UNIT-V

Disposal of Sewage and Sludge Treatment :-

Disposal of sewage :-

Sewage disposal is defined as the process of disposing or getting rid of sewage, without affecting the environment or the place of disposal. The proper disposal of sewage wastes is an essential part of health protection and disease prevention.

objects of sewage disposal :-

i) To elimate or reduce danger to the public health by possible contamination of water supplies.

ii) To render sewage inoffensive without causing nuisance.

Methods of waste water disposal :-

Methods of disposal can be classified as follows.

a) Natural method of disposal
   (i) Dilution
   (ii) Land treatment

b) Artificial method of disposal
   (i) Primary treatment
   (ii) secondary treatment.

Self - Purification of Natural Water :-

* When sewage is discharged into the natural body of water gets polluted due to waste products present in sewage effluent. But the conditions donot remain same forever, beacuse the natural forces of purification go on acting upon the pollution elements and bring back the water into its original condition.
* This automatic purification in due course of time is called the "self purification" phenomena.

process involved in self purification :-

The following five process are involved in the self purification of river.

a) Dilution
b) Sedimentation
c) oxidation
d) Reduction
e) Sunlight.

a) Dilution :-

* when the perishable organic matter is discharged into river stream, it gets rapidly dispersed and diluted.
* This results in lowering of waste concentration and thus reduces the potential nuisance of sewage.

b) Sedimentation :-

The settleable solids present in effluents will settle down into the river bed, thus helping in the self purification process.

c) Oxidation :-

The oxidation of the organic matter present in the sewage effluent, will start as soon as the sewage outfalls into the river water containing dissolved oxgen.

* The deficiency of oxygen so created, will be filled up by the atmospheric oxygen.

d) Reduction :-

* Reduction occurs due to hydrolysis of organic matter settled at the bottom either chemically or biologically

e) Sunlight :-

* The Sunlight has a bleaching and stabilizing effect of bacteria.
* Algae produces oxygen in the presence of Sunlight due to photo synthesis.

Oxygen Sag curve:-

* The amount of resultant oxygen deficit can be obtained by algebraically adding the de-oxygenation and re-oxygenation curves. The resultant curve so obtained is called "Oxygen sag curve".

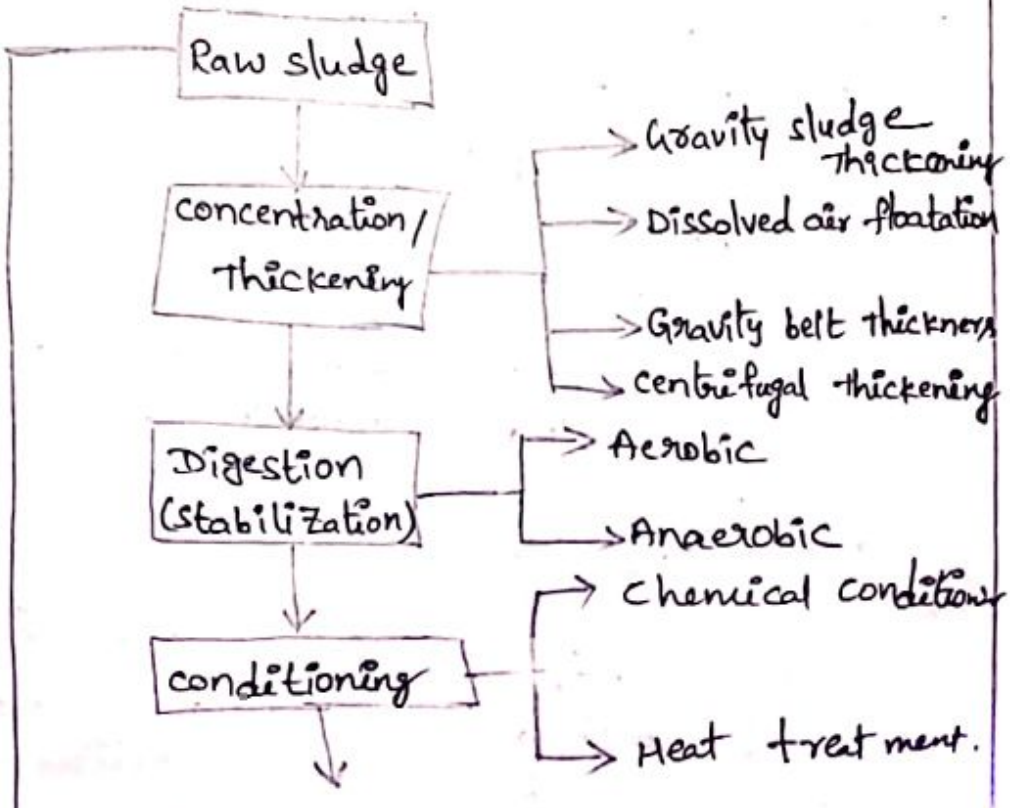
Sludge treatment processes:-

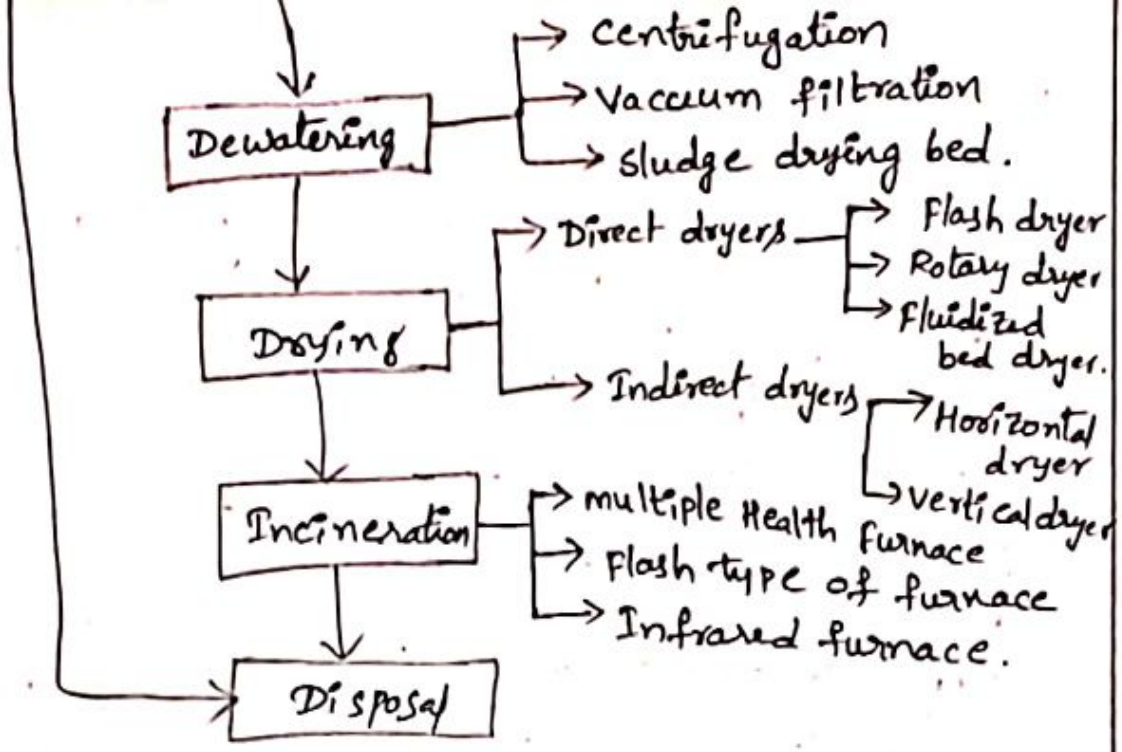
Sludge treatment may include all or a combination of the following unit operations and processes.

1) Thickening or concentration
2) Digestion
3) conditioning
4) Dewatering
5) Drying
6) Incineration.

Figure shows the flow chart for sludge treatment and disposal. The arrows in the diagram indicate possible flow paths.

Flow chart:-





1) Sludge Thickening :-

* The first step in sewage sludge treatment plant is called thickening
* In this step, the sewage sludge is thickened in a gravity thickner to reduce the overall volume, the enabling the easy handling of the sludge.
* air bubbles to allow the solid may to float to the top.

2) Sludge Digestion :-

* After massing all the solids from the sewage sludge begen the sludge digestion procen.
* This is a biological procen in which the organic solids present in the sludge get decomposed into stable substances.

3) Dewatering :-

* After retrieving use gases and other by products the sludge is dewatered before disposal.
* Dewatered sludge generally contains a significant amount of water, as much as 70% in spite of it's solidfication state.

4) Disposal :-

* once the sludge has been effectively dewatered it can be buried in a underground in a sanitary land fill or can be used as fertilizer, depending on it's chemical composition

Sludge thickening:-

The role of sludge thickening is to thicken the sludge of low concentration generated in STPs and to make subsequent process such as sludge digestion and sludge de-watering more effective. Thickened sludge may be of two kinds: Primary sludge generated in the primary settling tank and excess sludge generated in the secondary settling tank.

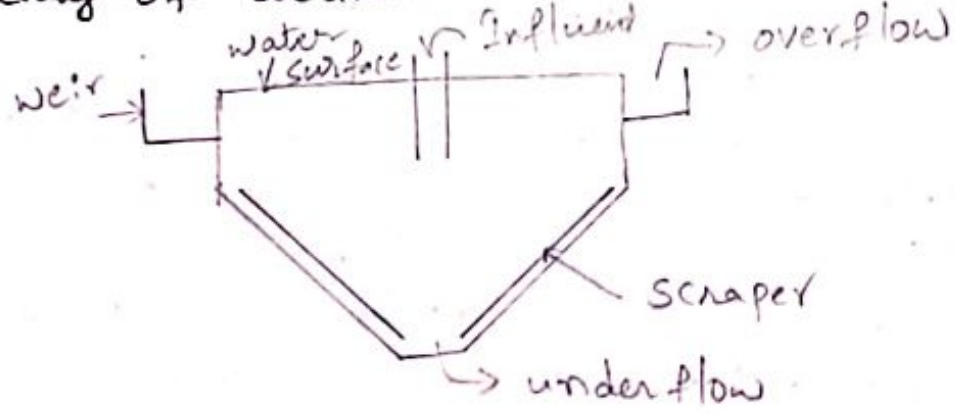
Sludge thickening may be broadly classified into four type. They are.

i) Gravity thickening
ii) centrifugal thickening.
iii) Flotation thickening
iv) Belt-type thickening.

Gravity - Sludge thickening:-

Gravity thickening is the most common practice for concentration of sludge and concentrates sludge through simple gravity sedimentation of the suspended solids.

This is adopted for primary sludge or combined primary and waste activated sludge, but is not successful in dealing with activated sludge alone. Independently, gravity thickening of combined sludge is not effective when activate sludge weight, and other methods of thickening of activated sludge have to be considered.



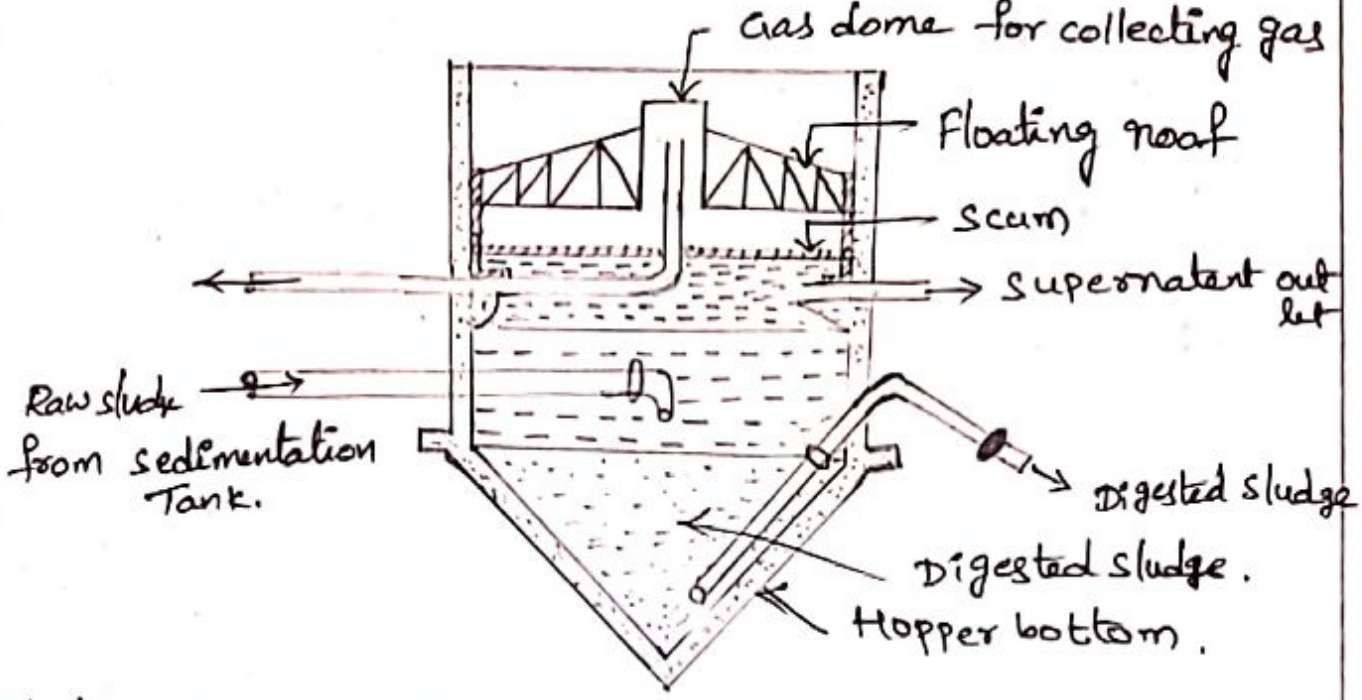
Sludge Digestion:-

Sludge digestion is the process of decomposition of organic matter under anaerobic conditions. The anaerobic digestion is employed not only for treatment of organic sludge but also for different types of concentrated organic wastes. The two basic processes involved in anaerobic digestion are (1) Liquefaction (2) Gasification.

The primary sludge and the secondary sludge are digested anaerobically in a sludge digestion tank.

Sludge digestion tank:-

* The sludge digestion tank is an R.C.C cylindrical shaped tank with hopper bottom.
* The top is covered with a floating steel drum to collect the gas.
* The raw sludge from primary sedimentation tank and secondary sedimentation tank is pumped into the sludge digestion tank.
* Initially the digester can be seeded with previously digested sludge for effective and immediate starting of the anaerobic process.
* The time required for digestion depends on (a) Temperature (b) pH value (c) Seeding (d) mixing and Stirring of the sludge in digester.
* For our Indian conditions of temperature, it requires 30 to 50 days for digestion. Best results are obtained at 29°C when about 90% digestion is completed in about 30 days.
* During digestion, care must be taken to avoid acidic conditions and pH should be maintained in the range of 6.8 to 7.2
* Mechanical stirring of the sludge also helps in effective digestion.



Sludge Drying Beds :-

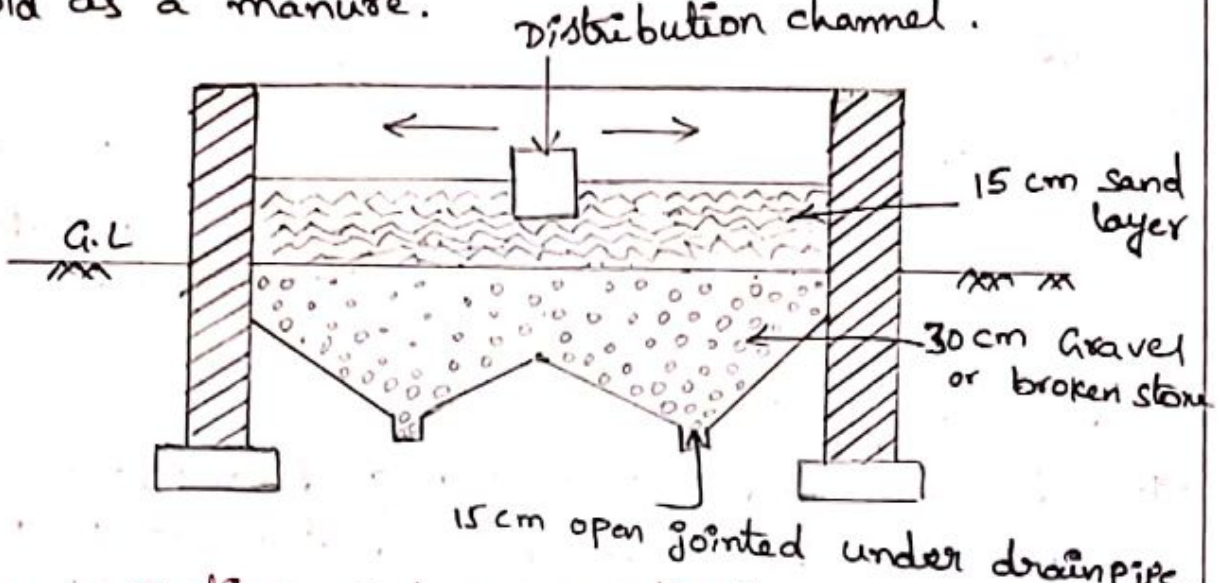
The digested sludge contains a good amount of water content which has to be removed for the purpose of final disposal of dried sludge as a manure.

Dewatering can be done by (1) Filter pressing (2) Vaccum filtration (3) centrifuging (4) Sludge drying on beds.

Sludge drying on beds are the most common method in our country now. By this, moisture content is reduced to about 50% and volume to about 25%.

* The drying bed consists of 150 to 300 mm of coarse sand underlain by layers of graded gravel at bottom.
* open jointed tile drains 100 mm dia, laid in gravel are provided at intervals of about 3 to 6m to drain away the percolated water.
* The side walls project 1.6m above sand surface.
* The top of bed is left open. The bed may be 12 to 18m wide and 30 to 40 m long.

* The digested sludge from the digester is applied on the bed to a depth of 200 to 300 mm and is exposed to sun and atmosphere for about 7 to 10 days.
* The water content is slowly evaporated leaving behind the dried sludge called sludge cake which can be sold as a manure.



Factors Affecting Sludge Digestion:-

The important factors which affect the process of Sludge digestion and are therefore controlled in a digestion tank are
a) Temperature (b) pH value (c) seeding with digested sludge
d) Mixing and stirring of the raw sewage with digested sludge.

a) Temperature :-

The process of the digestion is greatly influenced by temperature, rate of digestion being more at high temperatures and vice - versa.

The effect of temperature on digestion is indicated into two distinct temperatures zones.

1. zone of thermophilic digestion - 35°c to 60°c
2. zone of mesophilic digestion - 26°c to 35°c

b) pH value :-

pH value should not lower below 6.5.

* optimum value - 7.2 to 7.4 (in final stage)
* Acidity increases due to
  → over dosing of raw sludge
  → over withdrawal of digested sludge
  → sudden admission of Industrial waste.

c) Seeding with the digested sludge :-

When a sludge digestion tank is first put in operation, it is highly beneficial to seed it with digested sludge from another tank without seeding. Proper seeding will help to attain quick balance conditions of reactions.

d) Mixing and stirring of raw sludge with digested sludge

Incoming fresh raw sludge should be thoroughly mixed with digested sludge, by some effective method of agitation. So as to make a homogenous mass of raw as well as digested sludge.

Disposal of Sludge :-

The sludge treated by secondary or biological units may be disposed by any of the following methods.

1. Spreading on soil
2. Lagooning
3. Dumping
4. Sanitary land fill
5. Drying on drying beds
6. Heat drying
7. Incineration
8. Ocean disposal.

1. Spreading on soil :-

The digested sludge may be disposed by spreading over farm lands and ploughing after it has dried. the humus improves the moisture holding capacity of the soil and conditions it.

2. Lagooning :-

It is simple and economical if the treatment Plant is in a remote location. A lagoon is an earth basin into which the raw or digested sludge is

deposited. If it is a raw sludge, it may lead to the production of bad odours due to decomposition. Hence it is advisable to use lagoons only for digested sludge.

3. Dumping:-

In this method, the digested sludge, grit and incinerator residue etc. are dumped into an abandoned mine quarry.

4. Sanitary land fill:-

A sanitary land fill can be used for the disposal of sludge, grease and grit whether it is stabilized or not if a suitable site is available. This method consists of depositing the sludge in the area, compacting it and then covering with soil for a depth of 225 mm.

5. Drying on drying beds:-

The digested sludge is allowed to spread on drying beds and dried. The dried sludge cake is disposed as manure.

6. Heat drying:-

The sludge is dried artificially by applying heat, in this method. the dried sludge is disposed as a manure. It is a costly method.

7. Incineration:-

In this method, the sludge is burnt in either.
a) Flash type incinerator b) multiple heath type incinerator

8. ocean disposal:-

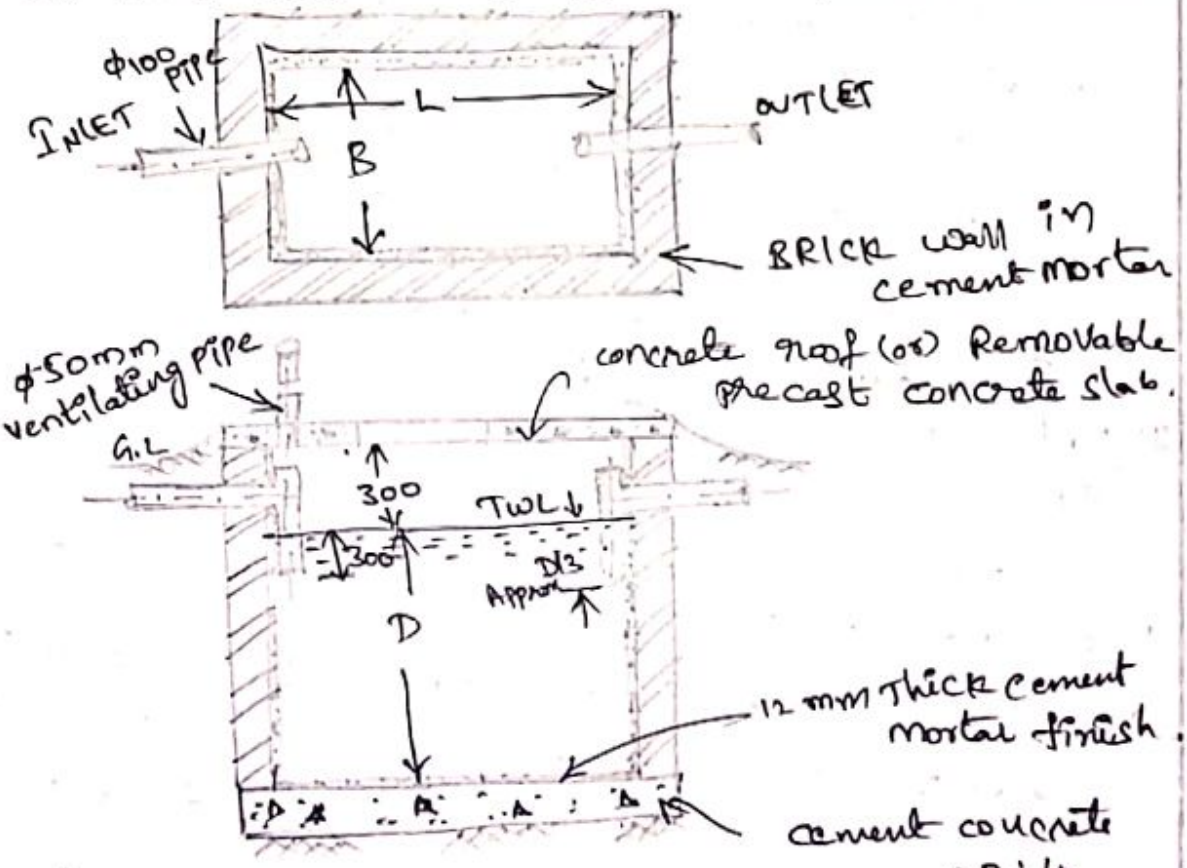
The wet digested sludge may some times be disposed into the sea from hopper barges or through submerged out fall sewers. This method of disposal may not be allowed in the future.

Septic tank, working principles and design

A septic tank is defined as a primary sedimentation tank with a longer detention period (12 to 36 hours) and with additional provisions for digestion of the settled sludge.

Due to anaerobic decomposition of the settled sludge, foul gases will be evolved in the tank and the septic tank will be completed covered and provided with a high air vent pipe for escape of gases.

Septic tanks are provided in places, where sewer pipes have not been laid and especially septic tanks are provided for isolated communities, schools, hospitals, hotels and other isolated public institutions etc.



Criteria for design of septic tank.

Capacity of tank:-

The volume of liquid which a septic tank can be accommodate is called its capacity. A septic tank should be capable of storing the sewage flow during the detention period and additional volume of sludge for 6 months to 3 years.

Flow of sewage:-

The ~~average~~ sewage flow will be about 40 to 70 Lpcd. But when the sludge is also discharged into the septic tank, the sewage flow may be 90 to 150 Lpcd. The rate of accumulated sludge has been recommended as 30 Lpcd.

Free board:-

A free board about 0.3 to 0.5m may be provided above the sewage line in the tank. It helps to accommodate the scum and gases in the tank.

Shape of Tank:-

Septic tanks are usually rectangular in shape with the length of 2 to 3 times of the width.

$L = 2B$ to $3B$.

The width should not be less than 0.9m. The length of the tank should be 1.2 to 1.8m.

Detention period:-

It varies from 12 to 36 hrs. But generally 24 hrs is adopted.

Inlet and outlet:-

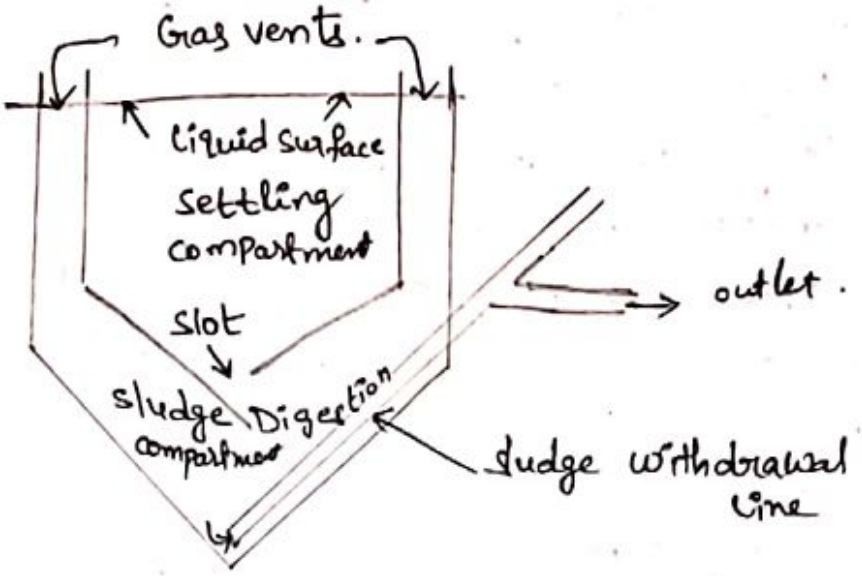
The baffle and te walls should be extended up to top level of scum (about 22cm above the top sewage line). The outlet invert line should be kept 5 to 7.5 cm below the inlet invert level.

Sludge withdrawal:-

Sludge is withdrawn from septic tank yearly through 150 mm dia pipe under pressure (Pumping).

Imhoff tanks, principles and design:-

Imhoff tank was developed by Karl Imhoff, a German engineer. Imhoff tank is an improvement over septic tank.



The Imhoff tank may be either circular or rectangular and is divided into three compartments.

1. The upper section or sedimentation compartment
2. The lower section knowns as the digestion compartment
3. The gas vent and scum section.

In operation, all of the wastewater flows through the upper compartment. solids settle to the bottom of this sloped compartment, slide down and pass through an opening or slot to the digestion compartment. one of the bottom slopes extends at least six inches beyond the slot. This forms a trap to prevent gas or digesting sludge particles in the lower section from entering the waste stream in the upper section. The gas and any rising sludge particles are diverted to the gas vent and scum section.

Design criteria:

i) Detention period in sedimentation chamber : 2 to 4 hrs.
ii) Flow through velocity ≯ 0.3 m/min
iii) Surface loading ≯ 30000 L/m² of plan area/day.
iv) length of tank ≯ 30m
v) length to width ratio = 3 to 5
vi) Depth = 3 to 3.5m
vii) Freeboard = 0.45m.

Q Design a septic tank for 200 persons assuming water supply as 120 LPCD.

Given data,

water supply = 120 LPCD.
Population = 200 persons.

Quantity of water supplied = 120 × 200 = 24000 Lit/day

Assuming that 80% of water supplied becomes sewage, we have.

Quantity of sewage produced = $24000 \times \frac{80}{100}$
= 19200 Lt/day.

Assuming the detention time to 24 hours.

Quantity of sewage produced during the detention period = $19200 \times \frac{24}{24}$ = 19200 Lts

Now, assuming the rate of deposited sludge as 30 LPCD and also assuming the period of cleaning as 1 year, we have.

Volume of sludge accumulated = Rate of sludge deposition × Population × period of cleaning
= 30 × 200 × 1
= 6000 Litres.

Total capacity of the tank = capacity of sewage + capacity of sludge
= 19200 + 6000
= 25200 Lts
= 25.2 m³ (∵ 1m³ = 1000 Lts, 1Lt = $\frac{1}{1000}$ m³)

Assuming a depth of 1.5m.

Surface area of the tank = $\frac{25.2}{1.5}$ = 16.8 m².

Assuming L:B ratio as 1:3.

$L = 3B$

Surface area $= L \times B = 3B \times B = 3B^2$

$16.8 = 3B^2$

$B = 2.37m \simeq 2.40m$

Length $L = 3 \times 2.4 = 7.2m$

Assuming 0.3m as free board.

overall depth $= 1.5 + 0.3 = 1.8m$.

Dimensions of the tank is $7.2m \times 2.4m \times 1.8m$.

Soil absorption system:-

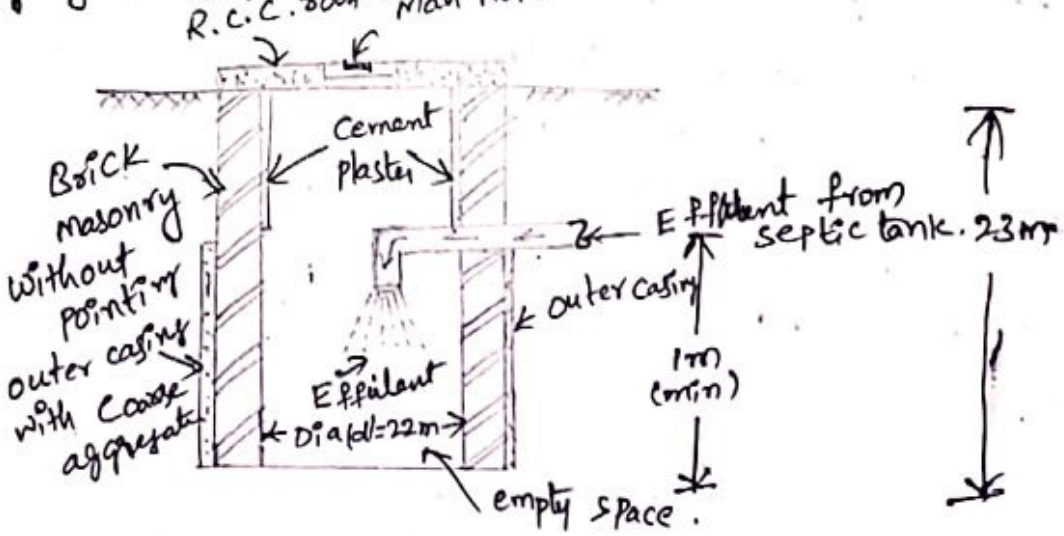
Soil absorption system may be

i) Soak pit

ii) Dispersion trenches.

i) Soak pit:-

A soak pit is a closed porous chamber that is directly connected to a primary treatment unit of a residential or commercial building. It serves the function of letting the waste water coming from the septic tank to slowly soak into the underlying ground.



Empty Soak pit.

Necessity :-

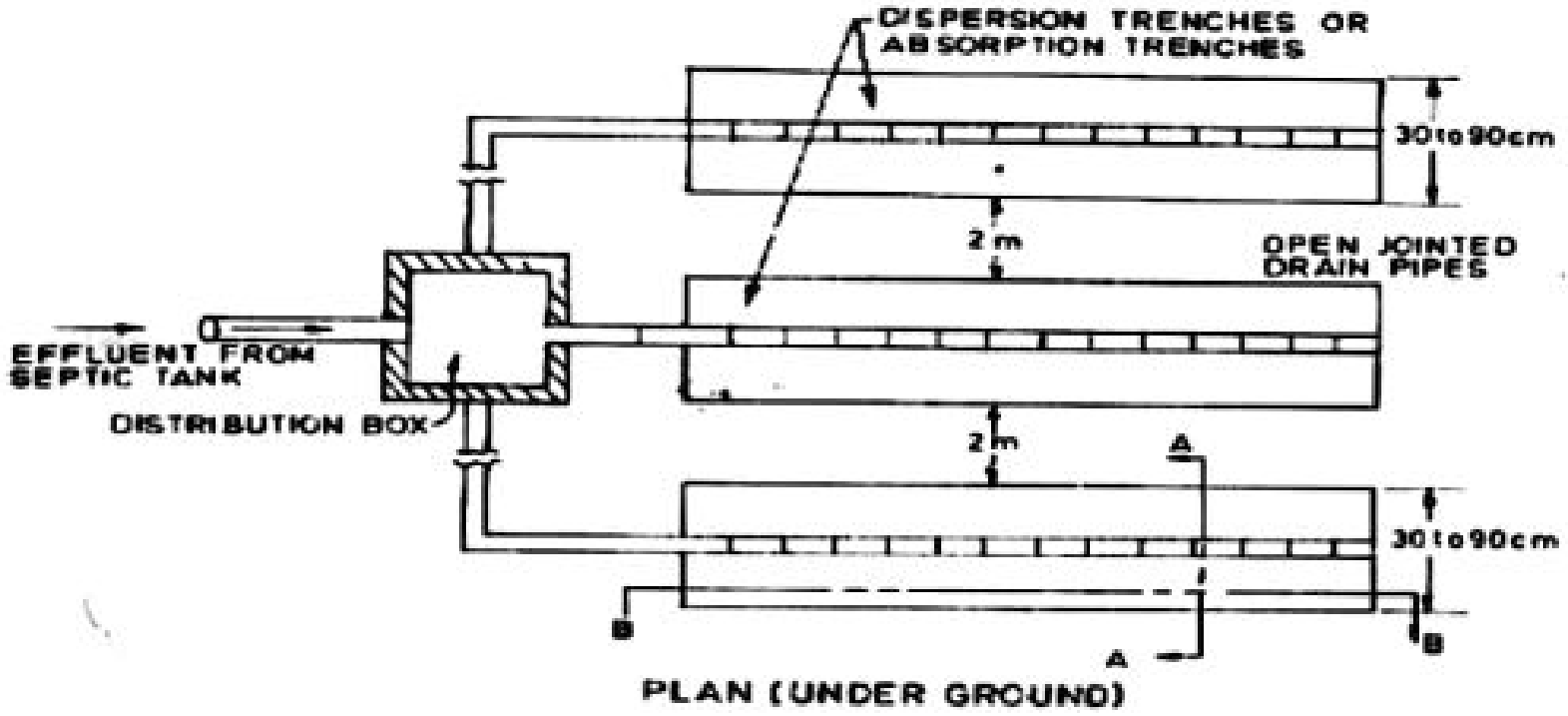
* The water coming out from a primary treatment chamber is not pure. The primary treatment unit can be a septic tank, a biogas settler, anaeorbic baffled reactor, twin-pit etc.
* The effluent water coming out of these units are called grey water, which must be subjected to a partial treatment before letting it into the ground soil.
* For this partial treatment, most of the wastewater management system needs a soak pit.
* There is no intention to re use the wastewater that is coming from the primary treatment unit
* But the partial treatment of effluent water through a soak pit is a safety way of discharging the water into the environment.

(ii) Dispersion trench :-

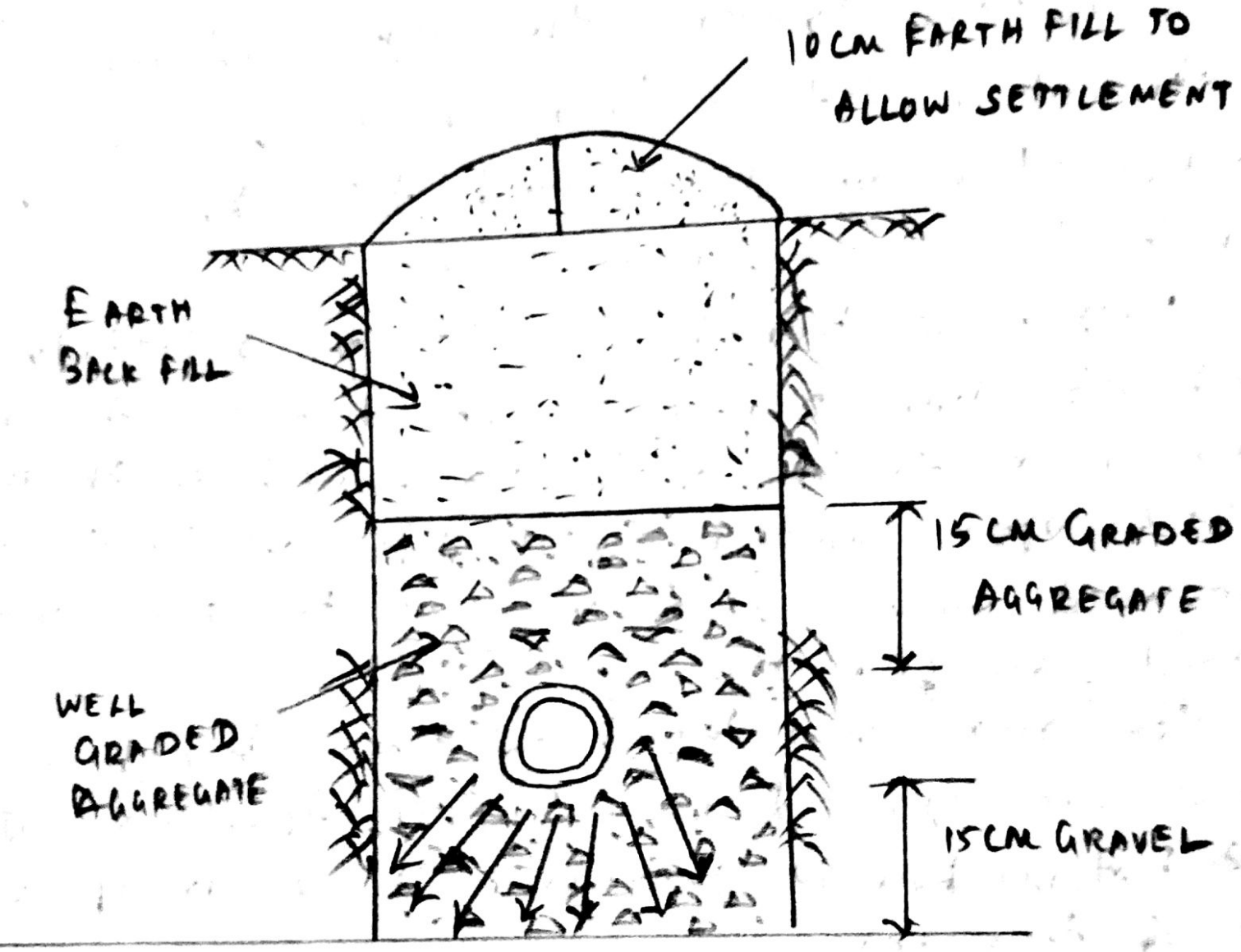
In this system, the septic effluent is uniformly distributed into a large area of subsoil through open jointed or perforated tile drains.

Dispersion trench consists of relatively narrow and shallow trenches about 0.5m - 1m deep and 0.3-1m wide excavated with gradient 0.25%. open jointed earth pipes of 70 to 100mm diameter are used over a bed of 15cm to 25cm wasted gravel crusted stone.

* The minimum length of each trench is 30m and these are spaced not closer than 2m past are distribution box is provided in a group of above 3 to 4 trenchs.



PLAN (UNDER GROUND)


10 CM EARTH FILL TO ALLOW SETTLEMENT
EARTH BACK FILL
15 CM GRADED AGGREGATE
WELL GRADED AGGREGATE
15 CM GRAVEL
SEEPING SEWAGE

SECTION A-A