Section-C

Unit-V (Sewage Treatment)

☒ Objectives of Sewage Treatment :→

(i) Removal of suspended and floatable material
(ii) Treatment of biodegradable organics
(iii) Elimination of pathogenic organics.
(iv) also removal of
(a) nutrients (b) Suspended solid
(c) BOD (d) dissolved solids
(e) toxic substances

This phase of wastewater treatment is known as advanced wastewater treatment or tertiary treatment.

- This advanced wastewater treatment (AWT) refers to methods and processes that remove more contaminants from the wastewater than are usually taken out by the usual conventional treatment and techniques.

☒ Suspended Solids Removal :→

It is one of the most important and common application of advanced wastewater treatment. Techniques used for reduction of suspended

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solids concentration are:
(i) micro-screening, (ii) diatomaceous earth filters (iii) ultrafiltration, (iv) Granular media filtration and (v) Chemical coagulation followed by sedimentation.

(i) Micro-screening :→
It utilizes a special woven metallic or plastic filter fabric which is mounted on the periphery of a revolving drum provided with continuous backwashing. Wastewater enters through the open U/S end of the drum and flows radially outward through the microfabric, leaving behind the suspended solids.

(ii) Diatomaceous-Earth Filters :→
They are available both as a vacuum and as a pressure filter. The diatomaceous earth consists of skeltons of diatoms 0.5 to 12 μ in size mined from deposits laid down in ancient seas. These filters are designed with either septums or leafs. The septum consists of a hollow, fluted and perforated cylinder, wound with wire or plastic which supports the filter cake.

(iii) Ultrafiltration :→

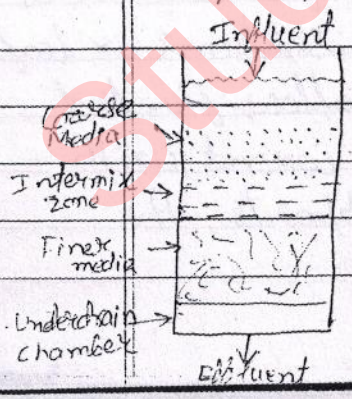
It is a system similar in operation to reverse osmosis save that the membrane is far coarser and the pressure lower. Ultrafiltration membranes are thin film cast from organic polymer solutions. The film is ~~entis~~ anisotropic i.e. it has an extremely thin separation layer. The membranes may be packed either as a plate device or as a tube device.

(iv) Granular Media Filtration :→

It is one of the principal unit operations used in the portable water treatment, the filtration of effluents from waste water treatment processes is a relatively recent practice. It is used to achieve

(i) supplemental removals of suspended solids

(ii) Removal of chemical precipitated phosphorous



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Industrial Wastewater Treatment :→
Industrial wastewaters are either discharged directly into the receiving water or else are discharged into municipal sewers. Sometimes, industrial wastewaters are treated partially before their discharged into sewers, or else are treated separately through suitable treatment processes so that the ~~treatment~~ treated effluent is safe.

⇒ Pollutants in industrial wastewater and their effects :→

1) Organic Substances :- These deplete DO of streams and impose great load on secondary treatment units
2) Inorganic Substances :- These include carbonates, nitrogen etc. They are undesirable for micro-plants of receiving water body. They render the water body unfit for further use.
3) Acids and alkalies :- These greatly affect the aquatic life of receiving water body. They also cause series problems in the operation of treatment units.
4) Toxic Substances :- These include alcohol etc. due to which flora and fauna of receiving

water is greatly affected.

5) Colour-producing substances :- They impart objectionable colour in the receiving water bodies.

6) Oil etc :- These hinder self-purification process of stream. They ~~are~~ also cause operational problems in the treatment plants.

✱ Methods Of Treatment :→

The important factors which effect the planning for the treatment are :-

(a) discontinuous flow

(b) high-concentration of pollutants

(c) Non-biodegradability and toxicity of some pollution parameters.

Processes :→

(i) Equalization (ii) Neutralization

(iii) Physical treatment (iv) Chemical treatment

(v) Biological treatment

1) Equalization :→

When the characteristics of wastewater ~~various~~ varies during the day and also when the discharge is either not uniform or

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else is discontinuous, equalization is necessary. This process consists of holding the wastewater for some predetermined time, in continuously mixed holding tanks so as to get wastewater of uniform character and at uniform rate. Thus, equalization needs adequate storage.

2) Neutralization:→
This is necessary when the wastewater contains either excess alkali or excess acid, and is achieved by the addition of either acid or alkali respectively. This may be done either in the equalization tank, if the conditions to permit, or else in a separate neutralization tank.

3) Physical Treatment:→
It is similar to primary treatment of domestic wastewater. Various processes that fall under this head are:
(i) Screening (ii) Sedimentation
(iii) Floatation and (iv) Filtration
Primary sedimentation becomes essential when the wastewater contains high percentage of settleable solids. Floatation

– is provided to remove the finer particles.

4) Chemical Treatment:→
It is one of the essential part in the treatment of industrial wastewater, specially for those which are amenable to biological treatment. Various processes are used for treatment are:
(i) Coagulation (ii) Chemical precipitation
(iii) Hyper-filtration or reverse osmosis
(iv) Chemical oxidation (v) Absorption
(vi) Ion exchange (vii) Electrodialysis
(viii) Thermal reduction.

5) Biological Treatment:→
This is used only when the industrial wastewater contains large quantities of bio-degradable substances. If the BOD/COD ratio of the industrial wastewater is more than 0.6, it is biologically treatable. If the ratio is less than 0.6 but is upto 0.3, acclimatisation is necessary before biological treatment. If the ratio is less than 0.3, biological treatment is not necessary.

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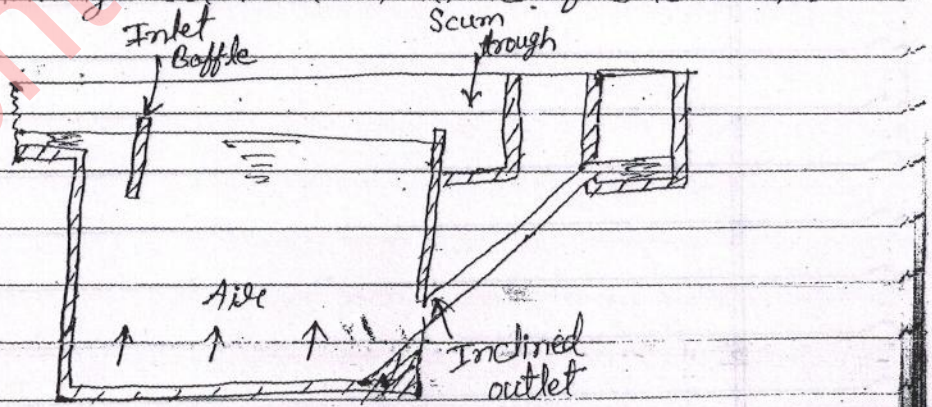
⇒ Acclimantisation is a process of seeding or raising initial microbial population under a controlled condition, by gradual exposure of the wastewater in increasing concentration.

☒ Skimming Tanks :→

These are installed, just ahead of sedimentation tanks to remove floating substances like grease, oil, fats, waxes. If these are not removed, they seriously affect the working of various treatment units. It is a chamber so arranged that floating matter rises and remains on the surface of wastewater until removed, while liquid flows out continuously through outlet located at depth. Most skimming tanks are rectangular or circular, having a detention time of 3 to 5 min.



For effluent efficient working of skimming tank, air diffusers are provided at the bottom of the tank. The rising air bubbles congeal the greasy and oily material and push it to the side compartment.

The aeration of sewage in this tank has following advantages:-

1) It skims the oil and greasy matter out of the sewage and raises it to the surface.
2) It freshens the sewage, supplying some dissolved oxygen
3) Objectionable gases are driven out.
4) It causes flocculation of colloidal matter.

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Secondary Treatment - Biological Filtration

☒ **Trickling Filters:→** or Percolating Filters
Also known as percolating filters or sprinkling filters are similar to contact beds in construction, but their operation is continuous and they allow constant aeration. In this system, sewage is allowed to sprinkle or trickle over a bed of coarse, rough, hard filter media, and it is then collected through the underdrainage system. Spray nozzles or rotary distributors are used for this purpose.

The trickling filter is always preceded by primary sedimentation along with skimming ~~tanks~~ devices to remove the scum. This will prevent the clogging of the filter by settleable solids.

Merits:→

1) The effluent obtained from filters is highly nitrified and stabilised.
2) It has good dependability to produce good effluent under very widely varying weather and other conditions.
3) They can remove 80% of suspended solids

and about 75 to 80% of BOD
4) The rate of filter loading is relatively higher.
5) Working is simple and cheap
6) Does not require any skilled supervision
7) Contains less mechanical equipment
8) Operation requires less electrical power

Demerits :->
1) The loss of head through the filter system is high.
2) The cost of construction is high
3) They require large area
4) Final settlement in humus tank is necessary.
5) Process may develop odour
6) Require preliminary treatment

* High Rate Trickling Filter :->
Experiments conducted on trickling filters with increasing rate of sewage flow revealed the following :
1) As the sewage flow is increased, the thickness of the gelatinous biofilm is reduced and the organic materials deposited on the contact surface is continuously washed.

away with the effluent.

2) Thinner biofilm is more continuous nutrients to the aerobic bacteria.

3) The precipitation and biological coagulation of the dissolved and colloidal matter is more or less of the same degree as in normal rate filters.

4) there is lesser oxidation of organic matter because of reduction in the contact period.

5) The sludge formed as a result of high rate infiltration is not easily digestible

6) The cost of construction and land etc. decreases with the increase in the infiltration rate.

Due to these reasons, high rate trickling filters become more popular.

☒ Other Types of Filters or Miscellaneous Filter :→

(i) Dunbar filters (ii) Magnetic filters.
(iii) Rapid Sand filteres

(i) Dunbar filter :→

This filter is so named because it was first developed and used at Dunbar, a

town in Germany. The filter, rectangular in shape with length to breadth ratio of 3 to 4, is similar in construction to intermittent sand filter. The depth of filter is kept from 1 to 1.2 m. The walls may be of masonry or concrete, and the floors of concrete, sloping cross-ways on either side towards a central longitudinal drain. Such filters are useful only for very small populations.

(ii) Magnetite filter:→

The filter consists of a bed of magnetite sand, about 75 to 80 mm thick. The magnetite sand is about 0.85 mm grain size. When an effluent from a plain or chemical precipitation tank is filtered through the magnetite sand layer, the suspended solids are retained in the voids.

iii) Rapid Sand filters:→

Such filters are similar to the one used for treating raw water for public water supplies. These are used for treating the sewage, with the sole purpose of reclaiming the used water, the reclaimed

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water can subsequently be used for gardening etc. These filters get clogged very soon, and are therefore not generally used.

Secondary Clarifiers (Humus Tank):→

The coagulated suspended mass, ~~which~~ having dark brown color and flocculent in character and termed as 'humus', is discharged in the trickling filter effluent.

The design of this tank is similar to the design of primary settling tanks, except that the surface loading rate is based on the plant flow plus recycle flow. The overflow rate at peak flow should not exceed 48 m^3/day/m^2. Detention period in this tank varies from 1 to 3 hrs, the common value being 2 hr. For the secondary clarification, ordinary rectangular tanks with hor. flow, or circular tanks with spiral flow can be provided.

Activated Sludge Process :→

This process was developed in England in 1914 by Ardern and Lockett was and was so named because it involved the production of an activated mass of micro-organisms capable of aerobically stabilizing a waste.

The activated sludge is the sludge which is obtained by settling sewage in presence of abundant oxygen.

The effluent from the primary settling tank is mixed with a dose of activated sludge and is aerated in an aeration tank for a period of some hours.

In this process, part of organic matter is synthesised into new cells and part is oxidised to derive energy.

The biological mass generated in the aeration tanks consists of zoogleal bacteria, protozoa etc. The biomass is generally flocculated flocculant and quick settling. The mixture of recycled sludge and sewage in the aeration is referred to as mixed liquor.

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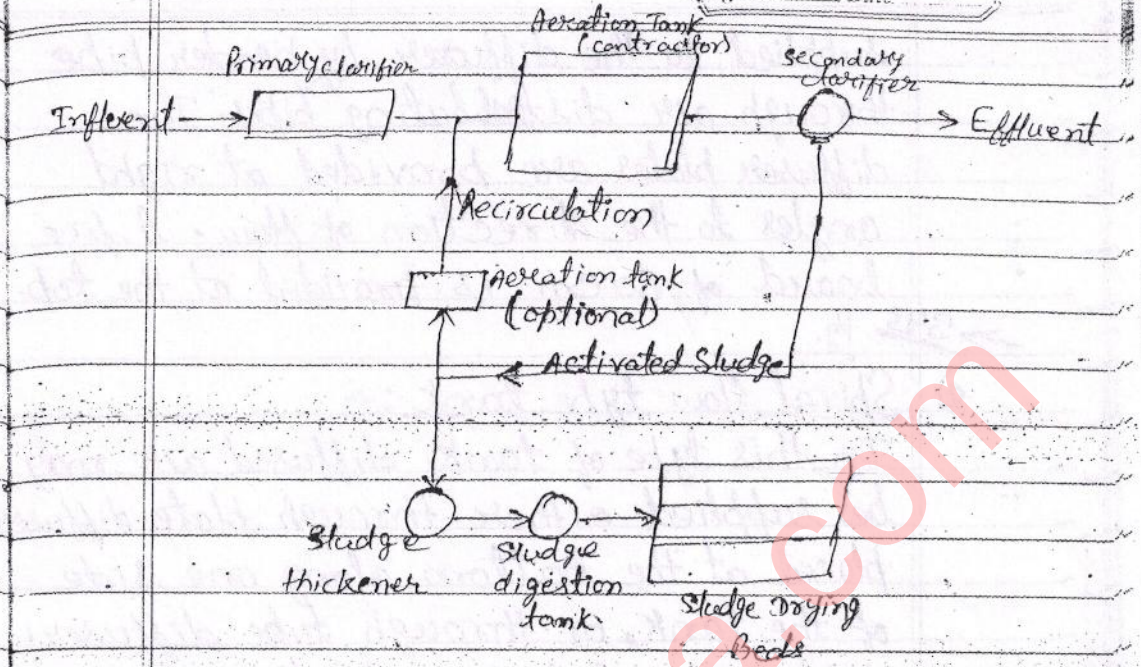

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Aeration Tanks :→

Types:—

(i) Ridge and furrow type
(ii) Spiral flow type

1) Ridge and furrow type :→

Used with fine bubble aeration through diffuser plates placed in the furrows or depressions. These tanks are in the form of narrow rectangular channels 30 to 120 m. long, 4.5 to 9 m wide and 3 to 4.5 m deep, laid parallel to each other. The diffuser tiles are fixed in the furrow portion by cement or bituminous compounds and are made air-tight by rubber rings. Air is

supplied to the diffuser by header pipe through air distributing pipes. The diffuser plates are provided at right angles to the direction of flow. A free board of 60 cm is provided at the top.

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2) Spiral flow type tank :->

In this type of tank, diffused air may be supplied either through plate diffusers placed at the bottom along one side of the tank, or through tube diffusers kept suspended from the top, though tube diffusers are more commonly used.

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