UNIT-III

Sewage characteristics & treatment of sewage

Sampling and Analysis of waste water:-

sewage samples are collected for the purpose of physical and chemical analysis of waste water

→ Generally we have two types of sample collection techniques

They are 1) Grab sample.

2) Composite sample.

1) Grab sample:-

→ the physical and chemical characteristics of sewage vary from top to bottom of sewage depth

(sewage లోపల physical & chemical characteristics change అవుతాయి sewage పైన)

→ so it is difficult to take a sample for testing

→ so we have take a sample beneath (below) the surface of the earth on that place the sewage particles are thoroughly mixing of

→ This sample is called Grab sample

→ This type of sample valid only certain period it means on that sample having waste water. This waste water not changing the quality

→ The test result for the grab sample represents the condition of sewage (or) waste water at that particular time & location of sample collection

→ Grab samples are most suitable for testing pH, residual chlorine and dissolved oxygen

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(2) Composite sample:-

The name itself says (composite also) 3 materials are mixing

→ In many cases the Grab samples are taken below the earth surface in one position in many incidences the Grab sample quality changes from hour to hour so the test result will not give the exact values so while reducing of this cause

→ Composite samples are taken Composite samples are obtained by mixing of individual grab samples taken at regular intervals

→ It means composite sample are mixture of smaller samples taken from every hour from morning to evening, timing

The general requirements for sampling are

→ The sample must be truly representative of the existing conditions

→ At that place the character of sewage is continuously changing with respect the depth of sewage flow as well as with time.

→ The time between collection and analysis of the sample should be as short as possible.

→ The appropriate preservation techniques should be applied inorder to slow down the biological (or) chemical changes in between sample collection and its analysis

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Analysis of sewage :-

Analysis of sewage is necessary why because which type of treatment is should be select to treat the sewage. before disposal of land.

→ The waste water contains 99.9% liquid and 0.1% of solids. A small position of solids present in waste water undergo. change change its properties this is known as "Decomposition"

Decomposition (or) degradation = oxidation + Reduction.

where oxidation = Aerobic decomposition (decomposition in the presence of air)

Reduction (or) putrification } = Anaerobic decomposition (decomposition in the absence of air)

→ decomposition it creates nuisense to man and his surroundings.

→ To know the nuisense potential of the waste we have performed various kinds of tests

The followings examinations are conducted on sewage

1) Physical examination
2) Chemical "
3) Biological (or) Bacteriological examination

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(3.2) Physical, chemical and Biological examination:-

(1) Physical Examination of sewage:-

Physical Examination of sewage is to be conducted to know the state and condition of sewage

1) colour
2) odour
3) Turbidity and
4) Temperature.

1) colour:-

Fresh domestic sewage has a soap solution occur

→ The sewage colour changes its black it is indicated decomposition starts

→ The colour of the septic sewage is more (or) less black

Fresh sewage ⟶ yellow to light brown

state & septic sewage ⟶ Dark brown to Black

2) odour:- (వాసన)

Fresh domestic sewage has slightly soapy (or) oily odour

→ In the normal temperature when sewage passes through the sewers, the offensive smell will start after 2 hours

Fresh sewage ⟶ musty smell.

state & septic sewage ⟶ ~~High turbi~~ foul smell.
(కుళ్ళు వాసన)

3) Turbidity (మబ్బుదనం)

The turbidity of the sewage directly depends on the quantity of solid matter present ~~in~~ in the suspension state (తేలియాడుతూ)

Fresh sewage ⟶ low turbidity.

state & septic sewage ⟶ High turbidity
(కుళ్ళు వాసన)

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iv) Temperature :-

Generally the temperature of the sewage is slightly higher than the water temperature.

→ When the sewage flows in closed conduits its temperature further rises resulting increase of viscosity and bacterial activity

→ the temperature of the sewage varies with the season also

Fresh sewage ⟶ Temperature ≅ 30°C

stale & septic sewage ⟶ Temperature > 30°C

(2) Chemical Examination of sewage :-

The chemical examination of mainly involves in

1) organic content
2) Inorganic content and
3) Dissolved gases

1) organic content :-

The organic content present in the sewage if the combination of proteins, carbohydrates, oils, fats etc.

→ There are no straight testing procedure to find the organic content present in the waste.

> Amount of oxygen consumed ∝ Amount of organic content

Therefore by finding the oxygen demand, of the waste waters organic content of the waste is determined

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The following oxygen demand tests are performed to find organic content of the waste is determined

1) Bio-chemical oxygen demand (BOD)
2) Chemical oxygen Demand (COD)
3) Total oxygen Demand (TOD) and
4) Theoretical oxygen Demand (Th.O.D)
5) Solids - total, volatile, suspended, organic and inorganic
6) Stability and Relative stability
7) Chlorides and sulphates
8) Chlorine demand
9) Nitrogen
10) PH-value
11) Grease, oil and Fats. (:: waste white paper heap)

This white paper waste on 2nd cabin of South Paper Plaza

2) In organic content:-

→ The waste in sewage which do not reacts with any kind of substance (i.e) synthetic is called inorganic content. (odorless)

→ There will be no harm with inorganic waste but the in organic waste is presence in sewage it is objections to the flow.

→ so it should be removed from the sewage.

3) Dissolved gases:-

The sewage waste is decomposed several types of gases are released in the sewer line, which will effect the people who work over there

→ To avoid those circumstances we should eliminate about 6 dissolved gases.

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10) pH - value

11) Grease, oil and Fats. (∵ waste white paper heap)

(3) Biological (or) Bacteriological examination:-

Sewage containing large quantity of bacteria

All the bacterias present in sewage are not harmful.

more quantity of harmless bacterias, which help to treat the sewage and reduce the cost of treatment plants

→ only pathogenic bacteria this bacteria will cause the persons having in sick the diseases are cholera, Ty Phoid, etc are harmful to human health

→ The biological tests is conducted on sewage. to determine the types of bacteria. present in the sewage

→ The biological tests are done with microscope

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3.3 Measurement of BOD :-

→ sewage contains 0.8% of oxygen which is necessary for the survival of various types of organisms

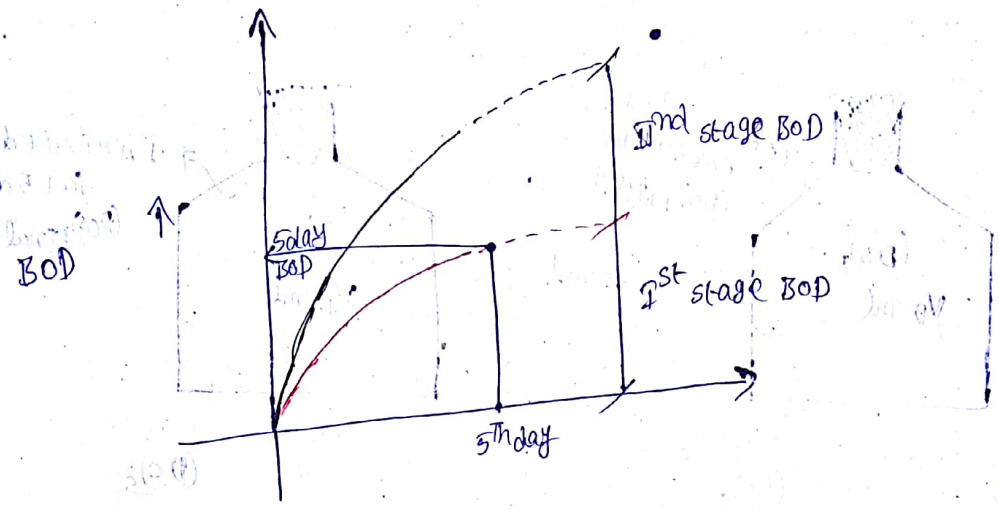
(sewage లో 0.8% ఆక్సిజన్ ఉండాలి sewage లో bacteria organisms బ్రతకడానికి ఆక్సిజన్ కావాలి)

→ The amount of oxygen is used to decompose bio-degradable organic matter present in waste water under aerobic conditions

→ The BOD is measure the strength of waste water

Nuisense Potential $\propto$ BOD and

BOD $\propto$ Bio-degradable organic matter



- In Ist stage of BOD → carbonaceous matter gets oxidised (i.e) upto 30%
- In IInd stage of BOD → Nitrogeneous matter gets oxidised

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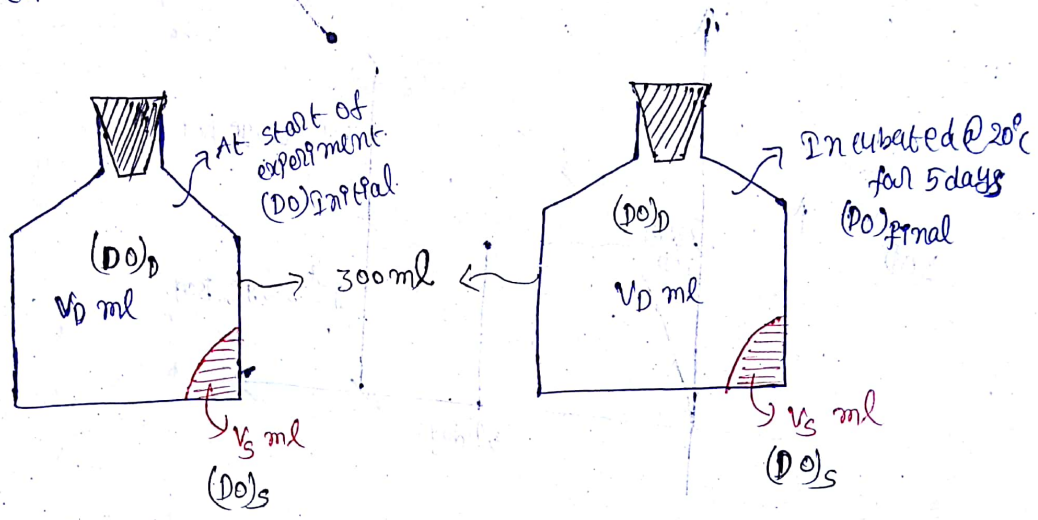
- To measure complete oxygen demand it will take very long time because Reaction is Asymptotic.

  Therefore 5 days oxygen demand is estimated because with in 5 days 60-70% of organic content is oxidised. which is taken as standard universal Reference.

- BOD test is conducted at 20°C at 5 days temperature 20° just suppose growth of organisms can easily

  At high temperature growth is maximum and meeting oxygen demand is difficult

→ The procedure for testing BOD at 20°C for 5 days is explained below.



→ Take a BOD bottle of volume 300ml which is filled with distilled water of volume "V_D" dissolved oxygen $(DO)_D$ and is mixed with sewage sample of volume "V_S" of dissolved oxygen $(DO)_S$

→ Now we will find Dissolved oxygen at the starting of the experiment as

$$(DO)_{Initial} = (DO)_{mix} = \frac{[V_D * (DO)_D] + [V_S + (DO)_S]}{V_D + V_S}$$

and

V_D → volume of Distilled water

V_S → volume of sewage sample

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same procedure to find $(DO)_{final}$

→ But we estimate BOD for 5 days at 20°C.

5 days BOD @ 20°C,

$$y_5^{20^\circ C} = \left[(DO)_{Initial} - (DO)_{final}\right] * \text{Dilution factor (D.F)}$$

$$\text{Dilution Factor (D.F)} = \frac{300}{\text{volume of sewage sample } (V_s)} = \frac{100}{\text{percentage sample/Dilution}}$$

(∵ BOD bottle volume 300 ml)

5 day BOD @ 20°C, $y_5^{20^\circ C} = \left[(DO)_I - (DO)_F\right] * D.F$

Dilution Factor D.F $= \frac{300}{V_s} = \frac{100}{\text{Percentage sample/dilution}}$

V_s → volume of sewage sample.

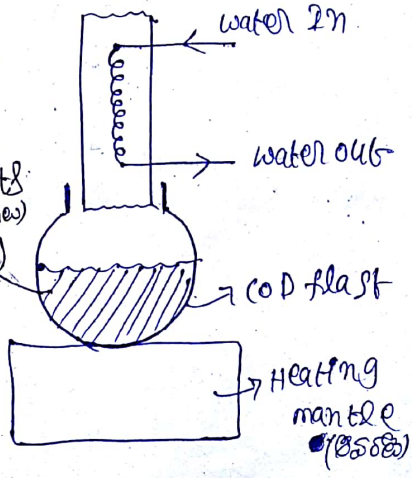
→ In this experiment, dissolved oxygen in distilled water is equal to dissolved oxygen in bio-degradable matter (i.e)

$$(DO)_D = (DO)_B$$

Measurement of COD :-

It is the amount of oxygen demanded to decompose bio-degradable and non-biodegradable organic matter present in waste water using a strong chemical oxidant such as "potassium dichromate"

→ COD test is conducted by "Reflex Apparatus" (or) "COD Digester"



Reagents (రసాయనాలు)

1. Potassium dichromate → oxidant
2. mercuric sulphate → Inhibitor (నిరోధకం)
3. Silver sulphate → Catalyst (ఉత్ప్రేరకం)
4. concentrated H_2SO_4 → To maintain acidic (ఆమ్ల) medium.

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→ After 2hrs of boiling, sample is titrated to find left over (unused) dichromate.

* Titrant: Ferrous Ammonium sulphate (FAS)

Indicator: ferroin.

Colour: Green to Brick Red.

↳ By knowing the BOD and COD values the nature of the waste can be predicted.

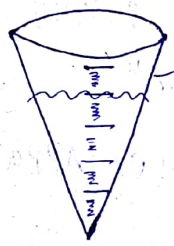
1) If $\frac{BOD}{COD} > 0.6$ → Bio-degradable waste

2) If $\frac{BOD}{COD} < 0.6$ → Non-Bio degradable waste

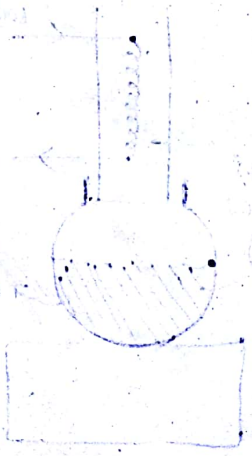
3) If BOD = 0 ; COD > 0 → toxic waste (i.e) $\frac{BOD}{COD} = 0$

4) If BOD = 0 ; COD = 0 → Non organic matter present in waste water (free from organic matter)

↳ settleable solids present in water is measured by "Imhoff cone"



→ Imhoff cone



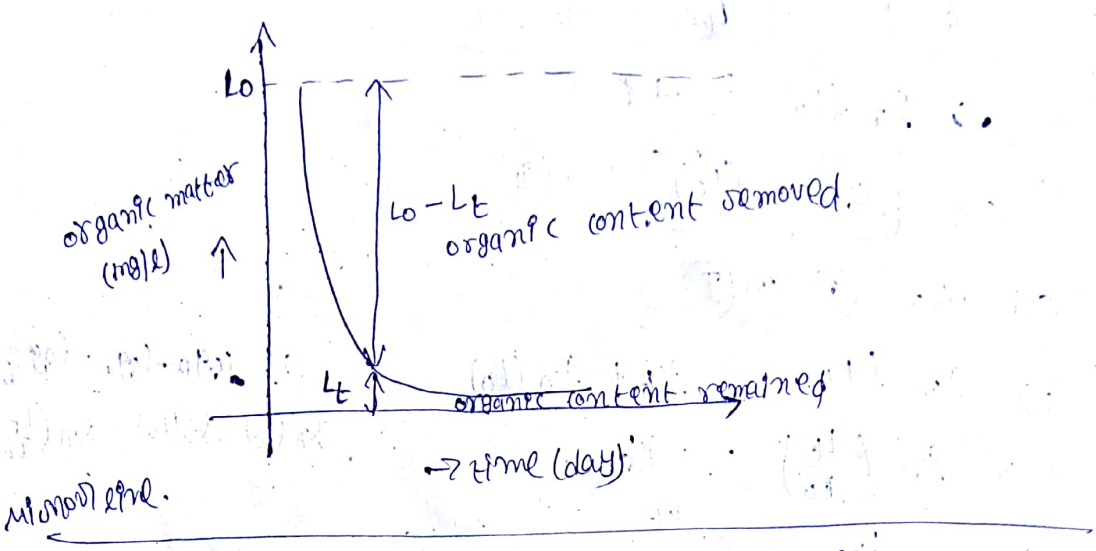
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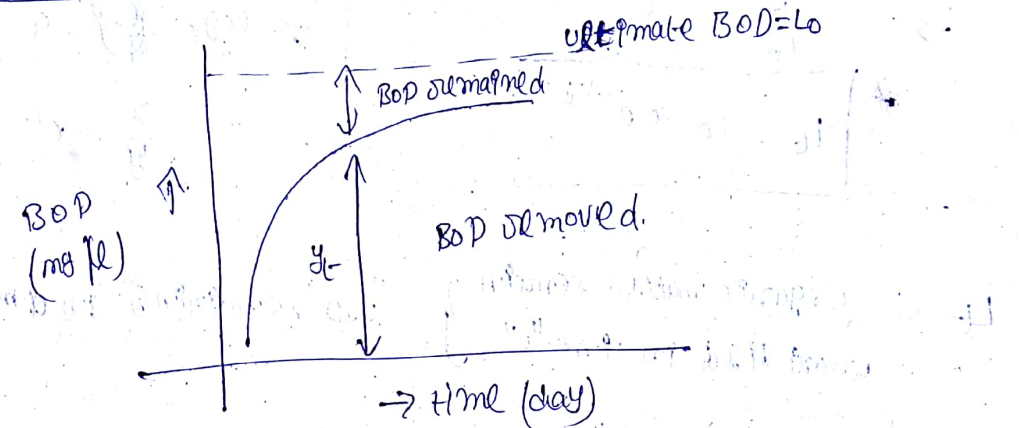
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(3.4) BOD Equations:-

BOD equations are generally called as, mathematical expressions of BOD.

↳ Let "L_o" be the initial amount of organic matter present





→ From the above two graphs, "organic matter (mg/l)" vs "time (days)" and "BOD (mg/l)" vs "time (days)" curves are mirror images

↳ From the graph the change in presence of organic matter with respect to time is directly proportional to organic content remained.

$$\text{(i.e)} \quad \frac{dL}{dt} \propto L_t$$

$$\Rightarrow \frac{dL}{dt} = -k \cdot L_t$$

$$\Rightarrow \int \frac{dL}{dt} = -\int k \cdot L_t$$

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$$\Rightarrow \int \frac{dL}{dt} = -\int k \cdot L_t$$

$$\Rightarrow \boxed{\ln(L_t) = -kt + C} \rightarrow (I)$$

Apply boundary conditions and find "C"

@ $t = 0$; $L_t = L_0$

$$\Rightarrow \ln(L_0) = 0 + C$$

$$\Rightarrow \boxed{C = \ln(L_0)} \Rightarrow (II).$$

Sub eq/n (II) in (I)

$$\Rightarrow \ln(L_t) = -kt + \ln(L_0) \quad \left[\because \log a - \log b = \log \frac{a}{b}\right]$$

$$\ln(L_t) - \ln(L_0) = \ln\left(\frac{L_t}{L_0}\right)$$

$$\Rightarrow \ln\left(\frac{L_t}{L_0}\right) = -kt$$

$$\Rightarrow \frac{L_t}{L_0} = e^{-kt} \quad \left[\because \log_e \frac{x}{y} = a, \ \frac{x}{y} = e^a\right]$$

$$\boxed{L_t = L_0 * e^{-kt}}$$

L_t = organic matter remain unoxidised in time "t" } = "BOD" remaining in time "t"

BOD at any time "t", $y_t = L_0 - L_t$

$$\Rightarrow y_t = L_0 - L_0 * e^{-kt}$$

$$\Rightarrow \boxed{y_t = L_0(1 - e^{-kt})}$$

y_t = organic matter removed.

K (or) K_T = BOD rate constant in

Standard eq/n: $\boxed{K_T = K_{20}(1.047)^{(T-20)}}$ (base e) $\frac{1}{day}$ (or) day^{-1}

Standard eq/n: $\boxed{K_T \text{ (base e)} = 2.3 * K_T \text{ (base 10)}}$

$[\because K_{20}$ (base e) $= 2.3 * K_{20}$ (base 10)$]$

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* $y_t^{T^\circ C} = L_o\left[1 - e^{-K_T t}\right]$

* 5 day BOD @ $20^\circ C$, $y_5^{20^\circ C} = [(DO)_I - (DO)_F] * D.F = L_o\left[1 - e^{-k_{20} * 5}\right]$

Population equivalent:

Total strength of any waste is called as Total BOD

Total BOD (kg/day) = Q (MLD) * y (mg/l) = Population (equivalent) * Per capita BOD

Million litres per day

=> Population equivalent = $\frac{\text{Total BOD}}{\text{Per capita BOD}} = \frac{Q * y}{\text{Per capita BOD}}$

Relative stability (Sr):-

$$S_r = \frac{L_o - L_T}{L_o} * 100$$

$$= \frac{y_t}{L_o} * 100$$

$$= \frac{L_o\left[1 - e^{-kt}\right]}{L_o} * 100$$

$$S_r = 100\left[1 - e^{-kt}\right]$$

@ temp = $20^\circ C$, $k_{20} = 0.23\ d^{-1}$

** $S_r = 100 * \left[1 - (0.794)^t\right]$

$\because e^{(-0.23)} = 0.794$

@ temp $30^\circ C$, $k_{30} = 0.364\ d^{-1}$

$S_r = 100 * \left[1 - (0.694)^t\right]$

$\because e^{(-0.364)} = 0.694$

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sample called sewage sample BOD — dilution called dilution factor in BOD

Problem ①

1) In a BOD test using 5% dilution of the sample that is 15 ml of sample and 285 ml of distilled water (15 ml of sample called sewage sample BOD, 285 ml of water called dilution / distilled water BOD) the Dissolved oxygen (D.O) values for the sample and the dilution / distilled water before incubation were 3.80 and 8.80 mg/litre respectively. The D.O present after incubation in the diluted sample was 0.80 mg/litre the 5 day BOD @ 20°C of the sample is?

Sol:-

Volume of sample (V_S) = 15 ml

volume of distilled water (V_D) = 285 ml

$(DO)_{sample}$ = 3.80 mg/litre

$(D.O)_{distilled\ water}$ = 8.80 mg/litre

5 day BOD @ 20°C

$$^{20^\circ C}_{y\,5day} = \left[(DO)_{Initial} - (D.O)_{final}\right] * \text{Dilution factor}$$

$(D.O)_{final}$ = 0.80 mg/litre.

$$(D.O)_{Initial} = \frac{\left[V_D * (DO)_D\right] + \left[V_S * (DO)_S\right]}{V_D + V_S}$$

$$= \frac{[285 * 8.80] + [15 * 3.80]}{285 + 15}$$

$(D.O)_{Initial}$ = 8.55 mg/litre

Dilution factor (D.f) = $\frac{300\ ml}{V_S}$ (or) $\frac{100}{\%\ of\ dilution}$

(V_S ↑ volume of sewage sample)

= $\frac{300}{15}$ (or) $\frac{100\ \%}{5\%}$

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(D.f) = 20 (or) 20

(D.O) @ 20°C for 5 days = $[(DO)_I - (DO)_F] * D.F$

$= (8.55 - 0.80) * 20$

$= 155$ mg/lits

Note:-

BOD bottle (DO) volume

$300\,ml * \frac{5}{100} \Rightarrow 15$

$300 - 15 = 285$

(2) A 2% solution of a sewage sample is kept at an incubation temperature of 20°C. If initial and final (D.O) values after 5 days of incubation period are 8 and 5 mg/litre respectively. Calculate the 5 day BOD @ 20°C

Sol:- BOD bottle volume 300ml.

2% solution of a sewage sample is given.

so $\frac{2}{100} * 300 = 6\,ml$ → sewage sample

$300 - 6 = 294\,ml$ → distilled water

volume of distilled water = 294 ml.

sample = 6 ml.

(D.O) Initial = 8 mg/lit

(D.O) final = 5 mg/lit

Dilution factor (D.f) = $\frac{100}{2\%}$

$= 50$

∴ 5 day BOD @ 20°C = $[(DO)_I - (DO)_F] * D.F$

$= (8 - 5) * 50$

$= 150$ mg/lit

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(3) ~~A sewage~~ A sample of sewage is estimated to have a 5 day BOD @ 20°C is 250 mg/lit. If the test temperature be 30°C, in how many days the same value of BOD can be obtained?

Sol:

BOD at any time "t" $y_t = L_o - L_t$

$\Rightarrow y_t = L_o - L_o * e^{-kt}$ $\quad [\because L_t = L_o * e^{-kt}]$

$y_t = L_o [1 - e^{-kt}]$

$250 = L_o [1 - e^{-k_{30} t}]$

$250 = L_o [1 - e^{-k_{20} * 5}]$

$0 = L_o [1 - e^{-k_{30} t}] - L_o [1 - e^{-k_{20} * 5}]$

$L_o [1 - e^{-k_{20} * 5}] = L_o [1 - e^{-k_{30} t}]$

$e^{-k_{20} * 5} = e^{-k_{30} * t}$

When the basses are equal powers are added.

$k_{20} * 5 = k_{30} * t$

$t = \frac{0.23}{0.364} * 5$ → doubt

$t = 3.15$ days

Constant value
$[\because k_{20} = 0.23$
$k_{30} = 0.364]$

$K_T = k_{20} (1.047)^{T-20}$

$k_{30} = k_{20} (1.047)^{30-20}$
$= 0.23 (1.047)^{10}$
$= 0.364$

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(4) Determine the ultimate BOD of a waste water sample which was subjected to the BOD determination as follows:

6 ml of waste water containing no dissolved oxygen was mixed with 294 ml of distilled water containing 8.6 mg/litre of D.O. After incubation @ 20°C for 5 days the D.O of the mixture was 5.4 mg/litre. The BOD rate constant (k) to the BOX k_T is 0.25 per day?

Sol:-

Ultimate BOD = Initial amount of organic matter present in sample

$$y_5^{@20^\circ C} = L_0 (1 - e^{-K_T * t})$$

$$(D.O)_{final} = 5.4 \text{ mg/lit}$$

$$(D.O)_{Initial} = \frac{V_D * (D.O)_D + V_S * (D.O)_S}{V_D + V_S}$$

$$= \frac{294 * 8.6 + 6 * (0)}{294 + 6}$$

$$= 8.428$$

$$\text{Dilution factor} = \frac{300}{\text{volume of sample}} = \frac{300}{6}$$

$$= 50$$

5 days BOD @ 20°C, $y_5^{@20^\circ C}$ $= [(DO)_I - (DO)_F] * D.F$

$$= [8.428 - 5.4] * 50$$

$$= (3.028) * 50$$

$$= 151.4 \text{ mg/lit}$$

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$y_5^{@20^0C} = L_0\left(1-e^{-K_T \cdot t}\right)$

[∵ K_T value are given in problem]

$151.4 = L_0\left(1-e^{-0.25*5}\right)$

$L_0 = 215.29$ mg/lit

(5) 5 day BOD @ 30°C of a sewage sample is 110 mg/lit. Calculate its 5 day BOD @ 20°C. Assume $K_{20} = 0.1\ day^{-1}$ (Base 10)

sol:-

$K_{20} = 0.1$ (base 10)

2.30 ✓

$y_5^{@30^0C} = 110$ mg/lit

$y_5^{30^0C} = L_0\left(1-e^{-K_T * t}\right)$

$110 = L_0\left(1-e^{-0.364*5}\right)$ → ?

[∵ $K_{30} = 0.364$]

(base)$_e$ =

(base)$_{10}$ =

$L_0 = 131.26$ mg/lit

$y_5^{@20^0C} = L_0\left(1-e^{-K_T * t}\right)$

$= 131.26\left(1-e^{-0.23*5}\right)$ → ?

[∵ $K_{20} = 0.23$]

$y_5^{@20^0C} = 89.698$ mg/lit

base10 — 0.23

base e — 0.1/day

For K_{40}, K_{50} Calculation

$K_T = K_{20} * (1.047)^{T-20^0C}$

$K_T = K_{20}(1.047)^{T-20}$

$K_{30} = 0.23(1.047)^{30-20}$

$(base\ e) = 0.36$

$K_{30}{}_{base\ 10} = 2.3 * T_T$

$= 2.3 * 30$

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(6) The BOD of sewage incubated for 1 day at 30°C has been found to be 110 mg/lit. What will be the 5 day BOD @ 20°C ?

Sol:

$K_{30^\circ C} = 0.364$

$y_{1\,day}^{@30^\circ C} = L_o\left(1 - e^{-K_T * t}\right)$

$y_{1\,day}^{@30^\circ C} = L_o\left(1 - e^{-0.364 * 1}\right)$

[$\because k_{20} = 0.20$, $k_{30} = 0.364$]

$110 = L_o\left(1 - e^{-0.364 * 1}\right)$

$L_o = 360.58$ mg/lit

$y_5^{@30^\circ C} = L_o\left(1 - e^{-K_T * t}\right)$

$y_5^{@30^\circ C} = 360.53 * \left(1 - e^{-0.364 * 5}\right)$

$y_5^{@20^\circ C} = 302.114$

$y_5^{@20^\circ C} = L_o * \left(1 - e^{-K_T * t}\right)$

$= 360.53 * \left(1 - e^{-0.23 * 5}\right)$

$y_5^{@20^\circ C} = 246.37$ mg/lit

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(7) A portion of waste water sample was subjected standard BOD test yielding a value of 180 mg/lit. The reaction rate constant (to the base e) at 20°C was taken of 0.18/day. The reaction rate constant at other temperature may be estimated by $K_T = K_{20}(1.047)^{T-20}$. The temperature at which the other portion of the sample should be tested to exhibit the same BOD in 2.5 day.

Sol:-

$y_t = L_o(1-e^{-K_T * t})$ (∵ y_t = organic matter removed)

$180 = L_o(1-e^{-K_{20} * 5})$

$180 = L_o(1-e^{-0.18 * 5})$

$L_o = 303.40$ mg/lit

[∵ @20°C $K = 0.18$/day]

$K_T = K_{20}(1.047)^{T-20}$ → formula

@T°C @20°C

$y_{2.5} = y_5$

$L_o(1-e^{-K_T * 2.5}) = L_o(1-e^{-K_{20} * 5})$ [∵ $y_t = L_o(1-e^{-K_T * t})$]

$K_T * 2.5 = K_{20} * 5$

$K_{20}(1.047)^{T-20} * 2.5 = 0.18 * 5$

$0.18(1.047)^{T-20} * 2.5 = 0.18 * 5$

$(1.047)^{T-20} = \frac{0.18 * 5}{0.18 * 2.5}$

$\frac{(1.047)^T}{(1.047)^{20}} = 2$

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$$\log(1.047)^T = \log 2(1.047)^{20}$$

$$T \log(1.047) = \log(5.01)$$

$$T = \frac{\log(5.01)}{\log(1.047)}$$

$$T = 35.08^{\circ}C$$

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Treatment of waste waters

The waste water treatment is aimed to removal of BOD

→ There are so many number of substances in waste waters which interfere with BOD first remove that substances in waste water

The treatment process can be classified into the following stages

1) Preliminary treatment
2) Primary treatment
3) secondary treatment
4) Tertiary treatment

(1) Preliminary treatment:-

Preliminary treatment consists slowly in separating the floating materials like dead animals, tree branches, papers, pieces of rags, wood etc and also the heavy settleable inorganic solids

(a) ఇది ఎందుకు ఉపయోగం

→ It is also helps in removing the oils and greases etc from the sewage.

→ This treatment reduces the BOD of the waste water by about 5 to 30%.

The process is used are screening for removing floating papers, rags, cloaths etc.

→ Grit chambers (or) Detritus tanks for removing grit and sand

→ skimming tanks for removing oils and greases

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(2) primary treatment:- (settleable organic solids are removed)

Primary treatment consists in removing large suspended organic solids.

→ These large particles are usually accomplished by sedimentation in settling basins

→ The liquid effluent after completion of primary treatment does not have any suspended organic materials removing of large amount of suspended organic materials and has a high BOD (about 60% of original)

→ some times, the preliminary as well as primary treatments are classified together, under primary treatment.

→ The organic solids, which are seperated out in the sedimentation tanks (in primary treatment) after that decomposition in a digestion tank (or) in (related)

(3) secondary treatment:- (BOD removal)

→ The waste coming from the primary sedimentation tank. This waste will be in biological decomposition.

→ It means either aerobic (or) anaerobic conditions send to biological units

→ The biological units bacteria will decompose the fine organic matter to produce clearer effluent

→ In the biological units we can used in the treatment reactors

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~~so we called as~~

→ In treatment reactors the organics is decomposed (ఆర్గానిక్స్ కుళ్ళిపోతాయి)

by aerobic bacteria. are known as aerobic biological units

This unit consist of

(i) filters

↳ Intermittent sand filters as well as trickling filters

(ii) Aeration tanks

(recycled activated sludge)

(iii) oxidation ponds and Aerated lagoons

→ finally the effluent from the secondary biological treatment will usually contain a little BOD (5 to 10%)

(iii) Tertiary treatment (Recycling and Reuse of waste water)

The tertiary treatment some time we called as Final (or) Advanced treatment.

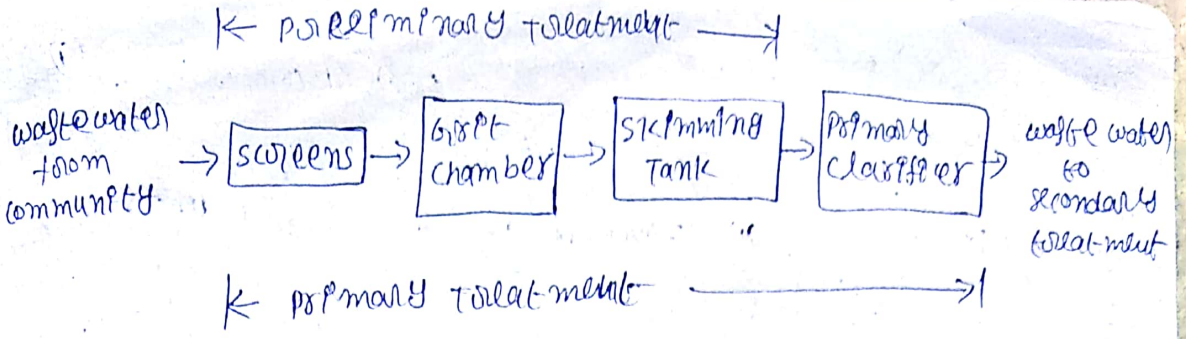
→ This treatment we use removing of organic matter present after the secondary treatment and particularly to kill the Pathogenic bacteria

→ This treatment, which is normally carried out by chlorination

→

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(3.5) Primary treatment - Screens - Grits :-

→ screening is the very first operation carried out at a sewage treatment plant

→ It consists of passing of sewage through different types of screens.

→ This screens are aimed to remove large floating objects such of waste paper, cloth, wooden pieces, cork, glass bottles, plastic bottles, empty coco-nut shells etc,

→ These floating materials, if not removed, will cause ~~the choke~~ flow. clog into ~~pumps~~ pipes so this will be effect of working of sewage pumping system.

→ The main idea to providing the screens it is to protect the pumps and other equipments

→ screens may be placed after the grit chambers or sometimes be accommodated in the body of the grit chambers themselves.

→ depending upon size of the openings, screens may be classified as coarse screens, medium screens, and fine screens

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Based on size of openings:-

1) coarse screens → size of openings > 50mm
2) medium screens → size of openings = 6mm to 40mm
3) Fine screens → size of openings = 3mm to 6mm

(1) coarse screens :-

Coarse screens is a device provided with uniform sized openings made upon with number of Racks, It means divided by number of Parallel bars (or) rods.

→ The spacing between the bars is about 50mm (or) more
→ These screens do help in removing large floating objects from sewage.
→ They will collect about 6 litres of solids per million litre of sewage. The materials are seperate by coarse screens are wood, paper etc.
→ This will be disposed by incineration, burial, dumping (కాల్చివేయడం) (పాతిపెట్టడం) (కుప్పనింపడం)

(2) medium screens :-

→ The spacing between bars is about 6 to 40 mm.
→ These screens will ordinarily collect 30 to 90 litres of materials per million litre of sewage.
→ The screenings usually contain some quantity of organic materials, which may putrefy (కుళ్ళిపోవు) more offensive అసహ్యమైన
→ so these waste are disposed by incineration (or) burial. (not by dumping)
→ Rectangular shaped coarse and medium screens are now-a-days widely used at sewage treatment plant.

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→ They are made of steel bars, fixed parallel to one another at desired spacing on a rectangular steel frame and are called bar screens

→ The screens are set in a masonry (or) R.C.C chamber, called the screen chamber

→ Now-a-days, these screens are generally kept inclined about 30° to 60° to the direction of flow so as to increase the opening area, and to reduce the flow velocity this will result making the screening more effective

→ while designing the screens, we should provided a clear openings and sufficient total area. the velocity through them is not more than 0.8 to 1 m/sec

→ The materials collected on bar screens can be removed either manually (or) mechanically

→ The manual cleaning is practised at small plants with hand operated rakes.

→ The inclined screens help in their ~~screens~~ cleaning by the upward stroke of the rake, which move over the screens, either continuously (or) intermittently.

→ screens are sometimes classified as fixed (or) movable, depending upon whether the screens are stationary (or) ~~movable~~ capable of motion

→ Fixed screens are permanently set in position

→ movable screens are stationary during their operating period.

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But they can lifted up bodily and removed from their positions for the purpose of cleaning

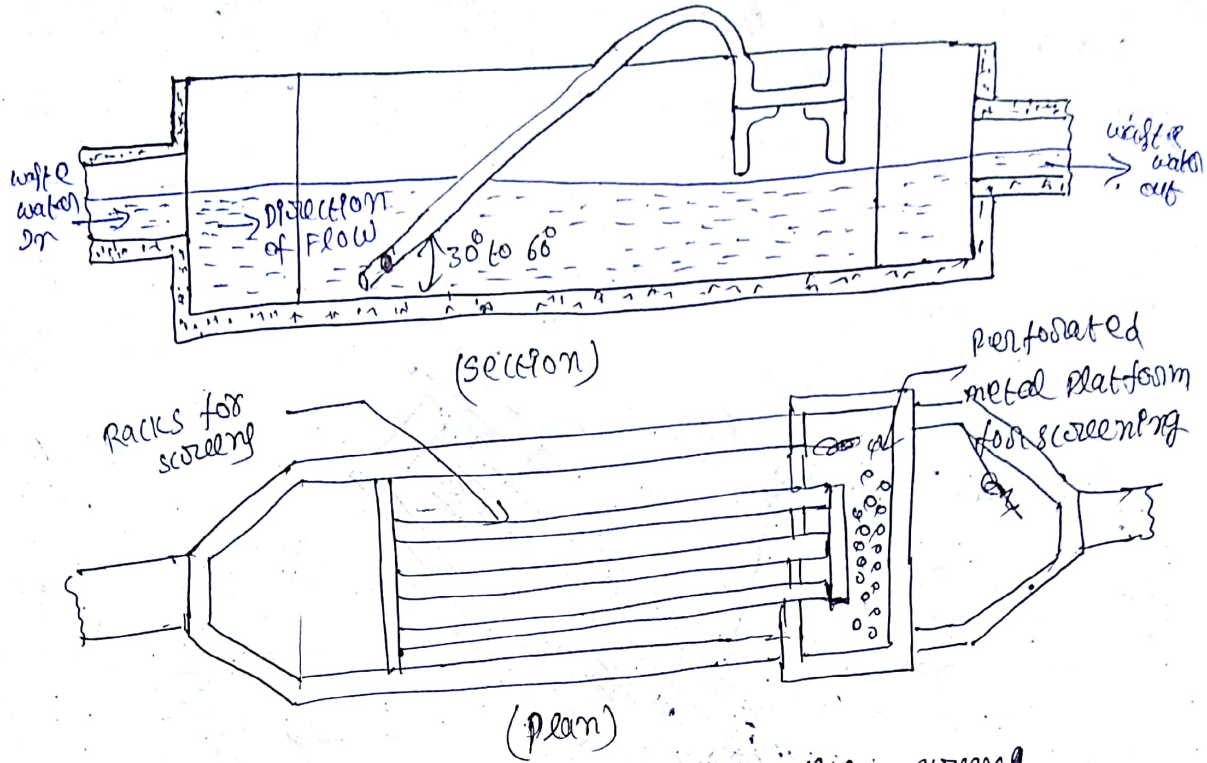


Fig Fixed bed type coarse (or) medium screens

(5) Fine screens:-

→ These fine screens are having an size of 1.5mm to 3mm.

→ The installation of these screens prove very effective and they remove as much as 20% of the suspended solids from sewage

→ These screens are clogged small interval of time so need frequently cleaning.

→ They are used for only treating the industrial waste waters (or) for treating those municipal wastewaters

→ These screens will considerably reduce the load on further treatment units

→ Brass (or) Bronze plates (or) wire mesh are generally used for constructing fine screens

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→ The metal used should be resistant to rust and corrosion

→ The fine screens may be disc (or) drum type, and are operated continuously by electrical motors which are cleaned by a cone brush.

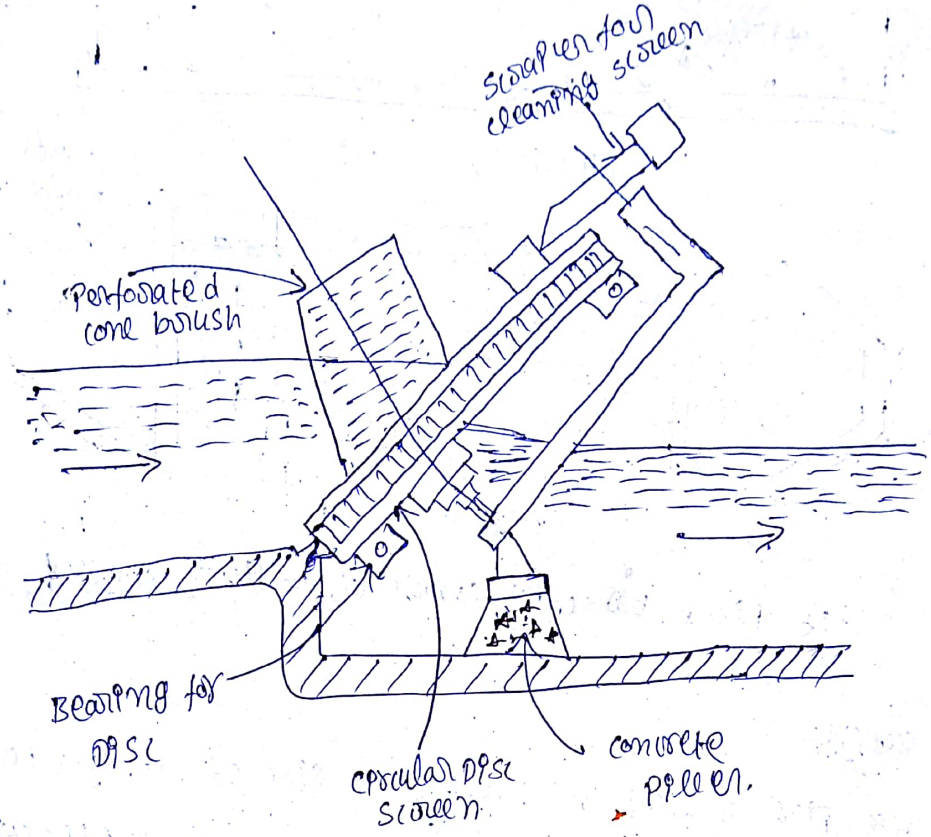


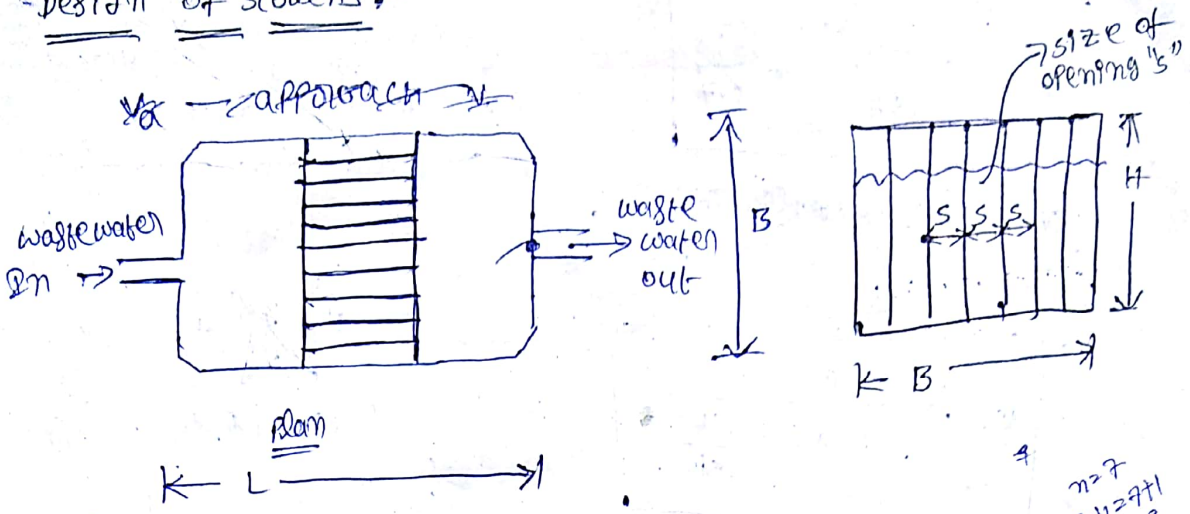
Fig: Repnsch - Wuon screen (disc type fine screen)

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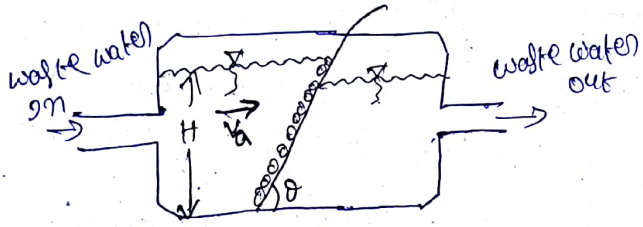
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~~Design of Grit chambers:-~~

- Design of screens:-



n = 7
n+1 = 7+1 = 8



cross section



Design of screens:-

V_a – approach velocity = 0.6 to 1.2 m/sec

cross sectional area of screen $B * H = \frac{Q}{V_a}$

H = 0.8m to 1.1m

B = ?

Let "n" be the number of openings of screen with size of each opening is "s" then,

number of bars = n+1

Let diameter of each bar be "ϕ"

$B = n * s + (n+1)\phi$

number of openings, n = ?

number of bars, (n+1) = ?

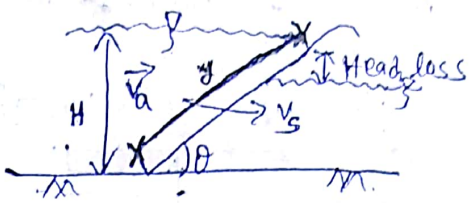
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Head loss Through screens (H_s):-

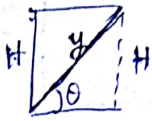
[∵ slope = y]

$$H_s = \frac{V_s^2 - V_a^2}{2g} * \frac{1}{0.7}$$



V_s → velocity of flow through screens

$$V_s = \frac{Q}{n * s * \frac{H}{\sin\theta}}$$



$\sin\theta = \frac{H}{y} \Rightarrow y = \frac{H}{\sin\theta}$

Problems

pg no 289 sk garg

1) Estimate the screen requirement for a plant treating a peak flow of 60 million litres per day of sewage?

Sol:- [∵ ಈ problem ಅಲ್ಲಿ screen requirements ಅನ್ನೋ ಕಡೆ ಅಥವಾ ವಿವರಣೆ ಇಲ್ಲ marriage ಸಮಸ್ಯೆಗಳಲ್ಲಿ ಹಾಗೆ ಅಲ್ಲಿ requirements ಕೊಡಲೇ ಬೇಕು ಅಂತ ಇಲ್ಲ ಅಥವಾ ಕೊಡಬಹುದು ಕೊಡದೆ ಇರಬಹುದು]

Sol:- Peak flow = 60 mℓ/day.

$= \frac{60 \times 10^6}{1000}$ cu-m/day.

$= \frac{60,000}{24 * 60 * 60}$ cu-m/sec

$= 0.694$ m^3/sec ✓

[∵ million = 10^6

∵ 1 liter = 0.001 cu.m $= \frac{1}{1000}$ cu.m]

[∵ cubic meter ಅನ್ನು meter cube ಅನ್ನು ಬರಬಹುದು]

Assuming that the velocity through the screens (at peak flow) is not allowed to exceed 0.8 m/sec ✓ we have

The net area of screen openings required

$= \frac{0.694}{0.8}$ $\frac{m^3/sec}{m/sec}$ [∵ $\frac{Q}{V_a}$]

$= 0.87 m^2$ ✓

∵ Area × velocity (A) × (V) = Q ⇒ A = Q/V

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using rectangular steel bars in the screen, having 1 cm width and placed at 5cm clear spacing, we have

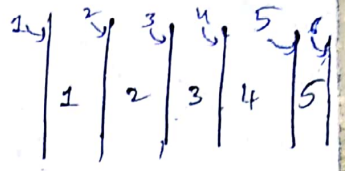
$$= \frac{0.87 * (n+1)}{5}$$

$$= \frac{0.87 * (5+1)}{5}$$

$$= 1.044 \ m^2$$

[$\because \frac{b}{b+s} = \frac{A}{H}$, $H = \frac{A}{b+s} * b$]

5cm clear spacing అని వాడితే 5 spacing అవుతుంది 6 bars వేయాలి $(n+1) = 5+1 = 6$



Assuming that the screens bars are placed at 60° to the horizontal, we have

The gross area of the screen needed,

$$= \frac{H}{\sin\theta}$$

$$= \frac{1.04}{\sin 60^\circ} \Rightarrow \frac{1.04}{\frac{\sqrt{3}}{2}} \Rightarrow \frac{1.04 \times 2}{\sqrt{3}}$$

$$\Rightarrow 1.2 \ m^2$$

$\sin\theta$	30°	45°	60°	90°
	$\frac{1}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{\sqrt{3}}{2}$	1

Hence, a coarse screen of $1.2 \ m^2$ area is required

While designing the screen, we have also to design the cleaning frequency.

The cleaning frequency is governed by the head loss (calculated) through the screen

Note:-

more screen openings are clogged, more head loss through the screen

[screens లోపలి వైపుగా వెళ్ళే కొద్దీ screen కి అడ్డుపడి waste water పైకి ఎగదన్నడం వలన ఇంకొంచెం ఎక్కువ water ఆగిపోయి head loss ఎక్కువ అవుతుంది]

Generally, not more than half the screen clogging is allowed

(screen లో సగం కన్నా ఎక్కువ half of the screen లో మురుగునీరు ఆగిపోకూడదు)

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The head loss through the cleared screen and half-cleared screen can be computed as follows

velocity through the screen (V_s) = 0.8 m/sec

velocity above the screen (V_a) $= \frac{0.8 \times 5}{(n+1)} \Rightarrow \frac{0.8 \times 5}{(5+1)}$

(rectangular steel bars 5 cm each, spacing 80 mm)

(number of bars + 1)

$= \frac{0.8 \times 5}{6}$ m/sec

$= 0.67$ m/sec

Head loss through the screen

$(H_s) = \frac{V_s^2 - V_a^2}{2g} \times \frac{1}{0.7}$

$= 0.0729 (V_s^2 - V_a^2)$

$= 0.0729 [(0.8)^2 - (0.67)^2]$

$= 0.0134$

$\simeq 0.013$ m

When the screen openings get half clogged, then the velocity through the screen

$V_s = 0.8 \times 2$

$= 1.6$ m/sec

Head loss through the screen

$(H_s) = \frac{V_s^2 - V_a^2}{2g} \times \frac{1}{0.7}$

$= 0.0729 (V_s^2 - V_a^2)$

$= 0.0729 [(1.6)^2 - (0.67)^2]$

$= 0.1538$

$\simeq 0.15$ m

This shows that when the screens are totally clean, the head loss is negligible (i.e) about 0.013 m (or) 1.3 cm. only whereas, the head loss shoots upto about 15 cm at half the clogging,

1 m = 100 cm.

$\frac{1}{100}$ m. = 1 cm

$m = \frac{100}{1}$ cm

The screens should therefore be cleaned frequently, so as to keep the head loss with in the allowable range.

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Grit Chamber:-

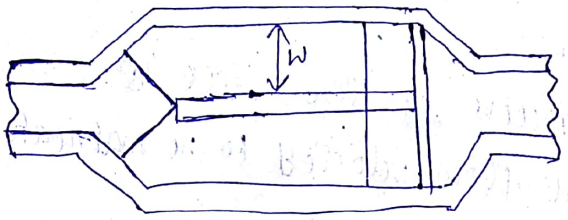
→ Grit chambers is also called Grit channels

→ The sewage contains large amount of gritty substance in addition to other matters

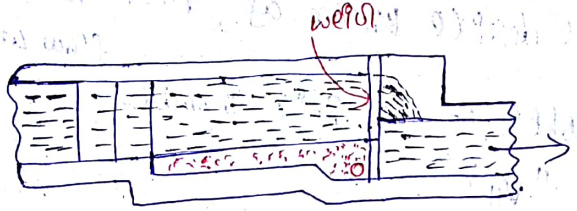
→ The main source of grit are industrial wastes, kitchens storm water run off, pumping from excavations and ground water seepage

→ These Grit Chamber is aimed to remove grit particles from waste water flow

→ Grit must be removed before pumping of sewage to other treatment units, otherwise it will cause an obstruction to the flow



Plan



sectional elevation

→ Grit is composed of

(1) An organic grit:-

size < 0.2 mm ; specific gravity ≥ 2.65

Ex:- sand, silt, clay, broken glass pieces, metal fragments etc

(2) organic grit :- (Non-biodegradable)

size > 2mm ; specific gravity = 1.05 to 1.1

Ex:- coffee grounds, tea grounds, egg shells, Bone chips, seeds, etc (partially cooked)

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→ Grit chamber consist of 10 - 17 m long narrow rectangular channel.

→ The sewage flows in this chamber horizontally with a constant velocity between 0.24 m/second to 0.3 m/second (V_H)

→ so larger and heavier grit particles may settle down in the bottom but lighter organic solids can escape out with the sewage.

→ The depth of liquid in these chamber is usually kept between 1 - 1.3 m.

→ The weir type outlet is provided.

⇒ A 25% increase in Horizontal velocity (V_H) leads to scouring of settled grit. (settle కావు waste అయ్యి పోతుంది)

→ A 25% decrease in "V_H" leads to settling of not targeted particles.

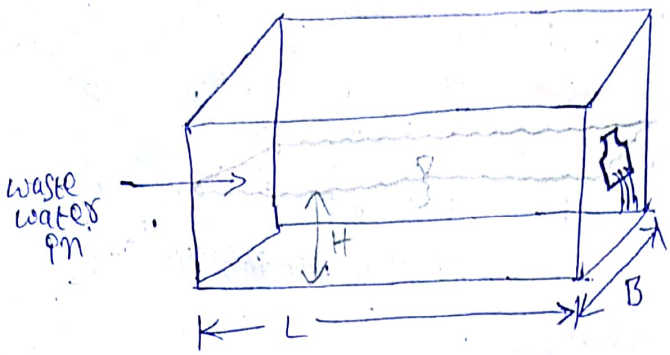
→ so avoid the irrespective of flow rate 'Q' so maintain constant flow velocity to be maintained through out its operation.

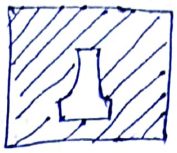
→ A velocity control device known as "proportional flow weir" is provided to the outlet of the grit chamber to maintain constant "V_H"

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Design of Grit chamber:-





Design parameters

(1) Detention Time (DT):

$DT = 1$ to 3 min

Volume of grit chamber $= Q * DT$

$(L * B * H)$ $\quad m^3/min * min$

$\Rightarrow DT = \frac{\text{volume}}{Q}$

(2) Flow through velocity "V_H" $(V_H = 0.3\ m/sec)$

C/S Area $= \frac{Q}{V_H}$

$(B \times H)$

length of grit chamber $= V_H * DT$

(3) SLR (or) SOR "V_0" (surface loading rate (or) surface overflow rate):

surface Area (plan Area), $L * B = \frac{Q}{V_0}$

(4) settling velocity "V_S":-

$$V_S = \frac{g(s-1)d^2}{18\nu}$$

where

s – specific gravity of grit

d = dia of grit

ν = kinematic viscosity

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Hazens formula for grit particles

$$v_s = 60.6\,(s-1)\,d\,\frac{3T+70}{100}$$

where, T = temperature in "°C"

d = dia of grit in "cm"

v_s = settling velocity in "cm/sec"

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Pg No 304 SK Garg

1) An rectangular grit chamber is designed to remove particles with a diameter of 0.2 mm, specific gravity 2.65. settling velocity for these particles has been found to range from 0.016 to 0.022 m/sec, depending on the their shape factors. A flow through velocity of 0.3 m/sec will be maintained by proportioning weir. Determine the channel dimensions for a maximum waste water flow 10,000 cu.m/day?

Sol:- Let provide a rectangular channel section, since a proportional flow weir is provided for controlling velocity of flow

Now,

Horizontal velocity of flow (V_h) = 0.3 m/sec

settling velocity is between 0.016 to 0.022 m/sec,

so assume ~~to be taken~~ let it be 0.020 m/sec

[$\because Q = AV$]

Now,

Q = velocity * cross-section Area

$Q = V_h * A$

$10,000 \text{ cu.m/day} = 0.3 \text{ m/sec} * A$

$\frac{10,000}{24*60*60} \text{ m}^3/\text{sec} = 0.3 \text{ m/sec} * A$

$0.116 \text{ m}^3/\text{sec} = 0.3 \text{ m/sec} * A$

$A = \frac{0.116 \text{ m}^3/\text{sec}}{0.3 \text{ m/sec}} \Rightarrow A = 0.385 \text{ m}^2$

Assuming a water depth (H) of 1m above the crest of the weir, which is kept 0.3 m above the tank bottom, we have the width (B) of the basin as

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

$B * 1 = \frac{0.116}{0.3}$

$B = 0.385 \text{ m} \cong 0.4 \text{ m}$ (say)

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(or)

overall depth of grit chamber (D)

= water depth above the crest of weir + 0.3m.
+ free board of 0.45 m

= 1.0 m + 0.3 + 0.45 m

= 1.75 m.

Now, settling velocity

$V_s = 0.02$ m/sec [∵ we are already assuming]

∴ Detention time = $\frac{\text{water depth in the basin}}{\text{settling velocity}}$

$= \frac{1}{0.02}$

$= 50$ secs

Length of the tank = V_h * Detention time.

$= 0.3 \frac{m}{sec} * 50\ sec$

$= 15$ m

The length of the channel is increased beyond theoretical value by a factor of 10–50% to account for non ideality on the flow and settling particles (irregular in the flow)

Hence using about 30% (say) increased length we get L = 20 m.

Hence, use a rectangular tank, with dimensions

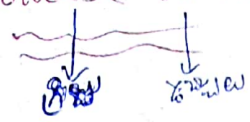
Length (L) = 20 m.
Width (B) = 0.4 m.
Depth (D) = 1.75 m.
} Ans

15 m & 30% increase
15 + 4.5 = 19.5 ≈ 20
[$\frac{15}{100} * 30\% = 4.5$]

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(3.6) Grease traps - Floation - sedimentation:-



⇒ Grease traps

→ mostly all types of sewage containg floating matters such as grease, oils, fats etc

→ The sources of these sewage floating matters are kitchens, garages, soap-industries etc

→ These matters foam scum over the surface of the sewage and while removing of this (తేలియాడే పదార్థాలు) will perform various sewage treatment operations

→ Due to the following difficulties should be occured. you should not removing greasy and oily matters from the sewage.

(i) They foam scum in the sedimentation tanks (తేలియాడే పదార్థాలు)

(ii) They clog fine screens

(iii) They considerably reduce the efficiency of the activated sludge process

(iv) They decrease the biological growth due to which various bacteria and protozoa can not perform their work

(v) they occupy large space resulting in the decrease in the efficiency of sewage treatment process and increase their maintenance cost.

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Floation :- → (తేలియాడే పద్ధతి)

→ All lighter weight of particles are float on the surface of sewage water. so the oils, fats and greases are lighter weight so this will float on the surface of the sewage.

→ will rise to the surface of sewage, will form scum on surface (పై భాగం)

→ which can be easily removed by hand (or) mechanically

⇒ specific gravity of oil and grease granules is less than specific gravity of waste water, therefore they settly on top surface of waste water.

→ If the sewage is flowing, then most of these materials will remain in suspension (or) mixed condition so

→ therefore removal of this sewage first This oils & grease matters on this sewage first restrict the flow in quiescent condition. (నిశ్చల పరిస్థితి)

→ After that this sewage filled in a tank and is allowed to remain at rest,

→ Then result large oily matters will rise more rapidly

∴ The quantity of oils and greasy matters rising at the surface ∝ Detention period.

→ while improving the efficiency of floation (తేలియాడే) in oil & grease on the surface of sewage. we can applying compressed air from bottom

→ This compressed air bubbles will rise up and will lift solids upwards

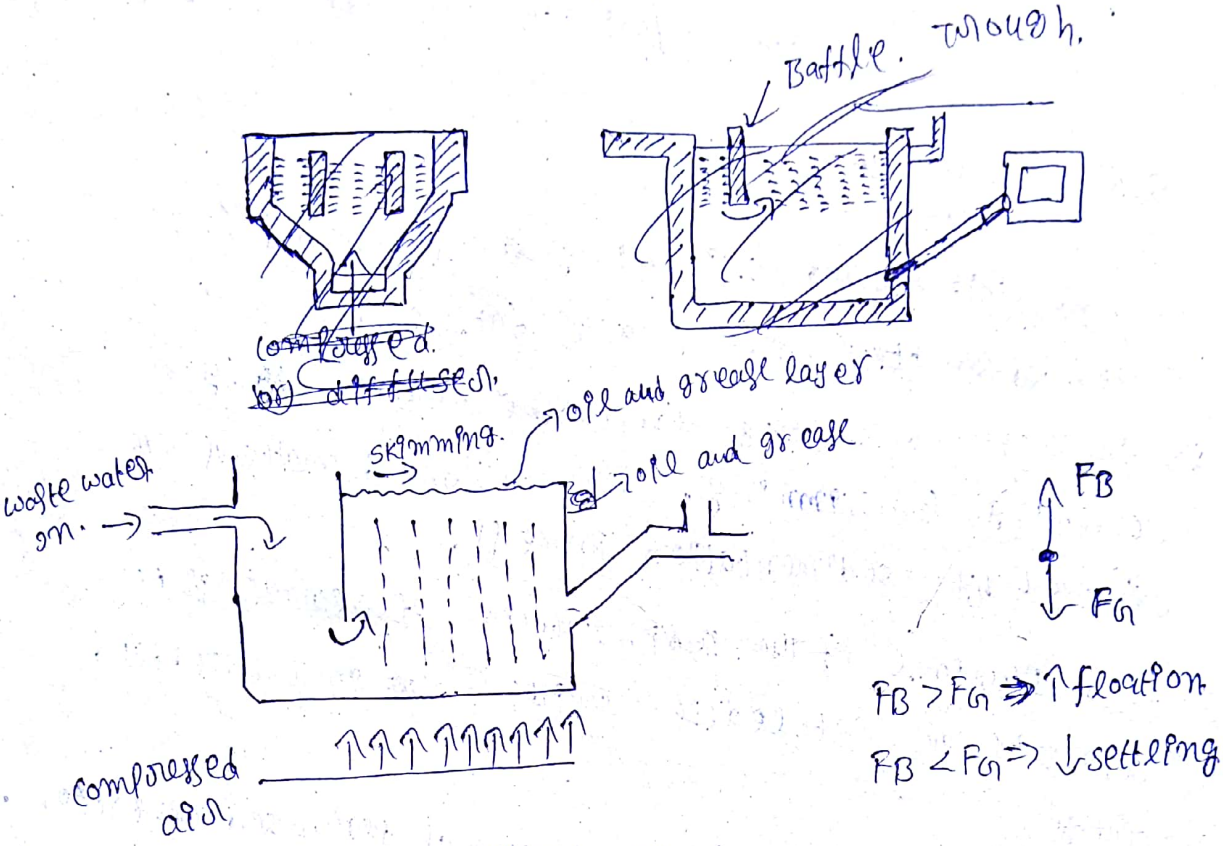
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→ only smaller bubbles do this work, larger bubbles have, no lifting value.

→ These four from top oil & Grease layers ~~skimmed~~ are removed by mechanical Procedures.

→ The skimming tank is used to removing oil, grease and fats of the sewage



Design:-

→ This tank is the form of long, trough shaped structure (eg: 5 to 10 m)

→ The detention period of 3 to 5 min. is provided in these tanks

→ To prevent heavy solids from settling in the bed

→ The compressed air is blown through the diffusers placed on the floor of the tank

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The surface Area of the tank is determined by the formula,

Pg No 317 SK Gosh

$$\text{surface Area} = 0.00622 * \frac{Q}{V_r} \text{ sqm}$$

$$L * B$$

Q = rate of flow of sewage in m^3/day

V_r = minimum rising velocity of the oily material to be removed in metre/minute

= 0.25 m/minute for most of the cases

Sedimentation:-

→ screening and skimming can removed large suspended matters, oils, grease, fats etc.

→ fine suspended matters cannot be removed by screening (or) skimming. These suspended matters are removed by sedimentation process.

→ the purpose of the sedimentation of sewage is to seperate the settleable solids in the settled sewage

→ the sedimentation tanks, known as plain sedimentation (or) primary settling tanks are located after screens and, grit chambers:

→ The secondary sedimentation (or) secondary settling tanks are use in settling of the effluents from secondary treatment operations like trickling filter (or) activated sludge process

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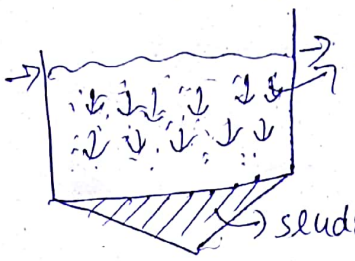
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→ Primary settling tanks are aimed to capture settleable organic solids from waste water flow.

** → It removes 70% of bio-degradable organic solids where achieves 20-30% of BOD removal.

→ Primary clarifier follows TYPE-III settling where of type-III settling is known as Hindered Settling.

→ Particles settles due to hinderance (ie) interference



$a = \frac{}{}$

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