UNIT-VI

Bio-solids (sludge) Management

(6.1) Characteristics of Bio-solids (sludge):-

we will having several types of Treated sewage sludge used as soil conditioners

The bio solids are created through the treatment of domestic waste water generated from sewage treatment facilities.

we will be having two types of sludge, That is Raw sludge and secondary sludge removed from primary and secondary settling tanks respectively

→ when fresh sewage (or) waste water enters a primary settling tank, approximately 50% of the suspended solid matter will be settle down at an hour This collection of solids is known as raw sludge

→ Raw sludge is untreated non-stabilized sludge, which can be taken from waste water treatment plants

→ will not properly treated of this sludge will create a odour nuisence.

→ In raw sludge the moisture content is 95%

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→ secondary sludge, is also known as activated sludge ~~process~~. in the case of the activated sludge process

→ This type of sludge is coming from secondary settling tank, it is commonly in a brownish colour

→ in secondary sludge the moisture content of high as 99%.

→ The volume of sludge and the percentage of solids are expressed by the following relation ship

$$V = \frac{W}{S * 1000} = \frac{W}{(100 - W) * 100}$$

where V = volume of sludge in cu-m

W = weight of dry solids in kg

S = solids content in percent

W = moisture content in ~~per~~ cent

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(6.2) Handling and treatment of sludge :-

→ sludge is a semi-solid material is coming from industrial waste water (or) sewage treatment processes.

→ sludge is obtained from primary and secondary clarifiers both of them are treated to get the "Volume Reduction" and strength Reduction"

Important (today).

Sludge handling processes :-

1) Primary operations
2) sludge thickening
3) sludge stabilization
4) sludge conditioning
5) sludge Dewatering
6) Heat drying
7) Incineration

(1) Primary operations :-

This process include

(i) Grinding :-

Particle size reduction

(ii) screening :-

Removal of fibrous materials
(పీచు పదార్థాలు)

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(iii) degritting :-

grit removal

↓

[illegible]

(iv) ~~blending :- (sedimentation)~~

~~homogenization~~

(2) sludge Thickening :-

Removing the moisture content in sludge

methods

→ gravity Thickening

→ ~~Flotation~~ Flotation Thickening

→ centrifugation

→ Rotatory drum Thickening

(3) sludge stabilization :-

For stabilization process

→ Reduce Pathogens having in sludge

→ Reduce Potential for Putrefaction
(ఈ ప్రభావాన్ని, దుర్వాసన)

→ production of usable gas (methane)

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(4) Sludge conditioning :-

In this process sludge solids are treated with chemicals (or) prepare sludge for dewatering

→ To improve ability of sludge by heat treatment (or) chemical treatment-

(5) Sludge dewatering :-

→ to remove remaining moisture from the sludge

→ mechanical dewatering is often selected due to its low energy requirement compared to Thermal for water reduction.

Methods of dewatering

(i) Centrifugation :-

For separating liquids of different densities, thickening slurries

(ii) Belt filter press :-

uses principle of gravity drainage and mechanically applied pressure.

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(6) Heat drying:-

It involves the application of heat to evaporate water and to reduce the moisture content

Methods of heat drying:-

(i) Direct drying:-

The waste water solids come into contact with hot gases, which cause evaporation of moisture

→ Dryers such as rotary dryer and fluidized bed dryer are used.

(ii) Indirect drying:-

~~moisture~~ the waste water solids come into contact with metal surface

→ this metal surface is heated by the hot medium

→ Dryers such as Paddle dryers, hallow flight and disc dryers are used.

(7) Incineration:-

It involves total conversion of organic solids to oxidized end products

→ sludge stabilization is not necessary before incineration

→ water, carbon-dioxide and ash are primarily end products

Methods of Incineration:-

i) multiple hearth incinerators

Dewatered sludge to dry ash used in large plants.

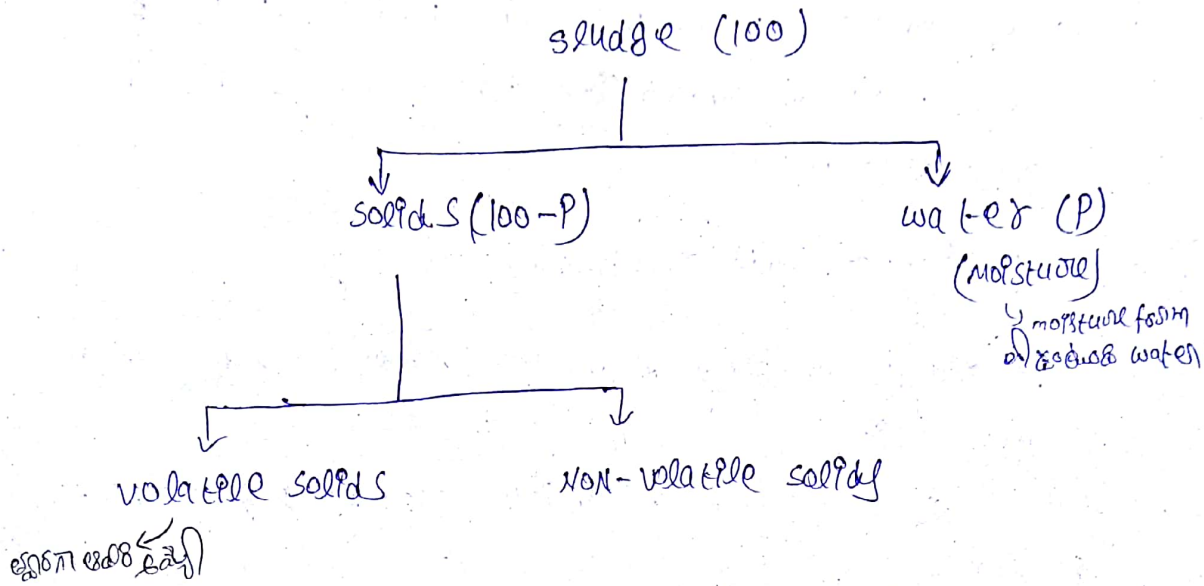
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(iii) Fluidized bed Incineration:- (4)

wastes are quickly and uniformly incinerated. with utilizing thermal capacity of hot fluidizing sand.

Composition of sludge:-



∴ sludge = solids + water

solids = 0.25 % to 12 %

water = 88 % to 99.75 %

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Sludge Treatment:-

main objectives of sludge Treatment is :-

→ Digestion of organic matter by common methods

→ Distruction of pathogenic organisms

→ Safe and aesthetically acceptable disposal of sludge (ఆకర్షణీయ, కన్నుకు ఇంపుగా)

→ By product of methane is used of fuel & and helps in controlling temperature and also generates power

Pg No 498
Bindra Bindra

Necessity of sludge Treatment:-

The sludge obtained from the primary and secondary treatment units

→ Due to the following necessity, the sewage treatment is done

(i) To distroy all the pathogens, that it may not pollute the receiving waters and make than unsafe for use

(ii) To reduce the volume of sewage sludge, so that it can be easily disposed off.

(iii) To reduce the percentage of water in sludge it is easy to handling and transporting upto disposal places.

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Sludge Treatment

~~Treatment process~~

The sludge treatment process involves in the following steps

(i) Thickening (or) concentration.
(ii) Digestion (or) stabilization
(iii) Anaerobic digestion
(iv) Dewatering
(v) Drying
(vi) ~~Disposal~~ Incineration
(vii) Disposal

(i) Thickening (or) concentration:-

→ Reduction of moisture content of raw sludge
→ while reducing of moisture content It helps in ~~reducing control of~~ control of digestion condition
→ It can produce sludge of less than 10% solid content
→ units of thickening are gravity thickener, floation thickener, elutriation thickner are used.

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(iv) Digestion (or) stabilization:-

→ In this process involves in reduction of organic content

→ Greatly reduces odour of the pollutant matter

→ Digestion should be involved in Anaerobic digestion, Aerobic digestion

Anaerobic digestion:-

A bacterial process carried out in the absence of oxygen.

→ converts of sludge into liquid & gases and also reduces odours,

→ the Bacteria like saprophytic organisms are present That react on complex organic matter and decomposed.

Aerobic digestion:-

A bacterial process carried out in the presence of oxygen

→ under aerobic conditions, bacteria rapidly consume organic matter and convert into carbon dioxide.

→ once there is a lack of organic matter, bacteria die and are used as food by other bacteria

→ This stage of the process is known as "endogenous respiration"

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(iv) De watering:-

Some of the operations are used to reduce the moisture content of sludge

1) Floation
2) Vaccum filtration
3) centrifuging

(v) Drying:-

It involves the application of heat to evaporate water to reduce the moisture content of bio solids

→ the main advantage of this method is reduce the transportation costs, improve storage capability

the following methods are used of drying

(i) Heating
(ii) Air drying
(iii) Heat and pressure drying

(vi) Incineration

Involves total conversion of organic solids to oxidized end products

(vii) ~~sludge~~ Disposal:-

sewage sludge contains both compounds of agricultural value and pollutants

→ Agricultural value — organic matter, nitrogen, phosphorus and potassium.

→ Pollutants — heavy metals, organic pollutants and pathogens

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Methods of sludge disposal is

1) Land fill
2) Agricultural use
3) other methods

1) Land fill:-

The sludge is disposed dug the soil ppt and disposed of sludge on to the ppt

(2) Agricultural use:-

some of the sludge is used as agricultural purpose

(3) other methods:-

some of the sludge disposed by 1) ocean
2) surface disposal

Flow chart:-

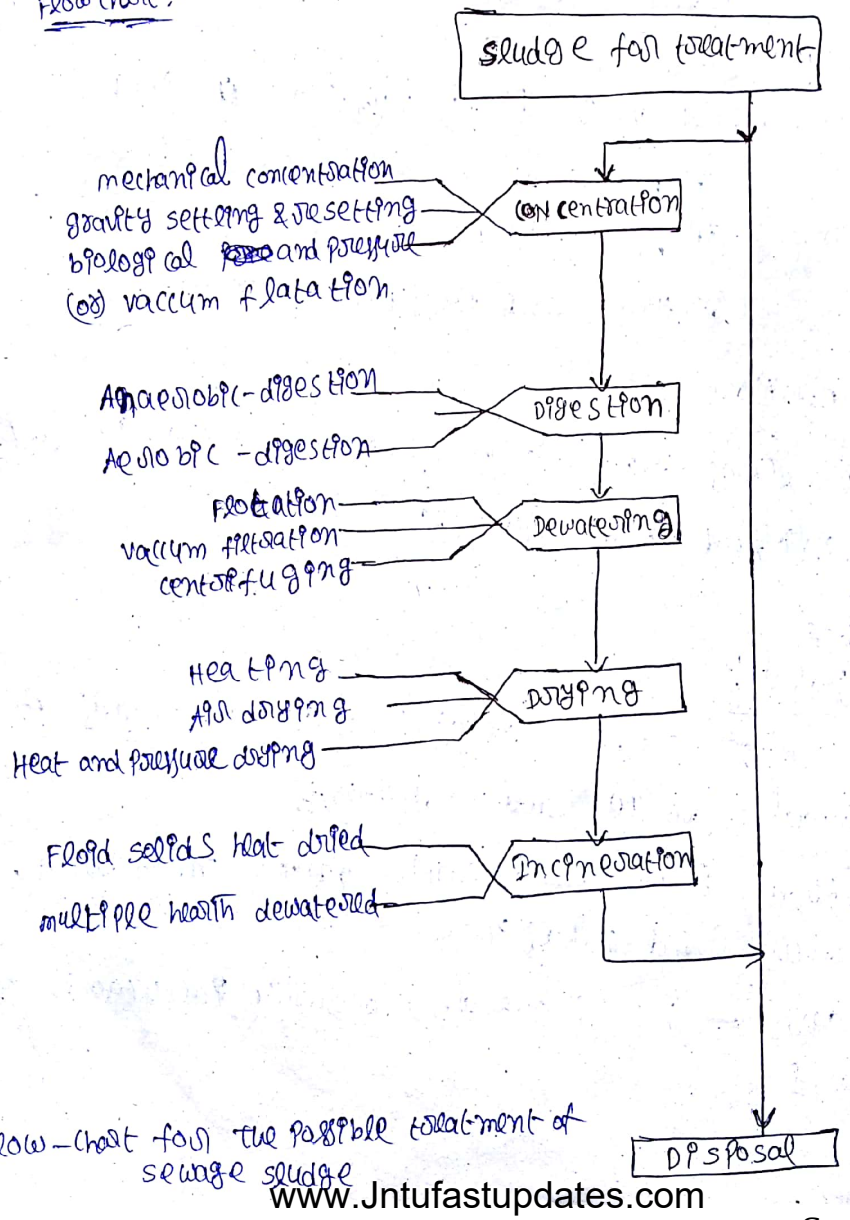


Fig:- Flow-chart for the possible treatment of sewage sludge

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Sludge Thickening:-

~~Thickening~~.

Sludge Thickening is nothing but dewatering of sludge it means reducing of moisture content in sludge

→ ~~Dewatering~~ sludge Thickening (or) dewatering of sludge is adopted for reducing the volume of sludge and increasing the solid contents

This will help in following

(i) Increasing of digestion condition.

(ii) To reduce the transport and handling cost of the sludge

(iii) minimize the land required for final disposal of sludge

(iv) save the fuel for incineration process.

→ In sludge Thickening greater amount of water is removed from the sludge. This will reduces overall volume of the sludge

→ The Thickening of the sludge can be achieved either by gravity Thickening, application of air floation (or) by centrifugation.

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Gravity Thickening:-

Gravity Thickening is accomplished in a tank (దిబ్బ, చెరువు, సాధారణ)
similar in design to a sedimentation tank.

→ Gravity Thickeners can be operated either as continuous flow (or) fill and draw type with (or) without chemical addition

→ The thickend sludge is drawn from the bottom of the tank and pumped to the digesters

→ This gravity Thickeners are the simplest and most commonly used for Thickening of sludge

→ This Thickeners consists of a small circular open tank, similar to a conventional sedimentation tank

→ This Thickners having a greater volume of sludge, and has a heavier raking mechanism

→ The slowly rotating of raking mechanism into a circular tank for this raking mechanism provided deep troughs.

→ This rotating raking mechanism will mix the slude (for rotating) continuously.

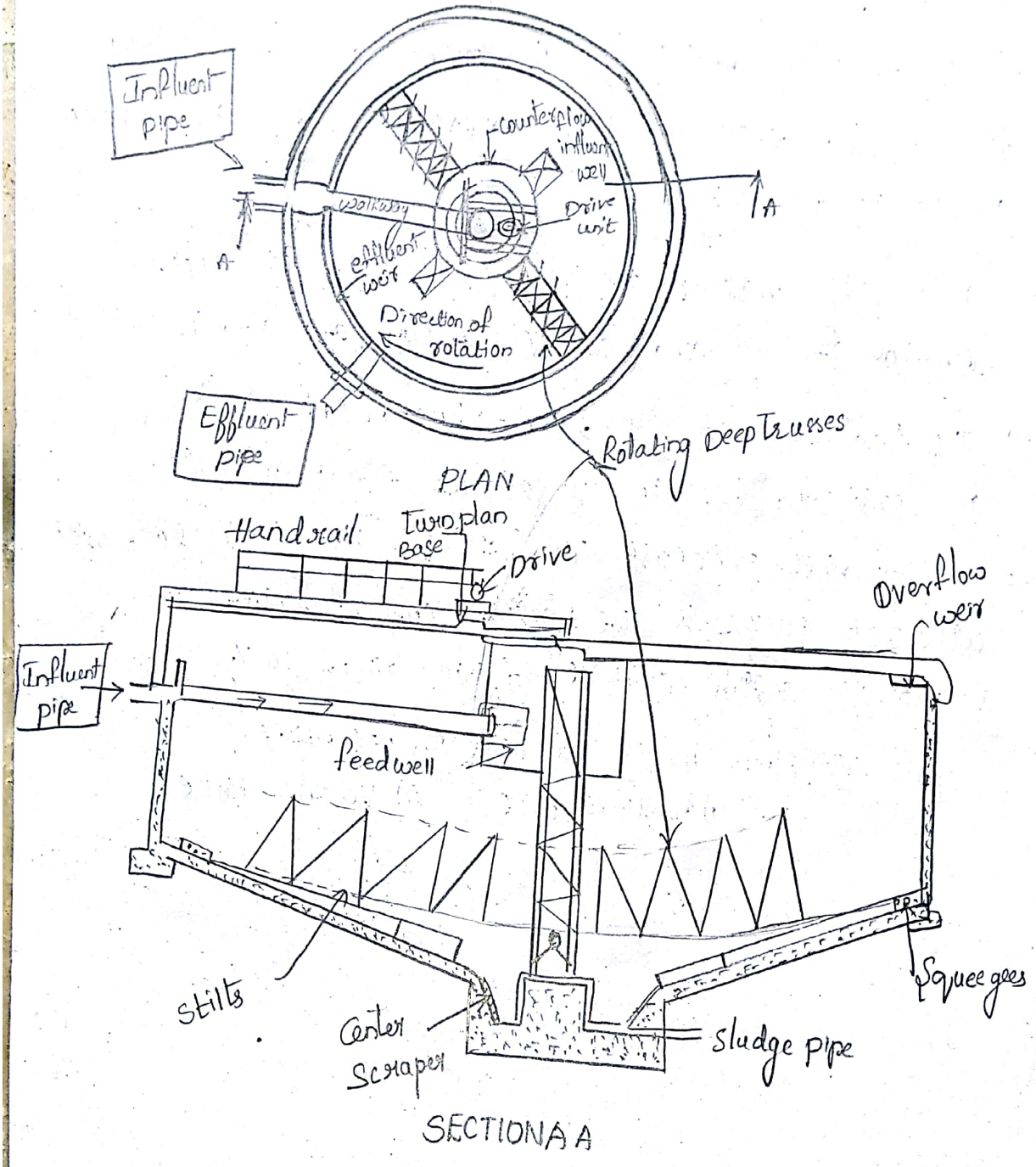
→ The sludge first enters into the center of the tank after the mixing the supernatant liquor (ద్రవ రూపంలో water) continuously overflow a peripheral weir

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→ The thickend sludge is drawn from the bottom of the tank

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2 diagrams
3K Garg



A typical gravity thickner

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Air floatation :-

By applying air under pressure (or) vacuum the thickening of the sludge can be achieved

→ This is normally preferred for Activated sludge process (ASP)

→ This requires additional equipment and also required for skilled persons for operation and maintenance hence it is costly

→ For this method the main advantage is better removal of oil and grease, solids and odour control.

→ the addition of alum, polyelectrolytes can increase the efficiency of the floation unit.

→ Alum will increase the sludge but polyelectrolyte will not increase the solids concentration but improves solids capture from 90 to 98 %.

The floation units can be in two types

1) pressure type 2) vacuum type

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centrifugation:-

sludge thickening by centrifugation is used only when land ~~surface~~ available is limited and sludge characteristics will not permit adoption of other methods

→ this will require high maintenance and operational cost

→ the centrifugation acts both ways to thicken the sludge and to dewater sludge.

→ this will works on centrifugal force

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Pg No 383 SK Garg

(6.3) Anaerobic Digestion of sludge :-

~~→ The sludge is coming from secondary~~

→ The sludge is with drawn from the sedimentation basins It contains a lot of Putrescible (decomposable) organic matter), and it is decomposed of without any treatment

→ The organic matter may decompose, producing foul gases and a lot of nuisance, pollution and health hazards (ఇబ్బందులు)

→ In order to avoid such pollutions, the sludge is, first of all, stabilised by decomposing the organic matter under controlled anaerobic conditions

→ This sludge is disposed of suitably after drying (remove of moisture content in sludge)

on drying beds etc

→ This process of stabilisation is called the sludge digestion.. and this process is carried out in sludge digestion tank.

→ In a sludge digestion process, the sludge gets broken into the following three forms

(i) Digested sludge :-

→ It is a stable humus like solid matter will be (ఎర్రటి రంగు) having black in colour ~~and the moisture content is also less~~.

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→ while reducing of moisture content in sludge digested sludge is easy, comparatively on undigested sludge

→ This digested sludge free from Pathogenic bacteria why because this bacteria was killed by the digestion process.

→ It contains cysts and eggs of bacteria, protozoa and worms (పురుగులు)

(ii) supernatant liquor:-

It is changed from a solid to liquid state and finely divided solid matter and It is having high BOD about 3000 ppm

(iii) Gases of decomposition:-

Gases like methane (65 to 70%) Carbon dioxide (30%), and other inert gases like nitrogen, hydrogen sulphide etc are evolved (ఉత్పన్నమవుతాయి)

→ They may be collected and used as a fuel

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Stages in the sludge digestion process :-

Anaerobic digestion of sludge is nothing but "strength Reduction of sludge" (i.e) "BOD removal"

→ strength Reduction of sludges are achieved by sludge digestion

→ sludge digestion is the method of decomposing the sludges anaerobically

→ The sludge digestion occurs in three stages

(i) Acid fermentation (కిణ్వనం (or) పులియ బారడం)

(ii) Acid regression and

(iii) Alkaline fermentation

(i) Acid fermentation :- (or) Acid production stage

→ This is the first stage of sludge digestion

In this stage fresh sewage-sludge begins to be acted upon by anaerobic and facultative bacteria, called acid formers

→ These organisms solubilize the organic solids in hydrolysis process

→ the soluble products are then fermented to volatile acids and organic alcohols of low molecular weight like propionic acid, acetic acid etc

→ the Gases like methane, carbon dioxide and hydrogen sulphide are also evolved (released)

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(ii) Acid Regression stage:-

→ This is the intermediate stage in this stage the volatile organic acids and nitrogeneous compounds of the previous stage, are attacked by the bacteria, so as to form acid carbonates and ammonia compounds

→ small amounts of hydrogen sulphide and carbon-dioxide gases are also released

→ The decomposed sludge has a very offensive odour (దుర్వాసన) released.

→ The pH value rises a little about 6.8

→ This decomposition sludge rises why because on the surface of the sludge will be form a scum (పొర) due to entraps the gases due to

→ This stage for a period of about 3 months in this stage BOD demand is high.

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(iii) Alkaline Fermentation stage:-

This is final stage in this stage more resistant materials like proteins and organic acids are attacked and broken up by anaerobic bacteria, ~~called as "methane formers"~~ this anaerobic bacteria called as "methane formers" and also form a simple substances like ammonia, organic acids and gases.

→ During this stage, the liquid separates out from the solids and the digested sludge is formed

→ this sludge is granular and stable, and does not give offencive odour
(దుర్వాసన రాదు)

→ This digested sludge is collected at the bottom of the digestion tank and this sludge is also called as ripened sludge

→ Large amount of methane gas along with small amount of carbon dioxide and nitrogen are released during this stage

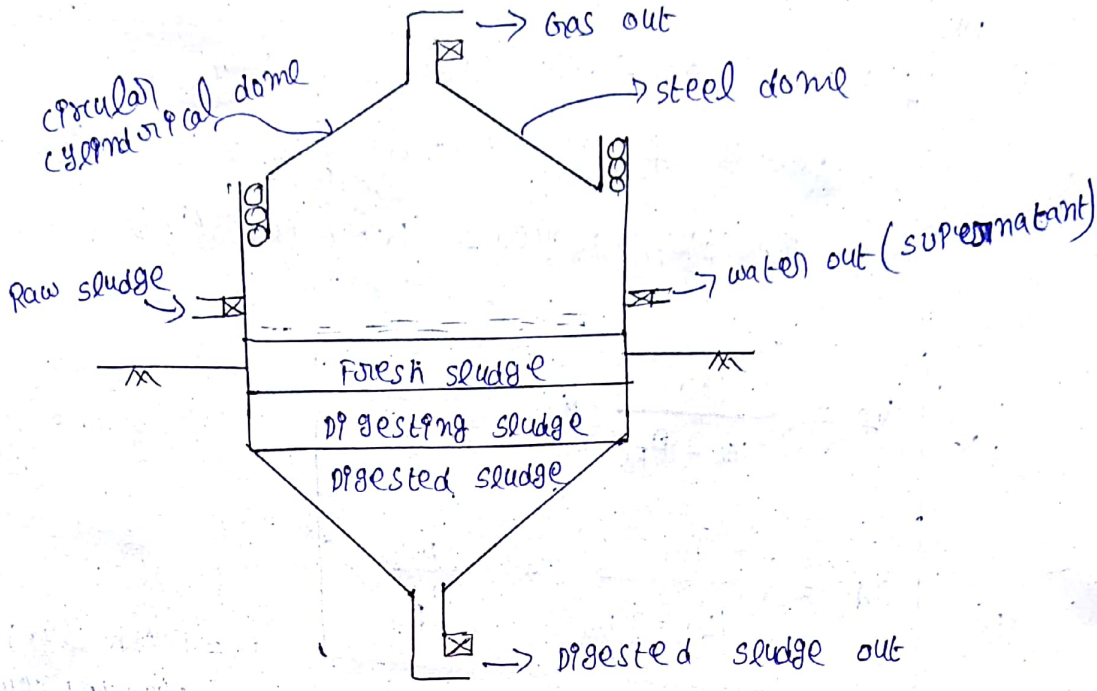
→ This stage ~~is~~ for a period of about one month

→ The BOD of the sludge also rapidly falls down during this stage.

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⇒ The sludges are anaerobically digested using a reactor known as "sludge digester"



→ sludge digestor is a circular cylindrical tank with floating steel dome.

diameter = 3 to 6 m
height = 6 to 12 m

Rate of gas production = 0.9 m^3/kg of volatiles destroyed

The produced gases are
methane CH_4 → 60 – 70%
Carbon dioxide CO_2 → 20 – 30%
remaining gases → traces

* Energy content (fuel value) of methane (CH_4) = 5200 – 5800 kg/m^3

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Capacity of Digestion (volume of digestion) $= \left[\frac{V_f + V_d}{2}\right] t$

where

V_f = volume of fresh sludge/day $= V_1$

V_d = volume of digested sludge/day $= V_2$

t = digestion periods (detention time)

$$\Rightarrow V_f = \frac{100}{100 - P_{FS}} * \frac{m}{\rho_{FS}}$$

$$\Rightarrow V_d = \frac{100}{100 - P_{DS}} * \frac{m}{\rho_{DS}}$$

FS = Fresh sludge

DS = Digested sludge

temperature = 10° to 40° C → time (t) = 30 to 60 days
(mesophilic organisms)

temperature = 45° to 60° C → time (t) = 18 to 25 days
(thermophilic organisms)

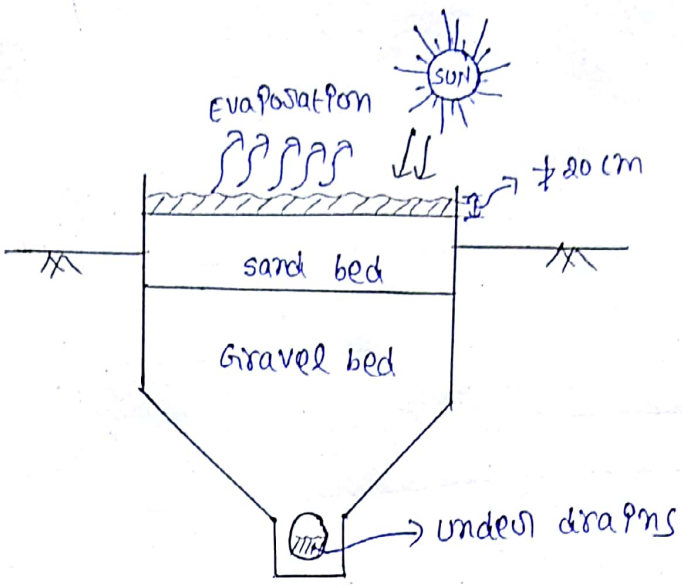
Sludge drying beds:-

Digested sludge dewatered and dried.

by "solar drying Beds" (sludge drying Beds)

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Breath (B) = 3 to 8 m

length (L) = 20 to 30 m

→ After solar drying for 4 to 5 weeks it produce to sludge cake (manure)

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Disposal of sewage:-

→ The sewage is coming from cities and industries areas so that sewage will be having hazardous impurities are having should perform a treatment (or) hazardous impurities are not having should not perform any treatment

→ The sewage will contain hazardous matter should perform a treatment after that disposal

→ The sewage will not contain any hazardous matter should not perform any treatment directly disposing

→ Final The sewage can be disposed by off without treatment (or) after suitable treatment

→ So finally the sewage is disposed off either on natural water courses (or) on land.

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~~method~~ Pg No 416 Birdie & Birdie

(6.4) method of disposal :-

The method of disposal sewage in 2 ways

(1) The natural methods
   (i) By dilution
   (ii) Land Treatment
(2) The Artificial methods
   (i) primary treatment
   (ii) secondary treatment

→ The Artificial methods of sewage disposal of primary treatment and secondary treatment will be discussed in previous chapter. so

→ the waste water can be disposed by natural methods in most of the cases

→ they are using in a ways for natural method of sewage disposal by
   (i) By dilution (water disposal)
   (ii) Land treatment (Land disposal)

~~(i) Disposal of waste~~

(i) Disposal by dilution (water disposal) :-

(6.5) Disposing the treated effluent into fresh water body is known as disposal by dilution.

(or)

the disposal of sewage by discharging it into water courses such as streams, rivers (or) large water body such as lake, sea is called dilution.

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→ This method of disposal is only possible when the natural (or) large water body is available near the town

→ while discharging sewage into the natural water bodies, care should be taken that the sewage may not pollute the natural water

→ If should not take any care while disposing of sewage in natural water bodies, result the natural water bodies can be polluted and this water unfit for any other purposes such as bathing, drinking, fish culture, rough industrial use and irrigation.

The method of sewage disposal by dilution is most suited under the following circumstances (షరతులు)

(i) when the city is situated near the sea, rivers (or) lake

(ii) the disposing sewage should be in fresh (or) non-septic

(iii) when at the point of disposal the depth of water is sufficient.

(iv) the sewage should dispose into large volume of water bodies with out causing its pollution.

(v) during the flood season the receiving water will not come backward flow in sewers

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(vi) on large water bodies should be having sufficient amount of fresh water with enough "DO" (Dissolved oxygen)

→ Effluent can be disposed by dilution. should follow some standards given by government.

Parameters	Domestic waste waters	Industrial waste water
BOD	— ≤ 20 mg/lt	— ≤ 30 mg/lt
COD	— ≤ 250 mg/lt	— ≤ 250 mg/lt
Oil and Grease	— ≤ 10 mg/lt	— ≤ 10 mg/lt
Total solids	— ≤ 100 mg/lt	— ≤ 100 mg/lt

After disposing of ~~effluent~~ sewage effluents onto the large water bodies the effluents can be ~~removed~~ purified by self purification.

self purification of water bodies occurs due to the following mechanisms

1) Dilution (Mixing) } concentration Reduces
2) Dispersion (spreading) }
3) sedimentation
4) oxidation } BOD ≈ 0
5) Reduction }
6) Disinfection due to sunlight (Destruction of micro organism)

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(ii) Land treatment (Land disposal) :- (16)

(6.7)

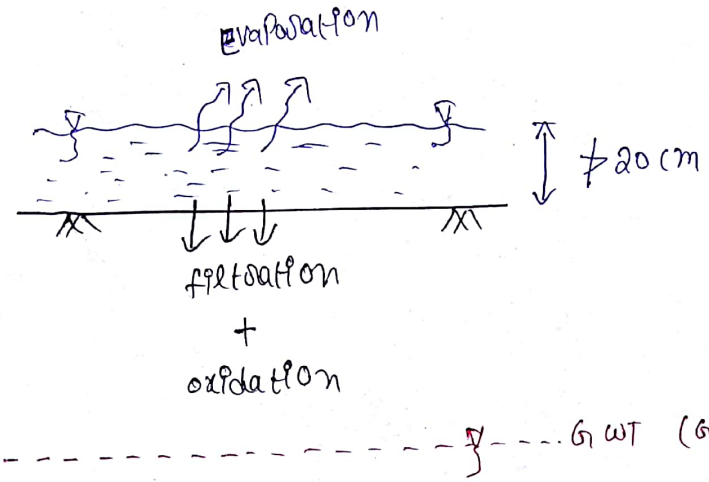
When the sewage is evenly spread on the surface of land, the method is called land treatment

→ The sewage contain water and organic suspended solids

→ The sewage disposed on land surface the sewage contains water This water will percolate below the soil mass and this sewage contains suspended solids This solids ~~retain the~~.

will not enter into the soil mass will be retain at the surface of the soil

→ It means while passing sewage through soil, some of the effluents evaporated and some more pass through soil



$$\text{Land required for disposal} = \frac{Q}{\text{consuming capacity of soil}}$$

→ This is the natural process of sewage purification.

In soil filtered by sewage and. Performs oxidation and. bio chemical action of organic matters

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→ The complex compounds of sewage are converted into harmless mineral salts which serve as a valuable fertilizer.

→ This valuable fertilizer can be used for growing of crops

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(6.6) oxygen sag curve:-

PG NO 119
Birdie Birdie

When the sewage is discharged into a water body, in the beginning there is depletion of dissolved oxygen content of the stream waters (decreasing of oxygen in water body)

→ the water in order to meet the biological requirement (B.O.D) of the sewage.

[∴ It means the water requires the oxygen]

→ This phenomenon is known as deoxygenation

→ the rate of the deoxygenation mainly depends on the volume of B.O.D of the sewage time available for the decomposition and the temperature of the stream.

→ It means the deoxygenation mainly depends on the decomposition of volume of the sewage

→ the dissolved oxygen of the ~~sea~~ stream water decreases due to deoxygenation, but on the other hand the oxygen is also absorbed by the stream water from the atmosphere and also due to its aeration by various natural processes.

→ the process of absorption of oxygen by the stream waters is known as the recreation (or) re-oxygenation and its rate depends on the condition of the body of waters, consumption of oxygen and the depth of the stream.

~~The Two~~ (or)
deficit of (D.O)
(or) (or)
difference of (D.O)

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→ If the cumulative rates of the de-oxygenation and Re-oxygenation (or) Re creation are plotted with respect to the time scale, these both rates can be determined from these curves of shown in figure below

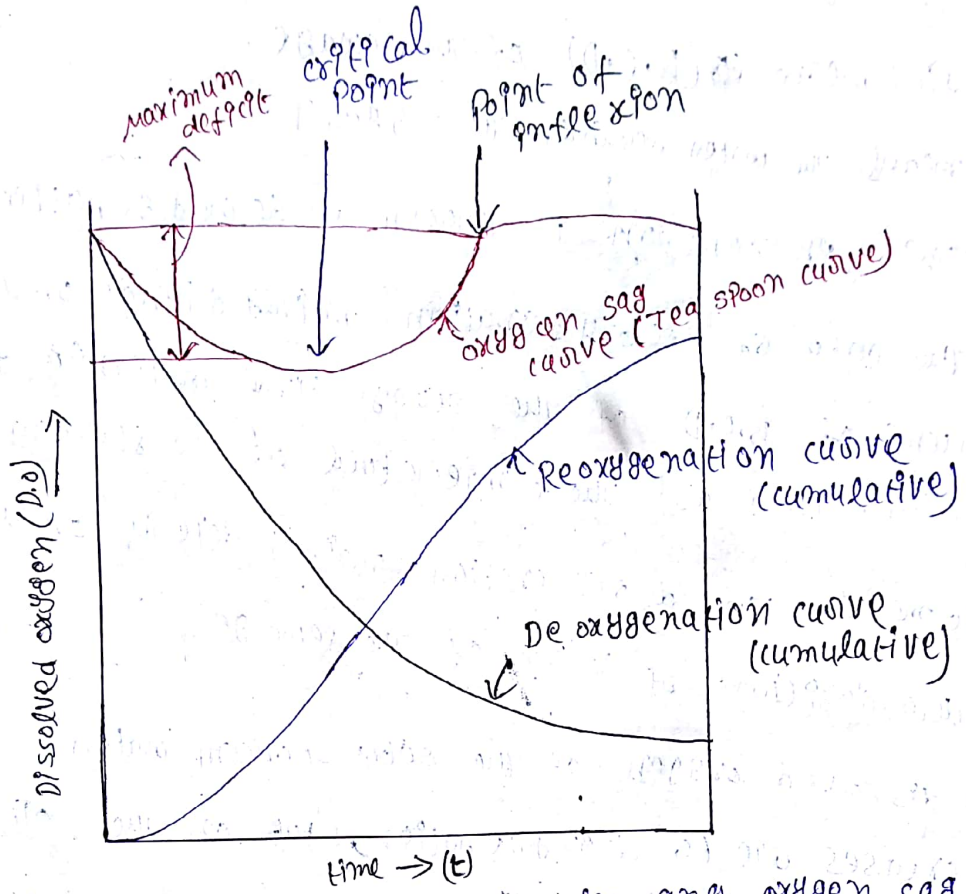


Fig: Deoxygenation, Reoxygenation and oxygen sag curve

→ For determining the quantity of dissolved oxygen (D.O) at any instant, the two curves can be combined together to obtain the Dissolved oxygen curve (D.O) curve

→ this curve is also known as the oxygen sag curve

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→ The study of oxygen-sag curve levels that (or) indicates

critical point (or) the least oxygen conten point occurs when the oxygen deficit (లోటు) is maximum.

→ similarly the point of inflexion occurs when the rate of recovery of oxygen is maximum

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(6.8) sewage sickness:-

(19)

When the sewage is continuously applied on the land on one place. on that place the pores of soil continuously go on decreasing it means the gap between soil particle to soil particle decreasing.

→ For this stage comes the gaps of the soil particle will be filled with sewage solids and also the air can not circulate through the soil pores. so anaerobic conditions can not continue why because aerobic reaction will perform on the presence of oxygen

→ finally resulting in the starting of Anaerobic conditions.

→ when anaerobic decompositions starts, the hydrogen sulphide gas is produced creating nuisance in the area.

→ In this condition the sewage treating capacity of the land is decreased. They can not treat more load of sewage

→ when such stage is reached the land is said to be sick.

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In order to prevent the sewage sickness of a land, the following preventive measures may be adopted.

PGN6273 SKG18(9) Primary Treatment of sewage:-

Before disposing of sewage on to the land, should perform a primary treatment, such as screening, grit removal, and sedimentation.

→ This will help in removing settleable solids and reducing the B.O.D. and soil pores will not get clogged, quickly.

(ii) Choice of Land:-

The land is choose for sewage disposal normally by sandy (or) loamy (ఇసుకమట్టి లేదా ఒండ్రు soil)

→ clayey lands should be avoided.

~~(iii) Choice of land:-~~

(iii) Underdrainage of soil:-

Underdrains (ie open jointed pipes) is laid below the soil, to collect the effluent; and this will also minimise the possibilities of sewage sickness.

(iv) Giving Rest to the land:-

The land being used for disposal should be given rest, periodically, by providing a number of lands for disposal of sewage

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→ More number of lands should be selected for sewage disposal.

→ when sewage is coming disposed on first land after some time again coming of sewage not disposing on first land giving rest on first land and disposing the sewage into second land.

(v) Rotation of crops:-

sewage sickness can be reduced by planting different crops

→ this will help the sewage utilising the fertilising element and also help in aeration of soil.

(vi) Applying shallow depths:-

the sewage should not be filled over the area in large depths, but it should be applied in thin layers.

→ suppose the large depth of sewage dispose on land surface. result clogging it means the soil particle to particle gap should be filled fastly by sewage solids.

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