UNIT V

EFFLUENT DISPOSAL:

Methods:

After conveying the waste water through sewers, the next step is its disposal, either after treatment or even before treatment. The methods of disposal of wastewater may be classified under the following categories.

1. Natural methods: (a) By dilution, and
   (b) By land treatment
2. Artificial methods: (a) Primary treatment, and
   (b) Secondary treatment.
3. Combined methods: (a) Primary treatment, and
   (b) Effluent disposal by natural methods

Dilution, a prominent method of natural disposal, consists of discharging the wastewater into receiving water body (such as river, sea, lake, etc). This is done on the assumption that sufficient dissolved oxygen is available in the water body so that biochemical oxygen demand is satisfied. If however, the diluting water is not sufficient to supply the biological (or biochemical) oxygen demand to oxidise the entire matter present, there will be nuisance of foul odour and unsightly islands of half-digested floating, putrefying matter at the surface. In addition to this problem, the depletion of oxygen would kill the aquatic life, and if this dilution water is used at the downstream side for drinking water purpose, it will cause danger to public health. Hence modem practice is to give at least primary treatment to the wastewater before the effluent is disposed of by natural methods.

Disposal by Dilution: Disposal by dilution is the process whereby the treated wastewater or effluent from treatment plants is discharged either in large static water bodies (such as lake or sea) or in moving water bodies such as rivers or streams. The discharged wastewater or effluent is purified, in due course of time, by the so called self-purification process of natural waters. The limit of effluent discharge and the degree of treatment of wastewater depend upon the self purification capacity of natural waters as well as the intended use of the water body at the downstream side.

Condition favouring dilution without treatment: Wastewater, can be directly discharged into receiving waters under the following conditions favourable for dilution.

1. Where the wastewater is quite fresh, i.e. it is discharged within 2 to 3 hours of its collection.

2. Where the floating matter and settleable solids have been removed.
3. Where water body has large volume in comparison to the volume of wastewater (iv) where the diluting water has high content of DO, so that not only the BOD is satisfied, but sufficient DO remains available for the aquatic life.
4. Where it is possible to thoroughly mix or diffuse the wastewaters through the water body.
5. Where swift forward currents are available, so that there is no deposition of sewage at the site.
6. Where the wastewater does not contain industrial wastewater having toxic substances.
7. Where the receiving water is not a source of drinking water collection immediately to the downstream side.

Conditions essential for treatment before dilution:

1. Where the wastewater discharge is detrimental to aquatic life
2. Where the wastewater contains industrial wastes containing toxic substance or where industrial effluent is quite warm.
3. Where the volume of diluting water is insufficient.
4. Where the receiving waters are used for inland navigation
5. Where the receiving water is a source for drinking water
6. Where wastewater is not fresh but is stale
7. Where the effluent is not likely to be dispersed easily due to tides, winds, cross-currents etc.

Types of Receiving Waters for Dilution:

1. Perennial rivers and streams
2. Lakes
3. Ocean or sea
4. Esturies
5. Creeks.

Perennial rivers or streams are probably the best type of receiving waters, since the water is in continuous motion. Also in natural streams there is balance between plant and animal life, with considerable interaction among the various life forms. However the discharge flowing during summer and during winter varies. During summer, there may be minimum flow in the stream, with the result that dilution factor may be low and also high temperature of water may result in low solubility of oxygen, necessitating proper treatment before dilution.

Sometimes, especially when perennial streams are not available, lakes may be used for dilution. Various characteristics of lakes, such as its size, shape, volume of fresh water flowing into it etc. should be critically examined before deciding its self-purifying capacity.

Ocean has abundant water and the dilution factor is unlimited. However, sea water has about 20% less DO than river or stream, water is turbid due to dissolved impurities and penetration of sun's rays is less. Due to this, dilution by sea results usually into anaerobic conditions leading to formation of sludge banks and emission of foul odour. A creek is in the form of an inlet on sea coast, which may not have dry weather flow during some part of the year.

Due to this, great care should be taken in disposal of effluent into it. Estuary is wide lower tidal part of a river. Hence the dilution in an estuary is affected both by ocean water as well as river water. However, the process of dilution is generally satisfactory in estuaries.

SELF PURIFICATION OF NATURAL STREAMS:

When the wastewater or the effluent is discharged into a natural stream, the organic matter is broken down by bacteria to ammonia. Nitrates, sulphates, carbon dioxide etc. In this process of oxidation, the dissolved oxygen content of natural water is utilised. Due to this, deficiency of dissolved oxygen is created.

As the excess organic matter is stabilized, the normal cycle will be replenished in a process known as self-purification where in the oxygen in replenished by its re-aeration by wind. Also, the stable by products of oxidation mentioned above are utilized by plants and algae to produce carbohydrates and oxygen.

Water quality standards are often based upon maintenance of some minimum dissolved oxygen concentration which will protect the natural cycle in the stream while taking advantage of its natural assimilative capacity. Actions involved the self-purifications are physical.

Actions involved in self-purification.

The following are various factors which affect the process of self-purification of stream.

1. **Dilution:** When wastewater is discharged into the receiving water, dilution takes place due to which the concentration of organic matter is reduced and the potential nuisance of sewage is also reduced. If C_s and Q_R are the concentrations of any impurity such as organic content, BOD, suspended solids in the sewage and river having discharge rates Q_s and Q_R respectively, the resulting concentration C of the mixture is given by

$C_sQ_s + C_RQ_R = C(Q_s+Q_R)$

$$C = \frac{C_SQ_S + C_RQ_R}{Q_S + Q_R}$$

When the dilution ratio is quite high, large quantities of DO are always available which will reduce the chances of putrefaction and pollutional effects. Aerobic conditions will always exist because of dilution. This will however, not be there if dilution ratio is small. i.e. when large quantities of effluent is discharged into a small stream.

2. **Dispersion due to Currents:** Self-purification of stream largely depends upon currents which will readily disperse the wastewater in the stream, preventing locally high concentration of pollutants. High velocity improves re-aeration which reduces the concentration of pollutants. High velocity improves re-aeration which reduces these time of recovery, though length of stream affected by the wastewater is increased.
3. **Sedimentation:** If the stream velocity is lesser than the scour velocity of particles, sedimentation will take place, which will have two effects:
   1. The suspended solids, which contribute largely to oxygen demand will be removed by settling and hence water quality to the downstream will be increased
   2. Due to settled solids, anaerobic decomposition may take place.
4. **Oxidation:** The organic matter, present in the wastewater is oxidised by aerobic bacteria utilising dissolved oxygen of the natural water. This process prevails till complete oxidation of organic matter takes place. The Stream which is capable of absorbing more oxygen rapidly through re-aeration etc. can purify heavily polluted water in a short time.
5. **Reduction:** The reduction occurs in the streams due to hydrolysis of the organic matter biologically or chemically. Anaerobic bacteria will split the organic matter into liquids and gases, thus paving way for their ultimate stabilization by oxidation.
6. **Temperature:** At low temperature, the activities or bacteria is low and hence rate of decomposition will also be slow, though DO will be more because of increased solubility of oxygen in water. At higher temperatures, however, the self-purification takes lesser time, though the quantity of DO will be less.
7. **Sunlight:** Sunlight helps certain micro-organisms to absorb carbon dioxide and give out oxygen, thus assisting in self-purification. Sunlight acts as a disinfectant and stimulates the growth of algae which produce oxygen during daylight but utilise

oxygen at night. Hence wherever there is algal growth, the water may be supersaturated with DO during day light hours, though anaerobic conditions exist in night.

Oxygen sag or deficit curve:

- Deficit means "lacking"
- Oxygen deficit D at any time in a polluted river is the difference between saturation D.O and actual D.O.

  Oxygen Deficit (D) = Saturation DO – Actual DO.
- The saturation DO value for fresh water depends upon the temperature and total dissolved salts present in it; and its value varies from 14.62 mg/L at 0^{o}C to 7.63 mg/L at 30^{o}C, and lower DO at higher temperatures.
- The DO in the stream may not be at saturation level and there may be initial oxygen deficit 'D_o'.
- At this stage, when the effluent with initial BOD load Lo, is discharged in to stream, the DO content of the stream starts depleting and the oxygen deficit (D) increases.
- The variation of oxygen deficit (D) with the distance along the stream, and hence with the time of flow from the point of pollution is shown by the 'Oxygen Sag Curve'.

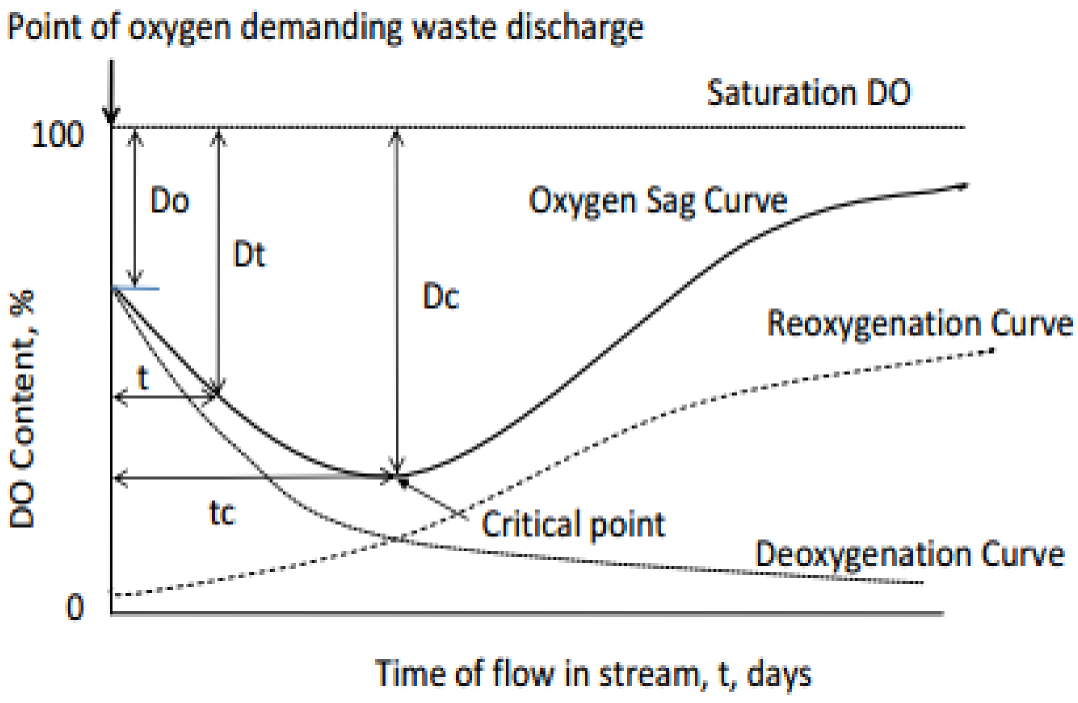


Fig: De-oxygenation, Re-oxygenation and oxygen sag curve

- The major point in sag analysis is point of minimum DO, i.e., maximum deficit.
- The maximum or critical deficit (D_c) occurs at the inflexion points of the oxygen sag curve.
- The amount of resultant oxygen deficit can be obtained by adding re-oxygenation and de-oxygenation curve.
- The resultant curve is called oxygen sag curve or oxygen deficit curve.
- When De-oxygenation rate exceeds the re-oxygenation rate, the oxygen sag curve shows increasing deficit of oxygen.
- When both rates become equal, the critical point is reached.
- Finally when rate of de-oxygenation falls below that of re-oxygenation the oxygen deficit goes on decreasing till becoming zero.

MARINE DISPOSAL:

- The saturation concentration of dissolved oxygen in water decreases with increasing salt content. Due to this reason, the saturation concentration in sea water is approximately 80% of that in water.
- In addition to this deficiency, the temperature of sea water is lower than the sewage temperature, whereas the specific gravity is higher. Due to these reasons, when Sewage is discharged into the sea water, the lighter and warmer sewage will rise up to the surface, resulting in the spreading of the sewage at the top surface of sea in a thin film or sleek.
- Moreover, 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 resulting in formation of sludge banks.
- These sludge banks and thin milky layer formed at the top of sea water produce offensive hydrogen sulphide gas by reacting with the sulphate rich water of the sea. The various chemical actions and the prevailing dissolved matter in the sea water reduce its capacity to absorb more quantity of sewage.
- However, since the sea contains large volume of water, most of these deficiencies can be overcome if the sewage is discharged deep into the sea, much away from the coast line, with extreme care. The following points should be kept in mind.

1. The sewage should be discharged deep into the sea, preferably 1 to 1.5 km away from the shore. This is accomplished by submarine outfalls that consist of a long section of pipe to transport the wastewater some distance from the shore. Such outfalls are placed on a firm rocky foundation. The cast iron pipe used for this purpose is encased in thick stone masonry or special type of concrete.
2. The out fall should be so designed that proper dilution of waste with seawater is a accomplished before the waste tries to rise to the surface.
3. The minimum depth of water at the outfall point should be 3 to 5 m.
4. The sewage should be disposed off only during the low tides.
5. While deciding the position of outfall, the direction of wind velocity and direction of ocean currents should be carefully taken into consideration.

DISPOSAL BY LAND TREATMENT:

- When the wastewater, either raw or partly treated, is applied or spread on the surface of land, the method is called disposal by land treatment.
- Some part of the wastewater evaporates while other part percolates in the ground leaving behind suspended solids which are partly acted upon by the bacteria and partly oxidised by exposure to atmospheric actions of air, heat and light.
- The sewage adds to the fertilising value of the land, and crops can be profitably raised on such land. Due to this, the disposal by land treatment is also called as sewage farming. The three principal processes of land treatment of wastewater are:
    1. Broad irrigation or sewage farming.
    2. Rapid infiltration
    3. Overland runoff

The first two processes depend upon moving or percolating the water downward through the soil and thus are limited by infiltration and percolating capacity of the land. While the percolating capacity is a function of soil characteristics, the infiltration depends upon the degree of clogging at the soil surface. If the waste is sufficiently pre-treated, clogging will be minimised and percolation will limit the rate at which liquid can be applied. For percolation rate of 6 to 25 mm/min. rapid infiltration is practicable; for 2 to 6 mm/min., irrigation is suitable and below 2 mm/min. overland run off should be adopted.

Rapid infiltration may be used for waste disposal, ground water recharge or both. For this process, wastewater is discharged into large basin underlined by sand and soils of high permeability. Bottom of the basin may be covered with grass like bermuda which can persist in wet or dry condition.

The grass assists in nitrogen removal and helps maintain the infiltration capacity of the surface. The technique of overland runoff is applied when soils have poor permeability. It is not a true disposal system since wastewater must be collected after passage over the soil. Plant or tree cover is essential to minimise and assist in nutrient removal. Hay grasses are usually employed.

The process by which the purification of sewage takes place in first two methods described above, is the same, i.e. mechanical straining or filtration of organic matter present in the sewage. The complex compounds in the sewage are thus converted into harmless mineral salts which serve as valuable fertilizer. The nutrients in sewage like nitrogen, phosphorous and

Potassium along with the micro-nutrients as well as organic matter present in it could be advantageously employed for sewage farming to add to the fertility of the soil, along with the irrigation potential of the water content.

Methods of application of wastewater: Wastewater can be applied to land by the following three methods.

1. Sprinkler or spray irrigation.
2. Subsurface irrigation
3. Surface irrigation
    - i. Basin method
    - ii. Flooding method
    - iii. Furrow method.

Out of these, spray irrigation is most commonly employed in western countries, while surface irrigation is commonly adopted in India. In the subsurface irrigation system, wastewater is supplied directly to the root zone of plants through a system of underground pipes with open joints. The method is not suitable for untreated wastewater containing a lot of suspended solids.

Conditions favourable for land treatment: Disposal of sewage by land treatments is favoured under the following conditions.

1. When natural rivers or streams are not located in the vicinity, land treatment is the only alternative.

2. When rivers run dry or have a very small flow during summer, discharging sewage into them is out of question.
3. When plentiful land with sandy, loamy or alluvial soil overlying soft moorum, sand or gravel is available, land treatment is favoured. Such soils are easily aerated and it is easy to maintain aerobic conditions in them.
4. When climate is arid, land treatment is favoured.
5. Land treatment is favoured when sub soil water table is low even during the wet season.
6. Land treatment is favoured when rainfall is low and there is an acute demand for irrigation water.
7. When large open areas in the surround locality are available, broad irrigation by sewage can be easily practiced.
8. Cash crops can be easily grown on sewage farms.

Broad Irrigation: Broad irrigation is similar to sewage farming though the purposes of the two are different. In sewage farming the prime consideration is the successful growing of the crops while in broad irrigation (also known as effluent irrigation), the prime consideration is the successful disposal of sewage. However, in both the processes, the ultimate result is that crop is raised and at the same time sewage is disposed by land application.

In sewage farming, raw sewage is not used while in broad irrigation, raw or settled sewage is applied on vacant land having a provision of properly laid underdrains to collect the small quantity of percolating effluent. In broad irrigation, applied on relatively more pervious soil having higher percentage of voids, the sewage is stabilised by aerobic action.

Sewage sickness: After continuous application of sewage on land, the pores of the soil get clogged, preventing oxidation and causing noxious smells. The land is unable to take any further load of sewage. This phenomenon of soil is known as sewage sickness of land. Sewage sickness can be prevented by adopting the following measures.

1. **Pre-treatment of sewage:** By giving primary treatment to the sewage, the suspended solids are removed. Due to this measure, the pores of the soil will not get clogged quickly. Also, BOD load will be reduced by about 30%.

2. Provision of extra land: Extra land, as reserve or standby should be available so that the land with sewage sickness can be given the desired rest. During the rest period, the sick land should be properly ploughed so that it is broken up and aerated.

3. Under Drainage of soil: Subsoil drains should be provided to collect the percolating effluent. This will minimise the possibility of sewage sickness.

4. Proper choice of land: The land chosen for this purpose should be sandy or loamy, having higher permeability. Clayey soil should be avoided.

5. Rotation of crops: Rotation of crops minimise the chances of sewage sickness.

6. Shallow depth application: Sewage should be applied in shallow depths. If sewage is applied in greater depths, chances of sewage sickness are increases.

WORKING PRINCIPLE AND DESIGN OF SEPTIC TANK:

- A septic tank is a special form of primary sedimentation tank with a longer detention time, in which digestion of settled sludge also takes place. In other words, a septic tank is a combined sedimentation cum digestion tank.
- This tank has, therefore, larger capacity than ordinary primary sedimentation tank, so as to accommodate and hold the settled sludge for its subsequent digestion. This unit, therefore, is grouped under the primary treatment units.
- The digestion of settled sludge is carried out by anaerobic decomposition process, giving rise to septicity or septic condition; that's why this unit is known as septic tank.
- Since the foul gases (such as hydrogen sulphide, methane, carbon dioxide) are evolved during the digestion process, the tank is kept completely covered on the top, with a provision of a high vertical vent shaft for the escape of these gases.
- The effluent from the septic tank is sufficiently foul in nature, containing considerable amount of dissolved and suspended putrescible organic solids and viable pathogens. Hence it is disposed of either for sub-surface irrigation or in soak pits or through other suitable methods.
- Due to anaerobic digestion of sludge and consequent release of gases, appreciable reduction in the volume of sludge takes place.
- Because of unsatisfactory quality of the effluent and also difficulty of providing proper disposal system for the effluents, septic tanks are recommended only for individual homes and small communities and institutions (such as schools, hospitals etc.) whose contributory population does not exceed 300 or where suitable wastewater carriage system is not available.

Design and Construction Features:

Since a septic tank is a settling-cum-digestion tank, its rational design is based on the following three functions it is expected to perform:

1. Sedimentation to remove the maximum possible amount of suspended solids from the sewage.
2. Digestion of settled sludge resulting in a much reduced volume of dense. Digested sludge
3. Storage of sludge and scum accumulating in between successive cleanings thereby preventing their escape. Hence the tank should be large enough to provide for the above three requirements.

    1. **Sewage flow:** The maximum sewage flow into a septic tank is based on the number of plumbing fixtures discharging simultaneously rather than the number of users and per capita wastewater expected to reach the tank. The estimated number of fixture units and the number of fixture units that contribute to the peak discharge in small installations serving upto 50 persons, for residential housing colonies upto 300 persons.

Tank dimensions: As stated earlier, the tank capacity and hence tank dimensions are based on the three functions of sedimentation, sludge digestion and sludge storage.

Sedimentation: For Indian conditions, at a temperature of 25°Cthe surface area required will be 0.92m^2 for every10 lpm peak flow rate. This is based on 75% removal of sewage particles of size 0.03 mm and above with a specific gravity of 1.2. A min. depth of.25_30 cm is necessary. The length is mainted 2-4 times the breadth.

Sludge digestion: The time required for anaerobic digestion is temperature dependant fig:.17.1 shows there relation between avg. annual temperature and the period(days)or detention time require for digestion. The suspended solidspercapitamaybetakenas70gm/day. Assuming that 60% of the solids is removed along with fresh sludge, of which70% is volatile, with a solids content of 5% (or moisture content of 95%), the volume of fresh sludge will work out to be 0.00083m^3/cap/day. Considering that 2/3 of the volatile matter is destroyed of which ¼ is mineralised during digestion and solids content of 13% in the digested sludge, the volume of digested sludge works out to be 0.0002 m^3/day. The digestion zone contains both the fresh sludge and hence volume of both of these will work out to be 0.000515 m^3/cap/day. From Fig. 17.1, the digestion period at 25°C, for average sludge works out to be 63 days. Hence the capacity for sludge digestion works out to be = 63 x 0.000515 = 0.032 m^3/capita.

Storage of sludge and scum: A sludge storage capacity of 0.0002 x 365 x 100= 7.30m^3/100 persons for an interval of cleaning of 1 year is provided below the sedimentation zone.

Total Capacity: The total capacity will be equal to the sum of the above three requirements, plus a free board of not less than 30 cm (to accommodate the depth of scum). No additional capacity for seed sludge is provided, it are is taken during desludging to leave about 5 to 10% digested sludge or a min. of 25 to 50mm depth of sludge on the tank bottom.

Thus, for 10 persons, the total capacity will be as follow:

1. **Sedimentation:**

Peak flow for 10 persons will be 20 lps, for which area required = (0.92/10) x 20 = 1.84m^2.

Keeping a depth of 30 cm for sedimentation, volume = 1.84x 0.3 = 0.55 m^3

2. **Digestion:** = 0032 x 10 = 0.32 m^2
3. **Sludge storage:** = (7.3/100) 10 = 0.73 m^3
4. **Free board** (including 0.25 m^3 for

Seed sludge) = 1.84 x 0.3 = 0.55 m^3

Total for 10 persons = 2.15 m^3

Detention period: The design criteria discussed above normally provides for a detention period of 24 to 48 hours based on an average daily flow of sewage. However, since the average daily now varies so widely from one installation to another, the detention period should not be considered as an important design criteria.

Sludge with drawl: Sludge is withdrawn from the septic tank either hall yearly or yearly. For small domestic tanks, desludging may he done at least once in 2 to 3 years. The digested sludge

is withdrawn through a dip pipe of at least 15 cm dia. under a hydrostatic pressure of at least 45 cm.

Construction details:

- The tank may be constructed of brick masonry, stone-masonry or even in concrete.
- They are provided with water tight cover, along with a ventilation pipe, extending at least 2 m above the top of highest building within a radius of 20 m for smaller capacity. only one compartment is provided, while for larger capacities, two compartments are provided, with a partition wall at a distance of about 2/3 the length from the inlet. The inlet and outlet are located at the two opposite ends.
- Baffles are generally provided at both inlet and outlet and should dip 25 lo 10 cm into, and project 15 cm above the liquid level. The baffles should be placed at a distance of one fifth of the tank length from the mouth of straight inlet pipe.

- The invert of outlet pipe should be placed at a level of 5 to 7 cm below the invert level of the inlet pipe. The floor of the tank should be of cement concrete and slope towards the sludge outlet.

EFFLUENT DISPOSAL IN SEPTIC TANKS:

The effluent coming out of the tank will be septic and malodorous, final purification of the effluent and the removal/death of pathogen is affected out by the following methods:

1. Soil absorption systems 2. Upnow titters.3 .Biological filters.

1. Soil Absorption systems: Soil absorption systems may be of two types

(a) Seepage pit or soak pit, and

(b) Dispersion trenches

Soak pits or dispersion trenches can be adopted in all porous soil where percolation rate is below 25 minutes per cm and the depth at u «1 table is t80 cm or more from the ground level The total subsurface soil area required for the soak pits or dispersion trenches is given by the following empirical relation :

$$Q = 130/\sqrt{t}$$

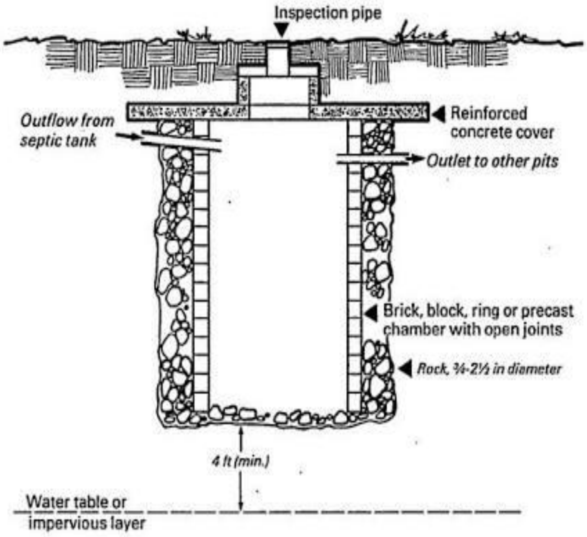
Where Q = max. rate of effluent application in lpd/m^2 of leaching surface.

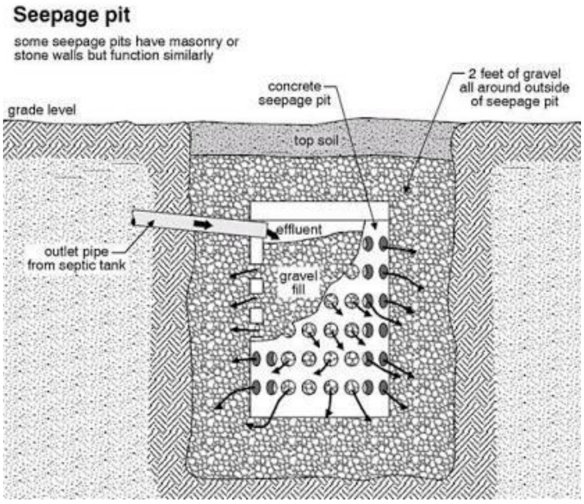
t = Standard percolation rate for the soil, in minutes per cm.

In calculating the effective leaching area required, only area of trench bottom in case of dispersion trenches and effective side wall area below the inlet level for soak pits should be taken into account.

1. **Seepage pit or soak pits:** Soak pits (or seepage pits) may be of any regular shape, but circular shape is more common. These are preferred only when water table is low, available land area is less or when a porous layer underlies an impervious layer at the top.

   The minimum horizontal dimension of soak pit should be 1 m, the depth below the invert level being at least 1 m. It should be covered at the top and the top should be raised above the adjacent ground to prevent damage by flooding etc. They be lined or unlined as shown in below fig. The lined soak pit is kept empty while unlined soak pit is filled with brick and stone aggregates.





2. **Dispersion trenches:** In this system, the septic tank effluent is uniformly distributed into a large area of sub-soil through open jointed or perforated tile drains, each housed in a dispersion trench as shown in below. Dispersion trenches consist of relatively narrow and shallow trenches about 0.5 to l m deep and 0.3 to l m wide excavated to a slight gradient of about 0.25%. Open jointed earthen ware or concrete pipes of 70 to 100 mm dia. are laid in the trenches over a bed of 15 to 25 cm of washed gravel or crushed stone. The maximum length of each trench is kept as 30 m, and these are spaced not closer than 2 m apart. One distribution box is provided for a group of about 3 to 4 trenches.

3. **Upflow anaerobic filters:** The effluent from the septic tank can be successfully treated by the use of upflow filter in the form of secondary treatment. It is a

submerged filter with stone media, 0.6 to 1.2 m deep. Septic tank effluent is introduced to it from the bottom. The microbial growth is retained on the stone media making possible higher loading rates and efficient digestion. The capacity of the unit is 0.04 to 0.05 m^3 per capita or 1/3 to 1/2 the liquid capacity of the septic tank it serves. The BOD removal is about 70%. The effluent is clear and free from nuisance.

4. **Biological filters:** These filters are similar to trickling filters. The effluent from the septic tank is sprayed on the filter through a rotary distributor. The filter media, consisting of coarse stones maybe 0.9 m to 1.4 m in thickness. Suitable microbial him is formed around the coarse media, which requires ample ventilation to get required oxygen for bio-oxidation. To achieve this purpose, the underdrains are connected to air vents situated at least 0.15 m above the ground level.

Advantages and Disadvantages of Septic Tanks:

Advantages:

1. Septic tanks can be constructed easily.
2. Very little attention and skilled attendance is required.
3. The sludge is relatively small, most of it being liquefied and digested. The reduction in volume is about 60% and reduction in weight is about 30%.
4. Cost is quite small and within the reach of private householders
5. There are no moving parts for its operation.
6. The effluent can be disposed of easily without much trouble.
7. When once installed, they give long carefree service.

Disadvantages:

1. The size required is large and uneconomical.
2. Their functioning and action is erratic.
3. The effluent is dark and foul smelling with high BOD and is often worse than the influent.
4. Leakage of gases from the top cause bad smell and environmental pollution.
5. Periodic cleaning, removal and disposal of sludge is often tedious.

Problem: Design a septic tank for a hostel housing 125 persons.

Solution:

The estimated peak discharge for 125 persons is equal to 300 lpm. Let us assume sludge withdrawal once in a year.

Surface area of tank @ 0.92 m^2 for every 10 lpm is = $(0.92/10) \times 300 = 27.6\ m^2$

Keeping a depth of 30 cm for sedimentation, also providing a free board of 0.3m. total volume of the tank will be as follows

1. **Sedimentation:** = 27.6 × 0.3 = 8.28 m^3
2. **Digestion:** = 0032 x 125 = 4.00 m^3
3. **Sludge storage:** = (7.3/100) 125 = 9.125 m^3
4. **Free board** (including provision for

Seed sludge) = 27.6 × 0.3 = 8.28 m^3

Total = 29.685 m^3

Total depth of tank = (29.685 / 27.6) = 1.076 m

Provide depth of tank = 1.1 m

Let us keep L/B ratio as 2.5

(2.5 B)(B) = 27.6

From which B = 3.32

Keep B – 3.4 m and L = 8.3 m.

Hence the tank dimensions are 8.3 m x 3.4 m x 1.1 m.