Sewage Characteristics

Physical Characteristics of Sewage:

The physical characteristics of wastewater include those items that can be detected using the physical senses. They are temperature, color, odor, and solids.

Temperature

Temperature of wastewater varies greatly, depending upon the type of operations being conducted at your installation. Temperature of sewage the sewage is slightly more than that of water, because of the presence of industrial sewage. The temperature changes when sewage becomes septic because of chemical process. The lower temperature indicates the entrance of ground water into the sewage.

Color of fresh sewage is yellowish grey to light brown. While that of the septic is black or dark due to oxidation of organic matter.

Odor smell of the fresh sewage is oily or soapy while the septic sewage develops an objectionable. H2S is the major source of pollution.

Solids

All matter except the water contained in liquid materials is classed as solid matter. The usual definition of solids, however refers to; “the matter that remain as residual upon evaporation and drying at 103 ± 20C”.

Those solids that are not dissolved in wastewater are called suspended solids. When suspended solids float, they are called floatable solids or scum. Those suspended solids that settle are called settleable solids, grit, or sludge.

All solids that burn or evaporate at 500°C to 600°C are called volatile solids. These solids serve as a food source for bacteria and other living forms in a wastewater treatment plant. Most organic solids in municipal waste originate from living plants or animals.

Those solids that do not burn or evaporate at 500°C to 600°C, but remain as a residue, are called fixed solids. Fixed solids are usually inorganic in nature and may be composed of grit, clay, salts, and metals.

Turbidity

The term “turbid” is applied to water/wastewater containing suspended matter or in which the visual depth is restricted.

Chemical Characteristics of Sewage (Wastewater):

Wastewater characteristics and their sources	
Physical	
Color	Domestic/Industrial wastes, natural decay of organic matter,
Odor	Industrial wastes, decomposing wastewater
Solids	Industrial/domestic wastes, soil erosion, inflow etc
Chemical	
Pesticides	Agricultural run-off
Phenols	Industrial wastes
Heavy metals	Industrial wastes
pH	Industrial wastes
Toxic compounds	Industrial wastes
Biological	Open water courses, treatment units etc

Sewage contains both organic and inorganic chemicals in addition to various gases like H2S, CO2, CH4, and NH3 etc that are formed due to the decomposition of sewage. The chemical characteristics of wastewater of special concern are pH, DO (dissolved oxygen), oxygen demand, nutrients, and toxic substances.

PH value

PH is used to describe the acid or base properties of water solutions. The pH of sewage is initially high and drops when the sewage becomes septic but becomes increases again with the treatment processes.

Dissolved oxygen (DO)

Wastewater that has DO is called aerobic or fresh. The solubility of oxygen in fresh water ranges from 14.6 mg/L at 0oC to about 07 mg/L at 35oC at 1.0 atm pressure.

Oxygen Demand

It is the amount of oxygen used by bacteria and other wastewater organisms as they feed upon the organic solids in the wastewater.

BOD

BOD is defined as the amount of oxygen required by the bacteria while stabilizing decomposable organic matter under aerobic condition. It is written as by BOD or

BOD520. “It is the amount of oxygen required by aerobic bacteria to decompose/stabilized the organic matter at a standard temperature of 20oC for a period of 05 days”. For domestic sewage 05 days BOD represents approx. 2/3 times of demand for complete decomposition.

COD

By definition the COD is the amount of oxygen required to stabilized the organic matter chemically, i.e. the COD is used as a measure of the oxygen equivalent of the organic matter contents of a sample that is susceptible to oxidation by a strong chemical oxidant.

Nutrients

Are life-supporting nitrogen and phosphorus.

Toxic Chemicals most industrial use various types of toxic chemicals, the discharges of which can be harmful to wastewater treatment processes.

Biological Characteristics of Wastewater:

The three biological organisms present in wastewater are bacteria, viruses, and parasites.

Bacteria

NEQS (Pak-EPA)

Parameter	Limits
Temperature	40°C
pH	6-10
BOD	80 mg/L
COD	150 mg/L
TSS	150 mg/L
TDS	3500 mg/L
Phenols	0.1 mg/L
Sulfates	600 mg/L
Chloride	1000 mg/L
Ammonia	40 mg/L
Pesticide, etc	0.15 mg/L
Chromium	1.0 mg/L
Lead	0.5 mg/L
Arsenic	1.0 mg/L
Mercury	0.01 mg/L
Total Toxic Metals	2.0 mg/L

Sewage consists of vast quantities of bacteria, most of which are harmless to man. However, pathogenic (disease-causing) organisms such as typhoid, dysentery, and other intestinal disorders may be present in wastewater. The bacteria in raw swage may be expected to in the range from 500, 000 to 5,000,000 per mL. These bacteria are responsible for the decomposition of complex compounds to stable compounds with the help of some extracellular and intracellular enzymes. Depending upon the mode of action of bacteria may be divided into the following three categories;

- Aerobic Bacteria
- Anaerobic Bacteria
- Facultative Bacteria

Aerobic A condition in which free dissolved oxygen is present in the aquatic environment.

Aerobic Bacteria A bacterium, which lives and reproduces only in an environment containing oxygen which is available for their respiration (breathing). Oxygen combined chemically; such as in water molecules (H2O) cannot be used for respiration by aerobic bacteria.

Anaerobic Bacteria Bacteria that do not utilize free dissolved oxygen to survive but derive oxygen from compounds such as sulphate

Natural Method of Sewage Disposal

The disposal of sewage without treatment or after treatment may be carried out by the following two methods: 1. Dilution or the Disposal of Sewage in Water 2. Land Treatment or the Disposal of Sewage on Land.

1. Disposal by Dilution:

In this method, the raw sewage or the treated sewage (or the effluent from treatment plants) is discharged into natural water bodies such as streams or rivers, lakes, sea, etc., having large quantity of water. The discharged sewage, in due course of time, is purified by what is known as self-purification process of natural water bodies.

Sewage discharged into a natural water body is mainly got rid of by its dilution or dispersion into the body of water with large volumes of water contained in it. The main action involved in this process of purification is due to the forces of purification operating in the sewage polluted waters. As such disposal by dilution may be referred to as the treatment by natural purification in water.

In order to achieve better efficiency of purification the amount of raw sewage to be discharged into water body may have to be controlled, and also the raw sewage may be given partial treatment before being discharged into water body.

The limit of discharge of raw sewage into water body and the degree of treatment to be given to raw sewage before being discharged into water body will depend not only on the quality of raw sewage but also on the self-purification capacity of the water body as well as the intended use of its water on the downstream side.

Conditions Favouring Disposal of Raw or Untreated Sewage by Dilution:

The following conditions are favourable for the disposal of raw or untreated sewage by dilution:

(i) Where sewage is comparatively fresh, i.e., it is discharged within 4 to 5 hours of its production.

(ii) Where the floating matter and the settle able solids have been removed from the sewage to be discharged.

(iii) Where the water body has large volume of water in comparison to the volume of the sewage to be discharged.

(iv) Where it is possible to thoroughly mix or diffuse sewage through diluting water.

(v) Where diluting water has high content of dissolved oxygen (DO).

Conditions Necessitating Treatment of Sewage before Disposal by Dilution:

The following conditions necessitate the treatment of sewage before its disposal by dilution:

(i) Where sewage contains such substances which are detrimental to the aquatic life in the receiving water body.

(ii) Where sewage contains industrial sewage containing toxic substances, and where industrial sewage is quite warm.

(iii) Where the volume of diluting water is insufficient,

(iv) Where the receiving water body is to be used for navigation,

(v) Where the receiving water body is to be used as a source of water supply,

Standards of Dilution:

The ratio of the quantity of diluting water to that of sewage is known as dilution factor or dilution ratio. Depending upon the value of dilution factor, the Royal Commission on Sewage Disposal has laid down certain standards of purification required or degrees of treatment required to be given to sewage before its disposal into water body. These standards are indicated in Table 9.1.

TABLE 9.1 : Standards of Dilution

Dilution factor	*Standards of purification required*
Above 500	No treatment is necessary. Raw sewage can be discharged directly into water body.
300 to 500	Preliminary treatment such as plain sedimentation should be given to sewage and the content of suspended solids should not exceed 150 ppm.
150 to 300	Preliminary treatment including chemical precipitation should be given to sewage and the content of suspended solids should not exceed 60 ppm.
Less than 150	Sewage should be treated extensively. The content of suspended solids should not be more than 30 ppm and 5-day BOD should not exceed 20 ppm.

The standards given in Table 9.1 have been operative in England since 1912 and have also been followed in our country without much variance.

The tolerance limits for industrial effluents discharged into inland surface waters are as indicated in Table 9.3

TABLE 9.3
Tolerance Limits for Industrial Effluents Discharged into Inland Surface Waters

Characteristics	Tolerance limit
1. Total suspended solids	Max. 100 mg/l
2. Particle size of total suspended solids	Shall pass 850-micron IS sieve
3. pH	5.5 to 9.0
4. Temperature	Shall not exceed 40°C in any section of the stream within 15 metres downstream from the effluent outlet
5. BOD (5-day at 20°C)	Max. 30 mg/l
6. Oil and grease	Max. 10 mg/l
7. Phenolic compounds	Max. 10 mg/l
8. Cyanides (as CN)	Max. 0.2 mg/l
9. Sulphides (as S)	Max. 2.0 mg/l
10. Radioactive materials (a) Alpha emitters (b) Beta emitters	 Max. 10^{-7} μc/ml Max. 10^{-6} μc/ml
11. Insecticides	Absent
12, Total residual chlorine	1.0 mg/l
13. Fluorides (as F)	Max. 2.0 mg/l
14. Arsenic (as As)	Max. 0.2 mg/l
15. Cadmium (as Cd)	Max. 2.0 mg/l
16. Hexavalent chromium (as Cr)	Max. 0.1 mg/l
17. Copper (as Cu)	Max. 3.0 mg/l
18. Lead (as Pb)	Max. 0.1 mg/l
19. Mercury (as Hg)	Max. 0.01 mg/l
20. Nickel (as Ni)	Max. 3.0 mg/l
21. Selenium (as Se)	Max. 0.05 mg/l
22. Zinc (as Zn)	Max. 5 mg/l
23. Ammoniacal nitrogen	Max. 50 mg/l
24. COD (Chemical oxygen demand)	Max. 250 mg/l

The tolerance limits for colour and odour have not been prescribed in this standard but it is recommended that as far as practicable, colour and unpleasant odours should not be present in the industrial effluents.

Besides these standards, Bureau of Indian Standards has also framed the following standard.

Tolerance limits for inland surface water subject to pollution.

This standard prescribes the tolerance limits for inland surface waters subject to pollution due to discharge of industrial and sewage effluents into inland surface waters which are used for the following purposes:

(a) Drinking water source without conventional treatment followed by disinfection;

(b) Outdoor bathing;

(c) Drinking water source with conventional treatment followed by disinfection;

(d) Fish culture and wild life propagation; and

(e) Irrigation, industrial cooling and controlled waste disposal.

Types of Natural Water Bodies:

Various natural water bodies into which sewage can be discharged for dilution are as follows:

(1) Creeks;

(2) Estuaries;

(3) Ground waters;

(4) Lakes;

(5) Ocean or sea;

(6) Perennial rivers or streams.

(1) Creeks:

A creek is a narrow inlet or bay on sea coast. It may not have dry weather flow during some period of the year, and hence disposal of sewage into such a creek should be done with great care.

(2) Estuaries:

The wide lower tidal mouth of a river is known as estuary. The dilution of sewage in estuaries is affected by ocean or sea water in addition to river water. Hence the process of dilution of sewage in estuaries is generally satisfactory.

(3) Groundwaters:

The sewage, when applied on land, ultimately filters out through different layers of soil and it meets groundwaters at great depth. If groundwater flows through favourable strata of soil, the dilution of sewage is satisfactory.

(4) Lakes:

A lake is an enclosed body of water which may be used for the purpose of dilution of sewage. In some cases, lakes are used for dual purposes, namely, for the supply of water and for the disposal of sewage. In such cases, the location of sewage discharge point should be carefully decided so as not to affect the water supply intake. Various characteristics of lake such as its size, shape, nature of surrounding area, volume of fresh water flow in it, etc., should be carefully studied before using it for disposal of sewage.

(5) Ocean or Sea:

Ocean or sea has water in abundance and hence its capacity to dilute sewage is practically unlimited. Moreover, sewage of any quality can be diluted in ocean or sea. Since the saturation concentration of dissolved oxygen (DO) in water decreases with increase in salt content, the saturation concentration of dissolved oxygen (DO) in sea water is approximately about 80% of that in ordinary water.

In addition to this deficiency, the temperature of sea water is lower than the sewage temperature, and its specific gravity is higher. Due to these reasons, when sewage is discharged into sea water, the lighter and warmer sewage rises up to the surface, resulting in spreading of the sewage at the top surface of sea in a thin film or sleek.

Further sea water contains a large amount of dissolved matter which chemically react with the sewage solids, resulting in the precipitation of some of the sewage solids, giving a milky appearance to the sea water and also in the formation of sludge banks. These sludge banks and thin milky layer formed at the top surface of sea water produce offensive hydrogen sulphide (H2S) gas by reacting with sulphate rich water of the sea.

Hence, extreme care should be taken while discharging sewage in sea and following points should be noted:

(i) There should be sufficient depth of water at the point of sewage discharge into the sea.

(ii) The sewage should be discharged deep into the sea and at a distance of 1 to 1.5 km away from the shore so as not to cause any nuisance at the sea shore.

(iii) The sea outfall for sewage should be placed on a firm rocky foundation.

(iv) The outfall should be so designed that proper dilution of sewage with sea water is accomplished before it tries to rise to the surface. This is accomplished by providing a diffuser at the end section. At the end of the outfall sewage is released in a simple stream or jetted through a manifold or multiple-point diffuser.

(v) The sewage should be discharged below low water level and only at the time of low tides. This is accomplished by holding sewage into large sized tanks constructed near the sea shore during the high tides and releasing the same during the low tides.

(vi) While deciding the position of sea outfall, the ocean current and direction of velocity of wind should be taken into consideration. The point of sewage discharge should be such that sewage is carried away from the shore and there is no nuisance from the blowing of wind.

(6) Perennial Rivers or Streams:

Perennial rivers or streams possess some flow throughout the year. However, the flow rate varies considerably from a minimum flow during summer to a maximum flow during rainy season. As such during summer the dilution factor is low, and also high temperature of water results in low solubility of oxygen. The sewage, under such circumstances, should be properly treated before dilution.

Table 9.4 gives a comparison of sewage dilution by ocean or sea and river or stream-

TABLE 9.4
Comparison between Sewage Dilution by Ocean or Sea and River or Stream

S.No.	Item	Dilution by ocean or sea	Dilution by river or stream
1.	Specific gravity	High	Low
2.	Quantity of solids in suspension	More	Less
3.	Penetration of sun rays	Less due to turbid water	More due to clear water
4.	Dissolved oxygen	About 20% less than river or stream water	More
5.	Maximum sewage load	No limit	Depends on river or stream discharge
6.	Condition of sewage after discharge	Usually anaerobic, formation of sludge banks and giving foul odour.	Mostly remain aerobic
7.	Suitability	Suitable for towns or cities situated on sea shore.	Suitable for towns or cities situated on banks of big rivers or streams

Self Purifications of Streams

It is the natural process in which the oxygen of water of streams is consumed by sewage. Oxygen is consumed by decompostions and stablization and at the same time streams are filled again by the atmospheric oxygen.

Factors Affecting Self- purifcation of streams:

1. Dilution
2. Oxidation
3. Sedimentation
4. Reduction Temperature

2. Disposal by Land Treatment:

In this method, the raw sewage or the partly treated sewage is applied on land.

The disposal of sewage by land treatment may be accomplished in the following three ways:

(1) Irrigation or sewage farming;

(2) Overland flow; and

(3) Rapid infiltration or Infiltration-percolation.

(1) Irrigation or Sewage Farming:

Irrigation involves the controlled discharge of sewage to the land to support plant growth (Fig. 9.4a). Besides the disposal of sewage, this method may help to increase crop yield. It is found that it is possible to have 33 per cent or so more yield under sewage irrigated crops than under the canal or well irrigation.

This is so because sewage generally contains a lot of fertilising elements such as nitrogen, phosphate, potash, etc., which add to the fertility of the soil. Crops such as cotton, sugarcane, plantain, potatoes and grass can be profitably grown on sewage irrigated lands. However, the sewage effluent before being used for irrigation must be made safe.

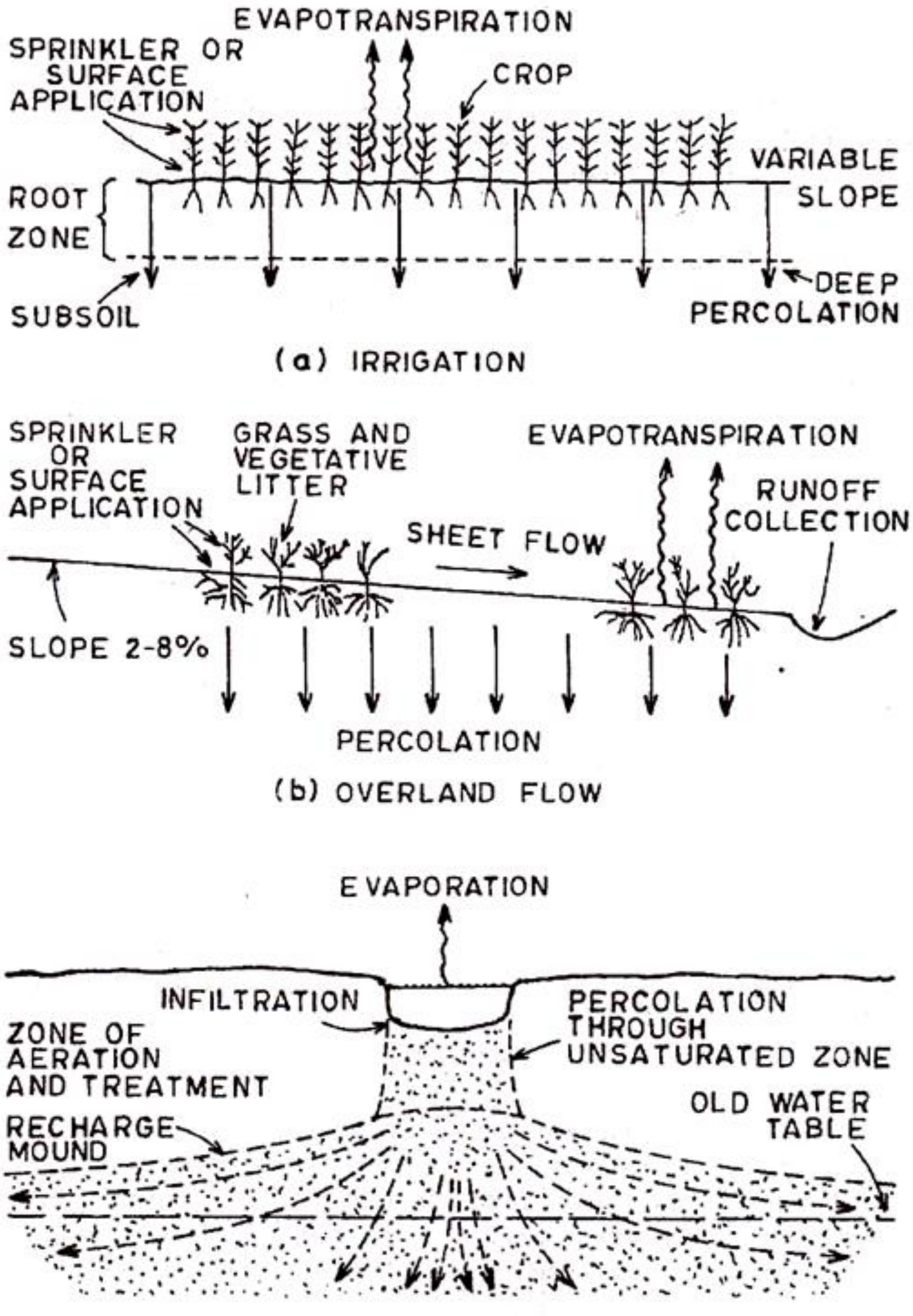


Fig. 9.4 Schematic representation of the three principal processes for land treatment.

Sewage can be applied by the following three methods of irrigation:

(a) Sprinkler or spray irrigation;

(b) Sub-surface irrigation; and

(c) Surface irrigation.

(a) Sprinkler or Spray Irrigation:

In this method, sewage is spread over the land through nozzles which are fitted at the tips of pipes. Sewage is sprinkled under pressure and the process can also be used for watering gardens and lawns. Hydrants for the supply of sewage under pressure may be located at suitable intervals so as to cover the entire field. This method of sewage application is useful for sandy soils and also for hilly land having steep slopes.

(b) Sub-Surface Irrigation:

In this method, sewage is supplied directly to the root zone of plants through a system of underground pipes with open joints. Sewage, as it flows through these pipes, percolates through the open joints, and it is distributed in the surrounding area through the capillary action.

This method is useful for places where rain fall is poor and demand for irrigation is high and subsoil water level is low. It entails less loss of water due to evaporation and absorption. However, this method is costly and it gives less yield of crops. Hence it is not generally adopted in practice.

(c) Surface Irrigation:

In this method, sewage is applied directly on the land.

This method is widely adopted in practice and its different modes of application are as follows:

(i) Basin method;

(ii) Flooding method; and

(iii) Furrow method

The selection of the method of sewage application will depend on crops to be raised, characteristics of soil, topography of country and quantity of available sewage.

(i) Basin Method:

In this method, basins are constructed around the plants and they are filled by sewage. The sewage slowly percolates to the root zone of plants and maintains the root zone in moist or damp condition. This method is useful for orchards or gardens of fruit trees.

(ii) Flooding Method:

In this method the land is divided into rectangular plots of convenient dimensions. Sewage is distributed over these plots to a depth of 30 cm to 60 cm. Subsoil drain pipes are provided to supply air to the soil and to remove the percolated effluent through the soil.

(iii) Furrow Method:

In this method, furrows and ridges are formed. Furrows are very small ditches having depth of about 30 to 50 cm and width of about 120 to 150 cm. Ridges have length of about 15 to 30 m and width of about 120 to 250 cm.

Furrows are filled with sewage to about two-third of their depth. Sewage from two adjoining furrows percolates from their sides and beds and thus cause saturation of root zones of plants which are grown on the ridges. Subsoil drain pipes are provided to collect percolated effluent and lead it to nearby natural waters for disposal. This method is useful when sewage is not to be kept in contact with beds of crops.

Sewage Treatment

Sewage Treatment Process -There are three main stages of treatment in a typical sewage treatment plant, but the design or layout can vary from site to site. These plants are categorised into one of three types, based on the method of secondary treatment, i.e. Activated Sludge,

1. **Primary Treatment** It is essential to remove large solids, e.g. road grit and silt from the raw sewage in order to prevent mechanical damage or blockages to pumps, valves, channels, and orifices. The initial stage of the Primary Treatment includes a settling channel or tank, known as Grit Removal, followed by screening, to remove floating and large organic material. Coarse screens, generally bars with 6mm spacing, are followed by fine screens, and then drum filters. Screening may be combined with maceration, which involves shredding the raw sewage, followed by a process to crush the solids into very small particles.The screened sewage is then passed to a further tank, known as Sedimentation, to settle the bulk of the suspended matter. Colloidal and dissolved solids are not removed and require further treatment at the Secondary Treatment stage.

2. **Secondary Treatment** Biological Reactions The sewage consists of toxic chemicals both organic or inorganic. Organic waste, containing carbon, combined with other chemical elements, is broken down by the biological processes. This involves developing a culture of bacteria and other micro-organisms, which in the presence of sufficient oxygen, multiplies and feeds on the chemical substances in the sewage. Oxidation of the ammonia, for example, results in the conversion to nitrogen compounds, such as nitrite (NO_2^-), and with further oxidation, to nitrate (NO_3^-). This reaction is termed nitrification. Inorganic chemicals can also be treated, to a lesser extent by biological action, but they may require some form of chemical treatment. If the process is carried out correctly, the net result is a treated sewage which has a very low toxicity level, suitable for final discharge. The growth of the population of micro-organisms is determined by the availability of nutrient (provided by the raw sewage), temperature, pH, and (most importantly) dissolved oxygen. Optimum conditions vary according to the species, but are approximately 25 to 32°C, 5.5 to 9.5pH, and $2 mgl^{-1}$ respectively

3. **Tertiary Treatment** Treated sewage from the secondary treatment is then passed for final clarification or filtration before discharge to the river or sea. The clarifier is a settling tank, similar to that used for primary treatment, and may be followed by a polishing filter.

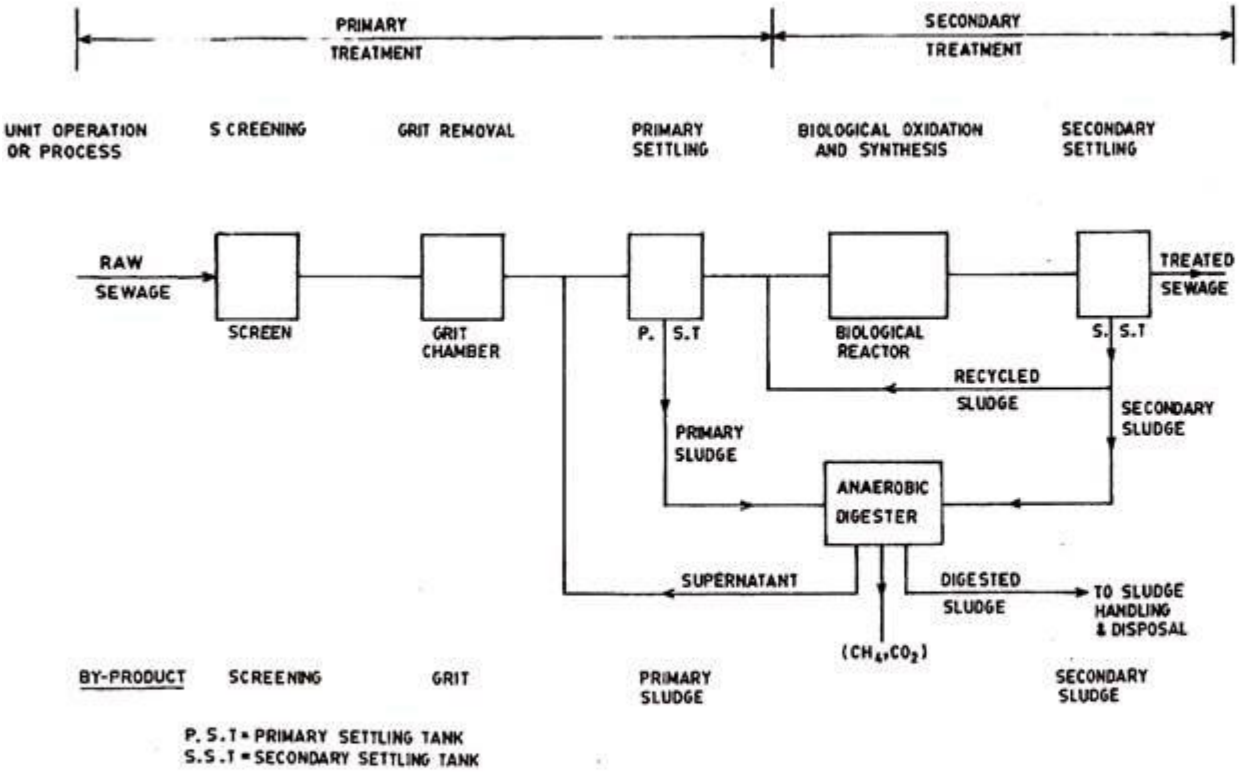


Fig. 10.1 Process flow sheet of conventional Domestic sewage treatment.

ACTIVATED SLUDGE The organic material present in the primary effluent, which overflows the primary settling tanks exhibits certain characteristics which require additional forms of treatment. This organic material is comprised of dissolved and finely divided suspended or, colloidal solids which account for the turbid appearance of the primary effluent. By nature, the dissolved organic material present in the influent will remain in solution in the liquid flow during primary treatment. The colloidal solids present are very small in size and mass and do not settle during primary treatment. It is not possible nor practical to increase the detention time of the wastewater in the primary tanks in an effort to remove these colloidal solids. Increased detention times would promote the development of septic conditions within the settling tanks and solids removal efficiencies would actually decrease. To treat the primary effluent waste stream a secondary biological treatment process is used known as the activated sludge process. This process effectively removes the dissolved organic material in addition to a portion of the colloidal matter and converts the remaining colloidal material to a biological sludge which rapidly settles. Activated sludge consists of sludge particles produced by the growth of organisms in the presence of free dissolved oxygen.

These microorganisms cleanse the wastewater by using the organic material present as a food source to grow and reproduce. The organisms stabilize soluble or colloidal solids by partial oxidation forming carbon dioxide, water, and sulphate and nitrate compounds. There are many variations or modifications of the activated sludge process however basic principles of operation apply to all. Wastewater to be treated is thoroughly mixed with the activated sludge to form what is termed mixed liquor. The mixed liquor flows through large aeration basins which allow for detention times between 4 to 6 hours. Here, oxygen is dissolved into the mixed liquor by blowing air through the flow or by mechanical surface mixers which splash the mixed liquor into the air allowing oxygen from the atmosphere to be dissolved. Following this aeration period the aerobic organisms present in the mixed liquor are directed to a secondary clarifier where they flocculate and settle to form a sludge. A portion of this settled sludge is sent back to the beginning of the process as return activated sludge to maintain and continue the process. Sludge produced in excess of process requirements is wasted or discharged from the treatment system back to the primary settling tanks or a separate sludge thickening operation.

Screening

The first unit operation generally encountered in wastewater treatment plants is screening. A screen is a device with openings, generally of uniform size, that is used to retain solids found in the influent wastewater to the treatment pant. The principal role of screening is to remove coarse materials (pieces of wood, plastics, rags, papers, leaves, roots etc.) from the flow stream that could:

- Damage subsequent process equipment e.g. pumps, valves, pipe lines, impellers.
- Reduce overall treatment process reliability & effectiveness, or
- Contaminate waste way

Grit Chamber- It is a long chamber constructing for the removing sand and other inorganic matter from sewage. Grit particles include sand, gravel and inert inorganic material.

Objective of Grit chamber

1. The grit may block the dilution channels by depositing on the bed.
2. It wear out pumps, conduits, pipes etc. Which increase the maintenance cost.
3. It also occupies larges volume in digestion tanks and tends to reduce their useful capacity.

Skimming tanks are used for removing Oils & Grease form the sewage constructed before the sedimentation tank. Municipal Raw Sewage Contains oils, fats, waxes, soaps, fatty acids, etc. The greacy and oily matter may form unsightly and odorous scum on the surface on the surface of settling tanks or may interfere with the activated sludge process.

In skimming tanks air is blown along with chlorine gas by air diffuser placed at the bottom of the tank.

The rising air tends to coagulate and solidify the grease and cause it to rise to the top of the tank whereas chlorine destroys the protective colloidal effect of protein, which holds the grease in emulsified form. The greasy materials are collected from the top of the tank and the collected are skimmed of specially designed mechanical equipment’s.

Detritus Tank

A chamber for removing the large heavy suspended matter from sewage

Plain sedimentation tank

Plain sedimentation is the process of removing suspended matters from the water by keeping it quiescent in tanks, so that suspended matter may settle down in the bottom due to force of gravity.

Process of Treating Water by Plain Sedimentation:

In the process of treating water by plain sedimentation the water is retained in a basin so that the suspended particles may settle down due to force of gravity only. After the settlement of suspended particles has taken place, the water is taken out from the basin without causing any disturbance to the suspended impurities.

Plain sedimentation is suitable for relatively pure water which contains undesirable amounts of suspended matters. Practical experience has shown that the water containing large amount of suspended matter can be easily clarified by sedimentation than a water containing less suspended matter.

Primary clarifier

Primary clarifier are sedimentation tank located just after the grit chamber for treating raw sewage

Objective of primary clarifier

It reduce the strength of sewage by about 40%

It minimize the quantity of settleable solids by about 85%

Secondary clarifier

It is sedimentation tank placed just after the secondary treatment unit such as activated process unit are called as secondary clarifier.

Contact Bed

It is a water tight tank or chamber with masonry walls.It made of broken stones of size 25-75mm.

Intermittent Sand Filters

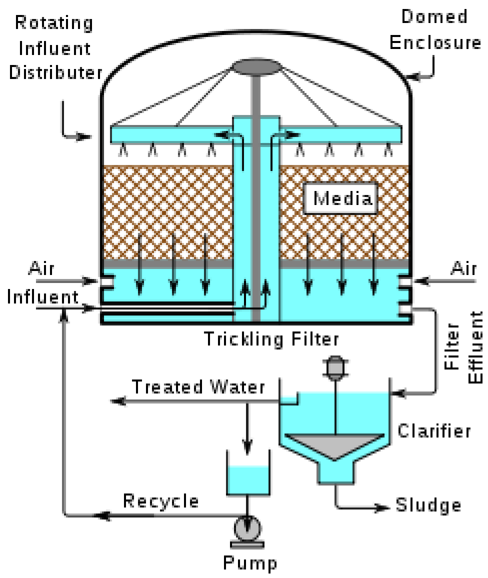
These sand filters are the early forms of biological treatment plants. In this type of sand filter the sawage is applied at regular interval.

A **trickling filter** is a type of wastewater treatment system. It consists of a fixed bed of rocks, coke, gravel, slag, polyurethane foam, sphagnum peat moss, ceramic, or plastic media over which sewage or other wastewater flows downward and causes a layer of microbial slime (biofilm) to grow, covering the bed of media. Aerobic conditions are maintained by splashing, diffusion, and either by forced-air flowing through the bed or natural convection of air if the filter medium is porous.

The terms **trickle filter**, **trickling biofilter**, **biofilter**, **biological filter** and **biological trickling filter** are often used to refer to a **trickling filter**. These systems have also been described as roughing filters, intermittent filters, packed media bed filters, alternative septic systems, percolating filters, attached growth processes, and fixed film processes.

settled sewage flow enters at a high level and flows through the primary settlement tank. The supernatant from the tank flows into a dosing device, often a tipping bucket which delivers flow to the arms of the filter. The flush of water flows through the arms and exits through a series of holes pointing at an angle downwards. This propels the arms around distributing the liquid evenly over the surface of the filter media. Most are uncovered (unlike the accompanying diagram) and are freely ventilated to the atmosphere.

The removal of pollutants from the waste water stream involves both absorption and adsorption of organic compounds and some inorganic species such as nitrite and nitrate ions by the layer of microbial bio film. The filter media is typically chosen to provide a very high surface area to volume. Typical materials are often porous and have considerable internal surface area in addition to the external surface of the medium. Passage of the waste water over the media provides dissolved oxygen which the bio-film layer requires for the biochemical oxidation of the organic compounds and releases carbon dioxide gas, water and other oxidized end products. As the bio film layer thickens, it eventually sloughs off into the liquid flow and subsequently forms part of the secondary sludge. Typically, a trickling filter is followed by a clarifier or sedimentation tank for the separation and removal of the sloughed film. Other filters utilizing higher-density media such as sand, foam and peat moss do not produce a sludge that must be removed, but require forced air blowers and backwashing or an enclosed anaerobic environment



Oxidation Pond

Oxidation pond can define as the **stabilization pond** that stabilizes the domestic, trade, industrial wastes etc. by the **microbial interaction,** primarily bacteria and algae.

It is the large, shallow ponds having 2-6 feet height of water body. Oxidation pond requires the presence of sunlight and oxygen for the **secondary treatment** of domestic and trade wastes. The secondary treatment of the organic and inorganic waste coming from raw sewage and industrial effluents is necessary. The direct disposal of the wastewater to the aquatic system can affect the life of water-bodies and the quality of water as well.

Advantages

- The stabilization pond can reduce the **biological oxygen demand** up to 90% naturally.
- It is a **simple** method to operate, does not require sophisticated equipment.
- Oxidation pond is a practical and **effective** method for the wastewater treatment of domestic and trade wastes in the tropical areas.
- The operation of a stabilization pond does not require much labour-power.
- It is an **economical** method for the treatment of wastewater from small and isolated units.

Disadvantages

- The construction of a stabilization pond requires **more land area**.
- The **maintenance** is quite intricate.
- Sometimes, it gives a **foul smell** and **mosquito menace** during the process if not appropriately maintained.
- There may get a chance of **effluent seepage** into the ground water, which can ultimately cause ground water pollution.

Buiding Drainage

Aim of Buiding drainage

1. Providing healthy condition in the building.

2. Disposal of liquid waste as early as possible.

3. Avoiding the entry of foul gases from sewer in to building

Requirements of Good Building Drainage

1. A Drainage plan of the building must be prepared before starting plumbing work.

2. The drains should be laid in straight line between point of access and all changes of directions.

3. The levels of the building, sewer line and other point of outlet should be determined accurately.

4. The detailed drainage plan should also be prepared.

5. The branch drains should be as short as possible.

6. The drains laid should be ensure their safety in future.

Different Sanitary Fitting and Fixture

The following sanitary fittings are provided in buildings:

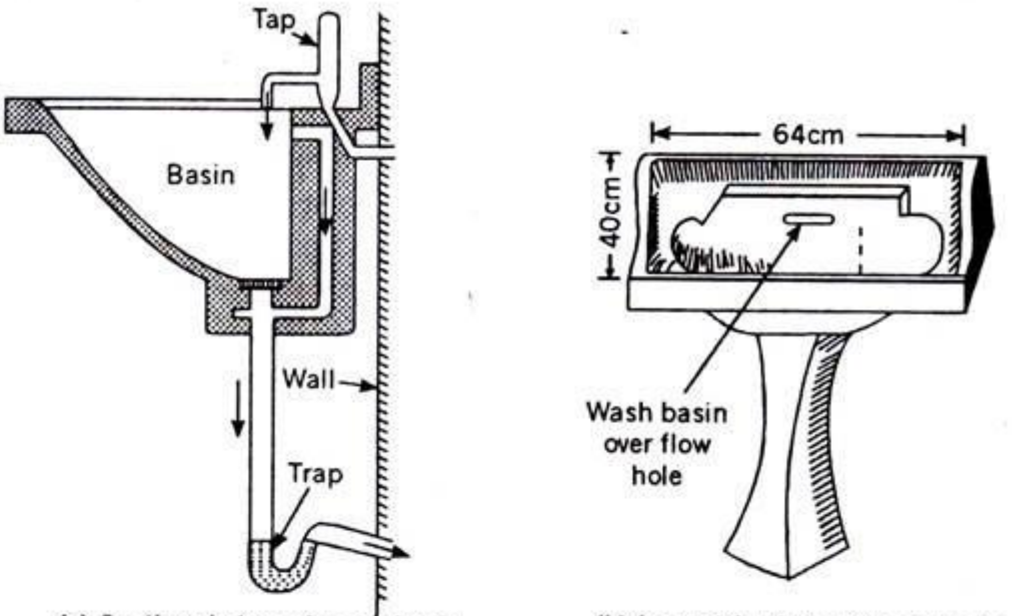
1. Wash Basin 2. Sink

2. Water closet 4. Urinal

4. Flushing Cistern 6. Bath Tubs

Wash Basin

A basin provided for the purpose of washing hands, mouth etc. Is known as wash basin.



(a) Sectional view of wash basin. (b) Isometric view of wash basin.

Fig. 25.1. Wash basin.

2. Sinks:

These are rectangular shallow receptacles suitable for kitchens or laboratory. Fig. 25.2 shows a kitchen sink which is mostly used. It is of one piece construction, provided with or without rim.

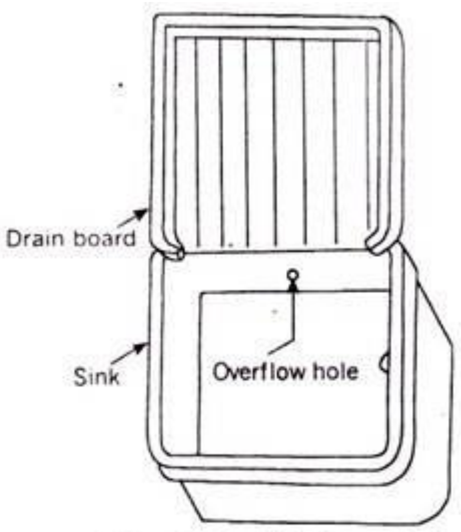


Fig. 25.2. Kitchen sink.

The floor of the sink is given a slope towards the waste outlet. The sinks are provided with circular waste hole. All the kitchen sinks are provided with a draining board which is fixed on the right of the user. Weir type overflow slots are also provided in some sinks.

The usual dimensions of the sinks are:

The sinks are made of glazed earthenware or stoneware. The height of the top of the sink from the floor should be 90 cm.

Water Closet

It may be defined as a water flushed plumbing fitting design to receive human excreta directly from the user.

Type

1. Indian or squatting type or oriental type

2. European or Pedestal type or western type

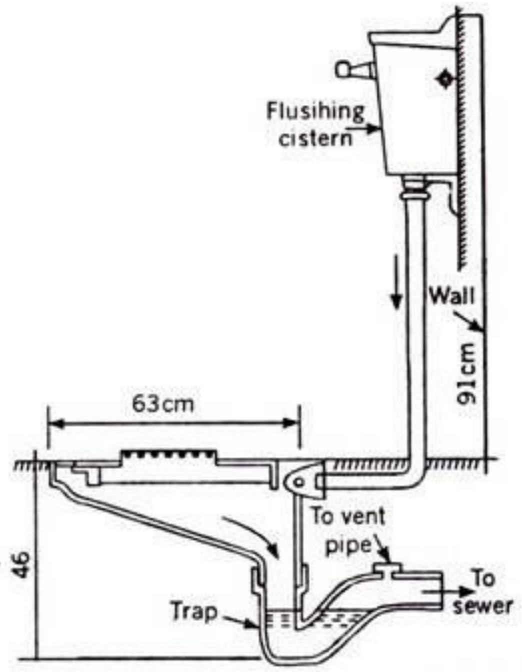


Fig. 25.6. Indian Type Water Closet.

Urinals

The arrangement provided for receiving human urine is called urinals.Urinals are available in different sizes and patterens.

Types of urinal

1. Bowl type

i) Flat back(430mm x 250mm x 350mm)

ii) Angle back(350mm x 430mmx 275mm)

2. Slab and stall type(single 450mm x 1000mm)

3. Squatting plate urinal(600mm x 350mm)ss

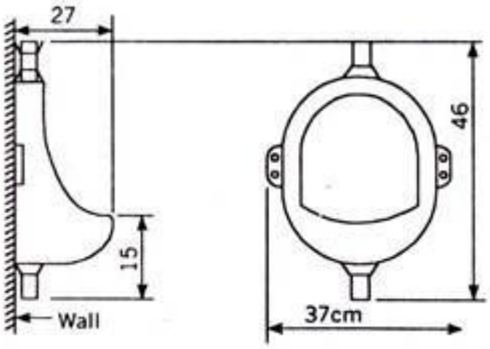


Fig. 25.10. Bowl type urinal.

Flushing Cistern

The arrangement provide for flushing out water closets or urinals called flushing Cistern .It is made up of cast iron.

Bath Tubs

A Tub provided for bathing is known as bathing tub. They are made up of various materials such as marble,glazed fire, clay, plastic, cast iron,enamelled pressed steel etc.

Traps

The depression or bend provided in a drainage system which is used to prevent foul air or gases in the atmosphere.

Requirement of a good Trap

It should be fixed easily with the drain.

It should provide always an adequate water seal.

For easy cleaning, a plug or cap must be provided.

It should have self cleaning velocity which help in cleaning of W.C.

Seal in Trap

The vertical distance between inside lowest point and inside highest point.The depth of water seal varies from 2.5cm to 10cm.

Causes of Breaking of Seal

Due to faulty Joints

Due to any cracks in bottom of seal from atmospheric agencies

The seal may break if it is not used regularly.