Civil Engineering by Sandeep Jyani Sir
Environment Engineering

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Changing the way of learning…

Environment Engineering

Civil Engineering by Sandeep Jyani

Environment Engineering

- **Environment Engineering 1**
  - Water Supply Engineering / Raw Water Engineering
- **Environment Engineering 2**
  - Waste Water Engineering
  - Solid Waste Management
  - Air Pollution and Noise Pollution

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Government of India
Ministry of Railways
Railway Recruitment Boards

Environment Engineering

<u>Syllabus</u>

1. Public Water Supply
2. Environment Pollution and Control
3. Domestic Sewage
4. Solid Waste Management
5. Environmental Sanitation

Water Supply Engineering

1. Water Demand
2. Quality Parameters of Water
3. Treatment of Water
4. Distribution, source and Conveyance of Water

Water Supply Engineering

Chapter 1: Water Demand

- To design a water supply scheme, we must first estimate the population for which the scheme should be designed.
- The scheme once installed must cater for the demand of projected population up to some pre determined future date.

Design Period:

- A water supply scheme includes huge and costly structures such as reservoirs, dams, pumping units, distribution system, etc. which can not be replaced or increased in their capacities easily.
- Various components are designed such that future needs of the community gets satisfied. This future need is called Design Period.
- The design period should be neither too short nor too long

As per Government of India Manual (GOI)

Sr. No	Component	Design Period
1	Water treatment units	15 years
2	Pipe Connections	30 Years
3	Service Reservoirs (OHT or ground Tank)	15 Years
4	Distribution System	30 Years

Population Forecasting

There are three main factors responsible for growth or decline in Population:

1. **Birth**
2. **Death**
3. **Migration**

Population Forecasting Methods

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1. Arithmetic Progression Method

- Increase in population from decade to decade is assumed to be constant

$$\boxed{P_n = P_0 + n\bar{x}}$$

P_n =Projected population after n decades

P_0 = initial population/ last census

n = number of decades between now and future

$\bar{x}$ =average increase in population per decade

Population Forecasting Methods

Que. 1 The population of 5 decades are given. Find out the population after 1 and 6 decades beyond last census by arithmetic progression method.

Year	Population	Increase
1930	25000	
1940	28000	3000
1950	34000	6000
1960	42000	8000
1970	47000	5000

$$\boxed{P_n = P_0 + n\overline{x}}$$

$\overline{x}$ =average increase in population per decade

$$Average\ Increase = \frac{2200}{4}$$

$$\overline{x} = 5500$$

1. $Population\ after\ 1\ decade\ P_1 = ?$

$$P_1 = P_0 + n\overline{x}$$

$$\Rightarrow P_{1980} = 47000 + (1) \times 5500$$

$$\Rightarrow P_{1980} = 52500$$

Population Forecasting Methods

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$$Average\ Increase = \frac{2200}{4}$$

$$\bar{x} = 5500$$

2. $Population\ after\ 6\ \ decades\ P_6 = ?$

$$P_6 = P_0 + n\bar{x}$$

$$\Rightarrow P_{2030} = 47000 + (6) \times 5500$$

$$\Rightarrow P_{2030} = 80000$$

Population Forecasting Methods

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2. Geometric Progression Method or Geometric Increase Method

- In this method Percentage Increase in population from decade to decade is assumed to be constant

Note: GOI Manual recommends Geometric Progressive Method because it gives the maximum value out of other methods

$$\boxed{P_n = P_0\left(1+\frac{r}{100}\right)^n}$$

P_n =Projected population after n decades

P_0 = population of last known decade

n = number of decades between now and future

r =geometric mean rate of increase in population per decade

$$r = \sqrt[m]{r_1 r_2 r_3 r_4 \ldots rm}$$

Que. 2 Determine the future population of a town by Geometric Increase method in the year 2011.

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

Year	Population (in 1000)	Increase		Percentage Increase
1951	93			
1961	111	18	$\frac{18}{93} \times 100 =$	19.35 %
1971	132	21	$\frac{21}{111} \times 100 =$	18.91 %
1981	161	29	$\frac{29}{132} \times 100 =$	21.96 %

$$r = \sqrt[m]{r_1 r_2 r_3 r_4 \ldots rm}$$

$$\Rightarrow\ r = \sqrt[3]{19.35 \times 18.91 \times 21.96}$$

$$\Rightarrow\ r = 20.9\ \%\ \ per\ decade$$

$$P_{2011} = P_{1981}\left(1 + \frac{20.9}{100}\right)^3$$

$$= 161\left(1 + \frac{20.9}{100}\right)^3 \boxed{= 284.514}$$

Population Forecasting Methods

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c) Incremental Increase Method

- Combination of Arithmetic and Geometric Increase method
- Actual increase in each decade is found
- Average increment of increases is found

Population after n decades from present is given by

$$\boxed{P_n = P_0 + n\bar{x} + \frac{n(n+1)}{2}\bar{y}}$$

P_n =Projected population after n decades
P_0 = population of last known decade
n = number of decades between now and future
$\bar{x}$ =average increase of population of known decades
$\bar{y}$ =average of incremental increase of known decades

Que. 3 Determine the future population of a town by Incremental Increase method in the year 2000.

$$P_n = P_0 + n\bar{x} + \frac{n(n+1)}{2}\bar{y}$$

Year	Population	Increase	Incremental Increase
1940	23798624		
1950	46978325	23179701	
1960	54786437	7808112	-15371589
1970	63467823	8681386	873274
1980	69077421	5609598	-3071788

$\bar{x}$ =average increase of population of known decades

$$\bar{x} = \frac{45278979}{4}$$

$$\boxed{\bar{x} = 11319699.2}$$

$$\bar{y} = \frac{-17570103}{3}$$

$$\boxed{\bar{y} = -5856701}$$

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$$\boxed{P_n = P_0 + n\bar{x} + \frac{n(n+1)}{2}\bar{y}}$$

$$\Rightarrow P_{2000} = P_{1980} + (2)(11319699.2\ ) + \frac{2(2+1)}{2}(-5856701)$$

$$\Rightarrow P_{2000} = 69077421 + (2)(11319699.2\ ) + \frac{2(2+1)}{2}(-5856701)$$

$$\Rightarrow P_{2000} = 74146716.6$$

$$\Rightarrow P_{2000} = 74146717$$

GOI Manual Recommends..

1. Arithmetic Increase Method is used for old cities, where growth rate is constant
2. For new and younger cities, we will use geometric Progression method
3. Whenever there is negative rate of increase, incremental increase method is used
4. Incremental Increase Method generally gives values in between Arithmetic progression method and Geometric Progression Method

Water Demand

1. Domestic Water Demand

- Water required in private buildings for drinking, cooking, gardening, etc.
- GOI manual lays down a limit on water consumption between 135 LPCD to 225 (Litre Per Capita per Day)
- Under ordinary conditions, Minimum domestic water requirement for a town with full flushing system should be taken as 200 LPCD
- For low income groups, demand can be reduced to 135 litres per capita per day

Water Demand

2. Commercial/ Institutional Water Demand

- On an average, per capita demand of 20 LPCD is usually considered to be enough to meet commercial and institutional demands. For highly commercialized cities, this value is taken as 50 LPCD.
- In Cinemas and theatres, demand is minimum (approx. 15 LPCD) and in hospitals, demand is maximum(340 to 380 LPCD)

Water Demand

3. Industrial Water Demand

- **The industrial water demand represents the water demand of industries which are existing or likely to be started in future.**
- **For paper industries, for 1 tonne of paper production, 200-400 Litres of water is used.**
- **For petroleum refinery and sugar mills, per tonne production requires one to two litres of water.**

Water Demand

4. Demand for Public Use

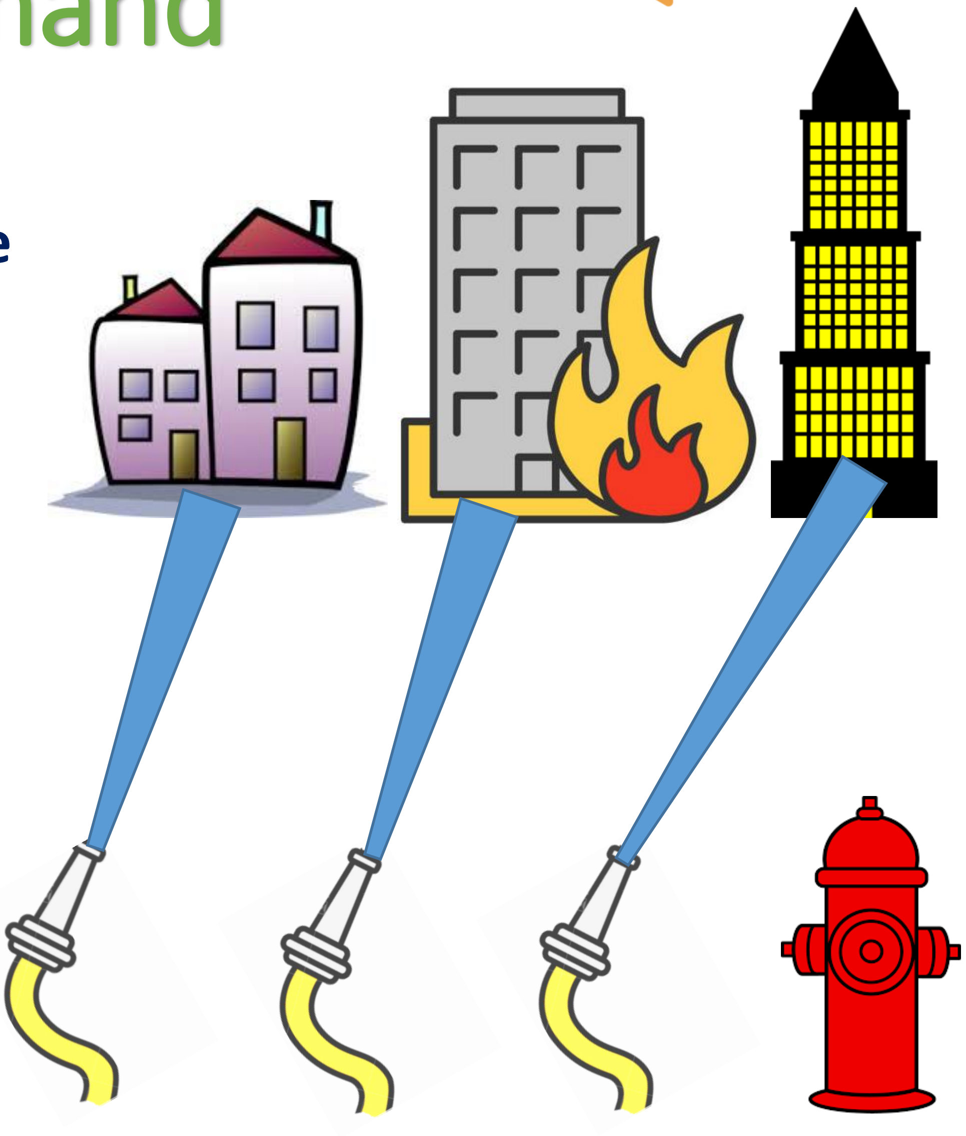
- This includes water requirement for Parks, washing of roads, public drinking, etc.
- A nominal amount not exceeding 5% of the total consumption of city is provided as demand for public use

Water Demand

5. Fire Demand

Following requirements must be met for Fire Demand:

- **Three jet stream are simultaneously thrown from each hydrant, one on the burning property and one on each adjacent property**
- **Discharge in each stream should not be less than 1100 L/min.**
- **The minimum head available should be 12 to 15 metre and should be maintained for 4 to 5 hours**



Water Demand

5. Fire Demand

- For a total amount of water consumption, for a city of 50 Lacs population, it hardly amounts to 1 LPCD, but this water should be easily available and kept always stored in service reservoirs

$$Kuichling's\ Formula\ \ for\ fire\ Demand$$

$$\boxed{Q = 3182\sqrt{P}}$$

$$Q = quantity\ of\ water\ in\ Litres\ per\ minute$$

$$P = population\ in\ thousands$$

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Que 4. Compute the fire demand for a city having population of 140 000.

$$\boxed{Q = 3182\sqrt{P}}$$

$$Q = 3182\sqrt{140}$$

$$\boxed{\cancel{Q = 1,191,343.7\ litres\ per\ minute}}$$

$$\boxed{Q = 37650\ litres\ per\ minute}$$

Water Demand

6. Losses and Thefts

- Water lost in leakage due to bad plumbing, theft, unauthorized water connections and other losses.
- This amount is taken as 15% of total demand

PER CAPITA Demand

It is annual AVERAGE amount of Daily water required by 1 person and includes domestic, industrial, commercial, public use, thefts, etc.

$$q = \frac{Total\ yearly\ water\ requirement\ of\ city}{population\ \times 365}$$

Factors Affecting Per capita demand:

1. Size of city
2. Climatic Condition
3. Quality of water supply
4. Pressure in distribution system
5. System of Supply

Various types of Demand for Design

1. **Maximum Daily Consumption**

$$= 1.8 \times Average\ Daily\ consumption$$

$$= 1.8\, q$$

2. **Maximum Hourly Consumption/Peak Demand**

$$= hourly\ variation\ factor \times \frac{max\ daily\ consumption}{24}$$

$$= 1.5 \times \frac{1.8\, q}{24}$$

$$= 2.7 \times \frac{q}{24}$$

Various types of Demand for Design

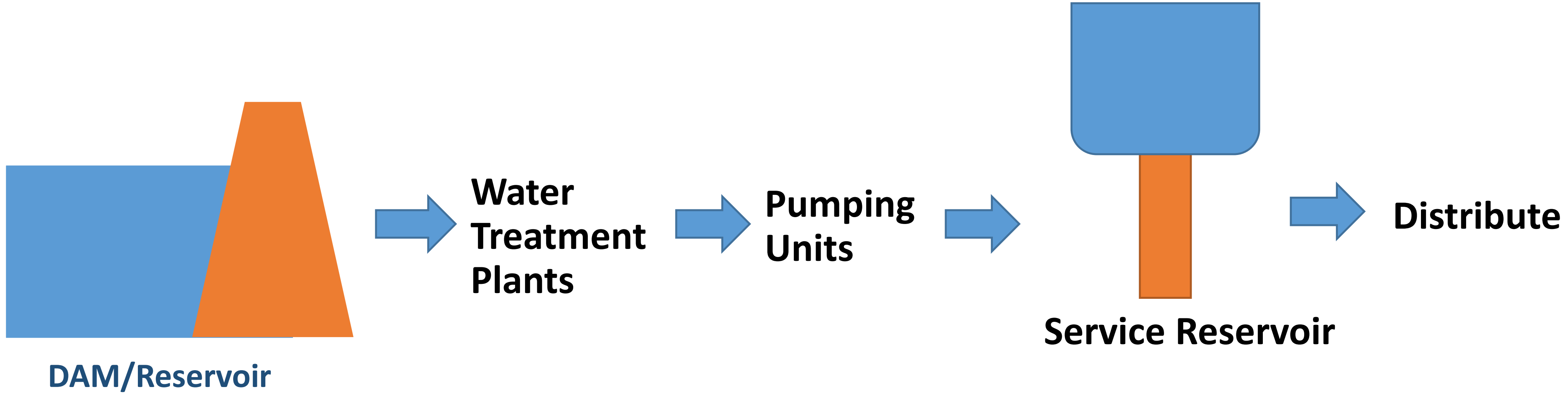
3. **Coincident Draft/Demand/Supply**

$$= maximum\ daily\ demand + fire\ demand$$

4. **Total Draft**

$$= maximum\ of\ \{Coincident\ draft, maximum\ hourly\ consumption\}$$

Design Capacity of Various Component of Water Supply Scheme



Source of Supply may be designed for maximum daily consumption (1.8q)

The pipe mains that take water from source to service reservoir and other treatment units are designed for maximum daily draft

Pumps may be designed for maximum daily draft + some additional reserve

Distribution system should be designed for Total Draft

Que 5. The total water requirement of a city is generally assessed on the basis of

a) Maximum hourly demand

b) Maximum daily demand + fire demand

c) Average daily demand + fire demand

d) Greater of (a) and (b)

Que 5. The total water requirement of a city is generally assessed on the basis of

a) Maximum hourly demand
b) Maximum daily demand + fire demand (Coincident draft)
c) Average daily demand + fire demand
d) Greater of (a) and (b)

Que 6. Water supply includes

a) Collection, transportation and treatment of water
b) Distribution of water to consumers
c) Provisions of Hydrants for fire fighting
d) All of the above

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Que 7. The total water demand may be taken as

a) 135 lpcd

b) 160 lpcd

c) 210 lpcd

d) 270 lpcd

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a) 135 lpcd

b) 160 lpcd

c) 210 lpcd

d) <u>270 lpcd</u>

Domestic water demand = 135-225 lpcd

Industrial 50-450 lpcd

Public use 10 lpcd

Commercial/ institutional 20-50 lpcd

Que 8. The distribution system in water supplies is designed on the basis of

a) Average daily demand

b) Peak hourly demand

c) Coincident of draft

d) Greater of (b) and (c)

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a) Average daily demand
b) Peak hourly demand
c) Coincident of draft
d) Greater of (b) and (c)

Que 9. On peak hourly demand, what is the maximum daily consumption of the city which have average daily consumption of 100 000 m^3?

a) 140 000

b) 170 000

c) 200 000

d) 270 000

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a) 140 000

b) 170 000

c) 200 000

d) <u>270 000</u>

Que 10. Which of the following represents the value of hourly variation factor?

a) 1.2

b) 1.5

c) 1.7

d) 2.5

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a) 1.2

b) <u>1.5</u>

c) 1.7

d) 2.5

Quality Parameters of Water

The Properties that ascertain qualities of raw water are termed as Quality Parameters.

<u>Water Impurities are Classified as</u>:

1. **Physical**
2. **Chemical**
3. **Biological**

Quality Parameters of Water

1. Physical Water Quality Parameters

i. Suspended Solids

For Suspended solids, as per Environmental Protection Agency, the maximum permissible limit is **30mg/L** for drinking water

Quality Parameters of Water

1. Physical Water Quality Parameters

ii. Turbidity

Measure of extent to which light is either absorbed or scattered by suspended matter in water. It is objectionable because:

A. Aesthetically displeasing

B. It provides absorption sites for chemical and biological agents thereby reducing the efficiency of further treatment

C. They may also be biologically active which may result in causing various diseases

D. In Natural water bodies(rivers, ponds..) turbidity interferes with light penetration and hence with photosynthesis reactions

Quality Parameters of Water

1. Physical Water Quality Parameters

ii. Turbidity

Measure of turbidity is done by:

A. Turbidity rod
B. Jackson's turbidimeter
C. Bayli's Turbidity meter
D. Nephelometer

Quality Parameters of Water

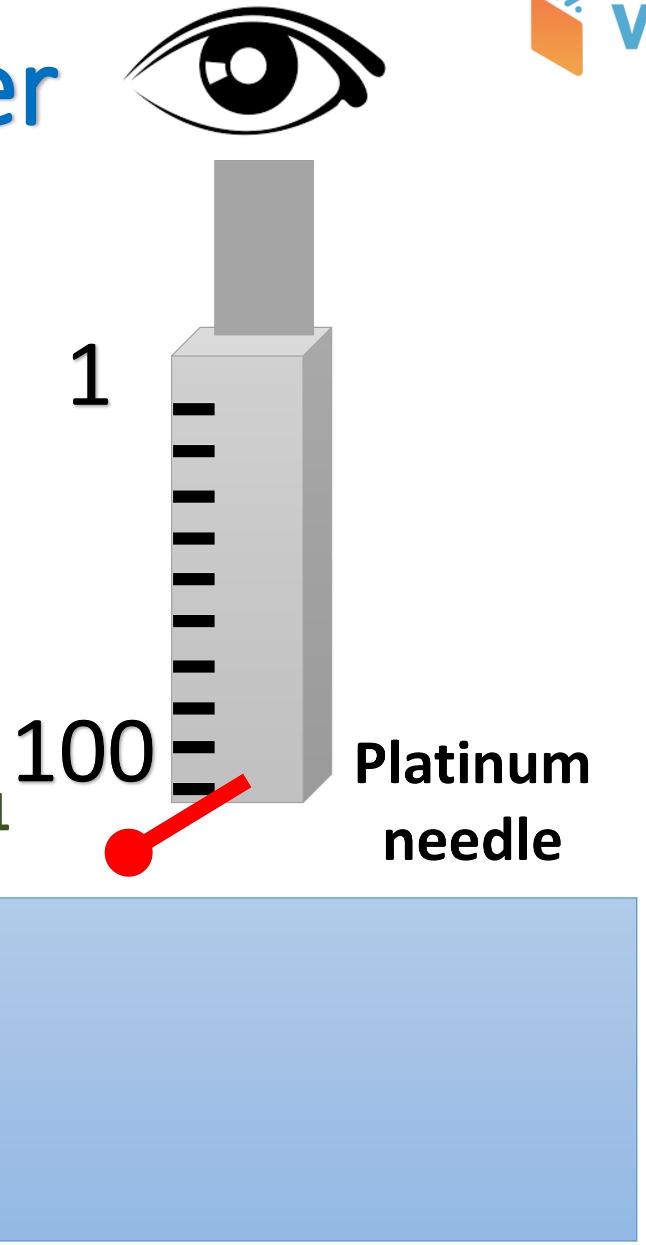
1. Physical Water Quality Parameters

ii. Turbidity

Measure of turbidity is done by:

A. Turbidity rod

- Graduations are encrypted in rod in ppm(1mg/L =ppm)
- As depth of insertion increases, reading decreases
- Turbidity which 1 mg of Silica produces in 1 litre of distilled water is taken as 1 unit



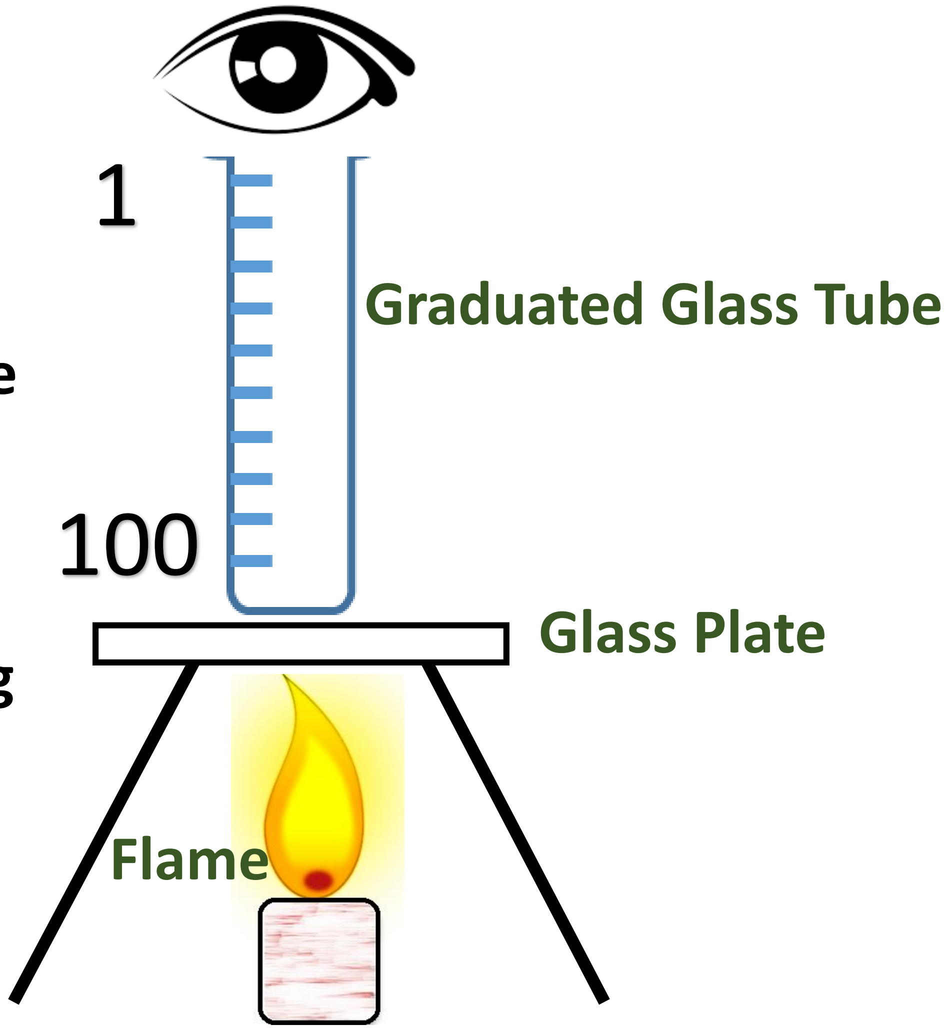
Quality Parameters of Water

1. Physical Water Quality Parameters

ii. Turbidity

B. Jackson's Turbidity meter

- Level of water is increased till image of flame disappears
- This method is used only when turbidity is greater than 25ppm
- This method is not used for drinking water



Quality Parameters of Water

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1. Physical Water Quality Parameters

ii. Turbidity

C. Bayli's Turbidity meter and Nephelometer

- Turbidity less than 1ppm can also be measured
- So most widely used for domestic supplies

➢ UNIT in Nephelometer is NTU (Nephelometer Turbidity Unit)
➢ Similarly JTU for Jackson's Turbidity Meter
➢ Acceptable limit for turbidity is 1 mg/L or 1 NTU
➢ Permissible limit for turbidity is 5 mg/L or 5 NTU
➢ Cause for rejection is 10 mg/L or 10 NTU

1. Physical Water Quality Parameters

iii. Colour

- Colour is produced by suspended matter and dissolved matter
- True Colour → Dissolved Solids
- Apparent colour→ Suspended Solids
- Why is colour objectionable?
- Iron Oxide gives Reddish colour
- Manganese oxide gives brown/Black colour
- Humic acid gives yellowish brown colour
- Colour is measured by TINTOMETER
- Result is expressed in True Colour Units (TCU) or Hazen Unit
- AL = 5 TCU
- CFR = 15 TCU

1. Physical Water Quality Parameters

iv. Taste and Odour

- Caused by Chemicals and dissolved gases like H_2S, methane, etc industrial liquids, ammonia, etc.
- Taste and odour are objectionable because of carcinogenic nature
- Taste and odour are measured by instrument known as Osmoscope
- Intensity of taste and odour is measure in Threshold Odour Number (TON)
- $TON = \frac{A+B}{A}$
- GOI recommends TON between 1 and 3

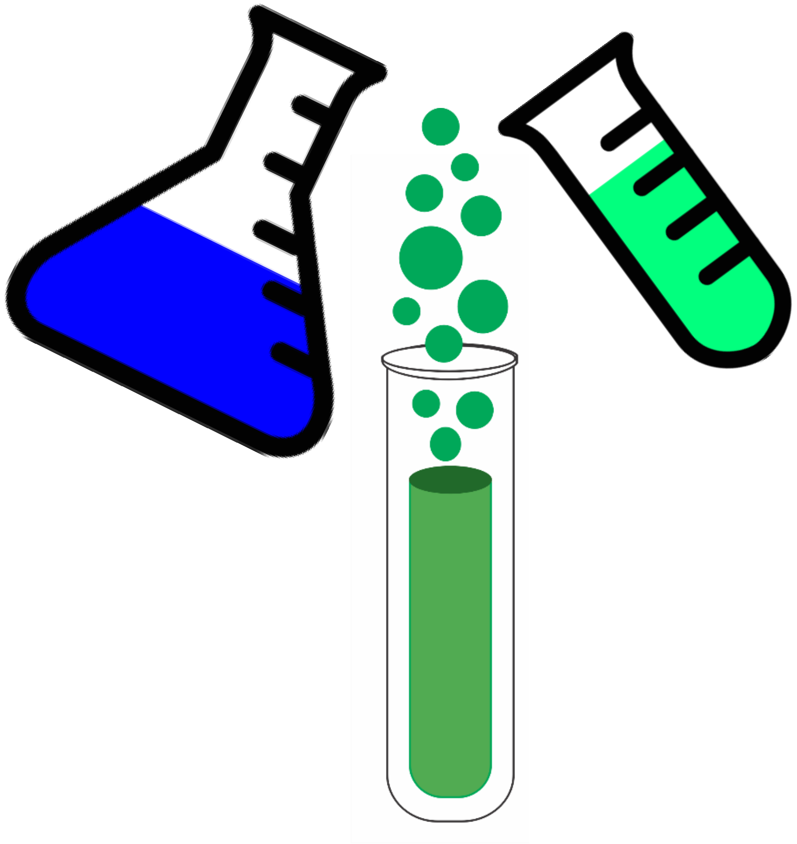
1. Physical Water Quality Parameters

v. Temperature

- **Temperature affects chemical and biological reactions**
- **For water supply, it should be between 10 to 25°C and greater than 25°C is objectionable**

2. Chemical Parameters

i. Dissolved solids
ii. pH
iii. Alkalinity
iv. Hardness
v. Chloride content
vi. Nitrogen Content
vii. Phosphorous
viii. Fluorides
ix. Metals



2. Chemical Parameters

i. Dissolved solids

GOI manual recommends Acceptance Limit as **500mg/L**

Cause for rejection as **2000 mg/L**

ii. pH

- $pH = -log[H^{+}]$, where $[H^+]$ is in moles/Litre
- AL = 6.5 – 8.5
- pH can be measure by colored indicators like methyl orange and phenolphthalein

Working range of methyl orange is 3.1 to 4.4

Working range of phenolphthalein is 8.6 to 10.3

2. Chemical Parameters

iii. Alkalinity

- Quantity of ions that will neutralize H^+ ions
- Alkalinity is due to CO_3^{2-} , HCO_3^{-1} , OH^-, HS^-, HPO_4^- , etc.
- $CO_3^{2-} + H^+ \rightarrow HCO_3^{-1}$
- $HCO_3^{-1} + H^+ \rightarrow H_2CO_3$
- Major constituents of Alkalinity:

  CO_3^{2-} (carbonate)

  HCO_3^{-1} (Bicarbonate alkalinity)

  OH^- (caustic alkalinity)

2. Chemical Parameters

iv. Hardness

- Hardness is the concentration of multivalent metallic cations present in water. Hardness may be induced due to Ca^{2+}, Mg^{2+} ,AL^{3+} , Fe^{2+} , etc
- Major constituent are Ca^{2+}, Mg^{2+} .
- Hardness can be of two types:
  1. Carbonate Hardness(Temporary hardness) (carbonates and bicarbonates of multivalent ions)
  2. Non Carbonate Hardness (Permanent Hardness) (chlorides, Sulphates, nitrates, etc of multivalent ions)
- Hardness of water is determined by titrating it against EDTA (Ethylene diamine tetraacetic acid) solution, using EBT (Eriochrome black T)
- Initially EBT forms red colour and titration changes colour to blue

2. Chemical Parameters

iv. Hardness

- Acceptable limit of hardness = 200 mg/L
- Cause for rejection = 600 mg/L
- For domestic supply it should be between 75 – 150mg/L

v. Chloride Content

- Acceptable limit = 200 mg/L
- Cause for rejection = 1000 mg/L

2. Chemical Parameters

vi. Nitrogen Content

- Presence of Nitrogen represent presence of organic matter.
- Nitrogen occurs in following forms:
  1. Free Ammonia (NH_3) : indicates recent Pollution
     - AL = 0.15 mg/L
     - CFR= 0.30 mg/L
  2. Organic Ammonia (Albuminoid) : quantity of oxygen before decomposition of organic matter has started
     - AL = 0.30 mg/L
     - CFR= 0.45 mg/L
  3. Nitrite (NO_2^-): indicates partly decomposed condition
     - AL=0 (toxic in nature, so not acceptable)
  4. Nitrate (NO_3^-): indicates fully oxidized organic matter, it can also indicate old pollution
     - AL = 45 mg/L
     - CFR= 45 mg/L
     - Blue baby disease is caused due to Nitrate

2. Chemical Parameters

vii. Fluorides

- Upto 1 mg/L, it helps to prevent dental cavities
- During formation of permanent teeth, it combines chemically with enamel, resulting in harder and stronger teeth
- Excess of it (greater than 1.5 mg/L) results in decoloration of teeth/mottling of teeth.
- Fluorides greater than 5mg/L causes deformation of Bones (Bone Flourosis)
- AL = 1 mg/L
- CFR= 1.5 mg/L

2. Chemical Parameters

viii. Metals

	Metal	Acceptance Limit	Cause for Rejection	Comments
1	Iron and Mangnese			
	Iron	0.1 mg/L	1 mg/L	
	Manganese	0.05 mg/L	0.05 mg/L	
2	Copper	0.05 mg/L	1.5 mg/L	Large quantities affects lungs and respiratory organs
3	Sulphate	100 mg/L	400 mg/L	
4	Zinc	5 mg/L	15mg/L	Zinc is called nutrient of life
5	Arsenic	0.01mg/L	0.05 mg/L	Causes acute toxicity to humans
6	Cyanide	0.05 mg/L	0.05 mg/L	cyanide renders the body incapable of carrying oxygen
7	Mercury	0.001 mg/L	0.001 mg/L	Mercury is toxic to all forms of life. It should not be greater than 0.001 mg/L

3. Biological Parameters

- Most important organisms are pathogens because they are capable of transmitting diseases, exp (bacteria, virus, protozoa, helminth, etc.)
- Coliforms: harmless aerobic lactose fermenters organisms
- E-coli (Escherichia-coli)

Que. 11 The total solids in water are due to presence of

a) Colloidal and settleable solids

b) Suspended and floating solids

c) Suspended and dissolved solids

d) Colloidal and bacterial load

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Que. 12 Permanent hardness of water can be removed by

a) Adding alum

b) Adding lime

c) Adding chlorine

d) Zeolite process

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Que. 13 The maximum permissible limit for fluoride in drinking water is

a) 0.1 mg/L

b) 1.5 mg/L

c) 5 mg/L

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Que. 14 Nitrates more than 45 gm/L in water leads to disease called

a) Gastroenteritis

b) Mottled teeth

c) Polio

d) None of these

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a) Gastroenteritis
b) Mottled teeth
c) Polio
d) None of these (blue baby - METHEMOGLOBINEMIA)

Que. 15 Hardness in water is caused mainly due to

a) Chlorides and Sulphates

b) Calcium and magnesium

c) Nitrites and nitrates

d) Sodium and potassium

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a) Chlorides and Sulphates

b) Calcium and magnesium

c) Nitrites and nitrates

d) Sodium and potassium

Que. 16 **The product of H^+ ions and OH^- ions in a strong alkali at 25°C is**

a) 0

b) 1

c) 10^{-1}

d) 10^{-14}

Que. 16 The product of H^+ ions and OH^- ions in a strong alkali at 25°C is

a) 0

b) 1

c) 10^{-1}

d) 10^{-14}

Que 17. Disinfection of water is done to remove

a) Turbidity
b) Odour
c) Colour
d) Bacteria

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a) Arithmetic increase method
b) Geometric progression method
c) Graphical Method
d) Logistic curve method

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Que 19 The population of a town as per census records were as follows. Find population in the year 2011 using arithmetic mean method.

Population	Year
2 00 000	1981
2 10 000	1991
2 30 000	2001

a) 250000

b) 255000

c) 240000

d) 245000

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Que 20 The population of a town as per census records were as follows. Find population in the year 2011 using Geometric mean method.

Population	Year
2 00 000	1981
2 10 000	1991
2 30 000	2001

a) 244872
b) 245870
c) 246820
d) None of these

Que 20 The population of a town as per census records were as follows. Find population in the year 2011 using Geometric mean method.

Population	Year
2 00 000	1981
2 10 000	1991
2 30 000	2001

a) 244872

b) <u>245870</u>

c) 246820

d) None of these

Methods of Treatment

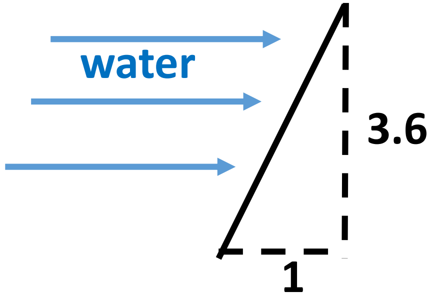
1. **Screening**
2. **Aeration**
3. **Sedimentation**
4. **Coagulation**
5. **Flocculation**
6. **Filtration**
7. **Disinfection**
8. **Other Methods**

Methods of Treatment

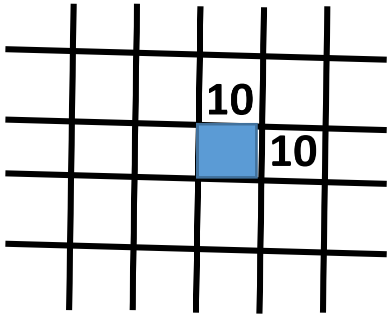
1. Screening

- Screening is done to remove the heavier suspended impurities from the water like plants, stones, animals, etc.
- Screening is generally adopted with the help of two types of screens:
  1. Coarse screens
  2. Fine Screens

1. Coarse screens
   - It is in the form of bars of dia 25mm and spacing of 20-100mm and spacing. These screens are generally placed 3.6 vertical to 1 horizontal



2. Fine Screens
   - These are generally in the form of wire mesh of size 10mm
   - Fine screen is generally avoided as it gets clogged frequently and requires cleaning at short intervals, thus increases operational cost.
   - As per GOI manual, it is recommended to use coarse screen instead of fine screens and remove the finer particles in other treatment stages



Methods of Treatment

2. Aeration

- To remove gases like H_2S and CO_2
- Aeration adds oxygen to water to carry out the oxidation of undesirable substances like organic matter and oils
- Aeration also removes phenols, humic acids from water

$$Fe^{3\,+\,+}O_2 + H_2O \rightarrow \mathrm{Fe(OH)_3\,(ppt)} + \mathrm{H}^{+}\text{(Acidity)}$$

$$Mn^{2\,+\,+}O_2 \rightarrow \mathrm{MnO_2\,(ppt)}$$

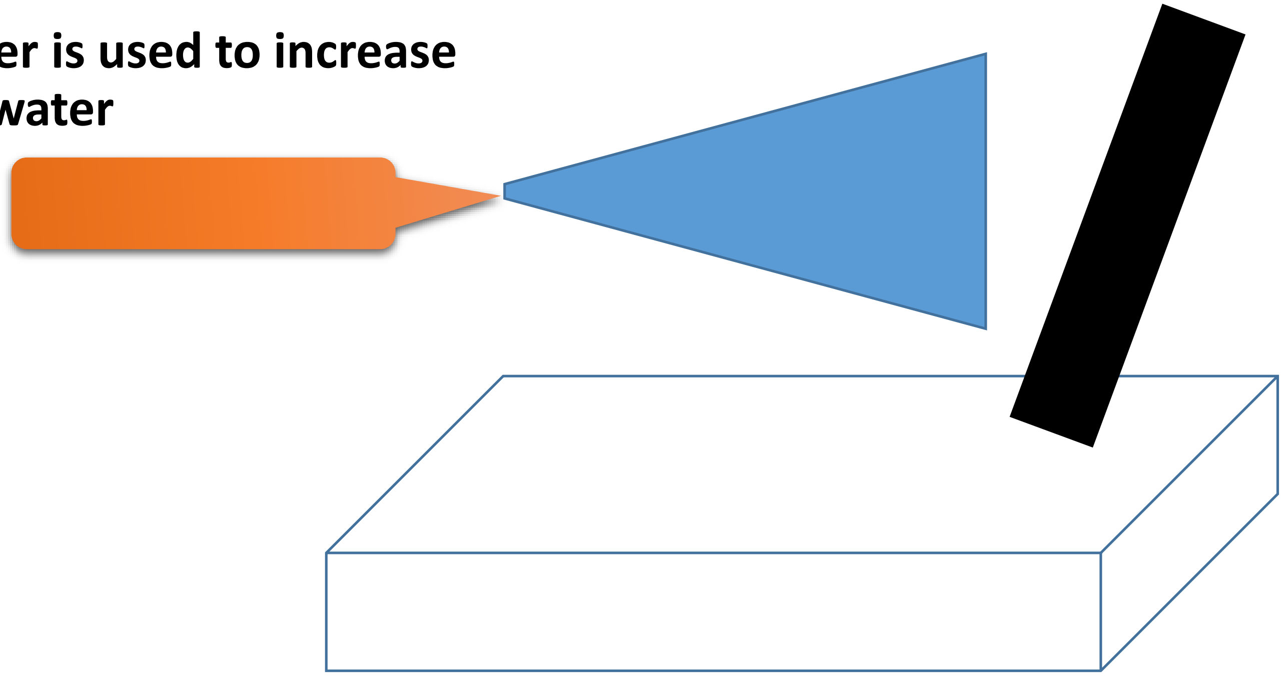
Methods of Treatment

2. Aeration

Methods of Aeration

A. Spray Nozzle Method

- **Most efficient method**
- **Pressurized water is used to increase surface area of water**



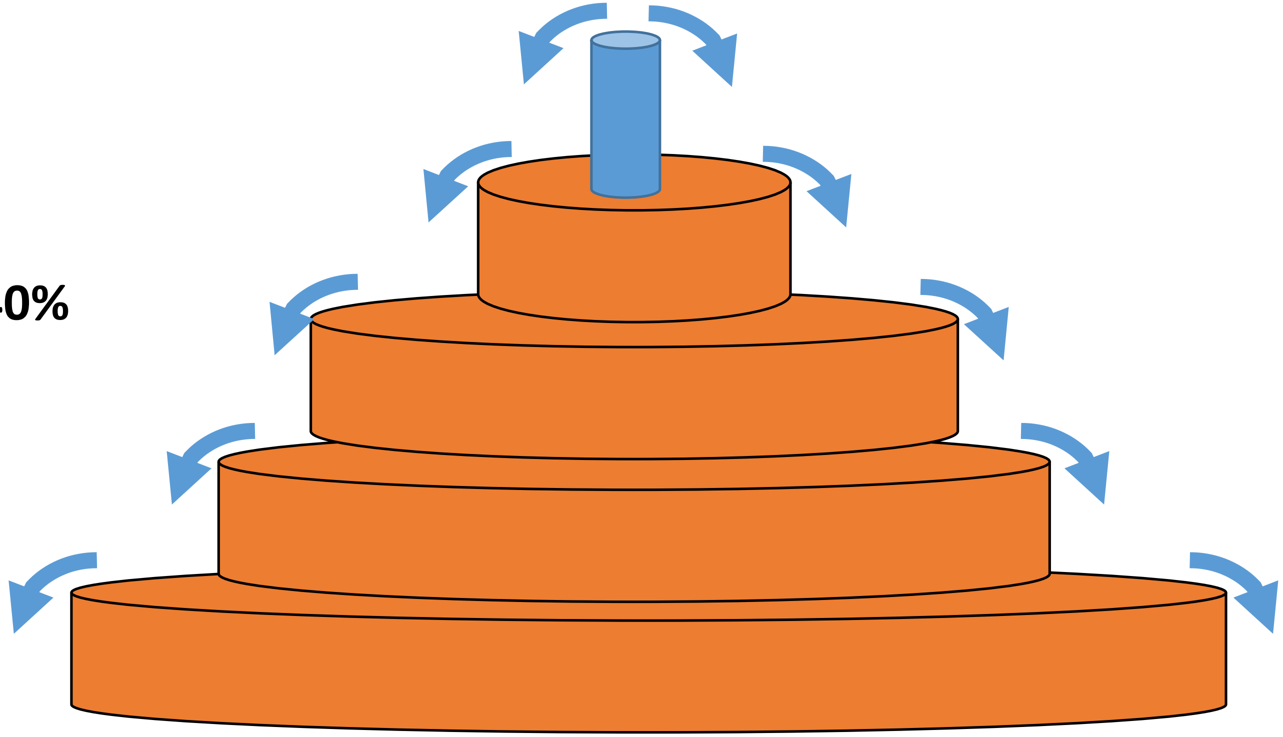
Methods of Treatment

2. Aeration

Methods of Aeration

B. Cascade Aerator

- Efficiency is about 40%



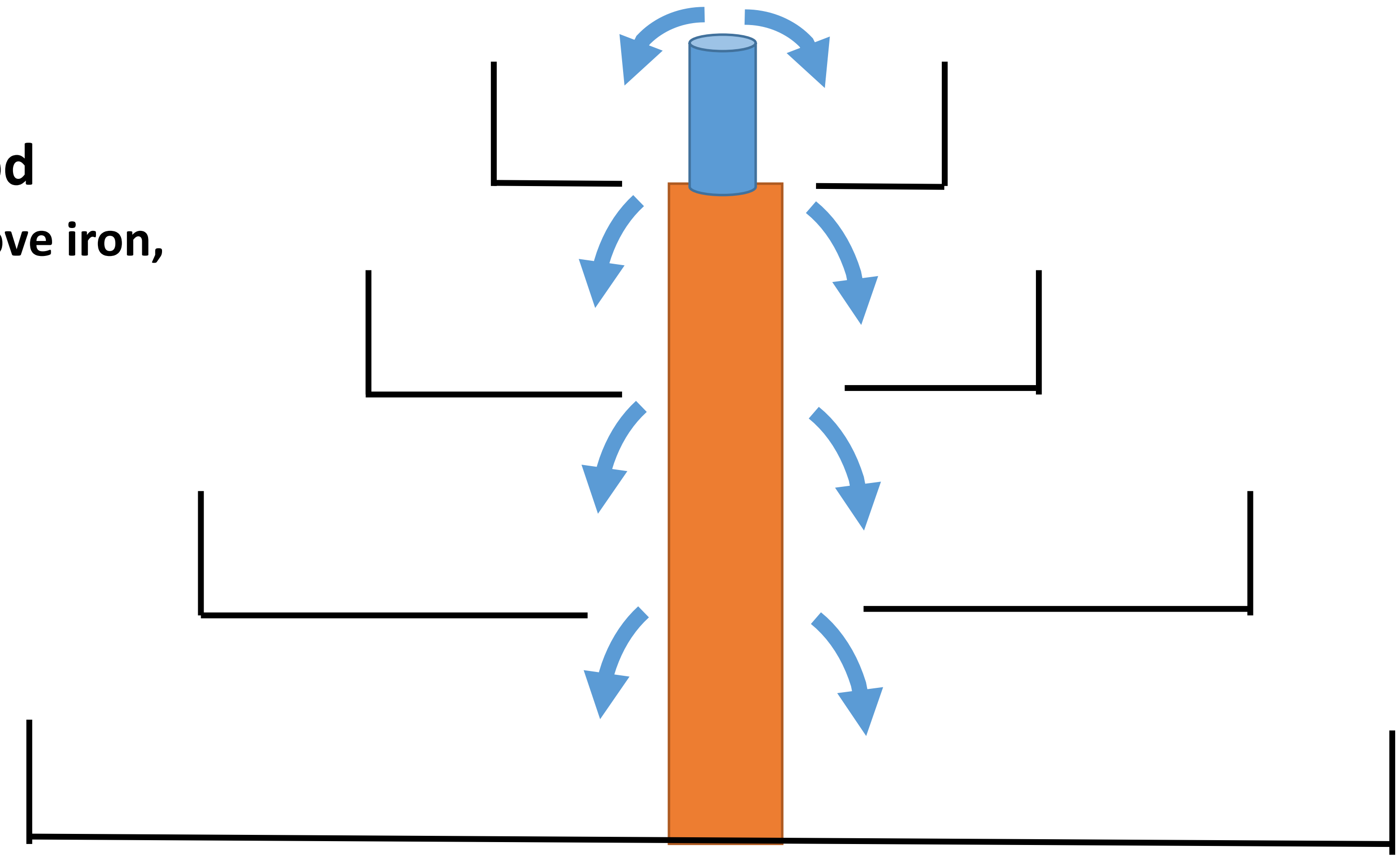
Methods of Treatment

2. Aeration

Methods of Aeration

C. Spray Tower Method

- Best method to remove iron, manganese and CO_2



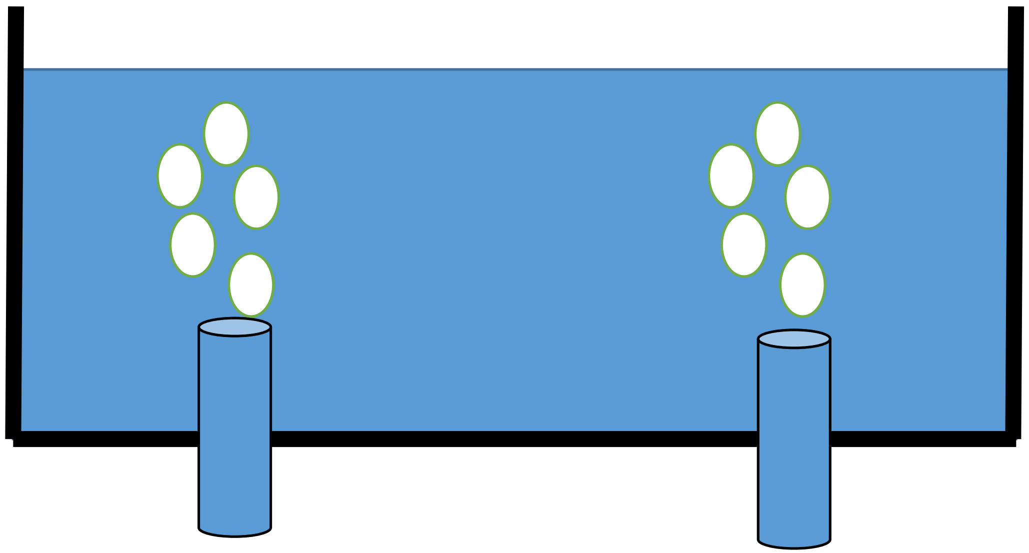
Methods of Treatment

2. Aeration

Methods of Aeration

D. Diffused air Method

- It has highest operational cost



Methods of Treatment

3. Sedimentation

- **Sedimentation is a natural process by which solids with higher density than he fluid in which they are suspended, settles under the action of gravity**
- **Sedimentation tank is used to remove suspended solids**

According to Stoke's law

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

ν=kinematic viscosity (m^2/sec)

G_s=specific gravity of particle

d=dia of particle

Methods of Treatment

3. Sedimentation

- **Sedimentation Tank is of two types**
  1. **Quiescent Type**
  2. **Continuous Type**

1. Quiescent Type

- **Quiescent Type has a detention time of 24 hours and cleaning interval of 8 to 12hours.**
- **Tank is designed for maximum daily flow (1.8q)**

Methods of Treatment

3. Sedimentation

2. Continuous Type

- There are two types of continuous flow tanks:
    1. Horizontal flow tanks - rectangular
    2. Vertical flow tank – circular

1. <u>Horizontal flow tanks:</u>

    <u>Assumptions:</u>

    a. A particle is removed when it reaches the bottom of settling tank

    b. The concentration of suspended particles of each size is same at all vertical cross section

3. Sedimentation

Design of Sedimentation tank

V_H= horizontal velocity or flow velocity

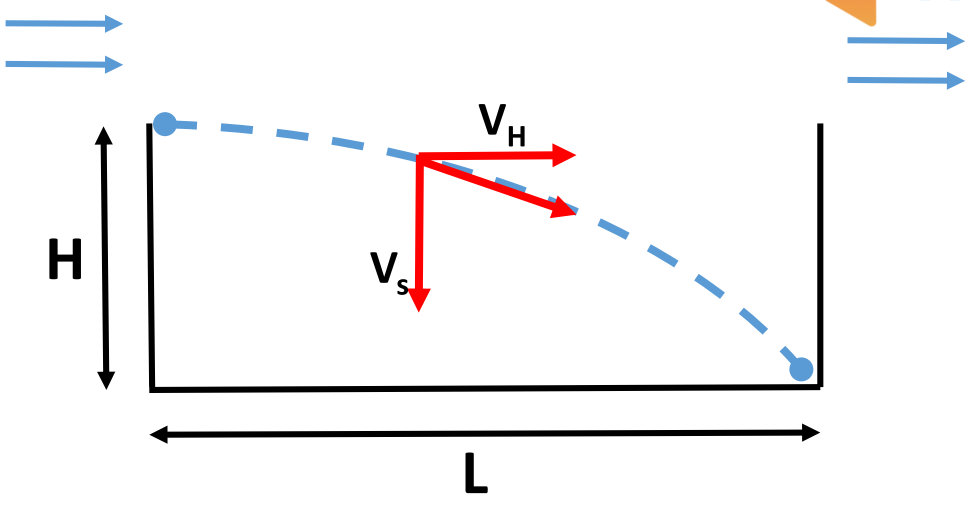
V_s= settling velocity

Time of horizontal flow = $\frac{L}{V_H}$

$= \frac{L}{\frac{Q}{BH}}$

$= \frac{LBH}{Q}$

$$Detention\ time\ DT = \frac{Volume}{Q}$$



Actual settling velocity $V_s = \frac{g(G_s - 1)d^2}{18\nu}$

$$Surface\ overflow\ rate\ \ V_0 = \frac{Q}{BL}$$

Time of Falling through height H => $t = \frac{H}{V_s}$

If first assumption is valid, $t = D_T$

$$D_T = \frac{LBH}{Q} = t = \frac{H}{V_s} \quad => \quad V_S = \frac{Q}{BL}$$

Surface overflow rate can be thought of a settling velocity of that particle which if introduced at the top most point at inlet will reach the bottom most point at outlet. This V_s is shown by another symbol V_0

- Particles having settling velocity less than the overflow rate will not get completely removed.
- Particles having settling velocity greater than the overflow rate, will get completely removed

Methods of Treatment

3. Sedimentation

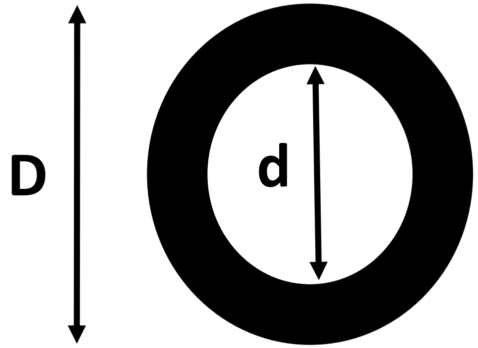
<u>Data for design of Sedimentation Tank</u>:

a) For plane sedimentation, overflow rate V_0=15000-30000 L/m^2/day
b) For plane sedimentation Detention time = 3 to 4 hours
c) For Sedimentation with coagulation, overflow rate V_0=30000-40000 L/m^2/day
d) For Sedimentation with coagulation, detention time 2 -2.5 hours
e) Width of tank =10-12m, Depth of tank is taken 3m
f) Sedimentation tank is designed for maximum daily flow (1.8q)

Vertical Flow Tank

In circular tank, the volume of tank is given by empirical relation

$$V = D^2(0.011D + 0.785H)$$



$$V_0 = \frac{discharge}{surface\ area} = \frac{Q}{\frac{\pi(D^2 - d^2)}{4}}$$

$$Detention\ time = \frac{volume\ of\ tank}{rate\ of\ flow} = \frac{D^2(0.011D + 0.785H)}{Q}$$

Methods of Treatment

4. Coagulation:

- The efficiency of sedimentation is very less when water contains very fine suspended solids. Hence to improve efficiency, coagulation is done along with sedimentation.
- Coagulation is process in which certain chemicals known as are added in the water so as to neutralize the changes over the particles so that the particles can come together to increase efficiency. A certain minimum amount of Energy is required for this process, known as Threshold Energy which is provided in the coagulation process by inducing rapid mixing in the water

Entire process of Coagulation is carried out in three steps:

A. Coagulation-Fast mixing
B. Flocculation-slow mixing
C. Sedimentation

Methods of Treatment

4. Coagulation:

Different types of Coagulants used are:

A. Alum $Al_2(SO_4)_3.18H_20$
B. Copperas $FeSO_4.7H_2O$
C. Chlorinated Copperas $Fe_2(SO_4)_3\ .\ FeCl_3$
D. Sodium Aluminate $Na_2Al_2O_4$
E. Lime

Methods of Treatment

4. Coagulation:

A. Alum $Al_2(SO_4)_3.18H_20$

$$Al_2(SO_4)_3.18H_20 + 3Ca(HCO_3)_2 \rightarrow 3CaSO_4 + 2Al(OH)_3 + 18H_2O + 6\ CO_2$$

This process adds hardness to water (due to $CaSO_4$) and increases acidity of water (due to CO_2)

If alkalinity is not present, external alkaline agents like lime and soda ash are added to induce artificial alkalinity

$$Al_2(SO_4)_3.18H_20 + 3Ca(OH)_2 \rightarrow 3CaSO_4 + 2Al(OH)_3 + 18H_2O$$

When lime is added, acidity is not induced but hardness is induced

$$Al_2(SO_4)_3.18H_20 + Na_2(CO)_3 \rightarrow 3Na_2SO_4 + 2Al(OH)_3 + CO_2 + H_2O$$

When soda ash is added, acidity is induced but hardness is not induced

Dose of Alum varies from 10 mg/L to 30 mg/L

Methods of Treatment

4. Coagulation:

B. Copperas $FeSO_4.7H_2O$

$$FeSO_4.7H_2O + 3Ca(HCO_3)_2 \rightarrow CaSO_4 + Fe(HCO)_3 + H_2O + 6\ CO_2$$

$$Fe(HCO)_3 \rightarrow Fe(OH)_3 + \text{other compounds}$$

This process also adds hardness to water

Coperas is never used for treatment of coloured water as it foms carcinogenic compounds

Dose of Coperas is same as that of Alum (10-30 mg/L)

Methods of Treatment

4. Coagulation:

C. Chlorinated Copperas $Fe_2(SO_4)_3 \cdot FeCl_3$

It is formed by chlorination of Copperas

Methods of Treatment

4. Coagulation:

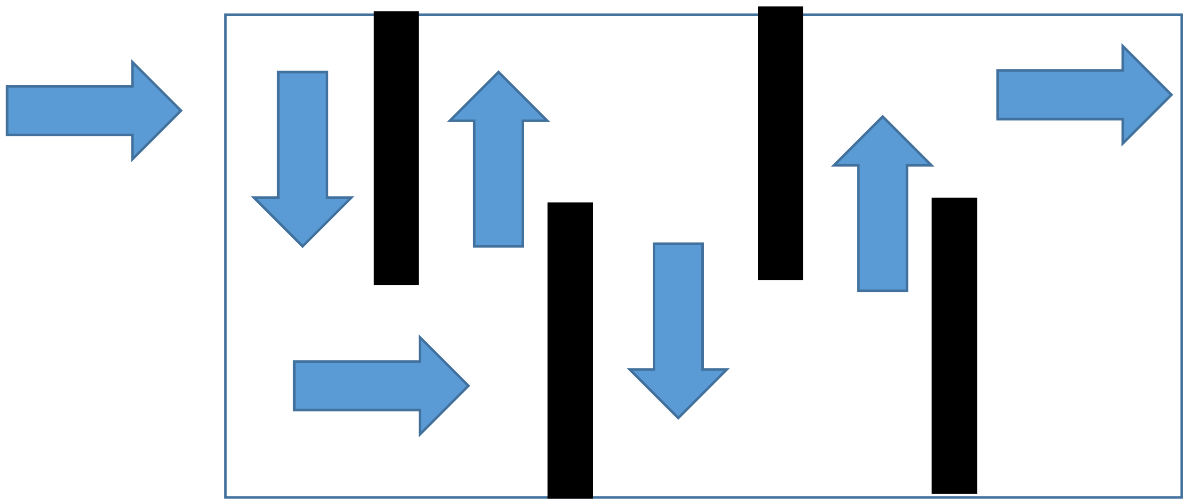
D. Sodium Aluminate $Na_2Al_2O_4$

- It reacts with calcium and Magnesium present in water to form sticky precipitate of Calcium Magnesium Aluminate
- This process removes both temporary and permanent hardness
- This process does not require presence of alkalinity in water

Methods of Treatment

4. Coagulation:

COAGULATION METHODS : Horizontal Flow Basin



TOP VIEW

In Mixing basins, mixing is induced by creating the turbulence in water and turbulence is created by rapid change in direction of flow of water

Methods of Treatment

4. Coagulation:

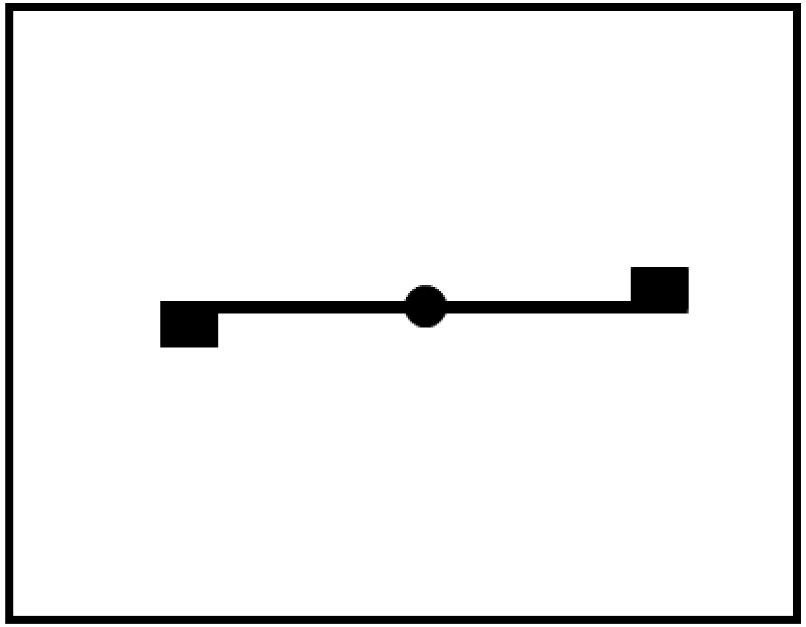
COAGULATION METHODS : Vertical Flow Basin

FRONT VIEW

Methods of Treatment

4. Coagulation:

Mechanical Mixers: Horizontal Mixing type

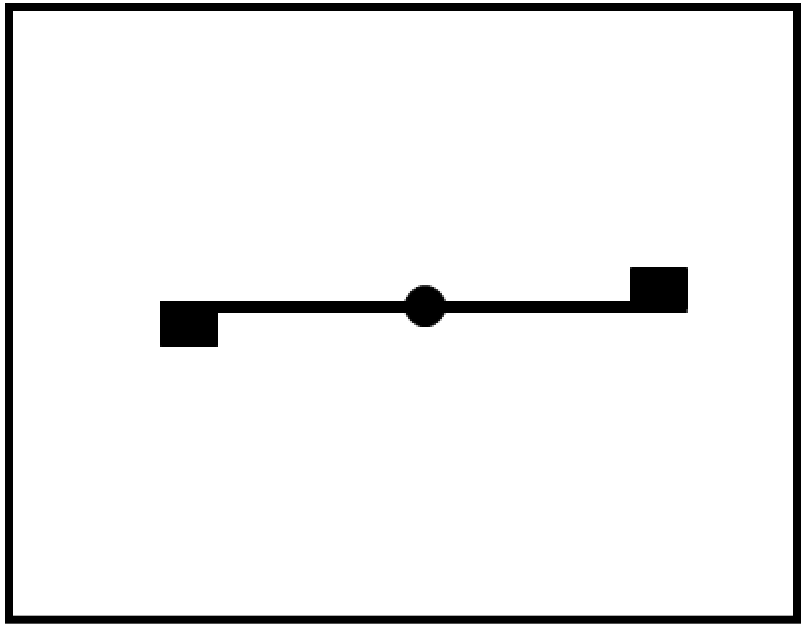


TOP VIEW

Methods of Treatment

4. Coagulation:

Mechanical Mixers: Vertical Mixing type



FRONT VIEW

In Mechanical Mixers, mixing is induced in water by vigorous agitation with the help of external power

Methods of Treatment

5. Flocculation:

- In Flocculation, neutralized, suspended particles are provided with sufficient contact time so as to combine and grow in size and get finally removed in the sedimentation process.
- In order to promote the contact between neutralized particle so as to from bigger sized flocs, slow mixing is done
- Flocculation depends on:
  1. Turbidity : More turbidity, more will be flocculation
  2. Type and dose of Coagulant: iron coagulant will form heavy flocs in less time
  3. Temporal mean velocity gradient (G)

Methods of Treatment

6. Filtration:

- **Filtration is most often used as limiting step to remove the flocs and finer unsedimented particles through beds of granular materials**
- **Filtration also removes suspended organic matter, microorganisms and dissolved minerals from the water**
- **Two types of Filters are used**
  1. **Gravity Filters**
  2. **Pressure Filter**

6. Filtration:

1. **Gravity Filters**

   These are the types of filter in which head is required by water to pass through filter medium. This head is provided by height of water itself over the filter medium.

   These are of two types:

   A. Slow sand Filters

   B. Rapid Sand Filters

2. **Pressure Filters**

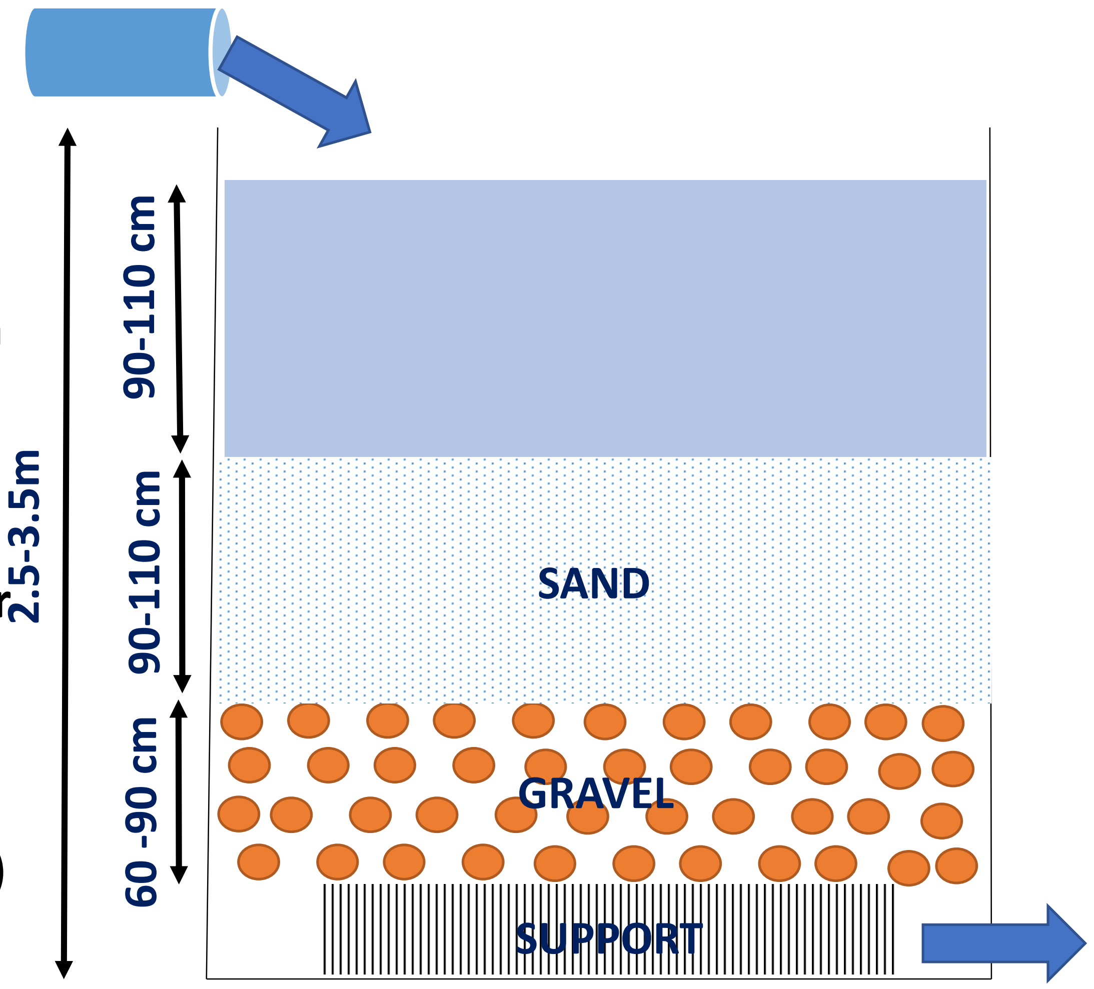
   These are the types of filter in which head required by water to pass through filter medium is provided artificially by the application of pressure over the water

6. Filtration:

1. Gravity Filters

A. Slow sand Filters

- Effective size of sand particles is taken to be 0.2 to 0.3mm
- Head maintained at the top of sand layer is equal to depth of sand layer
- Coefficient of Uniformity ($C_u = \frac{d_{60}}{d_{10}}$) for filter medium should be 5
- Design life of filters = 10 to 15 years
- Frequency of cleaning is 1-3 months
- During cleaning, top layer (1.5 to 3cm) of sand is removed
- Rate of filtration is 2400-2800 L/m²/day



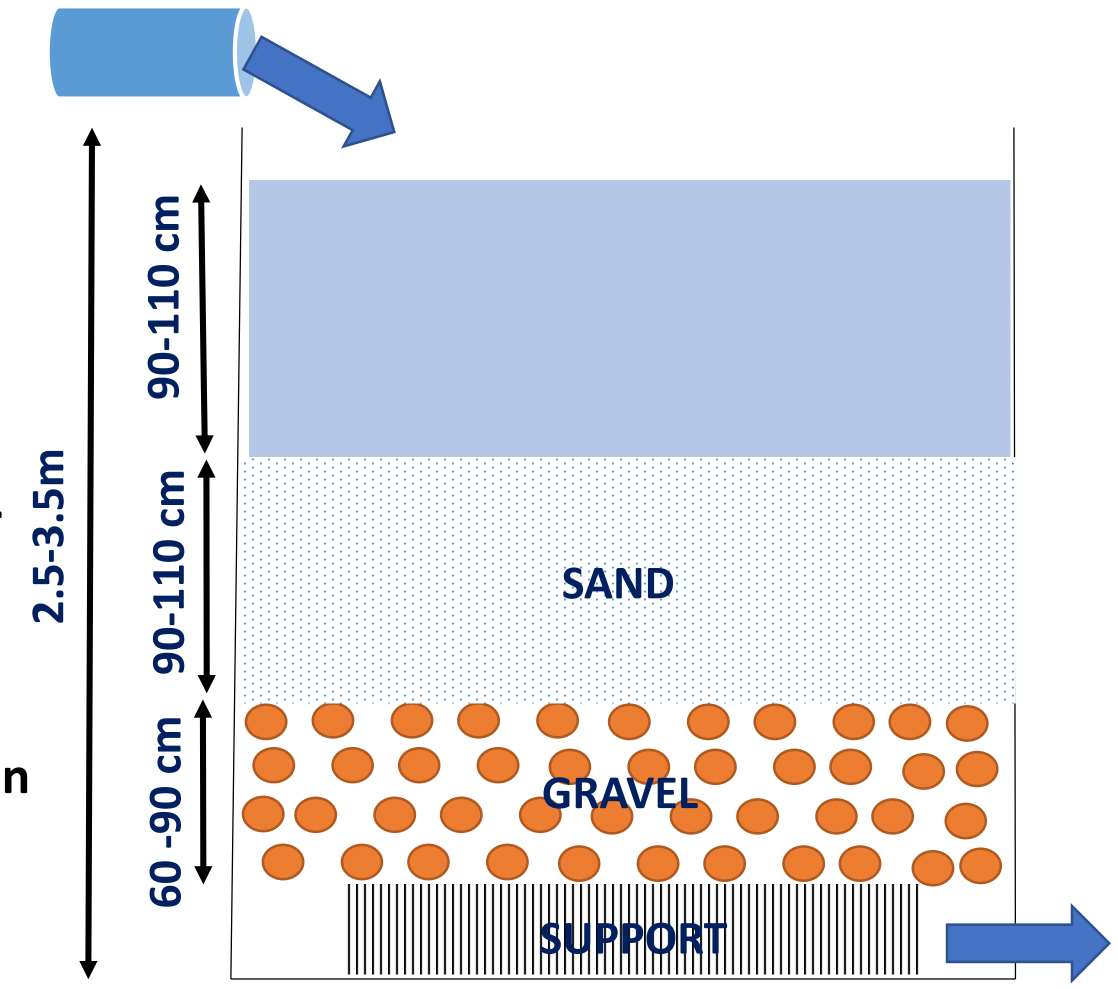
Plan area = 100 – 2000 m²

6. Filtration:

1. Gravity Filters

A. Slow sand Filters

- After cleaning of filter, it is washed with clean water and again loaded with effluent from plane sedimentation but this filtered water is not used for 24-36 hours
- The efficiency of this filter is 98-99%
- Slow Sand Filters should be used for small town/villages having population < 5000
- These are not used for water having turbidity > 50 NTU



Plan area = 100 – 2000 m^2

Theory of Filtration

1. Mechanical Straining

- **Impurities greater than the size of filter are strained over the filter**

2. Sedimentation

- **Turbulence is removed from water during filtration hence suspended particles tend to settle over sand partilces**

3. Biological changes

- $\textbf{Organic matter} \rightarrow \boldsymbol{Algae} \xrightarrow{\boldsymbol{Photosyntheis}} \boldsymbol{Oxygen} \rightarrow \boldsymbol{Oxidation\ of\ organic\ matter}$
- **This dirty layer of bacteria, algae, organic matter is called as <u>Schmutzdecke</u> layer**
- **More the thickness of schmutzdecke layer, more will be the biological efficiency of filter**

4. Electrolytic Changes

- **Impurities and filter media particles carry opposite charge and hence neutralization of charge occurs in water**

Slow Sand Filters

- **Number of filter required for treatment depends on the area of filter**

Area (m^2)	Number of Filters
<20	2 (including 1 standby)
20-249	3 (1 standby)
250-649	4 (1 standby)
650-1200	5 (1 standby)
>1200	6 (1 standby)

1. Gravity Filters

   B. Rapid sand Filters

      - Rapid sand filters removes suspended and colloidal matter. It also removes microorganisms.
      - In case of rapid sand filter, size of sand particles /(filter media) is large, hence impurities penetrate the deep inside the sand layer.
      - So surface washing alone is not sufficient, so we go for back washing
      - The entire process of back washing takes 15 minutes
      - Amount of water for back washing is 2-5 % of the total water filtered. Backwashing period is 24-48 hours

1. Gravity Filters

   B. Rapid sand Filters

      - Area of tank 10 to 100 m^2 per unit (tank)
      - Effective size (d_{10}) of sand is 0.45 to 0.75mm
      - Minimum free board is 0.5 m
      - Base material is gravel an its depth is 45cm
      - Coefficient of Uniformity ($C_u = \frac{d_{60}}{d_{10}}$) = 1.3 to 1.7

2. Pressure Filters

- Pressure filter is like a rapid sand filter with a difference that complete unit is inside a closed chamber where flow of water is under pressure and not due to gravity
- In pressure filter, water entering is neither flocculated, nor sedimented
- It is used for small scale works such as houses, swimming pool, small scale industries, etc.

Filter Troubles

1. Mud Ball Formation
    - Dust/Mud from the atmosphere gets deposited on the sand surface and during inadequate washing, the mud sinks down in the filter bed. Thereby forming mud balls
    - These mud balls go on increasing in size and during back washing, they interrupt and make the filter choke
2. Cracking of Filter
    - Fine sand in the top layer shrinks forming shrinkage cracks, thus flocs, mud and other impurities penetrate deep down in the filter, thereby reducing efficiency
3. Air Binding
    - More and more impurities are trapped on the surface. A stage comes when the frictional resistance by filter media exceeds the head of water over the sand.
    - The bottom sand then acts like a vacuum where no water can pass, thus making air bubbles inside the sand thereby seriously affecting the operation.
    - To prevent air binding, filter should be frequently cleaned or depth of water over the sand should be increased

7. Disinfection:

- Disinfection may be defined as the process of destruction of harmful microorganisms either by physical process or chemical process.
- Physical- Boiling, UV treatment, etc.
- Chemical- Chlorination, treatment by Bromine, Iodine, Ozone, potassium permanganate, etc.

7. Disinfection:

CHLORINATION

$$Cl_2 + H_2O \rightleftarrows HOCl + OCl^-$$

$$HOCl + H_2O \rightleftarrows H^+ + OCl^-$$

$At\ pH < 5,$ *chlorine does not react with water and remain as Free chlorine*

$HOCl, OCl^-$ *and* Cl_2 *are combinely called as Free Chlorine*

HOCl is most destructive

pH of water during chlorination should be between 5 to 7

7. Disinfection:

CHLORINATION

Chlorine immediately reacts with ammonia present in water to form chloramines. Chloramines are combined form of Chlorine and are less effective than freely available chlorine. But chloramines are stable and remain in water for a long duration. In the usual chlorine treatment, in which pH is kept between 5 to 7, dichloramine is predominately present.

The dose of Chlorine should be sufficient so as to leave 0.2 mg/L of chlorine after 10 minutes of contact period. This dose is called Chlorine demand of water.

$$NH_3 + HOCl \rightarrow NH_2Cl + H_2O$$

$$NH_2Cl + HOCl \rightarrow NHCl_2 + H_2O$$

$$NHCl_2 + HOCl \rightarrow NCl_3 + H_2O$$

7. Disinfection:

CHLORINATION

Forms in which Chlorine is added are:

A. As free chlorine
B. Bleaching powder or Hypochlorite ($CaOCl_2$)
C. Chloramines
D. Chlorine dioxide (ClO_2)

Effective in Disinfection: ClO_2 >HOCl>Chloramines>Ocl^-

7. Disinfection:

CHLORINATION

Types of Chlorination

A. Plane Chlorination

B. Pre Chlorination

C. Super Chlorination

7. Disinfection:

<u>CHLORINATION</u>

Testing of Chlorine Residue

A. Orthotolidene Test
B. DPD Test (DiEthyl Paraphenylene Diamene)
C. Starch Iodide Test
D. Chlorotex Test

7. Disinfection:

CHLORINATION

Testing of Chlorine Residue

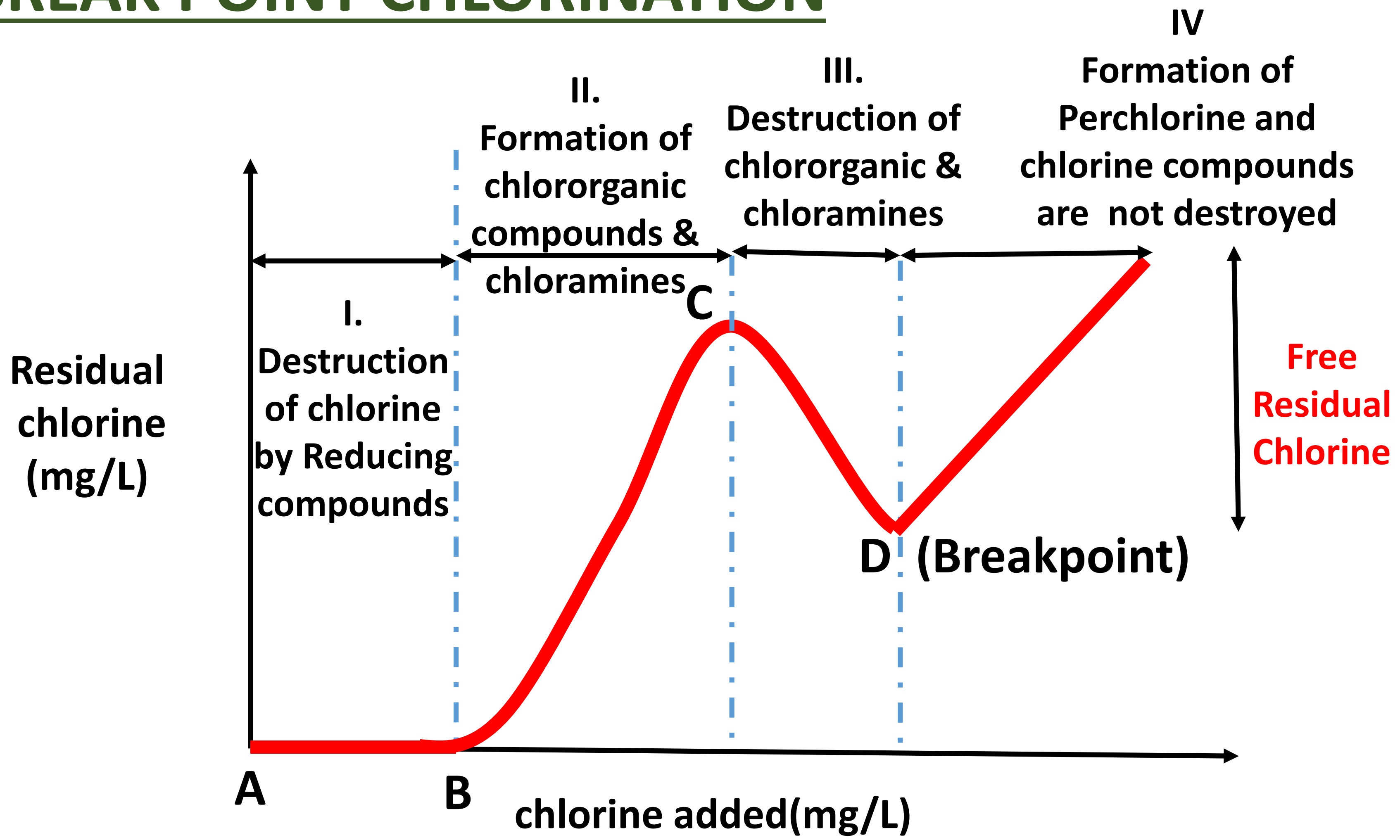
A. Orthotolidene Test
B. DPD Test (DiEthyl Paraphenylene Diamene)
C. Starch Iodide Test
D. Chlorotex Test

Various dechlorinating agents are:

a) Sodium thiosulphate
b) Activated carbon
c) Sulphur dioxide

7. Disinfection:

BREAK POINT CHLORINATION



Source of Water

1. Infiltration Gallery

- Horizontal tunnels constructed at shallow depth along the banks of a river through water bearing strata
- These are also called as Horizontal Wells

2. Infiltration Well

- These are shallow wells constructed in series along the banks of a river in order to collect water
- These are constructed in brick masonry

3. Springs

- The natural outflow of ground water at Earth Surface is called Spring
- They are purest form of ground water
- Sometimes they may contain sulphur which increases temperature of water hence they are called hot springs

Water Distribution, Conveyance and its Source

Methods of Distribution

Water is distributed in following ways:

1. **Gravitational System**
2. **Pumping system**
3. **Combined System**

System of Supply

1. **Continuous supply**
2. **Intermittent supply**

Water Distribution, Conveyance and its Source

Layout of Distribution System:

- The distribution pipe system consists of Mains, Sub mains, Laterals, Branches and Service connections
- Distribution pipes are laid along the roads or below footpaths depending upon local conditions, there can be several types of system:

Water Distribution, Conveyance and its Source

Layout of Distribution System:

1. Dead End System (Tree System)

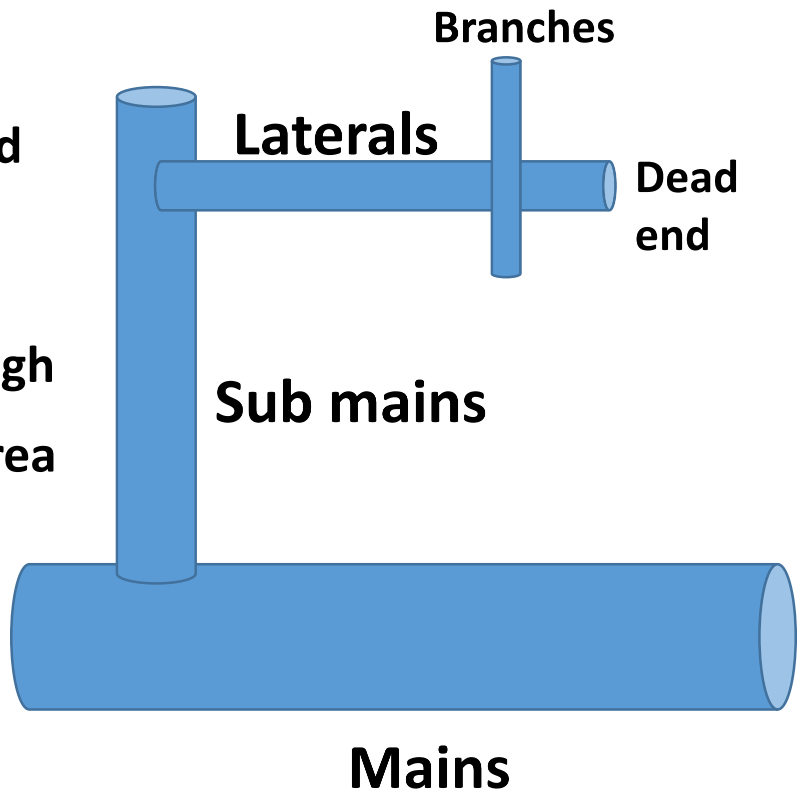
- ✓ Used for Old towns where houses are in unplanned way
- ✓ It is easy to design and is cheap and simple

Disadvantage

i. Water can reach at a particular point only through one route, hence if some fault occurs at one point, water supply may get disturbed in that area as flow is unidirectional

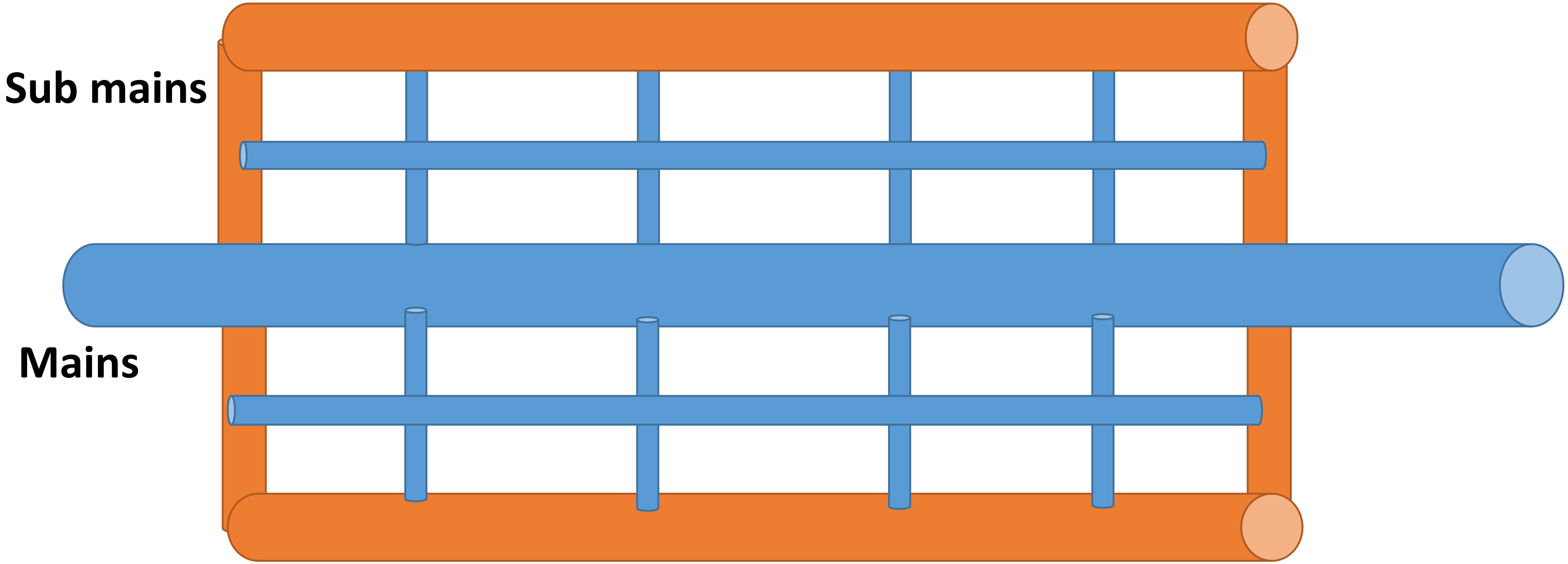
ii. There are many dead ends which prevent free circulation of water

iii. Stagnant water has to be removed periodically and this results in wastage of treated water



Layout of Distribution System:

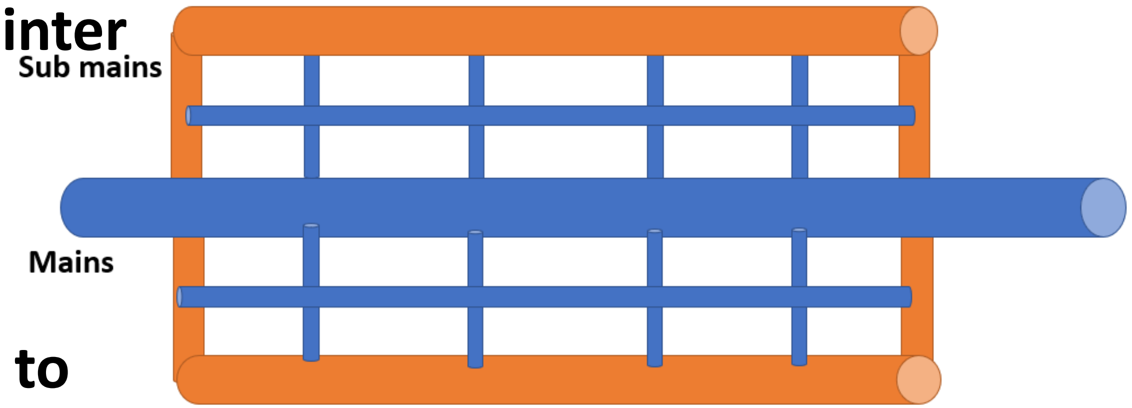
2. Grid Iron System



Layout of Distribution System:

2. Grid Iron System

- It is also known as **Reticular System**
- One main pipe runs through centre and branches and laterals run in grid pattern which are inter connected



Advantages:

✓ Dead ends are eliminated

✓ At the time of fire, water can be diverted to affected areas by closing the valves of other areas

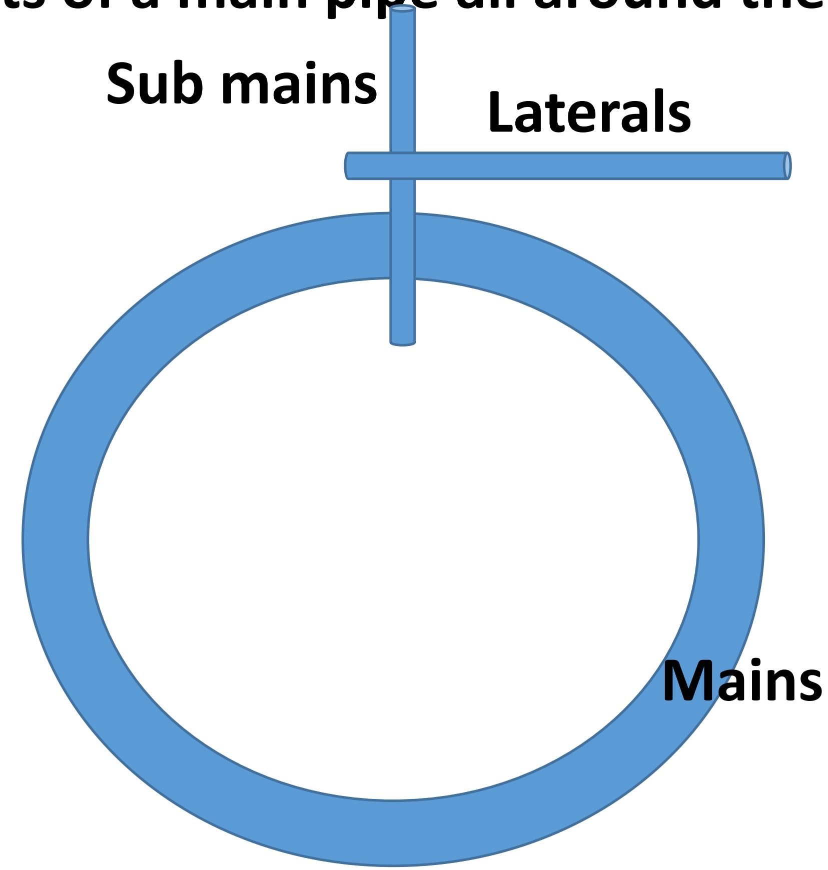
Disadvantages:

- Design is a bit difficult, size of pipes are larger and more number of valves are required
- It is most suited for a planned city only

Layout of Distribution System:

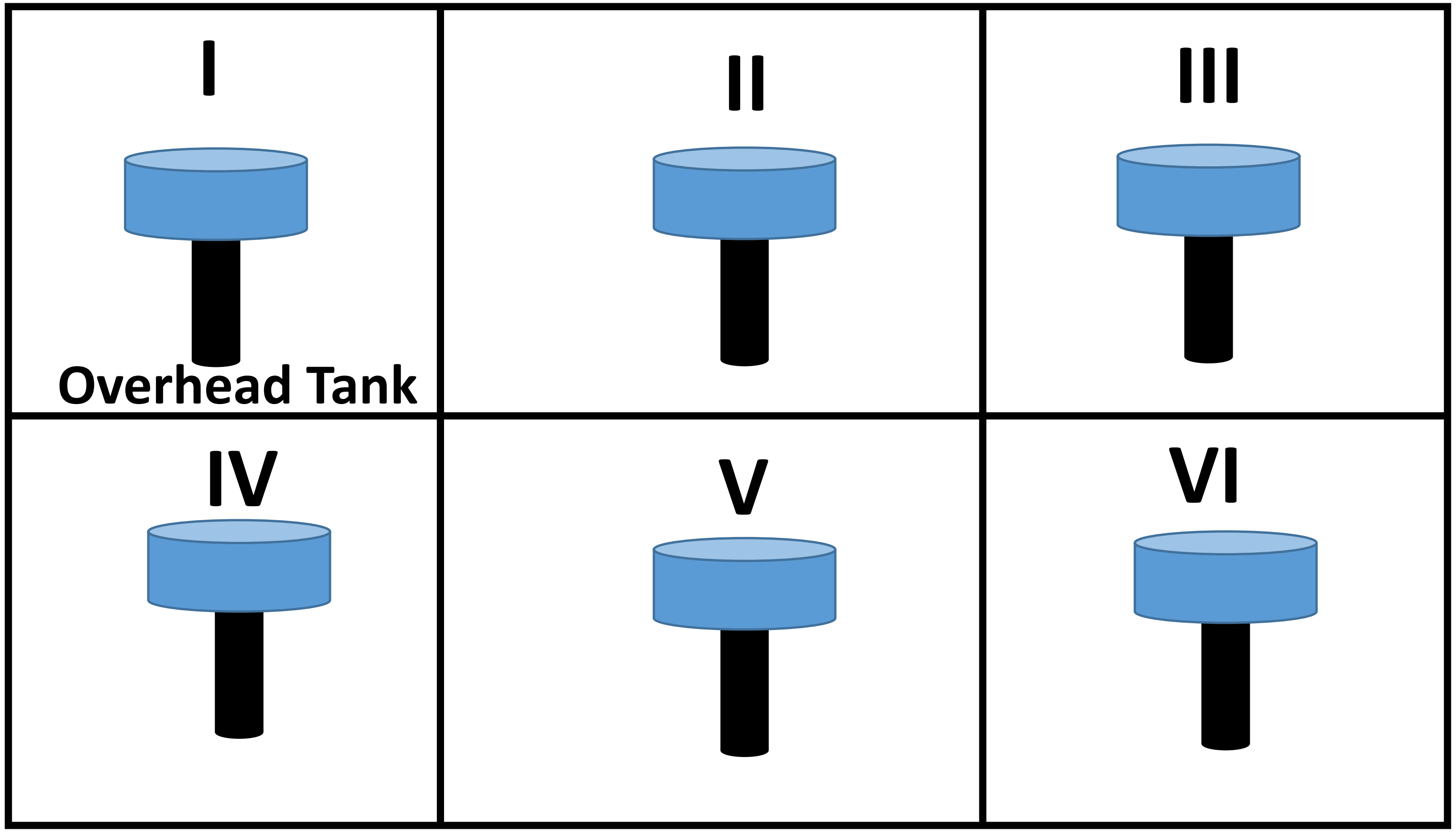
3. Ring System

- This is also known as Circular system
- It consists of a main pipe all around the area



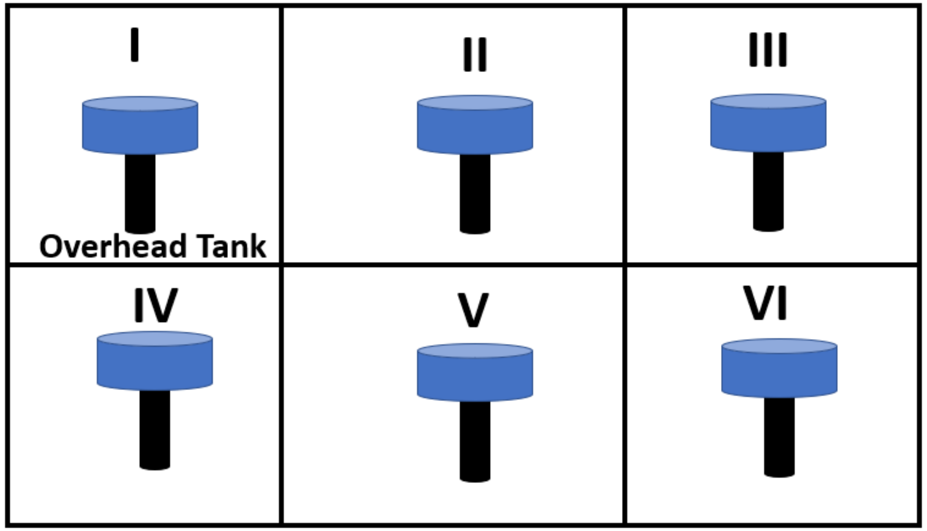
Layout of Distribution System:

4. Radial System



Layout of Distribution System:

4. Radial System



- A very large area is divided into several zones and at the centre of each zone, a distribution reservoir is kept

Advantage:

- This method gives higher service head and efficient water distribution

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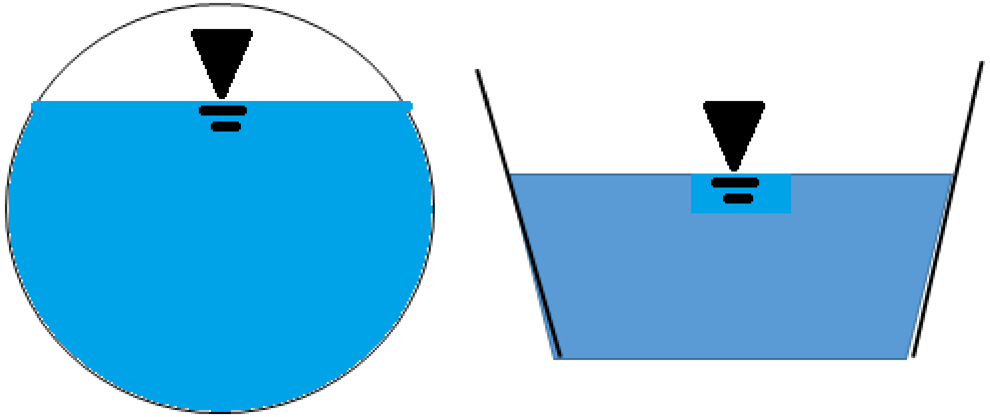
CONVEYANCE

Conduits for Water Supply

1. Gravity Conduits
2. Pressure Conduits



Gravity Conduits :

Water flows under the action of Gravity flow.

Gravity flow can occur in pipes, canals, aqueducts, flumes, etc

Pressure Conduits:

Water flows under pressure above atmospheric pressure. These pipes can freely go up and down over the surface and sometimes above mountains also

CONVEYANCE

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Various types of Pipes under pressure :

Metallic Pipes

1. Cast Iron pipes

- Most widely used as Mains because they are economical, unreactive

2. Steel Pipes

- They are used when inside pressure is high and larger size is required

3. Wrought iron pipe

- They are called Galvanized iron pipes
- They are easily workable and lighter than cast iron pipes, hence they are used as distribution inside a building

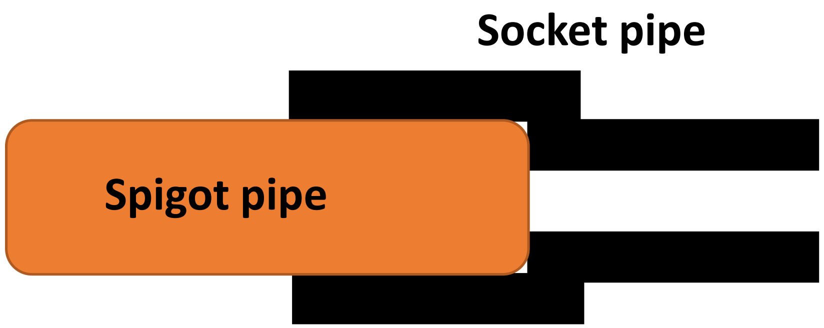
Non Metallic Pipes

1. RCC pipes- mostly used as Mains
2. Pre Stress Concrete Pipes: They can withstand high pressure, they are corrosion resistant
3. Asbestos Pipe: Silica and Cement are cemented together to a stiff material called asbestos-Highly corrosion resistant
4. Plastic Pipes:
    - UPVC pipe (Unplasticides Polyvinyl Chloride)
    - Polyethylene pipes
    - GRP (Glass reinforced pipes)

JOINTS IN PIPELINES

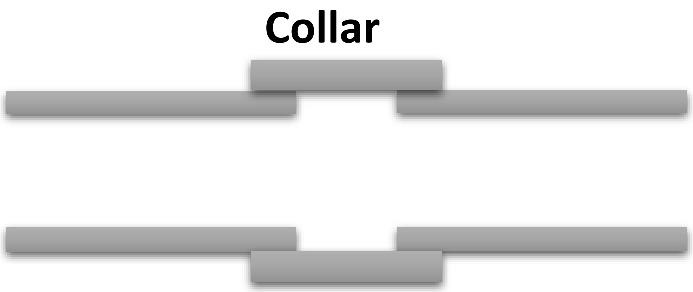
1. SPIGOT JOINT

- It is also called Bell and Spigot Joint
- This is used to connect cast iron pipes and steel pipes



2. COLLAR JOINT

- It is used for joining RCC pipes and asbestos pipes

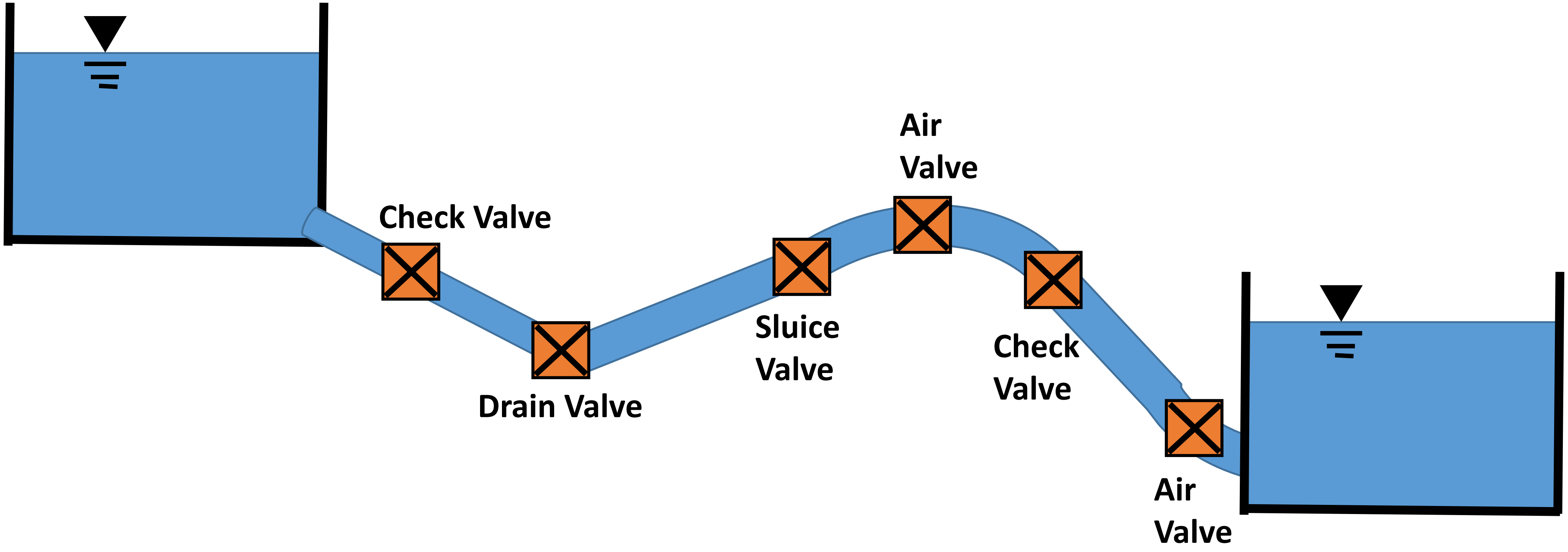


JOINTS IN PIPELINES

3. EXPANSION JOINT

- **Expansion joints are provided in metal pipe at suitable interval to take into account the change in pipe length due to temperature variation**
- ***Contraction joints are not provided for water supply lines***

PIPE APPERTENANCES



PIPE APPERTENANCES

1. **Sluice valve:**
   - **They are also known as Gate valves or shut off valves**
   - **These are provided to regulate the flow of water through the pipe and are essential to divide the mains into several sections.**
   - **These are placed usually at summit of the pressure pipes where the pressure is low**
2. **Air Valves/ Air relief valves**
   - **Water always carries some air with it while flowing**
   - **This air tends to accumulate at summit of pipe, due to accumulation of air, blockage of water takes place, so air valve is provided at summit to release pressure**

PIPE APPERTENANCES

3. **Check valve / Reflux Valve / Non returning valve:**
   - **These are automatic devices that permits the flow in one direction only**
4. **Drain valve/ scouring valve / blow off valve**
   - **Its function is to remove sand, silt, etc. deposited in the pipelines**
5. **Butterfly Valve**
   - **They regulate and stop the flow in large sized pipes**
6. **Ball Valves / Ball Float valves:**
   - **They are used to maintain a constant level in an elevated tank or a reservoir**

PIPE APPERTENANCES

7. Pressure Relief Valve / Safety Valve

- **When the pressure of water suddenly increases and exceeds the permissible pressure, it results in water hammer**
- **The valve opens automatically to release the excess pressure instantaneously.**
- **Thus the pipeline is protected from bursting**

Environment Engineering II

1. Waste Water Characteristics
2. Biochemical Reactions in waste water
3. Disposal of Sewage Effluents
4. Design of Sewerage system
5. Treatment of Waste water
6. Solid waste management
7. Air and noise pollution

Waste Water Characteristics

- **Waste water is usually classified as**
  - **→ Industrial waste water and**
  - **→ Municipal waste water**
- **Industrial waste water with characteristics compatible with municipal water is often discharged into municipal sewer.**
- **Many Industrial waste waters require pretreatment to remove non compatible substances prior to discharge into the municipal sewers**

Properties of Waste Water

Waste water = water + liquid waste originated from locality

1. **Domestic sewage: It is a mixture of water and liquid waste originating due to domestic activities like washing, cooking, bathing, etc.**
2. **Industrial sewage: Waste water originated due to industrial activities**
3. **Storm Water Drainage: It is sewage that is originated due to rains.**

Note: Combination of kitchen and Bathroom waste is termed as sullage

SEWERAGE SYSTEM

- **It is a system of collection, treatment and disposal of the treated sewage**
- **Sewerage system is of 3 types:**
  1. **Separate sewerage system**
  2. **Combined sewerage system**
  3. **Partially separate sewerage system**

Physical Waste Water Parameters

- **All physical water quality parameters like total solids, suspended solids, Turbidity, colour, Temperature, etc. are applicable here also.**
- **Sewage Consists of Both Organic & Inorganic particles**
- **Average temperature of sewage in India is 20°C.**
- **As per GOI manual, 80% of water supplied goes into the sewage.**

Chemical Parameters of Waste Water

Solids present in waste water can be of four forms:

1. **Suspended solids**
2. **Dissolved solids**
3. **Colloidal solids**
4. **Settleable solids**

Chemical Parameters of Waste Water

1. **Suspended solids** are those which remain floating in water. **(>100nm)**
2. **Dissolved solids** are these which dissolve in waste water. **(< 1 nm)**
3. **Colloidal solids** are those which have particle size in between dissolved and suspended. **(1-100nm)**
4. **Settleable** solids are that portion of solid matter which settles out if the waste water is allowed to remain undisturbed for 2 hours.

Chemical Parameters of Waste Water

The amount of various kinds of solids present in waste water can be determined as below:

- **Total amount of solids can be determined by evaporating a known volume of waste water and weighing the residue left. The mass of residue left divided by the known volume of water is expressed in mg/L**
- **The suspended solids are also called as Filterable Solids that are retained on a filter of 1µm pore size.**
- **The quantity of settleable solids with the help of Imhoff Cone.**
  - **Waste water is allowed to stand in the cone for 2 hours and the quantity of solids settled down in the bottom is directly read out.**

Chemical Parameters of Waste Water

2. **pH Value**
    - **The alkalinity of fresh waste water is alkaline but as time passes it becomes acidic because of the bacterial action in anaerobic processes**
3. **Chloride content: The normal chloride content of waste water of domestic nature is taken as 120 mg/L.**
4. **Dissolved oxygen (DO)**
    - Respiration of aerobic microorganisms
    - The dissolved oxygen in fresh waste water depends upon temperature. It the temp of sewage is more, DO content will be less.
    - **For survival of fish, 4ppm (4mg/L) DO is required**
    - **DO content of waste water is found out by Winkler's method**

Chemical Parameters of Waste Water

5. Chemical Oxygen Demand (COD)

- COD is used to measure the content of Biodegradable as well as Non biodegradable organic matter

- COD – BOD = non biodegradable organic matter

6. Theoretical Oxygen Demand (ThOD)

- Amount of oxygen required to oxidize the quantity of all organic matter

7. Biochemical Oxygen Demand (BOD)

- BOD is used as a measure of the quantity of oxygen required for oxidation of Biodegradable organic matter present in water sample by aerobic bio chemical reactions.
- BOD of water during 5 days at 20°c is taken as standard BOD and is approx., equal to 67% of ultimate BOD
- The BOD is determined by diluting a known volume of a sample of waste water with a known volume of Aerated water and then calculating DO of the diluted sample.
- The diluted sample is then incubated at 20°c for 5 days the DO at the end of 5 days is again calculated.
- The difference between initial DO and final DO will indicate the oxygen consumed

7. Biochemical Oxygen Demand (BOD)

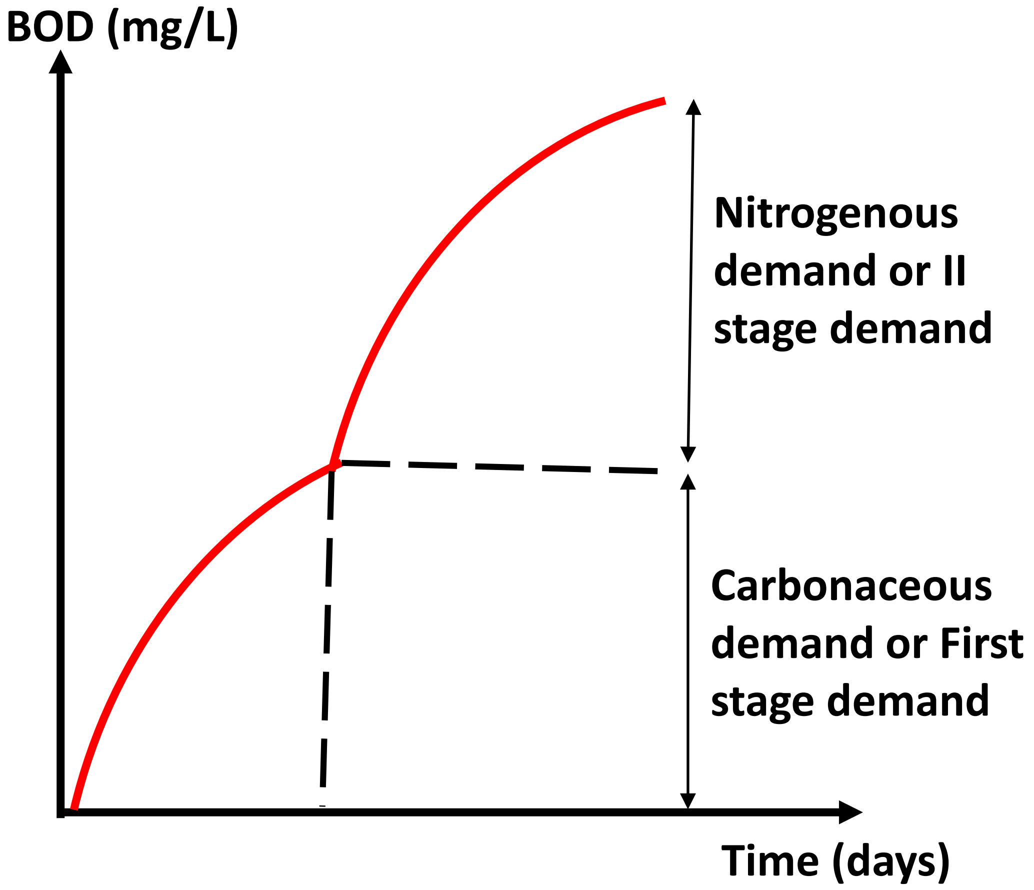
- $BOD = \left(DO_i - DO_f\right) \times D.F\ .$

$$Dilution\ factor\ DF = \frac{volume\ of\ diluted\ somple}{volume\ of\ undiluted\ sample\ taken}$$

Que 21. 5mL of waste water sample is taken to form 100mL of diluted sample. Given that DO_i = 5mg/L and DO_F = 2mg/L. Find BOD.

7. Biochemical Oxygen Demand (BOD)

- The first Demand occurs due to oxidation of organic matter and is called Carbonaceous demand or First stage demand.
- The later demand occurs due to biological oxidation of Ammonia and is called Nitrogenous demand or II stage demand
- Nitrogenous demand starts only after 8 days because the reproduction rate of Nitrification bacteria is very slow.



7. Biochemical Oxygen Demand (BOD)

Let L_t = amount of organic matter present at any time t

t = time in days

K=rate constant (unit=per day) or deoxygenation constant

L_0 = maximum amount of organic matter present

$$\frac{d\,Lt}{dt} = -K\,Lt$$

$$=> \frac{d\,Lt}{Lt} = -K\,dt$$

$$=> [ln\,L_t]_{L0}^{Lt} = -K\,[t_2 - t_1]$$

$$=> L_t = L_0\,e^{-kt}$$

$$BOD_t = L_o - L_t$$

$$= L_0 - L_0\,e^{-kt}$$

$$BOD_t = L_0\left(1 - e^{-kt}\right)$$

$$K_D^{T°c} = K_D^{20°c}\,(1.047)^{T-20°}$$

Population Equivalent

- It indicates strength of industrial waste water for estimating the treatment required at the municipal treatment plant
- Average BOD of domestic sewage is 80g/capita/day
- $Population\ equivalent = \dfrac{total\ BOD_5\ of\ the\ industry\ in\ kg/day}{0.08\ kg/day}$

Biochemical reactions in Waste Water

- The aerobic and anaerobic are the two basic forms of Biological stabilization reaction whose occurrence is dependent upon the availability or non-availability of oxygen.
- Aerobic Reactions taken place in the presence of free oxygen and produce Stable inorganic end products with relatively low energy content.
- Anaerobic reactions occur in the absence of free oxygen.
- Anaerobic reactions are slow and do not remove the organic content completely.

Various Types of Bacteria

- **Bacteria are primary decomposers of organic material**
- **Bacteria require energy and material for growth and reproduction**
- **Energy for bacteria is derived from biological oxidation or reduction of organic or inorganic compounds**
- **Material is derived from organic or inorganic compounds. Bacteria are classified according to the energy source**

Various Types of Bacteria

1. **AUTOTROPS: They derive both energy and material from inorganic substances.**
2. **HETEROTROPHS: They derive both energy & material from organic substances**
3. **PHOTOTROPS: They utilize sunlight as energy source and inorganic substances as material source**
4. **FACULTATIVE HETROTROPS: They are capable of functioning both in the presence and in the absence of oxygen to oxidize organic matter.**
5. **AEROBIC HETROTROPS: They utilize organics in the presence of oxygen.**
6. **ANAEROBIC HETROTROPS: They utilize organics in the absence of oxygen.**

Que 22. The depression of water table in a well due to pumping will be maximum

a) At a distance r from the well
b) Close to the well
c) At a distance R/2 from the well
d) None of the above

Que 22. The depression of water table in a well due to pumping will be maximum

a) At a distance r from the well
b) Close to the well
c) At a distance R/2 from the well
d) None of the above

Que 23. The devices that are installed for drawing water from the sources are called as

a) **Aquifers**
b) **Aquiclude**
c) **Filters**
d) **Intakes**

Que 23. The devices that are installed for drawing water from the sources are called as

a) Aquifers
b) Aquiclude
c) Filters
d) <u>Intakes</u>

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Que 24. Maximum discharge of a tube well is about

a) 5 litres/sec
b) 50 litres/sec
c) 500 litres/sec
d) 1000 litres/sec

Que 24. Maximum discharge of a tube well is about

a) 5 litres/sec
b) <u>50 litres/sec</u>
c) 500 litres/sec
d) 1000 litres/sec

Que 25. As compared to shallow wells, deep wells have

a) More depth
b) Less depth
c) More discharge
d) Less discharge

Que 25. As compared to shallow wells, deep wells have

a) More depth
b) Less depth
c) More discharge
d) Less discharge

Que 26. Ground water is usually free from

a) Suspended Impurities
b) Dissolved impurities
c) Both suspended and dissolved impurities
d) NOTA

wifistudy

Que 26. Ground water is usually free from

a) Suspended Impurities
b) Dissolved impurities
c) Both suspended and dissolved impurities
d) NOTA

Que 27. Polluted water is the one which

a) Contains pathogenic bacteria
b) Consists of undesirable substances rendering it unfit for drinking and domestic use
c) Is safe and suitable for drinking and domestic use
d) Is contaminated

Que 27. Polluted water is the one which

a) Contains pathogenic bacteria
b) Consists of undesirable substances rendering it unfit for drinking and domestic use
c) Is safe and suitable for drinking and domestic use
d) Is contaminated

Que 28. Which of the following is not a water borne disease?

a) Dysentery
b) Cholera
c) Typhoid
d) Malaria

Que 28. Which of the following is not a water borne disease?

a) Dysentery
b) Cholera
c) Typhoid
d) Malaria

Que 29. The most common cause of acidity in water is

a) Carbon dioxide
b) Oxygen
c) Hydrogen
d) Nitrogen

Que 29. The most common cause of acidity in water is

a) <u>Carbon dioxide</u>
b) Oxygen
c) Hydrogen
d) Nitrogen

Que 30. The phenolic compounds in public water supply should not be more than

a) 0.1 ppm
b) 0.01 ppm
c) 0.001 ppm
d) 0.0001 ppm

Que 30. The phenolic compounds in public water supply should not be more than

a) 0.1 ppm
b) 0.01 ppm
c) <u>0.001 ppm</u>
d) 0.0001 ppm

Que 31. The maximum permissible limit for fluoride content in drinking water is

a) 0.1 ppm

b) 1.5 ppm

c) 5 ppm

d) 10 ppm

Que 31. The maximum permissible limit for fluoride content in drinking water is

a) 0.1 ppm

b) <u>1.5 ppm</u>

c) 5 ppm

d) 10 ppm

DESIGN AND CONSTRUCTION OF SEWERS

The major roles of a sewer system :

- **Improvement in the environment by removing the sewage as it originates**
- **Preventing inundation of low lying areas that may be otherwise caused by not providing sewers**
- **Prevention of sewage stagnations**
- **Avoiding cross connections with freshwater sources by seepage**

LAYING OF SEWERS

Priorities of works shall be followed during execution in sequence as:

(1) Sewage treatment plants

(2) Trunk mains

(3) Sewage pumping stations (if required)

(4) Main sewers

(5) Sub main sewers

(6) Sewers (Laterals)

SEWER CONSTRUCTION

1. **Removing pavement**
2. **Removal of the material from the ground, and its separation, its classification where necessary, and its final disposal**
3. **Sheeting and bracing the sides of the trench**
4. **Removal of water (if any) from the trench**
5. **Protection of other structures, both underground and on the surface, whose foundations may be affected**
6. **Backfilling, and**
7. **Replacement of the pavement.**

ESTIMATION OF DESIGN FLOWS

a) DESIGN PERIOD: The length of time up to which the capacity of a sewer will be adequate is referred to as the design period.

Sl. No	Component	Design Period, Years (from base year)
1	Land Acquisition	30
2	Conventional sewers (A)	30
3	Non-conventional sewers (B)	15
4	Pumping mains	15
5	Pumping Stations-Civil Work	30
6	Pumping Machinery	15
7	Sewage Treatment Plants	15
8	Effluent disposal	30
9	Effluent Utilization	15 or as the case may be

(A) Typical underground sewers with manholes laid in the roads
(B) All types such as small bore, shallow sewers, pressure sewers, vacuum sewers

Central Public Health and Environmental Engineering Organization (CPHEEO)

ESTIMATION OF DESIGN FLOWS

b) POPULATION FORECAST:

- Arithmetic increase method
- Geometrical increase method
- Incremental increase method

Flow Formula

1. Manning's Formula:

$$V = [(1/n)] \times \left[R^{2/3} \; S^{1/2} \right]$$

- n : Manning's coefficient
- V : Velocity in m/s
- S : Slope of hydraulic gradient
- R : Hydraulic radius in m

$$\mathrm{R} = \frac{\text{wetted area}}{\text{Wetted Perimeter}}$$

2. Hazen-Williams Formula

$$V = 0.849\, C\, R^{0.63} \;\; S^{0.540}.63$$

$$c = Hazen\, William\; constant$$

Design Data

- Sanitary Sewers are designed to run partially full and under gravity
- As per GOI manual,

PIPE SIZE	DESIGN CONDITION
D < 0.4m	$\frac{1}{2}$ *full at max discharge*
0.4m $\leq$ D $\leq$ 0.9m	$\frac{2}{3}$ *full at max discharge*
D > 0.9m	$\frac{3}{4}$ *full at max discharge*

Design Data

- **Sewer should be designed to carry peak discharge i.e. maximum hourly discharge and should be checked to ensure that at minimum discharge i.e. minimum hourly discharge velocity generated should be greater than self cleansing velocity**
- **Self Cleansing Velocity is the minimum velocity at which no solid gets deposited at the bottom of the sewer**
- **To avoid erosion of pipe material, maximum velocity should be limited as follows:**
  - **For concrete sewer, 2.5 - 3 m/sec**
  - **For Cast iron, 3.5 - 4.5 m/sec**

PEAK SEWAGE FLOW

$$Q_{max} = \frac{18 + \sqrt{P}}{4 + \sqrt{P}}$$

- Where P is population in thousand

SEWER APPURTENANCES

1. Manhole

A manhole is an opening through which a man may enter a sewer for inspection, cleaning and other maintenance and is fitted with a removable cover to withstand traffic loads in sewers

SEWER APPURTENANCES

1. <u>Manhole</u>

- **Manhole should be built at every change of alignment, gradient or diameter, at the head of all sewers and branches and at every junction of sewers**
- **The spacing of manholes above 90 to 150 m is allowed on straight sewer lines of dia 0.9 – 1.5 m**
- **Spacing of manholes above 150 to 200m is allowed on straight sewer lines of dia 1.5 – 2m**
- **The depth less than 1m is considered as normal manhole and depth greater than 1.5m is considered as deep manhole**

SEWER APPURTENANCES

1. **Types of Manhole**
   - **Straight Manhole:** Built on a straight run of sewer with no change in size of Sewer or no junctions in the sewer
   - **Junction Manhole:** Built at every junction of two or more sewers
   - **Drop Manholes:** Built to connect the high level branch sewer to the low level main sewer

SEWER APPURTENANCES

2. **Grease and Oil Traps**
   - **Constructed on Sewer lines for excluding grease and oil from the sewage**
3. **Catch Basin**
   - **Rectangular chamber which allows the storm water to enter the sewer and eliminating silt and stones**

Corrosion of Concrete Sewers

- **Hydrogen Sulphide is produced in Sewer lines and it gets oxidized to Sulphuric acid which reacts with the constituents of Cement which forms $CaSO_4$ to occupy greater volume than the compounds they replace**

Que 32. Harmful bacteria which may be present in Sewage-

a) E coli

b) B Colli

c) Vibriocholera

d) Entamoeba histolytica

Que 32. Harmful bacteria which may be present in Sewage-

a) **E coli (harmless bacteria)**

b) **B Colli (parasites)**

c) **Vibriocholera**

d) **Entamoeba histolytica (parasites)**

Que 33. The minimum diameter of an opening on a manhole is

a) 25 cm
b) 50 cm
c) 75 cm
d) 105 cm

Que 33. The minimum diameter of an opening on a manhole is

a) 25 cm

b) 50 cm

c) 75 cm

d) 105 cm

Que 34. Sewage treatment units are usually designed for

a) 5-10 years
b) 15-20 years
c) 30-40 years
d) 50 years

Que 34. Sewage treatment units are usually designed for

a) 5-10 years
b) 15-20 years
c) 30-40 years
d) 50 years

Que 35. The pH value of fresh sewage is

a) Less than 7
b) More than 7
c) Equal to 7
d) 0

Que 35. The pH value of fresh sewage is

a) Less than 7

b) More than 7

c) Equal to 7

d) 0

Que 36. A sewer which receives the discharge of a number of house sewers is called

a) House Sewer
b) Lateral Sewer
c) Intercepting sewer
d) Sub mains sewer

Que 36. A sewer which receives the discharge of a number of house sewers is called

a) House Sewer
b) Lateral Sewer
c) Intercepting sewer
d) Sub mains sewer

Que 37. A manhole is generally provided at each

a) Bend
b) Junction
c) Change of gradient
d) All of the above

Que 37. A manhole is generally provided at each

a) Bend
b) Junction
c) Change of gradient
d) <u>All of the above</u>

Que 38. Pick up the incorrect statement from the following:

a) Manholes are provided in Sewer pipes at suitable intervals
b) Catch Basins are generally provided in Sewers for carrying drainage discharge
c) Inlets are generally provided in all Sewers
d) NOTA

Que 38. Pick up the incorrect statement from the following:

a) **Manholes are provided in Sewer pipes at suitable intervals**
b) **Catch Basins are generally provided in Sewers for carrying drainage discharge**
c) **<u>Inlets are generally provided in all Sewers</u>**
d) **NOTA**

Que 39. Before entering a manhole, a candle is lowered into the manhole

a) To illuminate it
b) To detect toxic gases
c) To give signal to adjacent manhole
d) To find out the presence of Oxygen

Que 39. Before entering a manhole, a candle is lowered into the manhole

a) To illuminate it
b) To detect toxic gases
c) To give signal to adjacent manhole
d) <u>To find out the presence of Oxygen</u>

Que 40. The trap which is provided to disconnect the house drain from the street sewer is called

a) Master trap
b) Intercepting trap
c) Interception manhole
d) All of the above

Que 40. The trap which is provided to disconnect the house drain from the street sewer is called

a) Master trap
b) <u>Intercepting trap</u>
c) Interception manhole
d) All of the above

Que 41. The inspection pit is a manhole provided in a base drainage system

a) At every change of direction
b) At every change of gradient
c) At every 30m interval
d) All of the above

Que 41. The inspection pit is a manhole provided in a base drainage system

a) At every change of direction
b) At every change of gradient
c) At every 30m interval
d) <u>All of the above</u>

Que 42. The diameter of a domestic sewer pipe laid at gradient 1 in 100 is recommended

a) 100mm
b) 150mm
c) 175mm
d) 200mm

Que 42. The diameter of a domestic sewer pipe laid at gradient 1 in 100 is recommended

a) 100mm

b) <u>150mm</u>

c) 175mm

d) 200mm

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Que 43. Which type of drainage system will collect the rain water

a) Primary
b) Secondary
c) Tertiary
d) Primary and Tertiary

wifistudy

Que 43. Which type of drainage system will collect the rain water

a) Primary
b) Secondary
c) Tertiary
d) Primary and Tertiary

Que 44. The correct relation between theoretical oxygen demand (TOD), Biochemical Oxygen demand (BOD) and Chemical Oxygen demand (COD) is given by

a) TOD>BOD>COD

b) TOD>COD>BOD

c) BOD>COD>TOD

d) COD>BOD>TOD

Que 44. The correct relation between theoretical oxygen demand (TOD), Biochemical Oxygen demand (BOD) and Chemical Oxygen demand (COD) is given by

a) TOD>BOD>COD

b) TOD>COD>BOD

c) BOD>COD>TOD

d) COD>BOD>TOD

Que 45. Standard EDTA solution is used to determine

a) Hardness in water

b) Turbidity in water

c) Dissolved oxygen in water

d) Residual chlorine in water

Que 45. Standard EDTA solution is used to determine

a) <u>Hardness in water</u>

b) Turbidity in water

c) Dissolved oxygen in water

d) Residual chlorine in water

Que 46. If coliform bacteria is present in a sample of water, then the coliform test to be conducted is

i. Presumptive coliform test
ii. Confirmed coliform test
iii. Completed coliform test

a) Only (i)
b) Both (i) and (ii)
c) Both (i) and (iii)
d) All of the above

Que 46. If coliform bacteria is present in a sample of water, then the coliform test to be conducted is

i. **Presumptive coliform test**

ii. **Confirmed coliform test**

iii. **Completed coliform test**

a) **Only (i)**

b) **Both (i) and (ii)**

c) **Both (i) and (iii)**

d) **All of the above**

Que 47. Alkalinity in water is expressed as milligrams per lire in terms of equivalent

a) Calcium carbonate

b) Magnesium carbonate

c) Sodium carbonate

d) Calcium hydroxide

Que 47. Alkalinity in water is expressed as milligrams per lire in terms of equivalent

a) <u>Calcium carbonate</u>

b) Magnesium carbonate

c) Sodium carbonate

d) Calcium hydroxide

Que 48. Which of the following values of pH represents a stronger acid?

a) 2

b) 5

c) 7

d) 10

Que 48. Which of the following values of pH represents a stronger acid?

a) 2

b) 5

c) 7

d) 10

Que 49. Turbidity is measured on

a) Standard silica scale

b) Standard cobalt scale

c) Standard platinum scale

d) Platinum cobalt scale

Que 49. Turbidity is measured on

a) Standard silica scale

b) Standard cobalt scale

c) Standard platinum scale

d) Platinum cobalt scale

Que 50. On standard – silica scale, the turbidity in drinking water should be limited to

a) 10 ppm

b) 20 ppm

c) 30 ppm

d) 50 ppm

Que 50. On standard – silica scale, the turbidity in drinking water should be limited to

a) 10 ppm

b) 20 ppm

c) 30 ppm

d) 50 ppm

Que 51. Residual chlorine in water is determined by

a) Starch iodide method

b) Orthotolidene method

c) Both (a) and (b)

d) None of these

Que 51. Residual chlorine in water is determined by

a) Starch iodide method

b) Orthotolidene method

c) Both (a) and (b)

d) None of these

Que 52. Orthotolidene test is used for determination of

a) Dissolved oxygen

b) Residual chlorine

c) Biochemical oxygen demand

d) Dose of coagulant

Que 52. Orthotolidene test is used for determination of

a) Dissolved oxygen

b) Residual chlorine

c) Biochemical oxygen demand

d) Dose of coagulant

Que 53. If the total hardness of water is greater than its total alkalinity, the carbonate hardness will be equal to

a) Total alkalinity

b) Total hardness

c) Total hardness – total alkalinity

d) Non carbonate hardness

Que 53. If the total hardness of water is greater than its total alkalinity, the carbonate hardness will be equal to

a) <u>Total alkalinity</u>

b) Total hardness

c) Total hardness – total alkalinity

d) Non carbonate hardness

Carbonate hardness = minimum of (total hardness, alkalinity)

Que 54. The amount of residual chlorine left in public water supply for safety against pathogenic bacteria is about

a) 0.01 to 0.05 ppm

b) 0.05 to 0.5 ppm

c) 0.5 to 1.0 ppm

d) 1.0 to 5.0 ppm

Que 54. The amount of residual chlorine left in public water supply for safety against pathogenic bacteria is about

a) 0.01 to 0.05 ppm

b) 0.05 to 0.5 ppm

c) 0.5 to 1.0 ppm

d) 1.0 to 5.0 ppm

Que 55. The dissolved oxygen level in natural unpolluted water at normal temperature is found to be of the order of

a) 1 mg / litre

b) 10 mg / litre

c) 100 mg / litre

d) 1000 mg / litre

Que 55. The dissolved oxygen level in natural unpolluted water at normal temperature is found to be of the order of

a) 1 mg / litre

b) 10 mg / litre

c) 100 mg / litre

d) 1000 mg / litre

Que 56. The velocity of flow of water in a sedimentation tank is about

a) 5 to 10 cm/sec.

b) 15 to 30 cm/sec.

c) 15 to 30 cm / minute

d) 15 to 30 cm / hour

Que 56. The velocity of flow of water in a sedimentation tank is about

a) 5 to 10 cm/sec.

b) 15 to 30 cm/sec.

c) 15 to 30 cm / minute

d) 15 to 30 cm / hour

Que 57. The length of rectangular sedimentation tank should not be more than

a) B

b) 2 B

c) 4B

d) 8 B

Que 57. The length of rectangular sedimentation tank should not be more than

a) B

b) 2 B

c) 4B

d) 8 B

Que 58. The overflow rate for plain sedimentation tanks is about

a) 500 to 750 liters / hour/m^2

b) 1000 to 1250 liters / hour/m^2

c) 1250 to 1500 liters / hour/m^2

d) 1500 to 2000 liters / hour/m^2

Que 58. The overflow rate for plain sedimentation tanks is about

a) 500 to 750 liters / hour/m^2

b) 1000 to 1250 liters / hour/m^2 (when coagulants are used)

c) 1250 to 1500 liters / hour/m^2

d) 1500 to 2000 liters / hour/m^2

Que 59. Percentage of bacterial load that can be removed from water by the process of plain sedimentation is about

a) 10 to 25

b) 50

c) 75

d) 100

wifistudy

Que 59. Percentage of bacterial load that can be removed from water by the process of plain sedimentation is about

a) 10 to 25

b) 50

c) 75

d) 100

Que 60. For a given discharge, the efficiency of sedimentation tank can be increased by

a) Increasing the depth of tank

b) Decreasing the depth of tank

c) Increasing the surface area of tank

d) Decreasing the surface area of tank

Que 60. For a given discharge, the efficiency of sedimentation tank can be increased by

a) Increasing the depth of tank

b) Decreasing the depth of tank

c) Increasing the surface area of tank

d) Decreasing the surface area of tank

For small particles, Low overflow rate is required, hence surface area is increased

$$Surface\ overflow\ rate\ \ V_0 = \frac{Q}{BL}$$

Que 61. The detention period and overflow rate respectively for plain sedimentation as compared to sedimentation with coagulation are generally

a) Less and more

b) Less and less

c) More and less

d) More and more

Que 61. The detention period and overflow rate respectively for plain sedimentation as compared to sedimentation with coagulation are generally

a) Less and more

b) Less and less

c) More and less

d) More and more

Que 62. The amount of coagulant needed for coagulation of water increases with

A. increase in turbidity of water

B. Decrease in turbidity of water

C. Increase in temperature of water

D. Decrease in temperature of water

The correct answer is

a) A and B

b) A and D

c) B and C

d) B and D

Que 62. The amount of coagulant needed for coagulation of water increases with

A. increase in turbidity of water

B. Decrease in turbidity of water

C. Increase in temperature of water

D. Decrease in temperature of water

The correct answer is

a) A and B

b) A and D

c) B and C

d) B and D

Que 63. Alum as a coagulant is found to be most effective when pH range of water is

a) 2 to 4

b) 4 to 6

c) 6 to 8

d) 8 to 10

Que 63. Alum as a coagulant is found to be most effective when pH range of water is

a) 2 to 4

b) 4 to 6

c) 6 to 8

d) 8 to 10

Que 64. The detention period in coagulation tanks is usually kept as

a) 1 to 2 minutes

b) 30 to 45 minutes

c) 2 to 6 hours

d) 2 to 6 days

Que 64. The detention period in coagulation tanks is usually kept as

a) 1 to 2 minutes

b) 30 to 45 minutes

c) 2 to 6 hours

d) 2 to 6 days

Que 65. The alum, when added as a coagulant in water

a) Does not require alkalinity in water for flocculation

b) Does not affect pH value of water

c) Increases pH value of water

d) Decreases pH value of water

Que 65. The alum, when added as a coagulant in water

a) Does not require alkalinity in water for flocculation

b) Does not affect pH value of water

c) Increases pH value of water

d) Decreases pH value of water

Que 66. The chemical most commonly used to increases speed of sedimentation of sewage is

a) Sulphuric acid

b) Copper sulphate

c) Lime

d) Sodium permanganate

Que 66. The chemical most commonly used to increases speed of sedimentation of sewage is

a) Sulphuric acid

b) Copper sulphate

c) Lime

d) Sodium permanganate

Que 67. In water treatment, rapid gravity filters are adopted to remove

a) Dissolved organic substances

b) Dissolved solids and dissolved gases

c) Floating solids and dissolved inorganic solids

d) Bacteria and colloidal solids

Que 67. In water treatment, rapid gravity filters are adopted to remove

a) Dissolved organic substances

b) Dissolved solids and dissolved gases

c) Floating solids and dissolved inorganic solids

d) Bacteria and colloidal solids

Que 68. The rate of filtration in slow sand filters in million liters per day per hectare is about

a) 50 to 60

b) 100 to 150

c) 500 to 600

d) 1400 to 1500

Que 68. The rate of filtration in slow sand filters in million liters per day per hectare is about

a) <u>50 to 60</u>

b) 100 to 150

c) 500 to 600

d) 1400 to 1500

Que 69. The effective size of sand particle used in slow sand filters is

a) 0.25 to 0.35 mm

b) 0.35 to 0.60 mm

c) 0.60 to 1.00 mm

d) 1.00 to 1.80 mm

Que 69. The effective size of sand particle used in slow sand filters is

a) <u>0.25 to 0.35 mm</u>

b) 0.35 to 0.60 mm

c) 0.60 to 1.00 mm

d) 1.00 to 1.80 mm

Que 70. As compared to rapid sand filters, slow sand filters give

A. Slower filtration rate

B. Higher filtration rate

C. Lesser efficiency in removal of bacteria

D. Higher efficiency in removal bacteria

The correct answer is

a) A and B

b) B and C

c) A and D

d) B and D

Que 70. As compared to rapid sand filters, slow sand filters give

A. Slower filtration rate

B. Higher filtration rate

C. Lesser efficiency in removal of bacteria

D. Higher efficiency in removal bacteria

The correct answer is

a) A and B

b) B and C

c) A and D

d) B and D

Que 71. Assertion A: Slow sand filters are more efficient in removal of bacteria than rapid sand filters.

Reason R: The sand used in slow sand filters is finer than that in rapid sand filters.

Select your answer based on the coding system given below:

a) Both A and R are true and R is the correct explanation of A.

b) both A and R are true but R is not the correct explanation of A.

c) A is true but R is false

d) A is false but R is true

Que 71. Assertion A: Slow sand filters are more efficient in removal of bacteria than rapid sand filters.

Reason R: The sand used in slow sand filters is finer than that in rapid sand filters.

Select your answer based on the coding system given below:

a) Both A and R are true and R is the correct explanation of A.

b) both A and R are true but R is not the correct explanation of A.

c) A is true but R is false

d) A is false but R is true

Que 72. Air binding phenomena in rapid sand filter occur due to

a) Excessive negative head

b) Mud ball formation

c) Higher turbidity in the effluent

d) Low temperature

Que 72. Air binding phenomena in rapid sand filter occur due to

a) Excessive negative head

b) Mud ball formation

c) Higher turbidity in the effluent

d) Low temperature

Que 73. The percentage of filtered water, which is used for backwashing in rapid sand filters, is about

a) 0.2 to 0.4

b) 0.4 to 1.0

c) 2 to 4

d) 5 to 7

Que 73. The percentage of filtered water, which is used for backwashing in rapid sand filters, is about

a) 0.2 to 0.4

b) 0.4 to 1.0

c) 2 to 4

d) 5 to 7

Que 74. Period of cleaning of slow sand filters is about

a) 24 – 45 hours

b) 10 – 12 days

c) 2 – 3 months

d) 1 – 2 days

Que 74. Period of cleaning of slow sand filters is about

a) 24 – 45 hours

b) 10 – 12 days

c) <u>2 – 3 months</u>

d) 1 – 2 days

Que 75. Select the correct statement.

a) 5 day BOD is the ultimate BOD.

b) 5 day BOD is greater than 4 day BOD keeping other conditions same.

c) 5 day BOD is less than 4 day BOD keeping other conditions same.

d) BOD does not depend on time.

Que 75. Select the correct statement.

a) 5 day BOD is the ultimate BOD.

b) 5 day BOD is greater than 4 day BOD keeping other conditions same.

c) 5 day BOD is less than 4 day BOD keeping other conditions same.

d) BOD does not depend on time.

Que 76. If Biochemical oxygen demand(BOD) of a town is 20000 kg/day and BOD per capita per day is 0.05 kg, then population equivalent of town is

a) 1000

b) 4000

c) 100000

d) 400000

Que 76. If Biochemical oxygen demand(BOD) of a town is 20000 kg/day and BOD per capita per day is 0.05 kg, then population equivalent of town is

a) 1000

b) 4000

c) 100000

d) 400000

Que 77. The rate of BOD exerted at any time is

a) Directly proportional ot BOD satisfied

b) Directly proportional to BOD remaining

c) Inversely proportional to BOD satisfied

d) Inversely proportional to BOD remaining

Que 77. The rate of BOD exerted at any time is

a) Directly proportional ot BOD satisfied

b) Directly proportional to BOD remaining

c) Inversely proportional to BOD satisfied

d) Inversely proportional to BOD remaining

Que 78. The ratio of 5 day BOD to ultimate BOD is about

a) 1/3

b) 2/3

c) ¾

d) 1.0

Que 78. The ratio of 5 day BOD to ultimate BOD is about

a) 1/3

b) 2/3

c) ¾

d) 1.0

Que 79. In a BOD test, 1.0 ml of raw sewage was diluted to 100 ml and the dissolved oxygen concentration of diluted sample at the beginning was 6 ppm and it was 4 ppm at the end of 5 day incubation at 20^0C.

The BOD of raw sewage will be

a) 100 ppm

b) 200 ppm

c) 300 ppm

d) 400 ppm

Que 79. In a BOD test, 1.0 ml of raw sewage was diluted to 100 ml and the dissolved oxygen concentration of diluted sample at the beginning was 6 ppm and it was 4 ppm at the end of 5 day incubation at 20^0C.

The BOD of raw sewage will be

a) 100 ppm

b) 200 ppm

c) 300 ppm

d) 400 ppm

Que 80. The minimum dissolved oxygen which should always be present in water in order to save the aquatic life is

a) 1 ppm

b) 4 ppm

c) 10 ppm

d) 40 ppm

Que 80. The minimum dissolved oxygen which should always be present in water in order to save the aquatic life is

a) 1 ppm

b) 4 ppm

c) 10 ppm

d) 40 ppm

Que 81. Dissolved oxygen in streams is

a) Maximum at noon

b) Minimum at noon

c) Maximum at midnight

d) Same throughout the day

Que 81. Dissolved oxygen in streams is

a) Maximum at noon

b) Minimum at noon

c) Maximum at midnight

d) Same throughout the day

Que 82. Facultative bacteria are able to work in

a) Presence of oxygen only

b) Absence of oxygen only

c) Presence as well as in absence of oxygen

d) Presence of water

Que 82. Facultative bacteria are able to work in

a) Presence of oxygen only

b) Absence of oxygen only

c) Presence as well as in absence of oxygen

d) Presence of water

Que 83. The means of access for inspection and cleaning of sewer line is known as

a) Inlet

b) Manhole

c) Drop manhole

d) Catch basin

Que 83. The means of access for inspection and cleaning of sewer line is known as

a) Inlet

b) Manhole

c) Drop manhole

d) Catch basin

Que 84. Sewerage system is designed for

a) maximum flow only

b) Minimum flow only

c) Average flow only

d) Maximum and minimum flow

Que 84. Sewerage system is designed for

a) maximum flow only

b) Minimum flow only

c) Average flow only

d) Maximum and minimum flow

Que 85. Sewage treatment units are designed for

a) Maximum flow only
b) Minimum flow only
c) Average flow only
d) Maximum and minimum flow

Que 85. Sewage treatment units are designed for

a) Maximum flow only

b) Minimum flow only

c) Average flow only

d) Maximum and minimum flow

Que 86. Laying of sewers is usually done with the help of

a) Theodolite
b) Compass
c) Sight rails and boning rod
d) A plane table

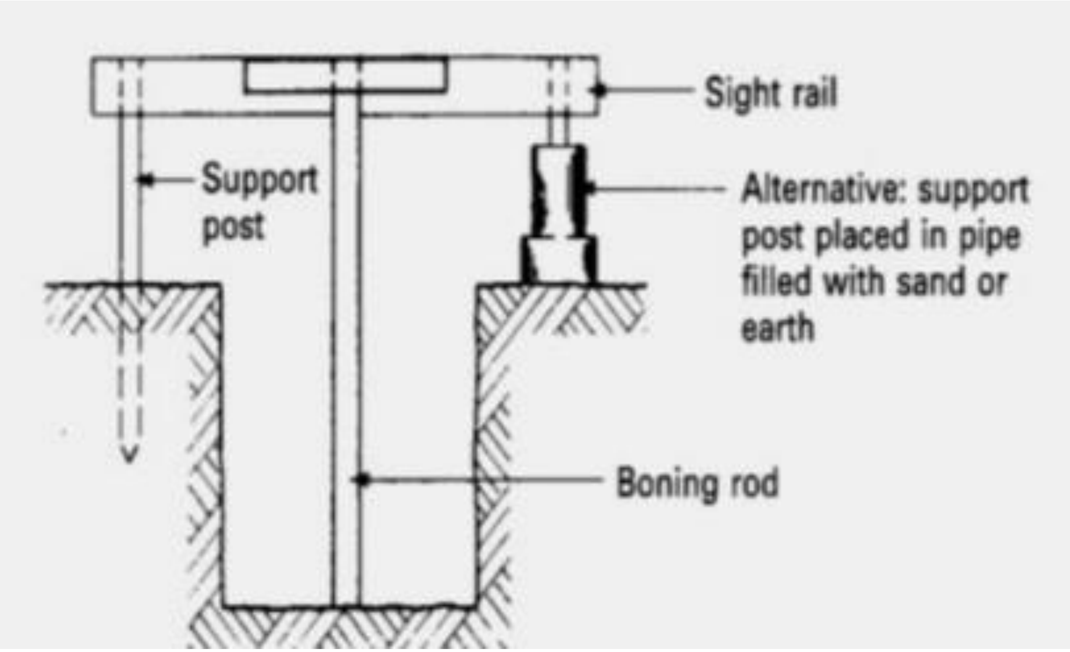
Que 86. Laying of sewers is usually done with the help of

a) Theodolite

b) Compass

c) Sight rails and boning rod

d) A plane table



Que 87. Corrosion in Concrete Sewers is caused by

a) **Septic conditions**
b) **Dissolved oxygen**
c) **Chlorine**
d) **nitrogen**

Que 87. Corrosion in Concrete Sewers is caused by

a) Septic conditions
b) Dissolved oxygen
c) Chlorine
d) nitrogen

Hydrogen Sulphide is produced in Sewer lines and it gets oxidized to Sulphuric acid which reacts with the constituents of Cement which forms $CaSO_4$ to occupy greater volume than the compounds they replace

Que 88. If the sewage contains Grease and fatty acids, these are removed in

a) **Grit chambers**

b) **Detritus tanks**

c) **Skimming tanks**

d) **Sedimentation tanks**

Que 88. If the sewage contains Grease and fatty acids, these are removed in

a) Grit chambers

b) Detritus tanks

c) Skimming tanks

d) Sedimentation tanks

Que 89. The minimum recommended diameter of sewers, is

a) 5cm

b) 10cm

c) 15cm

d) 20cm

Que 89. The minimum recommended diameter of sewers, is

a) 5cm

b) 10cm

c) 15cm

d) 20cm

Que 90. Aerobic bacterias

a) **Flourish in the presence of free oxygen**
b) **consume organic matter as their food**
c) **oxidise organic matter in sewage**
d) **All the above.**

Que 90. Aerobic bacterias

a) Flourish in the presence of free oxygen

b) consume organic matter as their food

c) oxidise organic matter in sewage

d) All the above.

Que 91. If 2% solution of a sewage sample is incubated for 5 days at 20°C and depletion of oxygen was found to be 5 ppm, B.O.D. of the sewage is

a) 200 ppm

b) 225 ppm

c) 250 ppm

d) None of these

Que 91. If 2% solution of a sewage sample is incubated for 5 days at 20°C and depletion of oxygen was found to be 5 ppm, B.O.D. of the sewage is

a) 200 ppm

b) 225 ppm

c) <u>250 ppm</u> <u>(5 * 100/2)</u>

d) None of these

Que 92. If *D* is the diameter of upper circular portion, the overall depth of a standard egg shaped section, is

a) D

b) 1.25 D

c) 1.5 D

d) 1.75 D

Que 92. If *D* is the diameter of upper circular portion, the overall depth of a standard egg shaped section, is

a) D

b) 1.25 D

c) <u>1.5 D</u>

d) 1.75 D

Que 93. Self-cleansing velocity is

a) velocity at dry weather flow

b) velocity of water at flushing

c) velocity at which no accumulation remains in the drains

d) velocity of water in a pressure filter.

Que 93. Self-cleansing velocity is

a) velocity at dry weather flow

b) velocity of water at flushing

c) velocity at which no accumulation remains in the drains

d) velocity of water in a pressure filter.

Que 94. A rainfall may be classified as acidic if its pH value is less or equal to

a) 6

b) 7

c) 5

d) 6.5

Que 94. A rainfall may be classified as acidic if its pH value is less or equal to

a) 6

b) 7

c) 5

d) 6.5

Que 95. Rate of flow of sewage is generally assumed

a) more than the rate of water supply

b) equal to the rate of water supply

c) less than the rate of water supply

d) at 150 litres per capita

Que 95. Rate of flow of sewage is generally assumed

a) more than the rate of water supply
b) equal to the rate of water supply
c) less than the rate of water supply
d) at 150 litres per capita

Que 96. The gradient of sewers depends upon

a) velocity of flow
b) diameter of the sewer
c) Discharge
d) all the above.

Que 96. The gradient of sewers depends upon

a) **velocity of flow**
b) **diameter of the sewer**
c) **Discharge**
d) **<u>all the above.</u>**

DISPOSAL OF SEWAGE EFFLUENTS

After treatment, the sewage effluents generally is disposed off by two methods.

1. **Dilution, (disposal in water).**
2. **Effluent irrigation or Broad irrigation or sewage farming, (disposal on land)**

DISPOSAL OF SEWAGE EFFLUENTS

1. Dilution:

- Disposal by dilution is the process in which the treated sewage or the effluent from the sewage treatment plant is discharged into a river stream, or a large body of water, such as a lake or sea.
- The discharged sewage, in due course of time, is purified by what is known as self *purification process of natural waters*

DISPOSAL OF SEWAGE EFFLUENTS

1. Dilution:

Standards of Dilution for discharging of waste water into rivers

Dilution factor	Standards of Purification required
Above 500	No treatment such as sewage can be directly discharged into the volume of dilution water.
Between 300 to 500	Primary treatment such as plain sedimentation should be given to sewage, and the effluents should not contain suspended solids more than 150 ppm.
Between 150 to 300	Treatment such as sedimentation, screening and essentially chemical precipitation are required. The seage efficient should not contain suspended solids more than 60 ppm.
Less than 150	Complete through treatment should be given to sewage. The sewage effluent should not contain suspended solids more than 30 ppm. And its BOD_5 at 183° should not exceed 20 ppm.

DISPOSAL OF SEWAGE EFFLUENTS

1. Dilution:

Tolerance limit for sewage effluent discharged into surface water sources as per IS: 4764–1973 is

$BOD_5 - 20\ mg/L$

$TSS - 3.mg/L$

Dilution in Rivers and self-purification of Natural streams

- **When sewage is discharged into a natural body of water, the receiving water gets polluted due to waste products, present in sewage effluents**
- **But the conditions do not remain so forever, because the natural forces of purification, such as dilution, sedimentation, oxidation reduction in sunlight, etc; go on acting upon the pollution elements, and bring back the water into its original condition**
- **This automatic purification of polluted water, in due course, is called the *self purification phenomenon.***

Natural forces of purification which affect self-purification process

1. **Physical forces.**
   a) **Dilution and dispersion:** **When sewage of concentration C_S flows at the rate Q_S into a river stream with concentration C_R flowing at the rate Q_R, the concentration C of the resulting mixture is given by**

$$C = \frac{C_s Q_s + C_R Q_R}{Q_S + Q_R}$$

   b) ***Sedimentation***
   c) **Sun-Light: the sun light has a bleaching and stablishing effect of bacteria. It acts through the biochemical reactions.**

Natural forces of purification which affect self-purification process

2. **Chemical forces aided by biological forces:.**
   a) **Oxidation:**
      - **The oxidation of the organic matter present in sewage effluents, 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.**
      - **This is the most important action responsible of effecting self purification of rivers**

Natural forces of purification depends on

1. **Temperature**
2. **Turbulence**
3. **Hydrography**
4. **Available dissolved oxygen and the amount and type of organic matter present**
5. **Rate of re-aeration, etc.**

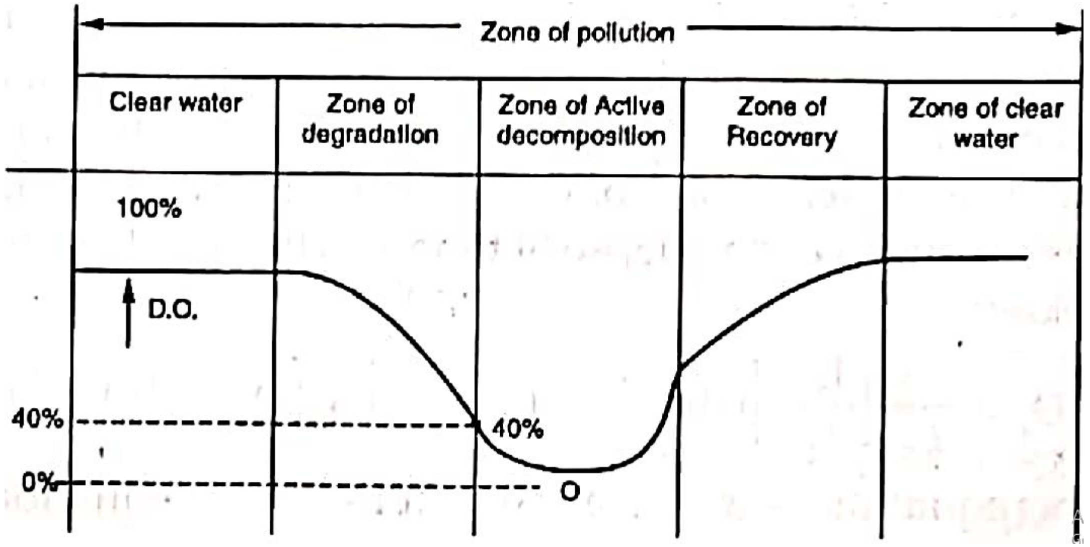
Natural forces of purification depends on

- **At higher temperature, the capacity to maintain the D.O. concentration is low; while the rate of biological and chemical activities are high, causing thereby rapid depletion of D.O.**
- **The larger amount of D.O. present in water, the better and earlier the self-purification will occur.**
- **Algae which absorbs CO_2 and gives oxygen, is thus, very helpful in the self-purification process**

Zones of pollution in a River-system

A polluted stream undergoing self-purification can be divided into the following four zones

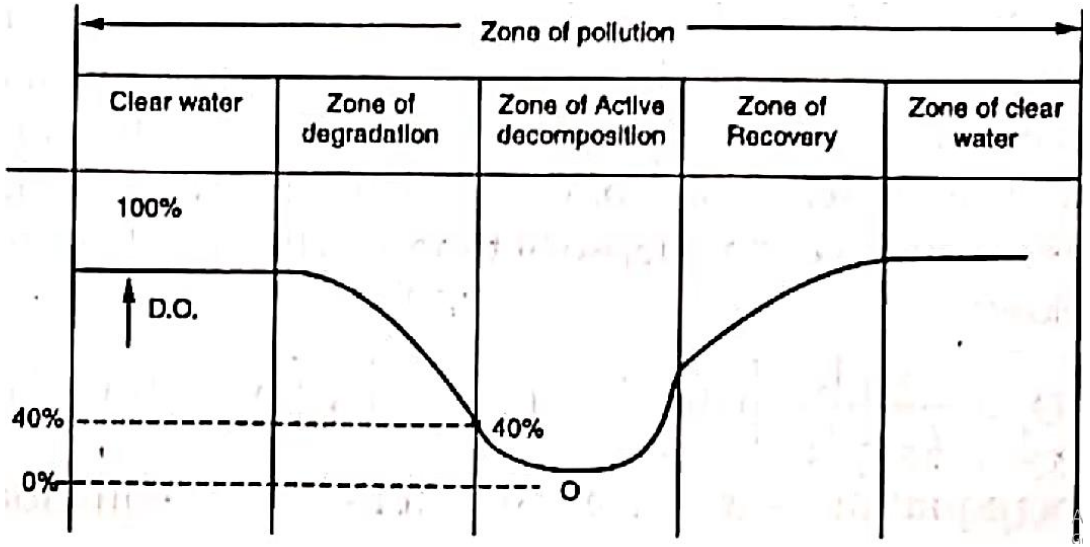
1. **Zone of degradation:**
   - **D.O. is reduced to about 40% of the saturation value. Reoxygenation (i.e. re-areation) occurs but is slower than de-oxygenation.**



Zones of pollution in a River-system

2. Zone of active decomposition:

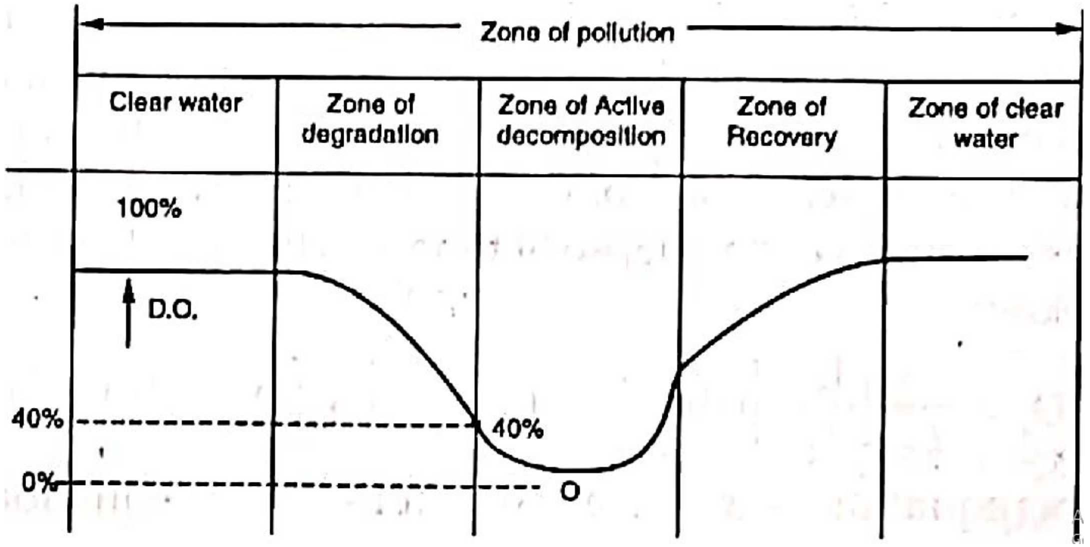
- This zone is marked by heavy pollution. It is characterized by water becoming greyish and darker than in the previous zone. D.O. concentration falls down to zero, and anaerobic conditions may set in with the evolution of gases like CH_4, CO_2, H_2S etc.



Zones of pollution in a River-system

3. Zone of recovery:

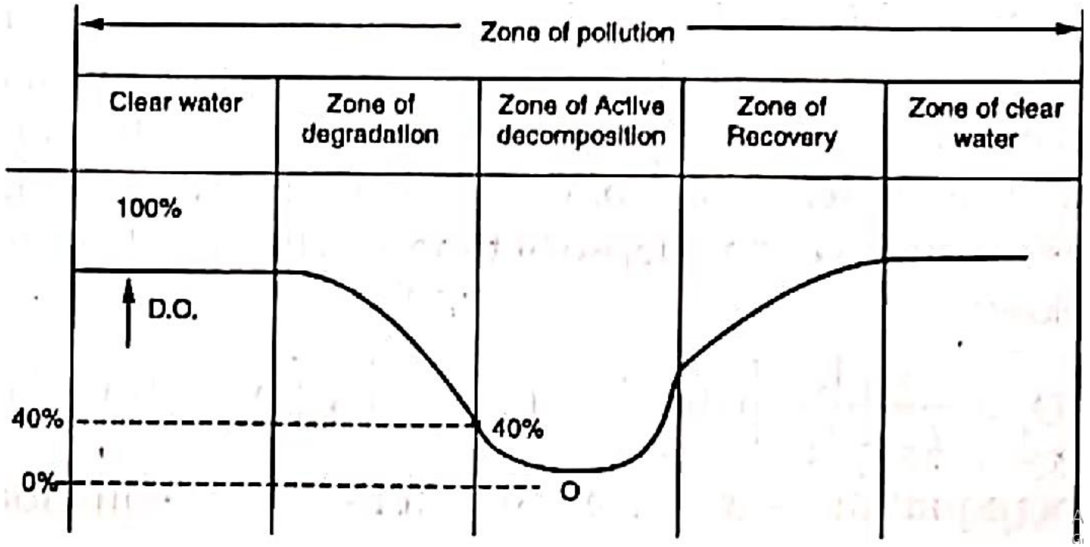
- In this zone B.O.D. falls down and D.O. content rises above 40% of the saturation value. The organic material will be mineralized to form nitrates, sulphates, phosphates, carbonates etc.



Zones of pollution in a River-system

4. Zone of clear Water:

- In this zone, the river attains its original conditions with D.O. rising up to the saturation value.
- When once a river water has been polluted, it will not be safe to drink it, unless it is properly treated.



Oxygen deficit of a polluted river stream.

- Oxygen deficit (D) = Saturated D.O. – Actual D.O.
- Oxygen deficit can be found out by knowing the rates of de-oxygenation and re-oxygenation
- If de-oxygenation is more rapid than the re-oxygenation, an oxygen deficit results.

Disposal of waste waters in lakes and management of lake waters

- The study of lakes is called *limnology*.
- Aerobic depth of water in a lake is called *epilimnion zone.*
- The lower depth of lakes which remains cooler, poorly mixed and anaerobic called the *hypolimnion zone.*
- In winter season entire depth of lakes behaves aerobic.

2. DISPOSAL ON LAND

Disposal of sewage effluents on land for irrigation

- **In this method, the sewage effluent (treated or diluted) is generally disposed off by applying it on land.**
- **The percolating water may join the water table**
- **The degree of treatment of raw sewage depend upon the type of soil of the land**

Quality standards for waste water effluents to be discharged on land for irrigation

Characteristic / Constituent of effluent waste water	Tolerance limit as per IS: 3307-1965
$\mathbf{BOD_5}$	500 mg/1
pH value	5.5 to 9.0
Total Dissolved Solid (TDS)	2100 mg/1
Oil and grease	30 mg/1
Chlorine (as CL)	600 mg/1
Boron	2 mg/1
Sulphates	1000 mg/1

Effluent irrigation and sewage farming

- **In effluent irrigation (or broad irrigation), the chief consideration is the successful disposal of sewage, while in sewage farming, the chief consideration is the successful growing of the crops.**

Sewage Sickness.

- **When sewage is applied continuously on a piece of land, the soil pores or voids may get filled up and clogged with sewage matter retained in them**
- **Free circulation of air will be prevented, and anaerobic condition will develop within the pores.**
- **The aerobic decomposition of organic matter will stop, and anaerobic decomposition will start**
- **The organic matter will thus, of course, be mineralized, but with the evolution of foul gases like H_2S, CO_2 and CH_4.**
- **This phenomenon of soil getting clogged is known as sewage sickness.**

Preventive measures for Sewage Sickness

- Primary treatment of sewage
- Choice of land
- Under-drainage of soil
- Giving rest to the land
- Rotation of crops
- By sewage in shallow depths.

TREATMENT OF SEWAGE

Classification of Treatment processes

1. Preliminary treatment.
    - It consists solely in separating the floating materials and also heavy settleable inorganic solids. This treatment reduces the BOD of the waste water by about 15 to 30%.
    - Screening is done for removing floating papers, rags, clothes etc
    - Skimming tank is used for removing oils and greases.

TREATMENT OF SEWAGE

Classification of Treatment processes

2. **Primary Treatment**
   - **It removes large suspended organic solids**
   - **This is accomplished by sedimentation in settling basins**
   - **The effluent contains a large amount of suspended organic material and has high BOD**
3. **Secondary or biological Treatment**
   - **It is accomplished through biological decomposition of organic matter which can be carried out either under aerobic or anaerobic conditions**
   - **Bacteria decompose the fine organic matter to produce clear effluent**

FUNCTIONS AND TYPES OF TRAPS BEING USED IN SANITARY PLUMBING SYSTEM

- **Traps: These may be defined as fittings, placed at the ends of the *soil pipes* or the *sullage pipes (waste pipes)* to prevent the passage of foul gases from the pipes to the outside. This is possible because traps do enclose or maintain water seal between the pipe and the outside**
- **Soil pipes: These are the pipes which carry the night soil, and**
- **Sullage pipes are the pipes which carry the sullage from bathrooms and kitchens**

TYPES OF TRAPS

- **Depending upon their shapes.**

i. P –traps ii) Q–traps iii) S–traps.

- **Depending upon their use.**

1. **Floor traps or Nahani trap: A floor trap or Nahani trap is provided at the head of each house drain.**
2. **Gully trap: A gully trap is provided at the junction of an unfoul roof or room drain and a foul bath or a kitchen drain.**
3. **Intercepting trap: An intercepting trap is provided at the junction of a house sewer and a municipal sewer.**

Environmental Pollution

AIR POLLUTION

Air pollution can be defined as the presence of air contaminants in the outdoor atmosphere in sufficient quantities of such characteristics and of such duration that it becomes injurious to health, plants or to properties and also interfere with the comfortable enjoyment of life and property.

Sources and Classification of Air Pollution

- Natural Contaminants
  - Natural fog, bacteria and products of volcanic eruption
- Aerosols
  - Also called as Particulates
  - It comprises of dust, smoke, mist, fog and fumes
- Gases and Vapours

Sources and Classification of Air Pollution

- <u>Aerosols</u>
  - It refers to dispersion of solid or liquid particles of microscopic size in gaseous media such as dust, smoke or mist

  <u>Dust:</u> It is produced by crushing, grinding, etc. of organic and inorganic materials
  - Size: 1 to 1000 μ (micron)
  - Sizes less than 5 μ do not settle in the ground surface and remain in suspension

  <u>Smoke:</u> It is finely divided particles produced by incomplete combustion. It consists of mainly carbon or its compounds
  - Particle size: 0.5 – 1 μ

  <u>Mist:</u> Mist refers to dispersion of water droplets in the atmosphere in low concentration
  - Particle size: < 10 μ

Sources and Classification of Air Pollution

- Aerosols

  Fog: If mist concentration is very high, such that it obscure visibility, the mist is called Fog

  Fumes: These are fine solid particles generated by condensation from the gaseous state. Fumes flocculate and then settles on the ground

Sources and Classification of Air Pollution

2. Gases

- Sulphur Dioxide
  - Produced by burning sulfur containing fossil fuels (coal, oil)
  - Coal-burning power plants major source
  - One of the major components of acid rain
  - Reacts in atmosphere to produce acids
  - When inhaled, can be very corrosive to lung tissue
- Hydrogen Sulphide
  - Foul smelling gas
  - Formed due to anaerobic biological decomposition, volcanoes and natural water springs
  - Major industries that produce H_2S are paper and pulp

Sources and Classification of Air Pollution

2.Gases

- Hydrogen Fluoride
  - Major source is manufacture of phosphate fertilizers, Aluminium industries, brick plants, etc
  - It causes more damage to plants as compared to animals
- Nitrogen Oxides
  - They are the second most abundant air pollutants after sulphur dioxide
  - Automobile engine is the main source
  - Industries where nitric acid is produced
  - There are seven types of oxides of Nitrogen
    a) N_2O
    b) NO (Nitric oxide = pollutant)
    c) NO_2 (Nitrogen dioxide=pollutant)
    d) N_2O_3
    e) N_2O_4
    f) NO
    g) N_2O_5

Sources and Classification of Air Pollution

2.Gases

- Carbon Monoxide
    - Produced by burning of organic material (coal, gas, wood, trash, etc.)
    - Automobiles biggest source (80%)
    - Toxic because binds to hemoglobin, reduces oxygen in blood
    - Not a persistent pollutant, combines with oxygen to form CO2

Primary and Secondary Air Pollution

- Primary air pollutants - Materials that when released pose health risks in their unmodified forms or those emitted directly from identifiable sources.
- Secondary air pollutants - Primary pollutants interact with one another, sunlight, or natural gases to produce new, harmful compound

Primary and Secondary Air Pollution

- Primary air pollutants
  - Five major materials released directly into the atmosphere in unmodified forms.
    -Carbon monoxide
    -Sulphur dioxide
    -Nitrogen oxides
    -Hydrocarbons
    -Particulate matter

Primary and Secondary Air Pollution

2.Secondary Air Pollutants

- Ozone
  - Ozone (O_3) is a highly reactive gas composed of three oxygen atoms.
  - It is both a natural and a man-made product that occurs in the Earth's upper atmosphere (the stratosphere) and lower atmosphere (the troposphere).
- PAN (peroxy acetyl nitrate)
- Photochemical smog
- Aerosols and mists (H_2SO_4)

Effects of Air Pollution

- Human Health Effects
  - Exposure to air pollution is associated with numerous effects on human health, including pulmonary, cardiac, vascular, and neurological impairments.
  - The health effects vary greatly from person to person. High-risk groups such as the elderly, infants, pregnant women, and sufferers from chronic heart and lung diseases are more susceptible to air pollution
  - Children are at greater risk because they are generally more active outdoors and their lungs are still developing.
  - Exposure to air pollution can cause both acute (short-term) and chronic (long-term) health effects.

Effects of Air Pollution

- Human Health Effects
  - Acute effects are usually immediate and often reversible when exposure to the pollutant ends. Some acute health effects include eye irritation, headaches, and nausea.
  - Chronic effects are usually not immediate and tend not to be reversible when exposure to the pollutant ends. - Some chronic health effects include decreased lung capacity and lung cancer resulting from long-term exposure to toxic air pollutants.
- Effects on Human respiratory system
  - Both gaseous and particulate air pollutants can have negative effects on the lung
  - Solid particles can settle on the walls of the trachea, bronchi, and bronchioles.
  - Damage to the lungs from air pollution can inhibit this process and contribute to the occurrence of respiratory diseases such as bronchitis, emphysema, and cancer

ACID RAIN

- It results when sulphur oxides and nitrogen oxides react with water vapour and sunlight and are chemically converted to strong acidic compounds(H_2SO_4 and HNO_3)
- If pH of rain is less than 5.6, it is called as Acid Rain
- At pH= 5.6, it is called as Clean Rain
- It affects vegetation, soils and results in complete vanishing of greenery
- It causes damage to monuments, buildings, etc
- Remedy: To neutralize acidity of soil, it is treated with lime

Global Warming and Green house effect

- Green house effect is caused due to
  - CO_2 (Carbon dioxide 57%)
  - CH_4 (Methane 12%)
  - N_2O (Nitrous Oxide 6%)
  - CFCs (25%)

  - Average temperature of earth is increasing due to which polar ice caps are melting and ocean level is rising
  - Climate changes

Que 97. The global warming is caused mainly due to ?

a) NO_x

b) SO_x

c) CO_2

d) O_2

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a)NO_x

b)SO_x

c)CO_2

d)O_2

Que 97. The global warming is caused mainly due to ?

a) NO_x

b) SO_x

c) CO_2 (57%)

d) O_2

Que 98. Which out of the following has maximum global warming potential?

a)CFC

b)No_x

c)CH_4

d)CO_2)

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a)CFC

b)No_x

c)CH_4

d)CO_2)

Global warming potential

(CFC>No_x >CH_4>CO_2)

Que 100. Deposit gauges are provided with copper sulphate solution

a)To prevent growth of bacteria

b)To prevent growth of algae

c)To scare birds

d)To prevent the decomposition of SPM

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Que 101. Green house effect of CO_2 is

a)Permitting the outside solar radiation to reach the ground but preventing terrestrial radiation from the ground into the space

b)Permitting the solar radiation of short length and reradiated terrestrial heat of long wave length

c)Reflecting the heat rays into the space thereby keeping the temperature of earth unaffected

d)Causing absorption of heat from troposphere and thereby decreasing the temperature of Earth with increase in CO_2 concentration

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Que. 102 The device used for easy separation of dry dust of 10-100 μm size is

a)Cyclone

b)Gravity settling chamber

c)Bag filter

d)scrubber

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Que. 103 The velocity of exit waste gases should be a minimum of ……. Of wind speed to prevent down drought

a)½

b)1 ½

c)2 ½

d)3 ½

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b)1 ½

c)2 ½

d)3 ½

Que 104. Which of the following are primary air pollutants?

a)Sulphur dioxide and Nitrogen oxides

b)Ozone and carbon monoxide

c)Sulphur dioxide and ozone

d)Nitrogen oxide and ozone

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Que 105. The path taken by the continuous discharge of gaseous effluents emitted from chimney is commonly known as….

a)Lapse rate

b)Inversion

c)Plume

d)NOTA

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a)Lapse rate

b)Inversion

c)<u>Plume</u>

d)NOTA

Que 106. The rate of accumulation of sludge in septic tanks is recommended

a)30 litres/person/year

b)25 litres/person/year

c) 30 litres/person/month

d)25 litres/person/month

Que 106. The rate of accumulation of sludge in septic tanks is recommended

a)30 litres/person/year

b)25 litres/person/year

c) 30 litres/person/month

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Que. 107 Pick up the correct statement from the following :

a)In treated sewage, 4 PPm of D.O. is essential

b)Only very fresh sewage contains some dissolved oxygen

c)The solubility of oxygen in sewage is 95% that is in distilled water

d)All the above.

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a)In treated sewage, 4 PPm of D.O. is essential

b)Only very fresh sewage contains some dissolved oxygen

c)The solubility of oxygen in sewage is 95% that is in distilled water

d)All the above.

Que 108. The screens are fixed

a)perpendicular to the direction of flow

b)parallel to the direction of flow

c)at an angle 30° to 60° to the direction of flow

d)none of these.

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a)perpendicular to the direction of flow

b)parallel to the direction of flow

c)at an angle 30° to 60° to the direction of flow

d)none of these.

Que 109. Clogging of sewers, is caused due to

a)Silting

b)greasy and oily matters

c)domestic wastes thrown in manholes

d)all the above.

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Que 110. The coagulant widely used for sewage treatment, is

a)Alum

b)ferric chloride

c)ferric sulphate

d)chlorinated copperas.

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Que 111. House connections to the laterals is generally made by

a)R.C.C.

b)P.C.C.

c)Cast iron

d)Glazed stoneware

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b)P.C.C.

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Que 112. Dilution method of disposing off sewage, is not preferred to

a)when sewage is fresh

b)when diluting water has high dissolved oxygen content

c)when diluting water is used for water supply near the point of sewage disposed

d)when the diluting water is having flow currents

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a)when sewage is fresh

b)when diluting water has high dissolved oxygen content

c)when diluting water is used for water supply near the point of sewage disposed

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Que 113. For house drainage minimum gradient is

a)1 in 60

b)1 in 80

c)1 in 10

d)1 in 400

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a)1 in 60

b)1 in 80

c)1 in 10

d)1 in 400

Que 114. Bio-chemical oxygen demand (BOD) for the first 20 days in generally referred to

a)initial demand

b)first stage demand

c)carbonaceous demand

d)all of these

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a)initial demand

b)first stage demand

c)carbonaceous demand

d)<u>all of these</u>

Que 115. Flocculated particles do not change their

a)Size

b)Shape

c)Weight

d)none of these

Que 115. Flocculated particles do not change their

a)Size

b)Shape

c)Weight

d)<u>none of these</u>

Que 116. Disposal to sewage in large cities, is done in

a)Irrigation

b)Dilution

c)Oxidation

d)putrifaction

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a)Irrigation

b)Dilution

c)Oxidation

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Que 117. For evaporation and measurement of settlable solids, the apparatus used, is

a)a jar

b)a breaker

c)a test tube

d)an Imhoff cone

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a)a jar

b)a breaker

c)a test tube

d)an Imhoff cone

Que 118. Removal of oil and grease from sewage, is known

a)Screening

b)Skimming

c)Filtration

d)none of these.

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a)Screening

b)Skimming

c)Filtration

d)none of these.

Que 119. The gas which may cause explosion in sewers, is

a)Carbon dioxide

b)Methane

c)Ammonia

d)Carbon monoxide

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a)Carbon dioxide

b)<u>Methane</u>

c)Ammonia

d)Carbon monoxide

Que 120. In sewers the effect of scouring is more on

a)top side

b)bottom side

c)horizontal side

d)all sides

Que 120. In sewers the effect of scouring is more on

a)top side

b)<u>bottom side</u>

c)horizontal side

d)all sides

Que 121. The most dangerous pollutant in vehicular emissions is

a)CO

b)SO_2

c)CO_2

d)O_3

Que 121. The most dangerous pollutant in vehicular emissions is

a)CO

b)SO_2

c)CO_2

d)O_3

Que 122. The drop man holes are generally provided in sewers for

a)industrial areas

b)large town ships

c)hilly town ships

d)cities in plains.

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a)industrial areas

b)large town ships

c)hilly town ships

d)cities in plains.

Que 123. The liquid wastes from kitchens, bath rooms and wash basins, is not called

a)liquid waste

b)Sullage

c)Sewage

d)None

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a)liquid waste

b)Sullage

c)Sewage

d)None

Que 1.

Assertion A: The consumption of water increases with increase in the distribution pressure

Reason R: Higher distribution pressure causes more loss and wastage of water

a) Both A and R are true and R is the correct explanation of A

b) Both A and R are true but R is not the correct explanation of A

c) A is true but R is false

d) A is false but R is true

Que 2. The per capita consumption of a locality is affected by

i. Climatic condition

ii. Quality of water

iii. Distribution pressure

The correct options are

a) Only i

b) Both i and ii

c) Both i and iii

d) All i, ii and iii

Que 3. Which one of the following causes a decrease in per capita consumption?

a)<u>Use of metering system</u>

b)Good quality of water

c)Better standard of living of the people

d)Hotter climate

Que 4. The hourly variation factor is usually taken as

a)1.5

b)1.8

c)2.0

d)2.7

Que 5. The type of valve which is provided on the suction of pipe in tube well is

a)Air relief valve

b)<u>Reflux valve</u>

c)Pressure relief valve

d)Sluice valve

Que 6. Disinfection efficiency is

a)reduced at higher pH value of water

b)Unaffected by pH value of water

c)Increased at higher pH value of water

d)Highest at pH value equal to 7

Que 7. As compared to cast iron pipes, steel pipes are

a)Heavier

b)Stronger

c)Costlier

d)Less susceptible to corrosion

Que 8. The method of analysis of distribution system in which the domestic supply is neglected and fire demand is considered is

a)Circle method

b)Equivalent pipe method

c)Hardy cross method

d)Electrical analysis method

Que 9. Which of the following methods of analysis of water distribution system is most suitable for long and narrow pipe system?

a)Circle method

b)Equivalent method

c)Hardy cross method

d)Electrical analysis method

Que 10. The type of valve which is provided to control the flow of water in the distribution system at street corners and where the pi
is…?

a)Check valve

b)<u>Sluice valve</u>

c)Safety valve

d)Scour valve

Que 11. A pipe conveying sewage from plumbing system of a single building to common sewer or point of immediate disposal is called

a)House sewer

b)Lateral sewer

c)Main sewer

d)Submain sewer

Que 12. Which of the following sewers is preferred for combined system of sewage?

a)Circular sewer

b)Egg shaped sewer

c)Rectangular sewer

d)None of these

Que 13. The suitable system of sanitation for area of distributed rainfall throughout the year with less intensity is

a)Separate system

b)<u>Combined system</u>

c)Partially separate system

d)Partially combined system

Que 14. The water carriage system of collection of waste products

a)Is cheaper in initial cost than dry conservancy system

b)Requires treatment before disposal

c)Creates hygienic problem

d)All of the above

Que 15. The time of concentration is defined as

a)The time taken by rainfall water to run from most distant point of water shed to the inlet of sewer

b)The time required for flow of water in sewer to the point under consideration

c)Sum of (a) and (b)

d)Difference of (a) and (b)

Que 16. The specific gravity of sewage is

a)Much greater than 1

b)Slightly less than 1

c)Equal to 1

d)Slightly greater than 1

Que 17. The self cleansing velocity fir all sewers in India is usually

a)Less than 1.0 m/sec

b)1.0 m/sec to 1.2 m/sec

c)1.5 m/sec to 2 m/sec

d)3.0 m/sec to 3.5 m/sec

Que 18. The slope of sewer shall be

a) Given in the direction of natural slope of ground

b) Given in the direction opposite to natural slope of ground

c) Zero

d) Steeper than 1 in 20

Que 19. The design discharge for the separate sewer system shall be taken as

a)Equal to dry weather flow (DWF)

b)2 x DWF

c)3 x DWF

d)<u>6 x DWF</u>

Que 20. The design discharge for the sewer system shall be taken as

a)Equal to dry weather flow (DWF)

b)Rainfall + DWF

c)Rainfall + 2 DWF

d)Rainfall + 6 DWF

Que 21. The minimum and maximum diameters of sewers shall preferably be

a)15cm and 100cm

b)15cm and 300cm

c)30cm and 450 cm

d)60 cm and 300 cm

Que 22. The main disadvantage of cement concrete sewers is

a)Less strength

b)Difficulty in construction

c)<u>Difficulty in transportation due to heavy weight</u>

d)Less life

Que 23. Most suitable section of sewer in separate sewage system is

a)Rectangular section

b)Circular section

c)Standard form of egg shaped sewer

d)Modified egg shaped sewer

Que 24. An egg shaped section sewer

a)Is economical than circular section

b)Provides self cleansing velocity at low discharges

c)Is more stable than circular section

d)Is easy to construct

Que 25. The velocity of flow does not depend on

a)Grade of sewer

b)Length of sewer

c)Hydraulic mean depth of sewer

d)Roughness of sewer

Que 26. The type of sewer which is suitable for both combined and separate system is

a)Circular sewer

b)Egg shaped sewer

c)Horse shoe type sewer

d)Semi elliptical sewer

Que 27. The characteristics of fresh and septic sewage respectively are

a)Acidic and alkaline

b)Alkaline and acidic

c)Both acidic

d)Both alkaline

Que 28. The pathogens are killed by

a)Nitrification

b)Chlorination

c)Oxidation

d)None of the above

Que 29. Which of the following retards the self purification of stream?

a)Higher temperature

b)Sunlight

c)Satisfying oxygen demand

d)<u>None of the above</u>

Que 30. Sewage treatment units are designed for

a)5-10 years

b)15-20 years

c)30-40 years

d)40-50 years

Que 31. Settling velocity increases with

a)Specific gravity of solid particles

b)Size of particles

c)<u>Depth of tank</u>

d)Temperature of liquid

Que 32. Standard BOD is measured at

a)20°C – 1 day

b)25°C – 3 day

c)20°C – 5 day

d)30°C – 5 day

Que 33. The correct relation between theoretical oxygen demand (TOD), Biochemical Oxygen demand (BOD) and Chemical Oxygen demand (COD) is given by

a) TOD>BOD>COD

b) TOD>COD>BOD

c) BOD>COD>TOD

d) COD>BOD>TOD

Que 34. Septic tank is a

i. Settling tank

ii.Digestion tank

iii.Aeration tank

The correct answer is

a)Only i

b)(i) and (ii)

c)(i) and (iii)

d)Only (iii)

Que 35. The maximum efficiency of BOD removal is achieved in

a)Oxidation Pond

b)Oxidation ditch

c)Aerated lagoons

d)Trickling filters

Que 36. In facultative stabilization pond, the sewage is treated by

a)Aerobic bacteria only

b)Algae only

c)Dual action of aerobic bacteria and anaerobic bacteria

d)sedimentation

Que 37. Composting and lagooning are the methods of

a)Sludge digestion

b)<u>Sludge disposal</u>

c)Sedimentation

d)Filtration

Que 38. Turbidity is measured on

a) Standard silica scale

b) Standard cobalt scale

c) Standard platinum scale

d) Platinum cobalt scale

Que 39. The pipe which is used to carry the discharge from sanitary fittings like bath rooms, kitchen, etc is called?

a)<u>Waste pipe</u>

b)Soil pipe

c)Vent pipe

d)Antisiphonage pipe

Que 40. Most of the bacteria in sewage are

a)Parasitic

b)Saprophytic

c)Pathogenic

d)anaerobic

Que 41. The gas from sludge digestion tank is mainly composed of

a)Nitrogen

b)Carbon dioxide

c)Hydrogen Sulphide

d)Methane

Que 42. The process of lagooning is primarily a means of

a)Reducing the excessive flow in sewers

b)<u>Disposing of sludge</u>

c)Increasing the capacity of storage reservoirs

d)Increasing flow of sewage through Imhoff tanks

Que 43 . The biological treatment of sewage effluents is essentially a process of

a)Oxidation

b)Dehydration

c)Reduction

d)alkalinization

Que 44. Chlorine is used in the treatment of sewage to

a)Help grease separation

b)Aid flocculation

c)Increase the biochemical oxygen demand

d)Cause bulking of activated sludge

Que 45. Ozone layer in the upper atmosphere is getting destroyed owing to its reaction with

a)Carbon dioxide

b)Hydrogen peroxide

c)Oxides of nitrogen

d)CFCs

Que 46. The intensification of green house effect is attributed to the increased level of

a)Carbon dioxide

b)Carbon monoxides

c)CFCs

d)Sulphur dioxides

Que 47. Electrostatic precipitators are used as pollution control device for the separation of

a)SO_2

b)No_x

c)Hydrocarbon

d)Particulate matter

Que 48. Select the secondary air pollutants among the following:

a)Ozone and carbon monoxide

b)Peroxy acycl nitrate (PAN) and ozone

c)Peroxy acycl nitrate (PAN) and carbon monoxide

d)Carbon monoxide and sulphur dioxide

Que 49. The primary pollutant caused by incomplete combustion of organic matter is

a)Ozone

b)Carbon monoxide

c)Sulphur dioxide

d)None of the above

Que 50. The spray tower can be used to control

a)Gaseous pollutants only

b)Particulate pollutants only

c)Both (a) and (b)

d)NOTA