EE-
Cor

Water →

Raw water → no artificial treatment was applied that water is known as Raw water.

Treated water → Artificial treatment has been applied like → filteration, sedimentation, Coagulation, and aeration etc.

Sources of water
- Surface Sources
  - Ponds & Lakes
  - Streams and Rivers
  - Storage Reservoirs
  - Oceans
- Subsurface Source
  - Springs
  - Infiltration galleries
  - Infiltration well
  - wells & tube wells

quality issues → water is running off on ground and carrying lots of sand silts with itself.

quality issues → water is clean and filtered but have hardness more than the surface water. more corrosive.

Ponds & Lakes → quality of water in lake is generally good and doesn't need much purification

→ Larger and older lakes, however provides comparatively purer water than smaller and ~~older~~ newer lakes.

→ Quality of water in smaller and newer lakes is not as good as compare to larger and older lakes

→ self purification (sedimentation) of water, Bleaching of colour, removal of Bacteria etc. makes quality of water ~~purer~~ purer

issues →

→ Growth of algae, weed and vegetable is more due to still water which will causes bad smells, tastes and colour to their water.

2. Streams and Rivers:— Larger and perennial streams may, however be used as source of water., by providing storage reservoirs, barrage, etc, across them.

Perennial rivers → the water is available throught the year.

Non-Perennial rivers → as the source of public supplies by providing storage on the upstream.

issues → In streams Availability of water is very small so no use of water supply.

→ quality of water is not so good because it contains ~~lots of~~ large amounts of silt, sand and lot of suspended matter.

→ Dispaal of treated and untreated sewage on river is also a big issue.

Note:⇒ River's water must be treated properly before supplying to the public.

3. Storage Reservoirs:— A barrier in the form of ~~dog~~ dam constructed across the river to form a pool of water on the upstream side of barrier. this pool or artificial lake formed on the upstream side of the ~~barrier~~ dam is known as storage reservoir.

B(i) Sub Surface Source ⇒ the water which gets stored in the ground water reservoir through infiltration, is known as underground water.

issues → ground water is rich in dissolved salts, minerals and gases etc.

The extent of salts and minerals present in ground water depends upon the type and extent of geological formation through which the water is passing before joining the water-table.

⇒ The ground water is brought to the surface by some natural processes like springs.

⇒ These waters are tapped by artificial means by constructing wells, tube wells, infiltration galleries etc.

(i) **Infiltration Galleries:-** are the horizontal or nearly horizontal tunnels constructed at shallow depth (3 to 5 m) along the banks of rivers through the water bearing strata. Sometimes called as horizontal wells.

(ii) **Infiltration Wells:-** Infiltration wells are shallow wells constructed in series along the banks of a river, in order to collect river water seeping through their bottoms.

(iii) **Springs:-** Natural out flow of ground water at the earth's surface is said to form a "spring".

- Gravity
- Surface
- Artesian springs

(iv) **Wells →** A water well is a hole usually vertical, excavated through the earth strata for lifting ground water to the surface.

- open / dug wells
  - shallow
  - Deep
- Tube well
  - Cavity type
  - Screen type
    - Streiner tube wells
    - slotted pipe gravel pack

Water quality requirement for different beneficial uses:-

Quality ⇒ The rain water, though pure in the beginning, gets considerably polluted till it reaches the river stream

Groundwater ⇒ free from suspended impurities and organic matter, which in turn, is generally responsible for disease producing bacteria. → very useful for domestic uses.

↳ ~~Hotter~~ ~~in~~ Hot in colder seasons and cold in Hot seasons

→ No less treatment required.

Water quality standard :-

- **Physical**
  - Turbidity
  - Colour
  - Taste & odour
  - Temperature
  - Suspended Solids
- **Chemical**
  - Dissolved Solids
  - pH value
  - Hardness of water
  - Chloride content
  - Nitrogen Content
  - Flouride Content
  - Dissolved gases
  - Some other metals and chemical substances
- **Biological**
  - Bacteria and other Micro-organism.
  - Pathogens
  - coliform
  - E-Coli-, B-Coli

(A) Physical :-

Turbidity :- when water appears muddy or turbid due to impurities likes suspended solids, finely divided organic materials, and inorganic solids like silt, clay etc. They are not harmful for humans but due to asethetic and psychological reasons water is rejected.

- Turbidity is measured by a turbidity rod or by a turbidimeter, with optical observations.
- Turbidity expressed as the amount of suspended matter in mg/lit or PPm.
- standard unit → 1 mg of silica in 1 litre of distilled water.
- Permissible limit → 5 to 10 units of turbidity for drinking water.
  - 5 → Desirable Limit
  - 10 → in case of no other source
- Turbidity in clear lake water is about 25 units.
- Excess of 5 units is easily detectable by naked eyes.
- ~~Scattering and absorbing light rays by SS and other pm~~ ~~Measurement of Turbidity~~
- Scattering and absorbing light rays due to SS and other impurities by passing through the water.

Measurement of Turbidity

Turbidity Rods

↓

Field method

↓

→ Al graduated rod to directly read turbidity

↑ Pt needle (1mm dia, 25mm Long)

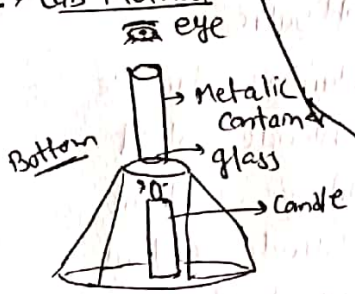
→ Direct in silica units

→ In order to measure the turbidity, the graduated Al rod is lowered in water, and keeping the eye at its upper end, the submerged needle of Pt is viewed till it just disappears due to the turbidity of water. The length of the rod under water is a measure of the turbidity. The lesser the length, the greater is the turbidity and vice-versa.

→ Rod is graduated specially and the reading on it near the surface of water directly gives the turbidity in ppm.

Jackson's ~~Turbidimeter~~ Turbidimeter

→ Lab Method



→ Jackson's Candle Turbidimeter.

→ Measures → 25-1000 mgl.

→ Principle → Measuring the interference caused by the water sample to the passage of light rays.

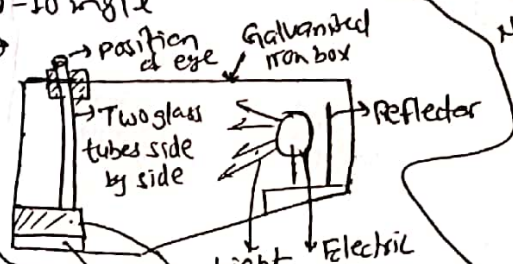
→ Not used to measure turbidity less than 25 JTU or 25 mgl.

Baylis Turbidimeter

↓

0-10 mgl

→



Principle → absorbtion of light

Formazine → Heterocyclic polymer produced by reaction of hexamethylene tetramine with hydrazine sulfate. ($C_{17}H_{13}N_5O_3$)

Nephelometers

Principle → Scattering of light

↓

NTU, FTU units

3. Temp. ⇒ Biological activities gets doubled after every 10°c rise of temp.

→ Limit → 10°c and 25°c for portable water.

2. Colour
- → True colour → due to dissolved solids
- → false colour → due to DS + SS.

→ Measured by → colour matching technique (Nesseler tubes)

→ Unit of Measurement → TCU → True colour unit

→ ~~Chemical~~ Standard unit → 1 mg of ~~Pt-Co~~ platinum cobalt dissolved in one litre of distilled water. (Pt → in form chloro platinate ion)

→ Instrument → Tintometer.

→ Limit → 5 – 25 TCU, for portable water it will be → 15 TCU

4. Taste & odour :- due to → Dissolved organic materials
→ Inorganic salts
→ Dissolved gases impart (H_2S, CH_4, CO_2, O_2 etc) (Combined with organic matter)

→ Mineral substances like NaCl, iron compounds, carbonates and sulphates of other elements.

→ Phenols and other oily matter, especially after chlorination.

→ Some tastes due to CO_2, and O_2 are desirable.

→ TON (Threshold odour Number), as it is generally called, represents the dilution ratio at which the odour is hardly detectable.

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

A = diluted water in (ml)
B = Water sample to be Tested (ml)

Final volume must not be more than 200ml.

→ Test sample is gradually diluted with distilled water until odour free water is not obtained, the number of times the sample is diluted, represents the TON.

eg. TS = 40ml (B)

Sample is diluted to make 200ml = (A+B)

So = TON = $\frac{200}{40} = 5$ $\boxed{\therefore A = 160}$

$\boxed{TON = 5}$

for public supplies = Limit = 1 to 3 TON

→ 1 TON means → No water is added to make odour free water. or water is already odour free.

→ 3 TON means → double amount of water ~~Test~~ is added as compare to Test sample.

5. **Suspended Solids** :- Suspended solids are physical parameter of water quality standards, where as dissolved solids considered as chemical parameter of water quality standards.

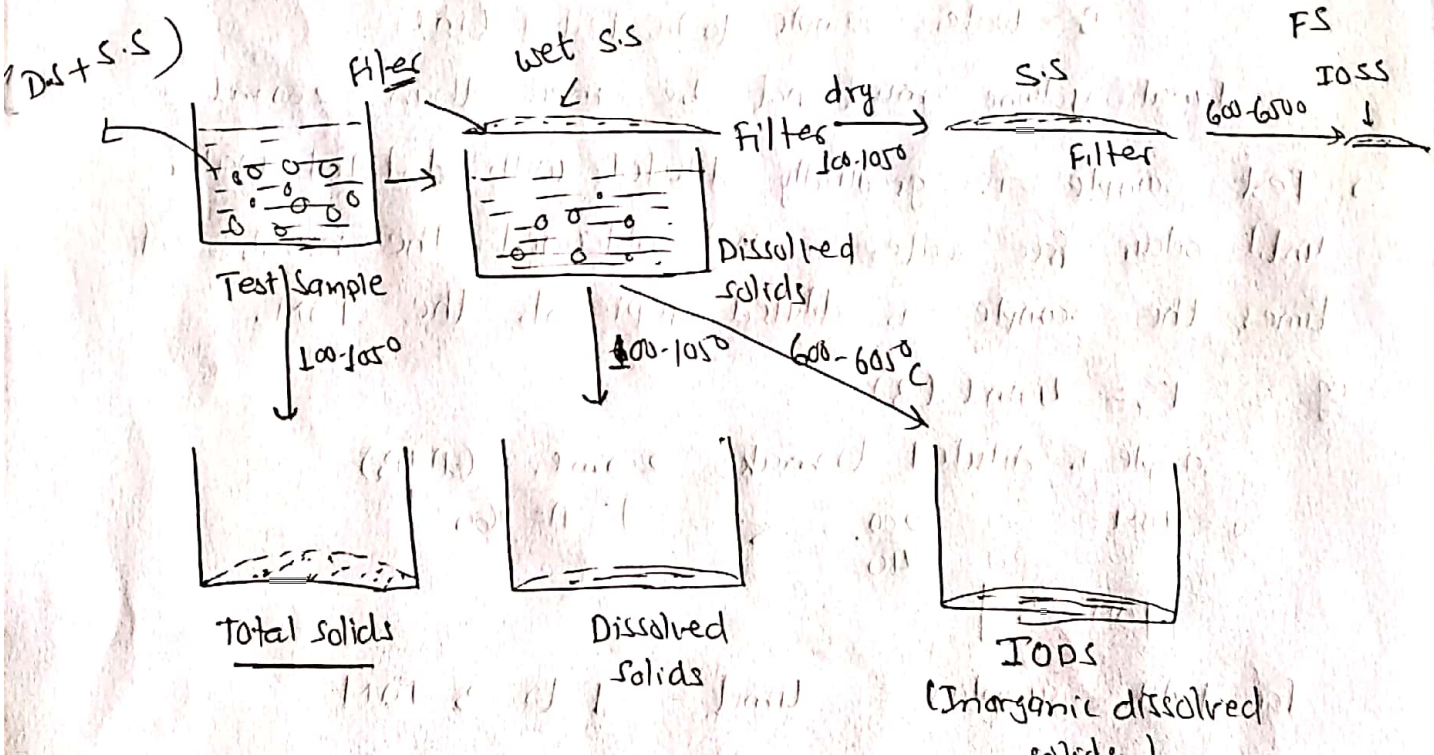
⇒ Measured by → Graviometric technique.

⇒ **To determine Total solids** → Evaporating a sample of water and weighing the dry residue left. (Temp. at 100-105°C)

⇒ **To determine Suspended Solids** :- Can be found by filtering the water sample and weighing the residue left on the filter paper.

⇒ **Dissolved Solids** :- Total solids − Suspended solids

→ Range ⇒ Desirable 500ppm | Cause for Rejection 1000 ppm / 2000 ppm.



VSS = SS − IOSS = VSS (volatile suspended solids)

ODS = DS − IODS = ODS (organic dissolved solids)

(B) Chemical parameters:-

1. Dissolved Solids → Can be determined by Graviometric Technique or by Determining the specific conductivity of water.

⇒ Specific Conductivity will give approximate value of D.S because all the D.S are not dissolved in water.

2. pH Value:- It is logrithmic scale. used for as a indicator of acid and base. varies from 0 to 14

Mathematically = $pH = -\log[H^+]$

Higher value of pH means lower $[H^+]$ concentration and vice versa.

$$[H^+] \times [OH^-] = 10^{-14}$$ Constant

$$pH + pOH = 14$$

[pH > 7 → alkaline ; pH < 7 → Acidic]

→ According to Law of electrolyes;

$$\frac{\text{Conc of cations} \times \text{Conc of anions}}{\text{Conc of undissociated molecules}} = \text{Constant.}$$

Measurement of pH ⇒ Potentiometer is used to measure pH of water quickly and automatically.

→ It measures the electrical potential exerted by Hydrogen ions and thus indicating their concentration.

→ Colour matching technique is also used for pH determination.

Permissible Value of pH:- 6.6 – 8.5 for public supplies.

cause for rejection pH < 6 and pH > 8.5

Q. In water treatment plant, the pH value of incoming and outgoing waters are 7.2 and 8.4 respectively. Assume linear variation of pH with time, determine the average pH value of water.

→ Sol^n:-

$$pH = \log\left[\frac{1}{H^+}\right]$$

1 = Incoming water; 2 = Outgoing water

$$(pH)_1 = 7.2 = -\log[H_1^+]$$

$$(pH)_2 = 8.4 = -\log[H_2^+]$$

Now ⇒ $H_1^+ = 10^{-7.2}$, $H_2^+ = 10^{-8.4}$

Avg. value of $H^+ = \frac{H_1^+ + H_2^+}{2} = \frac{10^{-7.2} + 10^{-8.4}}{2}$

$= 8.42 \times 10^{-8.4}$

∴ Avg. value of pH $= \log_{10}\left(\frac{1}{8.42\times10^{-8.4}}\right) = 7.474$ Ans.

4. Hardness of water:- Hardness is caused by all multivalent cations.

→ Due to Hard water formation of ~~lath~~ leather or foam is very difficult.

→ Hard water is undesirable → they may lead to greater soap consumption, scaling of boilers, causing corrosion and incrustation of pipes, making foods tastless etc.

Hardness

- Temporarily or Temporary → Carbonate Hardness → due to carbonate and bicarbonate of Ca^{+2} & Mg^{+2}
- Permanent → Non-Carbonate Hardness → due to SO_4^-, Cl^- and NO_3^{-2} of Ca^{+2} & Mg^{+2}

→ Removed easily by simple Boiling.

→ Cannot be removed at all by simple Boiling.

Measurement of Hardness :- is generally defined as the calcium Carbonate equivalent of calcium and magnesium ions present in water. and is expressed in mg/l.

→ Determining the amounts of calcium and magnesium ions present in water by titration with versnate solution. (i.e EDTA method),

Total Hardness in mg/l as $CaCO_3$ (T.H.)

$$= \left[Ca^{+2} \text{ in mg/l} \times \frac{\text{Combining wt. of } CaCO_3}{\text{Combing wt. of } Ca^{+2}} \right] + \left[Mg^{+2} \text{ in mg/l} \times \frac{\text{Combining wt. of } CaCO_3}{\text{Combing wt of } Mg^{+2}} \right]$$

equivalent wt. of $CaCO_3$

equivalent wt. of Ca^{+2}

eq. wt of $CaCO_3$

eq. wt of Mg^{+2}

Combining wt of Ca^{+2} and Mg^{+2} and $CaCO_3$ respectively are 20, 12 and 50.

$$\boxed{\text{Total Hardness} \Rightarrow [Ca^{+2}] \times \left[\frac{50}{20}\right] + [Mg^{+2}] \times \left[\frac{50}{12}\right]} \quad \text{— (1)}$$

Que Find out total Hardness of water sample containing 120 mg/l of Ca^{+2} and 72 mg/l of Mg^{+2} as ions.

Soln ⇒ Total Hardness = $120 \times \frac{50}{20} + 72 \times \frac{50}{12}$

= 300 + 300 = 600 mg/l.

Range for public water supplies ⇒ 75 to 115 ppm. for drinking purpose.

	Acceptable Limit	Cause for rejection
General Limit =	200 mg/l	600 mg/l

Measurement of Hardness:- is determined by titrating the water by standard versanate solution (EDTA), using EBT as indicator.

EDTA ⇒ etheylene di-amine tetra acetic acid.

EBT ⇒ ERIchrome Black-T

End point → wine red → Blue Black.

$EBT + Ca^{+2}/Mg^{+2} \longrightarrow$ EBT-Ca/Mg (weak Complex) (wine-red)

$EDTA + EBT\text{-}Ca/Mg \longrightarrow$ EDTA-Ca/Mg + EBT (Blue-Black)
stable Complex (colourless)

(4) → **Alkalinity:-** is defined as Concentration of all the ions present in water, that are capable of ~~not~~ neturalizing the hydronium ion (H^+). or it may be also be termed as capability of water to neutralized by the acid.

Major Constituents → CO_3^{-2}, OH^-, HCO_3^-

Minor Constituents → $H_2PO_4^-$, HPO_4^-, $H_2BO_3^-$, HS^-, NH_3, H_3SiO_3

Measurement of Alkalinity:-

Measured by titrating it with acid and ~~nothing~~ noting the H^+ equivalent of the alkalinity.

Indicater → phenopathalein (8.6 – 10.3) range
→ Methyl orange (2.8 – 4.2) range

(5) **Chloride Content:-** Presence of chloride in high Conc^n in water indicates it's pollution due to industrial waste or organic matter. (sewage)

→ chlride in water is determined by titrating it with standard Silver nitrate ($AgNO_3$) using K_2CrO_4 as indicater.

Range	Acceptable Limit	Cause for rejection
	200 mg/l	1000 mg/l.