EXAM ACHARYA
EDUCATION REDEFINED

GPSC - CIVIL

Environmental Engineering

"Education is the most Powerful Weapon which you can use to change the world."

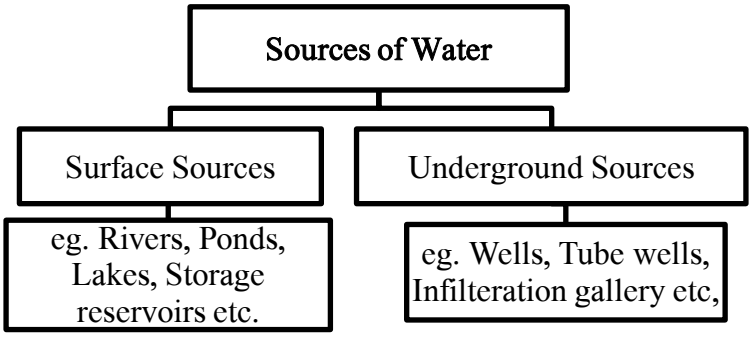
A.P.J. Abdul Kalam

The content of this book covers all PSC exam syllabus such as MPSC, RPSC, UPPSC, MPPSC, OPSC etc.

INDEX

CHAPTER 1:

SOURCES OF WATER AND WATER DEMAND



SOURCES OF WATER:

There are two sources of water:

i. Surface Sources:

The sources in which the water is flowing on the surface of earth is known as surface sources. E.g.: Rivers, Ponds, Lakes, Storage reservoirs (Like Dam, etc.) etc.

ii. Underground Sources:

The sources in which the water is flowing very deep inside the earth is known as underground sources. E.g.: Wells, Tube wells, Springs, Infiltration Gallery etc.

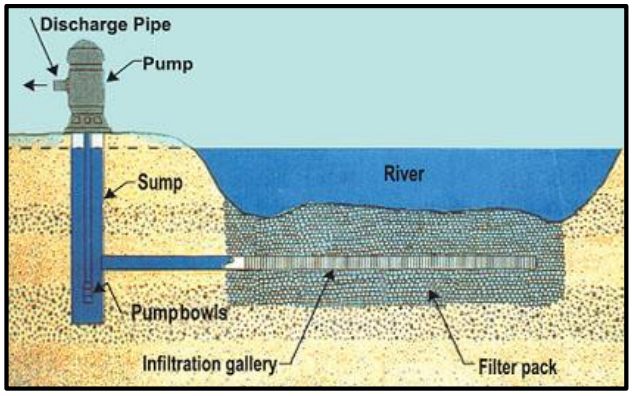
Springs:

The natural outflow of ground water at the earth's surface is said to form a spring.

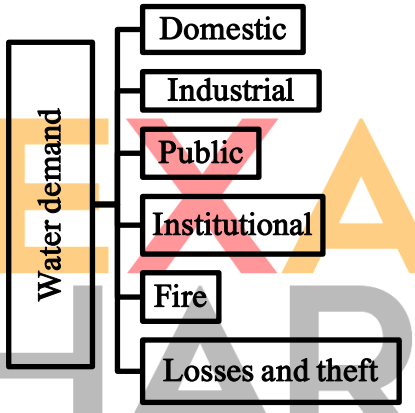
VC: johnnielawson

Infiltration Galleries:

This are the horizontal tunnels constructed at shallow depth i.e. 3 to 5m, along the bank of river through the water bearing strata.



WATER DEMAND:



1. Domestic Water Demand:

It is the amount of water required to satisfy domestic needs like drinking, cooking, washing, bathing etc. for a city having full flushing system it varies between 135 to 225 lpcd. Normally taken to be 200 lpcd. Although it can be reduced to 135 lpcd for economically weaker sections and LIG colonies.

Use	Consumption
Drinking	5 lpcd
Cooking	5 lpcd
Bathing	55 lpcd
Washing of clothes	20 lpcd
Washing of utensils	10 lpcd
Washing and cleaning of house and residencies	10 lpcd
Flushing of water closets etc.	30 lpcd
Total	135 lpcd

Where,

Q = Amount of water req. in lit/min

P = Population in thousands.

Conversions:

$$1\,\mathrm{l\,min^{-1}} = \frac{1}{60000}\,\mathrm{m^3 s^{-1}}$$

6. Water Demand for Losses and Theft:

This may be as high as 15% of total demand.

Note:

- Domestic water demand = 135 LPCD
- Total water demand = 270 LPCD

PER CAPITA DEMAND (q):

It is the annual average amount of daily water required by one person (in lit) and includes the domestic use, Industrial, commercial, Public use, wastes, theft etc.

$$\mathbf{q = \frac{Total\ yearly\ water\ requirement\ of\ city\ (V)}{365 \times Design\ population\ (P)}}\ lt/c/d$$

FACTORS EFFECTING THE WATER DEMAND:

1. Size of city,

2. Climatic condition,

3. Quality of water,

4. Cost of water,

5. Pressure in the distribution system,

6. Industrial and commercial activities,

7. Habits of people,

8. Development of sewage facilities,

9. Facility of metering and method of charging,

Note:
1) In intermittent supply system water is generally stored by consumers in tanks, drums etc. for non-supply periods. This water is thrown away by then even if unutilized as soon as the fresh supply is restored. This increase the wastage and losses considerably.
2) Cost of water is inversely proportional to consumption of water.
3) The loss of wastes due to leakage are considerably increased if pressure is high**.**

Geometric Rate Method:

This method is used for new cities.

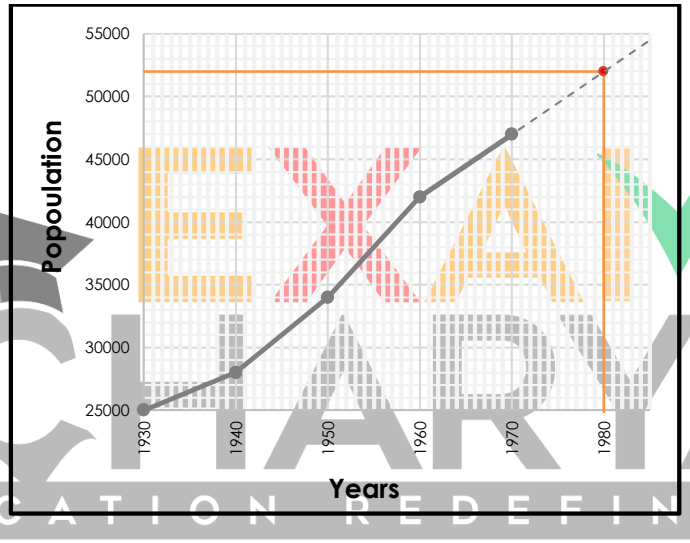
$$P_n = P_0\left[1 + \frac{r}{100}\right]^n$$

Decreasing rate of growth method:

$$P_1 = P_0 + \left\{\frac{(r_0 - r_1)}{100} \times P_0\right\}$$

$$P_2 = P_1 + \left\{\frac{(r_0 - r_1) - r_1}{100} \times P_0\right\}$$

Simple Graphical Method:



Where,

P_n = Population after **n** decades,

P_0 = Last known population given in question,

n = No. of decades,

$\bar{x}$ = Average increase in population per decades,

$\bar{y}$ = Incremental increase,

r = Increase in population in percent,

r_0 = Last known percentage decrease in population,

r_1 = Average percentage decrease in population.

EXAM ACHARYA
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GPSC - CIVIL

Building Material and Construction

Dream is not that which you see while sleeping it is something that does not let you sleep.

A.P.J. Abdul Kalam

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TEST YOUR SELF:

Qu6) A water supply scheme has to be designed for a city having a population of 2,00,000. If the average water consumption is 300 lpcd, the total draft in MLD will be_____

a) 165.2
b) 178.6
c) 172.8
d) 60

Qu7) The present population of a community is 25000 with an average water consumption of 5000 m^3/day. The design capacity of an existing water treatment plant is 6000m^3/day. During the next 20year it is expected that population will increase up to 35000. Assuming an arithmetic rate of population growth, the number of years from now when the plant will reach its design capacity will be_____

a) 1
b) 10
c) 100
d) 20

Answer:

1-(b), 2-(a), 3-(d), 4-(c), 5-(d), 6-(c), 7-(b)

$$\mathbf{TON} = \frac{\mathbf{A} + \mathbf{B}}{\mathbf{A}}$$

Where,

A = Vol. of odour water (in ml),

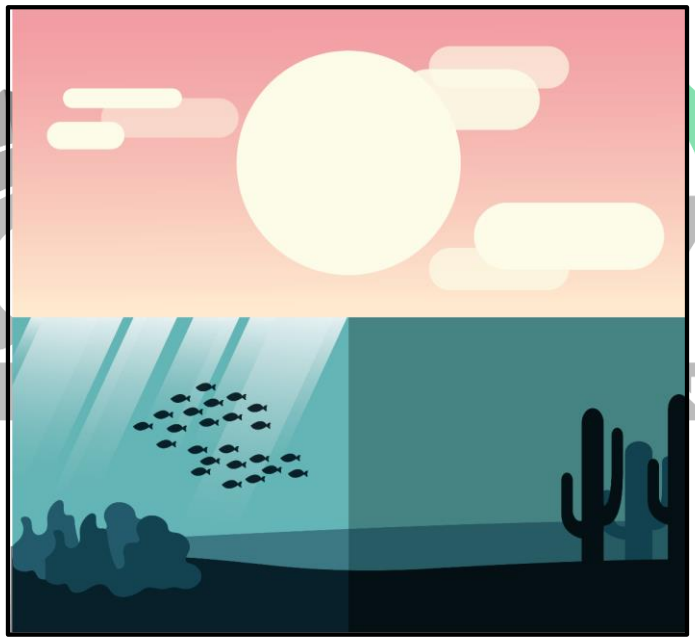
B = Vol. of distilled water (in ml).

Temperature:

It effects the chemical and biological reactions. An increase of 10° c in temperature doubles the biological activity. Hence for water supply, temperature measurement standard thermometer is used. For drinking purpose desirable limit is 8° - 12° c and permissible limit is ≤ 20° c and for conveyance we can use water of temp. ≤ 35° c.

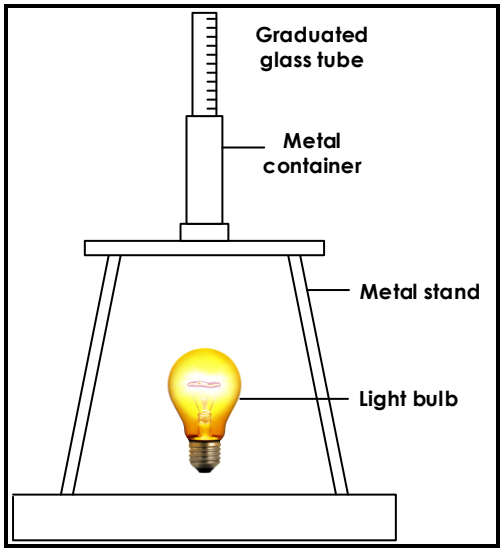
Turbidity:

It is the measure of extent to which light is either absorbed or scattered by suspended material in water. It is due to presence of clay, silt, fine organic material etc.



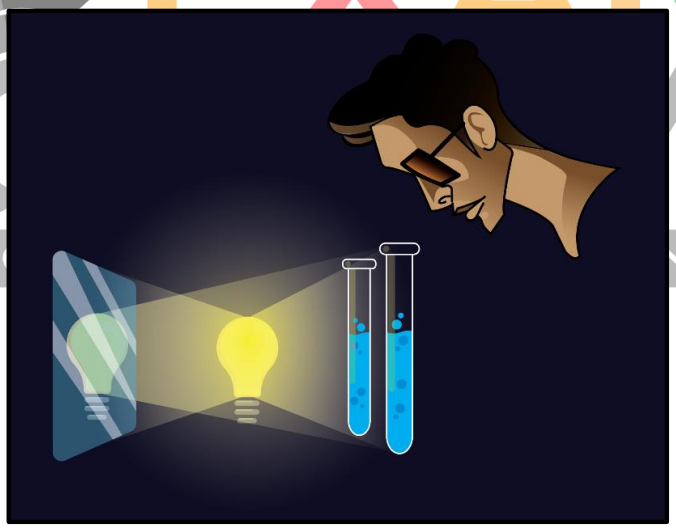
In natural water bodies turbidity interferes with light penetration and hence with photosynthetic reaction. The following matters may be available in water bodies which interferes with turbidity,

1. Settleable matter (G > 1)
2. Floating matter (G < 1)
3. Suspended matter (G = 1)



Note:
1. In both the above method principle involved in calculation of turbidity is same i.e. Light absorption principal.
2. Larger the length of the path travelled by the light, lesser will be the turbidity.

c) Baylis Turbidity Meter:



It consists of a closed galvanized iron box, on one side of which two glass tubes can be held vertically side by side. On the other side, in front of the tubes, an electric bulb is located with a reflector, so as to throw light on the tubes. One of the glass tube is filled with water sample (whose turbidity is to be measured) and the other is filled with standard water solution (of known turbidity). The electric bulb is lighted and the Colour in both the tubes is observed from the top of the instrument. If the Colour of both the tubes differ, the standard solution tubes are replaced by another standard tube of different turbidity. The process is continued till a matching is

New Batches are going to start.....

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7622050066

Test Series Available..

Total weekly test : 35

Total mid subject test : 16

Total full length test : 13

Mock test : 16

Total test : 80

CHEMICAL CHARACTERISTICS:

Total Solids:

The total amount of solids (suspended as well as dissolved solids) present in water can be determined by evaporating a sample of water and weighing the dry residue left (A). The suspended solids can be found by filtering the water sample and weighing the residue left on the filter paper (B). The difference between total solids (A) and suspended solids (B) will then represent nothing but the dissolved solids.

TDS = Total Solids – Suspended Solids

TDS = A - B

Another approximate method of determining the total dissolved solids is electrical conductivity test. In this test, di-ionic testers are used to measure electrical conductivity in µmho/cm at 25°C.

$$\mathbf{TDS = Electrical\ conductivity \times Correction\ factor}$$

$$\mathbf{TDS = Electrical\ conductivity \times 0.65}$$

Total dissolve solids, desirable limit is 500 mg/l, and permissible limit is 2000 mg/l.

Total suspended solids, permissible limit is 30 mg/l as per Environment Protection Agency (EPA).

pH:

It is defined as the negative logarithm of hydrogen ion concentration in water. It is an indicator to measure acidity or alkalinity of the water sample. It is measured on pH scale, which varies from 0 to 14.

$$\mathbf{p^H = -\log_{10}[H^+]}$$

$$\mathbf{p^{OH} = -\log_{10}[OH^-]}$$

$$\mathbf{p^H + p^{OH} = 14}$$

Where,

Unit of $[H^+]$ and $[OH^-]$ are moles/lit.

Acceptable limit for pH is 6.5 - 8.5.

If pH < 6.5 it will lead to Corrosion,

And if pH > 9.2 it will lead to Incrustation.

pH is measured by Potentiometer and Calorimetric method.

2) Non-Carbonate Hardness:

Hardness due to Cl^-, SO_4^{2-} and NO_3^- of Ca^{2+}, Mg^{2+}, Al^{3+} is known as non-carbonate hardness. It is also known as Permanent hardness and it can be removed by Zeolite (ion exchange) method or Lime soda process.

Note:
- By zeolite method 100% hardness can be removed.

Impacts:

1) Hardness leads to lesser formation of foam there by increases the consumption of soap.

2) Mg hardness of SO_4^{2-} induces laxative effect if greater than 50 mg/l.

3) Hardness leads to corrosion and incrustation.

4) Hardness leads to scaling in boilers which leads to bad economy.

Alkalinity:

It is the number of ions present in water which are capable of neutralizing $[H^+]$ ions in water. Alkalinity occurs because of presence of CO_3^{2-} ions, HCO_3^- ions and slightly because of $[OH^-]$ ions. On the basis of that alkalinity is divided into three categories,

i. Carbonate,

ii. Bicarbonate,

iii. Caustic.

Sources of alkalinity are the minerals present in water and atmospheric CO_2.

$$\mathbf{H_2O + CO_2 \rightleftharpoons H_2CO_3 \rightleftharpoons H^+ + HCO_3^-}$$

$$\mathbf{HCO_3^- \rightleftharpoons H^+ + CO_3^{2-}}$$

When pH is between 8-11 then,

$$\mathbf{CO_3^{2-} + H_2O \rightleftharpoons HCO_3^- + OH^-}$$

$$\mathbf{HCO_3^- \xrightarrow{algae} OH^-}$$

GPSC - CIVIL

Construction, Planning and Management

"All Birds find shelter during a rain.
But Eagle avoids rain by flying above
the Clouds."

A.P.J. Abdul Kalam

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Conversion of carbonate to bicarbonate is essentially completed at pH of 8.3 after this bicarbonate still requires hydronium ion for its complete neutralization. Hence it can be stated that half of the carbonate alkalinity is neutralized at pH of 8.3. Neutralization of hydroxide ion is also completed at pH of 8.3. Hence at pH of 8.3, total alkalinity neutralized is of half carbonate and caustic alkalinity. Volume of acid use to neutralize this alkalinity is "P" ml. At pH of 4.5 bicarbonate alkalinity originally present in this system and converted from carbonate is neutralized. Total volume of acid used for complete neutralization is "M" ml.

If pH is 2.8 to 4.4, methyl orange is used as an indicator which changes its Colour from red to yellow.

If pH is 8.6 to 10.3, Phenolphthalein is used as an indicator which changes its Colour from yellow to red.

If P = M, only caustic alkalinity is present,

If P = M/2, only carbonate alkalinity is present,

If P = 0, only bicarbonate alkalinity is present,

If P > M/2, caustic and carbonate alkalinity is present in major amount,

If P < M/2, carbonate and bicarbonate alkalinity is present in major amount.

Note:

- Carbonate hardness will always be equal to total hardness, generally in case of highly alkaline water for which noncarbonate hardness will always be negligible or zero.

Hardness as $CaCO_3$ mg/L	Degree of hardness
0-55	soft
56-100	Moderately soft
101-200	Hard
> 200	Very hard

Sodium Aluminate:

It reacts with Ca and Mg present in water,

$$Na_2Al_2O_4 + Ca(HCO_3)_2 \rightarrow Ca(Al_2O_4)_2 \downarrow + Na_2CO_3 + CO_2 + H_2O$$

$$Na_2Al_2O_4 + CaCl_2 \rightarrow Ca(Al_2O_4)_2 \downarrow + 2NaCl$$

$$Na_2Al_2O_4 + CaSO_4 \rightarrow Ca(Al_2O_4)_2 \downarrow + Na_2SO_4$$

It also reduces temporary and permanent hardness,

4. Nitrate:

The presence of nitrate in water indicate complete decomposition of organic matter.

Excess of nitrate causes methemoglobinemia (blue baby disease).

Its desirable and permissible limit is 45 mg/l.

It can be determined with the help of Colour matching technique and Colour is formed by phenol disulphonic acid and KOH.

Fluoride:

Water sources contain natural fluorides. Fluorides are mainly associated with some sedimentary and igneous rocks.

Its desirable limit is 1mg/l and permissible limit is 1.5 mg/l.

To remove fluoride, we use defluoridation. Defluoridation is done by following technique,

i. Addition of calcium phosphate,

ii. Nalgonda technique.

Effects:

< 1 mg/l, it helps to prevent dental cavities.

Up to 1.5 - 2 mg/l, decolourization of teeth or mottling of teeth occurs.

> 5 mg/l, deformation of bone called bone fluorosis or brittle bones occurs.

Chloride:

The presence of chloride in water indicates pollution due to sewage or industrial waste.

Its desirable limit is 250 mg/l, and permissible limit is 1000 mg/l.

For the determination of chloride content, we add Silver nitrate ($AgNO_3$) solution and titrate with Potassium chromate (K_2CrO_4).

BIOLOGICAL CHARACTERISTICS:

Pathogenic Bacteria:

Bacteria which can causes harm to human body is known as pathogenic bacteria.

Nonpathogenic Bacteria:

Bacteria can't cause harm to human body is known as nonpathogenic bacteria.

Aerobic Bacteria:

Bacteria which requires oxygen for their survival is known as aerobic bacteria. The process which takes place in the presence of oxygen is known as aerobic process.

Anaerobic Bacteria:

Bacteria which don't require oxygen for their survival is known as anaerobic bacteria and the process carried out by them is known as anaerobic process.

Facultative Bacteria:

Bacteria which can survive both in the presence and absence of oxygen in known as facultative bacteria.

Coliform Colony:

Coliform colony is of two types,

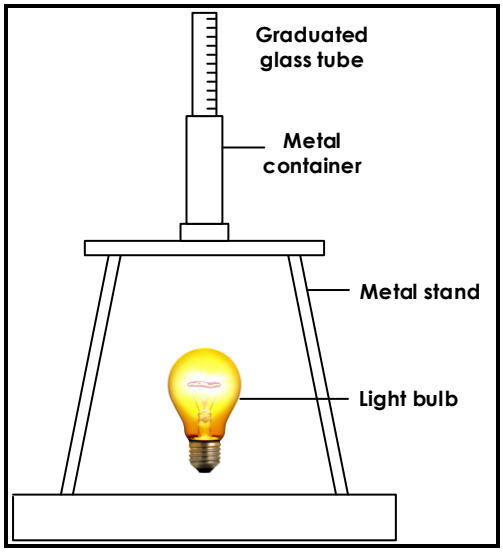
1. E. coli (Escherichia coli),
2. B. coli (bacillus coli).

E. Coli (Escherichia Coli):

It isn't a pathogenic bacteria, but it indicates probable presence of pathogenic bacteria in water. It is found in intestine of warm-blooded animals. It is very adaptive in nature and last longer.

Determination of Coliform:

We can determine the coliform by following techniques,



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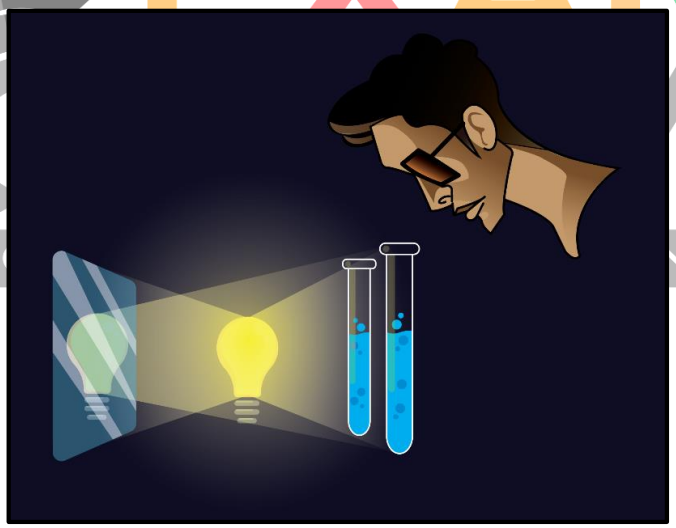

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Drinking water must have MPN = 0

i.e. 0 coliform colonies per 100 ml.

WATER BORNE DISEASE:

- **Bacteria (it gets nutrients from environment)**

  Typhoid (Salmonella typhi)

  Cholera (Vibrio cholerae)

  Bacillary dysentery (Sonne bacillus)

- **Virus (smaller than bacteria, live for very short time outside other living cells)**

  Jaundice (Hepatitis virus)

  Hepatitis (Hepatitis virus)

  Polio (Poliomyelitis virus)

- **Protozoa (bigger than bacteria, contains nucleus and other cell structure making them more like plant and animal cells)**

  Dysentery or Diarrhoea (Amoebic protozoa)

Qu6) The maximum safe permissible limit of sulphates in domestic water supply is

a) 100 mg/L

b) 200 mg/L

c) 500 mg/L

d) 600mg/L

Qu7) 60 ml of raw odourful sample is diluted to 420 ml, then what will be the TON_____

a) 8

b) 7

c) 6

d) 7.66

Qu8) The instrument which is used to measure the odour of water is_____

a) Tintometer

b) Osmoscope

c) Photometer

d) Bayli's meter

TEST YOUR SELF:

Qu9) A 200 ml of sample of water has initial pH 10. 30 ml of 0.02 N H_2SO_4 is require titrating the sample to pH of 4.5 and 11 ml of 0.02 N H_2SO_4 is require titrating the sample to pH of 8.3. The total alkalinity of water in mg/L as $CaCO_3$ is _____

a) 55

b) 150

c) 95

d) 105

EXAM ACHARYA
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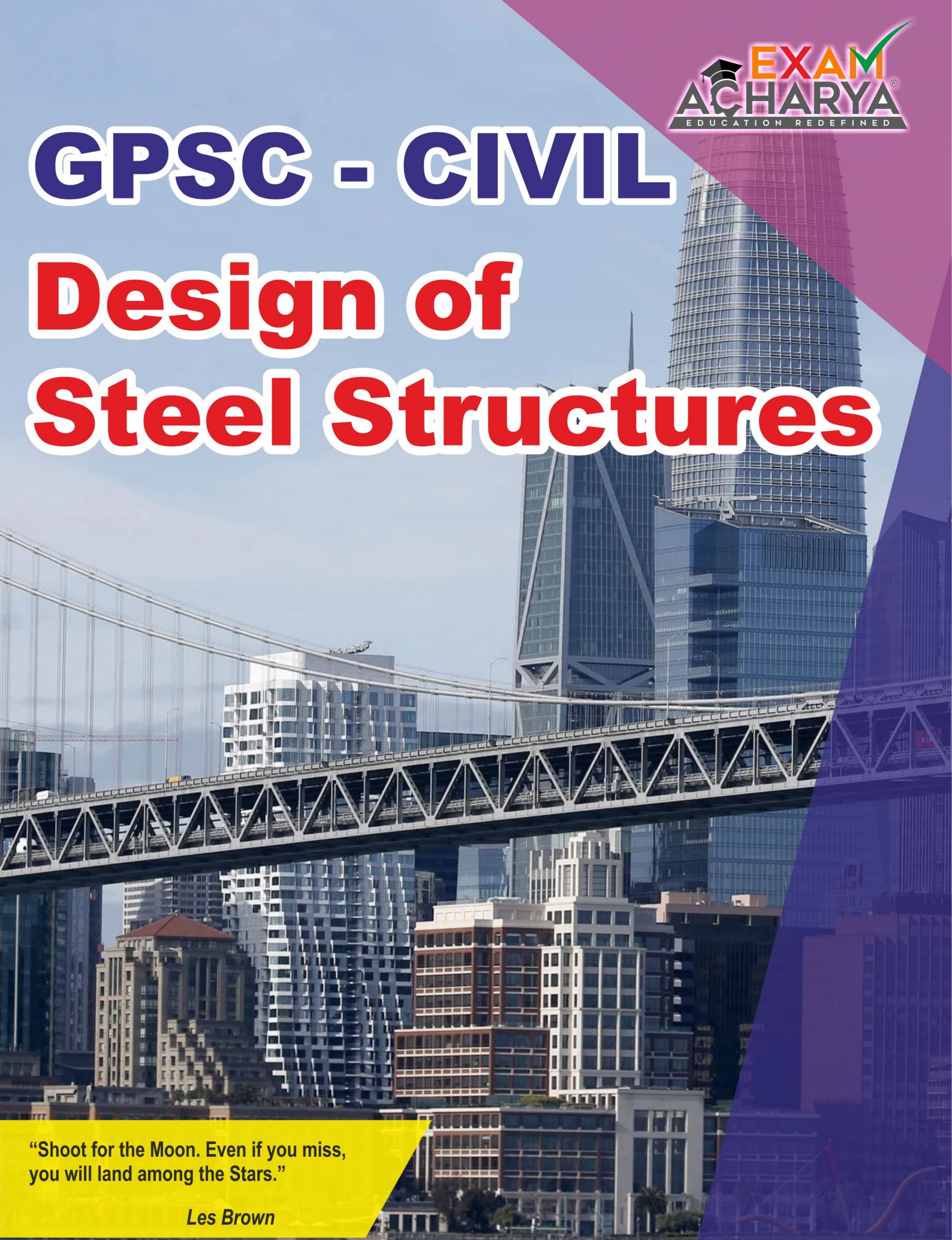
Design of Steel Structures



"Shoot for the Moon. Even if you miss, you will land among the Stars."

Les Brown

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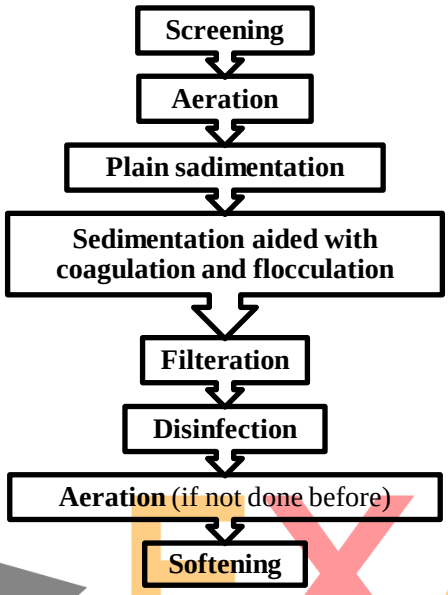
CHAPTER 3:

TREATMENT OF WATER

Following operation are carried out in purification of water,



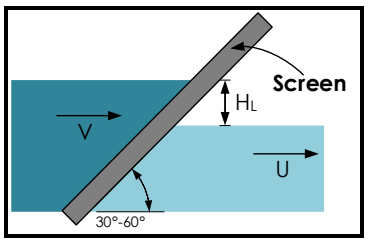
VC: Water Corporation

SCREENING:

It is done to remove the heavier impurities from the water like plants, trees, stones, animals etc. Screening is of following three types,

i. Coarse or trash screen (ϕ = 25 mm) (hole size is 20 – 100 mm)

ii. Fine or mesh (hole size is <10mm)



$$H_L = 0.0729(U^2 - V^2)$$

Where,

H_L = Head loss,

V = velocity before screen,

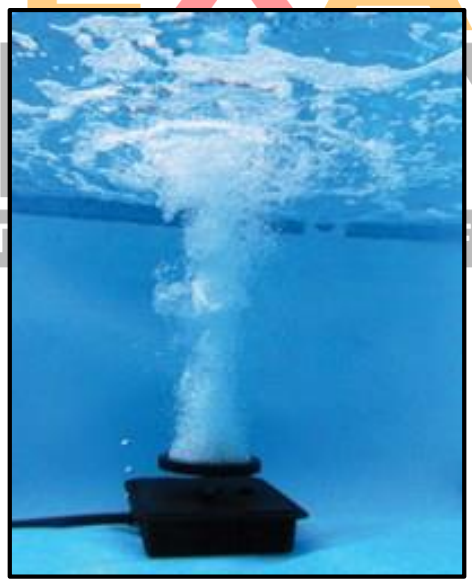
U = velocity after screen.

3. Mechanical Aeration:

In mechanical aeration, water is stirred through a rotating mechanical stirrer due to which it sucks the atmospheric airline above and gets aerated.

4. Diffused Aeration:

In diffused aeration compressed air is blown inside the aeration tank through an air compression machine.



As we know,

$$\mathbf{Q = \frac{Volume}{Time} = \frac{L \times B \times H}{T}}$$

As "t" is same for v_0 and v_H,

$$\therefore \mathbf{\frac{H}{v_0} = \frac{L}{v_H}}$$

$$\therefore \mathbf{V_0 = \frac{H}{t} = \frac{Q}{L \times B} = \frac{Q}{SA}}$$

and $\mathbf{V_H = \frac{L}{t} = \frac{Q}{H \times B}}$

Where,

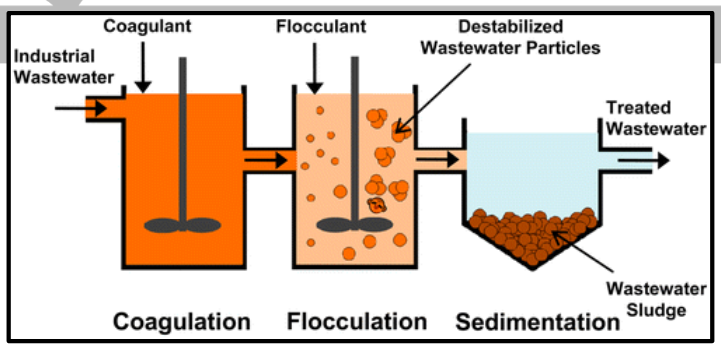
$\mathbf{V_0}$ = Overflow rate, loading rate or superficial velocity,

$\mathbf{V_H}$ = Horizontal or flow through velocity.

Note:
- For plain sedimentation $\mathbf{V_0}$ = 500 – 750 l/hr/m^2,
- For coagulation $\mathbf{V_0}$ = 1000 – 1250 l/hr/m^2.

$$\text{Efficiency, } \mathbf{\eta = \frac{V_s}{V_0} \times 100\%}$$

SEDIMENTATION AIDED WITH COAGULATION AND FLOCCULATION:



The efficiency of sedimentation tank is very less if very fine suspended particles are present in water. To increase the efficiency of the tank, coagulation and flocculation process is adopted which generally takes place in following three steps,

1. Coagulation (addition of coagulant with fast mixing),
2. Flocculation (slow mixing),
3. Sedimentation.

New Batches are going to start.....

Contact:

7622050066

Test Series Available..

Total weekly test : 35

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Mock test : 16

Total test : 80

iv) Inter Particle Bridging:

Larger molecules may be formed when alum or ferric sulphate dissociate in water. Several colloids may become attached to one molecule or various molecules resulting settleable mass.

Note:

For plain sedimentation,

$\mathbf{V_0}$ = 500 to 750 l/m^2/d

Detention time (t) = 4 – 8 hrs.

For sedimentation with coagulation,

$\mathbf{V_0}$ = 1000 to 1250 l/m^2/d

Detention time (t) = 2 - 4 hrs.

$\mathbf{V_H}$ = 0.15 – 0.9 m/min,

B = 10 – 12 m,

$\mathbf{L < 4B}$,

H = 3 m,

Sedimentation tank is designed for max. daily flow, max daily flow = 1.8 × average daily flow.

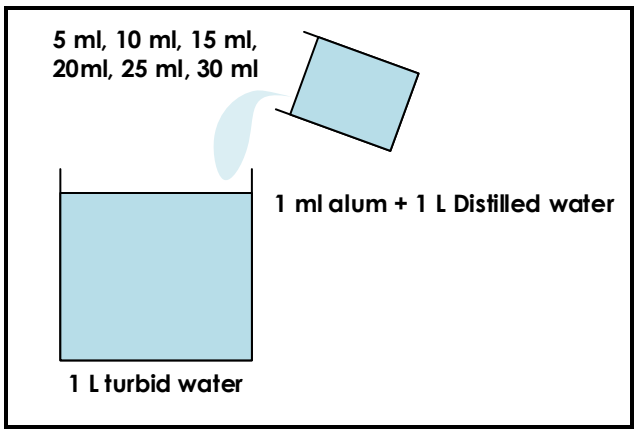
In circular sedimentation tank particle path will be parabolic path,

Volume of circular tank, $V = D^2(0.785H + 0.011D)$

When lime is added in water to increase alkalinity following reaction takes place,

$$Al_2(SO_4)_3 \cdot 18H_2O + 3Ca(OH)_2 \rightarrow 3CaSO_4 + 2Al(OH)_3 + 18H_2O$$

JAR TEST:



VC: NETCHEM Project

COAGULANTS:

1. Alum (Aluminium Sulphate : $Al_2(SO_4)_3$):

When alum is added in water it gets hydrated and forms $Al_2(SO_4)_3 \cdot 18H_2O$.

Alum requires alkaline medium for better efficiency hence pH of water is maintained in between 6.5 to 8.5.

When natural alkalinity is not present then lime is added for increasing alkalinity. Soda (Na_2CO_3) can also be added.

Quantity used is 10 to 30 mg/l.

$$Al_2(SO_4)_3 \cdot 18H_2O + 3Ca(HCO_3)_2 \rightarrow \underbrace{3CaSO_4}_{\text{Permanent hardness}} + \underbrace{2Al(OH)_3}_{\text{Floc sticky gelatinous}} + \underbrace{6CO_2}_{\text{Acidity leads to corrossion}} + 18H_2O$$

$$\underbrace{Ca(OH)_2}_{\text{Slaked lime}} + 2CO_2 \rightarrow Ca(HCO_3)_2$$

$$\underbrace{CaO}_{\text{Quick lime}} + H_2O \rightarrow Ca(OH)_2$$

2. Copperas (Ferrous Sulphate : $FeSO_4$):

When a copperas is added in water it gets hydrated and forms $FeSO_4 \cdot 7H_2O$.

It works in the pH range of 8.5 and above hence it is always used with lime.

Quantity used is 10 – 30 mg/l.

$$FeSO_4 \cdot 7H_2O + Ca(OH)_2 \rightarrow Fe(OH)_2 + CaSO_4 + 7H_2O$$

$$Fe(OH)_2 \xrightarrow{O_2} \underbrace{Fe(OH)_3}_{\text{Sticky gelatinous}}$$

$$FeSO_4 \cdot 7H_2O + Ca(HCO_3)_2 \rightarrow Fe(HCO_3)_2 + CaSO_4 + 7H_2O$$

$$Fe(HCO_3)_2 \xrightarrow{2Ca(OH)_2} Fe(OH)_2$$

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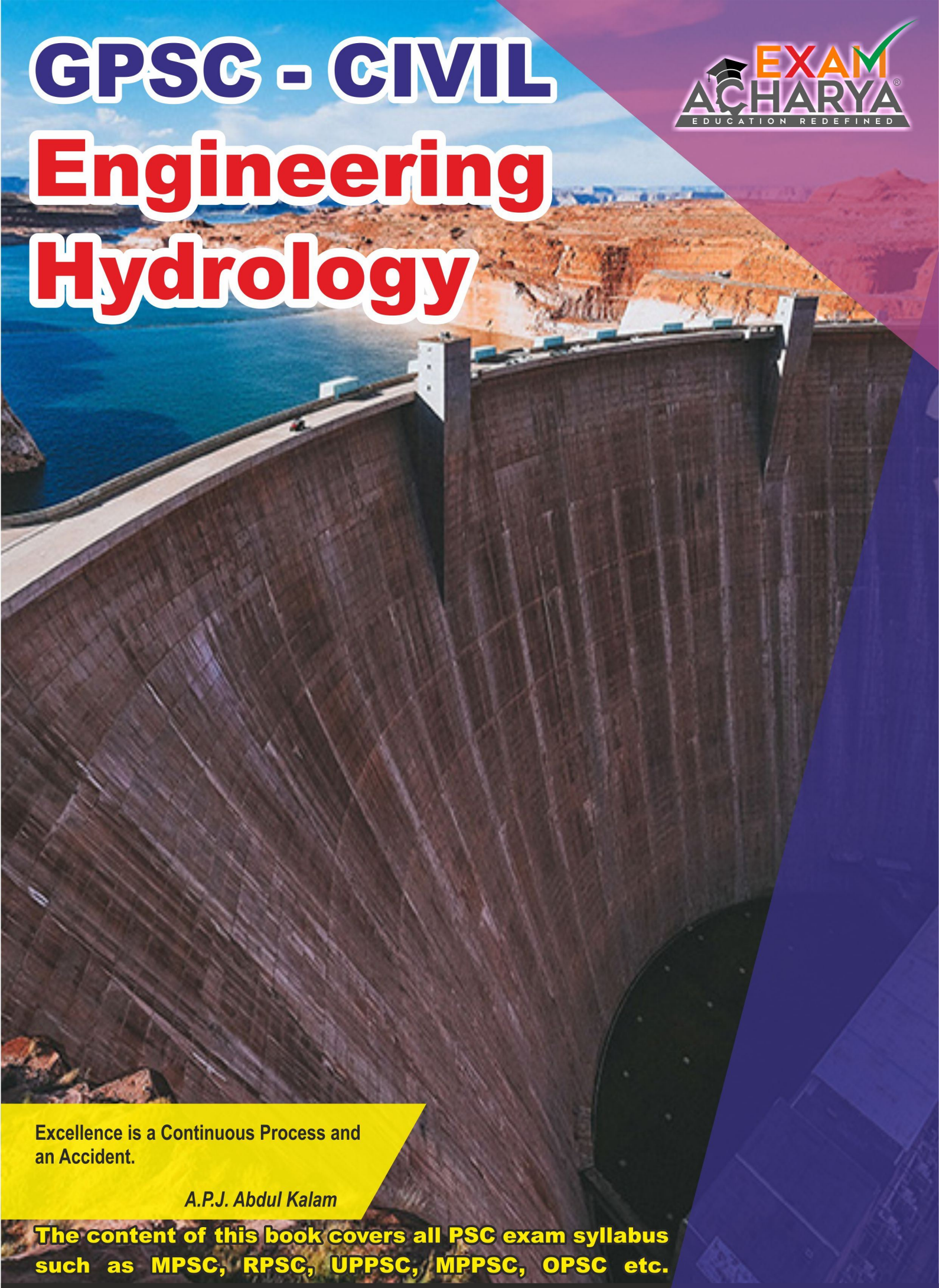

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Excellence is a Continuous Process and an Accident.

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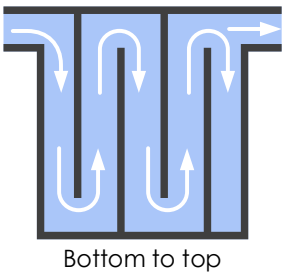
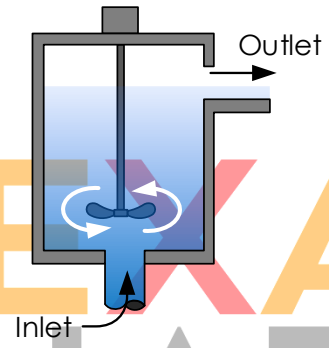
ii. Bottom to top



2. Mechanical stirrer

i. Rapid mix

ii. Slow mix



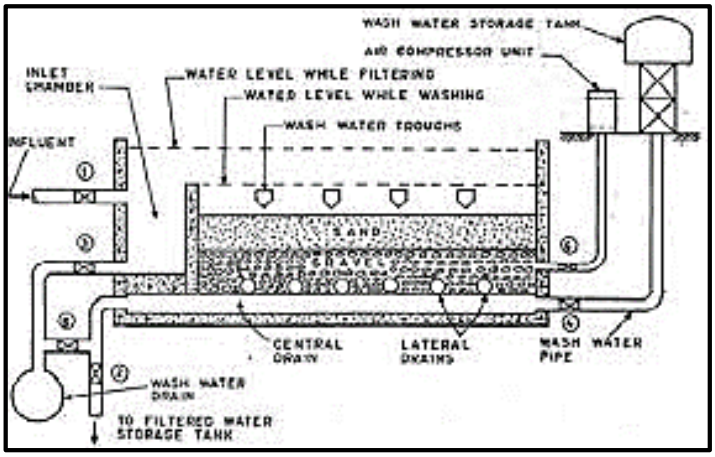
3. Secondary Sedimentation:

Always sedimentation process is done after coagulation and flocculation, but it is not necessary to done flocculation and coagulation before sedimentation.

FILTRATION:

Screening and sedimentation remove a large percentage of the suspended solids and organic matter present in raw supplies. The percentage of removal of the fines colloidal matter increases when coagulants are also used before sedimentation but however the resultant water will not be pure and may contain some very fine suspended particles and bacteria present in it. To remove or to reduce the remaining impurities still further and to produce portable water, the water is filtered through the bed of fine granular material such as sands etc. The process of passing the water through the beds of such granular materials (called filters) is known as filtration. Filtration may help in removing Colour, odour, turbidity, and pathogenic bacteria from the water.

2. Rapid Sand Filter:



When Filter is in Operation:

Valve 1 is first of all opened which leads the effluent of coagulation sedimentation tank to enter the inlet chamber of the filter. This water gets filter through the filter beds and the filtered water can be taken out from the main drain by opening valve 4. This filtered water can be taken to the disinfection unit. Thus, when filter is in working condition only this two valves (1 and 4) shall be kept open and all other valves kept closed.

Back Washing:

When sand becomes dirty as it is indicated by the excessive loss of head the filter must be cleaned and washed. For cleaning the raw supplies as well as the filtered water sent back upward through the filter beds this forced upward movement of wash water and compressed air will agitate the sand particles and thus removing the suspended impurities from it. The process of washing the filter and removing the dirty water is generally continued for a period of 3 – 5 min. The entire process of backwashing the filter and maintaining filter supplies taken about 15 min and the filter unit remains out of operation for this much of time the amount of water required for washing a rapid sand filter may vary from 2 – 5 % of the total amount of water filtered.

D_{10} = 0.45 – 0.7 mm, $\frac{D_{60}}{D_{10}}$ = 1.3 – 1.7

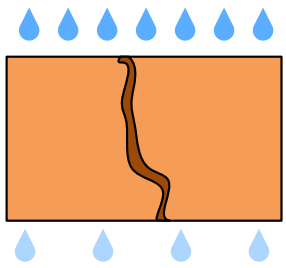
$H_{L,max}$ = 2.5 – 3 m

It is operated like a rapid sand gravity filter except that raw water is neither flocculated nor sedimented before it enters the filters rate of filtration is 6000 – 15000 l/m^2/hr.

Difference between SSF and RSF:

Slow sand filter	Rapid sand filter
i. Particle size = 0.2 – 0.3 mm.	**i.** Particle size = 0.45 – 0.7 mm.
ii. Discharge is slow.	**ii.** Discharge is more.
iii. Flexibility is less.	**iii.** No. of units are more hence flexibility is more.
iv. Maintenance cost is low, but installation cost is more.	**iv.** Maintenance cost is more but installation cost is less.
v. Surface loading is around 100 – 200 l/m^2/hr.	**v.** Surface loading rate is around 3000 – 6000 l/m^2/hr.
vi. Almost pure water is obtained in SSF with 98% to 99% disinfection hence no chlorination or slight chlorination is required.	**vi.** Chlorination is compulsory.
vii. Generally done after primary sedimentation tank.	**vii.** Generally done after secondary sedimentation tank i.e. after coagulation and flocculation.
viii. Method of cleaning by scraping of top 1.5 – 3 cm top layer of sand.	**viii.** Methods of cleaning by back washing with air or water.

Time for Reaching Particle Breakthrough (T_B):



It is the time elapsed form the start of filter run till turbidity in water reaches 2.5 NTU.

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Total mid subject test : 16

Total full length test : 13

Mock test : 16

Total test : 80

After killing the bacteria by using excessive lime, the next requirement is to reduce the pH value for making it fit for domestic purpose.

3. Treatment with Ozone:

Ozone gas is a faintly blue gas of pungent odour and is an excellent disinfectant. Ozone is produced by passing a high-tension electric current through a stream of air is a close chamber.

$$3O_2 \xrightarrow[\text{High electric arc voltage}]{\text{Passing through}} 2O_3$$

But as the ozone is highly unstable it breaks down in the ordinary oxygen and liberates nascent oxygen which can be shown by the following reaction.

$$O_3 \rightarrow O_2 + \underset{\text{(Nascent oxygen)}}{O}$$

The nascent oxygen is very powerful oxidizing agent and it kills all the bacteria's as well as oxidizes the organic matter present in the water.

4. Treatment with Iodine and Bromine:

The addition of iodine or bromine to water can help in killing the pathogenic bacteria and thereby disinfecting the same. The quantity of these disinfectants may be limited to about 8 ppm and a contact period of 5 minutes is generally enough. These disinfectants are now a days also available in the form of pills and are thus very handy. They are not used for treating any large-scale public supplies but may be used for treating small water supplies.

5. Disinfection by Potassium Permanganate:

This is the most common disinfectant used in the village for disinfection of dug well water, pond water or private source of water. In addition to the killing of bacteria it also reduces the organic matters by oxidizing them.

Due to its good oxidizing quality, it is sometimes added in small dose 0.05 to 0.1 mg/l in the chlorinated water also. In the rural areas it is common practice to dissolve a small amount of potassium permanganate in a bucket of water and mix it with the water of the well frequently, to kill the bacteria. After adding this in water the colour of water should become light pink.

The usual dose of $KMnO_4$ is 1 – 2 mg/l of water with contact period of 4 – 6 hrs. its efficiency is only 98%.

Reaction of chlorine with ammonia,

$$NH_3 + HOCl \rightarrow \underbrace{NH_2Cl}_{\text{Monochloramine}} + H_2O$$

$$NH_2Cl + HOCl \rightarrow \underbrace{NHCl_2}_{\text{Dichloramine}} + H_2O$$

$$NHCl_2 + HOCl \rightarrow \underbrace{NCl_3}_{\text{Trichloramine}} + H_2O$$

Monochloramine will exist for pH > 7.5,

Dichloramine will exist for pH = 5 – 6.5,

Trichloramine will exist for pH < 4.4.

CHLORINE APPLICATION:

Chlorine is applied into water in following ways,

i. Chlorine gas,

ii. Chloramine,

iii. Bleaching powder or Hypochlorite.

$$\underbrace{Ca(OCl)_2}_{\text{Bleaching powder}} \rightarrow Ca^{2+} + \underbrace{2OCl^-}_{\text{Hypochlorite ion}}$$

Chlorine available in bleaching powder is 30 -45 % and in hypochlorite is 60 -70 %.

TYPES OF CHLORINATION:

Chlorination is divided into following forms,

1. Plain Chlorination:

It indicated that no other treatment has been carried out (sedimentation, filtration, screening etc.) and only chlorine treatment is given. This technique may be used for treating relatively clearer water with turbidities less then 20 to 30 mg/L obtained from lakes, reservoirs etc. The dosage of chlorine should be such as to leave a residual chlorine of about 0.5 mg/L or more.

2. Pre-Chlorination:

It is the process of applying chlorine to the water before filtration or rather before sedimentation, coagulation. It helps in improving coagulation and reduces the loads

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Fluid Mechanics and Hydraulic Machines

"Success Consists of going from Failure without Loss of Enthusiasm."

Winston Churchill

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ORTHOTOLIDINE TEST:

It is a test conducted to find amount of residual chlorine in water. 10 ml of chlorinated water sample is added with 0.1 ml Orthotolidine solution and yellow Colour appeared is compared with standard Colour chart to find amount of residual chlorine.

5 sec of yellow Colour ⟶ Free available chlorine residual ($HOCl, OCl^-$)

5 min. of yellow Colour ⟶ Total chlorine residual (Chloramines, $HOCl, OCl^-$)

CHICK'S LAW:

Consumption of chlorine in water follows 1st order reaction i.e. rate of killing of bacteria is directly proportional to initial present concentration of bacteria.

$$\mathbf{\frac{dN_t}{dt} \propto N_t}$$

Where,

N_t = Microorganisms at time "t" remaining,

$\because \frac{dN_t}{dt} \propto N_t$

or, $\frac{dN_t}{dt} = -kN_t$, (K = Rate decay constant)

or, $\int_{N_0}^{N_t} \frac{dN_t}{N_t} = \int_0^t -kdt$

or, $[\log_e N_t]_{N_0}^{N_t} = -k[t]_0^t$

or, $\log_e \frac{N_t}{N_0} = -kt$

or, $\frac{N_t}{N_0} = e^{-kt}$

or, $N_t = N_0 e^{-kt}$

$$\boxed{\mathbf{N_t = N_0 e^{-kt}}}$$

$$\underbrace{Na_2Z}_{\text{Sodium Zeolite}} + \begin{Bmatrix} Ca \\ Mg \end{Bmatrix} \begin{Bmatrix} (HCO_3)_2 \\ SO_4 \\ Cl_2 \end{Bmatrix} \rightarrow \underbrace{Na_2 \begin{Bmatrix} (HCO_3)_2 \\ SO_4 \\ Cl_2 \end{Bmatrix}}_{\text{Sodium salts}} + \underbrace{\begin{Bmatrix} Ca \\ Mg \end{Bmatrix} \{Z\}}_{\text{Ca or Mg zeolite}}$$

The Ca or Mg zeolite can be regenerated into active sodium zeolite by treating it with 5 – 10 percent solution of sodium chloride. The exchange reacting that takes place during regeneration can be represented as.

$$\underbrace{\begin{Bmatrix} Ca \\ Mg \end{Bmatrix} \{Z\}}_{\text{Ca or Mg zeolite}} + 2NaCl \rightarrow Na_2Z + \begin{Bmatrix} Ca \\ Mg \end{Bmatrix} Cl_2$$

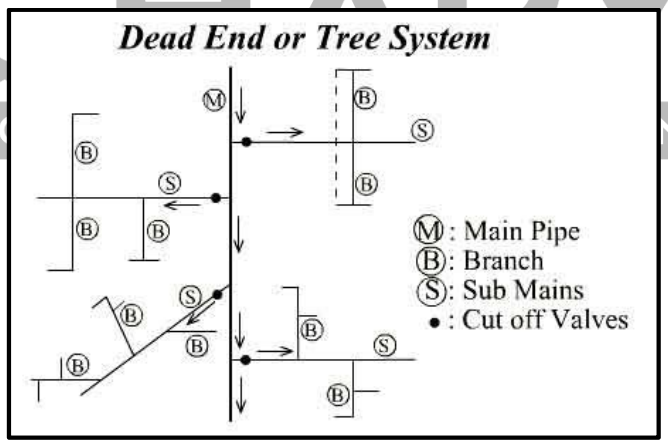
Note:
- Water of zero hardness can be obtained through zeolite process.

DISTRIBUTION SYSTEM:

There are four types of distribution systems are used,

1. Dead End System:

This is one main supply pipe from which originates a number of submain pipes. Each submain then divided into several branch pipe called laterals.



Advantages:

1. Lesser no. of cutoff valves required,

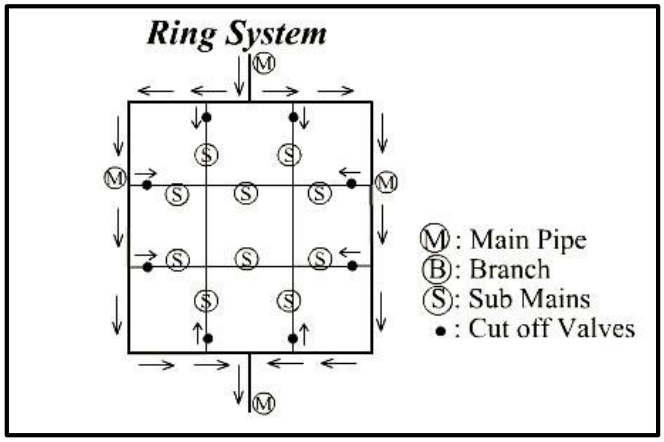
2. Cheap and economical,

3. Shorter pipe length,

4. Easier expansion.

3. Ring System:

A closed ring either circular or rectangular of main pipe is provided. It will improve pressure at various points. During fire break out, large quantity of water is available. The length of distribution main is much larger.



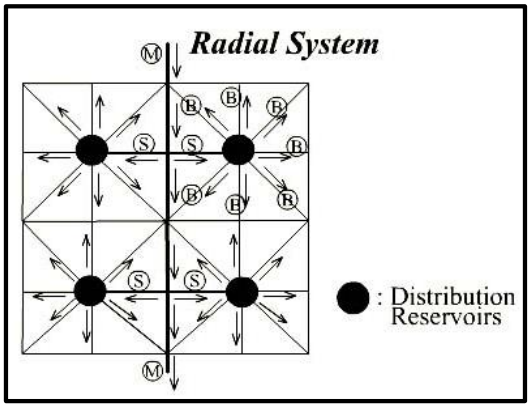
Advantages and disadvantages are same as that of grid iron system.

4. Radial System:

The area is divided into small distribution zones and in the center of each zone a distribution reservoir is provided. Water from these reservoirs is supplied radially laid distribution pipes running towards the periphery of the zone.

Ensures high pressure and efficient water distribution.

Suitable for cities with radial roads.



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4. By Using Waste Detection Meters:

These meter measure any unusually high flow passing through a water main during the period of low consumption such as during night or early morning, this unnatural excess flow from a portion of the pipe will indicate the leakage of the water through that section of pipe.

METHODS FOR THE ANALYSIS OF THE PIPE NETWORK:

i. Equivalent Pipe Method:

A complex system of pipes is replaced by a single hydraulically equivalent pipe. The equivalent pipe is one which will replace a given system of pipes with equal head loss for a given flow.

By using following formula, we calculate the dimensions of the equivalent pipe,

$$\frac{L_{eq}}{d_{eq}^5} = \frac{L_1}{d_1^5} + \frac{L_2}{d_2^5} + \frac{L_3}{d_3^5}$$

ii. Hardy Cross Method:

Following three laws are applicable,

a. In each separate pipe or element comprising the system there will be a relation between the head loss in the element and the quantity of water flowing through it.

b. At each junction, the algebraic sum of the quantities of the water entering and leaving the junction is zero. i.e. $\sum Q=0$.

c. In any closed path or circuit, the algebraic sum of the head loss in the individual element is zero. i.e. $\sum h_L=0$.

d. Modification in discharge, $\Delta Q = \frac{-\sum rQ^n}{\sum |nrQ^{n-1}|}$

4. Stop Cock:

It is provided before the water meter (if the water meter is provided) otherwise it is connected at the end of the service pipe and close to the boundary wall of the premises in an unaccessible position. It is housed in a small masonry chamber with a removable cover for stopping or opening the water supply to the premises.

5. Water Meter:

These are connected after the stop cock to measure the quantity of water supplied to a premises.

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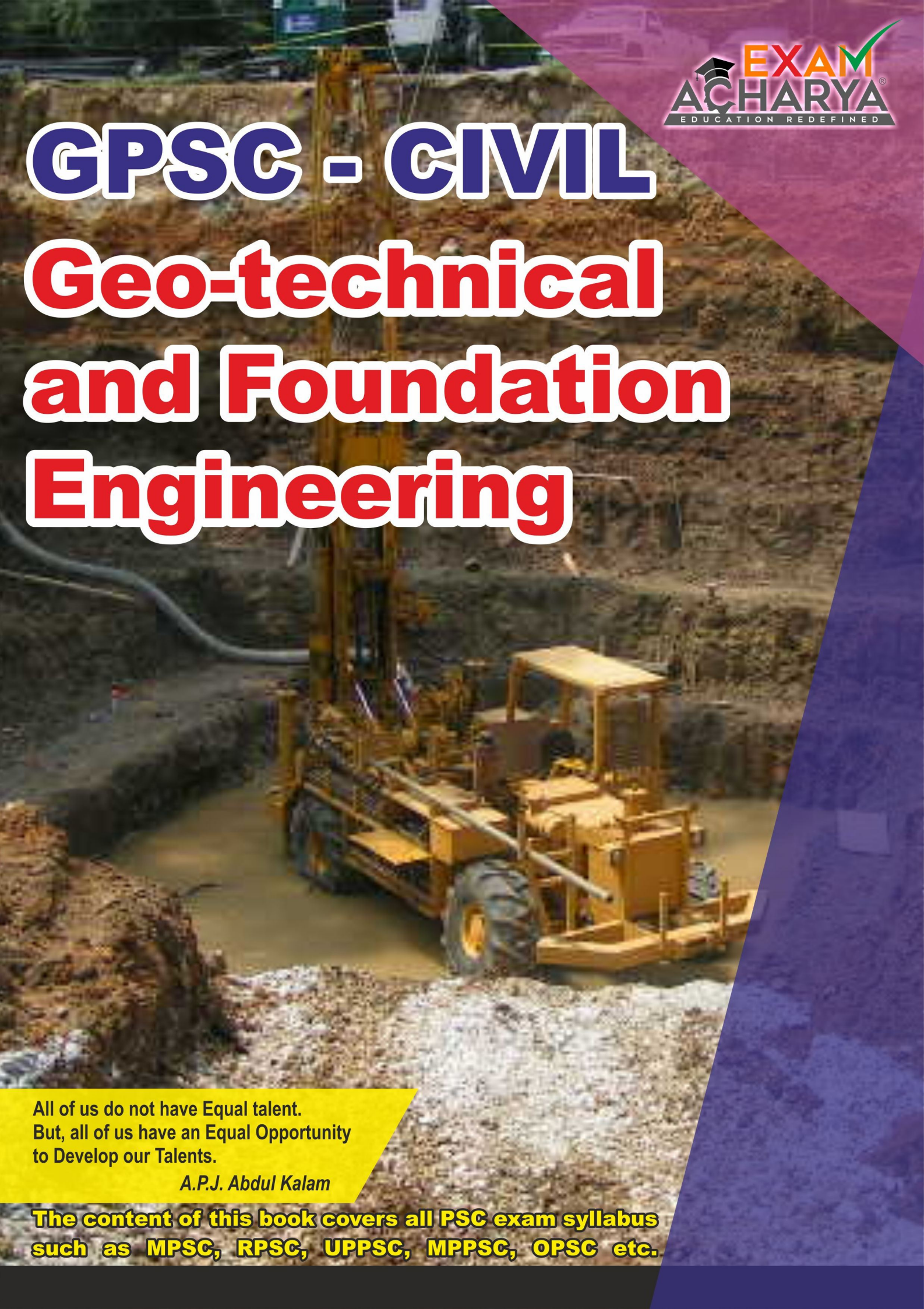

All of us do not have Equal talent.
But, all of us have an Equal Opportunity
to Develop our Talents.

A.P.J. Abdul Kalam

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4. Pressure Relief Valve:

Valve opens automatically as soon as pressure in a pipe exceeds the limit. It is provided on the upstream of sluice valve. It is also used to reduce the water hammering effect.

Qu6) The bacterial removal efficiency of the rapid sand filter is _____ in comparison to slow sand filter.

a) More

b) Less

c) Equal

d) Better

Qu7) Zeolites are complex compound of _____

a) Aluminium and lime

b) Silica and soda

c) Aluminium, silica and soda

d) Lime and soda

TEST YOUR SELF:

Qu8) If the discharge is 70MLD and settling is done for a particle of diameter 0.1mm, specific gravity is 2.5, kinematic viscosity is $2x10^{-2}cm^2/sec$, if B=L/3 and all particles are desired to be removed then the length of the sedimentation tank "in m" will be

a) 24.4

b) 34.4

c) 8.30

d) 10.24

Qu9) The amount of $Ca(HCO_3)_2$ required for 1998Kg of Alum will be _____

a) 1358

b) 1458

c) 1652

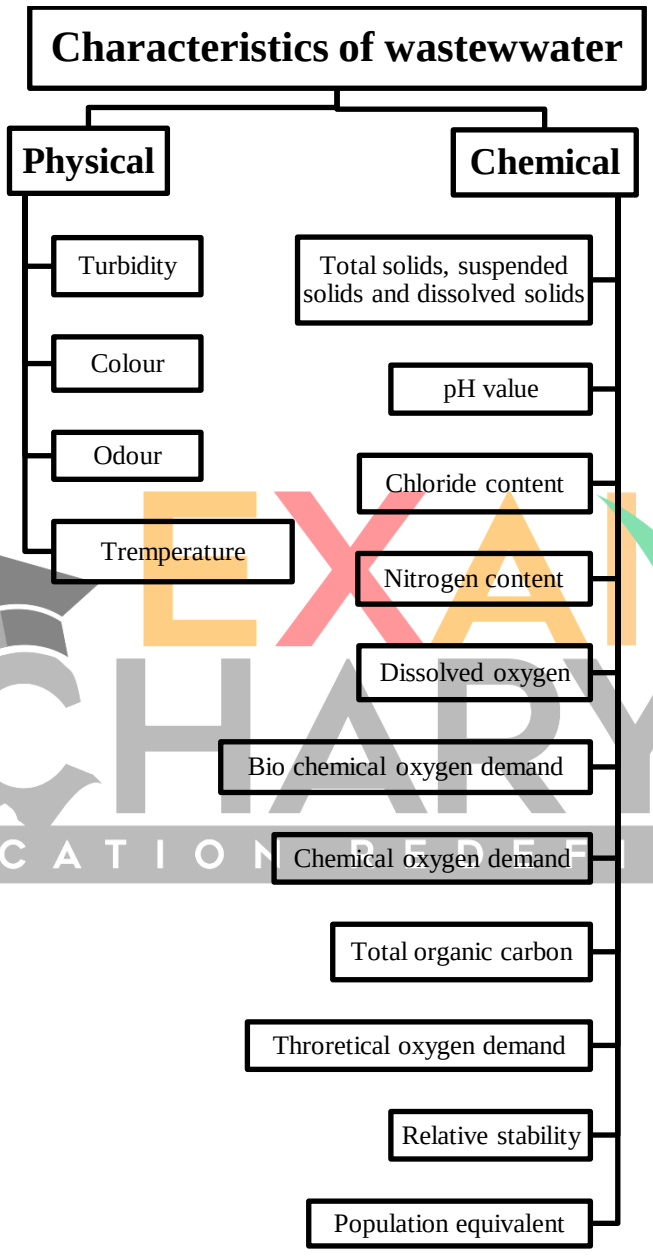
d) 1768

Qu10) Population of a city is 20000, per capita water demand is 150 LPCD. If bleaching powder contains 30% of available residual chlorine, the amount

CHAPTER 4:

WASTEWATER MANAGEMENT

CHARACTERISTICS OF WASTEWATER:



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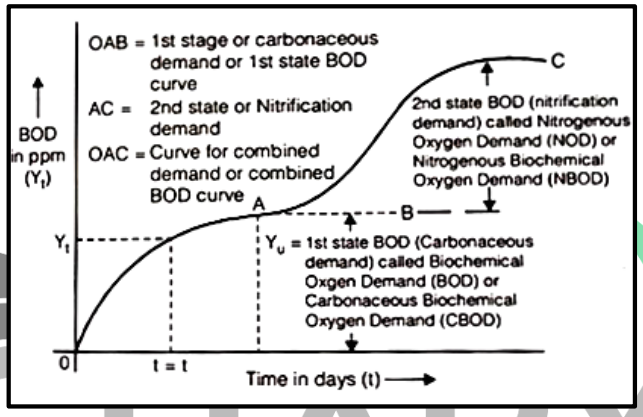
e. Dissolved Oxygen:

Dissolved oxygen refers to the level of free oxygen present in water. It is an important parameter in an assessing water quality because of its influence on the organisms within a body of water.

Note:
- At least 4ppm of dissolve oxygen is required for the survival of aquatic life.

f. Biochemical oxygen demand:

BOD is the oxygen demand exerted by bacteria in water for disintegration and decomposition of organic matters present in water. It follows first order reaction. Normal range of BOD for municipal sewage is 200 – 500 mg/L.



Nitrogenous demand starts only after 5 – 8 days because the reproduction rate of nitrification is slow. Nitrification bacteria are autotropes. They derive carbon for their growth from CO_2. Hence they have to spend energy in reduction of CO_2 to C. Thus, energy available for reproduction is less, thus by growth rate is less.

On the other hand, Carbonaceous matter oxidizing bacteria are heterotropes. They derive carbon from organic matter directly. Hence energy is not spent in getting carbon. Thus, by their reproduction rate is more.

To determine the BOD we use following formulas,

$$L_t = L_0 e^{-kt}$$

$$y_t = L_0 - L_t$$

$$y_t = L_0 - L_0 e^{-kt}$$

$$L_t = L_0 10^{-k_D t}$$

$$y_t = L_0 - L_t$$

In TOC test 100 ml of sample is taken in a test tube and added with few drops of methylene blue after which amount of H_2S gas produce is analyzed by a carbonaceous analyzer and total organic carbon is concluded.

i. Theoretical Oxygen Demand (ThOD):

It is the theoretical method of oxygen demand. If chemical formula is known ThOD can be easily computed.

$$C + O_2 = CO_2$$

1 mole C = 1 mole O_2

12 gm of C = 32 gm of O_2

1 gm of C = $\frac{32}{12}$ gm of O_2

= 2.67 gm of O_2

j. Relative Stability:

It is defined as the ration of available oxygen in sewage to the required oxygen for satisfying 1st stage BOD. The available oxygen will include dissolved oxygen as well as oxygen present as nitrite or nitrate.

$$S_R = 100[1 - (0.794)^{t_{20°C}}]$$

$$S_R = 100[1 - (0.630)^{t_{37°C}}]$$

t_{20} and t_{37} represent time in days at 20°C and 37°C incubation respectively.

k. Population Equivalent:

Industrial wastewater is generally compared with per capita normal wastewater so as to rationally charge the industries for the pollution caused by them.

$$\text{Population equivalent} = \frac{BOD_5 \text{ of industry (kg/d)}}{BOD_5 \text{ by a person (kg/c/d)}}$$

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Reinforced Cement Concrete

Education's purpose is to
replace an empty mind with an open one.

Malcolm Forbes

The content of this book covers all PSC exam syllabus such as MPSC, RPSC, UPPSC, MPPSC, OPSC etc.

Qu6) _____ indicates the freshness of sewage.

a) Turbidity

b) Colour

c) Temperature

d) COD

Qu7) What is the minimum quantity of dissolved oxygen that should be present in the treated sewage?

a) 6ppm

b) 4ppm

c) 1ppm

d) 10ppm

TEST YOUR SELF:

Qu8) Discharge of sewage water=0.5m^3/sec, Discharge of river water=8m^3/sec, BOD_5 of sewage= 600mg/l, BOD_5 of river= 10mg/l. The BOD_5 of the mixture will be _____(in mg/l)

a) 54.7

b) 34.4

c) 44.7

d) 55.5

Qu9) The standard solid of domestic sewage is 40gm per person per day, if 8000 litres daily contribution of industrial waste contains100 mg/l of suspended solids then population equivalent will be_____

a) 320

b) 200

c) 80

d) 32

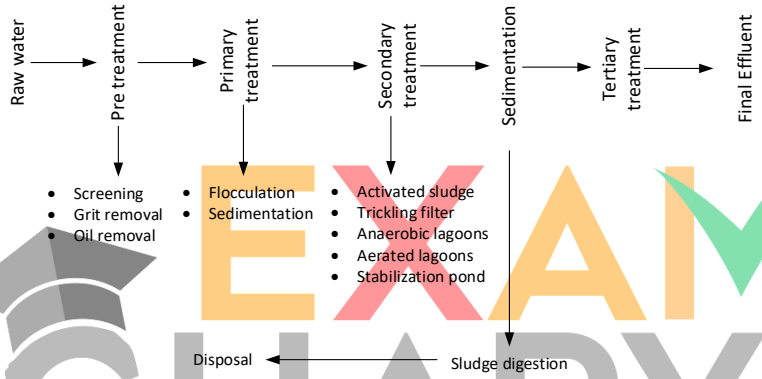
CHAPTER 5:

WASTEWATER TREATMENT

1. Preliminary and primary treatment also called physical or 1° treatment is to remove solid material from the incoming wastewater.

2. Secondary treatment (Biological treatment) also called 2° treatment usually consists of biological conversion of dissolved and colloidal organics into biomass that can subsequently be removed by sedimentation.

3. Tertiary treatment (chemical treatment) also called 3° treatment most often involves further removal of suspended solids and the removal of nutrients.



PRIMARY TREATMENT OF WASTEWATER:

i. Screening:

The screen is a device with openings generally uniform in size placed across the flow, to retain floating coarse solids.

It helps to reduce the loads on subsequent treatment unit.

Coarse screen = 20 to 100 mm spacing,

Fine screen = Less than 10 mm opening size.

ii. Grit Chamber or Detritus Tank:

Grit removal basins such as grit chamber or grit channels or detritus tanks are the sedimentation basins placed in front of the wastewater treatment plant to remove the inorganic particles (G = 2.65) such as sand, gravel, grit, egg shells, bones and other materials that may clog channels or damage pumps.

iv. Sedimentation Tank:

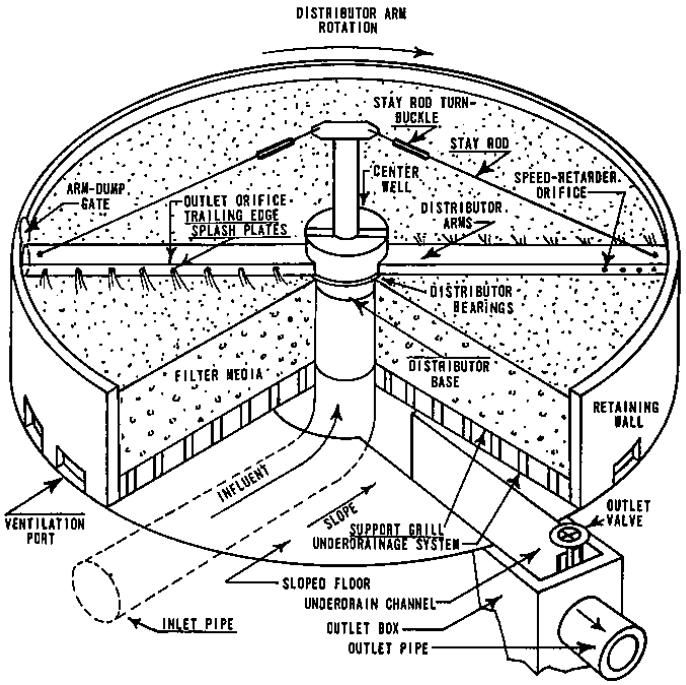
Same as water treatment.

$$v_H = \frac{L}{t}, v_0 = \frac{H}{t} = \frac{Q}{SA}$$

$$\eta = \frac{v_s}{v_0} \times 100$$

BIOLOGICAL TREATMENT:

1. Trickling filter:



Trickling filter is also called as Dip type filter or percolating filter, consist of tanks of coarser filtering media, over which the sewage is allowed to sprinkle or trickle down, by means of spray nozzles or rotary distributors. The percolating sewage is collected at the bottom of the tank through a well-designed under drainage system.

The decomposition of the organic matter and the resultant purification of the sewage is brought about by a population of microorganisms. Microorganisms and bacteria, which are naturally present in sewage, get attached to the filter media, organic matter from the sewage influent is also adsorbed on the biological film which is formed by microorganisms around the filtering media particle. In the outer portions of this film of biological mass or slime layer, the organic matter is degraded by the aerobic bacteria. As the microorganisms grow, the thickness of the slime layer increases and the diffused oxygen is consumed by the upper portions of the slime

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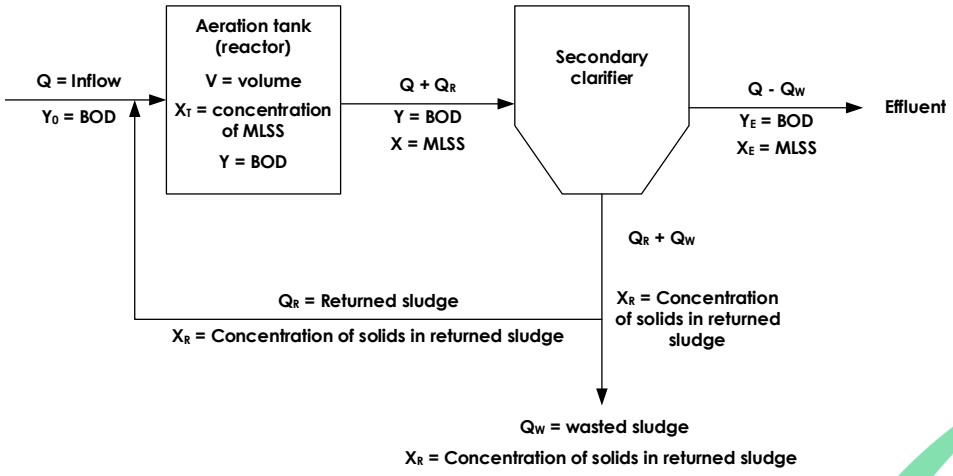
of the aeration tank to be mixed again with the sewage which is continuous being produced by this process and a portion of it being utilized and sent back to the aeration tank, whereas the excess portion is disposed of properly along with the sludge collected during primary treatment, after digestion. The effluent obtained from a properly operated activated sludge plant is of high quality usually having a lower BOD removal is up to 80-95% and bacteria removal is up to 90-95%.



Aeration Period or Hydraulic Retention Time (HRT):

$$\text{Detention period, } t = \frac{\text{Volume of tank}}{\text{Rate of sewage flow in the tank}}$$

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

$$= \frac{V}{Q} \times 24 \text{ hr.}$$

Sludge Age or Mean Cell Residence Time (MCRT):

Average time for which biomass stays in system is called sludge age or MCRT.

$$\theta = \frac{\text{Total biomass in system}}{\text{Biomass leaving per day}}$$

$$\theta = \frac{X_T \times V}{X_E(Q - Q_W) + X_R Q_W}$$

Where,

X_T = Concentration of solids in the influent of the aeration tank called the MLSS i.e. mixed liquor suspended solid in mg/L,

X_R = Concentration of solids in the returned sludge or in the wasted sludge,

X_E = Concentration of solids in the effluent in mg/L,

Recirculation Ratio (R):

$$\mathbf{R = \frac{Q_R}{Q}}$$

Organic Loading:

$$\textbf{Organic loading} = \frac{Y_{0x}Q}{V}\ \textbf{(kg/m}^3\textbf{/day)}$$

3. Oxidation Pond:

Oxidation ponds are open flow through earthen basins, specifically designed and constructed to treat sewage and biodegradable industries wastewater. Such pond provides comparatively long detention periods, extending from a few days to several days, during which time the wastes get stabilized by the action of natural forces.

In a total aerobic pond, the stabilization of wastes is brought about by aerobic bacteria, which flourish in the presence of oxygen. The oxygen demand of such bacteria in such a pond is met by the combined action of algae and other microorganisms called algal photosynthesis or algal symbiosis. In this symbiosis, the algae (which are microscopic plant) while growing in the presence of sunlight, produces oxygen by the action of photosynthesis and this oxygen is utilized by the bacteria for oxidizing the waste organic matter. The end products of the process are carbon dioxide, ammonia, and phosphates which are required by the algae to grow and continue to produce oxygen.

Properly operated ponds may be as effective as trickling filters in reducing the BOD of sewage. The BOD removal is up to 95% and coliform removal is up to 99% or so. Minimum depth of water to be kept in pond is 0.3m. Depth is 1 – 1.8 m, Detention time = 2 – 6 weeks.

4. Aerated Lagoons:

If oxygen is supplied to stabilization ponds by mechanical agitation they are termed as aerated lagoons.

5. Oxidation Ditch:

The oxidation ditch is a modified form of extended aeration of activated sludge process. It has been modified to eliminate the primary sedimentation tank and sludge digestion tank in a process called extended aeration, which aims at providing an aeration tank with a longer aeration time.

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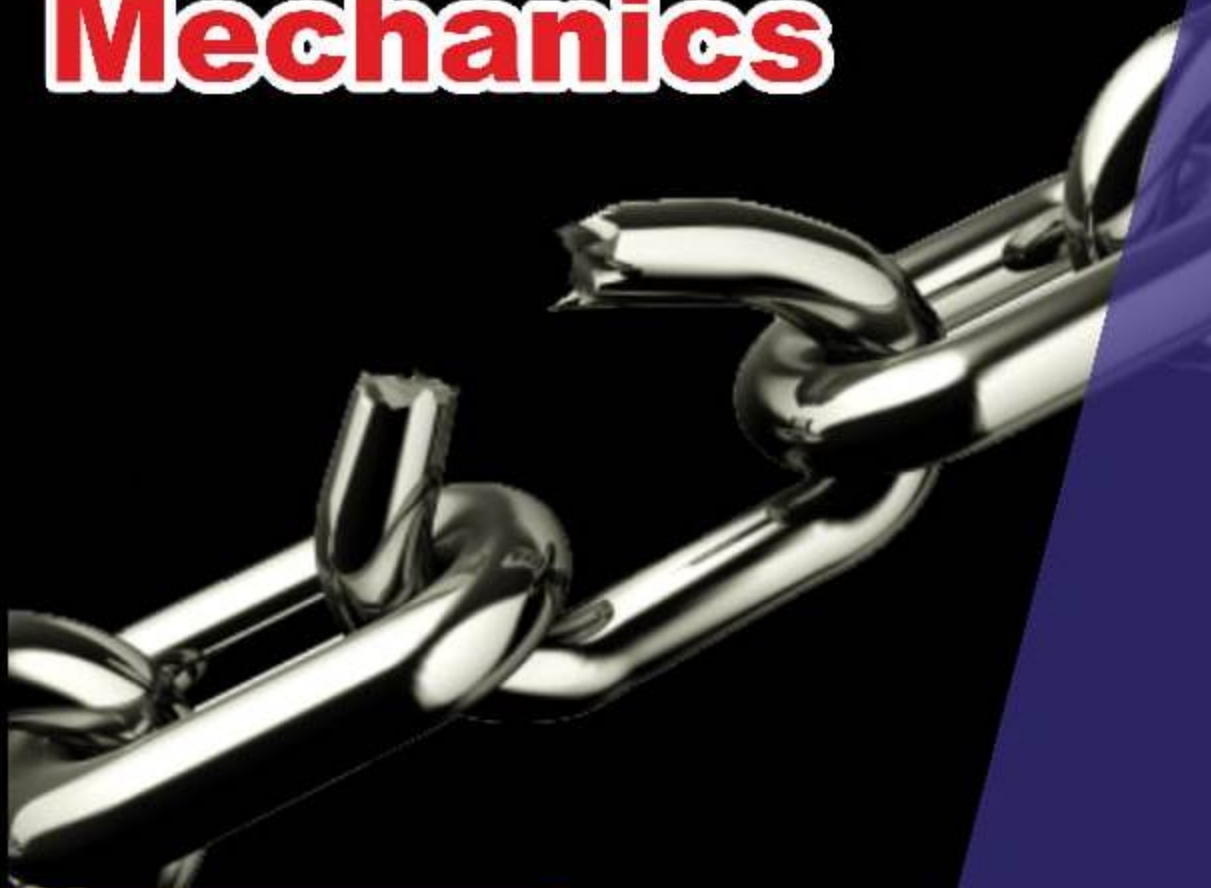
Solid Mechanics



"Education is the most Powerful Weapon which you can use to change the world."

A.P.J. Abdul Kalam

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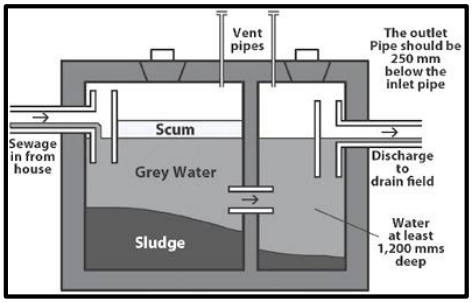
GPSC - CIVIL

Solid Mechanics

SEPTIC TANK:

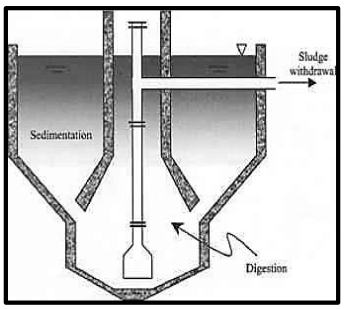


It is designed as ordinary settling tank except that detention time is 12 – 36 hr. with extra provision for digestion of sludge by anaerobic bacteria. Directly raw sewage is entered in the septic tank. The sludge settles at the bottom of tank and oil and greases rises to the top surface as scum. The settled sewage is allowed to remain in the tank for 6 – 12 months during which they are digested anaerobically. The scum remaining in the tank helps in holding back odour and acts as a sort of heat insulation which aids the bacterial action.

Note:
- Flow in sewage is taken as 40 – 70 LPCD,
- If sludge is also allowed in septic tank, flow is taken as 90 - 150 LPCD.
- Detention time 12 – 36 hr.
- Length / width ratio is 2 – 3.
- Depth is 1.2 – 1.8 m.
- Cleaning period is 6 months to 1 year.

IMHOFF TANK:

An Imhoff tank is an improvement over septic tank, in which the incoming sewage is not allowed to get mixed up with the sludge produced and the outgoing effluent is not allowed to carry with it large amount of organic load, as in the case of septic tank. They are sometimes also known as two story digestion tanks. It removes 60 – 65 % solids and 30 – 40 % BOD.



Note:
- L/B is 3 – 5 and L < 30m,
- Total depth is 9 – 11 m,
- Detention period is 2 – 4 hr.

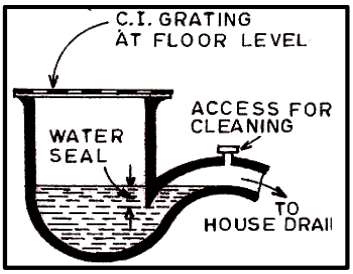
ii. Q Trap:

iii. S Trap:

Depending on their use traps may again be of three types,

i. Floor Trap:

These traps are generally used to admit wastewater (sullage) from the floors of the rooms, kitchen's, baths etc. into the said room drain (sullage pipe). A commonly used patented name of such a trap is Nahni trap.

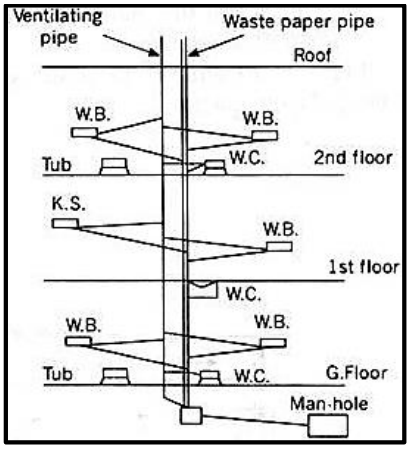


ii. Gully Trap:

It is often provided at the junction of a room or roof drain and the other drain coming from bath, kitchen etc. The water seal is usually 50 mm to 75 mm deep.

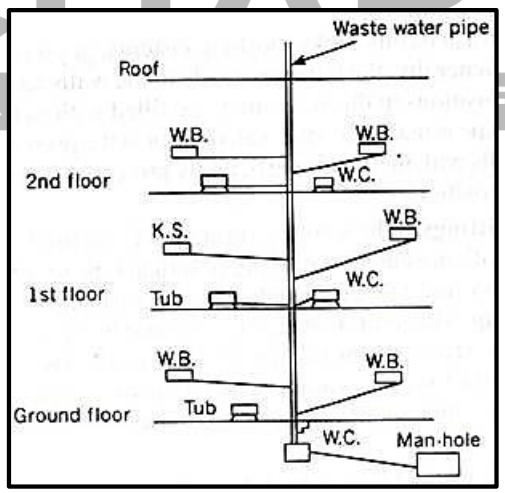
2. One Pipe System:

In this system instead of using two separate pipes, only one main vertical pipe is provided, which collects the night soil as well as the sullage water from their respective fixture through branch pipes. This main pipe is ventilated in itself by providing cowl at its top and in addition to this a separate vent pipe is also provided.



3. Single Stack System:

This system is a single pipe system without providing any separate ventilation pipe. Hence it uses only one pipe which carries the sewage as well as the sullage, and is not provided with any separate vent pipe, except that it itself is extended up to about 2 m higher than the roof level and provided with a cowl for removal of foul gases.



4. Partially Ventilated Single Stack or Single Pipe System:

This is an improved form of single stack system in the sense that in this system, the traps of the water closets are separately ventilated by a separate vent pipe called relief vent pipe.

New Batches are going to start.....

Contact:

7622050066

Test Series Available..

Total weekly test : 35

Total mid subject test : 16

Total full length test : 13

Mock test : 16

Total test : 80

Where,

R = Hydraulic mean radius,

S = Slope of sewer.

Hazen Williams formula:

$$\mathbf{V = 0.849CR^{0.63}S^{0.54}}$$

Where,

C = Hazen William coefficient.

Design of Sewer:

Sanitary sewers are design to run partially full.

Pipe size	Design condition
D < 0.4 m	$\frac{1}{2}$ full at max. discharge
0.4 ≤ D ≤ 0.9 m	$\frac{2}{3}$ fill at max. discharge
D > 0.9 m	$\frac{3}{4}$ full at max discharge

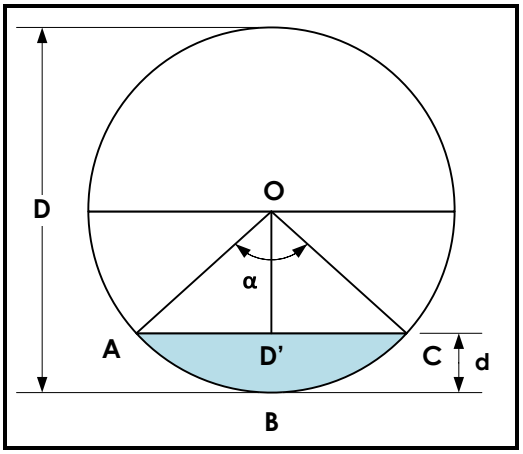
Max. hourly discharge = 3 × Average daily discharge

Max. daily discharge = 2 × Average daily discharge

Min. hourly discharge = $\frac{1}{3}$ × Average daily discharge

Min. daily discharge = $\frac{2}{3}$ × Average daily discharge

HYDRAULIC CHARACTERISTICS OF CIRCULAR SEWER:



$$= \frac{\pi D^2}{4}\left(\frac{\alpha}{360^\circ} - \frac{\sin\alpha}{2\pi}\right)$$

Proportionate area, $\frac{\mathbf{a}}{\mathbf{A}} = \left(\frac{\boldsymbol{\alpha}}{\mathbf{360^\circ}} - \frac{\boldsymbol{\sin\alpha}}{\boldsymbol{2\pi}}\right)$

$\because r = \frac{a}{p}$

$$= \frac{A\left(\frac{\alpha}{360^\circ} - \frac{\sin\alpha}{2\pi}\right)}{P\left(\frac{\alpha}{360^\circ}\right)}$$

$$= R\left[\frac{\frac{\alpha}{360^\circ} - \frac{\sin\alpha}{2\pi}}{\frac{\alpha}{360^\circ}}\right]$$

Proportionate Hydraulic radius, $\frac{r}{R} = \left[\frac{\frac{\alpha}{360^\circ} - \frac{\sin\alpha}{2\pi}}{\frac{\alpha}{360^\circ}}\right]$

Velocity of flow, $\mathbf{V = \frac{1}{n} R^{\frac{2}{3}} S^{\frac{1}{2}}}$

Proportional velocity, $\frac{v}{V} = \left(\frac{r}{R}\right)^{\frac{2}{3}}$

$$= \left[\frac{\frac{\alpha}{360^\circ} - \frac{\sin\alpha}{2\pi}}{\frac{\alpha}{360^\circ}}\right]^{\frac{2}{3}}$$

Discharge, $Q = AV$

Proportional discharge, $\frac{q}{Q} = \left(\frac{a}{A}\right) \times \left(\frac{v}{V}\right)$

$$= \left(\frac{\boldsymbol{\alpha}}{\mathbf{360^\circ}} - \frac{\boldsymbol{\sin\alpha}}{\boldsymbol{2\pi}}\right) \times \left[\frac{\frac{\alpha}{360^\circ} - \frac{\sin\alpha}{2\pi}}{\frac{\alpha}{360^\circ}}\right]^{\frac{2}{3}}$$

Note:

- For max velocity of flow, $\frac{d}{D} = 0.81$
- For max discharge, $\frac{d}{D} = 0.95$

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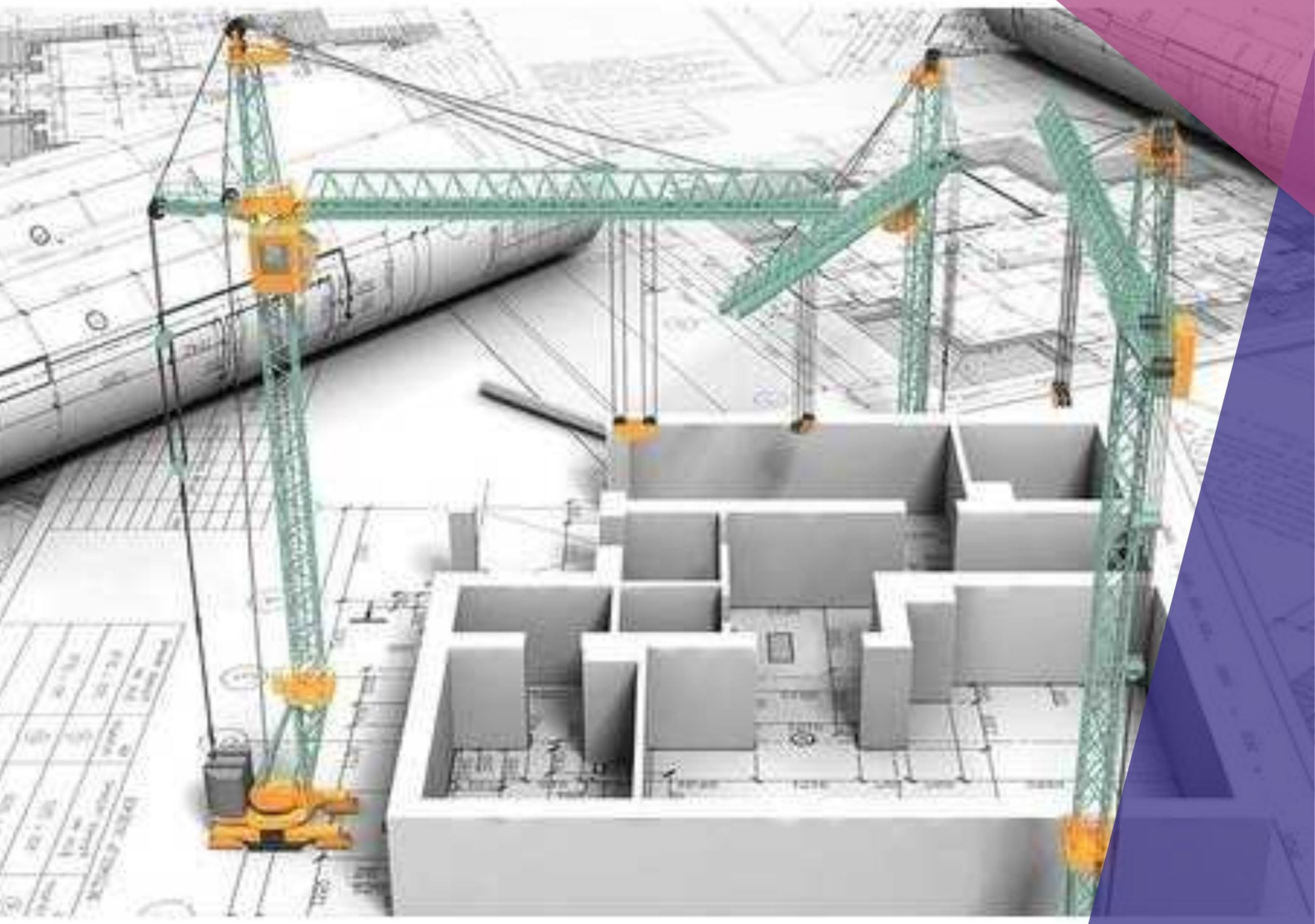

Structural Analysis

"All of us do not have Equal Talent.
But, all of us have an Equal Opportunity
to Develop our Talents."
A.P.J. Abdul Kalam

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ii. Sedimentation:

The settleable solids if present in sewage effluent will settle down into the bed of the river, near the outfall of sewage. Thus, helping in the self-purification process.

iii. Sunlight:

Due to sunlight in the process of photosynthesis, O_2 is released. This oxygen helps in oxidation of organic matter there by forming a settleable product.

2. Biochemical Forces:

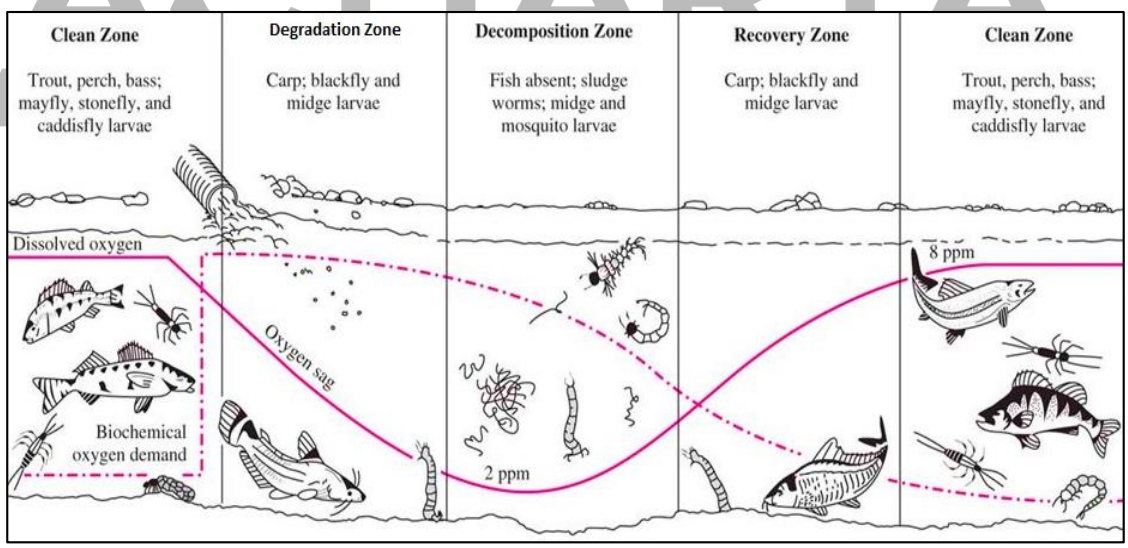
i. Oxidation:

The oxidation of the organic matter present in sewage effluent, will start as soon as the sewage outfalls into the river water containing dissolved oxygen. The deficiency of oxygen so created will be filled up by the atmospheric oxygen.

ii. Reduction:

Reduction occurs due to hydrolysis of organic matter settled at the bottom either chemically or biologically. Anaerobic bacteria will help in splitting the complex organic constituents of sewage into liquids and gases.

ZONE OF POLLUTION IN RIVER STREAM:



1. Zone of Degradation or Zone of Pollution:

This zone is formed for a certain length just below the point where sewage is discharged into the river stream. This zone is characterized by water becoming dark

CLEAR YOUR CONCEPT:

Qu1) The unit of dynamic viscosity is _____

a) Metre^2/Sec

b) Metre/Sec

c) Pa * Sec

d) Dimensionless

Qu2) The relation between dynamic and kinematic viscosity is given by _____

a) Dynamic viscosity = Kinematic viscosity * Density of water

b) Kinematic viscosity = Dynamic viscosity + Density of water

c) Dynamic viscosity = Kinematic viscosity * Density of water

d) Dynamic viscosity = Kinematic viscosity / Density of water

Qu3) Screens are inclined to the direction of flow to _____

a) Increase the flow velocity

b) Increase the opening area

c) Decrease the flow velocity

d) Increase the head loss

Qu4) The breaking of the biomass from the slime layer in conventional filter is called _____

a) Sloughing

b) Carbonation

c) Biological magnification

d) Weathering

Qu5) The organic loading in a trickling filter is measured in _____

a) m^3/day

b) gm/m^2/day

c) Kg/hectare-meter/day

d) Kg/hectare/day

Qu10) Discharge of activated sludge system is 500 m^3/hr, influent BOD is 150 mg/L, HRT is 8 hr, Effluent BOD is 10 mg/L, MCRT is 240 hr, Volume is 4000 m^3, MLSS is 2000 mg/L. The mass of solid wasted from the system in kg/day is _____

a) 900

b) 800

c) 650

d) 700

Answer:

1-(c), 2-(c), 3-(c), 4-(a), 5-(c), 6-(b), 7-(c), 8-(c), 9-(a), 10-(b)

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Contact:

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Total test : 80

under aerobic and anaerobic process. The refuse gets stabilized generally within a period of 2 -12 month and settles down by 20 – 40 % of its overall height.

2. Incineration:

Burning of refuse at high temperature in furnaces, only combustible matter is burnt, the left out ashes and clinkers along with nonrecycled incombustible material may be as much as 10 – 25 % which has to be disposed by some other method.

Large size incinerators are called destructors. The minimum temp. in the combustible chamber should be (> 670°C) sufficient so as to incinerate all organic matter and oxidize foul smelling gases.

3. Barging it Out into Sea:

Throwing refuse into the sea at reasonable distance from the coast (16 – 20 km). The sea depth at disposal point should not be less than 30 m or so.

4. Disposal of Refuse by Pulverization:

Refuse is pulverized in grinding machines so as to reduce its volume and to change its physical character, the grounded or pulverized refuse becomes practically odour less and unattractive to the insects. It has to be further disposed of by filling in trenches or digested in closed digesters.

5. Composting:

i. Indore Method of Composting:

Indore method of composting uses manual turning of piled up mass (refuse + night soil) for its decomposition under aerobic condition. In this method refuse and night soil are alternatively piled in depth of about 7.5 cm to 10 cm each, to a total depth of about 1.5 m in a trench or above the ground to form a mound called a windrow. The composting waste is aerated by periodically turning the waste mix for 2 to 3 months. This compost mass is then left for another 1 – 1.5 month without any turning. Thus, entire process takes 4 months (approximately).

ii. Bangalore Method of Composting:

This method involves anaerobic decomposition of wastes and doesn't involve any turning or handling of the mass and is hence clearer than the Indore method. This method is therefore widely adopted by municipal authorities throughout India. The refuse and night soil in this method are therefore piled up in layers in an underground trench. This mass is covered at its top by layer of earth of

CLEAR YOUR CONCEPT:

Qu1) Which of the following is not the land filling method?

a) Bangalore method

b) Area method

c) Depression method

d) Trench method

Qu2) Which of the following is not the municipal solid waste?

a) Radioactive substance

b) Ashes

c) Food waste

d) Rubbish

Qu3) Which of the following waste can be decomposed by bacteria?

a) Radioactive substance

b) Ashes

c) Food waste

d) Rubbish

Qu4) _____ is the crushing and grinding of municipal solid waste.

a) Landfills

b) Shredding

c) Pulverization

d) Composting

Qu5) In which method of composting, decomposition of anaerobic waste takes place?

a) Indian method

b) Depression method

c) Bangalore method

d) Trench method

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Surveying

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The best Brains of the Nation may be found on the last Benches of the Classroom.

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Qu9) There are 20,000 vehicles operating in a city with an average annual travel of 12000Km per vehicle. The NO_x emission rate is 2.0g/km per vehicle. The total annual release of NO_x will be _____ (in Kg)

a) 480000

b) 4800

c) 480

d) 48

Qu10) A coal containing 2% Sulphur is burned completely to ash in a brick kiln at a rate of 30Kg/min. The Sulphur content in the ash was found to be 6% of the initial amount of Sulphur present in the coal fed to the brick kiln. The molecular weights of S, H, and O are 32gm, 1gm and 16gm. The annual rate of Sulphur dioxide (SO_2) emission from the kiln (in tones/year) is

a) 533.29

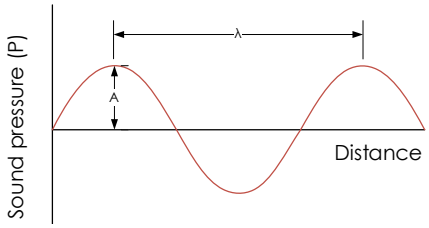
b) 592.84

c) 650.24

d) 492.24

Answer:

1-(a), 2-(a), 3-(c), 4-(c), 5-(c), 6-(d), 7-(c), 8-(b), 9-(a), 10-(b)



Amplitude:

The amplitude (A) of the wave is the height of the peak sound measure above or below zero pressure line. The equivalent pressure of such a sine wave is represented by root mean equal pressure (p_{rms}).

$$P_{rms} = \sqrt{P_t^2} \text{ or } P_{rms} = \sqrt{\frac{1}{T}\int_0^T P_t^2 dt}$$

Where, P_t = pressure at any time 't'.

Level of Noise:

The sound level (L) is represented as,

$$L = \log_{10}\frac{Q}{Q_0} \text{ bels}$$

Where,

Q = Measure quantity of sound pressure or sound intensity,

Q_0 = Reference standard quantity of sound pressure,

L = Sound levels in bel.

When sound level is expressed n decibels,

$$L = 10\log_{10}\frac{Q}{Q_0} \text{ dB}$$

The reference standard quantity Q_0 in the above equation is taken to be equal to 20 µPa when sound pressure is measured.

Note:
- The audible frequency of normal human ear is 20 Hz to 20000 Hz.

Averaging Sound Pressure Levels:

The average values of the various recorded sound pressure levels (L_p) at a particular place over a given period can't be computed by simple averaging due to log scale

ii. Aerosols particles are finely divided solid or liquid particles of microscopic size held suspended and dispersed in atmosphere. They cause visibility reduction, soiling of surfaces, corrosion etc. (e.g. dust, smoke, fog, mist, haze, fumes etc.).

iii. Microorganisms that infect plant and animals.

iv. Pollens (the small grains from the anthers of flowers) may cause allergic reactions.

v. Radioactive minerals.

vi. Volcanic ash and gases.

vii. Gases and odour from swamps and marshy lands.

2. Manmade Sources:

i. Combustion of fuels which accumulates CO_2, SO_2, NO_2 etc. in the atmosphere.

ii. Industries which emits undesirable gases.

iii. Thermal power plant (mainly emits SO_2).

iv. Automobiles exhaust contains CO, CO_2 which are the main sources of air pollution in congested cities.

v. Agricultural activities (Crop spraying, field burning etc.).

vi. Nuclear power plants which emits various radioactive substances.

CLASSIFICATION OF AIR POLLUTANTS

Air pollutants can be classified into following categories

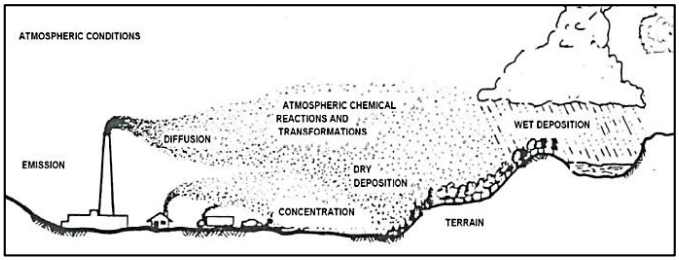
1. Primary Air Pollutants:

Primary air pollutants are those which are emitted directly from the identifiable sources.

e.g. Particulate Matter, Pollens, Sulphur compounds, Nitrogen compounds, Carbon monoxide and dioxide, Photochemical oxidant, Lead, Hydrocarbons, Radioactive materials, Halogen compounds.

DISPERSION OF AIR POLLUTANTS INTO THE ATMOSPHERE:

It causes disease, death to humans, damage to other living organisms such as food crops, or the natural or built environment.



Lapse Rate:

It is the decrease in temperature with increase in height.

Environmental Lapse Rate:

Environmental lapse rate (ELR) The rate at which the air temperature changes with height in the atmosphere surrounding a cloud.

Adiabatic Lapse Rate:

The adiabatic lapse rate is the rate at which the temperature of an air parcel changes in response to the compression or expansion associated with elevation change, under the assumption that the process is adiabatic, i.e., no heat exchange occurs between the given air parcel and its surroundings.

Super-Adiabatic Lapse Rate:

When ELR > ALR this phenomenon occurs. This is unstable.

Sub-Adiabatic Lapse Rate:

When ELR < ALR this takes place. This is stable.

Neutral Lapse Rate:

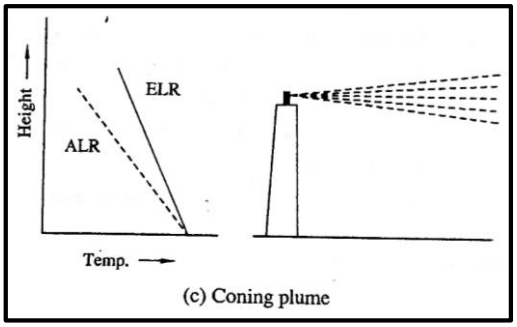
When ELR = ALR this is called as neutral lapse rate.

Inversion or Negative Lapse Rate:

If temp. increases with the increase in height, the lapse rate is known as inversion or negative lapse rate.

(iii) Coning Plume

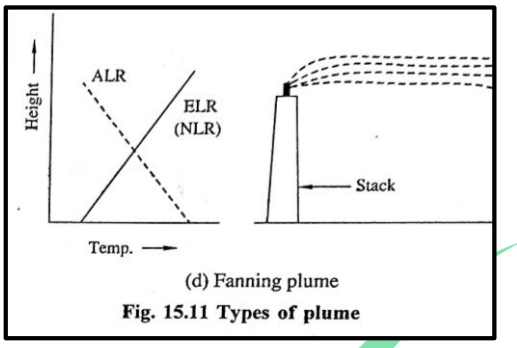
- → ELR < ALR, sub adiabatic condition.
- → Occurs when wind velocity is greater then 32 km/hr and cloud cover blocks the radiations.
- → Plume is cone shaped.
- → Environment is stable.



(c) Coning plume

(iv) Coning Plume

- → Occur under extreme inversion condition.
- → ELR = NLR
- → Plume will spread only horizontally



(d) Fanning plume

Fig. 15.11 Types of plume

➢ DESIGN OF STACK HEIGHT

(i) For chimney emitting particulate matter :

$h = 74 (Q_p)^{0.27}$ height in metre

Where,

Q_p = particulate matter emission tonnes/hr

(ii) For chimney emitting SO_2 :

$h = 14 (Q_s)^{0.33}$ height in metre

where,

$Q_s = SO_2$ emission (kg/hr)

EFFECTS ON PHYSICAL FEATURES:

1. Effect on Visibility:

Fog and photochemical smog reduce the visibility considerable.

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Transportation Engineering

END is not the end if fact E.N.D. means
" Effort Never dies"

A.P.J. Abdul Kalam

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b) Mehane (CH_4) 18 – 20 % contribution

Sources :

- From wetlands decomposition of organic matter by bacteria.
- Agricultural rice fields
- Termites
- Volcanoes

Residence time is 12 years

c) Nitrous Oxide (N_2O) : laughing gas - 6 % contribution

Sources :

- Bacteria breaking down nitrogen in soils and oceans.
- Use of nitrogen fertilizers in agriculture
- Burning of fossil fuels.
- Production of nitric acid.
- Residence time–120 years

d) Chloro Fluoro Carbon (CFC): 14% contribution

CFC = Carbon + hydrogen fluorine + chlorine

Sources :

- Air conditioners
- Refrigerators
- Cleaning electronic components

It has global warming potential of **12000 to 16000** times as compared to CO_2

e) Water Vapour: Water vapour in the atmosphere increases due to evaporation of water

- It retain the heat

f) Ozone (O_3): 8 % contribution

5. Acid rain:

The rainwater is slightly acidic. The acidity level increases with SO_2, NO_2 etc. The acidity in rainwater is caused due to the formation of secondary pollutants such as Sulphuric acid, Nitric acid, and Hydrochloric acid due to the reaction of water vapors with these gases.

It has been specified that when the pH of the rainwater is less than or equal to 5 the rain is termed as acid rain. $^{2}/_{3}^{rd}$ of acid rains is due to SO_2 which is produced mainly by the burning of coal and oil in industries. The SO_2 pollutant leads to H_2SO_4 acidity. Another primary pollutant responsible for $^{1}/_{3}^{rd}$ of acid rain is NO_2 which is produced mainly by the auto mobile emissions. The NO_2 pollutant leads to HNO_3 acidity. Acidic rains damage forest, crops, building, monuments.

When pH of rain water is less than 5.6, it is called acid rain.

$$CO_2 + H_2O \rightarrow H_2CO_3\ (Carbonic\ acid)$$

$$H_2CO_3 \leftrightharpoons H^+ \rightleftharpoons HCO_3$$

Release of H^+ ion increases acidity

Causes of Acid Rain :

- Dissolution of oxides of **Sulphur** (SO_2) and **Nitrogen** (NO_2) emitted from automobile exhaust, chimneys of smelting industries into rain water.

6. Global warming:

The increases in the average temp, of the atmosphere is called global warming. It is considered to be the outcome of the air pollution caused by the man made sources. The global warming may lead to burning of crops and may also cause forest fire.

➢ **Climate Change:**

It refers to change in climatic factors such as temperature, wind, precipitation for an unexpected period.

Natural Causes	Man Made Causes
- Change in sun's intensity - Change in earth's orbit - Change in ocean circulation	- Burning of fossil fuels - Deforestation - Desertification - Industrialization - Urbanization

➢ Ocean Acidification :

Ocean water absorbs atmospheric CO_2

As a result, the concentration of H^+ ions in the ocean increases and the concentration of OH^- ions decreases. **pH of the ocean decreases.** This process is called ocean acidification.

Effects :

- Less plankton growth
- Less productive fishes
- Acid rains

Carbon Credit :

A carbon credit is a tradeable certificate or permit representing the right to emit 1 tonne of carbon or carbon dioxide equivalent.

1 carbon credit = 1 tonne CO_2 equivalent gases

Or

1 tone carbon

- An organization which produces 1 tonne less carbon or carbon dioxide equivalent than the standard level of carbon emission allowed, earns 1 carbon credit.
- India, China are the biggest sellers of carbon credits. Europe is the largest buyers of carbon credits.
- Carbon credit trading is done globally.
- Carbon credit is also known as certified emission reduction (CER).

  1 CER = 1 tonne CO_2

- Let one country has a thermal power plant of 800 MW which releases 400 carbon equivalent into the atmosphere. If this country establishes wind power plant of 800 MW which does not produce any carbon, the country will get 400 carbon credits.

CLEAR YOUR CONCEPT:

Qu1) Which gas is mainly produced due to incomplete burning of wood?

a) CO

b) SO_2

c) NO_2

d) NO_3

Qu2) Which of the following is involved in production of carboxy haemoglobin?

a) CO

b) SO_2

c) NO_2

d) NO_3

Qu3) Which of the following is a liquid form of aerosol?

a) Fume

b) Dust

c) Mist

d) Smoke

Qu4) Which of the following is a secondary air pollutant?

a) SPM

b) PAN

c) SO_2

d) NO_2

Qu5) Which of the following is not a part of photochemical smog?

a) NO_2

b) O_3

c) PAN

d) SPM

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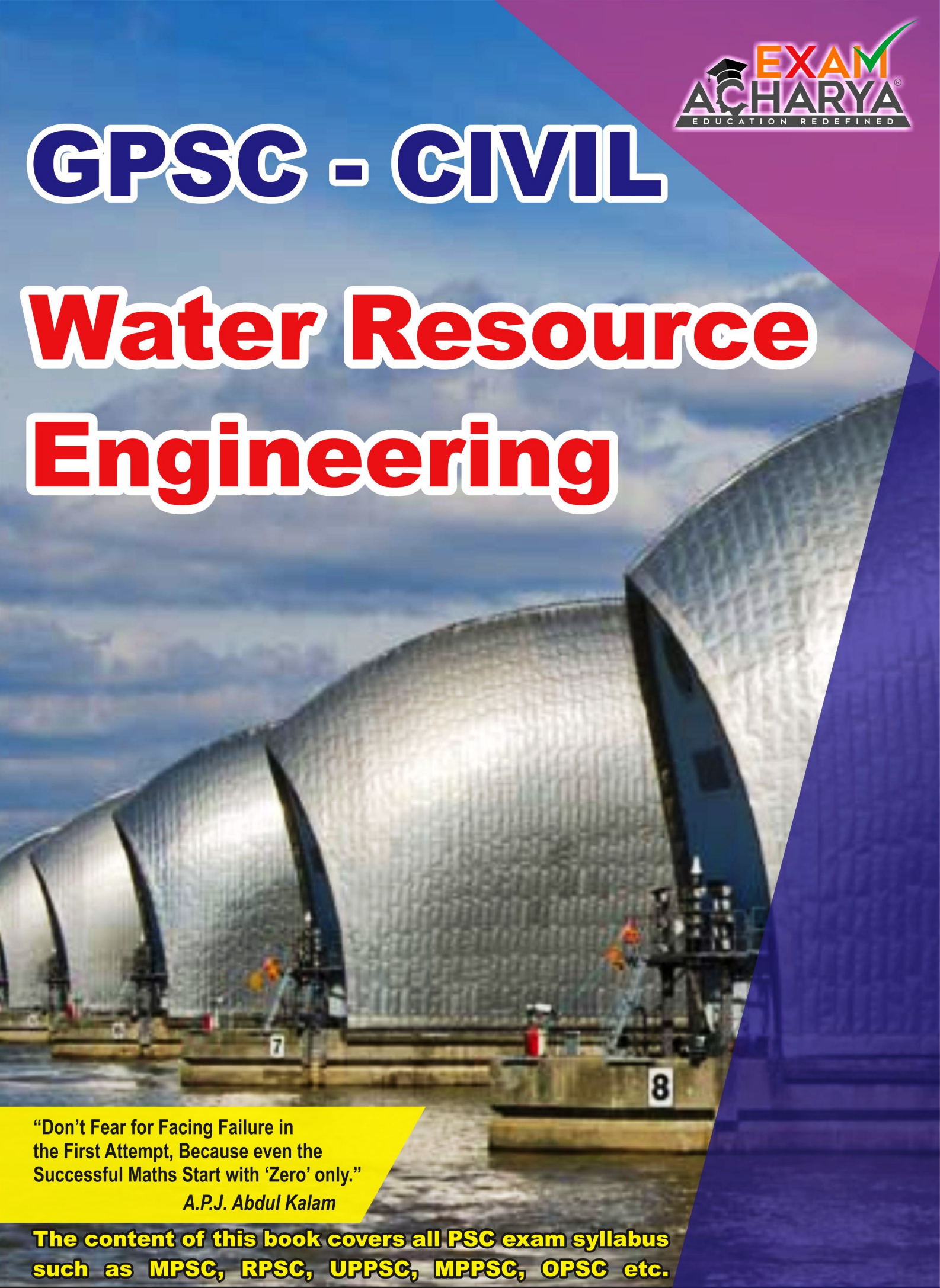

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Qu10) How many parameters are taken into consideration when measuring air quality, in India?

a) 4

b) 3

c) 8

d) 9

Answer:

1-(a), 2-(a), 3-(c), 4-(b), 5-(d), 6-(a), 7-(d), 8-(d), 9-(a), 10-(c)

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