14. ASSIGNMENT TOPICS WITH MATERIALS

UNIT 1

1. What are the Physical characteristics of Industrial Wastewater

2. What are the Chemical characteristics of Industrial Wastewater?

3. What are the effects On Sewage Treatment Plants

4. Explain wastewater coming from Organic chemicals industry and Electric power plants

5. Explain wastewater coming from Food industry

KEY

1.What are the Physical characteristics of Industrial Wastewater

Ans :The principal of physical characteristics of wastewater include Solids,colour, odour and temperature.

- Total Solids

The total solids in a wastewater consist of the insoluble or suspended solids and the soluble compounds dissolved in water. The suspended solids content is found by drying and weighing the residue removed by the filtering of the sample. When this residue is ignited the volatile solids are burned off. Volatile solids are presumed to be organic matter, although some organic matter will not burn and some inorganic salts break down at high temperatures. The organic matter consists mainly of proteins, carbohydrates and fats. Between 40 and 65 % of the solids in an average wastewater are suspended. Settleable solids, expressed as millilitres per litre, are those that can be removed by sedimentation. Usually about 60 % of the suspended solids in a municipal wastewater are settleable (Ron & George, 1998). Solids may be classified in another way as well: those that are volatilized at a high temperature (600 °C) and those that are not. The former are known as volatile solids, the latter as fixed solids. Usually, volatile solids are organic.

- Colour

Colour is a qualitative characteristic that can be used to assess the general condition of wastewater. Wastewater that is light brown in colour is less than 6 h old, while a light-to-medium grey colour is characteristic of wastewaters that have undergone some degree of decomposition or that have been in the collection system for some time. Lastly, if the colour is dark grey or black, the wastewater is typically septic, having undergone extensive bacterial decomposition under anaerobic conditions. The blackening of wastewater is often due to the formation of various sulphides, particularly, ferrous sulphide. This results when hydrogen sulphide produced under anaerobic conditions combines with divalent metal, such as iron, which may be present. Colour is measured by comparison with standards.

- Odour

The determination of odour has become increasingly important, as the general public has become more concerned with the proper operation of wastewater treatment facilities. The odour of fresh wastewater is usually not offensive, but a variety of odorous compounds are released when wastewater is decomposed biologically under anaerobic conditions.

2. What are the Chemical characteristics of Industrial Wastewater?

Ans:Biological Characteristics of Water

Water quality in developed and developing countries continues to deteriorate due to increased movement of refugees in developingcountries and natural disasters like flooding and droughts. Waterborne diseases bigger thanwars andAIDs.

Most important biological organisms inwater and wastewater are pathogens, as theytransmit diseases.

- not native to aquatic systems and usually require an animal host for growth and reproduction
- unfortunately, can betransported bywater,becominga temporarymemberof the aquatic community
- many species ofpathogens are able to survive in waterand maintain their infectious capabilities forsignificant periods of time
- include species of bacteria, viruses, protozoa, and helminths

***Bacteria*:**comes from Greekword rodor staff, the shape characteristic of mostbacteria

Fungi

- aerobicmulticellular, non-photosynthetic,heterotrophic
- most are saprophytes, obtaining food from dead organicmatter
- principle micro-organism along with bacteria that decomposes carbon
- without fungi, the carbon cycle would cease and organic matter would build up
- ideal conditions are high moisture and low pH

Microorganisms:extract from the environment substances needed to produce new cell material these substancesare called nutrients

Pathogen Indicators

- analysis of water for all known pathogens would be verytime consuming and expensive usually specific pathogens are not tested for unless theyare suspected, instead indicator organisms are used
- indicator organisms suggest that contamination had occurred and the level of contamination

3. What are the effects On Sewage Treatment Plants

Ans: The Pollution Characteristics of Wastes having readily definable effects on Sewers and Treatment Plants can be classified as follows:

Bio Chemical Oxygen Demand : It is usually exerted by Dissolved and Colloidal Organic Matter and imposes a load on the Biological units of the Treatment Plant. Oxygen must be provided so that Bacteria can grow and oxidise the organic matter. An Added B.O.D load, caused by an increase in Organic Waste, requires more Bacterial Activity, more oxygen, and greater Biological Unit capacity for its Treatment, which (makes) increases the capital cost and operating cost.

Suspended Solids: Suspended Solids are found in considerable quantity in many Industrial Wastes, such as Paper& Pulp Effluents. Solids removed by settling and separated from the flowing Sewage are called Sludge, which may then undergo an Anaerobic Decomposition known as Digestion and pumped to drying beds or vacuum filters for extraction of additional water. Suspended Solids in Industrial Waste may settle more rapidly or slowly than Sewage Suspended Matter. If Industrial Solids settle faster than those of Municipal Sewage, Sludge should be removed at shorter intervals to prevent excessive build up: a Slow Settling one will require a longer detention period and larger basins and increases the likelihood of sludge Decomposition with accompanying nuisances, during Sewage-Flow Periods. Any Increased demands on the System usually require larger Sludge handling devices and may ultimately necessitates an increase in the Plants capacity, with resulting Higher Capital and Operating Expenses.

Floating and Coloured Materials: Floating Materials and Coloured Matter such as Oil, Grease and Dyes From Textile-Finishing Mills, are disagreeable and visible nuisances. A Modern Treatment Plant will remove normal Grease loads in Primary Settling Tanks, but abnormally high loads of predominantly emulsified Greases from Laundries, Slaughterhouses etc Passing through the Primary Units into the Biological Units will clog Flow Distributing Devices and Air Nozzles. Volume: A Sewage Plant can handle any Volume of Flow if its units are sufficiently large. The Hydraulic Capacity of all Units must be analysed, Sewer Lines must be examined for Carrying Capacity, and all other Treatment Units are to be Designed for excessive loading

4. Explain wastewater coming from Organic chemicals industry and Electric power plants

Ans : A range of industries manufacture or use complex organic chemicals. These include pesticides, pharmaceuticals, paints and dyes, petrochemicals, detergents, plastics, paper pollution, etc. Waste waters can be contaminated by feedstock materials, by-products, product material in soluble or particulate form, washing and cleaning agents, solvents and added value products such as plasticizers. Treatment facilities that do not need control of their effluent typically opt for a type of aerobic treatment, i.e. aerated lagoons.[1]

Electric power plants

Fossil-fuel power stations, particularly coal-fired plants, are a major source of industrial wastewater. Many of these plants discharge wastewater with significant levels of metals such as lead,mercury, cadmium and chromium, as well as arsenic, selenium and nitrogen compounds (nitrates and nitrites). Wastewater streams include flue-gas desulfurization, fly ash, bottom ash andflue gas mercury control. Plants with air pollution controls such as wet scrubbers typically transfer the captured pollutants to the wastewater stream.[2]

Ash ponds, a type of surface impoundment, are a widely used treatment technology at coal-fired plants. These ponds use gravity to settle out large particulates (measured as total suspended solids) from power plant wastewater. This technology does not treat dissolved pollutants. Power stations use additional technologies to control pollutants, depending on the particular wastestream in the plant. These include dry ash handling, closed-loop ash recycling, chemical precipitation, biological treatment (such as an activated sludge process), and evaporation.

5. Explain wastewater coming from Food industry

Ans: Wastewater generated from agricultural and food operations has distinctive characteristics that set it apart from common municipal wastewater managed by public or private sewage treatment plants throughout the world: it is biodegradable and non-toxic, but has high concentrations of biochemical oxygen demand (BOD) and suspended solids (SS).[3] The constituents of food and agriculture wastewater are often complex to predict, due to the differences in BOD and pH in effluents from vegetable, fruit, and meat products and due to the seasonal nature of food processing and post-harvesting.

Processing of food from raw materials requires large volumes of high grade water. Vegetable washing generates waters with high loads of particulate matter and some dissolved organic matter. It may also contain surfactants.

Animal slaughter and processing produces very strong organic waste from body fluids, such as blood, and gut contents. This wastewater is frequently contaminated by significant levels ofantibiotics and growth hormones from the animals and by a variety of pesticides used to control external parasites.

Processing food for sale produces wastes generated from cooking which are often rich in plant organic material and may also contain salt, flavourings, colouring material and acids or alkali. Very significant quantities of oil or fats may also be present.

UNIT 2

1. Explain Preliminary Treatment

2. What is Equalization?

3. Explain Neutralization

4. Volume reduction

5.Explain Activated Sludge with Flow Equalization Basin

1. Explain Preliminary Treatment

Ans: 1. At most plants preliminary treatment is used to protect pumping equipment and facilitate subsequent treatment processes. Preliminary devices are designed to remove or cut up the larger suspended and floating solids, to remove the heavy inorganic solids, and to remove excessive amounts of oils or greases.
To effect the objectives of preliminary treatment, the following devices are commonly used :
- Screens - rack, bar or fine.
- Comminuting devices - grinders, cutters, shredders.
- Grit chambers.
- Pre-aeration tanks.

The purpose of preliminary treatment is to protect the operation of the wastewater treatment plant. This is achieved by removing from the wastewater any constituents which can clog or damage pumps, or interfere with subsequent treatment processes. Preliminary treatment devices are, therefore, designed to : (1) Remove or to reduce in size the large, entrained, suspended or floating solids. These solids consist of pieces of wood, cloth, paper, plastics, garbage, etc. together with some fecal matter. (2) Remove heavy inorganic solids such as sand and gravel as well as metal or glass. These objects are called grit. (3) Remove excessive amounts of oils or greases. A number of devices or types of equipment are used to obtain these objectives.

2. Racks and Bar Screens

Ans. These consist of bars usually spaced three-quarter inches to six inches. Those most commonly used provide clear openings of one to two inches. Although large screens are sometimes set vertically, screens are usually set at an angle of 45 to 60 degrees with the vertical. The incoming wastewater is passed through the bars or screens and periodically the accumulated material is removed. The racks or screens may be cleaned either manually or by means of automatically operated rakes. The solids removed by these units can be disposed of by burial or incineration.

2. What is Equalization?

Ans:Simply a well - mixed vessel with fluctuating input flow rates and / or concentration with fairly constant output flow rates and/or concentrations. Processes for waste treatment work best with uniform conditions. Shocks to the bioprocesses in the form of sudden changes in concentrations of nutrients can cause upsets. If the concentrations or flow rates of the waste vary greatly, dosages for treatment must be constantly be readjusted. Consider sedimentation. If the input flow increases suddenly, the settling patterns will be upset to lower collection efficiency. Equalization dampens fluctuations. Flow equalization can improve performance of subsequent steps significantly. Often the rest of the plant can be designed with smaller equipment (less capital investment) because of this improvement in performance. Equalization allows reactions in the equalization tank. There may be aeration both to keep the fluid from becoming anaerobic and smelly and to biodegrade some of the organic compounds present. More important for industrial wastes that can have wide swings in pH is the reaction of acids with bases because otherwise each would have to be neutralized with costs for equipment and reagents. Early in the process, usually following the initial step of collecting debris from the input stream from the sewer.

3. Explain Neutralization

Ans: Chemical reaction, according to the Arrhenius theory of acids and bases, in which a water solution of acid is mixed with a water solution of base to form a salt and water; this reaction is complete only if the resulting solution has neither acidic nor basic properties. Such a solution is called a neutral solution. Complete neutralization can take place when a strong acid, such as hydrochloric acid, HCl, is mixed with a strong base, such as sodium hydroxide, NaOH. Strong acids and strong bases completely break up, or dissociate, into their constituent ions when they dissolve in water. In the case of hydrochloric acid, hydrogen ions, H+, and chloride ions, Cl-, are formed. In the case of sodium hydroxide, sodium ions, Na+, and hydroxide ions, OH-, are formed. The hydrogen and hydroxide ions readily unite to form water. If the number of hydrogen ions in the hydrochloric acid solution is equal to the number of hydroxide ions in the sodium hydroxide solution, complete neutralization occurs when the two solutions are mixed. The resulting solution contains sodium ions and chloride ions that unite when the water evaporates to form sodium chloride, common table salt. In a neutralization reaction in which either a weak acid or a weak base is used, only partial neutralization occurs. In a neutralization reaction in which both a weak acid and a weak base are used, complete neutralization can occur if the acid and the base are equally weak. The heat produced in the reaction between an acid and a base is called the heat of neutralization. When any strong acid is mixed with any strong base, the heat of neutralization is always about 13,700 calories for each equivalent weight of acid and base neutralized. See article on pH; titration.

Two related classes of chemicals; the members of each class have a number of common properties when dissolved in a solvent, usually water.

1. Properties : Acids in water solutions exhibit the following common properties: they taste sour; turn litmus paper red; and react with certain metals, such as zinc, to yield hydrogen gas. Bases in water solutions exhibit these common properties: they taste bitter; turn litmus paper blue; and feel slippery. When a water solution of acid is mixed with a water solution of base, water and a salt are formed; this process, called neutralization, is complete only if the resulting solution has neither acidic nor basic properties.

2. Classification : Acids and bases can be classified as organic or inorganic. Some of the more common organic acids are: citric acid, carbonic acid, hydrogen cyanide, salicylic acid, lactic acid, and tartaric acid. Some examples of organic bases are: pyridine and ethylamine. Some of the common inorganic acids are: hydrogen sulfide, phosphoric acid, hydrogen chloride, and sulfuric acid. Some common inorganic bases are: sodium hydroxide, sodium carbonate, sodium bicarbonate, calcium hydroxide, and calcium carbonate.

4. Volume reduction

Ans:lVolume reduction can be achieved by

i. Classifications of wastes: Concentrated wastewaters of manufacturing process are segregated from dilute wastes as cooling waters, thereby reducing the intensive treatment required.

ii. Conservation of waste water.

iii. Improved process control, improved equipment design and use of different or better quality raw materials etc.

iv. Re-using both treated industrial and municipal effluents as raw water supplies.

v. Elimination of batch or slug discharges of process wastes.(If the waste is discharged in a short period of time, it is usually referred to as a slug discharge.)

This type of waste, because of its concentrated contaminants surge in volume can be troublesome to both treatment plants and receiving streams.

5.Explain Activated Sludge with Flow Equalization Basin

Ans:This option would result in an average flow of 25 mgd (1,095 L/s) into the SBIWTP with a flow equalization basin to accommodate peak flow storage and subsequent off-peak discharge to the secondary activated sludge facility. A flow equalization basin capable of storing advanced-primary-treated peak flows greater than 25 mgd (1,095 L/s) would be constructed for this alternative. A storage volume of 7 million gallons (MG) would be required. Accordingly, the average flow through both the advanced primary and secondary portions of the plant would be 25 mgd (1,095 L/s). Flow through the advanced primary portion of the plant is projected to follow the identified daily flow variations with a low flow from 3.5 mgd (153 L/s) to a peak flow of 50 mgd (2,190 L/s). Before this variable flow enters the secondary facility, it will be equalized by the basin to a steady rate of 25 mgd (1,095 L/s). The flow equalization basin would be located within the existing footprint of the SBIWTP. Other than the flow equalization basin, construction and operation of these facilities were addressed in the 1994 Final EIS and ROD. (A smaller flow equalization basin sized at 5.5 mg, however, was considered as part of the 1997 Final Interim Operation SEIS.) These proposed new activated sludge and related facilities are sized to treat a monthly average organic loading of 370 mg/L BOD_5 and 350 mg/L TSS, and an average flow of 25 mgd (1,095 L/s). The equalization basin facilities are designed to equalize flows to a constant 25 mgd (1,095 L/s). The activated sludge facilities are designed to provide an effluent quality of 19 mg/L BOD_5 and 19 mg/L TSS.

For this alternative, the secondary facility would be sized to treat peak flows up to 50 mgd (2,190 L/s). The number of secondary clarifiers would be doubled from 8 to 16 to accommodate these peaks. Thus, an average flow of 25 mgd (1,095 L/s) with peak flows up to 50 mgd (2,190 L/s) will be treated by both the advanced primary and secondary facilities. The proposed new facilities would be located on the existing footprint of the SBIWTP and on a portion of the Hofer site. Construction and operation of these facilities were addressed in the 1994 Final EIS and ROD. These proposed new activated sludge and related facilities are sized to treat an average monthly organic loading of 370 mg/L BOD_5, 350 mg/L TSS, and an average flow of 25 mgd (1,095 L/s). These facilities are designed to treat peak flows of 50 mgd (2,190 L/s).

UNIT 3

1. Nitrification

2. Rotating biological contractor

3. Denitrification

4. Phosphorous removal from wastewater

5. . Phosphorous removal processes

KEY

1. Nitrification

Ans: Nitrification is the biological process by which ammonia is first converted to nitrite and then to nitrate. Nitrification can be achieved in any aerobic-biological process at low organic loadings and where suitable environmental conditions are provided. Nitrifying bacteria are slower growing than the heterotrophic bacteria, which comprises the greater proportion of the biomass in both fixed film and suspended growth systems. The key requirement for nitrification to occur, therefore, is that the process should be so controlled that the net rate of accumulation of biomass, and hence, the net rate of withdrawal of biomass from the system, is less than the growth rate of the nitrifying bacteria (Barnes and Bliss

• There are two groups of chemoautotrophic bacteria that can be associated with the process of nitrification. • One group (Nitrosomonas) derives its energy through the oxidation of ammonium to nitrite, whereas the other group (Nitrobacter) obtains energy through the oxidation of nitrite to nitrate. Both the groups, collectively called Nitrifiers, obtain carbon required, from inorganic carbon forms. • Nitrification of ammonia to nitrate is a two step process: • 8/2/2017 IARE Hyd 144 • Stoichiometrically, 4.6 kg of oxygen is required for nitrifying 1 kg of nitrogen. • Under steady state conditions, experimental evidence has shown nitrite accumulation to be insignificant. • This suggests that the rate-limiting step for the conversion of ammonium to nitrate is the oxidation of ammonium to nitrite by the genus Nitrosomonas. qc = 1 m where m is the growth rate of nitrosomonas at the worst operating temperature. • Sludge age (or mean cell residence time), qc in a treatment plant must be sufficiently high if nitrification is desired.

2. Rotating biological contractor

Ans:RBC biofilm has an initial adsorption of microorganisms to the disk surface to form 1-4 mm thick biofilm that is responsible for BOD removal in rotating biological contractors. The rotating disks provided a large surface area for the attached biomass. The first stages of an RBC mostly removed organic materials, whereas subsequent stages removed NH3-N as a result of nitrification, when the BOD5 was low enough. Ammonia oxidizers could not effectively compete with the faster-growing heterotrophs that oxidize organic matter. Nitrification occurs only when the BOD was reduced to approximately 14 mg/L, and increases with rotation speed (Weng and Molof, 1974). RBC performance was negatively affected by low dissolved oxygen in the first stages and by low pH in the later stages where nitrification occurred (Hitdlebaugh and Miller, 1981).

An innovative operational process using recirculation in RBC was developed and used to improve nitrification (Klees and Silverstein, 1992). They found that it could improve nitrification at all hydraulic loading rates; the positive effect of recirculation on nitrification was due to the dilution of influent organic carbon. Degradable organic carbon inhibits nitrification at concentrations greater than 15-20 mg/L BOD5; extremely low concentrations of influent BOD5 (less than 10 mg/L) did not improve nitrification.
Figueroa and Silverstein (1992) studied the effect of particulate organic matter on biofilm nitrification in a pilot RBC. For a range of 12 and 82 mg/L total BOD to the pilot RBC, particulate BOD was found to inhibit nitrification to the same degree as soluble BOD. Total influent organic matter was found to be a better predictor of nitrification than soluble organic matter concentration. The inhibition of nitrification by particulate BOD suggested that clarified influent should be used for nitrifying the biofilm process.
Dunn, et al. (1984), investigated the nitrification process with a biofilm fluidized reactor. The bed was designed cone-shaped and filled with 0.2-0.3 mm diameter quartz sand. With three years of operation under a loading rate of 5.2 l/hr, recycle rate of 84 l/hr and NH4-N concentration of 45 mg/L, the maximum nitrification rate was observed as 134 mg N/g MLSS/hr for

Nitrosomonas, and 120 mg N/MLSS/hr for Nitrobacter. Optimum pH value was found to be around 7.8; optimum temperature was found between 30-40 C.

Tijhuis, et al. (1992), studied the development of nitrifying biofilms, as well as the short- and long-term influence on the nitrification capacity in a Biofilm-Airlift-Suspension-Reactor. They found that the specific nitrification capacity during start-up was constant, 1 g N/g TOC/d, which was high compared to the activated sludge process. The influence of the temperature on the nitrification rate was much less than could be expected from the pure culture experiments, and the maximum nitrification rate during the experiment was 6 kg N/m3/d, which was also relatively high compared to the activated sludge process.

3. Denitrification

Ans: Denitrification is the biological process by which nitrate is converted to nitrogen and other gaseous end products. The requirements for the denitrification process are: a) nitrogen present in the form of nitrates; b) an organic carbon source, and c) an anaerobic environment. The processes currently used for biological denitrification are presented as follows.

Continuous flow stirred reactor (CFSR): Moore and Schroeder (1971) investigated effects of nitrate feed rate and cell residence time on complete mixed continuous-flow stirred-reactor (CFSR) operated at the steady state. They concluded that denitrification processes could be operated at near maximum unit removal rates and still obtained acceptable nitrogen conversion (less than 2 mg of NO3-N/L in the denitrified effluent). Stensel, et al. (1973), also indicated that cell retention time in the reactor would depend on the organic carbon requirement and nitrate removal efficiency. An SRT of at least 4 days was recommended for design at 20 C and 30 C. An SRT of at least 8 days was recommended for design at 10 C.

Activated sludge systems

Lesouef, et al. (1992), demonstrated a test on a two zone in activated sludge systems and showed to be capable of removing 75% of the total N from about 30 mg TN/L in the feed to < 10 mg TN/L in the effluent. The multiple anoxic zones with a step feed process had recently been modeled and appeared to be the most cost effective denitrification option because it made the fullest use of the carbon that was present in the feed as the carbon source for step feed denitrification.

Fixed film reactor

Nurizzo and Mezzanatte (1992) studied denitrification results from a fixed-film anoxic sand reactor used for the treatment of drinking water. The anoxic reactor was operated downflowat 20 m3/h with a nitrate loading of 0.4-1.5 kg NO3-N/m3/d. They found that nitrate removal rates using sugar or glucose syrup as organic carbon sources were usually greater than 95%.

Fluidized bed biofilm reactor

Denitrification was performed in a fluidized-bed biofilm reactor using activated carbon particles (1.7 mm diam) as the carrier and molasses as the carbon source (Coelhoso, et al., 1992). The experimental results illustrated that the average cell residence was in the range 6.7-15.4 hours, which means biofilm was developed in a fast way; nitrogen removal was 5.3-8.6 kg NO3-N/m3/day. Experimental profiles of nitrate and nitrite were modeled by two consecutive zero-order reactions coupled with substrate diffusion into the biofilm.

Fluidized Bed Biofilm Reactor (FBBR) was also studied by Jesis and Owen (1977). It was found that the use of small, fluidized media enabled the FBBR to retain high biomass concentrations and, thereby, operated at significantly reduced hydraulic retention times. It was also reported that when the volatile solid concentrations were between 30,000 to 40,000 mg/L (when the pilot-scale denitrification was employed), 99% of influent nitrates could be removed at an empty bed with hydraulic retention times as low as 6 minutes.

4. Phosphorous removal from wastewater

Ans: Controlling phosphorous discharged from municipal and industrial wastewater treatment plants is a key factor in preventing eutrophication of surface waters. Phosphorous is one of the major nutrients contributing in the increased eutrophication of lakes and natural waters. Its presence causes many water quality problems including increased purification costs, decreased recreational and conservation value of an impoundments, loss of livestock and the possible lethal effect of algal toxins on drinking water.

Phosphate removal is currently achieved largely by chemical precipitation, which is expensive and causes an increase of sludge volume by up to 40%. An alternative is the biological phosphate removal (BPR).

Phosphorous in wastewater

Municipal wastewaters may contain from 5 to 20 mg/l of total phosphorous, of which 1-5 mg/l is organic and the rest in inorganic. The individual contribution tend to increase, because phosphorous is one of the main constituent of synthetic detergents. The individual phosphorous contribution varies between 0.65 and 4.80 g/inhabitant per day with an average of about 2.18 g. The usual forms of phosphorous found in aqueous solutions include:

- Orthophosphates: available for biological metabolism without further breakdown
- Polyphosphates: molecules with 2 or more phosphorous atoms, oxygen and in some cases hydrogen atoms combine in a complex molecule. Usually polyphosphates undergo hydrolysis and revert to the orthophosphate forms. This process is usually quite slow.

Normally secondary treatment can only remove 1-2 mg/l, so a large excess of phosphorous is discharged in the final effluent, causing eutrophication in surface waters. New legislation requires a maximum concentration of P discharges into sensitive water of 2 mg/l.

5. Phosphorous removal processes

Ans: The removal of phosphorous from wastewater involves the incorporation of phosphate into TSS and the subsequent removal from these solids. Phosphorous can be incorporated into either biological solids (e.g. microorganisms) or chemical precipitates.

Phosphate precipitation

Chemical precipitation is used to remove the inorganic forms of phosphate by the addition of a coagulant and a mixing of wastewater and coagulant. The multivalent metal ions most commonly used are calcium, aluminium and iron.

Calcium:

it is usually added in the form of lime $Ca(OH)_2$. It reacts with the natural alkalinity in the wastewater to produce calcium carbonate, which is primarily responsible for enhancing SS removal.

$Ca(HCO_3)_2 + Ca(OH)_2$ à $2CaCO_3 \downarrow + 2H_2O$

As the pH value of the wastewater increases beyond about 10, excess calcium ions will then react with the phosphate, to precipitate in hydroxylapatite:

$10\ Ca^{2+} + 6\ PO_4^{3-} + 2\ OH^- \leftrightarrow Ca_{10}(PO_4)*6(OH)_2 \downarrow$

Because the reaction is between the lime and the alkalinity of the wastewater, the quantity required will be, in general, independent of the amount of phosphate present. It will depend primarily on the alkalinity of the wastewater. The lime dose required can be approximated at 1.5 times the alkalinity as $CaCO_3$. Neutralisation may be required to reduce pH before subsequent treatment or disposal. Recarbonation with carbon dioxide (CO_2) is used to lower the pH value.

Aluminium and Iron:

Alum or hydrated aluminiumsulphate is widely used precipitating phosphates and aluminium phosphates ($AlPO_4$). The basic reaction is:

$Al^{3+} + H_nPO_4^{3-n} \leftrightarrow AlPO_4 + nH^+$

This reaction is deceptively simple and must be considered in light of the many competing reactions and their associated equilibrium constants and the effects of alkalinity, pH, trace elements found in wastewater. The dosage rate required is a function of the phosphorous removal required. The efficiency of coagulation falls as the concentration of phosphorous decreases. In practice, an 80-90% removal rate is achieved at coagulant dosage rates between 50 and 200 mg/l. Dosages are generally established on the basis of bench-scale tests and occasionally by full-scale tests, especially if polymers are used. Aluminium coagulants can adversely affect the microbial population in activated sludge, especially protozoa and rotifers, at dosage rates higher than 150 mg/l.

Ferric chloride or sulphate and ferrous sulphate also know as copperas, are all widely used for phosphorous removal, although the actual reactions are not fully understood. The basic reaction is:

$Fe^{3+} + H_nPO_4^{3-n} \leftrightarrow FePO_4 + nH^+$

Ferric ions combine to form ferric phosphate. They react slowly with the natural alkalinity and so a coagulant aid, such as lime, is normally add to raise the pH in order to enhance the coagulation.

The removal of phosphorous from wastewater involves the incorporation of phosphate into TSS and the subsequent removal from these solids. Phosphorous can be incorporated into either biological solids (e.g. microorganisms) or chemical precipitates.

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Strategies

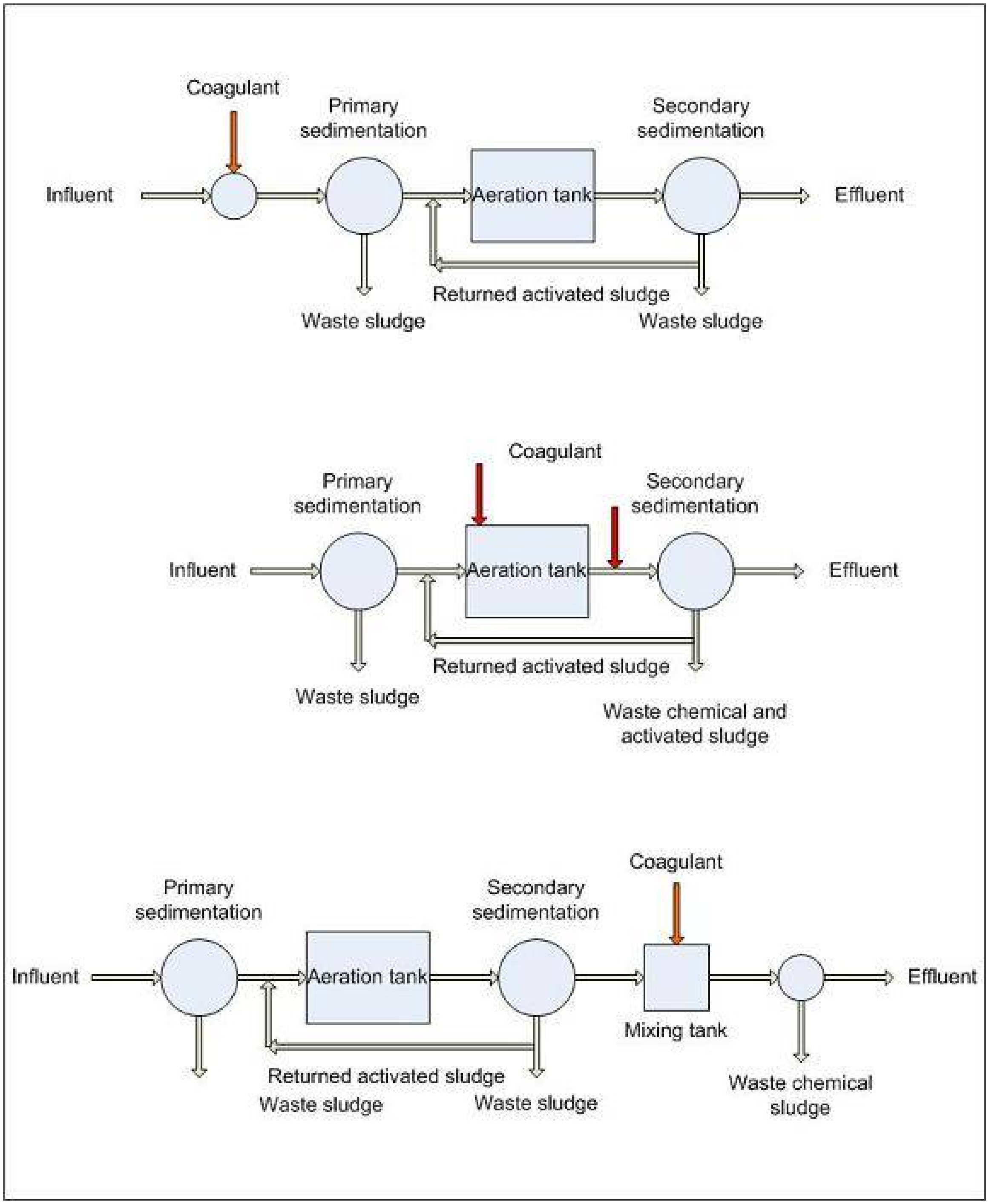
The main phosphate removal processes are (see picture below):

1. Treatment of raw/primary wastewater
2. Treatment of final effluent of biological plants (postprecipitation)
3. Treatment contemporary to the secondary biologic reaction (co-precipitation).

The first process is included in the general category of chemical precipitation processes. Phosphorous is removed with 90% efficiency and the final P concentration is lower than 0.5 mg/l. The chemical dosage for P removal is the same as the dosage needed for BOD and SS removal, which uses the main part of these chemicals. As mentioned above lime consumption is dependent on the alkalinity of the wastewater: only 10% of the lime fed is used in the phosphorous removal reaction. The remaining amount reacts with water alkalinity, with softening.

The postprecipitation is a standard treatment of a secondary effluent, usually using only metallic reagents. It is the process that gives the highest efficiency in phosphorous removal. Efficiency can reach 95%, and P concentration in the effluent can be lower than 0.5 mg/l. Postprecipitation gives also a good removal of the SS that escape the final sedimentation of the secondary process. Using ferric salts there is also the risk of having some iron in the effluent, with residual coloration. The metallic ions dosage is about 1.5-2.5 ions for every phosphorus ion (on average about 10-30 g/mc of water).

The coprecipitation process is particularly suitable for active sludge plants, where the chemicals are fed directly in the aeration tank or before it. The continuous sludge recirculation, together with the coagulation-flocculation and adsorption process due to active sludge, allows a reduction in chemical consumption.



UNIT 4

1. Characteristics of wastewaters

2. Explain sugarcane processing

3. Write the Process Description of Sugar Industry**.**

4. Explain modern production process.

5. What are the material required for food processing industries

1. Characteristics of wastewaters

Ans:Municipal wastewater is mainly comprised of water (99.9%) together with relatively small concentrations of suspended and dissolved organic and inorganic solids. Among the organic substances present in sewage are carbohydrates, lignin, fats, soaps, synthetic detergents, proteins and their decomposition products, as well as various natural and synthetic organic chemicals from the process industries. Table shows the levels of the major constituents of strong, medium and weak domestic wastewaters. In arid and semi-arid countries, water use is often fairly low and sewage tends to be very strong.

Constituent Concentration, mg/l

	Strong	Medium	Weak
Total solids	1200	700	350
Dissolved solids (TDS)[1]	850	500	250
Suspended solids	350	200	100
Nitrogen (as N)	85	40	20
Phosphorus (as P)	20	10	6
Chloride[1]	100	50	30
Alkalinity (as $CaCO_3$)	200	100	50
Grease	150	100	50
BOD_5[2]	300	200	100

The amounts of TDS and chloride should be increased by the concentrations of these constituents in the carriage water. BOD_5 is the biochemical oxygen demand at 20°C over 5 days and is a measure of the biodegradable organic matter in the wastewater. Municipal wastewater also contains a variety of inorganic substances from domestic and industrial sources (see Table 3), including a number of potentially toxic elements such as arsenic, cadmium, chromium, copper, lead, mercury, zinc, etc. Even if toxic materials are not present in concentrations likely to affect humans, they might well be at phytotoxic levels, which would limit their agricultural use. However, from the point of view of health, a very important consideration in agricultural use of wastewater, the contaminants of greatest concern are the pathogenic micro- and macro-organisms.

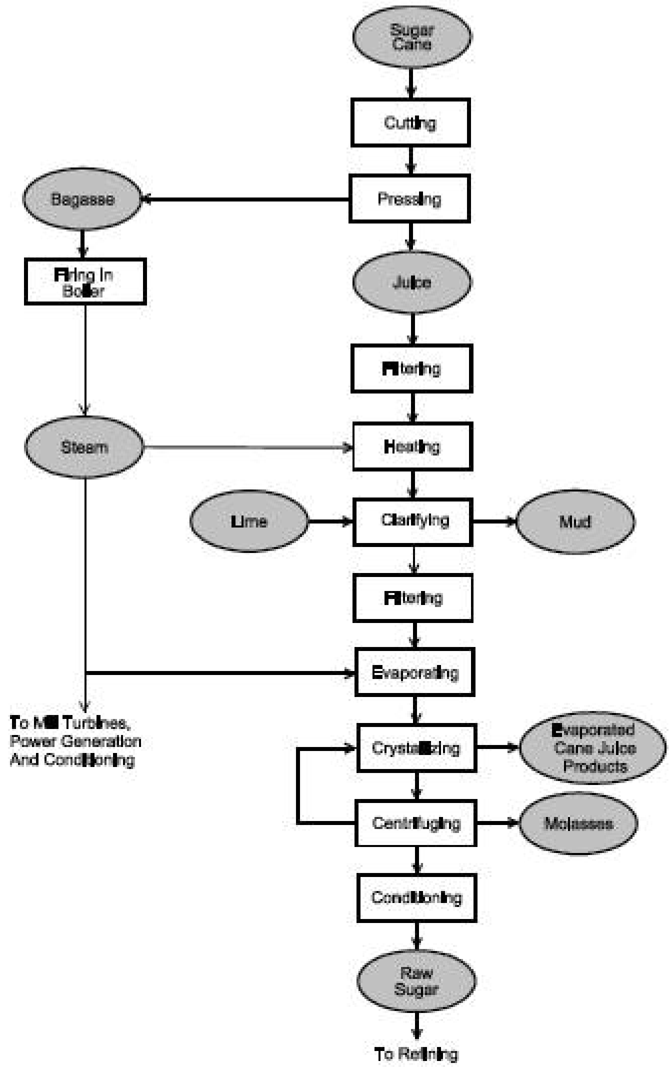
2. Explain sugarcane processing

Ans: Cane Sugar Processing: Cane sugar is processed in two major steps: producing raw sugar and refining it. Although both steps can be done in the same facility, the usual arrangement is for the sugar mill to produce the raw sugar and ship it to the sugar refinery. More recently, a trend has begun to build facilities that can both produce and refine the raw sugar. The processes in the mill and refinery are very similar. However, the sugar mill usually operates only right after the cane harvest. The refinery can store raw sugar and operate year round.

Cane Sugar Mills: Cane sugar mills process cane juice into a material called raw sugar. Raw sugar can then be stored in piles until needed by the refineries.Cutting And Pressing: Sugar cane is transported by rail or truck, and is unloaded onto a conveyor belt. Rotating cane knives cut the cane into smaller pieces, called billets. A series of turbine-driven presses, also called mills, tandems or stands, then squeeze out the juice. This operation is also known as grinding.

Clarifying: The cane juice is filtered and heated. Lime is added, and impurities fall to the bottom of the clarifying vessel as a precipitate, or mud. The clarified juice is then filtered again. This part of the process presents little hazard.
Crystallizing: Clarified juice is sent to steam-heated evaporators. In the evaporators, water is boiled from the juice under vacuum. Then the juice is sent to crystallizers to cool under vacuum. The rate of cooling must be closely controlled. This leaves a mixture of sugar crystals and molasses called massecuite. The steam heating system, the evaporators and the crystallizers are pressure vessels subject to rupture.
Centrifuging: Molasses is removed from the massecuite by rinsing the sugar crystals in centrifuges. Some sugar mills call these centrifugals. The molasses can be sold for animal feed, or it can be further processed for human consumption. The raw sugar is sent back through the crystallizing and centrifuging processes two or three more times. When finished, the raw sugar is sent to the refinery. Centrifuges can suffer mechanical breakdown typical of rotating equipment.

Conditioning: Some grades of raw sugar are conditioned, or dehumidified, to reduce clumping. Conditioning is usually done in steam-heated fluidized bed dryers. The hazards include fuel fired equipment and bag houses.



3. Write the Process Description of Sugar Industry.

Ans: The various steps involved for the production of Sugar are as follows:

1. Procurement of Sugarcane.
2. Milling of Sugarcane.
3. Juice Preparation.
4 Juice Concentration.
5. Syrup Processing and Crystallization.
6 Sugar Crystal Separation, Drying, Packaging and Molasses Handling.
7. Bagasse Utilization.
8. Explain sugarcane industry process.

The Sugarcanes are cut into pieces and crushed in a series of rollers to extract the juice, in the 'mill house'. The milk of lime is then added to the juice and heated, when all the colloidal and suspended impurities are coagulated. During this treatment, much of the colour is also removed.

The coagulated juice is then clarified to remove the sludge. The clarifier sludge is further filtered through filter presses and then disposed off as solid waste. The filtrate is recycled to the process and the entire quantity of clarified juice is treated by passing sulphur dioxide gas through it. This process is known as "Sulphitation" colour of the juice is completely bleached out in this process.

1. Procurement of Sugarcane:

An early variety of Sugarcane matures by second week of November. The late variety of Sugarcane matures towards the middle of the season. Depending upon the state of maturity, the Sugarcane is harvested in the field, where the roots and green leaves are removed manually and the Sugarcane is prepared for transportation to the factory. Depending on the location of the field, the cane is transported to the factory by bullock carts, tractor trolleys and trucks to the factory.

2. Milling of Sugarcane:

The Sugarcane is unloaded at the mill house by winch and crab on to the cane carrier, which feeds the fiberizing system. Here the Sugarcane is shredded into small pieces. The shredded Sugar cane is then squeezed through a series of pressure milling rolls containing grooved surface. Weak juice or water is added to last but one roller so that recovery of juice is of the order 95-97%.

3. Juice Preparation:

Double Sulphitation process is the latest process adopted for juice clarification. In this process, juice is heated at 70°C and is treated with lime and sulphur dioxide. The juice is adjusted to neutral pH and passed to the heat exchanger to raise its temperature to the boiling point. It is then sent to clarifier where the juice is clarified and then sent to multiple effect evaporators. The sediment from the clarifier is sent to vacuum filters. The juice mud is taken out as solid waste and the extracted juice is mixed with raw juice.

4. Juice Concentration:

The clarified juice is concentrated to about 65% solids from about 15% solids before entering the first multiple effect evaporator sending steam in the first evaporator. Vapours from the first evaporation are fed to the second evaporator and so on.

5. Syrup Processing and Crystallization:

The concentrated juice or syrup from the evaporator is again bleached by passing sulphur dioxide through it and the pH of the syrup drops down to about 5.4. It is then sent to the vacuum pan where the thickened syrup is boiled for three to four times as per purity in order to extract the sucrose content. It is then sent to crystallizers to deposit any additional sucrose content on the crystals. Fine Sugar is used as seed crystals.

6. Sugar Crystal Separation, Drying, Packing and Molasses Handling:

The Mixture of crystals and liquor, called ‘massecuite’, is sent to high-speed centrifuges. The liquor is re-concentrated and cooled successively to obtain more than one crops of crystals. The final mother liquor, called ‘Molasses’, which is still very rich in Sugar content is sent to steel storage tanks. Molasses is sold to various distilleries and other users against permit issued by excise department.

7. Bagasse Utilization:

The pulp expelled after extraction of juice is called ‘Bagasse’. As it comes out of the mill house, it contains about 50% moisture. A number of drying processes have been tried in the industry but unfortunately none of these were found industrially viable. Therefore, the wet Bagasse with 50% moisture is carried to boiler house by Bagasse carrier. It is able to generate about 2 kg of steam per kg on wet basis itself. With efficient boilers coming in the market.

4. Explain modern production process

Ans: Modern steelmaking can be broken down into six steps:

1. Iron making: In the first step, the raw inputs iron ore, coke, and lime are melted in a blast furnace. The resulting molten iron - also referred to as 'hot metal' - still contains 4-4.5% carbon and other impurities that make it brittle.

2. Primary Steelmaking: Primary steelmaking methods differ between BOS and EAF methods. BOS methods add recycled scrap steel to the molten iron in a converter. At high temperatures, oxygen is blown through the metal, which reduces the carbon content to between 0-1.5%. EAF methods, alternatively, feed recycled steel scrap through use high power electric arcs (temperatures up to 1650 °C) to melt the metal and convert it to high-quality steel.

3. Secondary Steelmaking: Secondary steelmaking involves treating the molten steel produced from both BOS and EAF routes to adjust the steel composition. This is done by adding or

removing certain elements and/or manipulating the temperature and production environment.Depending on the types of steel required, the following secondary steelmaking processes can be used:

- stirring
- ladle furnace
- ladle injection
- degassing

4. Continuous Casting: In this step, the molten steel is cast into a cooled mold causing a thin steel shell to solidify. The shell strand is withdrawn using guided rolls and fully cooled and solidified. The strand is cut into desired lengths depending on application; slabs for flat products (plate and strip), blooms for sections (beams), billets for long products (wires) or thin strips.

5. Primary Forming: The steel that is cast is then formed into various shapes, often by hot rolling, a process that eliminates cast defects and achieves the required shape and surface quality. Hot rolled products are divided into flat products, long products, seamless tubes, and specialty products.

6. Manufacturing, Fabrication, and Finishing: Finally, secondary forming techniques give the steel its final shape and properties.

These techniques include:

- shaping (e.g. cold rolling)
- machining (e.g. drilling)
- joining (e.g. welding)
- coating (e.g. galvanizing)
- Heat treatment (e.g. tempering)
- Surface treatment (e.g. carburizing)

5. What are the material required for food processing industries

Ans: Food processing industries process natural materials, which vary in quality and composition. Therefore, processes might be uncontrollable in their yield or the quality of the output. The result is a downstream effect on the Decoupling Point: delivery is buffered against the unpredictable production by placing a certain amount of inventory after that process. leaning times and set-ups are another important factor in the processing of food. Large (sequence-dependent) set-ups especially have a downstream effect on the location of the Decoupling Point. We already mentioned the perish ability of food; products might easily become obsolete, due to the limited shelf- lives of food products. As mentioned, products might become obsolete even if the best-before date is not reached. The last point to consider is the value of stock to which two factors are relevant: the value added in the process and the value of purchased materials. A high value added stimulates an upstream movement of the Decoupling Point, as it is more profitable to stock low-value materials instead of high-value finished products. However, if the value of the raw materials is relatively high (e.g. tobacco, coffee beans) and purchase of the raw materials can not be postponed, then the location of the Decoupling Point is not relevant for this aspect.

UNIT 5

1. Explain chemical treatment in textile industry?
2. Explain biological treatments in textile industry
3. Describe the tanning-process
4. What are the wastes from Nuclear Power Plants?
5. What are the characteristics Sewage?

1. Explain chemical treatment in textile industry?

Ans:Oxidative processes: Chemical oxidation represents the conversion or transformation of pollutants by chemical oxidation agents other than oxygen/air or bacteria to similar but less harmful or hazardous compounds and/or to short-chained and easily biodegradable organic components (aromatic rings cleavage of dye molecules). The modern textile dyes are resistant to mild oxidation conditions such those existing in biological treatment systems. Therefore, efficient dye and colour removal must be accomplished by more powerful oxidising agents such as chlorines, ozone, Fenton reagents,UV/peroxide, UV/ozone, or other oxidising procedures or combinations. Oxidative processes with hydrogen peroxide. The oxidation processes with hydrogen peroxide (oxidation potential, E°= 1.80 V at pH 0, and E°= 0.87 V at pH 14) can be explored as wastewater treatment alternatives in two systems: (1) homogenous systems based on the use of visible or ultraviolet light, soluble catalysts (Fenton reagents) and other chemical activators (e.g. ozone, peroxides etc.) and heterogenous systems based on the use of semiconductors, zeolites, clays with or without ultraviolet light, such as TiO2, stable modified zeolites with iron and aluminium

2. Ozonation process**:** Ozone is a powerful oxidizing agent (oxidation potential, E°= 2.07 V) capable of cleavage the aromatic rings of some textile dyes and decomposition of other organic pollutants from industrial effluents. The ozone decomposes the organic dyes with conjugated double bonds forming smaller molecules with increased carcinogenic or toxic properties, and so ozonation may be used alongside a physical method to prevent this (i.e.irradiation, membrane separation, adsorption, etc). Ozone can react directly or indirectly with dye molecules. In the direct pathway, the ozone molecule is itself the electron acceptor and hydroxide ions (i.e. pH > 7-8) catalyze the auto decomposition of ozone to hydroxyl radicals (·OH) in aqueous effluents (very strong and non-selective oxidants) which react with organic and inorganic chemicals. At low pH ozone efficiently reacts with unsaturated chromophoric bonds of a dye molecule via direct reactions

3. Oxidation process with sodium hypochlorite: This treatment implies the attack at the amino group of the dye molecule by Cl2, initiating and accelerating azo-bond cleavage. The increasing of chlorine concentration favors the dye removal and decolourization process, and also the decreasing of pH. The dye containing amino or substituted amino groups on the naphthalene ring (i.e. dyes derived from amino-naphtol- and naphtylamino-sulphonicacids) are most susceptible for chlorine decolourization.

2. Explain biological treatments in textile industry

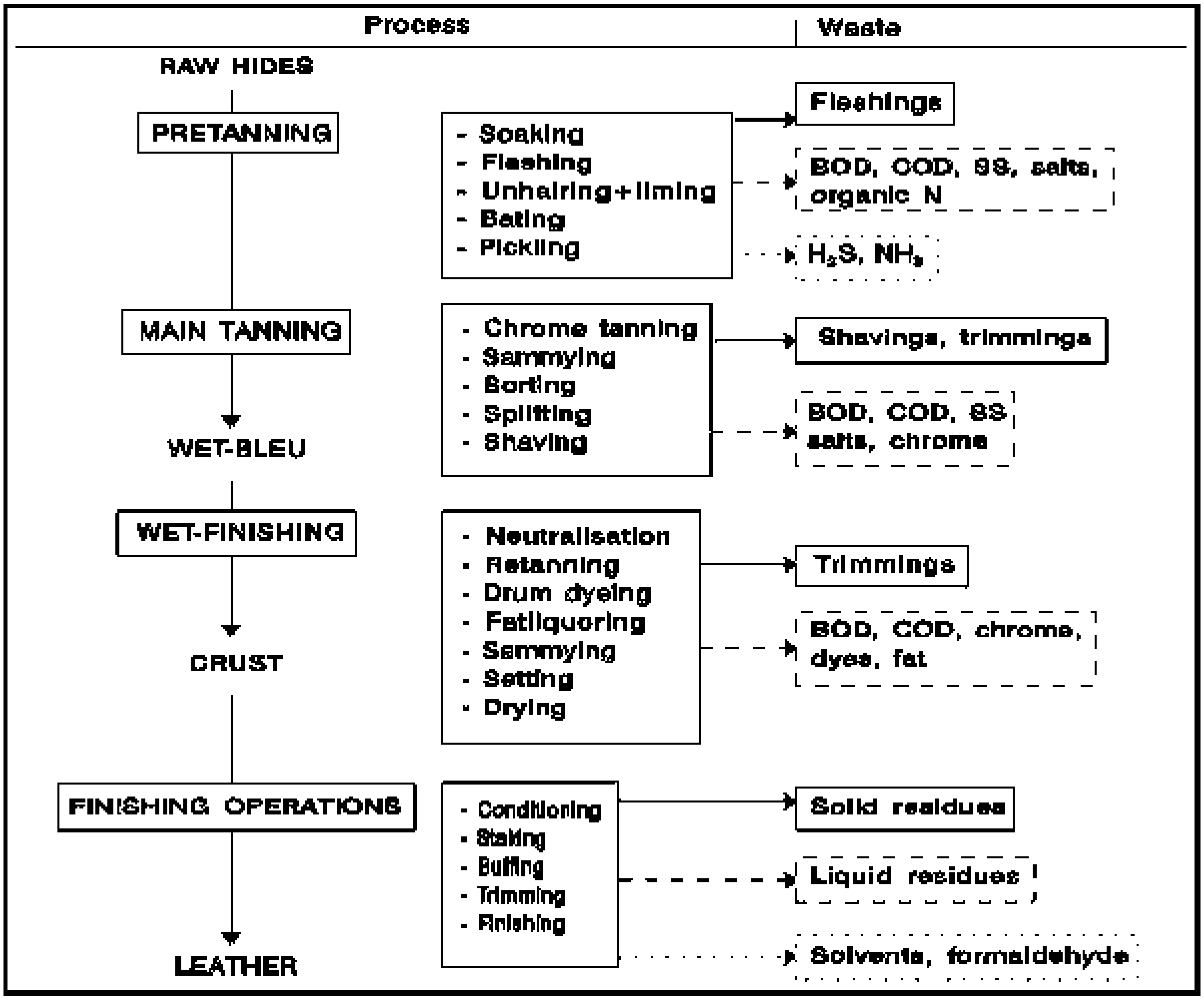
Ans: Biological treatments are considered reproduction, artificially or otherwise, of self-purification phenomena existing in natural environment. There are different biological treatments, performed in aerobic or anaerobic or combined anaerobic/aerobic conditions. The processing, quality, adaptability of micro organisms and the reactor type are decisive parameters for removal efficiency. To avoid that risk, anaerobic/aerobic sequential reactor systems seem to be an efficient procedure (i.e .efficient colour removal takes place during the anaerobic treatment, and high reduction of aromatic amines and other organic compounds occurs during the subsequent aerobic treatment). Under aerobic conditions, most of the azo dye metabolites are quickly degraded by oxidation of the substituents or of the side branches. However, some of them are still rather recalcitrant. Successful removal of poorly degradable amines was often achieved by adaptation of microorganisms

Anaerobic biodegradation of azo and other water-soluble dyes is mainly reported as an oxidation-reduction reaction with hydrogen, and formation of methane, hydrogen sulphide, carbon dioxide, other gaseous compounds, and releasing electrons. The electrons react with the dye reducing the azo bonds, causing the effluent decolourization.

3. Describe the tanning-process

Ans: The flow diagram of a tanning-process. Hides are a by-product of slaughter activities and can be processed into a wide range of end products. For each end product, the tanning process is different and the kind and amount of waste produced may vary enormously.

The chemicals traditionally used for tanning have been derived from plants, whereas the most common process nowadays is a combination of chrome salts (chrome tanning) and readily usable vegetable extracts (vegetable tanning) (Buljan 1994). While chrome tanned shoe leather is the most widely produced leather, this kind of leather will receive most attention in the following.



Soaking: The preserved raw hides regain their normal water contents. Dirt, manure, blood, preservatives (sodium chloride, bactericides) etc. are removed.
Fleshing and trimming: Extraneous tissue is removed. Unhairing is done by chemical dissolution of the hair and epidermis with an alkaline medium of sulphide and lime. When after skinning at the slaughterhouse, the hide appears to contain excessive meat, fleshing usually precedes unhairing and liming.
Bating: The unhaired, fleshed and alkaline hides are neutralized (deliming) with acid ammonium salts and treated with enzymes, similar to those found in the digestive system, to remove hair remnants and to degrade proteins. During this process hair roots and pigments are removed. The hides become somewhat softer by this enzyme treatment.
Pickling: Pickling increases the acidity of the hide to a pH of 3, enabling chromium tannins to enter the hide. Salts are added to prevent the hide from swelling. For preservation purposes, 0.03 2 weights present of fungicides and bactericides are applied.

4. What are the wastes from Nuclear Power Plants?

Ans: Nuclear power plants generate all forms of wastes—gaseous, liquid, and solid wastes. Their characteristics vary depending on the reactor type. The following sections describe the waste generated by boiling water reactors (BWRs) and pressurized water reactors (PWRs).

1. Gaseous Wastes: The filters used in the standby gas treatment system are designed to provide sufficient efficiency to remove 99.9 % or more of the iodine and particulate matter from the air released from the reactor building to the stack in the event of an accident. In a BWR, off-gas from the reactor is transferred to the turbine together with steam through the main stream pipe.

2. Liquid Wastes: The liquid waste treatment system separates both radioactive effluent and effluent potentially contaminated with radioactive material generated in the power plant according to characteristics, then collects and treats them. The treated water is reused in the power plant or discharged to the environment after assessment of the radioactivity concentration.

3. Solid Wastes: Solid wastes from nuclear power plants are classified into the following types and managed according to their properties.

   1. Sludge: This is stored in the sedimentation tank in the water purification system or solidified with cement or other material after storage for radioactive decay.
   2. Spent resin: This is stored in the spent resin tank for radioactive decay, before being incinerated at miscellaneous solid waste treatment facilities or solidified with cement or other material. The annual generation volume of spent exchange resin per reactor is 20m3 for a BWR and 4–7 m3 for a PWR.
   3. Combustible miscellaneous solid wastes: These are incinerated in incineration facilities for volume reduction. Incineration ash is stored in metal drums.
   4. Incombustible miscellaneous solid wastes: These are compacted for volume reduction if possible. In some power plants they may subjected to melting.

5. What are the characteristics Sewage?

Ans: Characterization of wastes is essential for an effective and economical waste management programme. It helps in the choice of treatment methods deciding the extent of treatment, assessing the beneficial uses of wastes and utilizing the waste purification capacity of natural bodies of water in a planned and controlled manner. While analysis of waste in each particular case is advisable and the data from other cities may be utilized during initial stage of planning.

Domestic sewage comprises spent water from kitchen, bathroom, lavatory, *etc*. The factors which contribute to variations in characteristics of the domestic sewage are daily per capita use of water, quality of water supply and the type, condition and extent of sewerage system, and habits of the people. Municipal sewage, which contains both domestic and industrial waste water, may differ from place to place depending upon the type of industries and industrial establishment. The important characteristics of sewage are discussed here.

Temperature: The observations of temperature of sewage are useful in indicating solubility of oxygen, which affects transfer capacity of aeration equipment in aerobic systems, and rate of biological activity .Extremely low temperature affects adversely on the efficiency of biological treatment system sand on efficiency of sedimentation. In general, under Indian condition the temperature of the raw sewage was observed to be between 15 to 350C at various places in different seasons.

The pH: The hydrogen ion concentration expressed as pH, is a valuable parameter in the operation of biological units. The pH of the fresh sewage is slightly more than the water supplied to the community. However, decomposition of organic matter may lower the pH, while the presence of
industrial wastewater may produce extreme fluctuations. Generally the pH of raw sewage is in the range 5.5 to 8.0.

Colour and Odour: Fresh domestic sewage has a slightly soapy and cloudy appearance depending upon its concentration. As time passes the sewage becomes stale, darkening in colour with a pronounced smell due to microbial activity.

Solids: Though sewage contains only about 0.1 percent solids, the rest being water, still the nuisance caused by the solids cannot be overlooked, as these solids are highly putrescible and therefore need proper disposal. The sewage solids may be classified into dissolved solids, suspended solids and volatile suspended solids. Knowledge of the volatile or organic fraction of solid, which decomposes, becomes necessary, as this constitutes the load on biological treatment units or oxygen resources of a stream when sewage is disposed of by dilution. The estimation of suspended solids, both organic and inorganic, gives a general picture of the load on sedimentation and grit removal system during sewage treatment. Dissolved inorganic fraction is to be considered when sewage is used for land irrigation or any other reuse is planned.

Nitrogen and Phosphorus: The principal nitrogen compounds in domestic sewage are proteins, amines, amino acids, andurea. Ammonia nitrogen in sewage results from the bacterial decomposition of these organic constituents. Nitrogen being an essential component of biological protoplasm, its concentration is important for proper functioning of biological treatment systems and disposal on land.

Chlorides: The chloride concentration in excess than the water supplied can be used as an index of the strength of the sewage. The daily contribution of chlorides averages to about 8 gm per person.
Based on an average sewage flow of 150 LPCD, this would result in the chloride content of sewage being 50 mg/L higher than that of the water supplied.

Organic Material: Organic compound present in sewage are of particular interest for sanitary engineering. A large variety of microorganisms (that may be present in the sewage or in the receiving water body) interact with the organic material by using it as an energy or material source. The utilization of the organic material by microorganisms is called metabolism. The conversion of organic material by microorganism to obtain energy is called catabolism and the incorporation of organic material in the cellular material is called anabolism.

16 UNIT WISE-QUESTION BANK

UNIT –I

TWO MARK QUESTIONS WITH ANSWERS

1. Organic chemicals industry

Ans:A range of industries manufacture or use complex organic chemicals. These include pesticides, pharmaceuticals, paints and dyes, petrochemicals, detergents, plastics, paper pollution, etc. Waste waters can be contaminated by feedstock materials, by-products, product material in soluble or particulate form, washing and cleaning agents, solvents and added value products such as plasticizers.

2. Explain wastewater coming from Iron and steel industry

Ans: The production of iron from its ores involves powerful reduction reactions in blast furnaces. Cooling waters are inevitably contaminated with products especially ammonia and cyanide. Production of coke from coal in coking plants also requires water cooling and the use of water in by-products separation.

3. **What ae the Physical characteristics of Industrial Wastewater**

Ans: The principal of physical characteristics of wastewater include Solids,colour, odour and temperature. Total Solids

4. Bio Chemical Oxygen Demand:

Ans: It is usually exerted by Dissolved and Colloidal Organic Matter and imposes a load on the Biological units of the Treatment Plant. Oxygen must be
provided so that Bacteria can grow and oxidise the organic matter. An Added B.O.D load, caused by an increase in Organic Waste, requires more Bacterial Activity, more oxygen, and greater Biological Unit capacity for its Treatment, which (makes) increases the capital cost and operating cost.

5. **Explain wastewater coming from Mines and quarries**

Ans: The principal waste-waters associated with mines and quarries are slurries of rock particles in water. These arise from rainfall washing exposed surfaces and haul roads and also from rock washing and grading processes. Volumes of water can be very high especially rainfall related arising on large sites. Some specialized separation operations, such as coal washing to separate coal from native rock using density gradients, can produce wastewater contaminated by fine particulate haematite and surfactants.

THREE MARK QUESTIONS WITH ANSWERS

1. Explain wastewater coming from Food industry

Ans: Wastewater generated from agricultural and food operations has distinctive characteristics that set it apart from common municipal wastewater managed by public or private sewage treatment plants throughout the world: it is biodegradable and non-toxic, but has high concentrations of biochemical oxygen demand (BOD) and suspended solids (SS).[3] The constituents of food and agriculture wastewater are often complex to predict, due to the differences in BOD and pH in effluents from vegetable, fruit, and meat products and due to the seasonal nature of food processing and post-harvesting.

Processing of food from raw materials requires large volumes of high grade water. Vegetable washing generates waters with high loads of particulate matter and some dissolved organic matter. It may also contain surfactants.

2.Explain wastewater coming from Electric power plants

Ans: Fossil-fuel power stations, particularly coal-fired plants, are a major source of industrial wastewater. Many of these plants discharge wastewater with significant levels of metals such as lead, mercury, cadmium and chromium, as well as arsenic, selenium and nitrogen compounds (nitrates and nitrites). Wastewater streams include flue-gas desulfurization, fly ash, bottom ash and flue gas mercury control. Plants with air pollution controls such as wet scrubbers typically transfer the captured pollutants to the wastewater stream.[2]

Ash ponds, a type of surface impoundment, are a widely used treatment technology at coal-fired plants. These ponds use gravity to settle out large particulates (measured as total suspended solids) from power plant wastewater. This technology does not treat dissolved pollutants. Power stations use additional technologies to control pollutants, depending on the particular waste stream in the plant. These include dry ash handling, closed-loop ash recycling, chemical precipitation, biological treatment (such as an activated sludge process), and evaporation.[2]

3. Explain wastewater coming from Iron and steel industry

Ans: The production of iron from its ores involves powerful reduction reactions in blast furnaces. Cooling waters are inevitably contaminated with products especially ammonia and cyanide. Production of coke from coal in coking plants also requires water cooling and the use of water in by-products separation. Contamination of waste streams includes gasification products such as benzene, naphthalene, anthracene, cyanide, ammonia, phenols, cresols together with a range of more complex organic compounds known collectively as polycyclic aromatic hydrocarbons (PAH).[4]

The conversion of iron or steel into sheet, wire or rods requires hot and cold mechanical transformation stages frequently employing water as a lubricant and coolant. Contaminants include hydraulic oils, tallow and particulate solids. Final treatment of iron and steel products before onward sale into manufacturing includes *pickling* in strong mineral acid to remove rust and prepare the surface for tin or chromium plating or for other surface treatments such as galvanisation or painting. The two acids commonly used are hydrochloric acid and sulfuric acid. Wastewaters include acidic rinse waters together with waste acid. Although many plants operate acid recovery plants (particularly those using hydrochloric acid), where the mineral acid is boiled away from the iron salts, there remains a large volume of highly acid ferrous sulfate or ferrous chloride to be disposed of. Many steel industry wastewaters are contaminated by hydraulic oil, also known as *soluble oil*.

4. Explain wastewater coming from nuclear industry and Pulp and paper industry

Ans: The waste production from the nuclear and radio-chemicals industry is dealt with as *radioactive waste.*

Pulp and paper industry

Effluent from the pulp and paper industry is generally high in suspended solids and BOD. Plants that bleach wood pulp for paper making may generate chloroform, dioxins (including 2,3,7,8-TCDD), furans, phenols and chemical oxygen demand (COD).[5] Stand-alone paper mills using imported pulp may only require simple primary treatment, such as sedimentation or dissolved air flotation. Increased BOD or COD loadings, as well as organic pollutants, may require biological treatment such as activated sludge or up flow anaerobic sludge blanket reactors. For mills with high inorganic loadings like salt, tertiary treatments may be required, either general membrane treatments like ultra filtration or reverse osmosis or treatments to remove specific contaminants, such as nutrients.

5. Explain wastewater coming from Industrial oil contamination, Water treatment Industrial oil contamination and Wool processing

Ans: Industrial applications where oil enters the wastewater stream may include vehicle wash bays, workshops, fuel storage depots, transport hubs and power generation. Often the wastewater is discharged into local sewer or trade waste systems and must meet local environmental specifications. Typical contaminants can include solvents, detergents, grit. Lubricants and hydrocarbons.

Water treatment

Many industries have a need to treat water to obtain very high quality water for demanding purposes such as environmental discharge compliance. Water treatment produces organic and mineral sludges from filtration and sedimentation. Ion exchange using natural or synthetic resins removes calcium, magnesium and carbonate ions from water, typically replacing them with sodium, chloride, hydroxyl and/or other ions. Regeneration of ion exchange columns with strong acids and alkalis produces a wastewater rich in hardness ions which are readily precipitated out, especially when in admixture with other wastewater constituents.

FIVE MARK QUESTIONS WITH ANSWERS

1. Explain wastewater coming from Organic chemicals industry and Electric power plants

Organic chemicals industry

Ans:A range of industries manufacture or use complex organic chemicals. These include pesticides, pharmaceuticals, paints and dyes, petrochemicals, detergents, plastics, paper pollution, etc. Waste waters can be contaminated by feedstock materials, by-products, product material in soluble or particulate form, washing and cleaning agents, solvents and added value products such as plasticizers. Treatment facilities that do not need control of their effluent typically opt for a type of aerobic treatment, i.e. aerated lagoons.[1]

Electric power plants

Fossil-fuel power stations, particularly coal-fired plants, are a major source of industrial wastewater. Many of these plants discharge wastewater with significant levels of metals such as lead ,mercury, cadmium and chromium, as well as arsenic, selenium and nitrogen compounds (nitrates and nitrites). Wastewater streams include flue-gas desulfurization, fly ash, bottom ash and flue gas mercury control. Plants with air pollution controls such as wet scrubbers typically transfer the captured pollutants to the wastewater stream.[2]

Ash ponds, a type of surface impoundment, are a widely used treatment technology at coal-fired plants. These ponds use gravity to settle out large particulates (measured as total suspended solids) from power plant wastewater. This technology does not treat dissolved pollutants. Power stations use additional technologies to control pollutants, depending on the particular waste stream in the plant. These include dry ash handling, closed-loop ash recycling, chemical precipitation, biological treatment (such as an activated sludge process), and evaporation.[2]

2. What are the Physical characteristics of Industrial Wastewater?

Ans: The principal of physical characteristics of wastewater include

Solids,colour, odour and temperature.

- Total Solids

The total solids in a wastewater consist of the insoluble or suspended solids and the soluble compounds dissolved in water. The suspended solids content is found by drying and weighing the residue removed by the filtering of the sample. When this residue is ignited the volatile solids are burned off. Volatile solids are presumed to be organic matter, although some organic matter will not burn and some inorganic salts break down at high temperatures. The organic matter consists mainly of proteins, carbohydrates and fats. Between 40 and 65 % of the solids in an average wastewater are suspended. Settleable solids, expressed as milliliters per liter, are those that can be removed by sedimentation. Usually about 60 % of the suspended solids in a municipal wastewater are settleable (Ron & George, 1998). Solids may be classified in another way as well: those that are volatilized at a high temperature (600 °C) and those that are not. The former are known as volatile solids, the latter as fixed solids. Usually, volatile solids are organic.

Colour

Colour is a qualitative characteristic that can be used to assess the general condition of wastewater. Wastewater that is light brown in colour is less than 6 h old, while a light-to-medium grey colour is characteristic of wastewaters that have undergone some degree of decomposition or that have been in the collection system for some time. Lastly, if the colour is dark grey or black, the wastewater is typically septic, having undergone extensive bacterial decomposition under anaerobic conditions. The blackening of wastewater is often due to the formation of various sulphides, particularly, ferrous sulphide. This results when hydrogen sulphide produced under anaerobic conditions combines with divalent metal, such as iron, which may be present. Colour is measured by comparison with standards.

Odour

The determination of odour has become increasingly important, as the general public has become more concerned with the proper operation of wastewater treatment facilities. The odour of fresh wastewater is usually not offensive, but a variety of odorous compounds are released when wastewater is decomposed biologically under anaerobic conditions. The different unpleasant odours produced by certain industrial wastewater are presented in Table

Industries	Origin of odours
Cement works, lime kilns	Acrolein, amines, mercaptans,
Pharmaceutical industries	Fermentation produces
Food industries	Fermentation produces
Food industries (fish)	Amines, sulphides, mercaptans
Rubber industries	Sulphides, mercaptans

Textile industries	Phenolic compounds
Paper pulp industries	H2S, SO2
Organics compost	Ammonia, sulphur compounds

- Temperature

The temperature of wastewater is commonly higher than that of the water supply because warm municipal water has been added. The measurement of temperature is important because most wastewater treatment schemes include biological processes that are temperature.

3. What are the Chemical characteristics of Industrial Wastewater?

Ans:Inorganic chemicals

The principal chemical tests include free ammonia, organic nitrogen, nitrites, nitrates, organic phosphorus and inorganic phosphorus. Nitrogen and phosphorus are important because these two nutrients are responsible for the growth of aquatic plants. Other tests, such as chloride, sulphate, pH and alkalinity, are performed to assess the suitability of reusing treated wastewater and in controlling the various treatment processes (Rein, 2005). Trace elements, which include some heavy metals, are not determined routinely, but trace elements may be a factor in the biological treatment of wastewater. All living organisms require varying amounts of some trace elements, such as iron, copper, zinc and cobalt, for proper growth. Heavy metals can also produce toxic effects; therefore, determination of the amounts of heavy metals is especially important where the further use of treated effluent or sludge is to be evaluated. Many of metals are also classified as priority pollutants such as arsenic, cadmium, chromium, mercury, etc. Measurements of gases, such as hydrogen sulphide, oxygen, methane and carbon dioxide, are made to help the system to operate. The presence of hydrogen sulphide needs to be determined not only because it is an odorous and very toxic gas but also because it can affect the maintenance of long sewers on flat slopes, since it can cause corrosion. Measurements of dissolved oxygen are made in order to monitor and control aerobic biological treatment processes. Methane and carbon dioxide measurements are used in connection with the operation of anaerobic digesters.

Organic chemicals

Over the years, a number of different tests have been developed to determine the organic content of wastewaters. In general, the tests may be divided into those used to measure gross concentrations of organic matter greater than about 1 mg/l and those used to measure trace concentration in the range of 10^{-12} to 10^{-3}mg/l. Laboratory methods commonly used today to measure gross amounts of organic matter (greater than 1 mg/l) in wastewater include

(1) Biochemical oxygen demand (BOD),

(2) chemical oxygen demand (COD) and

(3) total organic carbon(TOC).

Trace organics in the range of 10^{-12} to 10^{-3} mg/l are determined using instrumental methods including gas mass spectroscopy and chromatography. Specific organic compounds are determined to assess the presence of priority pollutants (Metcalf & Eddy, 1991). The BOD, COD and TOC tests are gross measures of organic content and as such do not reflect the response of the wastewater to various types of biological treatment technologies.

4. What are the Chemical characteristics of Industrial Wastewater?

Ans:Biological Characteristics of Water

Water quality in developed and developing countries continues to deteriorate due to increased movement of refugees in developing countries and natural disasters like flooding and droughts. Waterborne diseases bigger than wars and AIDs.

Most important biological organisms in water and wastewater are pathogens, as they transmit diseases.

- not native to aquatic systems and usually require an animal host for growth and reproduction
- unfortunately, can be transported by water, becoming a temporary member of the aquatic community
- many species of pathogens are able to survive in water and maintain their infectious capabilities for significant periods of time
- include species of bacteria, viruses, protozoa, and helminths

***Bacteria*:**comes from Greek word rodor staff, the shape characteristic of most bacteria
Fungi

- aerobic multi cellular, non-photo synthetic, heterotrophic
- most are saprophytes, obtaining food from dead organic matter
- principle micro-organism along with bacteria that decomposes carbon
- without fungi, the carbon cycle would cease and organic matter would build up
- ideal conditions are high moisture and low pH

Microorganisms: extract from the environment substances needed to produce new cell material these substances are called nutrients

Pathogen Indicators

- analysis of water for all known pathogens would be very time consuming and expensive usually specific pathogens are not tested for unless they are suspected, instead indicator organisms are used
- indicator organisms suggest that contamination had occurred and the level of contamination

5 . What are the effects On Sewage Treatment Plants

Ans: The Pollution Characteristics of Wastes having readily definable effects on Sewers and Treatment Plants can be classified as follows:

Bio Chemical Oxygen Demand: It is usually exerted by Dissolved and Colloidal Organic Matter and imposes a load on the Biological units of the Treatment Plant. Oxygen must be Provided so that Bacteria can grow and oxidise the organic matter. An Added B.O.D load, caused by an increase in Organic Waste, requires more Bacterial Activity, more oxygen, and greater Biological Unit capacity for its Treatment, which (makes) increases the capital cost and operating cost.

Suspended Solids: Suspended Solids are found in considerable quantity in many Industrial Wastes, such as Paper& Pulp Effluents. Solids removed by settling and separated from the flowing Sewage are called Sludge, which may then undergo an Anaerobic Decomposition known as Digestion and pumped to drying beds or vacuum filters for extraction of additional water. Suspended Solids in Industrial Waste may settle more rapidly or slowly than Sewage Suspended Matter. If Industrial Solids settle faster than those of Municipal Sewage, Sludge should be removed at shorter intervals to prevent excessive build up: a Slow Settling one will require a longer detention period and larger basins and increases the likelihood of sludge Decomposition with accompanying nuisances, during Sewage-Flow Periods. Any Increased demands on the System usually require larger Sludge handling devices and may ultimately necessitates an increase in the Plants capacity, with resulting Higher Capital and Operating Expenses.

Floating and Coloured Materials: Floating Materials and Coloured Matter such as Oil, Grease and Dyes From Textile-Finishing Mills, are disagreeable and visible nuisances. A Modern Treatment Plant will remove normal Grease loads in Primary Settling Tanks, but abnormally high loads of predominantly emulsified Greases from Laundries; Slaughterhouses etc passing through the Primary Units into the Biological Units will clog Flow Distributing Devices and Air Nozzles. Volume: A Sewage Plant can handle any Volume of Flow if its units are sufficiently large. The Hydraulic Capacity of all Units must be analysed, Sewer Lines must be examined for Carrying Capacity, and all other Treatment Units are to be designed for excessive loading

Harmful Constituents: Toxic Metals, Acids, or Alkalis, Pieces of Fat, Flammable Substances, Detergents and Phenols etc. cause nuisance in Treatment Plants.

OBJECTIVE QUESTION WITH ANSWERS

1. The minimum recommended diameter of sewers, is
a. 5 cm
b. 10 cm
c. 15 cm
d. 20 cm.

2. Aerobic bacteria
a. flourish in the presence of free oxygen
b. consume organic matter as their food
c. oxidise organic matter in sewage
d. All the above.

3. The rate of accumulation of sludge in septic tanks is recommended as
a. 30 litres/person/year
b. 25 litres/person/year
c. 30 litres/person/month
d. 25 litres/person/month.

4. If 2% solution of a sewage sample is incubated for 5 days at 20°C and depletion of oxygen was found to be 5 ppm, B.O.D. of the sewage is
a. 200 ppm
b. 225 ppm
c. 250 ppm
d. None of these.

5. If D is the diameter of upper circular portion, the overall depth of a standard egg shaped section, is
a. 1 D
b. 1.25 D
c. 1.5 D
d. 1.75 D

6. If the diameter of sewer is 225 mm, the gradient required for generating self cleansing velocity, is

a. 1 in 60
b. 1 in 100
c. 1 in 120
d. none of these.

7. Pick up the correct statement from the following:
a. pH value indicates acidity and alkalinity of sewage
b. In acidic sewage, the pH value is less than 7
c. In alkaline sewage, the pH value is more than 7
d. All the above

8. The non-clog pump which permits solid matter to pass out with the liquid sewage, is
a. centrifugal pump
b. reciprocating pump
c. pneumatic ejector
d. none of these.

9. Assertion (A) : Discharging the effluents from the oxidation ponds just up stream of lakes or reservoirs is undesirable.
Reason (R) : The discharged algae get settled in the reservoirs and cause anaerobic decomposition and other water qualities.
a. Both A and R are true and R is the correct explanation of A
b. Both A and R are true but R is not a correct explanation of A
c. A is true but R is false
d. A is false but R is true.

10. The width of a rectangular sewer is twice its depth while discharging 1.5 m/sec. The width of the sewer is
a. 0.68 m
b. 0.88 m
c. 1.36 m
d. 1.76 m.

KEY

Q.NO	1	2	3	4	5	6	7	8	9	10
Ans	C	d	a	c	c	c	d	a	a	c

FILL IN THE BLANKS

1. Cooling waters are inevitably contaminated with products especially -----------------

2. Effluent from the pulp and paper industry is generally high in suspended -----------------

3. Insecticide residues in fleeces are a particular problem in treating waters generated in -----------

4. ----------------- are presumed to be organic matter, although some organic matter will not burn and some inorganic salts break down at high temperatures.

5. The temperature of wastewater will vary from season to season and also with geographic location. In cold regions the temperature will vary from about 7 to 18 °C, while in warmer regions the temperatures vary from -----------------

6. ----------------- measurements are used in connection with the operation of anaerobic digesters

7. Solids removed by settling and separated from the flowing Sewage are called Sludge, which may then undergo an Anaerobic Decomposition known as -----------------

8. Floating Materials and Coloured Matter such as Oil, Grease and Dyes From Textile-Finishing Mills, are -----------------

9. Regeneration of ion exchange columns with ----------------- produces a wastewater rich in hardness ions which are readily precipitated

10. Contamination of waste streams includes gasification products such as benzene, naphthalene, anthracene, cyanide, ammonia, phenols, cresols together with a range of more complex organic compounds known collectively as ----------------

KEY

Q. NO	Ans
1	ammonia and cyanide
2	solids and BOD
3	wool processing
4	Volatile solids
5	13 to 24 °C
6	Digestion and pumped
7	Digestion and pumped
8	Disagreeable and visible nuisances
9	strong acids and alkalis
10	polycyclic aromatic hydrocarbons (PAH).

UNIT II

TWO MARK QUESTIONS WITH ANSWERS

1. What is Equalization?
Ans: Simply a well - mixed vessel with fluctuating input flow rates and / or concentration with fairly constant output flow rates and/or concentrations. Processes for waste treatment work best with uniform conditions. Shocks to the bioprocesses in the form of sudden changes in concentrations of nutrients can cause upsets. If the concentrations or flow rates of the waste vary greatly, dosages for treatment must be constantly be readjusted

2 . Explain In - Line and Side - Line Equalization
Ans: The top method is called *in-line*. The *side-line* shown above it has equalization in the surge tank with overflow when flow rates are high into the equalization tank. This method makes sense when there is a combined sewer system for both wastewater and storm water. Much of the time the surge tank is adequate.

3. Explain design of Equalization Units
Ans: Equalization vessels often have sloping sides to keep the head more constant as volume changes.

"Sloping Sides"...

A common method for combining aeration and mixing is to have a mixer at the surface to splash the liquid into the air. Because the level is changing, this mixer must be mounted on floats. The aeration in the equalization vessel will reduce the BOD of the wastewater by 10 to 20 %. A graphical method is used to specify the volume of an equalization vessel

4. Explain Fluctuating Volume
Ans: The vessel volume should equal the average flow multiplied by the time period, and then add on the fluctuating volume. Note that when the flow variation is small, the fluctuating volume is small so that the required vessel size is close to that based on average flow. When the variation is great, the equalization vessel is quite a bit larger than that based on the average flow.

5. Explain Neutralization
Ans: Chemical reaction, according to the Arrhenius theory of acids and bases, in which a water solution of acid is mixed with a water solution of base to form a salt and water; this reaction is complete only if the resulting solution has neither acidic nor basic properties. Such a solution is called a neutral solution

THREE MARK QUESTIONS WITH ANSWERS

1.Explain Activated Sludge with Flow Equalization Basin

Ans: This option would result in an average flow of 25 mgd (1,095 L/s) into the SBIWTP with a flow equalization basin to accommodate peak flow storage and subsequent off-peak discharge to the secondary activated sludge facility. A flow equalization basin capable of storing advanced-primary-treated peak flows greater than 25 mgd (1,095 L/s) would be constructed for this alternative. A storage volume of 7 million gallons (MG) would be required. Accordingly, the average flow through both the advanced primary and secondary portions of the plant would be 25 mgd (1,095 L/s). Flow through the advanced primary portion of the plant is projected to follow the identified daily flow variations with a low flow from 3.5 mgd (153 L/s) to a peak flow of 50 mgd (2,190 L/s). Before this variable flow enters the secondary facility, it will be equalized by the basin to a steady rate of 25 mgd (1,095 L/s). The flow equalization basin would be located within the existing footprint of the SBIWTP. Other than the flow equalization basin, construction and operation of these facilities were addressed in the 1994 Final EIS and ROD. (A smaller flow equalization basin sized at 5.5 mg, however, was considered as part of the 1997 Final Interim Operation SEIS.) These proposed new activated sludge and related facilities are sized to treat a monthly average organic loading of 370 mg/L BOD_5 and 350 mg/L TSS, and an average flow of 25 mgd (1,095 L/s). The equalization basin facilities are designed to equalize flows to a constant 25 mgd (1,095 L/s). The activated sludge facilities are designed to provide an effluent quality of 19 mg/LBOD_5 and 19 mg/L TSS.

2 . Explain In - Line and Side - Line Equalization

Ans: The top method is called *in-line*. The *side-line* shown above it has equalization in the surge tank with overflow when flow rates are high into the equalization tank. This method makes sense when there is a combined sewer system for both wastewater and storm water. Much of the time the surge tank is adequate. When there are heavy rains, this overflows into the equalization tank to be proportioned into the main stream over a period of time. The pump shown in blue is usually several pumps because one may be down for maintenance. The pumps may have constant flow, either off or on. One pump may have variable speed that is fairly expensive. The system must have some sort of logical control to decide which pumps are on and to add back the surplus wastewater at rates that keep the rest of the plant operating with nearly constant conditions. sludges from the various sedimentation units are digested anaerobically to reduce their organic matter and to improve handling and drying. The supernatant from treated sludge is rich in organic matter and goes back for more treatment. The equalization step is a good place to add back this supernatant.

3. What are the Storage Applications?

Ans: Storage is considered a necessary control alternative for wet weather flows because of the high volume and variability associated with storm water and combined sewer overflows. Some of the most critical problems currently facing wastewater management agencies are the control of Infiltration/Inflow (I/I)-induced sanitary sewer overflows (SSOs) and treatment facilities, including hydraulic overloading and disruptions of biological and other plant processes. As agencies examine alternative approaches to controlling I/I problems, storage facilities are increasingly being planned, designed, and constructed for the control of wet weather flows in sanitary sewer systems. While storage facilities have commonly been constructed at wastewater treatment facilities (where they are referred to as equalization basins) to maximize the processing of wastewater generated during wet weather while protecting the plant processes from hydraulic overloading or biological disruption, the use of storage at upstream locations within the collection system has only recently begun to gain acceptance. Collection system storage facilities are now being recognized as providing much of the benefit to treatment facilities realized with equalization basins, with the additional benefit of controlling SSOs and basement flooding while minimizing or eliminating the need to construct relief sewers.

4. Explain Activated Sludge with Flow Equalization Basin

Ans: This option would result in an average flow of 25 mgd (1,095 L/s) into the SBIWTP with a flow equalization basin to accommodate peak flow storage and subsequent off-peak discharge to the secondary activated sludge facility. A flow equalization basin capable of storing advanced-primary-treated peak flows greater than 25 mgd (1,095 L/s) would be constructed for this alternative. A storage volume of 7 million gallons (MG) would be required. Accordingly, the average flow through both the advanced primary and secondary portions of the plant would be 25 mgd (1,095 L/s). Flow through the advanced primary portion of the plant is projected to follow the identified daily flow variations with a low flow from 3.5 mgd (153 L/s) to a peak flow of 50 mgd (2,190 L/s). Before this variable flow enters the secondary facility, it will be equalized by the basin to a steady rate of 25 mgd (1,095 L/s). The flow equalization basin would be located within the existing footprint of the SBIWTP. Other than the flow equalization basin, construction and operation of these facilities were addressed in the 1994 Final EIS and ROD. (A smaller flow equalization basin sized at 5.5 mg, however, was considered as part of the 1997 Final Interim Operation SEIS.) These proposed new activated sludge and related facilities are sized to treat a monthly average organic loading of 370 mg/L BOD_5 and 350 mg/L TSS, and an average flow of 25 mgd (1,095 L/s). The equalization basin facilities are designed to equalize flows to a constant 25 mgd (1,095 L/s). The activated sludge facilities are designed to provide an effluent quality of 19 mg/L BOD_5 and 19 mg/L TSS.

5. Volume reduction

Ans: Volume reduction can be achieved by

i. Classifications of wastes: Concentrated wastewaters of manufacturing process are segregated from dilute wastes as cooling waters, thereby reducing the intensive treatment required.

ii. Conservation of waste water.

iii. Improved process control, improved equipment design and use of different or better quality raw materials etc.

iv. Re-using both treated industrial and municipal effluents as raw water supplies.

v. Elimination of batch or slug discharges of process wastes.(If the waste is discharged in a short period of time, it is usually referred to as a slug discharge.)

This type of waste, because of its concentrated contaminants surge in volume can be troublesome to both treatment plants and receiving streams.

FIVE MARK QUESTIONS WITH ANSWERS

1. Explain Preliminary Treatment

Ans: At most plants preliminary treatment is used to protect pumping equipment and facilitate subsequent treatment processes. Preliminary devices are designed to remove or cut up the larger suspended and floating solids, to remove the heavy inorganic solids, and to remove excessive amounts of oils or greases.

To effect the objectives of preliminary treatment, the following devices are commonly used:

- Screens - rack, bar or fine.

- Comminuting devices - grinders, cutters, shredders.

- Grit chambers.

- Pre-aeration tanks.

The purpose of preliminary treatment is to protect the operation of the wastewater treatment plant. This is achieved by removing from the wastewater any constituents which can clog or damage pumps, or interfere with subsequent treatment processes. Preliminary treatment devices are, therefore, designed to : (1) Remove or to reduce in size the large, entrained, suspended or floating solids. These solids consist of pieces of wood, cloth, paper, plastics, garbage, etc. together with some fecal matter. (2) Remove heavy inorganic solids such as sand and gravel as well as metal or glass. These objects are called grit. (3) Remove excessive amounts of oils or greases. A number of devices or types of equipment are used to obtain these objectives.

These consist of bars usually spaced three-quarter inches to six inches. Those most commonly used provide clear openings of one to two inches. Although large screens are sometimes set vertically, screens are usually set at an angle of 45 to 60 degrees with the vertical. The incoming wastewater is passed through the bars or screens and periodically the accumulated material is removed. The racks or screens may be cleaned either manually or by means of automatically operated rakes. The solids removed by these units can be disposed of by burial or incineration.

2. Explain Equalization in the Activated Sludge Process

Ans: The constant flow through both primary and secondary treatment would be 25 mgd (1,095 L/s). Mexico would be responsible for peak flows above 25 mgd (1,095 L/s). Construction and operation of these facilities were approved in the 1994 Final EIS and ROD for the SBIWTP project. The proposed new activated sludge and related facilities are sized to treat an average monthly organic loading of 370 milligrams per litre (mg/L) 5day biochemical oxygen demand (BOD_5), 350 mg/L total suspended solids (TSS), and an average flow of 25 mgd

(1,095 L/s). BOD_5 and TSS would be reduced to 19 mg/L each in the effluent from this alternative.

This option would result in an average flow of 25 mgd (1,095 L/s) into the SBIWTP with a flow equalization basin to accommodate peak flow storage and subsequent off-peak discharge to the secondary activated sludge facility. A flow equalization basin capable of storing advanced-primary-treated peak flows greater than 25 mgd (1,095 L/s) would be constructed for this alternative. A storage volume of 7 million gallons (MG) would be required. Accordingly, the average flow through both the advanced primary and secondary portions of the plant would be 25 mgd (1,095 L/s). Flow through the advanced primary portion of the plant is projected to follow the identified daily flow variations with a low flow from 3.5 mgd (153 L/s) to a peak flow of 50 mgd (2,190 L/s). Before this variable flow enters the secondary facility, it will be equalized by the basin to a steady rate of 25 mgd (1,095 L/s). The flow equalization basin would be located within the existing footprint of the SBIWTP. Other than the flow equalization basin, construction and operation of these facilities were addressed in the 1994 Final EIS and ROD. (A smaller flow equalization basin sized at 5.5 mg, however, was considered as part of the 1997 Final Interim Operation SEIS.) These proposed new activated sludge and related facilities are sized to treat a monthly average organic loading of 370 mg/L BOD_5 and 350 mg/L TSS, and an average flow of 25 mgd (1,095 L/s). The equalization basin facilities are designed to equalize flows to a constant 25 mgd (1,095 L/s). The activated sludge facilities are designed to provide an effluent quality of 19 mg/L BOD_5 and 19 mg/L TSS.

3.Explain Neutralization

Ans: Chemical reaction, according to the Arrhenius theory of acids and bases, in which a water solution of acid is mixed with a water solution of base to form a salt and water; this reaction is complete only if the resulting solution has neither acidic nor basic properties. Such a solution is called a neutral solution. Complete neutralization can take place when a strong acid, such as hydrochloric acid, HCl, is mixed with a strong base, such as sodium hydroxide, NaOH. Strong acids and strong bases completely break up, or dissociate, into their constituent ions when they dissolve in water. In the case of hydrochloric acid, hydrogen ions, H+, and chloride ions, Cl-, are formed. In the case of sodium hydroxide, sodium ions, Na+, and hydroxide ions, OH-, are formed. The hydrogen and hydroxide ions readily unite to form water. If the number of hydrogen ions in the hydrochloric acid solution is equal to the number of hydroxide ions in the sodium hydroxide solution, complete neutralization occurs when the two solutions are mixed. The resulting solution contains sodium ions and chloride ions that unite when the water evaporates to form sodium chloride, common table salt. In a neutralization reaction in which either a weak acid or a weak base is used, only partial neutralization occurs. In a neutralization reaction in which both a weak acid and a weak base are used, complete neutralization can occur if the acid and the base are equally weak. The heat produced in the reaction between an acid and a base is called the heat of neutralization. When any strong acid is mixed with any strong base, the heat of neutralization is always about 13,700 calories for each equivalent weight of acid and base neutralized.

Two related classes of chemicals; the members of each class have a number of common properties when dissolved in a solvent, usually water. 1. Properties: Acids in water solutions exhibit the following common properties: they taste sour; turn litmus paper red; and react with certain metals, such as zinc, to yield hydrogen gas. Bases in water solutions exhibit these common properties: they taste bitter; turn litmus paper blue; and feel slippery. When a water solution of acid is mixed with a water solution of base, water and a salt are formed; this process, called neutralization, is complete only if the resulting solution has neither acidic nor basic properties. 2. Classification : Acids and bases can be classified as organic or inorganic. Some of the more common organic acids are: citric acid, carbonic acid, hydrogen cyanide, salicylic acid, lactic acid, and tartaric acid. Some examples of organic bases are: pyridine and ethylamine. Some of the common inorganic acids are: hydrogen sulphide, phosphoric acid, hydrogen chloride, and sulphuric acid. Some common inorganic bases are: sodium hydroxide, sodium carbonate, sodium bicarbonate, calcium hydroxide, and calcium carbonate. 3. Acids, such as hydrochloric acid, and bases, such as potassium hydroxide, that have a great tendency to dissociate in water are completely ionized in solution; they are called strong acids or strong bases. Acids, such as acetic acid, and bases, such as ammonia, that are reluctant to dissociate in water are only partially ionized in solution; they are called weak acids or weak bases. Strong acids in solution produce a high concentration of hydrogen ions, and strong bases in solution produce a high concentration of hydroxide ions and a correspondingly low concentration of hydrogen ions. The hydrogen ion concentration is often expressed in terms of its negative logarithm or pH (see separate article). Strong acids and strong bases make very good electrolytes (see electrolysis), i.e., their solutions readily conduct electricity. Weak acids and weak bases make poor electrolytes. 4. See buffer; catalyst; indicators, acid-base; titration.

4. Proportioning

Ans: It is 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.

It 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:

i. To protect municipal sewage treatment from being impaired by a sudden overdose of chemicals contained in the industrial waste.

ii. To protect biological treatment devices from strong loads of industrial wastes, which may inactivate the bacteria.

iii. 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.

5.Strength reduction

Ans: Strength reduction can be achieved by

i. Process changes: industry can modify manufacturing process so that fewer wastes are created.

ii. Equipment modifications: changes in equipment can affect a reduction in the strength of the waste, usually by reducing the amounts of contaminants entering the waste stream.

iii. Segregation of wastes reduces the strength eliminating the difficulty of treating the final waste from an industrial plant.

It usually results in two types of wastes, one strong but smaller in volume and the other weaker of almost the same volume as the original unsegregated waste.

The strong waste can then be handled easily with specific methods as their quantity is less.

iv. Equalization of wastes: Blending of cool and hot wastes, acids and alkalis, strong waste and dilute waste nullifies or minimizes their pollution characteristics and renders them stable. Stable effluents are treated more easily and efficiently, than unstable ones.

v. By-product recovery: Almost all the wastes contain by products.

Recovery and use of these byproducts reduce the total pollutional strength of the waste. For example fly ash produced from thermal power plants can be used to manufacture bricks, cement etc.

vi. Proportioning of wastes.

vii. Monitoring waste streams: Accidental spills and controlling malfunctioning of treatment plants.

The preventive measures outlined above are general and one or more of them may be applied, depending on the specific case.

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OBJECTIVE QUESTION WITH ANSWERS

1. Pick up the correct statement from the following:
a. In treated sewage, 4 PPm of D.O. is essential
b. Only very fresh sewage contains some dissolved oxygen
c. The solubility of oxygen in sewage is 95% that is in distilled water
d. All the above.

2. In olden days the type of section adopted in trunk and out fall sewers was
a. parabolic shaped
b. horse shoe shaped
c. egg shaped
d. circular shaped.

3. For the survival of fish in a river stream, the minimum dissolved oxygen is prescribed
a. 3 PPm
b. 4 PPm
c. 5 PPm
d. 10 PPm.

4. In a fully mechanised composting plant, involves
a. mechanized receipt
b. mechanized segregation
c. mechanized pulverising of refuse
d. all of these.

5. Self-cleansing velocity is
a. velocity at dry weather flow
b. velocity of water at flushing
c. velocity at which no accumulation remains in the drains
d. velocity of water in a pressure filter.

6. If the over land flow from the critical point to the drain is 8 km and the difference in level is 12.4 m, the inlet time is
a. 2 hours
b. 3 hours
c. 4 hours

d. 5 hours.

7. An inverted siphon is designed generally for
a. one pipe
b. two pipes
c. three pipes
d. four pipes.

8. A rainfall may be classified as acidic if its pH value is less or equal to
a. 6
b. 7
c. 5
d. 6.5

9. When drainage to sewage ratio is 20, the peak dry weather flow is
a. 20% of the design discharge
b. slightly less than 5% of the design discharge
c. slightly more than 5% of the design discharge
d. none of these.

10. For treating the sewage of a large city, you will recommend
a. a sedimentation tank and an activated sludge treatment plant
b. a plant consisting of Imhoff tanks with low rate trickling filters
c. sedimentation tanks with high rate trickling filters
d. none of these.

KEY

Q.NO	1	2	3	4	5	6	7	8	9	10
Ans	d	b	b	d	c	c	c	c	b	a

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FILL IN THE BLANK QUESTIONS WITH ANSWERS

1. Remove heavy inorganic solids such as sand and gravel as well as metal or glass. These objects are called -----------------

2. The racks or screens may be cleaned either manually or by means of automatically operated rakes. The solids removed by these units can be disposed of by --------------

3. --------------- can improve performance of subsequent steps significantly. Often the rest of the plant can be designed with smaller equipment (less capital investment) because of this improvement in performance.

4. The --------------- has equalization in the surge tank with overflow when flow rates are high into the equalization tank

5. The wastewater would be treated in the pond systems to a secondary or secondary-equivalent level. One option under this alternative is a. ---------------

6. A given volume of a solution of unknown acidity may be titrated with a base of known concentration until complete neutralization has occurred. This point is called ---------------

7. --------------- of wastes reduces the strength eliminating the difficulty of treating the final waste from an industrial plant.

8. Mixing of different wastes of different polarities and concentrations so that the net effect is a . ---------------

9. The industrial waste must be equalized and retained, then proportioned to the sewer or stream according to the volume of. ---------------

10. When any strong acid is mixed with any strong base, the heat of neutralization is always about 13,700 calories for each equivalent weight of --------------

KEY

Q. NO	**Ans**
1	Grit
2	burial or incineration.
3	Flow equalization
4	*side-line*
5	Completely Mixed Aerated (CMA)
6	the equivalence point
7	Segregation
8	neutral pH.
9	domestic sewage or stream flow
10	acid and base neutralized

UNIT III

TWO MARK QUESTIONS WITH ANSWERS

1. Rotating biological contractor

Ans:RBC biofilm has an initial adsorption of microorganisms to the disk surface to form 1-4 mm thick biofilm that is responsible for BOD removal in rotating biological contractors. The rotating disks provided a large surface area for the attached biomass.

2. Denitrification

Ans: Denitrification is the biological process by which nitrate is converted to nitrogen and other gaseous end products. The requirements for the denitrification process are: a) nitrogen present in the form of nitrates; b) an organic carbon source, and c) an anaerobic environment

3. Carbon and Nitrogen Removal Process

Ans: Currently, the processes used for carbon and nitrogen removal can be divided into two major groups: separated stage and single stage processes. For multiple stages of carbon and nitrogen removal, there is a disadvantage for denitrification which occurs either in the addition of external carbon or the recycle part of the effluent of nitrifying bacteria

4. Wastewater Treatment Disposal:

Ans:A sharp distinction must be made between the term "wastewater disposal" and "wastewater treatment". All wastewater has to be disposed of. Some wastewater is subjected to various types of treatment before disposal, but some wastewater receives no treatment before disposal.

5. Disposal by Dilution...

Ans: Disposal by dilution is the simple method of discharging wastewater into a surface water such as a river, lake, ocean, estuaries or wetlands. This results in the pollution of the receiving water. The degree of pollution depends on the dilution, volume and composition of the wastewater as compared to the volume and quality of the water with which it is mixed.

THREE MARK QUESTIONS WITH ANSWERS

1. Phosphorous in wastewater

Ans: Municipal wastewaters may contain from 5 to 20 mg/l of total phosphorous, of which 1-5 mg/l is organic and the rest in inorganic. The individual contribution tend to increase, because phosphorous is one of the main constituent of synthetic detergents. The individual phosphorous contribution varies between 0.65 and 4.80 g/inhabitant per day with an average of about 2.18 g. The usual forms of phosphorous found in aqueous solutions include:

- Orthophosphates: available for biological metabolism without further breakdown
- Polyphosphates: molecules with 2 or more phosphorous atoms, oxygen and in some cases hydrogen atoms combine in a complex molecule. Usually polyphosphates undergo hydrolysis and revert to the orthophosphate forms. This process is usually quite slow.

Normally secondary treatment can only remove 1-2 mg/l, so a large excess of phosphorous is discharged in the final effluent, causing eutrophication in surface waters. New legislation requires a maximum concentration of P discharges into sensitive water of 2 mg/l.

2. Single Stage Process

Ans: The optimal COD loading rate was found to be 5 g/m2/d corresponding to the TN loading rate of 0.54 g/m2/d. At this loading rate, the removal rates of COD and TN of 4.8 and 0.43 g/m2/d, respectively (or 96% COD removal and 79% TN removal efficiencies), could be achieved. The overall AGCR performance was limited by the nitrification efficiency at the high TN loading rates of 0.54 g/m2/d.

A combined anaerobic-aerobic system with internal recirculation of effluent in a single fluidized bed reactor had demonstrated simultaneous removal of organic carbon and nitrogen. With the loading rate of organic carbon < 1.2 kg/m3/d and nitrogen < 0.2 kg/m3/d and HRT of 24 hours, the levels of purification could reach COD removals of > 80% and the effluent concentration of (BOD5)S< 10 mg/L, NOx-N < 5 mg/L, NH3-N < 1 mg/L

In the full-scale field test, the system was used for the treatment of sewage and operated with a schedule of 1.5 hours aeration and 0.5 hours agitation. Less than 20 mg/L of the effluent BOD (93% BOD removal) and 15 mg/L of total nitrogen could be achieved at the organic loading rate of 0.8 kg-BOD/m3/day. At the low temperature of 13 C, the nitrification rate was slow and the removal efficiency of nitrogen fell to 65%. Total nitrogen removal efficiency could reach as much as 75% with an annual average temperature of 13 C-31 C.

3. Trickling filters

Ans: The extent of nitrification in trickling filters depended on a variety of factors; including temperature, dissolved oxygen, pH, presence of inhibitors, filter depth and media type, loading rate, and wastewater BOD (Parker and Richards, 1986). Low-rate trickling filters allowed the development of a high-nitrifying population. For rock media filters, organic loading should not exceed 0.16 kg BOD5/m3/day (USEPA, 1975). Higher loading rates (0.36 kg BOD5/m3/day) were allowable in plastic media trickling filters because of the higher surface area of the plastic media (Stenquist, et al., 1974). If two filters were used, heterotrophic growth occurs in the first filter and nitrification in the second filter (Bitton, 1994). Boller and Gujer (1986) conducted a pilot plant study of tertiary trickling filters, recommending a media surface loading rate of 0.4 g NH3-N/m2/day for complete nitrification (effluent NH3-N < 2.0 mg/L) at a water temperature of 10 C.

4. Conventional activated sludge processes at low loadings

Ans: Weismann (1994) studied the nitrification in a conventional activated sludge system and found that it was relatively low for carbon removal and nitrification of sewage because carbon removal and nitrification occurred in the same reactor with an activated sludge system. This resulted in a population mixture of mainly heterotrophs and few autotrophs. In this kind of treatment system, it was not possible to enrich the autotrophic bacteria because the slower growing autotrophs were removed with the surplus sludge. It was necessary to separate the autotrophic from the heterotrophic biomass in order to increase the specific nitrification rate.

Suwa, et al. (1989), conducted a research on simultaneous organic carbon removal-nitrification by an activated sludge process with cross-flow filtration. Because of the recycle of sludges with cross-flow filtration, this process made the sludge retention time very long; simultaneous carbon removal-nitrification was achieved quite well under the loading rate of about 0.10 g BOD/g VSS/d. The efficiency of dissolved organic carbon removal was more than 95%, and nitrification was sufficient (NH3-N was not detected in the effluent).

5. Nitrification

Ans: Nitrification is the biological process by which ammonia is first converted to nitrite and then to nitrate. Nitrification can be achieved in any aerobic-biological process at low organic loadings and where suitable environmental conditions are provided. Nitrifying bacteria are slower growing than the heterotrophic bacteria, which comprises the greater proportion of the biomass in both fixed film and suspended growth systems. The key requirement for nitrification to occur, therefore, is that the process should be so controlled that the net rate of accumulation of biomass, and hence, the net rate of withdrawal of biomass from the system, is less than the growth rate of the nitrifying bacteria.

FIVE MARK QUESTIONS WITH ANSWERS

1. Rotating biological contractor

Ans:RBC biofilm has an initial adsorption of microorganisms to the disk surface to form 1-4 mm thick biofilm that is responsible for BOD removal in rotating biological contractors. The rotating disks provided a large surface area for the attached biomass. The first stages of an RBC mostly removed organic materials, whereas subsequent stages removed NH3-N as a result of nitrification, when the BOD5 was low enough. Ammonia oxidizers could not effectively compete with the faster-growing heterotrophy that oxidizes organic matter. Nitrification occurs only when the BOD was reduced to approximately 14 mg/L, and increases with rotation speed. RBC performance was negatively affected by low dissolved oxygen in the first stages and by low pH in the later stages where nitrification occurred (Hitdlebaugh and Miller, 1981).

An innovative operational process using recirculation in RBC was developed and used to improve nitrification (Klee's and Silverstein, 1992). They found that it could improve nitrification at all hydraulic loading rates; the positive effect of recirculation on nitrification was due to the dilution of influent organic carbon. Degradable organic carbon inhibits nitrification at concentrations greater than 15-20 mg/L BOD5; extremely low concentrations of influent BOD5 (less than 10 mg/L) did not improve nitrification.

Figueroa and Silverstein (1992) studied the effect of particulate organic matter on biofilm nitrification in a pilot RBC. For a range of 12 and 82 mg/L total BOD to the pilot RBC, particulate BOD was found to inhibit nitrification to the same degree as soluble BOD. Total

Influent organic matter was found to be a better predictor of nitrification than soluble organic matter concentration. The inhibition of nitrification by particulate BOD suggested that clarified influent should be used for nitrifying the biofilm process.

Dunn, et al. (1984), investigated the nitrification process with a biofilm fluidized reactor. The bed was designed cone-shaped and filled with 0.2-0.3 mm diameter quartz sand. With three years of operation under a loading rate of 5.2 l/hr, recycle rate of 84 l/hr and NH4-N concentration of 45 mg/L, the maximum nitrification rate was observed as 134 mg N/g MLSS/hr for Nitrosomonas, and 120 mg N/MLSS/hr for Nitrobacteria. Optimum pH value was found to be around 7.8; optimum temperature was found between 30-40 C.

Tijhuis, et al. (1992), studied the development of nitrifying biofilms, as well as the short- and long-term influence on the nitrification capacity in a Biofilm-Airlift-Suspension-Reactor. They found that the specific nitrification capacity during start-up was constant, 1 g N/g TOC/d, which was high compared to the activated sludge process. The influence of the temperature on the nitrification rate was much less than could be expected from the pure culture experiments, and the maximum nitrification rate during the experiment was 6 kg N/m3/d, which was also relatively high compared to the activated sludge process.

2. Phosphorous removal from wastewater

Ans: Controlling phosphorous discharged from municipal and industrial wastewater treatment plants is a key factor in preventing eutrophication of surface waters. Phosphorous is one of the major nutrients contributing in the increased eutrophication of lakes and natural waters. Its presence causes many water quality problems including increased purification costs, decreased recreational and conservation value of an impoundments, loss of livestock and the possible lethal effect of algal toxins on drinking water.

Phosphate removal is currently achieved largely by chemical precipitation, which is expensive and causes an increase of sludge volume by up to 40%. An alternative is the biological phosphate removal (BPR).

Municipal wastewaters may contain from 5 to 20 mg/l of total phosphorous, of which 1-5 mg/l is organic and the rest in inorganic. The individual contribution tend to increase, because phosphorous is one of the main constituent of synthetic detergents. The individual phosphorous contribution varies between 0.65 and 4.80 g/inhabitant per day with an average of about 2.18 g. The usual forms of phosphorous found in aqueous solutions include:

- Orthophosphates: available for biological metabolism without further breakdown
- Polyphosphates: molecules with 2 or more phosphorous atoms, oxygen and in some cases hydrogen atoms combine in a complex molecule. Usually polyphosphates undergo hydrolysis and revert to the orthophosphate forms. This process is usually quite slow.

Normally secondary treatment can only remove 1-2 mg/l, so a large excess of phosphorous is discharged in the final effluent, causing eutrophication in surface waters. New legislation requires a maximum concentration of P discharges into sensitive water of 2 mg/l.

3. Phosphorous removal processes

Ans: The removal of phosphorous from wastewater involves the incorporation of phosphate into TSS and the subsequent removal from these solids. Phosphorous can be incorporated into either biological solids (e.g. microorganisms) or chemical precipitates.

Phosphate precipitation

Chemical precipitation is used to remove the inorganic forms of phosphate by the addition of a coagulant and a mixing of wastewater and coagulant. The multivalent metal ions most commonly used are calcium, aluminium and iron.

Calcium:

it is usually added in the form of lime $Ca(OH)_2$. It reacts with the natural alkalinity in the wastewater to produce calcium carbonate, which is primarily responsible for enhancing SS removal.

$Ca(HCO_3)_2 + Ca(OH)_2$ à $2CaCO_3 \downarrow + 2H_2O$

As the pH value of the wastewater increases beyond about 10, excess calcium ions will then react with the phosphate, to precipitate in hydroxyl apatite:

$10\ Ca^{2+} + 6\ PO_4^{3-} + 2\ OH^- \leftrightarrow Ca_{10}(PO_4)*6(OH)_2 \downarrow$

Because the reaction is between the lime and the alkalinity of the wastewater, the quantity required will be, in general, independent of the amount of phosphate present. It will depend primarily on the alkalinity of the wastewater. The lime dose required can be approximated at 1.5 times the alkalinity as $CaCO_3$. Neutralisation may be required to reduce pH before subsequent treatment or disposal. Recarbonation with carbon dioxide (CO_2) is used to lower the pH value.

Aluminium and Iron:

Alum or hydrated aluminium sulphate is widely used precipitating phosphates and aluminium phosphates ($AlPO_4$). The basic reaction is:

$Al^{3+} + H_nPO_4^{3-n} \leftrightarrow AlPO_4 + nH^+$

This reaction is deceptively simple and must be considered in light of the many competing reactions and their associated equilibrium constants and the effects of alkalinity, pH, trace elements found in wastewater. The dosage rate required is a function of the phosphorous removal required. The efficiency of coagulation falls as the concentration of phosphorous decreases. In practice, an 80-90% removal rate is achieved at coagulant dosage rates between 50 and 200 mg/l. Dosages are generally established on the basis of bench-scale tests and occasionally by full-scale tests, especially if polymers are used. Aluminum coagulants can adversely affect the microbial population in activated sludge, especially protozoa and rotifers, at dosage rates higher than 150 mg/l.

Ferric chloride or sulphate and ferrous sulphate also know as copperas, are all widely used for phosphorous removal, although the actual reactions are not fully understood. The basic reaction is:

$Fe^{3+} + H_nPO_4^{3-n} \leftrightarrow FePO_4 + nH^+$

Ferric ions combine to form ferric phosphate. They react slowly with the natural alkalinity and so a coagulant aid, such as lime, is normally add to raise the pH in order to enhance the coagulation.

4. Wastewater Treatment Disposal:

Ans:A sharp distinction must be made between the term "wastewater disposal" and "wastewater treatment". All wastewater has to be disposed of. Some wastewater is subjected to various types of treatment before disposal, but some wastewater receives no treatment before disposal.

Wastewater Treatment...

Wastewater treatment is a process in which the solids in wastewater are partially removed and partially changed by decomposition from complex highly putrescible organic solids to mineral or relatively stable organic solids. The extent of this change is dependent on the treatment processes involved. After all treatment processes have been completed, it is still necessary to dispose of the liquid and the solids which have been removed.

Wastewater Disposal...

There are three methods by which final disposal of wastewater can be accomplished. The general problem areas that are of concern in final disposal are pathogenic microorganisms (viruses, etc.), heavy metals and the presence of biologically resistant organic compounds, such as pesticides or insecticides which can find their way into water supplies. More recently, there has been interest in the use of land for both surface and subsurface disposal after wastewater treatment.

Surface Disposal...

Generally this is disposal by irrigation. This involves spreading the wastewater over the surface of the ground, generally by irrigation ditches. There is some evaporation, but most of the wastewater soaks into the ground and supplies moisture with small amounts of fertilizing ingredients for plant life. This method is largely restricted to small volumes of wastewater from a relatively small population where land area is available and where nuisance problems will not be created. It has its best use in arid or semi-arid areas where the moisture added to the soil is of special value. If crops are cultivated on the disposal area, the growth of vegetation often must be excluded from wastewater. Because untreated wastewater will also contain pathogenic organisms, the production of foods for human consumption which may be eaten without cooking is not desirable.

Subsurface Disposal...

By this method wastewater is introduced into the ground below its surface through pits or tile fields. It is commonly used for disposal of settled wastewater from residences or institutions where there is only a limited volume of wastewater. Because it has little application for large scale use in municipalities.

Disposal by Dilution...

Disposal by dilution is the simple method of discharging wastewater into a surface water such as a river, lake, ocean, estuaries or wetlands. This results in the pollution of the receiving water. The degree of pollution depends on the dilution, volume and composition of the wastewater as compared to the volume and quality of the water with which it is mixed. When the volume and organic content of the wastewater is small, compared with the volume of the receiving water,.

5. Phosphorous removal from wastewater

Ans: Controlling phosphorous discharged from municipal and industrial wastewater treatment plants is a key factor in preventing eutrophication of surface waters. Phosphorous is one of the major nutrients contributing in the increased eutrophication of lakes and natural waters. Its presence causes many water quality problems including increased purification costs, decreased recreational and conservation value of an impoundments, loss of livestock and the possible lethal effect of algal toxins on drinking water.

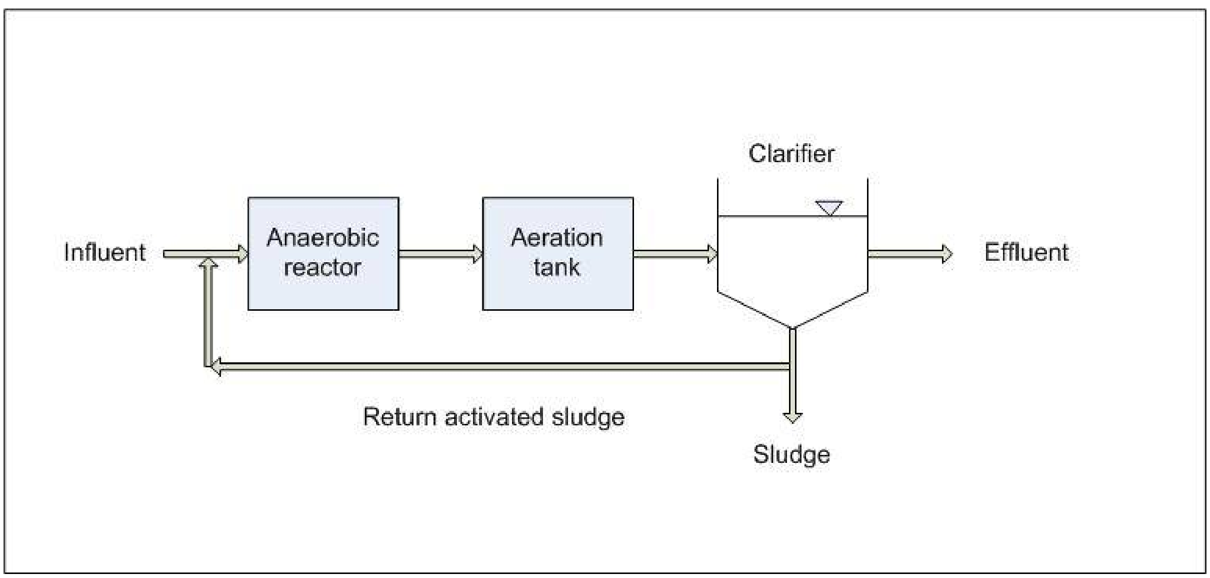
Phosphate removal is currently achieved largely by chemical precipitation, which is expensive and causes an in**.**

Biological processes

Several biological suspended growth process configurations have been used to accomplish biological phosphorous removal. The most important are shown in the following picture.

The principal advantages of biological phosphorous removal are reduced chemical costs and less sludge production as compared to chemical precipitation.

In the biological removal of phosphorous, the phosphorous in the influent wastewater is incorporated into cell biomass, which is subsequently removed from the process as a result of sludge wasting. The reactor configuration provides the P accumulating organisms (PAO) with a competitive advantage over other bacteria. So PAO are encouraged to grow and consume phosphorous. The reactor configuration in comprised of an anaerobic tank and an activated sludge activated tank. The retention time in the anaerobic tank is about 0.50 to 1.00 hours and its contents are mixed to provide contact with the return activated sludge and influent wastewater.



OBJECTIVE QUESTIONS WITH ANSWERS

1. Aerobic bacteria
a. flourish in the presence of free oxygen
b. consume organic matter as their food
c. oxidise organic matter in sewage
d. All the above.

2. Disposal to sewage in large cities, is done in
a. irrigation
b. dilution
c. oxidation
d. putrifaction.

3. The screens are fixed
a. perpendicular to the direction of flow
b. parallel to the direction of flow
c. at an angle 30° to 60° to the direction of flow
d. none of these.

4. In primary sedimentation, the 0.2 mm inorganic solids get separated if specific gravity is
a. 2.25
b. 2.50
c. 2.55
d. 2.65

5. Pick up the in-correct statement from the following:
a. Manholes are provided in sewer pipes at suitable intervals
b. Catch basins are generally provided in sewers for carrying drainage discharge
c. Inlets are generally provided in all sewers
d. None of these.

6. Clogging of sewers, is caused due to
a. silting
b. low discharge
c. greasy and oily matters

d. All the above

7. A sewer pipe contains 1 mm sand particles of specific gravity 2.65 and 5 mm organic particles of specific gravity 1.2, the minimum velocity required for removing the sewerage, is
a. 0.30 m/sec
b. 0.35 m/sec
c. 0.40 m/sec
d. 0.45 m/sec

8. The coagulant widely used for sewage treatment, is
a. alum
b. ferric chloride
c. ferric sulphate
d. chlorinated copperas.

9. House connections to the laterals is generally made by
a. R.C.C.
b. P.C.C.
c. Cast iron
d. Glazed stone wares.

10. The ratio of maximum sewage flow to average sewage flow for mains up to 1 m in diameter, is
a. 1.5
b. 2.0
c. 3.0
d. 4.0

key

Q.NO	1	2	3	4	5	6	7	8	9	10
Ans	D	b	c	d	c	d	D	b	d	b

FILL IN THE BLANK QUESTIONS WITH ANSWERS

1. ----------------- is the biological process by which ammonia is first converted to nitrite and then to nitrate

2. Degradable organic carbon inhibits nitrification at concentrations greater than**.** ------------------

3. The ----------------- process requires a slow-growing nitrifying bacteria with sludge that has been aged for a long time and high dissolved oxygen concentration

4. ----------------- is the biological process by which nitrate is converted to nitrogen and other gaseous end products

5. ----------------- removal occurring in a single unit is a possibility to overcome these disadvantages

6. The carbon removal and nitrification stages were performed in an aerobic activated sludge tank, while the denitrification was completed by either an-----------------

7. Bench-scale tests showed that a detention time of 10 minutes would yield a 1.5 mg/L drop in the mixed liquor-----------------

8. ----------------- is one of the major nutrients contributing in the increased eutrophication of lakes and natural waters

9. ----------------may contain from 5 to 20 mg/l of total phosphorous, of which 1-5 mg/l is organic and the rest in inorganic

10. Chemical precipitation is used to remove the inorganic forms of phosphate by the addition of a coagulant and a mixing of----------------

Q. NO	Ans
1	nitrification
2	15-20 mg/L BOD5
3	nitrification
4	Denitrification
5	Carbon and nitrogen
6	anaerobic stirred tank reactor
7	DO concentration
8	Phosphorous
9	Municipal wastewaters
10	wastewater and coagulant

UNIT IV

TWO MARK QUESTIONS WITH ANSWERS

1. Possible levels of pathogens in wastewater

Ans: Type of pathogen

Viruses:	Enteroviruse	5000
Bacteria:	Pathogenic	
Protozoa:	Entamoebahistolytica	4500
Helminths:	Ascaris Lumbricoides	600
	Hookworms[4]	32
	Schistosomamansoni	1
	Taeniasaginata	10
	Trichuristrichiura	120

2. What are the organic and inorganic constituents of drinking water of health significance.

Ans:Organic	**Inorganic**
Aldrin and dieldrin	Arsenic
Benzene	Cadmium
Benzo-a-pyrene	Chromium
Carbon tetrachloride	Cyanide
Chlordane	Fluoride
Chloroform	Lead
2,4 D	Mercury
DDT	Nitrate

3. Write the Process Description of Sugar Industry.

Ans: The various steps involved for the production of Sugar are as follows:

1. Procurement of Sugarcane.
2. Milling of Sugarcane.
3. Juice Preparation.
4 Juice Concentrations.
5. Syrup Processing and Crystallization.
6 Sugar Crystal Separations, Drying, Packaging and Molasses Handling.
7. Bagasse Utilization.
8. Explain sugarcane industry process

4. Explain Water Requirement of a Sugar Industry.

Ans: Major units that consume water in a Sugar plant are:

(i) Boiler feed water.

(ii) Cooling water for condenser.

(iii) Process water for maceration, lime preparation, dilution for control of brix, dilution in evaporators and massecuite dilution, filter mud, fly ash handling, and cane wastewater.

The Sugar cane received from the field contains about 70% moisture on an average. Majority of this water has to be discharged as factory wastewater. Material balance of a typical plant with respect to water requirement and wastewater generation.

5. Explain production process characteristics

Ans:• Processes have a variable yield and processing time.

• At least one of the processes deals with homogeneous products.

• The processing stages are not labor intensive.

• Production rate is determined mainly by capacity.

• Food industries have a divergent product structure, especially in the packaging stage.

• Factories that produce consumer goods can have an extensive, labor intensive packaging phase.

• Due to uncertainty in pricing, quality and supply of raw materials, several recipes are available for a product

THREE MARK QUESTIONS WITH ANSWERS

1. What are the basic Raw Materials for steel industries?

Ans: The basic raw materials of large-scale steel making are:

- iron ore, treated in some way after it comes from the mine;
- coal, which must be converted to coke;
- limestone;
- steel scrap - important both to the integrated steelworks as secondary feed to the
- steelmaking furnace, and to the smaller scale "mini-mill" operator and special
- steel producer;
- fluxing materials;
- refractory materials; and
- alloys,

The output, or capacity, of a steelworks is generally expressed in terms of tones per annum of raw steel (the gross output from steelmaking furnaces). However, the marketed tonnage is only about 90% of the raw steel because of process losses and recycled scrap arising from rejects and trimming to size. Nowadays integrated steel works are rarely viable at less than 3 million tones p.a. Where as mini mills operate successfully at 100,000 tones p.a. and upwards to 1.5 to 2.0 million tones p.a.

2. Characteristics of wastewaters

Ans: Municipal wastewater is mainly comprised of water (99.9%) together with relatively small concentrations of suspended and dissolved organic and inorganic solids. Among the organic substances present in sewage are carbohydrates, lignin, fats, soaps, synthetic detergents, proteins and their decomposition products, as well as various natural and synthetic organic chemicals from the process industries. Table shows the levels of the major constituents of strong, medium and weak domestic wastewaters. In arid and semi-arid countries, water use is often fairly low and sewage tends to be very strong.

Constituent Concentration, mg/l

	Strong	Medium	Weak
Total solids	1200	700	350
Dissolved solids (TDS)[1]	850	500	250
Suspended solids	350	200	100
Nitrogen (as N)	85	40	20
Phosphorus (as P)	20	10	6
Chloride[1]	100	50	30
Alkalinity (as $CaCO_3$)	200	100	50
Grease	150	100	50
BOD_5[2]	300	200	100

The amounts of TDS and chloride should be increased by the concentrations of these constituents in the carriage water. BOD_5 is the biochemical oxygen demand at 20°C over 5 days and is a measure of the biodegradable organic matter in the wastewater. Municipal wastewater also contains a variety of inorganic substances from domestic and industrial sources including a number of potentially toxic elements such as arsenic, cadmium, chromium, copper, lead, mercury, zinc, etc. Even if toxic materials are not present in concentrations likely to affect humans, they might well be at phototoxic levels, which would limit their agricultural use. However, from the point of view of health, a very important consideration in agricultural use of wastewater, the contaminants of greatest concern are the pathogenic micro- and macro-organisms.

3.What are the parameters of agricultural significance

Ans: The quality of irrigation water is of particular importance in arid zones where extremes of temperature and low relative humidity result in high rates of evaporation, with consequent deposition of salt which tends to accumulate in the soil profile. The physical and mechanical properties of the soil, such as dispersion of particles, stability of aggregates, soil structure and permeability, are very sensitive to the type of exchangeable ions present in irrigation water. Thus, when effluent use is being planned, several factors related to soil properties must be taken into consideration

Another aspect of agricultural concern is the effect of dissolved solids (TDS) in the irrigation water on the growth of plants. Dissolved salts increase the osmotic potential of soil water and an increase in osmotic pressure of the soil solution increases the amount of energy which plants must expend to take up water from the soil. As a result, respiration is increased and the growth and yield of most plants decline progressively as osmotic pressure increases. Although most plants respond to salinity as a function of the total osmotic potential of soil water, some plants are susceptible to specific ion toxicity.

4. Explain Solid Waste Problem Arising in Sugar Industry.

Ans: Two forms of solid wastes are normally generated in the manufacture of cane Sugar viz., Bagasse and Press mud. Every 1,000 tons of processed Sugarcane generates about 270 tons of Bagasse. The Sugar industry is faced with the problem of proper and economical disposal of large quantities of Bagasse and Press mud.

The most common method of disposing Bagasse is to burn it in boilers operated at sugar mills. Burning bagasse presents problems like polluted emissions with high degree of moisture and bulkiness. Utilization of Bagasse as a boiler fuel is impaired by the high degree of moisture (45-60%). In addition, its bulkiness requires the construction of special furnaces to operate efficiently.

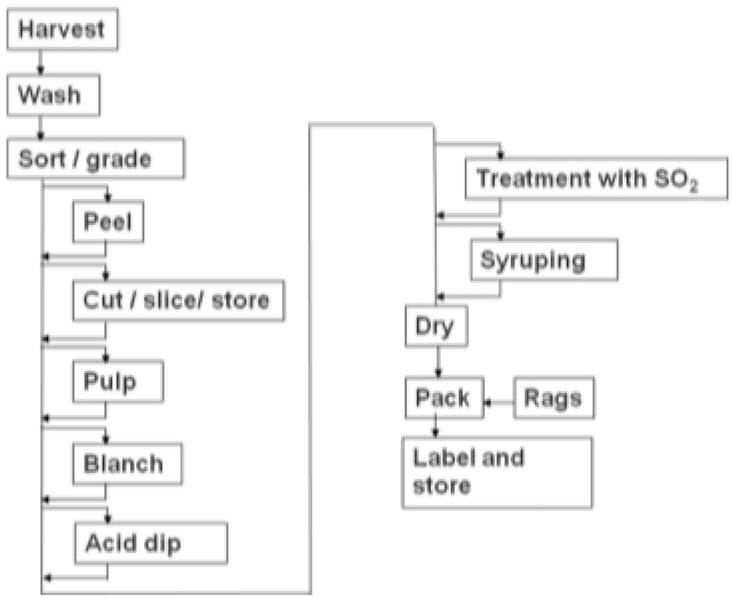
Considering the high cellulose content of bagasse and the organic matter, it offers a potential renewable source of biomass for biochemical conversion to methane by anaerobic fermentation. Bagasse and Molasses contain significant concentration of un-crystallized sugar and other organic compounds; the sugar content can be extracted. In addition, the residual digested sludge can have beneficial uses as fertilizer or as a soil conditioner.

5. Explain process flow charts of food industry?

Ans: (Flow chart, Different unit operations in milk processing with the help of flow charts, Know how to draw the flow charts and plant layouts)

Flow chart

A flow chart is a representation of sequence of operations in a processing plant or in a process. For example, if we want to prepare dried vegetables, the sequence of operations will be sorting, washing, peeling, slicing and then drying either under sun or in a mechanical dryer. But we may also think of blanching of the vegetable or treat with sulphur dioxide depending on the characteristics of the commodity and product. Thus if we prepare a flow chart of these processes.



FIVE MARKS QUESTIONS AND ANSWER

1. Explain modern production process.

Ans: Modern steelmaking can be broken down into six steps:

1. Iron making: In the first step, the raw inputs iron ore, coke, and lime are melted in a blast furnace. The resulting molten iron - also referred to as 'hot metal' - still contains 4-4.5% carbon and other impurities that make it brittle.

2. Primary Steelmaking: Primary steelmaking methods differ between BOS and EAF methods. BOS methods add recycled scrap steel to the molten iron in a converter. At high temperatures, oxygen is blown through the metal, which reduces the carbon content to between 0-1.5%. EAF methods, alternatively, feed recycled steel scrap through use high power electric arcs (temperatures up to 1650 °C) to melt the metal and convert it to high-quality steel.

3. Secondary Steelmaking: Secondary steelmaking involves treating the molten steel produced from both BOS and EAF routes to adjust the steel composition. This is done by adding or removing certain elements and/or manipulating the temperature and production environment. Depending on the types of steel required, the following secondary steelmaking processes can be used:

- stirring
- ladle furnace
- ladle injection
- degassing

4. Continuous Casting: In this step, the molten steel is cast into a cooled mold causing a thin steel shell to solidify. The shell strand is withdrawn using guided rolls and fully cooled and solidified. The strand is cut into desired lengths depending on application; slabs for flat products (plate and strip), blooms for sections (beams), billets for long products (wires) or thin strips.

5. Primary Forming: The steel that is cast is then formed into various shapes, often by hot rolling, a process that eliminates cast defects and achieves the required shape and surface quality. Hot rolled products are divided into flat products, long products, seamless tubes, and specialty products.

6. Manufacturing, Fabrication, and Finishing: Finally, secondary forming techniques give the steel its final shape and properties.

These techniques include:

- shaping (e.g. cold rolling)
- machining (e.g. drilling)
- joining (e.g. welding)
- coating (e.g. galvanizing)
- Heat treatment (e.g. tempering)

2. Explain Wastewater Treatment of Sugar Industry

Ans: The pollution load from Sugar mills can also be reduced with a better water and material economy practiced in the plant. Judicious use of water in various plant practices, and its recycle, wherever practicable, will reduce the volume of waste to a great extent. Volume of mill house waste can be reduced by recycling the water used for splashing.

Dry cleaning of floors or floor washings using controlled quantity of water will also reduce the volume of waste to a certain extent. The organic load of the waste can only be reduced by a proper control of the operations. Overloading of the evaporators and the vacuum pans and the extensive boiling of the syrup lead to a loss of sugar through condenser water, this in turn increases both volume and strength of the waste effluent.

Conventional Treatment Method:

The conventional system of treating wastewater is by Activated Sludge Process (ASP) from various units of a sugar plant is shown in Fig. 3. The various units include Bar Screen, Skimming Tank, Equalization Basin, Aeration Unit, Clarifier and Sludge Drying Beds.

13. What are the treatments for sugar industries.

Other Treatment Options:

1. Anaerobic Lagoon Technique.
2. Anaerobic Digestion.
3. Up flow Anaerobic Sludge Blanket (UASB).
4. Up flow Blanket Filter (UBF).
5. Aerobic Bioconversion.
6. Fixed Film Fixed Bed Reactor.

Anaerobic treatment of the effluent, using both lagoons and digesters have been found to be more effective and economical. Anaerobic lagoon with a detention time of 15 days and 0.38 kg BOD/m3d loading can achieve 89.6% BOD removal.

A BOD reduction of about 70% can be expected from an Anaerobic digester, with a BOD loading of 0.65 kg/m3/day and a detention time of 2.4 days under a controlled temperature of 37°C. The effluents of the anaerobic treatment units are found to contain sufficient nutrients (nitrogen and phosphorus). Further reduction of BOD can be accomplished in aerobic waste stabilization ponds.

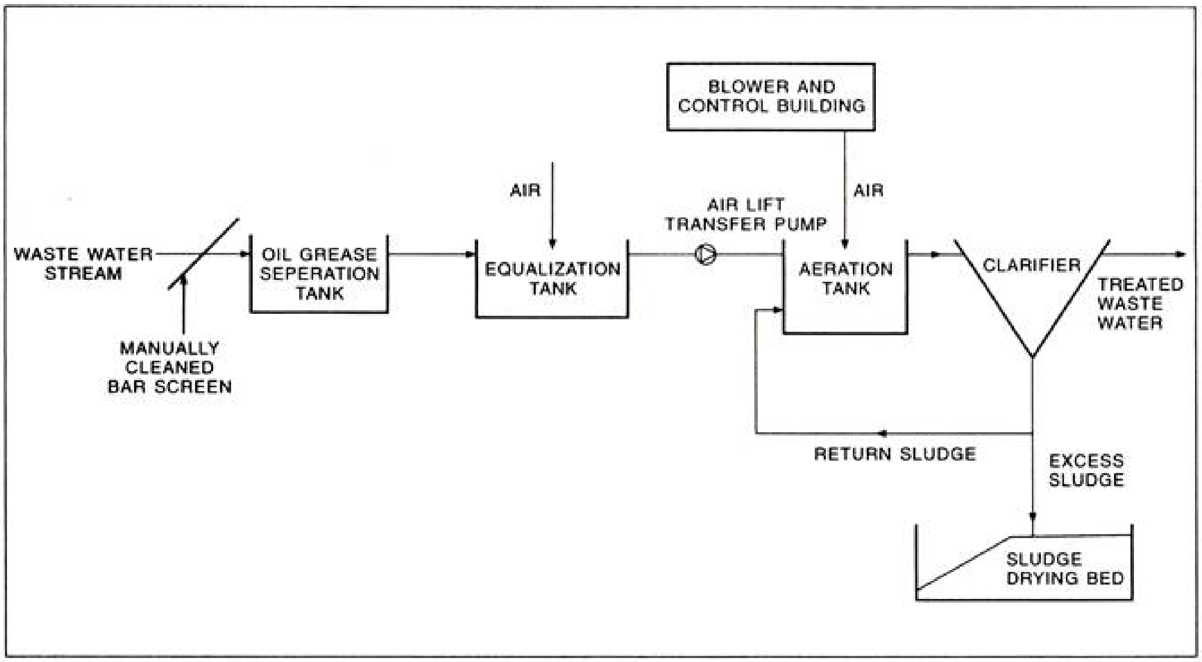


Fig. 3. Simplified flow diagram of effluent treatment plant in a sugar industry.

3. Write the Process Description of Sugar Industry.

Ans: The various steps involved for the production of Sugar are as follows:

1. Procurement of Sugarcane.
2. Milling of Sugarcane.
3. Juice Preparation.
4 Juice Concentrations.
5. Syrup Processing and Crystallization.
6 Sugar Crystal Separations, Drying, Packaging and Molasses Handling.
7. Bagasse Utilization.
8. Explain sugarcane industry process.

The Sugarcanes are cut into pieces and crushed in a series of rollers to extract the juice, in the 'mill house'. The milk of lime is then added to the juice and heated, when all the colloidal and suspended impurities are coagulated. During this treatment, much of the colour is also removed.

The coagulated juice is then clarified to remove the sludge. The clarifier sludge is further filtered through filter presses and then disposed off as solid waste. The filtrate is recycled to the process and the entire quantity of clarified juice is treated by passing sulphur dioxide gas through it. This process is known as "Sulphitation" colour of the juice is completely bleached out in this process.

1. Procurement of Sugarcane:

An early variety of Sugarcane matures by second week of November. The late variety of Sugarcane matures towards the middle of the season. Depending upon the state of maturity, the Sugarcane is harvested in the field, where the roots and green leaves are removed manually and the Sugarcane is prepared for transportation to the factory. Depending on the location of the field, the cane is transported to the factory by bullock carts, tractor trolleys and trucks to the factory.

2. Milling of Sugarcane:

The Sugarcane is unloaded at the mill house by winch and crab on to the cane carrier, which feeds the fiberizing system. Here the Sugarcane is shredded into small pieces. The shredded Sugar cane is then squeezed through a series of pressure milling rolls containing grooved surface. Weak juice or water is added to last but one roller so that recovery of juice is of the order 95-97%.

3. Juice Preparation:

Double Sulphitation process is the latest process adopted for juice clarification. In this process, juice is heated at 70°C and is treated with lime and sulphur dioxide. The juice is adjusted to neutral pH and passed to the heat exchanger to raise its temperature to the boiling point. It is then sent to clarifier where the juice is clarified and then sent to multiple effect evaporators. The sediment from the clarifier is sent to vacuum filters. The juice mud is taken out as solid waste and the extracted juice is mixed with raw juice.

4. Juice Concentration:

The clarified juice is concentrated to about 65% solids from about 15% solids before entering the first multiple effect evaporator sending steam in the first evaporator. Vapors from the first evaporation are fed to the second evaporator and so on.

5. Syrup Processing and Crystallization:

The concentrated juice or syrup from the evaporator is again bleached by passing sulphur dioxide through it and the pH of the syrup drops down to about 5.4. It is then sent to the vacuum pan where the thickened syrup is boiled for three to four times as per purity in order to extract the sucrose content. It is then sent to crystallizers to deposit any additional sucrose content on the crystals. Fine Sugar is used as seed crystals.

6. Sugar Crystal Separation, Drying, Packing and Molasses Handling:

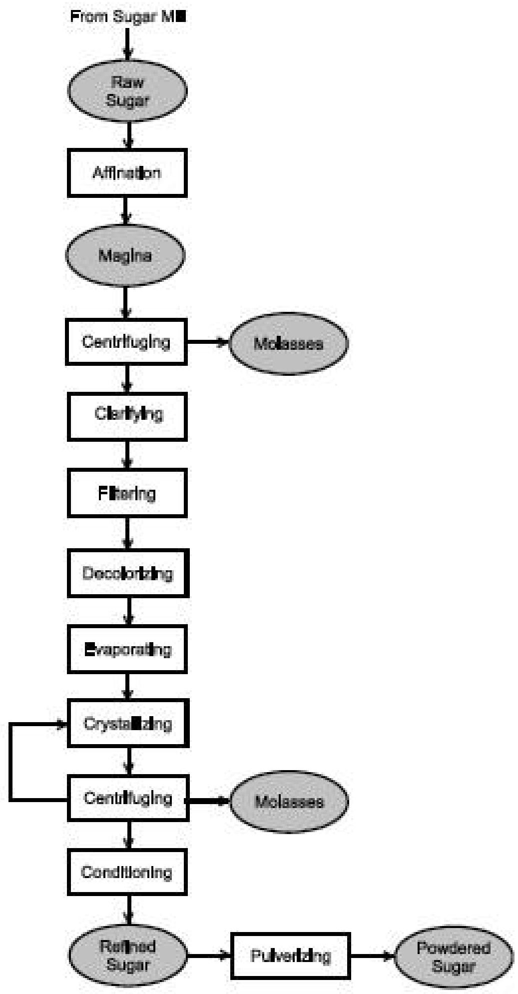
The Mixture of crystals and liquor, called ‘massecuite’, is sent to high-speed centrifuges. The liquor is re-concentrated and cooled successively to obtain more than one crops of crystals. The final mother liquor, called ‘Molasses’, which is still very rich in Sugar content is sent to steel storage tanks. Molasses is sold to various distilleries and other users against permit issued by excise department.

7. Bagasse Utilization:

The pulp expelled after extraction of juice is called ‘Bagasse’. As it comes out of the mill house, it contains about 50% moisture. A number of drying processes have been tried in the industry but unfortunately none of these were found industrially viable. Therefore, the wet Bagasse with 50% moisture is carried to boiler house by Bagasse carrier. It is able to generate about 2 kg of steam per kg on wet basis itself. With efficient boilers coming in the market,

4. Explain Cane Sugar Refineries.

Ans: Cane sugar refineries refine the raw sugar from the cane mill. Refined sugar is the common white table sugar consumers buy in grocery stores, or it may also be liquid sugar as used in beverages. Many steps are required to obtain the purity required of this product.



Affination: Raw sugar is mixed with a heated syrup solution in a vessel called a mingler. The mixing loosens impurities on the surface of the sugar crystals. Using syrup instead of plain water permits loosening the impurities from the surface of the crystals without dissolving them. The solution of heated syrup and crystals leaving the affination process is called magma. The primary hazards of this part of the process are those associated with the heating system.
Centrifuging: The magma is centrifuged to remove more molasses. At this point in the process, the sugar is called affined sugar. As in the sugar mill, these centrifuges can suffer mechanical breakdown typical of rotating equipment.
Clarifying: The magma is clarified in three or more steps. Phosphoric acid is added to make suspended solids float to the top, where they can be skimmed off. This part of the process is called phosphatation.

Decolorizing: Remaining molecules (primarily amino acids) that give the sugar a yellowish color are removed with bone char, activated carbon, ion exchange resins, or a combination of these materials.

Crystallizing: Decolorized sugar solution is sent to steam-heated evaporators. In the evaporators, water is boiled from the solution under vacuum. Then the juice is sent to crystallizers to cool under vacuum. This process is very similar to the crystallization process used in the raw sugar mill.

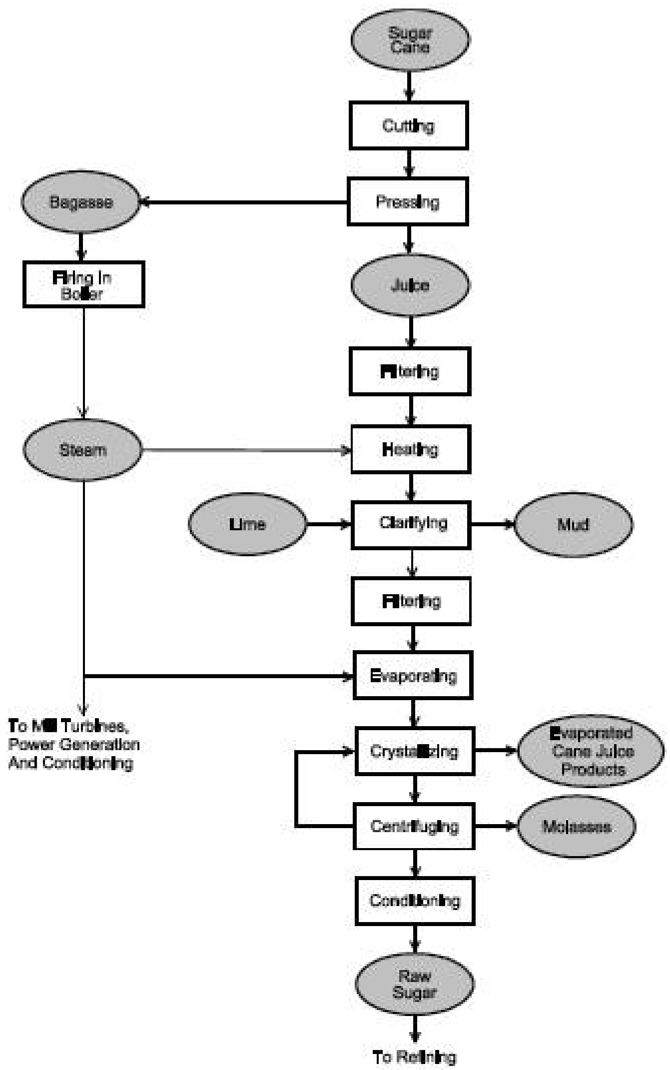
Centrifuging: The sugar is centrifuged again, then it is sent back through crystallizing and centrifuging two or three more times. The sugar obtained from the final centrifuging process is considered refined sugar. This step is similar to the centrifuging step in the sugar mill.
Conditioning Sugar is conditioned by drying it in a steam-heated, rotating drum granulator for approximately two to four days.

Pulverizing: If the finished product is to be powdered sugar (also called confectioners' sugar), the crystals are pulverized to achieve the desired particle size and consistency. This process generates very fine sugar dust, which can present an explosion hazard.

5. Explain sugarcane processing

Ans: Cane Sugar Processing: Cane sugar is processed in two major steps: producing raw sugar and refining it. Although both steps can be done in the same facility, the usual arrangement is for the sugar mill to produce the raw sugar and ship it to the sugar refinery. More recently, a trend has begun to build facilities that can both produce and refine the raw sugar. The processes in the mill and refinery are very similar. However, the sugar mill usually operates only right after the cane harvest. The refinery can store raw sugar and operate year round.
Cane Sugar Mills: Cane sugar mills process cane juice into a material called raw sugar. Raw sugar can then be stored in piles until needed by the refineries.
Cutting And Pressing: Sugar cane is transported by rail or truck, and is unloaded onto a conveyor belt. Rotating cane knives cut the cane into smaller pieces, called billets. A series of turbine-driven presses, also called mills, tandems or stands, then squeeze out the juice. This operation is also known as grinding.
Clarifying: The cane juice is filtered and heated. Lime is added, and impurities fall to the bottom of the clarifying vessel as a precipitate, or mud. The clarified juice is then filtered again. This part of the process presents little hazard.
Crystallizing: Clarified juice is sent to steam-heated evaporators. In the evaporators, water is boiled from the juice under vacuum. Then the juice is sent to crystallizers to cool under vacuum. The rate of cooling must be closely controlled. This leaves a mixture of sugar crystals and molasses called massecuite. The steam heating system, the evaporators and the crystallizers are pressure vessels subject to rupture.
Centrifuging: Molasses is removed from the massecuite by rinsing the sugar crystals in centrifuges. Some sugar mills call these centrifugals. The molasses can be sold for animal feed, or it can be further processed for human consumption. The raw sugar is sent back through the crystallizing and centrifuging processes two or three more times. When finished, the raw sugar is sent to the refinery. Centrifuges can suffer mechanical breakdown typical of rotating equipment.

Conditioning: Some grades of raw sugar are conditioned, or dehumidified, to reduce clumping. Conditioning is usually done in steam-heated fluidized bed dryers. The hazards include fuel fired equipment and bag houses.



MULTIPLE CHOICE QUESTIONS

1. Dilution method of disposing off sewage, is not preferred to
a. when sewage is fresh
b. when diluting water has high dissolved oxygen content
c. when diluting water is used for water supply near the point of sewage disposed
d. when the diluting water is having flow currents

2. For house drainage minimum gradient is
a. 1 in 60
b. 1 in 80
c. 1 in 10
d. 1 in 400

3. If the side of a square sewer is 1000 mm, the diameter of a hydraulically equivalent circular section, is
a. 1045 mm
b. 1065 mm
c. 1075 mm
d. 1095 mm.

4. The ratio of minimum hourly flow to the average flow of sewage is
a. 1/4
b. 1/3
c. 1/2
d. 3/4

5. Bio-chemical oxygen demand (BOD) for the first 20 days in generally referred to
a. initial demand
b. first stage demand
c. carbonaceous demand
d. all of these.

6. Flocculated particles do not change their
a. size
b. shape
c. weight
d. none of these

7. For non-scouring velocity 5 m/sec, the type of sewers generally preferred to, is
a. cast iron sewers
b. cement concrete sewers
c. glazed bricks sewers
d. stone ware sewers.

8. Disposal to sewage in large cities, is done in
a. irrigation
b. dilution
c. oxidation
d. putrifaction.

9. For the COD test of sewage, organic matter is oxidized by K2Cr207 in the presence of
a. H2SO4
b. HNO3
c. HCl
d. none of these.

10. In R.C. sewer pipes, the percentage longitudinal reinforcement to the cross-sectional area of concrete is kept
a. 10.0
b. 5.0
c. 2.0
d. 0.25

Q.NO	1	2	3	4	5	6	7	8	9	10
Ans	c	a	d	b	d	d	c	b	a	D

FILL IN THE BLANKS

1. Dissolved salts increase the--------------------- of soil water and an increase in osmotic pressure of the soil solution increases the amount of energy which plants must expend to take up water from the soil

2. --------------------- process cane juice into a material called raw sugar. Raw sugar can then be stored in piles until needed by the refineries

3. --------------------- is removed from the massecuite by rinsing the sugar crystals in centrifuges.

4. Raw sugar is mixed with a heated syrup solution in a vessel called a ---------------------

5. Phosphoric acid is added to make suspended solids float to the top, where they can be skimmed off. This part of the process is called ---------------------

6. The sugar is centrifuged again, then it is sent back through -------------------- two or three more times

7. The Sugarcanes are cut into pieces and crushed in a series of rollers to extract the juice, in the -----------------

8. The filtrate is recycled to the process and the entire quantity of clarified juice is treated by passing sulphur dioxide gas through it. This process is known as ---------------------

9. The liquor is re-concentrated and cooled successively to obtain more than one crops of crystals. The final mother liquor, called ---------------------

10.--------------------- contain significant concentration of un-crystallized sugar and other organic compounds; the sugar content can be extracted

Q. NO	Ans
1	Osmotic potential
2	Cane sugar mills
3	Molasses
4	mingler
5	Phosphatation
6	crystallizing and centrifuging
7	mill house
8	Sulphitation
9	Molasses
10	Bagasse and Molasses

UNIT V

TWO MARK QUESTIONS WITH ANSWERS

1. Anaerobic biological treatment in textile industry?
Ans: Anaerobic biodegradation of azo and other water-soluble dyes is mainly reported as an oxidation-reduction reaction with hydrogen, and formation of methane, hydrogen sulphide, carbon dioxide, other gaseous compounds, and releasing electrons. The electrons react with the dye reducing the azoic bonds, causing the effluent decolourization

2. What are the effluents of textile industry?
Ans:•As textile industry is one of the largest industries in the world and different fibres such as c ottonsilk,wool as well as synthetic fibres are all pretreated, processed, coloured and after treated using large amounts of water and a variety of chemicals, there is a need to understand the chemis try of the textile effluents very well.
• The textile waste characteristic needs to be understood clearly.

3. Classification of Treatment Methods

Ans: The individual treatment methods are usually classified as:

- Physical unit operations
- Chemical unit processes
- Biological unit processes.

4.Explain the treatment process?
Ans: The purification works at Manger provide both primary and secondary treatment processes. Primary treatment removes most of the solids from the effluent, but doesn't remove or degrade the dissolved organic matter. Secondary treatment uses microorganisms to convert these organics to simple compounds, and uses the energy of the sun to destroy pathogens.

5. What are the environmental problems and polluting effects from Textile organic dyes.
Ans: The environmental issues associated with residual dye content or residual colour in treated textile effluents are always a concern for each textile operator that directly discharges, both sewage treatment works and commercial textile operations, in terms of respecting the colour and residual dye requirements placed on treated effluent discharge.
The colour in watercourses is accepted as an aesthetic problem rather than an eco-toxic hazard. Therefore, the public seems to accept blue, green or brown colour of rivers but the ‘non-natural’ colour as red and purple usually cause most concern.

THREE MARK QUESTIONS WITH ANSWERS

1. Explain Classification and characteristics of Textile organic dyes

Ans: The dyes are natural and synthetic compounds that make the world more beautiful through coloured products. The textile dyes represent a category of organic compounds, generally considered as pollutants, presented into wastewaters resulting mainly from processes of chemical textile finishing.

The textile coloration industry is characterized by a very large number of dispersed dye houses of small and medium size that use a very wide range of textile dyes. The textile dyes are mainly classified in two different ways: (1) based on its application characteristics (i.e. CI Generic Name such as acid, basic, direct, disperse, mordant, reactive, sulphur dye, pigment, vat, azo insoluble), and (2) based on its chemical structure respectively

Excepting the colorant precursors such as azoic component, oxidation bases and sulphur dyes, almost two-third of all organic dyes are azo dyes used in a number of different industrial processes such as textile dyeing and printing, colour photography, finishing processing of leather, pharmaceutical, cosmetics, etc. The starting material or intermediates for dye production are aniline, chloroanilines, naphthylamines, methylanilines, benzidines, phenylenediamines, and others. Considering only the general structure, the textile dyes are also classified in anionic, nonionic and cationic dyes

2. What are the characterizes waste of Textile dye industries?

Ans: The identification of individual unknown dyes in a colored effluent or watercourse is difficult to be done and implies advanced analytical methods (i.e. individual and/or coupled spectrophotometry, G/L chromatography and mass spectrometry procedures), and also the colour determination and appreciation in different operating situations.

The characterization and identification data of the textile dyes as main chemicals in dyeing process must consist of:

• dye identity data (i.e. name, C.I. or CAS number, molecular and structural formula; composition, degree of purity, spectral data; methods of detection and determination)

• dye production information (i.e. production process, proposed uses, form, concentration in commercially available preparations, estimated production, recommended methods and precautions concerning handling, storage, transport, fire and other dangers, emergency measures, etc• dye physico-chemical properties (i.e. boiling point (b.p.), relative density, water solubility, partition coefficient, vapor pressure, self-ignition, oxidizing properties, granulometry, particle size distribution, etc.)

3. What are the environmental problems and polluting effects from Textile organic dyes.

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The colour in watercourses is accepted as an aesthetic problem rather than an eco-toxic hazard. Therefore, the public seems to accept blue, green or brown colour of rivers but the 'non-natural' colour as red and purple usually cause most concern.

The polluting effects of dyes against aquatic environment can be also the result of toxic effects due to their long time presence in environment (i.e. half-life time of several years),accumulation in sediments but especially in fishes or other aquatic life forms, decomposition of pollutants in carcinogenic or mutagenic compounds but also low aerobic biodegradability. Due to their synthetic nature and structure mainly aromatic, the most of dyes are non-biodegradable, having carcinogenic action or causing allergies, dermatitis, skin irritation or different tissular changes. Moreover, various azo dyes, mainly aromatic compounds, show both acute and chronic toxicity. High potential health risk is caused by adsorption of azo dyes and their breakdown products (toxic amines) through the gastrointestinal tract, skin, lungs, and also formation of hemoglobin adducts

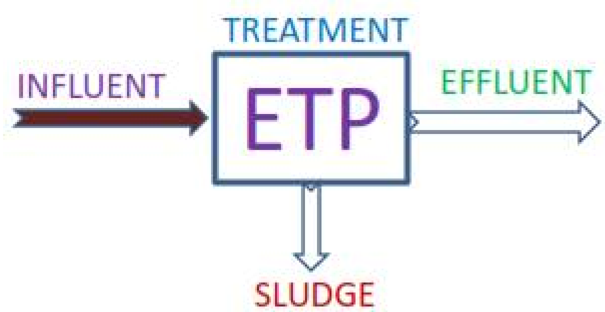
4. Explain coagulation-flocculation and precipitation?

Ans: It is clearly known that the colored colloid particles from textile effluents cannot be separated by simple gravitational means, and some chemicals (e.g., ferrous sulphate, ferricsulphate, ferric chloride, lime, polyaluminium chloride, polyaluminium sulphate, cationic organic polymers, etc.) are added to cause the solids to settle. These chemicals caused destabilization of colloidal and small suspended particles (e.g. dyes, clay, heavy metals, organic solids, oil in wastewater) and emulsions entrapping solids (coagulation) and/or the agglomeration of these particles to flocs large enough to settle (flocculation) or highly improve further filtration. The mechanism by which synthetic organic polymer removes dissolved residual dyes from effluents is best described in terms of the electrostatic attraction between the oppositely charged soluble dye and polymer molecules. Many of the most problematic dye types, such as reactive dyes, carry a residual negative charge in their hydrolyzed dissolved form, and so positively charged groups on the polymers provide the necessary counter for the interaction and subsequent precipitation to occur. The immediate result of this co precipitation is the almost instantaneous production of very small colored particles, having little strength and breaking down at any significant disturbances.

5. What is an ETP and need of ETP?

Ans:• ETP (Effluent Treatment Plant) is a process design for treating the industrial waste water for its reuse or safe disposal to the environment.

• Influent: Untreated industrial waste water.
• Effluent: Treated industrial waste water.
• Sludge: Solid part separated from waste water by ETP.



Need of ETP

- To clean industry effluent and recycle it for further use.
- To reduce the usage of fresh/potable water in Industries.
- To cut expenditure on water procurement.
- To meet the Standards for emission or discharge of environmental pollutants from various Industries set by the Government and avoid hefty penalties.
- To safeguard environment against pollution and contribute in sustainable development

FIVE MARK QUESTIONS WITH ANSWERS

1. What are the types of reactors used?

Ans:a) ***Batch Reactor***: These reactors are operated as fill and draw type. In this the wastewater flow is not continuous in the reactor. The reactors are operated in batch mode with fill time, reaction time, and with draw all-time. For example, BOD test, Sequencing Batch Reactor (SBR).There act or content may be completely mixed to ensure that no temperature or concentration gradient exists. All the elements in the reactor, under batch mode of operation, are exposed to treatment for the same length of time for which the substrateisheld in the reactor. Hence, they are like ideal plug flow reactors.

b) ***Plug-Flow(tubularflow)Reactor***:Inthisreactor,thefluidparticlespassthroughthetank and are discharged in the same sequence in which they enter in the tank. The particles remain inthetankforatimeequaltotheoreticaldetentiontime.Thereisnoovertakingorfalling behind; no intermixing or dispersion. Longitudinal dispersion is considered as minimum and this type can occur in high length to width ration of the tanks. For example, Grit Chamber, Aeration Tank of ASP with high length to width ratio.

c) ***Continuous-flow Stirred Tank (Complete – mixed) reactor***: In this reactors, particles are dispersed immediately as they enter the tank throughout the tank. Thus, the content in the reactor are perfectly homogeneous at all points in the reactor. This can be achieved in square, circular or rectangular tank. The particles leave the tank in proportion to their statistical population. The concentration of the effluent from the reactor is the same as that in the reactor.

d) ***Arbitrary Flow***: Any degree of partial mixing between plug flow and completely mixing condition exists in this reactor .Each element of the incoming flow resides in the reactor for different length of time .It is also called as intermixing or dispersed flow and lies between ideal plug flow and ideal completely mixed reactor. This flow condition can be used in practice to describe the flow conditions in most of the reactors.

e) ***Packed Bed Reactor***: They are filled with some packing medium, such as, rock, slag, ceramic or plastic media. With respect to flow they can be anaerobic filter, when completely filled and no air is supplied, or aerobic (trickling filter) when flow is intermittent or submerged aerobic filter when compressed air is supplied from the bottom.

f) ***Fluidized Bed Reactor***: This reactor is similar to packed bed except packing medium is expanded by upward movement of fluid (or air) than resting on each other in fixed bed. The porosity or degree of fluidization can be controlled by controlling flow rate of fluid (wastewater or air).

2. Explain classification and application of wastewater treatment methods

Ans: The degree of treatment required can be determined by comparing the influent wastewater characteristics to the required effluent characteristics, adhering to the regulations. Number of different treatment alternatives can be developed to achieve the treated wastewater quality.

Classification of Treatment Methods

The individual treatment methods are usually classified as:

- Physical unit operations
- Chemical unit processes
- Biological unit processes.

Physical Unit Operations: Treatment methods in which the application of physical forces predominates are known as physical unit operations. Most of these methods are based on physical forces, e.g. screening, mixing, flocculation, sedimentation, flotation, and filtration.
Chemical Unit Processes: Treatment methods in which removal or conversion of contaminant is brought by addition of chemicals or by other chemical reaction are known as chemical unit processes, for example, precipitation, gas transfer, adsorption, and disinfection.
Biological Unit Processes: Treatment methods in which the removal of contaminants is brought about by biological activity are known as biological unit processes.

- Thisisprimarilyusedtoremovebiodegradableorganicsubstancesfromthewastewater, either in colloidal or dissolved form.
- In the biological unit process, organic matter is converted into gases that can escape to the atmosphere and into bacterial cells, which can be removed by settling.
- Biologicaltreatmentisalsousedfornitrogenremovalandforphosphorousandsulphate removal from the wastewater.

The different treatment methods used in wastewater treatment plant are classified in three different categories as:

- Primary Treatment*:* Refers to physical unit operations.
- Secondary Treatment: Refers to chemical and biological unit processes.
- *Tertiary Treatment*: Physical unit operations and chemical or biological unit processes, used after secondary treatment.

3. What are the characteristics Sewage?
Ans: Characterization of wastes is essential for an effective and economical waste management programme. It helps in the choice of treatment methods deciding the extent of treatment, assessing the beneficial uses of wastes and utilizing the waste purification capacity of natural

bodies of water in a planned and controlled manner. While analysis of waste in each particular case is advisable and the data from other cities may be utilized during initial stage of planning.

Domestic sewage comprises spent water from kitchen, bathroom, lavatory, *etc.* The factors which contribute to variations in characteristics of the domestic sewage are daily per capita use of water, quality of water supply and the type, condition and extent of sewerage system, and habits of the people. Municipal sewage, which contains both domestic and industrial wastewater, may differ from place to place depending upon the type of industries and industrial establishment. The important characteristics of sewage are discussed here.

Temperature: The observations of temperature of sewage are useful in indicating solubility of oxygen, which affects transfer capacity of aeration equipment in aerobic systems, and rate of biological activity. Extremely low temperature affects adversely on the efficiency of biological treatment system sand on efficiency of sedimentation. In general, under Indian condition the temperature of the raw sewage was observed to be between 15 to 350C at various places in different seasons.

The pH: The hydrogen ion concentration expressed as pH, is a valuable parameter in the operation of biological units. The pH of the fresh sewage is slightly more than the water supplied to the community. However, decomposition of organic matter may lower the pH, while the presence of
industrial wastewater may produce extreme fluctuations. Generally the pH of raw sewage is in the range 5.5 to 8.0.

Colour and Odour: Fresh domestic sewage has a slightly soapy and cloudy appearance depending upon its concentration. As time passes the sewage becomes stale, darkening in colour with a pronounced smell due to microbial activity.

Solids: Though sewage contains only about 0.1 percent solids, the rest being water, still the nuisancecaused by the solids cannot be overlooked, as these solids are highly putrescible and therefore need proper disposal. The sewage solids may be classified into dissolved solids, suspended solids and volatile suspended solids. Knowledge of the volatile or organic fraction of solid, which decomposes, becomes necessary, as this constitutes the load on biological treatment units or oxygen resources of a stream when sewage is disposed of by dilution. The estimation of suspended solids, both organic and inorganic, gives a general picture of the load on sedimentation and grit removal system during sewage treatment. Dissolved inorganic fraction is to be considered when sewage is used for land irrigation or any other reuse is planned.

Nitrogen and Phosphorus: The principal nitrogen compounds in domestic sewage are proteins, amines, amino acids, andurea. Ammonia nitrogen in sewage results from the bacterial decomposition of these organic constituents. Nitrogen being an essential component of biological protoplasm, its concentration is important for proper functioning of biological treatment systems and disposal on land.

Chlorides: The chloride concentration in excess than the water supplied can be used as an index of the strength of the sewage. The daily contribution of chlorides averages to about 8 gm per person.

Based on an average sewage flow of 150 LPCD, this would result in the chloride content of sewage being 50 mg/L higher than that of the water supplied.

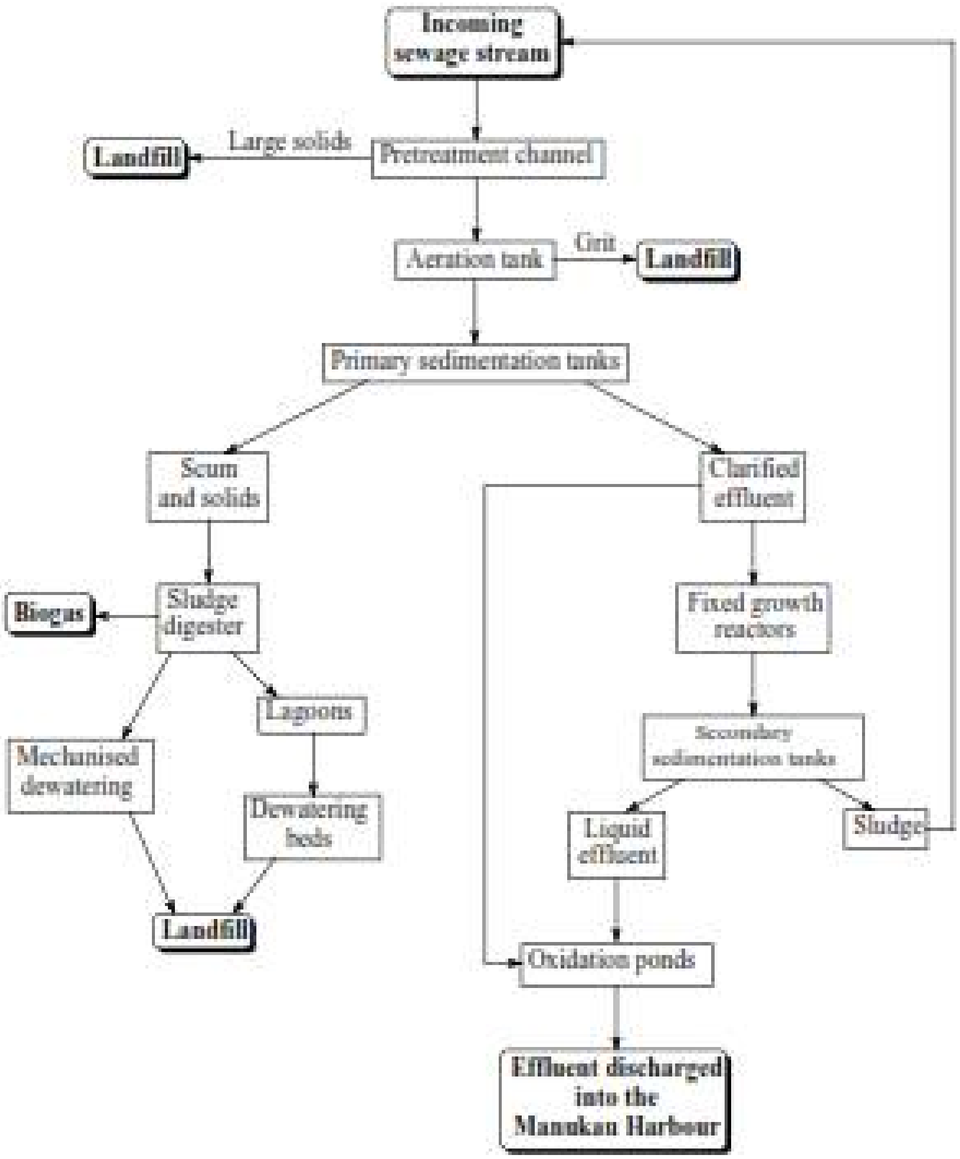
Organic Material: Organic compound present in sewage are of particular interest for sanitary engineering. A large variety of microorganisms (that may be present in the sewage or in the receiving water body) interact with the organic material by using it as an energy or material source. The utilization of the organic material by microorganisms is called metabolism. The conversion of organic material by microorganism to obtain energy is called catabolism and the incorporation of organic material in the cellular material is called anabolism.

4. Explain the treatment process?

Ans: The purification works at Manger provide both primary and secondary treatment processes. Primary treatment removes most of the solids from the effluent, but doesn't remove or degrade the dissolved organic matter. Secondary treatment uses microorganisms to convert these organics to simple compounds, and uses the energy of the sun to destroy pathogens.

The works have been designed to take advantage of the natural features of the site. Oxidation ponds provide very economical secondary treatment and these were chosen because a suitable area of harbor mudflats could be formed into ponds.

Conditions in the ponds promote the growth of unicellular algae: minute plants which, like any other plants, absorb carbon dioxide in daylight and give off oxygen by photosynthesis. This oxygen oxidizes the organics, thus purifying the sewage by reducing its oxygen demand. The ponds absorb an amount of solar energy equivalent to a 745 kW engine running continuously. Such engines are in fact required by other modern sewage treatment processes where the works must be restricted to a smaller area.



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The pH: The hydrogen ion concentration expressed as pH, is a valuable parameter in the operation of biological units. The pH of the fresh sewage is slightly more than the water supplied to the community. However, decomposition of organic matter may lower the pH, while the presence of
industrial wastewater may produce extreme fluctuations. Generally the pH of raw sewage is in the range 5.5 to 8.0.

Colour and Odour: Fresh domestic sewage has a slightly soapy and cloudy appearance depending upon its concentration. As time passes the sewage becomes stale, darkening in colour with a pronounced smell due to microbial activity.

Solids: Though sewage contains only about 0.1 percent solids, the rest being water, still the nuisance caused by the solids cannot be overlooked, as these solids are highly putrescible and there fore need proper disposal. The sewage solids may be classified into dissolved solids, suspended solids and volatile suspended solids. Knowledge of the volatile or organic fraction of solid ,which decomposes, becomes necessary, as this constitutes the load on biological treatment units or oxygen resources of a stream when sewage is disposed of by dilution. The estimation of suspended solids, both organic and inorganic, gives a general picture of the load on sedimentation and grit removal system during sewage treatment. Dissolved inorganic fraction is to be considered when sewage is used for land irrigation or any other reuse is planned.

Nitrogen and Phosphorus: The principal nitrogen compounds in domestic sewage are proteins, amines, amino acids, andurea. Ammonia nitrogen in sewage results from the bacterial decomposition of these organic constituents. Nitrogen being an essential component of biological protoplasm, its concentration is important for proper functioning of biological treatment systems and disposal on land.

Chlorides: The chloride concentration in excess than the water supplied can be used as an index of the strength of the sewage. The daily contribution of chlorides averages to about 8 gm per person.

Based on an average sewage flow of 150 LPCD, this would result in the chloride content of sewage being 50 mg/L higher than that of the water supplied.

Organic Material: Organic compound present in sewage are of particular interest for sanitary engineering. A large variety of microorganisms (that may be present in the sewage or in the receiving water body) interact with the organic material by using it as an energy or material source. The utilization of the organic material by microorganisms is called metabolism. The conversion of organic material by microorganism to obtain energy is called catabolism and the incorporation of organic material in the cellular material is called anabolism.

OBJECTIVE QUESTIONS WITH ANSWERS

1. The asbestos cement pipes are generally laid
a. horizontally
b. vertically
c. at an angle of 30°
d. at an angle of 60°.

2. Chlorination of water is done for the removal of
a. bacteria
b. suspended solids
c. sediments
d. hardness.

3. For evaporation and measurement of settable solids, the apparatus used, is
a.a jar
b.a breaker
c.a test tube
d.an Imhoff cone.

4. In SI units the power of sound is represented in
a. kgs
b.joules
c.neutons
d.watts.

5. A rain sanitary sewer is constructed to carry
a. sanitary sewage
b. storm sewage
c. surface water
d. ground water
e. all the above

6. The sewage is pumped up
a. from low lying areas
b. from flat areas
c. from basements

d. across a high ridge
E. all the above.

7. Removal of oil and grease from sewage, is known
a. screening
b. skimming
c. filtration
d. none of these.

8. The gas which may cause explosion in sewers, is
a. carbon dioxide
b. methane
c. ammonia
d. carbon monoxide.

9. In sewers the effect of scouring is more on
a. top side
b. bottom side
c. horizontal side
d. all sides.

10. Rate of flow of sewage is generally assumed
a. more than the rate of water supply
b. equal to the rate of water supply
c. less than the rate of water supply
d. at 150 liters per capita.

Q.NO	1	2	3	4	5	6	7	8	9	10
Ans	a	c	b	b	e	e	b	b	b	d

KG REDDY
College of Engineering
& Technology

FILL IN THE BLANKS WITH ANSWERS

1. -----------------tanned hides are often retained - during which process the desirable properties of more than one tanning agent are combined - and treated with dye and fat to obtain the proper filling, smoothness and color

2. ----------------- can catched dyes in their structures as a result of vender Waals forces, hydrogen bonds and hydrophobic interactions (physical adsorption).

3. The color in watercourses is accepted as an aesthetic problem rather than an -----------------

4. High potential health risk is caused by adsorption of azo dyes and their breakdown products

(toxic amines) through the gastrointestinal tract, skin, lungs, and also formation of -----------------

5. -----------------represents the conversion or transformation of pollutants by chemical oxidation agents other than oxygen/air or bacteria to similar but less harmful or hazardous compounds

6. ---------------- are a by-product of slaughter activities and can be processed into a wide range of end products

7. The process of chromium tanning is based on the cross-linkage of -----------------
with free carboxyl groups in the collagen.

8. Vegetable tanning probably results from hydrogen bonding of the tanning phenolic groups to the peptide bonds of the protein chains. In some cases as much as 50% by weight of tannin is incorporated into the hide -----------------

9. ----------------- stored in the sedimentation tank in the water purification system or solidified with cement or other material after storage for radioactive decay

10. -----------------is a process design for treating the industrial waste water for its reuse or safe disposal to the environment

Q. NO	Ans
1	Wet blue Chromium
2	Textile fibers
3	eco-toxic hazard
4	Hemoglobin adducts
5	Chemical oxidation
6	Hides
7	Chromium ions
8	Finishing
9	Sludge
10	ETP (Effluent Treatment Plant)