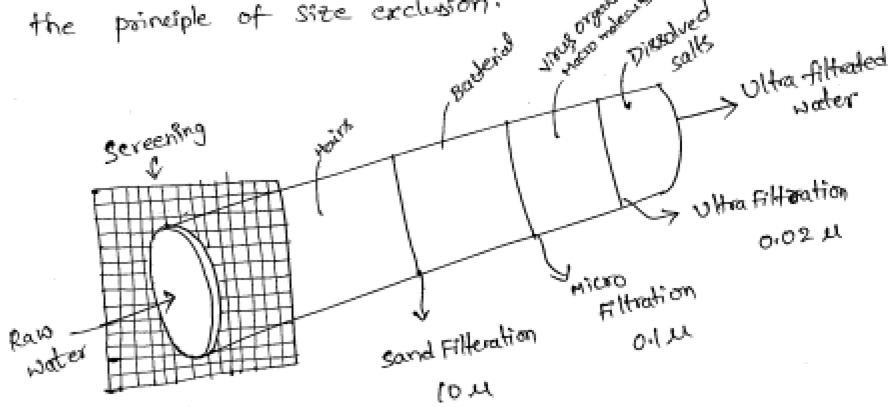
- To ensure that a flow is maintained during regeneration, ideally 100% standby units should be provided.
- During regeneration, the exchange process get reversed, as the anions absorbed on the resin get replaced by chloride ions and discharged to waste water with chloride ions.
- The capacity of a plant based on this technology may range from 500 l/h to 5000 l/h.
- Although the method ensures high efficiency of fluoride removal, yet it requires regular replacement of resin, and Large amount of salt (NaCl) for regeneration of resin saturated with fluroides.
- The method is hence found to be very costly, poor after sales service in villages.

Applications:-

- Ca, Mg (hardness removal) exchange with Na or H
- Fe, Mn removal from ground water
- Recovery of valuable waste products Ag, Au, U.
- Removal of NO_3, NH_4, PO_4 (nutrient removal)
- Demineralization [exchange all cations for H all anions For OH].

Ultra filteration :-

- Ultrafilteration (UF) is a variety of membrane filteration in which forces like pressure or concentration gradients lead to a separation through a semi-permeable membrane.
- Ultra filteration separates solids from liquid streams based on the principle of size exclusion.



- Ultra filteration process similar to Reverse osmosis, using hydrostatic pressure force to water through a semi-permeable membrane.
- The pore size of Ultra filtration membrane is usually 103-106 Daltons
- Ultrafiltration is a pressure driven barrier to suspended solids, bacteria viruses, endotoxins and other pathogens to produce water with very high purity and low silt density.
- Suspended solids and solutes of high molecular weight are retained while water and low molecular weight solutes pass through the membrane.
- Ultra filteration is not fundamentally different from Reverse osmosis, Microfiltration, nano filteration, except in terms of the size of the molecules it retains.

- Ultra Filtration membranes are used where essentially all colloidal particles (including most pathogenic organisms) must be removed but most of the dissolved solids may pass through the membrane without causing problems in the finished water.
- Ultrafiltration will remove most turbidity from water.

Working:-

- Ultrafiltration uses hollow fibers of membrane material and the feed water flows either inside the shell or in the lumen of the fibers.
- Suspended solids & high molecular weight solutes are retained, while water and low molecular weight solutes pass through the membrane.

Benifits:-

- No need for chemicals (coagulants, flocculates, disinfectants, pH adjustment)
- Size exclusion filtration as opposed to media depth filtration.
- Good and constant quality of the treated water in terms of particle and microbial removal
- process and plant compactness
- Simple Automation
- Environmentaly friendly.

3. Explain method for removal of iron and manganese from Industrial waste water.

Removal of Iron and Manganese :-

- Iron and Manganese are generally present in water supplies, either in suspension as hydrated oxides or in solution as bicarbonates.
- Water has iron dissolved in it as the result of carbon dioxide coming in contact with iron ore to form soluable Ferrous bicarbonate.
- Iron in natural waters may be in Ferric or Ferrous condition, soluble, colloidal or insoluble.
- When Manganese is also associated with iron, removal becomes more difficult.
- When they are present in amounts greater than 0.3 ppm, either alone or as total, the following objectionable effects may be noted:

  (i) Unpleasent taste & odour

  (ii) Cause staining of plumbing fixtures, clothing and textiles.

  (iii) Accumulation of precipitated iron in water mains.

(iv) Growth of Crenothrix in water mains.

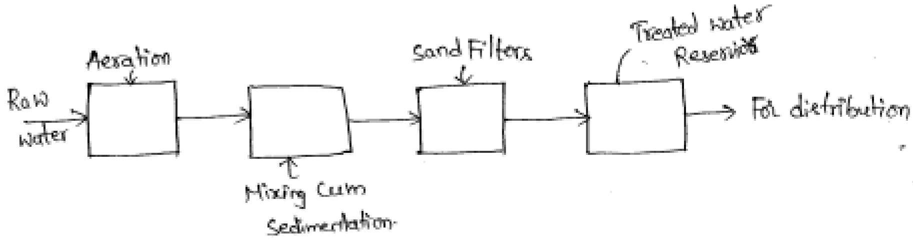
(v) Cause troubles in various manufacturing processes.

(vi) Sulphate iron cause acidity and corrosive action on Iron and Brass.

- The Reddish tinge in water is due to presence of iron while the Brownish tinge is due to presence of Manganese.

Method:- ①

When Iron and Manganese occur in water without organic matter, they can be remored by aeration, followed by Coagulation Sedimentation and filteration.



Flow diagram of Iron and Manganese removing plant

- By Aeration, dissolved Iron is oxidized to Ferric oxide which is insoluble in water. Similarly, dissolved Manganese Compounds are converted to insoluble Manganese Compounds.

- The precipitated floc can be settled down in settling tanks or be Further remored in Gravity or pressure Filters.

The following reaction takes place:

(i) $4Fe + O_2 + 10 H_2O \longrightarrow 4Fe(OH)_3 \downarrow + 8H$

A reaction period of about 5 minutes or less, at a pH of 7 to 7.5 and 0.14 mg of oxygen is required to convert 1 mg of Ferric Iron to Ferric hydroxide.

(ii) When Iron is present as Ferrous bicarbonate.

$$Fe(HCO_3)_2 + 2H_2O \longrightarrow FeO + 2CO_2 + 3H_2O$$

$$4FeO + O_2 \longrightarrow 2Fe_2O_3$$

$$Fe_2O_3 + 3H_2O \longrightarrow 2Fe(OH)_3 \downarrow$$

Here also, we find that 0.14 mg O_2 is required for 1mg of Iron.

(iii) In case of Manganese, the following reaction takes place:

$$6Mn + 3O_2 + 6H_2O \longrightarrow 6MnO_2 \downarrow + 12H$$

It shows that 1mg Mn requires 0.29 mg of O_2.

Manganese removal requires a pH adjustment upto 9.4 to 9.6

- This method of Iron and Manganese removal is most extensively used.
- In order to accelerate the oxidation particularly in waters with high CO_2, addition of lime, soda ash or caustic soda is done.
- Combination of Iron and Manganese, or Iron alone, loosely bound to organic matter, make their removal difficult. The bond between them is broken by adding lime and thus raising pH value more than 9, so that Iron & Manganese can be precipitated.

4. Explain method for removal of odour and colour from Industrial waste water.

Removal of Colour and odour :-

- The colour, odour in the water come due to presence of dissolved gases such as hydrogen sulphide, Organaic matter, Micro organisms and Contamination due to Industrial wastes containing phenol, excessive chlorine etc..
- The Following are the various treatments which are used in removing the colour and odour.

(a) Aeration

(b) Treatment with Activated carbon.

(c) Treatment with Copper Sulphate

(d) oxidation of organic matters.

(c) Aeration :- It is the process of bringing water in intimate contact with air, while doing so the water absorbs oxygen from the air.

- The CO_2 gas is also removed upto 70% and upto certain extent bacteria are also killed. Iron and Manganese and H_2S gas are also removed upto certain extent from the water.
- Following are the various methods of aeration which are commonly used.

i) By air diffusion :-

- In this method perforated pipes are fixed in the bottom of the settling tanks.
- The compressed air is blown through the pipes which comes out in the form of bubbles and stirr the whole water at greater speed.
- During the upward moment of air it is thoroughly mixed with water and does its aeration.
- The Aeration tanks are usually made 2.5 to 3 m deep and work on the principle of continous flow, having minimum detention period of 15 minutes.
- The quantity of air consumed varies from 0.3 – 0.6 cum per 1000 lt of water.

ii) By Trickling beds :-

- In this method the water is allowed to flow on the Trickling beds of coke, which are supported on the perforated bottom of the Trays.
- The water is allowed to Trickle from the top to the bottom under gravitational force. During this downward movement, the water gets mixed up with air and the aeration takes place.

- The size of coke tray ranges between 50 – 75 cm.
- The efficiency of this method is more than "Cascades" but it is less effective than the method of "spray nozzles".

(iii) By using spray nozzles:-

- In this method the water is thrown up in the air into fine sprays to a height of 2-2.5 m under pressure of 0.7 – 1.15 kg/cm².
- When small particles of water come in contact of greater surface area of the air, they absorb it and the water is Aerated.
- The dissolved gases like H_2S, CO_2 etc escape into the atomosphere and the oxidation of various substances and organic matter takes place.

(iv) By using Cascades:-

- In this method the water is allowed to fall over a series of concrete steps or over a weir etc. in thin film.
- During the fall, the water gets throughly mixed with air and gets Aerated.

→ Excessive Aeration should not be done, otherwise excessive absorption of O_2 will increase the corrosive property of water and it may require de-aeration process.

(b) Treatment with Activated Carbon:-

- Activated carbon is the most widely used substance for removal of Tastes and odours from public water supply, because it has excellent properties of attracting impurities, such as gases, finely divided solid particles and other liquid impurities.

- Activated carbon is usually used in powdered form and may be added either before and/or after coagulation with sedimentation. But it is used always before filteration.
- Activated carbon can also be used in granular form as a filter media, instead of using sand in the rapid gravity filter. But if used as filter media of pressure filters, it will be much better.

Advantages:-

1. If used in powder form it will increase the coagulation power of the process.
2. The chlorine demand of the water is reduced after using activated carbon.
3. The activated carbon removes tastes, odour & colour which are due to presence of Iron, Manganes, phenols, H_2S, chlorine, CO_2 etc.
4. The excessive dose of activated carbon is not harmful.
5. The process is simple requiring less skill.

(C) Treatment with copper sulphate :-

- Copper sulphate ($CuSO_4 \cdot 7H_2O$) also helps in removing colours, tastes and odours from water.
- The advantages of copper sulphate is that it checks the growth of algae even before its production, and also kills some bacteria.
- It is usualy applied at the rate of 0.5 – 0.65 mg/lt to the treated water, before it is allowed for distribution in the mains.
- The solution of copper sulphate is generally prepared and added just at the entry of the water in the distribution mains. It can also be added in the clear water storage reservoirs.

- It can also be added in the Lakes or impounded Reservoirs for the prevention of algae growth, but if excessive dose is added it will kill the fish and other living creatures, so quantity of dose should be properly determined in Laboratory and check it.

(d) By oxidation of organic matter:-

- chlorine, potassium permanganate, ozone etc are oxidising agents which are commonly used.
- The dose of potassium permanganate varies from 0.05 – 0.1 mg/lt. chlorine also helps in the removal of organic matter in addition to its disinfection work, if added beyond breakpoint chlorination (or) Super chlorination followed by dechlorination.
- chlorine dioxide gas and ozone can be used for oxidation purpose, but due to their heavy cost, they are uneconomical, hence are not used anywhere.

UNIT-3

1. Explain the necessity of equalization and proportioning for industrial wastewater treatment.

Equalization:

Equalization is a method of retaining wastes in a basin so that the effluent discharged is fairly uniform in its characteristics (pH, colour ,turbidity ,alkalinity , B.O.D etc). A secondary but significant effect is that of lowering the concentration of effluent contaminants. A retention pond serves to level out the effects of peak loadings on the plant while substantially lowering the B.O.D and suspended solids load to the aeration unit.

Air is sometimes injected into these basins to provide:

1. Better mixing
2. Chemical oxidation of reduced compounds
3. Some degree of biological oxidation
4. Agitation to prevent suspended solids from settling.

The size and shape of the basins vary with the quantity of waste and the pattern of its discharge from the industry. The capacity should be adequate to hold and render homogeneous, all the wastes from the plant. Almost all industrial plants operate on a cycle basis; thus if the cycle of operations is repeated for every two hours, an equalization tank which can hold a two -hour flow will usually be sufficient.

The mer holding of waste, however is not sufficient to equalizing it. Each unit volume of waste discharged must be adequately mixed with other unit volumes of waste discharged many hours previously.

This mixing may be brought about in the following ways:

1. Proper distribution and baffling
2. Mechanical agitation
3. Aeration and
4. Combination of all three.

Proportioning

Proportioning means the discharge of industrial wastes in proportion to the flow of municipal sewage in the sewers or to the stream flow in the receiving river. In most case sit is possible to combine equalization and proportion in the same basin. The effluent from the equalization basin is metered into the sewer or stream according to a predetermined schedule. The objective of proportioning in sewers is to keep

constant the percentage of industrial wastes to domestic sewage flow entering the municipal sewage plant.

This procedure has several purposes:

1. To protect municipal sewage treatment using chemicals from being impaired by a sudden overdose of chemicals contained in the industrial waste.
2. To protect biological treatment devices from strong loads of industrial wastes, which may inactivate the bacteria.
3. To minimize fluctuations of sanitary standards in the treated effluent.

The rate of flow of industrial waste varies from instant to instant, as does the flow of domestic sewage system. Therefore the industrial waste must be equalized and retained, then proportioned to the sewer or stream according to the volume of domestic sewage or stream flow.

2. Discuss: Volume reduction and strength reduction.

Volume reduction in wastewater management is the process of reducing the volume of wastewater before it is treated. This can be done through a variety of methods, including:

- Classification of waste: This involves separating wastewater into different streams, based on their composition. For example, non-hazardous wastewater can be separated from hazardous wastewater, and wastewater from different production processes can be separated. This allows for more efficient treatment of the different streams.
- Conservation of wastewater: This involves reducing the amount of water used in industrial and commercial processes. This can be done through a variety of methods, such as using water-saving fixtures, repairing leaks, and reusing water.
- Changing production techniques: This involves making changes to the way that products are manufactured, in order to reduce the amount of wastewater generated. For example, a company might switch to a more water-efficient cleaning process, or they might find a way to reuse wastewater in the production process.

- Reuse and recycling: This involves reusing or recycling wastewater, rather than treating it and discharging it into the environment. This can be done in a variety of ways, such as using wastewater to irrigate crops, or using it to generate steam or electricity.
- Elimination of batch and plug discharge: This involves eliminating the practice of discharging large amounts of wastewater all at once. This can be done by staggering the discharge of wastewater, or by using holding tanks to store wastewater until it can be treated.

Strength reduction:

Waste strength reduction is the second major objective for the industrial plant. The following are the methods which help in reducing the strength which include:

- Process change
- Equipment modification
- Segregation of waste
- Equalization
- Proportioning of waste
- Monitoring of waste stream
- Deduction in accidental spills
- By-product recovery.

Strength reduction in wastewater management is the process of reducing the concentration of pollutants in wastewater. This can be done by a variety of methods, including:

- Process changes: This involves making changes to the way a process is carried out in order to reduce the amount of pollutants that are generated. For example, an industrial plant might switch to a different type of raw material that is less polluting, or they might modify their manufacturing process to produce less waste.
- Equipment modifications: This involves installing new equipment or making changes to existing equipment in order to reduce the amount of pollutants that enter the wastewater stream. For example, a dairy plant might install screens on their drains to catch solids before they enter the wastewater stream.
- Segregation of wastes: This involves separating different types of wastewater so that they can be treated separately. This can be done by installing different treatment systems for different types of wastewater, or by physically segregating the wastewater streams.
- Equalization: This involves storing wastewater in a tank so that the flow rate and concentration of pollutants can be equalized. This can make it easier and more efficient to treat the wastewater.

- By-product recovery: This involves recovering valuable materials from wastewater before it is treated. This can reduce the amount of pollutants that need to be treated, and it can also generate revenue for the company.
- Proportioning of wastes: This involves mixing different types of wastewater together in order to achieve the desired concentration of pollutants. This can be done to make it easier to treat the wastewater, or to meet specific discharge limits.
- Monitoring of waste streams: This involves monitoring the concentration of pollutants in wastewater streams so that any problems can be identified and addressed quickly. This can help to prevent accidental spills and other incidents that could lead to environmental pollution.

3. Explain the process of industrial waste water sampling and preservation samples for analysis.

Sampling of Waste Water:

A source from which a sample is to be collected may not be a homogeneous one and its quality may not be time invariant. If a source is a flowing stream and its flow rate is time dependent, then the quality of the sample collected from such a source would be time dependent. While collecting a sample from a source one should bear in mind the above mentioned factors and employ a proper sampling technique in order to obtain a representative sample from the source.

Two basic sampling techniques normally used are:

(a) Grab Sampling:

It is carried out by collecting a sample at a specific pre-determined instant.

(b) Composite Sampling:

It is achieved by collecting several grab samples and mixing those judiciously so as to obtain an average sample. Analysis of a grab sample from a source would represent the quality of the source at the time of sampling only. A grab sample collected at the right time may yield information about the peak pollutant load of a waste water stream. Such information is essential for adjusting the process parameters of an effluent treatment plant (ETP) so as to operate the same properly.

Collection of a grab sample from a homogenous source (an effluent stream or a water body) poses no problem. But when a source is a non-homogeneous one, a grab sample should be collected carefully. From such a source a sample should neither be collected from the surface nor from the bottom but from a point about two-third of the way from the surface.

To obtain a time-averaged and flow-averaged composite sample, several grab samples should be collected from an effluent stream at pre-planned time intervals over a period of 24 hours. The collected samples should be mixed in proportion to the flow rates at the respective intervals. Analysis of such a composite sample would yield information about the daily average concentration of the pollutants present in an effluent stream.

Sample Preservation:

The ideal thing to do is to analyze a sample at the earliest after collection. But for various reasons it is not often possible. In such situations the samples should be stored at 3° C to 4° C. During storage chemical changes may occur in the samples and as a result the pollutants' concentration may change.

To prevent such changes it may be necessary to add chemicals (preservatives), which would arrest chemical changes of pollutants during storage. A preservative is a pollutant specific chemical and hence it is not to be added to the entire sample but to that portion set aside for estimation of concentration of a specific pollutant.

Analysis of Waste Water:

In general, the concentration of pollutants even in a highly polluted effluent/ water body is low when expressed in terms of mass per unit volume. Hence, for their estimation special techniques and instruments are used.

The concentration of pollutants being low generally those are expressed in the unit of mg/L (weight of a pollutant in mg per litre of a waste water sample) or ppm (weight of a pollutant per million parts of a waste water sample by weight). In the case of waste water, having a low solute content the numerical value of the pollutant concentration will be the same independent of whether it is expressed in mg/L or ppm. If a pollutant concentration be very low it is expressed either in μg/L or ppb.

Broadly speaking the analytical methods used for analysis of waste water samples may be classified into the following three groups:

(a) Classical methods

(b) colorimetric methods

(c) Newer Instrumental methods

The classical methods are those, which are developed initially for estimation of pollutant concentration. These methods are less costly in terms of laboratory equipment, instruments and chemicals, but are analyst-skill dependent. These tests in general are more time consuming.

The colorimetric methods are quick but may require sophisticated instruments and special chemicals. These methods do not require that much of skill. The newer instrumental methods are very quick but specific instruments/ accessories may be required for each specific pollutant.

The procedures for estimation of the different types of pollutants as well as those for each specific pollutant have been detailed in standard reference book-sand publications.

4. Discuss the application of zero discharge technology based on three R principles.

Zero Liquid Discharge (ZLD)

Zero-liquid discharge (ZLD) is a water treatment process in which all wastewater is purified and recycled; therefore, leaving zero discharge at the end of the treatment cycle. Zero liquid discharge is an advanced wastewater treatment method that includes ultrafiltration, reverse osmosis, evaporation/crystallization, and fractional electrodeionization.

Zero discharge technology (ZLD) is a set of processes that are used to treat wastewater so that no liquid waste is discharged. This is achieved by recovering water from the wastewater and reusing it, or by converting the wastewater into a solid or gaseous form that can be disposed of more easily.

The 3R principles can be applied to ZLD in a number of ways. For example, reducing the amount of wastewater generated can be achieved by using more efficient processes, such as closed-loop systems that reuse water. Reusing wastewater can be achieved by treating it to remove pollutants and then using it for other purposes, such as cooling or irrigation. Recycling wastewater can be achieved by converting it into a solid or gaseous form that can be disposed of more easily, such as by incineration or evaporation.

The application of the 3R principles to ZLD can help to reduce the environmental impact of wastewater treatment. By reducing, reusing, and recycling wastewater, it is possible to conserve water resources, reduce pollution, and protect the environment.

Here are some specific examples of how the 3R principles can be applied to ZLD:

- Reduce: An industrial plant could reduce the amount of wastewater it generates by using a closed-loop system that reuses water. This would reduce the amount of water that needs to be treated and discharged, which would help to conserve water resources.
- Reuse: A wastewater treatment plant could reuse treated wastewater for cooling or irrigation. This would help to reduce the amount of water that needs to be withdrawn from surface water or groundwater, which would help to protect these resources.
- Recycle: A wastewater treatment plant could convert treated wastewater into a solid or gaseous form that can be disposed of more easily. This could involve incineration, evaporation, or crystallization.

By applying the 3R principles to ZLD, it is possible to achieve a number of environmental benefits, including:

- Conservation of water resources: ZLD can help to conserve water resources by reducing the amount of water that needs to be treated and discharged.
- Reduction of pollution: ZLD can help to reduce pollution by removing pollutants from wastewater before it is discharged.
- Protection of the environment: ZLD can help to protect the environment by reducing the amount of wastewater that is discharged into rivers, lakes, and oceans.

5. Explain unit operations and processes involved in industrial waste water treatment

UNIT OPERATIONS AND PROCESSES:

Waste water treatment is any operation / process or combinations of operations and processes that can reduce the objectionable properties of waste water and render it less dangerous. Waste water treatment is a combination of physical, chemical and biological processes.
Methods of treatment in which application of physical forces predominate, are known as unit operations.
Methods of treatment in which chemical or biological activities are involved, known as unit processes.

The unit operations approach in water and waste water treatment has following advantages:

1. Gives better understanding of the processes and the capabilities of these processes in attaining the objectives.
2. Helps in developing mathematical and physical models of treatment mechanisms and the consequent design of treatment plants.
3. Helps in coordination of effective treatment procedure to attain the desired plant performance.

PHYSICAL UNIT OPERATIONS

OPERATION	APPLICATION
1. Screening	Removal of coarse and settleable solids bysurface straining
2. Comminution	Grinding of coarse solids
3. Flow Equalisation	Equalisation of flow and mass loadings ofBOD suspended solids.
4. Mixing	Mixing of chemicals and gases with waste water and maintaining solids in suspension
5. Flocculation	Promotion of aggregation of smaller particles into larger ones.
6. Sedimentation	Removal of settleable solids and thickeningof sludge.
7. Floatation	Removal of finely divided suspended solidsand particles. Also thickens biological sludge.
8. Filtration	Removal of fine residual suspended solids remaining after biological or chemical treatment.
9. Micro screening	Same as filtration. Also removal of algaefrom stabilization pond effluents

CHEMICAL UNIT PROCESSES

PROCESS	APPLICATION
1. Chemical Precipitation	Removal of phosphorous and enhancement of suspended solidsremoval in primary sedimentation
2. Gas Transfer	Addition and removal of gases
3. Adsorption	Removal of organics
4. Disinfection	Disinfection of disease causingorganisms
5. De chlorination	Removal of total combined chlorineresiduals
6. Miscellaneous	Achievement of specific objectives in waste water treatment

BIOLOGICAL UNIT PROCESSES

Biological unit processes are those in which removal of contaminants are brought about by biological activity In biological treatment of waste water, the objectives are to coagulate and remove the non settleable colloidal solids and to stabilize the organic matter. The waste water is generally from three sources (i) domestic waste water (ii) agricultural return waste water (iii) industrial waste water For domestic waste water, the objectives are to remove various nutrients, specifically nitrogen and phosphorous, which are otherwise capable of stimulating growth of aquatic plants. Biological processes are classified by the oxygen dependence of the primary microorganisms responsible for waste treatment.

Aerobic processes:

Biological treatment process that occurs in the presence of dissolved oxygen. The bacteria that can survive in the presence of DO are known as obligate aerobes. The aerobic process include the following:

1. Activated sludge process

2. Trickling filters

Anaerobic processes: Involves the decomposition of organic or inorganic matter in the absence of molecular oxygen

UNIT-5

1. Explain manufacturing process, origin, characteristics, effects, and treatment methods of liquid waste from steel plants, textiles, and Paper & pulp industries.

Textile industry

Manufacturing Process and origin of Liquid waste from Textile industry

- Textile manufacturing operations are among the major industrial water users.
- This industry has the wastes most difficult to treat satisfactorily.
- Textile wastes are variable in character which makes their treatment a complex problem.
- In a modern textile mill, many compounds produced by other industries are used.
- Synthetic yarns, dyes and finishes from the chemical industries and sizes from the food-producing industries are among these substances.
- Some of these compounds are added onto the basic fiber and then partially or wholly washed off as pollutants.
- These compounds may be organic or inorganic in nature.

•Inorganic materials may render water unsuitable for use because of excess concentrations of soluble salts, and because insoluble salts precipitate and deposit on stream bottoms, blanketing aquatic life and even clogging streams.

•The organic compounds may undergo a gradual chemical or biological change which removes oxygen from the water, resulting in a septic condition characterised by odours, gases, floating solids and a generally disagreeable appearance.

• Metal salts may be toxic to animals, fish and other aquatic life.

Effluents from Textile industry

•**1. Dyes:** Change color of water, high BOD, high COD, lead to cancer, disabilities, and disorders.

•**2. Acids:** It lowers the pH, cause corrosion, help in the liberation of Na_2S, destroy microorganism, and destroy self-purification system of water.

•**3. Alkalis:** Alkali increases the pH, help in the liberation of hydrogen ions, destroy microorganisms, and destroy self-purification of water.

•**4. Dissolved solids:** Chlorides, sulfates, nitrates, bicarbonates of various inorganic metals; plants and vegetable kingdom affected by osmotic changes, affect biological organisms, BOD.

•**5. Suspended matter:** Insoluble wastes, destroy self-purification of streams, reduce the photosynthetic activity of plants, choke the gill of fish, organic solids undergo purification giving rise to solids buoyed by gas, lead to floating masses, bad odor results.

•**6. Oils:** Absorption of O_2 from air into water affected, destroy the animal, plant life in water, high BOD.

•**7. Synthetic detergents:** Lower biodegradability, add on to toxicity, accelerate chain reactions, increase floating masses and affect natural aeration.

•**8. Toxic metals:** Self-purification of streams destroyed, cause skin diseases, disabilities and disorders, destroy microorganism aquatic plants and animals are killed, compounds containing mercury affect the food chain.

•**9. Gaseous pollutants:** Free chlorine, hydrogen sulfide, etc. increase toxicity, add on to oxygen demand, kill microorganism, destroy animals and plant kingdom.

•**10. Heated effluents:** Reduce dissolved oxygen concentration, aquatic life gets affected, destroy animal and plant kingdom, and affect the entire ecosystem because of temperature.

•**11. Radioactive wastes:** Its effects are numerous; induce metabolic changes, disorders, disabilities, genetic damage, chronic diseases, cancer, and the abnormal birth of human beings which are also common to plants and animals.

Textile Waste Characteristics

•The pollutional characterisitcs of textile wastes differ widely among various segments of the industry, and each type of waste presents a special treatment problem.

•Organic substances such as dyes, starches, and detergents in textile waste undergo chemical and biological changes which consume dissolved oxygen from the receiving stream and so destroy fish life.

•Such organics are to be removed to prevent septic conditions and obnoxious odours, and to avoid rendering the stream waters unsuitable for municipal, industrial, agricultural and residential use.

•High concentrations of soluble inorganic salts may make the stream unsuitable for industrial and municipal use, and may have a corrosive effect on boats and other structures.

•Metals such as chromium and zinc are toxic to aquatic life, and should be removed before discharge.

• Colours from dyes vary and, although not toxic, are esthetically objectionable particularly in drinking and recreational waters.

•Certain carrier chemicals used in dyeing, such as phenols, may add tastes and odours.

Treatment methods of liquid waste from textile industry

The wastes may be treated in various ways and the best combination of methods differs from plant to plant.

(A)**Physical and Chemical Methods**

(i) Segregation: The segregation of wastes for separate and special treatment depends

on the following:

• the characteristics of individual wastes and the stream requirements.

•the cost of in-plant changes such as piping and sewers.

•the benefits gained if weak effluent can be discharged untreated to the stream.

•the cost of having skilled workers to minimise human errors.

(***ii) Lagooning and Storage:***

•***Equalisation eliminates variation in flows and pollution*** load, and is accomplished by storage, as in a lagoon.

•Proper maintenance of lagoons is necessary to avoid odours.

•Aeration helps to reduce odours and other pollutional characteristics.

•Lagooning with aeration after other biotreatment processes serves as a polishing treatment and accomplishes maximum pollution removal, usually above 95%.

•Oxidation ponds, with and without aeration are the most effective type of lagoon.

•***(iii) Screening:*** *Bar screens and rotating screens remove objectionable coarse solids* from certain textile wastes containing fibers and trash.

•***(iv) Mechanical Filtration:*** *Coke, ash, coal, rock, and sand filters are frequently used* on highly polluted wastes as a secondary treatment, to polish the effluent to a high degree of clarity and usually to a BOD below 10 mg L-1.

•***(v) Pre-aeration and Post-aeration:*** *Physical and chemical aeration by diffusion,* spraying or cascading provides oxygen and prevents anaerobic decomposition to control malodourous gases.

•***(vi) Neutralisation: Neutralisation of wastewater is required to adjust its pH according*** to the pH limits required for the receiving streams, or to adjust the waste to pH less than 10.0 for biological treatment in conventional processes.

•***(vii) Chemical Precipitation: Good results are obtained either by chemical*** precipitation alone or by chemical precipitation in combination with lagooning. The cost of treatment is, however, higher than that done by biological methods.

•***(viii) Chemical Oxidation: Certain wastewaters containing dyes and auxiliary*** chemicals are reducing in character. These should be segregated and oxidised with air or chlorine before they are mixed with other plant wastes for further treatment. Chlorine oxidises reducing compounds and is also used in final treatment to reduce the bacteria count.

•Biological methods for removing pollutants utilise natural processes involving bacteria and other microorganisms for oxidation of the organic wastes to produce a satisfactory effluent.

•Certain textile wastes free from toxic substances may be treated biologically because of their high nutrient content of nitrogen and phosphorus.

(i) The trickling filter process:

•*This removes a large part of the organic pollution, and* the effluent can usually be discharged to a stream after final settling.

•Other approach for treating textile wastes more economically is the use of plastic media in the filters, followed by oxidation ponds for polishing.

•Trickling filter treatment of sewage and textile waste averages about 75% removal of BOD. More efficient operation can be obtained by recirculation of part of the treated effluent or by treating through 2 stages of filters in series.

• Trickling filters may also be used as a unique method to reduce the high alkali content of textile wastes of pH 12 or above, prior to activated sludge treatment.

(ii) The activated sludge process:

•*This treatment is very efficient and removes upto* 95% of the BOD resulting in a clear, stable effluent from normal wastes.

•The activated sludge process is more sensitive than trickling filters to changes in pH and to shock loads.

• It costs less to construct and requires little space. Sludge disposal must be provided.

•Total oxidation, extended aeration, prolonged aeration, indigenous respiration, and other activated sludge variations with greatly increased aeration periods are being used more extensively in treating textile waste because of their simplicity and low construction and operating costs.

•The process involves aerating seeded wastes from 12 to 72 hours, until the organic matter is nearly or totally oxidised, then discharging to the stream.

• Primary settling and sludge digestion and disposal may be eliminated.

• The effluent is usually settled, however, the sludge returned to the aeration tank for further oxidation.

• The method of aeration is optional, and either mechanical agitation or diffused air can be used advantageously to obtain efficiency and economy.

(iii) Oxidation ponding :

•*It is perhaps the cheapest method for reducing the pollution* load in textile waste, if land is available. Wastewater flows through a shallow pond, usually about 1.5 m deep if colorless, and 1 m deep if dye wastes are present, with upto 30 days retention time and a BOD loading of about 20 kg per acre per day.

•BOD loadings can range upto 40 kg or more if the waste has been biologically pretreated and seeded.

•Oxygen from air and from algae production feeds the active organisms which stabilise the organic matter. Recirculation may be used to prevent anaerobic conditions.

•Finally, we can say that each plant needs to study its own possible treatment methods

•to obtain the best treatment at the lowest cost. This involves the setting up of a pilot

•plant. It is desirable to consider all of the treatment methods mentioned above,

•particularly prolonged bioaeration and oxidation ponding processes. Trickling filters,

•especially the plastic type followed by polishing in oxidation ponds have been observed

•to be effective in the treatment of textile wastes.

PAPER AND PULP INDUSTRIES

Manufacturing process and origin

•Papers are made with the pulp of the woods, which is an Eco-friendly product.

Paper is made through the following processes:

•1) Pulping procedure will be done to separate and clean the fibers

•2) Refining procedure will be followed after pulping processes

•3) Dilution process to form a thin fiber mixture

•4) Formation of fibers on a thin screened

•5) Pressurization to enhance the materials density

•6) Drying to eliminate the density of materials

•7) Finishing procedure to provide a suitable surface for usgae

•Pulp and paper are made from cellulosic fibers and other plant materials.

•Some synthetic materials may be used to impart special qualities to the finished product.

•Paper is made from wood fibers, but rags, flax, cotton linters, and bagasse (sugar cane residues) are also used in some papers.

•Used paper is also recycled, and after purifying and sometimes deinking, it is often blended with virgin fibers and reformed again into paper.

•The pulping process is aimed at removing lignin without loosing fiber strength, thereby freeing the fibers and removing impurities that cause discoloration and possible future disintegration of the paper.

•Several extractives such as waxes, oleoresins are contained in wood but they do not contribute to its strength properties; these too are removed during the pulping process.

•The fiber extracted from any plant can be used for paper. However, the strength and quality of fiber, and other factors complicate the pulping process.

• In general, the softwoods (e.g., pines, firs, and spruces) yield long and strong fibers that contribute strength to paper and they are used for boxes and packaging.

•Hardwoods produce a weaker paper as they contain shorter fibers. Softwoods are smoother, transparent, and better suited for printing.

•Softwoods and hardwoods are used for paper-making and are sometimes mixed to provide both strength and print ability to the finished product.

Effects of liquid waste

•The major stream pollution problems arising from pulp and paper making are caused by *suspended matters and dissolved organic substances.*

•*The former forms* bottom deposits in receiving streams and latter are inimical to aquatic life, unsightly and odouriferous on decomposition. Such deposits can also exert an appreciable demand for the dissolved oxygen contained in the overlying water.

•The discharge of highly dispersed solids such as fiber debris, filler and coating materials can render the stream opalescent which retards self-purification by limiting light penetration.

•Dissolved solids found in spent pulping liquors can have a variety of effects on streams.

•Wood supers deplete the dissolved oxygen and stimulate the growth of slime organisms, causing biological imbalance.

•Lignins and tannins, cause discoloration and resin acid soaps and mercaptans, in high concentration, are toxic to aquatic life.

•Problems resulting from the normal discharge of inorganic compounds such as acids and alkalies are minor.

•Because the major difficulties arise from organic matter, these effluents are generally classified as *organic wastes.*

•The untreated wastewater from pulp and paper mills is generally discharged into water bodies and which cause damage to the water quality.

• The effluent imparts brown colour to water which is detectable over long distances.

• The effluents have high biological and chemical oxygen demands (BOD and COD), lignin compounds and their derivatives. The undiluted effluents are toxic to aquatic organisms and exhibit a strong mutagenic effect.

•Further more, some compounds in the effluents are resistant to biodegradation and can bioaccumulate in the aquatic food chain (Kumara Swamy et al).

Characteristics of Effluents

(i) Wood Preparation Effluents: *These effluents result from transporting, washing* and debarking wood and contain both coarse and fine particles of bark, wood slivers and silt. In addition, some dissolved solids are present in them from sap washed from the wood.

•***(ii) Screening and Pulp Cleaning Waters:*** *These contain wood debris, pulp, fines and* grit.

•***(iii) Mechanical Pulping Effluents:*** *They contain both fine and coarse wood debris* and solubles released on grinding or milling of the wood.

(iv) Mechanical-Chemical Pulping Effluents: *These are similar to mechanical* pulping effluents. In addition, they contain spent chemicals and soluble substances released by treatment of the wood with caustic soda or sodium bisulphite prior to mechanical pulping.

(v) Chemical Pulping Wastes:

•*They contain spent liquor itself, with the exceptions of* kraft and soda pulp production where the spent liquor is invariably recovered and some other types of pulp production where heavy spent liquor is segregated for recovery, by-product production or separate disposal.

• These effluents contain low level of suspended solids. Bulk of the impurities remain in solution in the form of lignins, tannins,carbohydrates, salts of fatty acids and other organics, wood ash constituents and spent cooking chemicals.

(vi) Textile Fiber Pulping Effluents:

•*These consist of draining and washwaters* obtained from the cooking and washing of jute, rags, flax, cotton linters, rope and similar materials.

•The cooking chemical is generally caustic in nature and in some instances a scouring step employing detergents precedes cooking.

•The effluents contain impurities present in the raw materials, cooking chemicals and products of cellulose hydrolysis.

Treatment of liquid waste from paper and pulp industries

Suspended Solids Reduction

•The suspended matter consists mainly of fiber, fiber debris, filling and coating materials such as clays, calcium carbonate and titanium dioxide.

• In most mills, the bulk of these materials are captured from the machine waters by means of screening, filtration, settling or flotation devices and are returned to the system for reuse.

•The most common means for treating solids-bearing wastes in the paper industry is *sedimentation, although in some plants flotation and filtration are used.*

(i)***Stabilisation Basins:***

•*These are the most widely used for biological oxidation of* pulp and paper effluents.

•Two types of basins used are: *natural reaeration type and* the *mechanically aerated type. The natural reaeration basin is normally shallow* and can be irregular in depth, since its design is based essentially on air-exposed water surface, particularly when a high degree of BOD reduction is required.

•*Mechanically aerated basins have come into use in recent years for raising oxidation* rates and hence shortening the storage period required.

(ii) Trickling Filters:

•*Many attempts have been made to apply trickling filters for* waste treatment.

•Experiments have indicated that filters using stone media are costly and are not satisfactory for general application as they cannot provide a high degree of purification at high loading rates and they are subjected to clogging with fiber.

•Plastic media have been employed in trickling filters providing partial purification of pulp mill effluents since they largely eliminate the media-clogging problem and can be operated at high hydraulic loadings.

• These media are also used for pretreatment and cooling of hot effluents prior to the application of other methods of oxidation.

(iii) Activated Sludge Treatment:

•*This process could be applied for reduction of* BOD of kraft pulping effluents to a high degree if good internal mill control of waste strength and alkalinity is practiced, and nutrients in the form of ammonia and phosphates are added.

• It is also effective for other wastes from the production of pulp and paper products, paperboard, roofing felt, neutral sulphite pupping, and deinking effluents.

•Effluents can also be treated in municipal activated sludge plants in combination with sanitary sewage.

Steel Industry

Manufacturing process and origin

UNIT-4

1. Explain problems associated with discharge of industrial waste water into streams, lakes, and oceans.

2. Explain advantages, suitability, limitations, and challenges in Common effluent treatment plants.