page no 7 UR related topic

UNIT-IV

Secondary treatment:-

The effluent coming from primary sedimentation tank contains about 60 to 80% of the unstable organic matters originally present in sewage

This unstable organic matter will not settled in sedimentation tank This unstable organic matter can be removed by further treatment That treatment is called secondary treatment

secondary treatment of waste water is aimed to remove

Soluble BOD [BOD in colloidal and dissolved form]

This can be removed by secondary treatment method.

This secondary treatment method may be classified as follows

1) Physico-chemical treatment methods
2) Biological treatment methods

1) Physico-chemical treatment methods:-

This method is used to treat waste water

whose $\frac{BOD}{COD} < 0.6$

→ But these methods are very expensive.

The Physico-chemical treatment methods are

(a) micro screening
(b) Adsorption.
(c) Absorption
(d) Chemical oxidation.
(e) Chemical coagulation.
(f) Air stripping
(g) Electrolysis etc

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(a) micro screening

→ micro screening is useful removing the waste particle in waste water.

→ The small diameter particles & minute particles are removed in micro screening

(b) Adsorption:-

Adsorption is the adhesion of molecules of gas, liquid (or) dissolved solids to a surface

(Adsorption లో waste water లో dissolved అవ్వని particles లో gasy అవు molicules అవు విడివిడి కాదు, ఒక దాని మీద ఇంకొకటి లేయర్స్ లా ఏర్పడి ఉంటాయి. easy గా లాగేయొచ్చు)

→ This process creates a film (పొర) on the surface of the adsorbent

(లో 2 లో molicules ఉన్న కొన్ని మీద surface పైన ఇలా పొరలాగా విచ్చుకుంటాయి)

లో (fluid Parameters లో is dissolved by a liquid (or) solid)

fluid Particles అన్ని liquid గా అయిపోయి లేదా solid గా మారిపోతాయి.

(c) Absorption :-

Absorption is the process in which a fluid is dissolved by a liquid (or) a solid

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(d) Chemical oxidation :-

→ ~~Chemical oxidation~~ This method may be used for

1) Treatment of Phenols and cyanides in wastewater.

2) combustion of certain wastes

→ The chemical oxidation process reduce the ~~reduce the~~ concentrations of waste water

(e) Chemical coagulation :-

The main chemicals used for coagulation are aluminium sulphate, (alum)

Poly aluminium chloride (liquid alum) are used.

→ The chemical coagulation is the important process in water treatment for the removal of turbidity

(f) Air stripping :-

Air stripping is the process of moving air in surface water

→ It removes the chemicals like "volatile organic compounds (the elements of hydrogen oxygen, fluorine, chlorine, bromine, sulfur, nitrogen)

: This chemicals react with air & can easily evaporate which means can change from a liquid to a vapor (gas)

(g) Electrolysis :-

Electrolysis is the ~~processing~~ passing of a direct electric current in a substance.

→ The use of this one is the dissolved solids in waste water producing chemical reactions result separate of materials

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(2) Biological treatment :-

This method is best suitable for waste (waters) whose $\frac{BOD}{COD} > 0.6$, which is ~~very economical method~~. low cost waste treatment methods

→ This method is remove the biodegradable organic substances toxic substances

→ The biological method. ~~of treating of waste~~. The waste water is done by. some conventional methods like trickling filters activated sludge process and low cost waste waters. treatment methods like aerated lagoon and oxidation pond.

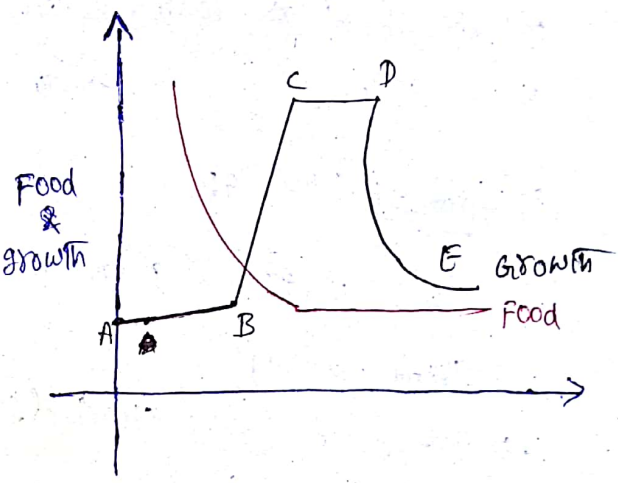
→ Graphical representation of bio-logical treatment is

AB – lag growth

BC – log growth

CD – stationary growth

DE = Declining growth Phase



Complex organic matter (food) → micro organisms (growth) → simple and stable end products

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(4.1) Aerobic & Anaerobic Treatment process – Comparison

Biological treatment is further divided into 2 categories

1) Aerobic Biological Treatment
2) An aerobic Biological Treatment

(1) Aerobic Biological Treatment:-

complex organic matter + Bacteria + oxygen → $CO_2 + NH_3$ + energy
(food)

simple & stable end products

→ Aerobic Biological Treatment the name itself indicates this treatment involves oxygen in it. (i.e) complex organic matter in waste combines with bacteria and oxygen. gives simple & and stable end products with energy.

→ This method is very fast but it produce huge amount of Bio mass

→ The sewage (or) waste water coming from industries contains organic impurities

→ This sewage (or) industrial waste water can not be directly discharged to the environment

→ This organic impurities present in waste water will consume dissolved oxygen. so this water is unsafe for drinking use and survival of aquatic life.

→ For treating sewage (or) industrial effluent for their organic impurities generally aerobic biological treatment is used

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(2) An aerobic Biological Treatment :-

Complex organic matter + Bacteria ⟶ $CH_4 + CO_2 + H_2S$ + energy
(food)

simple and stable end products

An aerobic Biological treatment the name itself indicates. The treatment does not involves oxygen in it (i.e) complex of organic matter in waste combines with only bacteria give sample and stable end products with Hydrogen sulphide and energy

→ This method is very slow, but no bio-mass problem occurs.

→ Anaerobic digestion is a naturally occurring process that is effectively utilized to treat waste

→ a lagoon with either a natural or) (ಲಿಖಿತ ಅರ್ಥ)
synthetic cover

The process has been around for decades and is quite effective. If significant space is available.

→ The anaerobic biological treatment plants will typically treat high-strength waste water

→ After completion of Anaerobic Biological treatment will do further treatments such as SBR (sequencing Batch Reactors) (or) MBR (membrane Bio Reactors) followed by RO (Reverse osmosis) It is possible to reuse water for selected purposes

Note:- waste waters are treated Aerobically and by-products (i.e) sludges are treated Anaerobically

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Comparision between Aerobic & Anaerobic Treatment Processes:- (4)

Aerobic Biological Treatment Process	An Aerobic Biological Treatment Process
→ This reaction undergoes under the presence of oxygen	→ This reaction undergoes under the absence of oxygen.
→ simple and stable end products are formed in this reaction along with energy	→ simple and stable end products are formed in this reaction along with H_2S and energy
→ Reaction is very fast.	→ Reaction is very slow
→ Huge amount of bio mass is formed	→ No bio-mass is formed.
→ waste waters are treated in this method.	→ By-products (sludges) are treated in this method.

Aerobic biological Treatment of waste water:-

Based on the food we offer to Micro organisms (microbes) సూక్ష్మ జీవులు
The treatments are classified into two types

(i) suspended culture system. Ex:- Activated sludge process
(suspended growth process)

(ii) Attached culture system. Ex:- Trickling filters
(Attached growth process)

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(4.2) Activated sludge process:-

Activated sludge process is a excellent method of treating of raw sewage. (or) most generally the settled sewage.

→ The sewage effluent coming from primary sedimentation tank which is normally utilised in this process.

→ ~~In this process~~ The sewage effluent coming from primary sedimentation tank from this sewage mixed with 20 to 30 percent of own volume of activated sludge.

→ so Result this sludge containg a large concentration of highly activate aerobic micro-organisms

↓
This micro organisms coated around sludge solidy

→ This mixture enters an aeration tank, where the micro-organisms and the sewage, are intimately mixed together with a large quantity of air for about 4 to 8 hours.

→ under these conditions, the moving organisms will oxidise the organic matter, and the suspended and colloidal matter tend to coagulate and form a precipitate

→ which settles down readily in the secondary settling tank.

→ This settled sludge (containg micro organisms) called activated sludge.

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→ This sludge is then recycled to the head of the aeration tank to be mixed again with the sewage being treated.

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(4.3) Activated sludge ~~processes~~ principles:-

Activated sludge processes works on the principle of suspended culture system

It employes two reactions. They are

1) Aeration.
2) secondary clarifier (secondary settling tank)

1) Aeration

Aeration is an activated sludge process is used. on pumping air into tanks, which promotes the microbial growth in waste water. (బ్యాక్టీరియా పెరుగుదల)

The microbes feed on the organic material, forming (సూక్ష్మజీవులు) (ఆహారం) flocs which can easily settle out (ఫ్లాక్స్)

→ Aeration brings water and air in close contact in order to remove dissolved gasses such as carbon dioxide and also dissolved metals such as iron, hydrogen sulfide, and volatile organic chemicals. (ఆవిరయ్యే ఆర్గానిక్ కెమికల్స్)

→ Aeration is often the first major process at the treatment plant.

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(2) ~~Secondary~~

2) Secondary clarifier

A circular basin in which effluent coming from the activated sludge process is held for a period of time

→ During this period of time heavier biomass (micro organisms) settle to the bottom

→ A secondary clarifier is generally used to remove solid particulates (or) suspended solids from liquid.

→ The clarifiers are ~~same~~ using in treatment plant almost all circular (or) sometimes rectangular

~~→ This secondary clarifier~~

→ This clarifier works on the principle of gravity settling.

→ The two main types of sludge produced from the wastewater treatment process. They are primary and secondary sludge.

The primary sludge will be produced of capture of suspended solids and organics in the primary treatment process and removed by primary clarifier.

→ In primary clarifiers aids in the content of suspended solids and pollutants embedded in suspended solids (మురుగు నీరు)

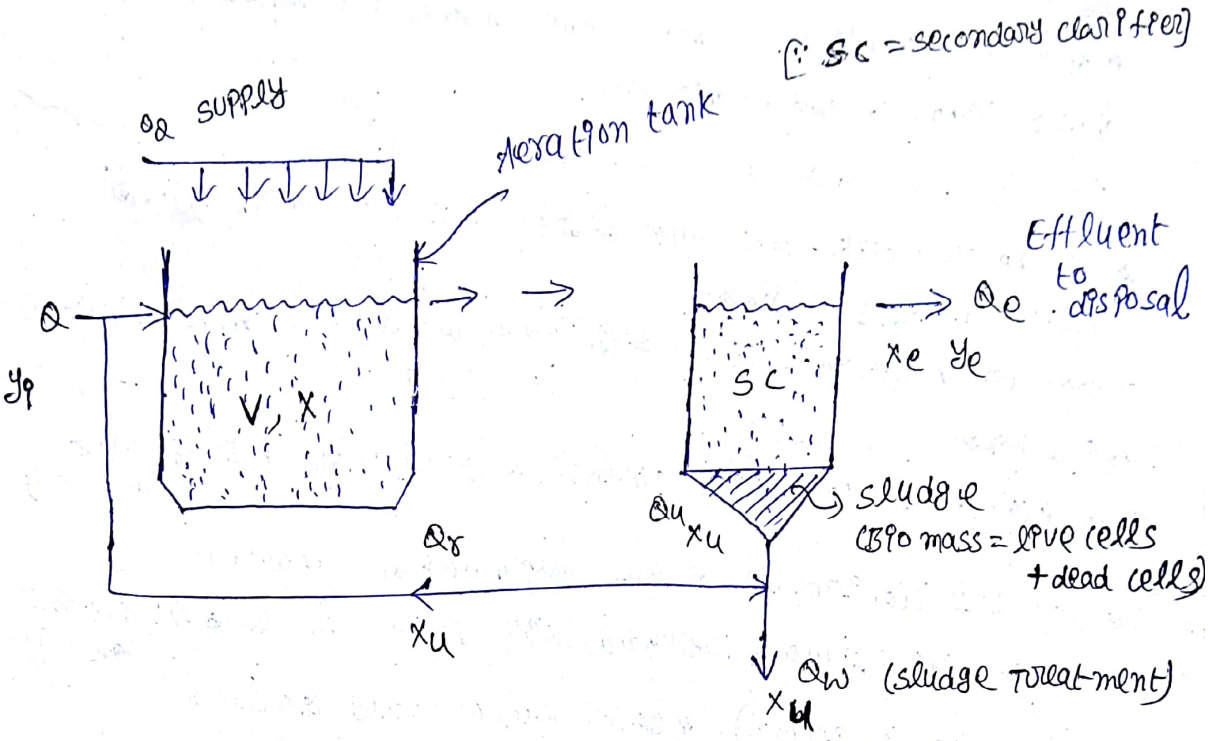
→ In primary treatment suspended solids pass through screens and grit chambers are removed from the sewage in sedimentation tanks. These tanks, also called primary clarifier, provided about two hours of detention time for gravity settling to take place

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→ Secondary clarifiers are used to remove the settleable suspended solids created in biological treatment process such as activated sludge process and trickling filters

(6)



where

Q – flow rate of waste water

y_f – Influent BOD

V – volume of aeration tank [L*B*H]

X – MLSS (mixed liquor suspended solids)

MLVSS (mixed liquor volatile suspended solids)

Q_e – Effluent flow rate

x_e – MLSS in effluent

y_e – Effluent BOD

Q_u – Rate of under flow (sludge flow rate)

X_u – MLSS in under flow (sludge)

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Q_w — waste sludge flow rate

Q_r — Rate of return sludge (Return sludge flow rate)

మీరు Diagram ని చూసి explain చేయాలి

'Q' కన్న waste water ని Aeration tank లోకి పంపిస్తాము

Aeration tank లోకి పంపిన waste water లో కన్న BOD తగ్గించి

V అనేది Volume of Aeration tank

'X' అనేది waste water లో ఉండే solids

So తో Aeration tank waste water లో తక్కువ ఆ ని కూడా supply చేస్తారట

ఇ లేదు reaction జరుగుతుంది.

So లేకుండా Aeration tank లో మొత్తం waste water ని secondary clarifier లోకి పంపిస్తాము

→ secondary clarifier. ఇందులో వచ్చిన water ని effluent flow rate

→ secondary clarifier లో తెల్లగా waste water ని. నిలువ లో

X అనేది mixed liquors suspended solids ఉంటాయి ఈ కన్న BOD తగ్గించడానికి

→ secondary clarifier లో కిందకి settle (sludge) ఉంటుంది

పైన clear water తెల్లగా ఉన్నాయి కదా

ఈ sludge. ఈ కన్న sludge కింద తెల్లగా ఉన్నట్లు. ఈ water ని BOD తగ్గించడానికి

ఈ sludge లో Xu కన్న suspended solids ఉంటాయి.

→ sludge లో 50% మొత్తాన్ని sludge Treatment Plant కి

పంపుతారు. 50% మొత్తాన్ని. Q_r return sludge కింద వుంచి

Aeration tank లోకి waste water ని పంపే తరుణంలో ఈ return sludge ని కలుపుతారు పంపుతారు Aeration tank లో already ఉన్న sludge activate కాని reaction జరగడానికి.

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(4.4) Design Parameters of Activated sludge Process (ASP):-

*1) F/M Ratio [Food to micro organisms Ratio]:-

Ratio of mass of food applied in unit time to unit mass of micro-organisms in the aeration tank.

$$\frac{F}{M} = \frac{Q * y_0}{VX}$$

$$\frac{m^3/day * mg/l}{m^3 * mg/l} = \frac{1}{day} = day^{-1}$$

$$\frac{F}{M} = \frac{Q(y_0 - y_e)}{VX}$$

$S_0 = y_0$ (substate = food)

$\frac{F}{M} = 0.2$ to 0.4 day^{-1} (Range)

*2) Mean cell Residence Time (mCRT, θ_c):-

(Average period of micro organisms = sludge age)

It is defined as "mass of solids in the reactor" to mass of solids wasted per day

$$mCRT, \theta_c = \frac{\text{mass of solids in reactor}}{\text{mass of solids wasted /day}}$$

$$mCRT, \theta_c = \frac{VX}{Q_w X_u + Q_e X_e}$$

$$(Flow)_{in} = (Flow)_{out}$$

$$Q = Q_e + Q_w$$

$$Q_e = Q - Q_w$$

$$mCRT, \theta_c = \frac{VX}{Q_w X_u + (Q - Q_w) X_e}$$

$$\frac{m^3 * mg/l}{m^3/day * mg/l} = day$$

Range $\Rightarrow \theta_c = 4$ to 15 days

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(3) Efficiency of BOD Removal (η) :-

$$\eta = \frac{y_p - y_e}{y_p} * 100$$

Range ⇒ η = 85 to 95%

(4) Aeration time (Detention time) :-

$$\text{Aeration period} = \frac{\text{volume of aeration tank}}{Q}$$

$$= \frac{V}{Q}$$

$$= \frac{L * B * H}{Q}$$

Range ⇒ Aeration period = 4 to 8 hours

(5) volumetric loading Rate (or) organic loading Rate (or) BOD loading Rate (V_L)

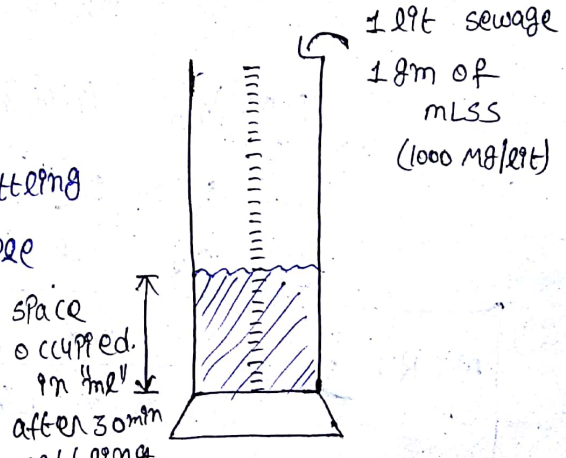
It is the total amount of BOD (food) applied per day per unit volume of reactor

$$V_L = \frac{Q y_p}{V} \quad [\text{kg of BOD/day/m}^3]$$

Range ⇒ V_L = 0.3 to 0.6 kg/day/m^3

(6) sludge volume Index (SVI) :-

SVI is defined as space occupied in "ml" by 1 gm of MLSS after settling for 30 min from 1 lit sewage sample



As per Indian conditions

SVI = 50 to 150 ml/gm. (range)

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(7) $X_U \simeq \frac{10^6}{SVI}$ (X_U in mg/l)

X_U = 9000 – 12000 mg/l
X = 1500 – 3000 mg/l
} Range.

(8)

(8) Recycling Ratio $\left(\frac{Q_r}{Q}\right)$:-

$$\frac{Q_r}{Q} = \frac{X}{\frac{10^6}{SVI} - X}$$

Range ⇒ $\frac{Q_r}{Q}$ = 0.25 to 0.5

Problems

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(1) An average operating data for conventional activated sludge treatment plant is as follows

(1) waste water flow = 35000 m^3/day
(2) volume of Aeration tank = 10900 m^3
(3) Influent BOD = 250 mg/litre
(4) Effluent BOD = 20 mg/litre
(5) mixed liquor suspended solids (MLSS) = 2500 mg/litre
(6) Effluent suspended solids = 30 mg/litre
(7) waste sludge suspended solids = 9700 mg/litre
(8) quantity of waste sludge = 220 m^3/day.

Based on the information above, determine

(a) Aeration period (hrs)
(b) Food to microorganism ratio (F/M) (kg BOD per day / kg MLSS)
(c) percentage efficiency of BOD removal
(d) sludge age (days)

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Soln: Given data.

$(Q) = 35000\ m^3/day$

$(V) = 10900\ m^3$

$(y_0) = 250\ mg/lt$

$(y_e) = 20\ mg/lt$

$MLSS\ (X) = 2500\ mg/lt$

$X_e = 30\ mg/lt$

$X_u = 9700\ mg/lt$

$Q_w = 220\ m^3/day$

(a) Aeration Period in hrs :-

$Q_e = Q - Q_w$

$= 35000 - 220$

$= 34780\ mg/lt$

Aeration Period. (or) Retention Period (t) $= \frac{\text{volume of the tank}}{\text{Rate of sewage flow on the tank}}$

$= \frac{10900}{35000}\ \frac{V}{Q}\ \frac{m^3}{m^3/day}$ $\left[\because \frac{V}{Q}\right]$

$= \frac{V}{Q}\ day$

$t = \frac{V}{Q} * 24\ hours$

where t = Aeration Period.

V = volume of aeration tank

Q = Quantity of waste water flow into the aeration tank excluding the quantity of recycled sludge.

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$$= \frac{10900}{35000} * 24 \text{ hr}$$

Detention time $(t) = 7.474$ hr

(b) Food to micro organisms ratio (F/M)

$$\frac{\text{Food}}{\text{Micro organisms}} = \frac{Q * y_0}{V X}$$

$$= \frac{35000 * 250}{10900 * 2500}$$

$$= 0.32 \text{ day}^{-1}$$

(c) percentage efficiency of BOD removal:-

$$\eta = \frac{y_0 - y_e}{y_0} * 100$$

$$= \frac{250 - 20}{250} * 100$$

$$= 92\ \%$$

(d) sludge age in days :-

$$\text{sludge AGE } (\theta_c) = \frac{V X}{Q_w X_u + (Q - Q_w) X_e}$$

$$= \frac{10900 * 2500}{220 * 9700 + (35000 - 220) 30}$$

$$= 8.576 \text{ days.}$$

$$\left[\because \frac{m^3 * mg/lt}{\frac{m^3}{day} * \frac{mg}{lt} + \frac{m^3}{day} * \frac{mg}{lt}} \Rightarrow \frac{m^3 * mg/lt}{\frac{m^3}{day} mg/lt} = day\right]$$

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(2) An Activated sludge system is operating at equilibrium with the following information waste water related data

1) Flow rate (Q) = 500 m^3/hr

2) Influent BOD (y_0) = 150 mg/litre

3) Effluent BOD (y_e) = 10 mg/litre

4) Aeration tank related data.

Hydraulic Retension time = 8 hours

5) mean cell Residence time (MCRT) θ_c = 240 hours

6) Volume (V) = 4000 m^3

7) mixed liquor suspended solids (X) = 2000 mg/litre

By using the above data, calculate

1) Food to micro organisms Ratio ?

2) mass of solids wasted per day in kg per day ?

Sol:-

$Q = 500$ m^3/hr

$= 500 * m^3 / \frac{1}{24}$ day

$= 500 * 24$ m^3/day

$= 12000$ m^3/day

[$\because$ 1 day = 24 hr

$\frac{1}{24}$ day = 1 hr]

$y_0 = 150$ mg/lt

$y_e = 10$ mg/lt

1 litre $= 10^{-3}$ m^3

1 m^3 = 1000 litre

Detention time (D.T) = 8 hours

$\theta_c = 240$ hours

$V = 4000$ m^3

$X = 2000$ mg/lt

[$\because$ 1 kg = 1000 mg]

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① Food / micro organisms

$$f/m = \frac{Q * y_p}{V X}$$

$$= \frac{12000\ m^3/day * 150}{4000 * 2000}$$

$$= 0.225\ day^{-1}$$

② mean cell Residence time (mcRT) $\theta_c = \frac{VX}{Q_w X_u + Q_e X_e}$

$$240\ hours = \frac{4000 * 2000}{Q_w X_u + Q_e X_e}$$

$$Q_w X_w + Q_e X_e = \frac{4000\ m^3 * 2000\ mg/lt}{240\ hours}$$

$1 litre = 10^{-3} m^3$

$1 m^3 = 1000 litre = 10^3 litre$

$$= \frac{4 * 10^6\ lit * (2000 * 10^{-3})\ kg/lt}{240 * \frac{1}{24}\ day}$$

$4000 * 1000$

$\because$ 1 day = 24 hr

$\frac{1}{24}$ day = 1 hr]

$$= \frac{4 * 10^6 * 2 * 24}{240}$$

doubt kg/day ka kya

$$= 8000\ 00\ mg/day$$

$$= 800\ kg/day$$

$$= 8000\ 00\ kg/day$$

$$= 8 * 10^5\ kg/day$$

[$\because$ 1kg = 1000 mg

$= 10^3$ mg

$\frac{1}{10^3}$ kg = 1mg

10^{-3} kg = 1mg

$\because$ 1kg = 1000 mg

$\frac{1}{1000}$ kg = 1mg]

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(3) Following data An activated sludge aeration tank of length 30m width 14m and effective liquid 4.3m has the following Parameters

flow = 0.0796 m^3/sec

Bod after primary settling = 130 mg/litre

mixed liquor suspended solids X = 2100 mg/litre ✓

mixed liquor volatile ~~solids~~ suspended solids = 1500 mg/litre

30 min settled sludge volume = 230 mg/litre ✓

Return sludge concentration = 9100 mg/litre

(a) Determine Aeration period in hours ?

(b) Food to micro organisms Ratio in day^{-1} ?

(c) Sludge volume Index ?

(d) Return sludge Rate in m^3/day ?

Sol :-

Given data

$Q = 0.0796\ m^3/sec$

$y_i = 130\ mg/lt$

$X = 2100\ mg/lt$

~~Accord~~ ~~$X_r = 230\ mg/lt$~~

(a) Aeration period = $\frac{\text{volume}}{\text{discharge}}$

$= \frac{L * B * H}{Q}$

$= \frac{30 * 14 * 4.3}{0.0796 * 60 * 60}$ (hr, min)

$= 6.302$ hours

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(b) Food / micro organisms Ratio.

$$F/m = \frac{Q \times y_0}{V \times X}$$

30 – 230
720
1000 – ?

$$= \frac{(0.0796 * 60 * 60 * 24) * 130}{(30 * 14 * 4.3) * (2100)}$$

m^3/sec

$$= 0.24\ day^{-1}$$

(c) sludge volume Index

$$\frac{Q_r}{Q} = \frac{X}{X_U - X}$$

230

$$Q = 0.079 * 24 * 60 * 60$$

$$= 6825.6$$

$$Q_r = 0.298 * Q$$

$$= 0.298 * 6825.6$$

$$= 2034 \text{ liters/day}$$

Assume

$\therefore \frac{Q_r}{Q} = 0.298$

$\Rightarrow Q_r = 0.298\ Q$

$\therefore 1 lt = 1000 ml$

$\therefore 1 gm = 1000 mg$

$\frac{1}{1000} gm = 1 mg$

$\therefore$ (X) 2100 mg/lt — 230 m g/lt (SVI)

2.1 g — 230

$1 gm = \frac{230}{2.1}$

$= 109.52$ (SVI)

$$X_U = \frac{10^6}{SVI}$$

$$= \frac{10^6}{109.52}$$

$$= 9130.75$$

(d) return sludge Rate

$$\frac{Q_r}{Q} = \frac{X}{X_U - X}$$

$$= \frac{2100}{9130.75 - 2100}$$

$$= 0.298.$$

Check

$$\frac{Q_r}{Q} = \frac{X}{X_U - X}$$

$$\frac{2034}{6825.6} = \frac{2100}{9130.75 - 2100}$$

$$0.29 = 0.29$$

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(4) Following data

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Operation problems associated with Activated sludge process (ASP):-

(12)

→ During the operation of an activated sludge plant, Food to micro organisms ratio F/M should be maintained properly which is achieved by increasing (or) decreasing the mixed liquor suspended solids (MLSS) levels in the aeration tank to suit the influent BOD_5 loads.

→ The MLSS in the aeration tank can be regulate by controlling the rate of return sludge

→ The poor settling characteristics sludge is known as bulking sludge.

→ These sludge bucking is occuring in industrial wastes The industrial wastes containing high concentration of carbohydrates in sewage.

→ These sludge bucking is controlling by eliminating the causes and application of chlorine (Cl2 gas) to the sewage (or) return sludge

→ some times the secondary settling tank may function poorly. That time the sludge may rise up in the tank and, escape with the effluent.

→ The RPSing sludge may be due to denitrification in the settling tank releasing nitrogen bubbles

→ the problems can be overcome by increasing the return sludge.

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So the main operational problems associated with the Activated sludge process is

1) Rising of sludge
2) Bulking of sludge

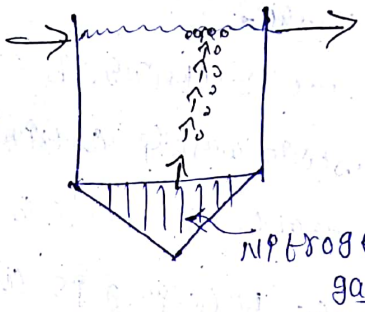
1). Rising of sludge.

The problem is because of accumulation of nitrogen gas in settled sludge

(Live cells > Dead cells in settled sludge)

Remedies :-

→ Increase Q_r → Rate of return sludge
→ decrease Q → Flow rate
→ decrease θ_c → sludge age



(2) Bulking of sludge :-

- Dead cells > Live cells in settled sludges
- SVI ≅ 150

Remedies :-

→ decrease SVI [SVI ≅ 100] → Add nutrients → decrease F/m
→ Increase DO → Increase pH ≅ 7

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(4.5) Modifications made to conventional Activated sludge process :-

→ The basic activated sludge process, also called conventional aeration process, The recirculated activated sludge is added to the inlet end of the aeration tank as a single dose.

→ In conventional activated sludge processes irrespective of oxygen is utilized.

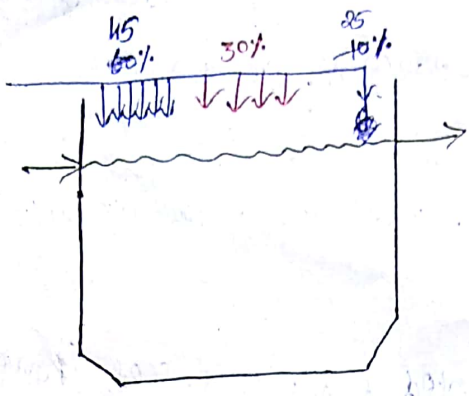
→ The oxygen supply is constant throughout aeration tank.

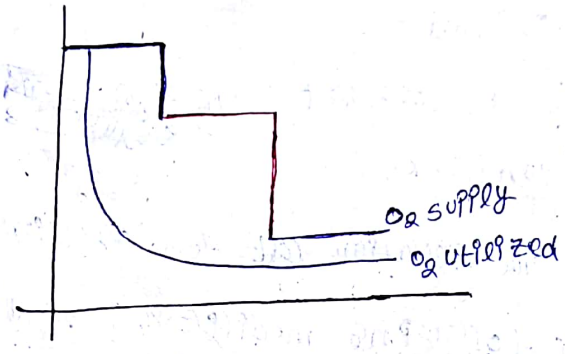
→ To bring down the operation cost for effective utilization of oxygen, The following modifications are done

(i) Tappered Aeration
(ii) Stepped Aeration
(iii) Extended Aeration
(iv) Constant Aeration.

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(9) Tapered Aeration:-





→ The process involves a very little modification in the higher air supply at the inlet

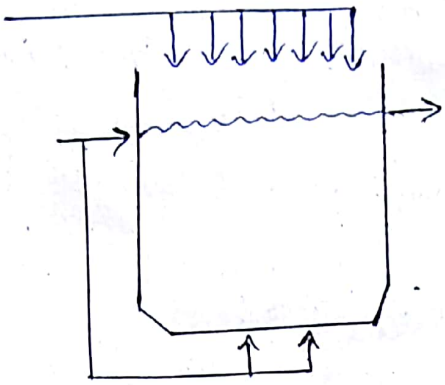
→ The air requirement on the Aeration tank goes on decreasing.

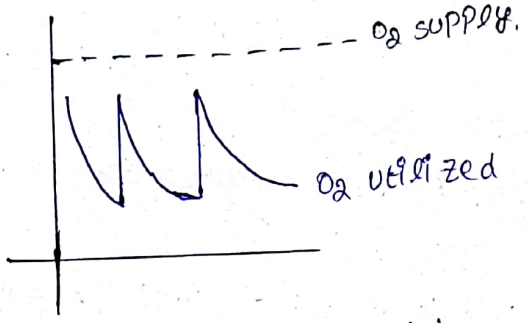
→ At the inlet of the aeration tank a compressed air is supplied at higher rates so the result gradually ~~reduce the sewage~~ decrease the sewage moves ~~to~~ towards the out let end of the tank

→ In the aeration tank 45% of air is supplied to the first one-third length of the tank, 30% of air is supplied to the second one-third length of the tank, and the remaining 25% of air is supplied in remaining one-third length of the tank.

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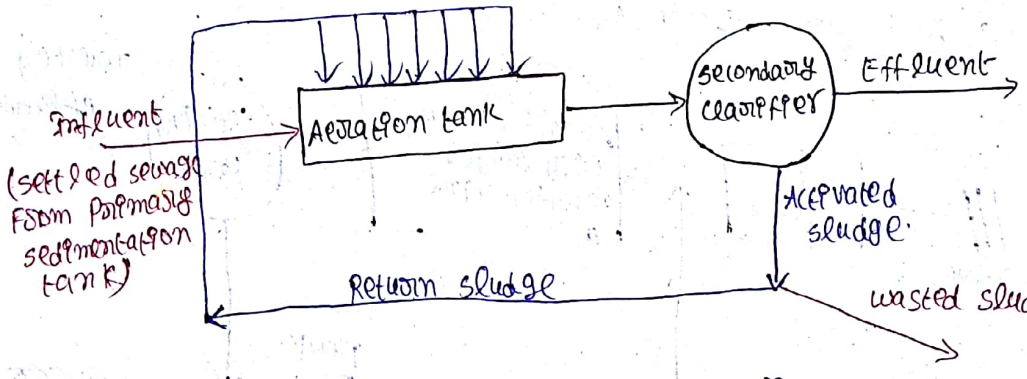
(9f) Stepped aeration





(08)

→ ~~In the step aeration process, the~~



→ In the step aeration process, the sewage is introduced along the length of the aeration tank in several steps on return sludge

→ ~~The above~~ in the aeration tank result the uniform air requirement along the entire length of the tank. so ~~and~~ uniform air is supply of the aeration tank.

→ This is method is used for large plants of capacity upto about 1000 MLD

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(iii) Extended Aeration:-

→ primary sedimentation is frequently avoided in this process. but grit chamber is provided for screenings.

→ The aeration period quite large about 18 to 24 hours and low F/M ratio → Food/micro organisms

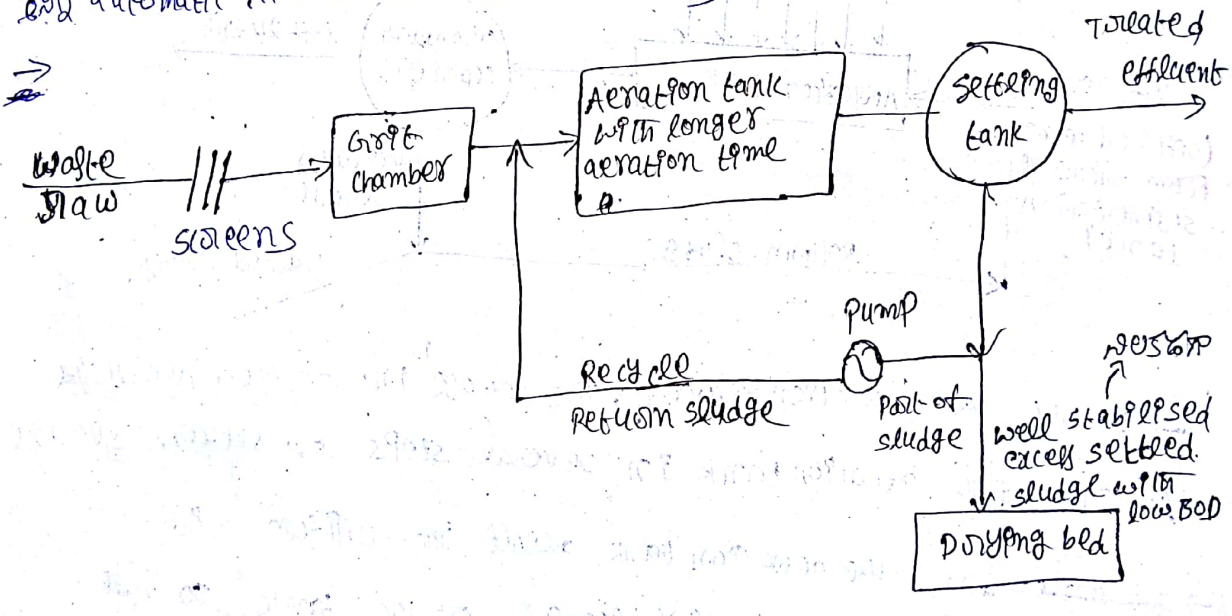
→ low F/M ratio [F/M = 0.05 – 0.1 day^{-1}]

→ The air (or) oxygen requirement is high. so the ~~increase~~ The cost of the plant is

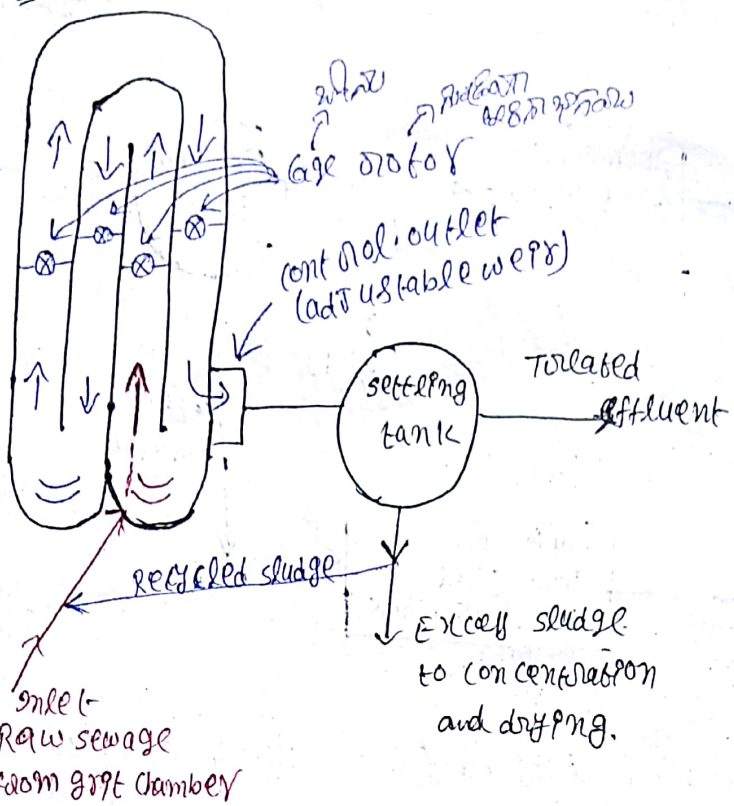
→ The advantage of the plant is no seperate sludge digestion is required.

(ఈ plant లో మొదట grit chamber లోని పెద్ద particles ని తీసివేసి తరువాత particles ని ఎలాంటివైతే ~~digested~~ sludge digestor లో ఉంచకుండా (or chemically) కొంతకాలం పాటు 24 hours long time వుంచి particles అన్ని automatic గా bottom లో settle అవుతాయి)

→



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→ An oxidation ditch is provided in the extended aeration system.

→ Each ditch will have horizontal axis rotor it is used for circulating the sludge and also oxygen supply to the sewage

→ the thoroughly aerated sewage is then settled in a settling tank by stopping the rotors for about 2 hours

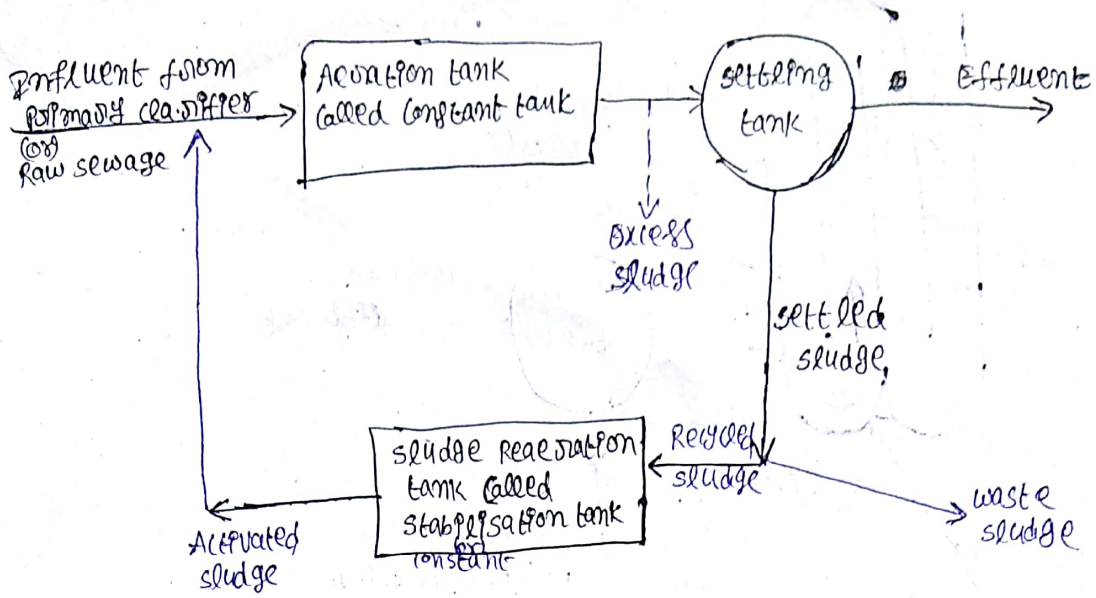
→ ~~some part of settled sludge is used for recirculating of raw water set for again coming of waste water~~

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(9U) Constant Aeration



→ This process has been designed for treating colloidal and suspended. organic matter

→ In this process the sewage and recycled (or) return sludge are mixed and aerated for comparatively shorter period of 0.5 to 1.5 hours in a special mixing tank called constant tank

→ This mixing will allow the suspended and dissolved organic matter in wastewater to be absorbed to the activated sludge

→ This absorbed organics matter are removed by secondary settling tank.

→ this method is well suited for the treatment of fresh domestic sewage

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(4.6) oxidation ponds :-

(ఆక్సిజన్ చెరువులు) (ఆక్సీకరణ చెరువులు) చెరువులు

→ "oxidation ponds" are low cost waste water treatment units.. Best suitable for small communities whose population < 10,000

→ oxidation ponds are aerobic waste stabilization ponds which remove BOD from waste water by Aerobic decomposition by oxidising the waste aerobically.

→ which are similar to the secondary treatment process of the sewage treatment units

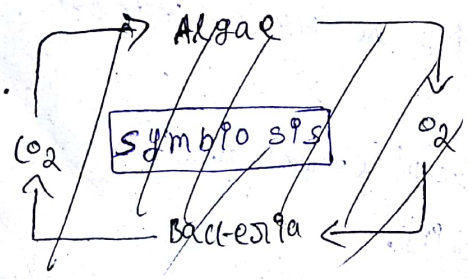
→ the oxidation ponds are shallow dug earthen ponds provided. with high embankments (లోతైన)

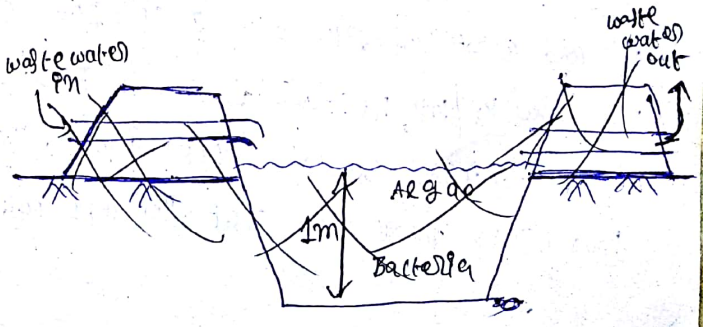
→ It is a rectangular plant with L:B = 2:1 to 4:1 and depth 1 to 1.5 m

→ oxidation ponds works best in tropical climate conditions (warm temperature zones)

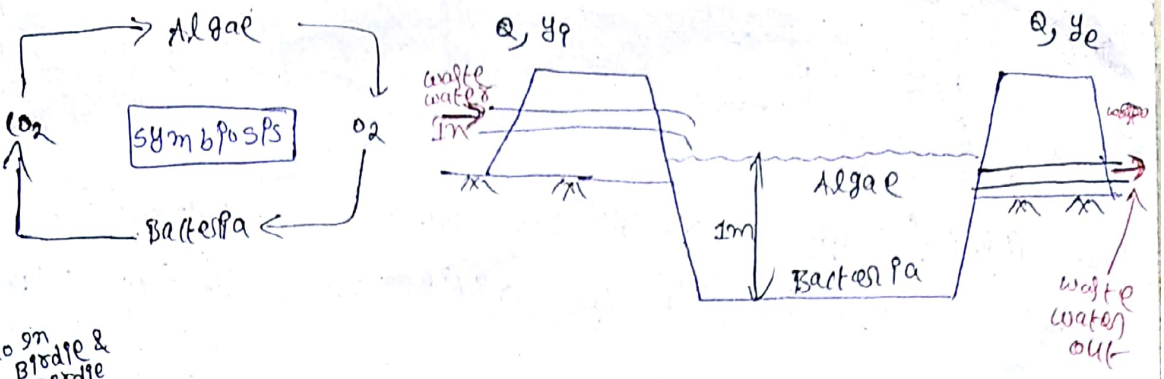
→ The efficiency of the oxidation ponds depends on the ~~temperature~~ temperature (which is directly affects the biological activity rate) and intensity of the ~~sun~~ sunlight (which is affects the photosynthesis in the algae)

→ The oxidation ponds works on the principle of "Algae & Bacterial symbiosis" (రెండు రకాల వాటి మధ్య సంబంధం)





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Ref No 520 on Brodie & Brodie

→ The surface area of the Ponds are kept as large as possible. depending on the loading.

→ The depth of the pond does not play any vital role. (3 ft) so therefore the Ponds should be kept shallow. Result sunlight and the oxygen may reach the sewage

→ The usual practice is to keep the depth between. 8 to 150 cm. Free board of 50 to 120 cm. is provided depending upon the size and location of the ponds to prevent the over-topping (పక్కలకి పైన ఇంకి లోపల పడకుండా) of the sewage due to high velocity wind. action.

→ Depending upon the intensity of sunlight and the temperature of the detention of 10 to 35 days is provided. But in India detention period of 10 to 15 days is sufficient.

→ In cold countries higher detention period even upto 45 days. may have to be provided.

Note: The loading of the sewage is also expressed in terms of "BOD" applied. In cold countries like Europe the "BOD" loading are between 40 to 80 kg/day/hectare at 5 days "B.O.D" In tropical countries like India, the "B.O.D" removal about four times more than that in cold countries.

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Design of oxidation pond :-

Design Parameters :-

(I) organic loading Rate (OLR) (or) BOD loading rate :-

(kg of BOD/day/Hectare)

$$\text{surface area of pond } (L*B) = \frac{\text{Total BOD applied to pond}}{\text{organic loading rate}} ;$$

$$OLR \propto \frac{1}{\text{latitude}}$$

$$L*B = \frac{Q*y_0}{OLR} = \frac{mLD * mg/l}{kg/day/ha}$$

$$= \frac{kg/day}{kg/day/ha}$$

$$= ha$$

$L:B = $ ——

$L = ?$; $B = ?$

(II) Detention time "t" (DT) :-

volume of pond $(L*B*H) = Q * DT$

(DT) = 2 to 6 weeks

$$DT,\ t = \frac{1}{k} \ln \frac{y_0}{y_e} \quad ; \quad \eta = \frac{y_i - y_e}{y_0} * 100$$

$\eta = 80-85\%$

→ Excess growth of algae in fresh water bodies leads to "Eutrophication" (Death of water body). This is controlled by copper sulphate.

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Pg No 456
SK Garg

~~→ the surface~~

Design criteria:-

→ The surface area of the tank assuming a suitable value.

It is suitable value for organic loading.

[area మీరు select చేసుకోవలంటే tank లో ఎంత organic load ఇవ్వొచ్చు depending on climatic condition & organic loading & సరిపడా area ని మనమే assume చేసుకోవాలి]

which may range from 300 - 150 kg / hectare / day.

(or)

In hot tropical countries like India about 90-60 kg/~~hectare~~ hectare/day

(or)

In cold countries situated at higher latitude. Each unit may have an area ranging between 0.5 to 1 hectare

→ The length of the tank may be kept at about twice the width.

The depth may be kept between 1 to 1.5m.

→ A free board is about 1m. usually kept on 20-30 days of detention period.

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Removal of settled sludge:-

→ During the designed of detention period in an oxidation pond, the organic solids will either be oxidised (or) will settle down

→ The average of sludge formation ~~observed~~ observed in several ponds is about 2 to 5 cm depth per year.

→ The maximum sludge removal once in 6 years for 1.2m deep ponds and once in 12 years for 1.5m deep ponds, so as to ensure a minimum liquid depth of 0.3 m all the time.

Advantages & Dis advantages:-

- Advantages

→ oxidation ponds are quite suitable in hot dry countries like India, and places where 200 (or) more sunny days are expected per year.

→ the biggest advantage of an oxidation pond treatment is very cheap their maintenance cost is also very minor and no skilled supervision is required, at any stage of construction (or) operation.

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Dis advantages:-

→ The main dis advantage of oxidation ponds is nuisance due to mosquito breeding and bad odours

→ To avoid mosquito breeding, the banks of the ponds should be kept clear of any grasses and bushes etc.

→ Similarly, to avoid bad odours, the oxidation ponds should be located sufficiently far from the residential areas

→ odours may also be kept under control by avoiding the over-loading.

→ when a pond gets over-loaded, the algae growth may be stimulated by adding sodium nitrate, which is both a plant food and an oxidising agent.

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Ref no 458 sk bag

Problems

(1) Design an oxidation pond for treating sewage from a hot climatic residential colony with 5000 persons, contributing sewage @ 120 litres per capita per day. The 5-day BOD of sewage is 300 mg/lt

Sol:- The quantity of sewage to be treated per day

[∵ 1 lakh = 100,000]

$= 5000 * 120$

$= 6,00,000$ litres

[∵ 1 million = 10 lakhs = 10,00,000]

$= \frac{6,00,000}{10,00,00}$ million litres

[∵ 1 litre = 0.001 cum
6,00,000 litre = ? cum
1 lit * ? cum = 6,00,000 * 0.001 = 600 cu.m]

$= 0.6$ million litres

$= 600$ cu.m (or) $600\ m^3$

Note:- quantity of sewage = 6,00,000 litres

$= \frac{6,00,000}{10,00,00}$ million litres [∵ 1 million = 10 lakh = 10,00,00]

$= 0.6$ ml

The BOD content per day $= 0.6$ ml $* 300$ mg/lit

$= 180$ kg

[∵ million litre * mg/litre
million * mg
1000000 * mg
∵ 1,000,000 mg = 1 kilogram]

Now, assuming the organic loading in the Pond (in hot climate) as say 300 kg/hectare/day, we have

The surface area required $= \frac{\text{Total BOD applied to pond}}{\text{organic loading rate}}$

$= \frac{180\ kg/day}{300\ kg/hectare.day}$

$= \frac{180}{300}$ ha

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$= \frac{180}{300} * 10^4 \ m^2$

$= 6000 \ m^2$

1 hectare = 10000 m^2

$= 10^4 \ m^2$

Assuming the length of the tank (L), as twice of its width (B), we have.

$2B^2 = 6000$

$B^2 = \frac{6000}{2}$

$B^2 = 3000$

$B = \sqrt{3000}$

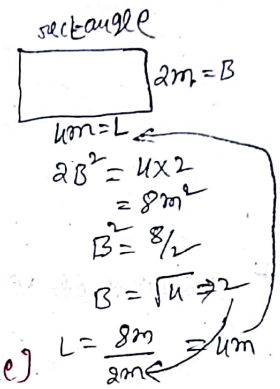
$B = 54.7m$ say 55m.

Use

Length (L) $= \frac{6000}{55}$

$= 110m.$

[∵ Ext:



Use

using a tank with effective depth as 1.2m, we have [Assumed value]

The provided capacity $= 110m * 55m * 1.2m$

$= 7260 m^3$

Now, capacity. = sewage flow per day * detention time in days

∴ detention time in days $= \frac{\text{capacity in cu.m}}{\text{sewage flow per day in cu.m/day}}$

$= \frac{7260 \ m^3}{600 \ m^3/day}$

$= 12.1$ days (say 12 days)

Hence, use an oxidation pond with length = 110m, width 55m and over all depth = (1.2 + 1) = 2.2m, and a detention period of 12days

{ free board should be provided at 1m depth

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Design of Inlet Pipe

Assuming an average velocity of sewage of 0.9 m/sec, and daily flow for 8 hours only.

$$\text{Discharge} = \frac{600}{8*60*60} \text{ cumecs (or) } m^3/sec \quad \left[\because = \frac{600 \text{ cum}}{1 \text{ hr}} = \frac{600 \text{ cum}}{8*60*60}\right]$$

$[\because 8 \text{ hr} * 60 \text{ min} * 60 \text{ sec}]$

$[\because 1 \text{ cumecs} = 1 m^3/sec]$

$\therefore$ Area of inlet pipe required $= \frac{\text{discharge}}{\text{velocity}}$

$$= \frac{\left[\frac{600}{8*60*60}\right] m^3/sec}{0.9 \text{ m/sec}}$$

$$= 0.023 \ m^2$$

$$= 0.023 * 10000$$

$$= 232 \ cm^2$$

$1 m = 100 cm$

$1 m^2 = 100 cm^2$

$= 100*100 \ cm^2$

$= 10000 \ cm^2$

$\therefore$ Dia of inlet pipe $= \sqrt{\frac{4*232}{\pi}}$ $\left[\because \sqrt{\frac{4A}{\pi}} \text{ area}\right]$

$= 17.2 \text{ cm.}$ (say 18 cm) Ans

Dia of outlet pipe may be taken as 1.5 times that of the inlet;

$= 1.5 * 18$

$= 27 \text{ cm}$ Ans

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(Pg No 459 Sk Gary)

(2) Stabilisation ponds for a town of 3000 population (స్థిరత్వము) are provided to operate in series. The larger cell has an area of 60,000 m^2, and the smaller one 30,000 m^2. The average daily waste flow is 900 m^3/day containing 200 kg of BOD (222 mg/l)

(i) for series operation, calculate the BOD loadings based on both the total pond area and the larger cell only.

(ii) Estimate the number of days of winter storage available between 0.6 m and 1.5 m water levels, assuming an evaporation and seepage loss of 2.5 mm. of water per day

Sol:-

(i) (a) BOD loading based on total pond area

Total pond area of both cells joined in series

$= 60,000\ m^2 + 30,000\ m^2$

$= 90,000\ m^2$

$= 9$ hectares

1 hectare $= 10,000\ m^2$

Total BOD per day = 200 kg/day

we know BOD loading in kg/ha/day $= \frac{200}{9}$ kg/day/ha (hectare 2a)

$= 22.2$ kg/ha/day

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(9)(b) BOD loading based on area of largest cell only

Area of largest cell = 60,000 m^2

1 hectare = 10,000 m^2

$= \frac{60,000}{10,000}$ ha

= 6 ha

Total BOD per day = 200 kg/day

BOD loading in kg/ha/day $= \frac{200}{6}$ kg/day/ha

$= 33.3$ kg/ha/day.

(9P) To calculate the number of days of storage between water levels (WL) 0.6 m and 1.5 m, we have

Depth available for storage = 1.5 − 0.6

= 0.9 m.

Total area = 90,000 m^2

∴ Volume of storage available = 90,000 m^2 * 0.9 m

= 81,000 m^3

Daily inflow of sewage = 900 m^3/day ✓ (given in problem)

$Q = A * V$

$= 81000$

The sewage volume which percolates and evaporates daily = 2.5 mm depth (given in problem)

[∵ m^3 (or) cubic metre (or) c.m. both are same]

$= \frac{2.5}{1000}$ m * surface Area of tanks

$= \frac{2.5}{1000}$ m * 90,000 m^2

$= 225\ m^3$ ✓

1 m = 100 cm

1 m = 1000 mm

$\frac{1}{1000}$ m = 1 mm

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∴ Net effective daily inflow of sewage

$= (900^{m^3/day} - 225^{m^3})\ m^3$

$= 675\ m^3/day$

∴ winter storage available as days

$= \dfrac{\text{volume of storage in } m^3}{\text{Daily net sewage inflow in } m^3/day}$

$= \dfrac{81{,}000\ m^3}{675\ m^3/day}$

$= 120$ days

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Pg No 463 Skgarg & Pg No 527 Sm Birdie & Birdie

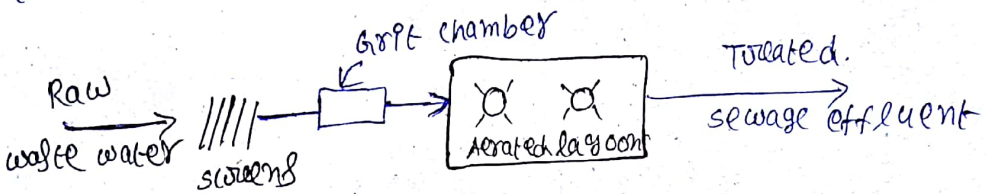
(4.7) Aerated lagoons :-

→ Aerated lagoon is an earthen basin, about 2m to 5.0 m deep

→ In which sewage is filled and aerated by means of diffused air (or) mechanical aeration commonly mechanical aerators are used.

→ To provide oxygen for the biological treatment of sewage to stabilize the organic matter.

→ The sewage was sent to primary treatment through screens after enter into Grit chamber while performing a biological treatment after completion of biological treatment will enter into the ~~Aerated~~ Aerated lagoon.



→ These aerated lagoons are frequently used for treating industrial waste waters as well as city sewage.

Aerated lagoons are of two types

(1) Facultative Aerated lagoons

(2) Aerobic lagoons

(1) ~~Facultative aerated la~~

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(1) Facultative Aerated lagoons:

→ some solids settled down on the lagoon and, some solids are may leave floating with the effluent &

→ The lower part of such lagoons is anaerobic and upper layer are aerobic which are called as "facultative aerated lagoons"

⇒ In India aerated lagoons have been used in, mumbai city at "Ghatkopar" sewage treatment plant of 690 MLD capacity.

The characteristics of Aerated lagoons are

Depth of lagoon → 2 to 5 m.

period of detention → 2 to 5 days

BOD removal efficiency → 90%.

Nitrification → Absent

sludge accumulation → 0.04 cum/person/year

sludge removal → once in 5 years.

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(4.8) Trickling Filters :- [Attached Growth Process] :-

Pg No 339
SK Garg

Trickling filters works on the principle of "attached growth process" (or) "attached culture system"

→ The trickling filters are known as high rate trickling filters and most of the cases used in secondary treatment of sewage

→ These filters are also called as percolating filters (or) sprinkling filters.

→ It consist of a tanks. This tanks consist of highly permeable coarser filtering media

→ The sewage (waste water) is sprinkle (or) trickle on by (కింద నుంచి లోపలకు ఇంజెక్ట్ చేయడం) coarser filtering media by using spray nozzles (or) rotary distributors.

→ The percolating sewage is collected at the bottom of the tank through a well designed under-drainage system.

→ The filter media made up of with usually broken bricks (or) broken stones of size 25-100 mm are randomly packed inside the trickling filters.

→ The sewage water mainly having aerobic bacteria, micro organisms This sewage passing onto the filter media result forming a. biofilms (పొరలాగా ఏర్పడటం) on the surface of the ~~media~~ filter media

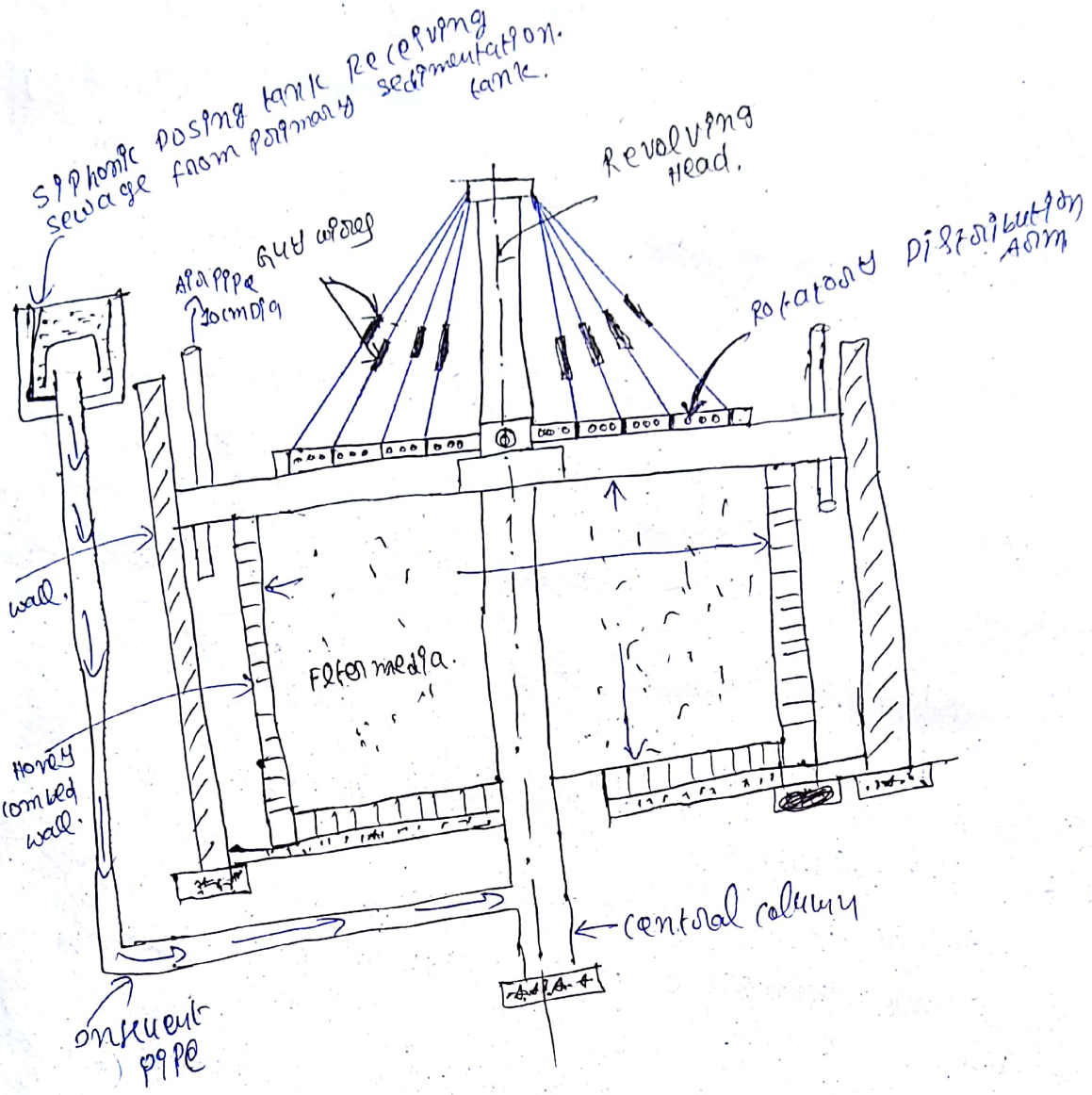
→ ~~The organic matter get oxidised. while removal of biofilms~~

→ so passage of large particle ~~are~~ into the filter media is ~~by~~ key

→ sufficient quantity of oxygen is supplied by providing the suitable ventilation facilities in the body of filters.

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To ensure the large scale growth of (ఎక్కువస్థాయిలో)
the aerobic bacteria.



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(4.9) Mechanism of Impurities Removal:-

Pg No 339 Sk Garg.

→ Trickling filters tanks are generally constructed above the ground

→ These tanks are either rectangular (or) circular in shape in generally most of the cases used in circulars

→ The Rectangular filters are provided with a network of pipes having fixed nozzles, which spray the incoming sewage into the air, which then fall over the filter bed under gravity.

→ the circular filters are provided with "Rotary distributors" having a number of distributing arms (generally four arms are used)

→ the rotary distributors rotate around a central support either by an electric motor (or) more generally by the force of reaction on the sprays.

→ self propelled reaction type of distributors are now-a-days preferred and used.

→ the rate of revolutions vary from 2 RPM for small distributors to less than ½ RPM for large distributors

→ There is an important difference between the action of rotary distributors and that of spray nozzles. In rotary distributors the application of sewage to the filters continuously but in spray nozzles the application of sewage to the filters 3 to 5 minutes and then rested for 5 to 10 minutes for next applying of sewage

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→ The size of materials in filter media may vary from 25 to 75mm.

→ The quality of stone is used in filter media should not effected by acidic sewage.

~~→ its quality.~~

→ The depth of the filtering media may vary from 2 to 3m The filtering material may placed in layers. The coarsest (coarse) stone used near the bottom, and finest material towards the top.

→ The walls of the filter tank are made by honey-combed (or) otherwise provided with openings for circulation of air

→ some times constructing the supporting walls, when the filtering materials all above the ground result better circulation of air from the surrounding atmosphere

(pg no 335 sickarg)

Operation:-

→ The passage of sewage into the filter bed completely and stand to a depth of about 5 to 10cm above the air top surface.

→ The outlet valve is kept closed. The filling takes 1 hour

→ The sewage water is stand over the bed about 2 hours so result the colloidal matter present in sewage will be transferred to voids during this period.

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→ The outlet valve is then opened and the sewage is removed slowly

The colloidal matter trapped in the voids of the filter media does not get washed out with the down-moving sewage

→ After the total passage of waste water through the beds the colloidal matter is struct into the voids of the filter media After that the filter bed is kept empty at rest for a period of 4 to 6 hours

→ During this period the organic matter trapped in the voids get oxidised by aerobic bacteria in the presence of free oxygen.

→ this completes one full cycle of operation, which takes about 8 to 12 hours

→ The stabilised organic matter from the voids is finally washed down on next cycle

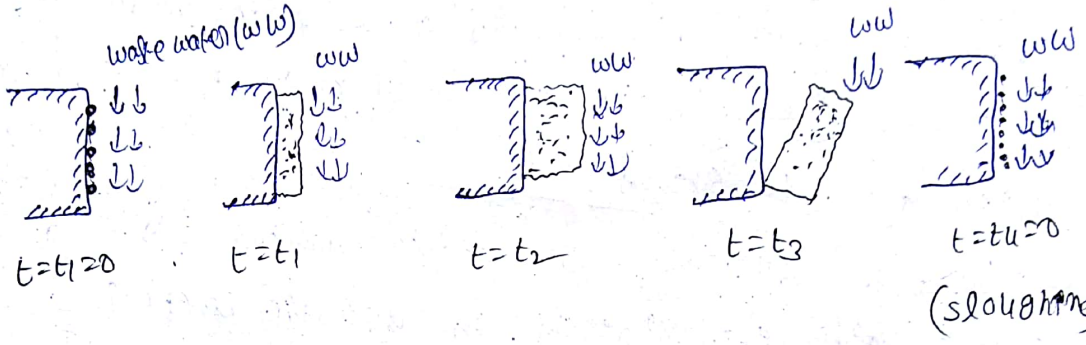
→ since the inflow of sewage is continuously while the beds are to be operated intermittently, several units will have to be constructed, so that the sewage can be applied in turn to the different units

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→ The waste water passes through the pore spaces which forms a layer on the media.

→ ~~when the water forms~~ as a layer o

→ water is continuously flows through the layer. the layer becomes thicker and fall down by increasing its self weight. This mechanism is called "sloughing"



sloughing :-

~~Detach~~ Detachment of attached bio-films from inert surface is known as sloughing.

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Pg No 343 SK Gupta

(4.10) Classification of Trickling filters:-

The trickling filters can be broadly classified into 2 types

~~1) Conventional filters (or) ordinary~~

1) Standard Rate trickling filters (or) conventional trickling filters (or) ordinary trickling filters (or) low rate trickling filters

2) High rate trickling filters (or) high rate filters

→ The high rate trickling filters of modern advancements

→ The difference of both trickling filters is on the high rate trickling filters made up of low recirculation of sewage through the filters by pumping the filter effluent to the primary settling tank and repassing through it and the filter.

~~The~~

→ The high rate ~~filter~~ trickling filters make it possible to pass ~~of~~ sewage at greater loadings and also.

This filter media requiring the less space.

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→ Based on the value of "F" (Recirculation factor), the Trickling filters are classified into

(1) Standard Rate Trickling filters

[R=0 ; $\frac{R}{I}$ = 0 ; F=1]



[∵ T.F = Trickling filter
S.C = secondary clarifier]

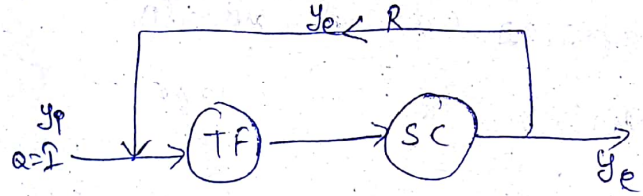
where
F = Recirculation factor.
$\frac{R}{I}$ = Recirculation ratio

$\frac{R}{I}$ = Effluent recycled / Influent recycled.

Q = waste water flow rate (MLD)

(2) High rate trickling filters

[R > 0 ; $\frac{R}{I}$ > 0 ; F > 1]



where

y_i = influent BOD
y_e = effluent BOD

$$\eta = \frac{100}{1 + 0.0044\sqrt{\frac{Qy_i}{VF}}}$$

(↓) $\eta \propto Qy_i$ (↓)

(↓) $\eta \propto \frac{1}{F}$ (↑)

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(4.11) Design of Trickling Filters:-

Trickling filters are designed by ~~the~~ based on Empirical equations proposed by NRC (USA)

NRT - National Research centre

Efficiency of Trickling filters:-

$$\eta = \frac{y_p - y_e}{y_p} * 100$$

$$\eta(\%) = \frac{100}{1 + 0.0044\sqrt{\frac{Qy_p}{VF}}}$$

where

η = Efficiency of the filter and its secondary clarifiers, interms of percentage (%) of applied BOD removed.

Q = waste water flow rate (MLD)

y_p = Influent BOD (mg/l)

y_e = Effluent BOD (mg/l)

V = volume of Trickling filter in ha.m

$$1 \text{ ha.m} = 10^4 m^3$$

$$1 m^3 = \frac{1}{10^4} \text{ ha.m}$$

TF - Trickling filters

Range → 80 - 90 %

$\frac{Qy_p}{V}$ = organic loading rate (or) BOD loading rate (OLR)

(kg of BOD/day/ha.m)

Range = 900 to 2200 kg/ha-m/day

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F = Recirculation Factor.

$$F = \frac{1 + \frac{R}{I}}{\left(1 + 0.1\,\frac{R}{I}\right)^2}$$

$\frac{R}{I}$ = Recirculation ratio

$$\frac{R}{I} = \frac{\text{Effluent Recycled}}{\text{Influent applied}}$$

~~⇒ Dia of the filter~~

⇒ It is desirable to keep the dia of the filter tank (circular) upto a maximum of 60m.

If the required filter media dia is more than 60m, then it is better to use more units of lesser dia.

⇒ The filter media dia and depth is designed for average value of sewage flow.

⇒ The quantity of sewage applied per unit of surface area of the filter per day. This is called "hydraulic-loading rate" and expressed in million litres per hectare per day.

The value of hydraulic loading for conventional filters may vary between 22 to 44 (normally 28) million litres per hectare per day (as against the value of 1.1 mL/ha/day for intermittent sand filters)

⇒ The hydraulic loading can still be increased to about 110 to 330 (normally 220) mL/ha/day in the high rate trickling filters.

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Problems

(1) The BOD of a sewage entering into a trickling filter is 200 mg/litre. If the effluent of the sewage of trickling filter is 40 mg/litre then calculate the efficiency of the trickling filter?

Sol: Efficiency $\eta = \frac{y_i - y_e}{y_i} \times 100$

y_i = Influent BOD
(or)
BOD of sewage entering into the trickling filter

$= 200$ mg/lt

y_e = Effluent BOD

$= 40$ mg/lt

Efficiency $\eta = \frac{200 \text{ mg/lt} - 40 \text{ mg/lt}}{200 \text{ mg/lt}} \times 100$

$= \frac{160}{200} \times 100$

$\eta = 80\%$

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2) A trickling filter is designed with a unit organic loading rate of 0.175 kg/m³/day. Calculate the effluent BOD. If the Influent BOD of the sewage is 150 mg/lt

Sol:-

Given data

organic loading rate = 0.175 kg/m³/day.

Influent BOD (y_i) = 150 mg/lt

Effluent BOD (y_e) = ?

Efficiency $\eta = \frac{y_i - y_e}{y_i} * 100$.

$\eta = \frac{100}{1 + 0.00444\sqrt{\frac{Qy_i}{VF}}}$ formula ②.

Efficiency $\eta = \frac{y_i - y_e}{y_i} * 100 = \frac{100}{1 + 0.00444\sqrt{\frac{Qy_i}{VF}}}$

organic loading rate $\left(\frac{Qy_i}{V}\right)$ = 0.175 kg/m³/day.

Note:- volume "V" in hectare metre

1 ha.m = 10^4 m³

$\frac{1}{10^4}$ ha-m = 1 m³

$\frac{Qy_i}{V}$ = 0.175 kg/$\frac{1}{10^4}$ ha-m/day

= $0.175 * 10^4$ kg/ha-m/day.

Note:- F = 1 standard Rate Trickling filter

F > 1 High Rate Trickling filter

* Here, in the problem not given Recirculation factor, so we have to design for standard rate trickling filter where F = 1

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$$\frac{y_1 - y_e}{y_1} \times 100 = \frac{100}{1 + 0.00444\sqrt{\frac{0.y_1}{VF}}}$$

$$\frac{150 - y_e}{150} \times 100 = \frac{100}{1 + 0.00444\sqrt{\frac{0.175 \times 10^4}{1}}}$$

$\left[\because \frac{0.y_1}{V} = 0.175 \times 10^4\right]$ ← organic loading rate

$$= \frac{100}{1 + 0.00444\sqrt{0.175 \times 10^4}}$$

$=$

$$y_e = 23.32 \text{ mg/lt}$$

(3) From the primary settling tank sewage flows to a standard trickling filter at a rate of 6 MLD having a 5day BOD of 150 mg/lt. Calculate.

(1) The depth and the volume of the filter adopting a surface loading rate of 2500 lt/m²/day and a organic loading rate of 175 gm/m³/day?

(2) The efficiency of the filter unit using.
NRC equation.?
↓
National Research centre

(3) The BOD of Effluent?

Sol

Influent BOD (y_1) = 150 mg/lt

[∵ 1 million = 10^6]

Discharge = 6 million litres per day

$= 6 * 10^6$ litres/day.

surface loading rate = 2500 litres/m²/day

organic loading rate = 175 gm/m³/day.

F = 1 [∵ standard rate trickling filter is given in problem]

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To find.

depth (H) = ?

volume (V) = ?

surface loading Rate (SLR) = $\frac{Q}{\text{surface area (S.A)}}$

surface area = $\frac{Q}{SLR}$

= $\frac{6 * 10^6 \text{ lit/day}}{2500 \text{ lit/m}^2\text{/day}}$

surface area (S.A) = 2400 m^2

organic loading Rate = 175 gm/m^3/day

organic loading Rate $\left(\frac{Q y_0}{V}\right)$ = 175 gm/m^3/day.

volume (V) = $\frac{Q y_0}{175 \text{ g m/m}^3\text{/day}}$

= $\frac{(6 * 10^6) * 150 \text{ mg/lit}}{175 * 10^{-3} \text{ kg/m}^3\text{/day}}$

[∵ 1 kg = 1000 gm, $\frac{1}{1000}$ kg = 1 gm, 10^{-3} kg = 1 gm]

[∵ 1 MLD * 1 mg/lit = kg/day]

= $\frac{6 \text{ MLD} * 150 \text{ mg/lit}}{175 * 10^{-3} \text{ kg/m}^3\text{/day}}$

= $\frac{6 * 150 \text{ kg/day}}{175 * 10^{-3} \text{ kg/m}^3\text{/day}}$

(V) = 5142.85 m^3

Now to find depth = $\frac{\text{volume}}{\text{surface area}}$

= $\frac{5142.85 \text{ m}^3}{2400 \text{ m}^2}$

= 2.142 m

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(2) Efficiency $(\eta) = \frac{y_p - y_e}{y_p} \times 100 = \frac{100}{1 + 0.0044\sqrt{\frac{Qy_p}{VF}}}$

$= \frac{150 - y_e}{150} \times 100 = \frac{100}{1 + 0.0044\sqrt{\frac{Q \times y_p}{V \times F}}}$

we know that

organic loading rate $\left(\frac{Q \times y_p}{V}\right) = 175\ gm/m^3/day$

$= 175 \times 10^{-3}\ kg/m^3/day$

$= 175 \times 10^{-3}\ kg/\frac{1}{10^4}$ hectare metre/day

$= 175 \times 10^{-3} \times 10^4\ kg/ha\text{-}m/day$

$\left(\frac{Q \times y_p}{V}\right) = 1750\ kg/ha\text{-}m/day$

$\eta = \frac{150 - y_e}{150} \times 100 = \frac{100}{1 + 0.0044\sqrt{\frac{1750}{1}}}$ [$\because F = 1$]

↑ standard rate trickling filter

$y_e = 23.31\ mg/lt$

$\therefore$ Efficiency $(\eta) = \frac{y_p - y_e}{y_p} \times 100$

$= \frac{150 - 23.31}{150} \times 100$

$\eta = 84.45\%$

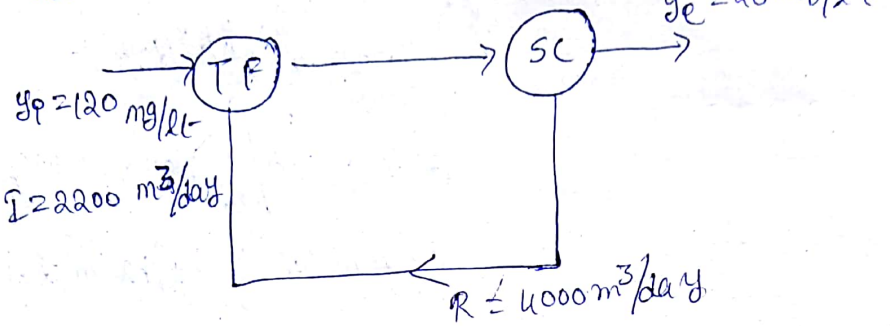
(3) The effluent BOD $(y_e) = 23.31\ mg/lt$

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(4) Calculate the volume of the single stage trickling filtre required to yield an effluent of BOD 5 of 20 mg/litre when treating settled domestic sewage with BOD 5 of 120 mg/litre the sewage flow is 2200 m^3/day. and Recirculation constant at 4000 m^3/day ? Calculate the volume ?

Sol:



Given data

single stage trickling filtre

y_o = 120 mg/litre

y_e = 20 mg/litre

Influent applied I = 2200 m^3/day

Recirculation constant R = 4000 m^3/day

Efficiency $\eta = \frac{y_o - y_e}{y_o} * 100 = \frac{100}{1 + 0.0044\sqrt{\frac{Q * y_o}{V * F}}}$

$$F = \frac{1 + R/I}{\left(1 + 0.1\frac{R}{I}\right)^2}$$

$$= \frac{1 + \frac{4000}{2200}}{\left[1 + 0.1 * \left(\frac{4000}{2200}\right)\right]^2}$$

$$F = 2.017$$

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We know that

$$\frac{y_p - y_e}{y_p} * 100 = \frac{100}{1 + 0.00444 \sqrt{\frac{Q * y_p}{V * F}}}$$

$$\frac{120 - 20}{120} * 100 = \frac{100}{1 + 0.00444 \sqrt{\frac{2.2 * 120}{V * 2.017}}}$$

Note:

I (or) Q = 2200 m^3/day

= $2200 * 10^3$ litre/day

= $2200 * 10^3 * 10^{-6}$ MLD/day

= 2.2 MLD/day

i.e. $1 m^3 = 1000$ litre/day

$= 10^3$ litre/day

1 million litre/day $= 10^6$ litre/day

$\frac{1}{10^6}$ MLD = 1 litre per day

10^{-6} MLD = 1 litre

$$1 + 0.00444 \sqrt{\frac{2.2 * 120}{V * 2.017}} = \frac{100}{\frac{120 - 20}{120} * 100}$$

$$1 + 0.00444 \left(\frac{11.44}{\sqrt{V}}\right) = 1.2$$

$$V = 0.0633 \text{ ha-m}$$

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PGNO 347 SEWAGE

(5) Design suitable dimensions of a circular trickling filter units for treating 5 million litres of sewage per day. The BOD of sewage is 150 mg/l

(32)

Sol:-

Total BOD present in sewage to be treated per day

$= 5\ MLD * 150\ mg/lt$

$\Rightarrow$ million litres/day * mg/lt

$\Rightarrow$ 1 million $= 10^6$

$\Rightarrow 10^6$ mg/day

$= 750$ kg

1 kg = 1000 gm

1 gm = 1000 mg

1 kg = 1000000 mg

1 kg = 10^6 mg

$\frac{1}{10^6}$ kg = 1 mg

10^{-6} kg = 1 mg

$10^6 * 10^{-6}$ kg/day

= kg/day

So

MLD * mg/lt = kg

Assuming the value of organic loading as 1500 kg/hectare-metre/day

[i.e between 900 to 2200 kg/ha-m/day.] [$\because \frac{Q*y_0}{V} = 1500$]

we have

Volume of the filter media required.

$= \frac{750}{}$

[$\because \frac{Q*y_0}{V} = 1500$

$\frac{Q*y_0}{1500} = V$

$V = \frac{5*150}{1500}$

$V = \frac{750}{1500}$]

$V = \frac{750\ kg}{1500\ kg/ha\text{-}m/day}$

$= 0.5$ ha-m.

$= 0.5 * 10{,}000\ m^3$

$= 5000\ m^3$

[$\because$ 1 hectare = 10,000 m^2

1 hectare-metre = 10,000 $m^2 * m$

1 ha-m = 10,000 m^3]

Assuming the effective depth of filter, of say 2m, we have

(i) Assuming value.

The surface area of the filter required

$= \frac{5000\ m^3}{2m}$ $\leftarrow$ $\frac{\text{volume}}{\text{depth}} = \text{Area}$.

$= 2500\ m^2$

Assuming value upto 60m we can assume

Using a circular trickling filters of dia 40m, we have

The number of units required.

$= \frac{\text{Total Area required.}}{\text{Area of one unit}}$

$= \frac{2500}{\frac{\pi}{4}(40)^2}$ $\rightarrow$ [$\because \pi/4\, d^2$]

$\simeq$ 2 Nos

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check for Hydraulic loading :-

The surface Area of the filter bed required can also be worked out by assuming the value of hydraulic loading say, 25 million litres per day. [i.e between 22 to 44 mL/ha/day]

$$\therefore \text{surface Area required} = \frac{\text{Total sewage to be treated per day}}{\text{Hydraulic loading per day}}$$

$$= \frac{5}{25} \frac{\text{million litres/day}}{\text{million litres/hectare/day}}$$

$$= \frac{5}{25} \text{ hectares}$$

$$= \frac{5}{25} \times 10{,}000 \text{ m}^2$$

$$= 2000 \text{ m}^2$$

The surface Area chosen is 2500 m^2, which is greater than 2000 sq.m, and hence safe

Hence 2 units each of 40m dia and 2m effective depth (i.e 2.6 m over depth), can be adopted.

(2m b/w (2 to 3m allowed)

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(6) The sewage is flowing @ 4.5 million litres per day from primary clarifier to a standard rate trickling filter. The 5-day BOD of the influent is 160 mg/l. The value of the adopted organic loading is to be 160 gm/m³/day, and surface loading 2000 l/m²/day. Determine the volume of the filter and its depth. Also calculate the efficiency of this filter unit.

Sol:-

The 5 day BOD present in sewage

$= 160 \text{ mg/lt} * 4.5 \text{ million litres/day}$ [∵ 1 million = 10^6]

$= 160 * (4.5 * 10^6) \text{ mg/day}$

[∵ 1 kg = 1000 gm. (gram)
1 gm = 1000 mg (milligram)
$\frac{1}{1000}$ gm = 1 mg
$\frac{1}{10^3}$ gm = 1 mg]

$= \frac{160 * (4.5 * 10^6)}{10^3} \text{ gm/day}$

$= 7,20,000 \text{ gm/day}$

volume of filter media required.

$= \frac{\text{Total BOD}}{\text{organic loading}}$

$= \frac{7,20,000 \text{ gm/day}}{160 \text{ gm/m}^3\text{/day}}$

$= 4500 \text{ m}^3$

surface Area required for the filter

$= \frac{\text{Total flow}}{\text{Hydraulic loading}}$

$= \frac{4.5 \text{ million litres/day}}{2000 \text{ litres/m}^2\text{/day}}$ [∵ 1 million = 10^6]

$= \frac{4.5 * 10^6 \text{ litres/day}}{2000 \text{ litres/m}^2\text{/day}}$

$= 2250 \text{ m}^2$

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Depth of the bed required $= \frac{4500\ m^3}{2250\ m^2}$ [$\because$ Depth $= \frac{\text{volume}}{\text{Area}}$]

$= 2m$

Efficiency of the filter is given by

$$\eta = \frac{100}{1 + 0.0044\sqrt{\frac{Q*Y_P}{V*F}}}$$

since organic loading rate $\left(\frac{Q*Y_P}{V}\right) = 160\ gm/m^3/day$

[$\because$ Standard organic loading rate is kg/ha-m/day ಆಗಿರಬೇಕು]

[$\because$ 1 hectare $= 10^4 m^2$

1 hectare . metre $= 10^4 m^2 * m$

1 ha-m $= 10^4 m^3$

$\frac{1}{10^4}$ ha-m $= 1 m^3$

1 kg $= 1000$ gm.

$\frac{1}{1000}$ kg $= 1$ gm.

$$\left(\frac{Q*Y_P}{V}\right) = \frac{160 * \frac{1}{1000}\ kg}{\frac{1}{10^4}\ ha\text{-}m\ /\ day}$$

$$\left(\frac{Q*Y_P}{V}\right) = 160 * \frac{1}{1000}\ kg * 10^4\ ha\text{-}m$$

$= 160 * \frac{1}{1000} * 10^4$ kg/ha-m/day

$= 1600$ kg/ha-m/day

Here, in the problem not given re circulation factor, so we have to design for standard rate trickling filter where $F = 1$

Hence efficiency $(\eta) = \frac{100}{1 + 0.0044\sqrt{\frac{1600}{1}}}$

[$\because \eta = \frac{100}{1 + 0.0044\sqrt{\frac{Q*Y_P}{V*F}}}$]

Here $F = 1$

$= 85.03\%$

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(7) Determine the size of a high rate trickling filter for the following data

(i) sewage flow = 4.5 Mld

(ii) Recirculation ratio = 1.5

(iii) BOD of raw sewage = 250 mg/lt

(iv) BOD removal in primary tank = 30%

(v) Final effluent BOD desired = 30 mg/lt

Sol:-

Quantity of sewage flowing into the ~~sewage~~ filter per day = 4.5 million litre/day

BOD concentration in raw sewage = 250 mg/lt

Total BOD present in raw sewage

$= 4.5 \text{ million litre} * 250 \text{ milligram/litre}$

$= (4.5 * 10^6) * 250 \left(\frac{1}{10^3} gm\right)$

$= (4.5 * 10^6) * 250 \left(\frac{1}{10^3} * \frac{1}{10^3} kg\right)$

$= (4.5 * 10^6) * 250 \left(\frac{1}{10^6} kg\right)$

$= 4.5 * 250 \text{ kg}$

$= 1125 \text{ kg}$

[∵ 1 million = 10^6

1 kg = 1000 gm (grams)

1 gm = 1000 mg (milligram)

$\frac{1}{1000}$ gm = 1 mg

$\frac{1}{10^3}$ gm = mg

1 kg = 1000 gm

$\frac{1}{10^3}$ kg = gm.

BOD removed in primary tank = 30% (given in problem)

Note:- Primary tank లో 30% BOD remove అయిన తరువాత తరువాత 100% − 30% = 70% తరువాత 70% BOD వస్తుంది raw sewage లో]

BOD left in the sewage entering per day in the filter unit

$= 1125 \text{ kg} * 70\%$

$= 1125 \text{ kg} * \frac{70}{100}$

$= 1125 \text{ kg} * (0.7)$

$= 787.5 \text{ kg}$

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BOD concentration desired in final effluent

= 30 mg/lt (given in problem)

∴ Total BOD left in the effluent per day

= 4.5 million litre * 30 mg/lt

= (4.5 * 10^6) litre * (30 * $\frac{1}{10^6}$ kg/lt)

= 4.5 * 30 kg.

= 135 kg

∴ BOD removed by the filter.

= 787.5 kg − 135 kg

= 652.5 kg.

Efficiency of the filter

$$\eta = \frac{\text{BOD removed}}{\text{Total BOD}} * 100$$

$$= \frac{652.5 \text{ kg}}{787.5 \text{ kg}} * 100$$

$$\eta = 82.85\ \%$$

We know that

$$\eta = \frac{100}{1 + 0.00044\sqrt{\frac{Q * y_0}{V * F}}}$$

$$= \frac{100}{1 + 0.00044\sqrt{\frac{(1125) * 0.7}{V * F}}}$$

→ Total BOD in kg = 787.5 kg

V = ?

F = ?

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Recirculation Factor $(F) = \dfrac{1+\frac{R}{I}}{\left(1+0.1\frac{R}{I}\right)^2}$

Here $\frac{R}{I} = 1.5$ given in problem

Recirculation Ratio $\left(\frac{R}{I}\right) = 1.5$

$$\therefore F = \frac{1+1.5}{(1+0.1*1.5)^2}$$

$$= \frac{2.5}{1.3225}$$

$$= 1.89$$

$$\therefore \text{Efficiency } (\eta) = \frac{100}{1+0.0044\sqrt{\frac{Q*\eta}{V*F}}}$$

$$82.85\% = \frac{100}{1+0.0044\sqrt{\frac{1125*0.7}{V*1.89}}}$$

$$1+0.0044\sqrt{\frac{416.6}{V}} = \frac{100}{82.85}$$

$$0.0044\sqrt{\frac{416.6}{V}} = 1.2-1$$

$$\sqrt{\frac{416.6}{V}} = \frac{0.2}{0.0044}$$

$V = 0.2$ hectare $-$ m [$\because$ 1 hectare $= 10^4\ m^2$]

$= (0.2 * 10^4\ m^2) * m$

$= 2000\ m^3$

Assuming the depth of the filter as 1.5 m, we have

The surface area required $= \dfrac{2000\ m^3}{1.5\ m}$

$= 1333.3\ m^2$

Dia of the circular filters required $= \sqrt{\dfrac{4 * 1333.3}{\pi}}$ [$\because \sqrt{\frac{4a}{\pi}}$]

$= 41.2$ m.

Hence, use a high rate trickling filter with 41.2 m diameter, 1.5 m deep filter media, and with recirculation (sludge stage) ratio of 1.5 ANS

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(8) Determine the size of a high rate trickling filter for the following data

Flow = 4.5 mld

Recirculation ratio = 1.4

BOD of raw sewage = 250 mg/lt

BOD removed in primary clarifiers = 25 %

Final effluent BOD desired = 50 mg/lt

Calculate also the size of the standard rate trickling filter to accomplish the above requirement

Sol:

Total BOD present in raw sewage per day

= 4.5 million litres/day * 250 milligram/litre

$= (4.5 * 10^6) * (250 * \frac{1}{10^6}\ kg)$

$= 4.5 * 250\ kg$

$= 1125\ kg$

[∵ 1 million = 10^6
1 kg = 1000 gram.
1 gram = 1000 milligram
1 kg = (1000*1000) milligram
1 kg = 10^6 milligram
$\frac{1}{10^6}$ kg = milligram]

BOD removed in the primary clarifiers

= 25 % (given in Problem)

∴ ~~BOD left in the sewage entering per day in the filter unit~~

Note: Primary tank లలో Total 100 % BOD లో 25 % remove అవుతుంది

So 100 - 25 = 75 % BOD మాత్రం raw sewage లో మిగిలి ఉంది.

∴ BOD left in the sewage entering per day in the filter unit

= 1125 kg * 75 %

$= 1125\ kg * \frac{75}{100}$

= 1125 kg * 0.75

= 843.75 kg.

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BOD concentration desposed in the effluent

= 50 mg/lt (given in problem)

∴ Total BOD left in the effluent per day

= 4.5 million litre * 50 mg/lt

= $(4.5 * 10^6)$ litre * 50 * $\frac{1}{10^6}$ kg/lt)

= 4.5 * 50 kg.

= 225 kg

BOD removed by the filters per day.

= 843.75 kg − 225 kg

= 618.75 kg

Efficiency of the filters = $\frac{\text{BOD removed}}{\text{Total BOD entering}} * 100$

= $\frac{618.75 \text{ kg}}{843.75 \text{ kg}} * 100$

= 73.3%

Now we know that efficiency of the filters is given by the equation of

$$\eta = \frac{100}{1 + 0.0044 \sqrt{\frac{Q * y_0}{V * F}}}$$

where

$Q * y_0$ = Total BOD in kg

= 1125 * 0.75 kg

$$= \frac{100}{1 + 0.0044 \sqrt{\frac{1125 * 0.75}{V * F}}}$$

V = ?

F = ?

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Recirculation Factor (F) = $\frac{1+\frac{R}{I}}{\left(1+0.1\frac{R}{I}\right)^2}$

Here $\frac{R}{I}$ = Recirculation ratio = 1.4 given in problem

$$F = \frac{1+1.4}{(1+0.1*1.4)^2}$$

$$= \frac{2.4}{(1.14)^2}$$

$$= \frac{2.4}{1.3} \Rightarrow 1.85$$

$$\therefore \text{Efficiency } (\eta) = \frac{100}{1+0.0044\sqrt{\frac{Q*yp}{v*F}}}$$

$$73.3 = \frac{100}{1+0.0044\sqrt{\frac{1125*0.75}{v*1.85}}}$$

$$1+0.0044\sqrt{\frac{456.08}{v}} = \frac{100}{73.3}$$

$$0.0044\sqrt{\frac{456.08}{v}} = 1.36-1$$

$$\sqrt{\frac{456}{v}} = \frac{0.36}{0.0044}$$

$v = 0.0980$ hectare $-m$ [1 hectare $= 10^4 m^2$]

$= (0.0980 * 10^4 m^2) * m$

$= 980.90 m^3$

Assuming the depth of the filter as 1.5 m, we have

The surface area required $= \frac{980.90 m^3}{1.5 m}$

$= 653.9 m^2$

Dia of the filter tank required $= \sqrt{\frac{4*653.9}{\pi}}$ [$\because \sqrt{\frac{4q}{\pi}}$]

$= 28.85 m$

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(9) A single stage filter is to treat a flow of 3.79 m.l.d of raw sewage with BOD of 240 mg/lt. It is to be designed for a loading of 11086 kg of BOD in raw sewage per hectare metre, and the recirculation ratio is to be 1. What will be the strength of the effluent, according to the recommendations of the national Research council of U.S.A ?

Sol:-

Total BOD present in raw sewage

$= 3.79 \text{ million litres} * 240 \text{ milligram/litre}$

$= (3.79 * 10^6) * (240 * \frac{1}{10^6} kg)$ [$\because$ 1 million $= 10^6$]

$= 3.79 * 240 \text{ kg}$ 1 kg = 1000 grams

$= 909.6 \text{ kg}$ 1 gram = 1000 milligram

1 kg = (1000 * 1000) milligram

1 kg = 10^6 mg

$\frac{1}{10^6}$ kg = 1 mg]

Now, filter volume required,

$$= \frac{\text{Total BOD in raw sewage in kg}}{\text{Given BOD loading rate of 11,086 kg/ha-m}}$$

$$= \frac{909.6 \text{ kg}}{11086 \text{ kg/ha-m}}$$

$$= 0.082 \text{ ha-m}$$

Now, assuming that 35% of BOD is removed in Primary clarifiers we have.

note: primary tank లో Total 100% BOD లో 35% BOD remove అవుతుంది so remaining BOD is want to sewage water is

$100 - 35 = 65\%$

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∴ BOD left in the sewage entering per day in the filters unit is

$= 909.6\ kg * 65\%$

$= 909.6\ kg * \frac{65}{100}$

$= 909.6\ kg * 0.65$

$= 591.24\ kg$

$$\text{Efficiency} = \frac{100}{1 + 0.0044\sqrt{\frac{Q * y_p}{V * F}}}$$

where

$Q * y_p$ = Total BOD applied to the filters per kg

$= 909.6 * 0.65$

$= 591.24$

V = volume of the filter in ha-m

$= 0.082$ ha-m.

$F = ?$

$$\text{Recirculation factor } (F) = \frac{1 + \frac{R}{I}}{\left[1 + 0.1\frac{R}{I}\right]^2}$$

where Recirculation factor $\left(\frac{R}{I}\right) = 1$ (given in problem)

$$= \frac{1 + 1}{\left[1 + 0.1 * (1)\right]^2}$$

$$= \frac{2}{1.21}$$

$= 1.65$

Now

$$\text{Efficiency } (\eta) = \frac{100}{1 + 0.0044\sqrt{\frac{Q * y_p}{V * F}}}$$

$$= \frac{100}{1 + 0.0044\sqrt{\frac{909.6 * 0.65}{0.082 * 1.65}}}$$

$= 77.45\%$

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∴ The amount of BOD left in the effluent.

(I/P value) (η value)

$$= 591.24 \left[1 - \frac{77.45}{100}\right]$$

$$= 133.32 \text{ kg}$$

∴ BOD concentration in the effluent

$$= \frac{\text{Total BOD}}{\text{sewage volume}}$$

$$= \frac{133.32 \text{ kg}}{3.79 \text{ million litres}} \quad [\because 1 \text{ kg} = 10^6 \text{ milligrams}]$$

$$= \frac{133.32 \times 10^6 \text{ mg}}{3.79 \times 10^6 \text{ litres}} \quad [\because 1 \text{ million} = 10^6]$$

$$= \frac{133.32 \times 10^6 \text{ mg}}{3.79 \times 10^6 \text{ litres}} \quad [1 m^3 = 1000 \text{ litres} = 10^3 \text{ litres}]$$

$$= \frac{133.32 \times 10^6 \text{ mg}}{3.79 \times 10^6 \text{ litres}}$$

$$= 35.17 \text{ mg/litre}.$$

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(10) It is proposed to use a two stage plant instead of the single stage plant in the above example problem number (9). The total volume of filter medium remains the same as was in one filter (i.e) 0.082 ha-m, and each filter is to contain half of this material and the recirculation ratio is to be 1 for each filter. Determine the BOD of the plant effluent?

Sol:

For each filter $F = 1.65$ [∵ previous problem నుండి తీసుకోవాలి]

for the first stage filter, the efficiency is given by

$$\eta = \frac{100}{1 + 0.0044\sqrt{\frac{Q * y_p}{V * F}}}$$

where $Q * y_p$ = Total BOD applied on filter

= 591.24 (coming from previous problem)

V = Volume of filter = $\frac{0.082}{2}$

= 0.041 ha-m

2 filters are used.

$$\therefore \eta = \frac{100}{1 + 0.0044\sqrt{\frac{591.24}{0.041 * 1.65}}}$$

$$= \frac{100}{1.41}$$

$$= 70.92\ \%$$

∴ Percentage of BOD removed in first stage filter.

$= 70.92\ \%$

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∴ Amount of BOD left in the effluent from the filter $= 591.24 \left[1 - \frac{70.92}{100}\right]$

$= 591.24 \left[1 - 0.7092\right]$

$= 171.9 \text{ kg}$

for the second stage filters, the efficiency is given by equation

The efficiency $\eta' = \dfrac{100}{1 + \dfrac{0.0044}{1-\eta}\sqrt{\dfrac{Q' * y_0'}{V' * F'}}}$

where $Q' * y_0' = 591.24 * 0.2908$

$= 171.9 \text{ kg}$

$V' = 0.041 \text{ ha-m.}$

$F' = 1.65$

$\eta = \frac{70.92}{100} \Rightarrow 0.7092$

$\therefore \eta' = \dfrac{100}{1 + \dfrac{0.0044}{1-0.7092}\sqrt{\dfrac{171.9}{0.041 * 1.65}}}$

$= \dfrac{100}{1.762}$

$= 56.75\%$

∴ The amount of BOD left in the effluent from the plant $=$

$= 171.9 \left[\frac{100 - 56.75}{100}\right] \text{kg}$

$= 74.35 \text{ kg}$

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∴ BOD concentration in the effluent

$$= \frac{\text{Total BOD}}{\text{sewage volume}} \quad [\because 1\,kg = 10^6\,mg]$$

$$= \frac{74.35 * 10^6\ mg}{3.79 * 10^6\ \text{litres}}$$

$$= 19.61\ mg/lt$$

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(11) The design flow of sewage is 3.8 million ltrs per day, and the BOD of the raw sewage is 300 mg/lt. Design a single stage RPO trickling filter to produce an effluent having a BOD of 45 mg/lt (or) less?

(40)

Sol:-

Total BOD present in raw sewage per day

$= 3.8$ million ltrs $* 300$ mg/lt

$= (3.8 * 10^6) * 300 * \left(\frac{1}{10^6}\right)$ kg

$= 3.8 * 300$ kg

$= 1140$ kg

[$\because$ 1 million $= 10^6$
1 kg $= 10^6$ mg
$\frac{1}{10^6}$ kg $= 1$ mg]

Assuming that 35% of this BOD is removed in primary sedimentation tank, we have.

Note:- Total BOD of 35% in primary sedimentation tank or clean Bay's is so 100 − 35 = 65%. So 65% of BOD present in BOD of sewage water.

The Total daily BOD applied to the filter.

$= 1140 * 65\%$

$= 1140 * \frac{65}{100}$

$= 1140 * 0.65$ kg

$= 741$ kg

Now, the total daily BOD present in the effluent. (permissible maximum)

$= 3.8$ million ltrs $* 45$ mg/lt

$= (3.8 * 10^6) * 45 * \frac{1}{10^6}$ kg

$= 3.8 * 45$ kg

$= 171$ kg

[$\because$ 1 million $= 10^6$
1 kg $= 10^6$ mg
$\frac{1}{10^6}$ kg $= 1$ mg]

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∴ Total daily BOD to be removed by the filter

$= 741 - 171$ $[\because y_p - y_e]$

$= 570$ kg

Efficiency of the filter

$$(\eta) = \frac{(y_p - y_e)}{y_p} * 100$$

$$= \frac{570}{741} * 100$$

$$= 76.92\ \%$$

Assuming an organic loading of say 10,000 kg/ha-m/day (i.e, between 9,000 to 14,000] we have

volume of filter required

$$= \frac{\text{Total daily BOD removed}}{\text{organic loading rate}}$$

$$= \frac{570\ \text{kg}}{10{,}000\ \text{kg/ha-m/day}}\ \text{ha-m.}$$

$= 0.057$ ha-m. $[\because 1\ \text{hectare} = 10^4\ m^2]$

$= 0.057 * 10^4 (m^2 * m)$

$= 570\ m^3$

Now using the equation of

$$\eta = \frac{100}{1 + 0.0044\sqrt{\frac{Q * y_p}{V * F}}}$$

where

$Q * y_p$ = Total BOD applied to filter in kg

$= 570$ kg

V = volume of filter

$= 0.057$ ha-m.

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and η = efficiency = 76.92%.
(Assumed dil canopies)

$$\therefore \quad 76.92 = \frac{100}{1+0.0044\sqrt{\frac{570}{0.057 * F}}}$$

$$76.92 = \frac{100}{1+0.0044\sqrt{\frac{10,000}{F}}}$$

$$1+0.0044\sqrt{\frac{10,000}{F}} = \frac{100}{76.92}$$

$$0.0044\sqrt{\frac{10,000}{F}} = \frac{100}{76.92} - 1$$

$$= \frac{0.30}{0.0044}$$

$$\sqrt{\frac{10,000}{F}} = 68.19.$$

$$F = 2.15$$

But we know that

$$\text{Recirculation factor } (F) = \frac{1+\frac{R}{I}}{\left(1+0.1\frac{R}{I}\right)^2}$$

$$2.15 = \frac{1+\frac{R}{I}}{\left(1+0.1*\frac{R}{I}\right)^2}$$

$$\frac{R}{I} = 2.2.$$

Hence the recirculation ratio could be use as 2.2.

Note: The ratio can be reduced by reducing the organic loading.

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(4.12) operation and maintenance problems of trickling filters:-

operation:-

→ The sewage coming from primary settling tank that sewage pass through trickling filters

→ This filtering media have moving arms.

→ when the sewage is pass through the filter media this sewage starts percolating down waord. through the contact media

→

→ The dissolved and colloidal organic matters are precipitated and flocculated by the action of the bacteria and fourm a gelatinous layer at the surface of the contact media

→ The aerobic bacteria eat up this gelatinous layer and oxidize it and convert it to sulphate, phosphates, nitrates etc.

→ with the time the gelatinous slime become thicken and heavies, and move towards the bottom of the trickling filter and pass out with the effluent and settles in the secondary settling tank.

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The operational problems associated with Trickling filters (T.F)

The major and normally occurring problems while operating Trickling filters (TF) are two in number they are

(1) Psychoda problems (Fly nuisance)

(2) Ponding problems (odour nuisance)

→ cost of construction of trickling filters is high

→ These filters can not treat raw sewage, and primary sedimentation is must.

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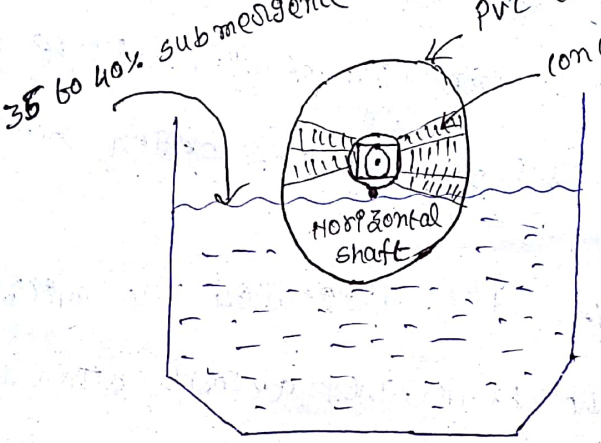
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(4.8) Rotating Biological contractors (RBC's):-

→ The Rotating Biological contractors process of secondary waste water treatment has been recently developed.

→ A rotating biological contactors (RBC's) is a cylindrical media made of closely mounted thin flat circular plastic sheets (or) discs of 3 to 3.5 m in diameter, 10mm thick ~~and placed at 30 to 40mm~~

→ These cylindrical media will be placed on seeped with a spacing of 30 to 40mm of common shaft.



→ The R.B.C's are usually made in upto 8m length and may be placed in series (or) parallel.

→ The R.B.C's are kept immersed in waste water by about 40% of their diameter

→ the R.B.C's are rotated around their central horizontal shaft, at a speed of 1-2 rpm by means of power supplied to the shaft

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→ Approximately 95% of the surface ~~Area~~ cylindrical media of surface Area is alternately immersed in the waste water and then exposed to the atomosphere above the liquid

→ when the disc rotates in the waste water, the micro organisms of the waste water will be adhere to the rotating surface of the disc (sewage) will be forming a layer of 1 to 3 mm

→ ~~This~~ when the disc rotates on that disc will be attached. of micro organisms when the micro organisms will be coming ~~bottom~~ waste water bottom to top by rotating of disc when coming of micro organisms in top surface will be absorbing of oxygen and then again going to bottom of waste ~~water~~ water by rotating of disc

→ ~~So this~~ so while the ~~layer~~ film of layer will be attaching of disc will be uses of (air) mixing of oxygen into the waste water.

→ This will result ~~The~~ ~~decomposed~~ the micro organisms pass through the tank, they absorb other organisms for break down finally. They move down of the ~~tank~~ settling tank.

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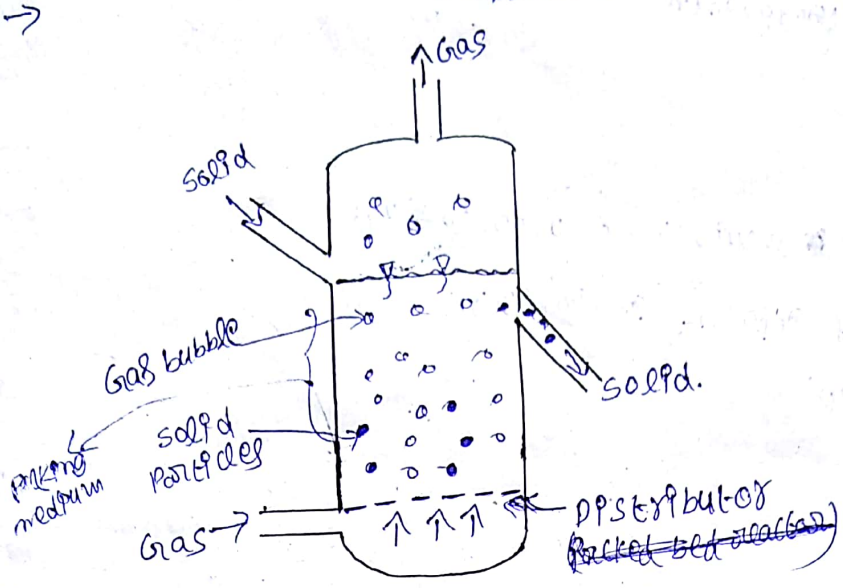
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SK Gaur 1065

(4.14) Fluidized Bed Reactors :- (FBR's)

ఈ రియాక్టరు చాలా ఉపయోగపడుతుంది
& చాలా (or) ఎక్కువగా లేదు దీనికి

→



→ The fluidized bed reactor is a similar to the packed bed reactor.. located at ~~bottom~~ top of the tank

→ This packing medium is expanded by the upward movement of the fluid (air (or) water) ~~so~~ so the air (or) water pass through the bed.

→ ~~The fluid~~ In this tank ~~solids~~ solid particles ~~are~~ having in waste water to be filled up

→ ~~A~~ Gas should be passed at bottom. This gas should be used to mixing of solids & waste water particles are throughly. & This Gas molecules are escape at top

→ ~~After~~ After the mixing of solid & water This mixing send into settling tank ~~so~~ so result ~~all~~ all particles are settling onto the settling tank.

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Advantages

→ uniform particle mixing
→ uniform temperature gradients
→ Ability to operate reactor in continuous state

Disadvantages

→ Pumping of measurements under pressure
→ Erosion of internal components
→ pressure loss

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