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IES/GATE

CIVIL ENGINEERING

VOLUME – I

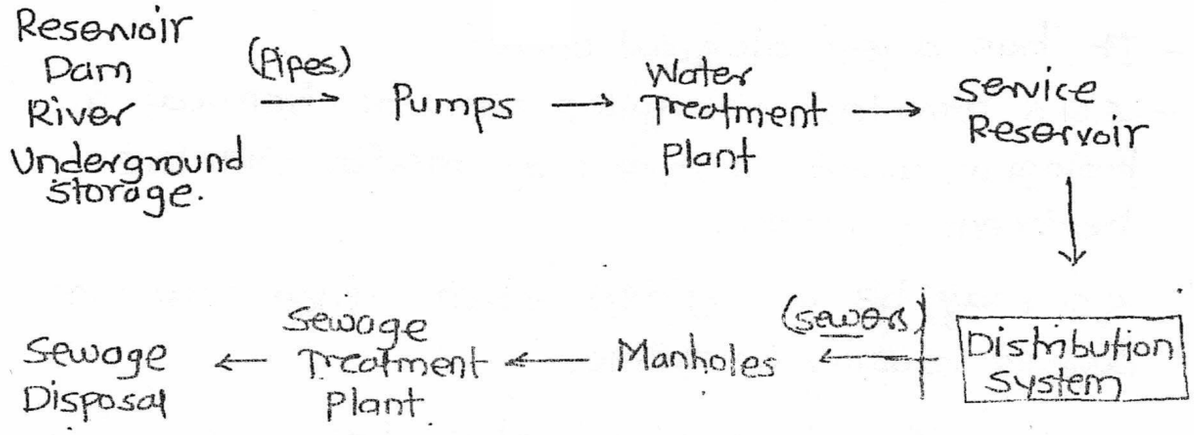
ENVIRONMENTAL

SIERRA INNOVATIONS

Index

Environmental

Chapter 1 - Water Supply Engineering



* Water Quality Parameters *

Physical water quality parameter are those felt by our senses. These parameters tells abt physical quality of the water.

1) Suspended Solids :-

It is physical water quality parameter but dissolved solid is chemical water quality parameter.

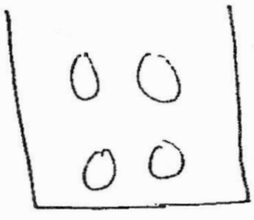
* Sources :-

Suspended solids comes in water from inorganic particles

like oils & greese. And it may also come from orggnic particles like plant fibres (e Algae)

* Impacts of suspended solids:-
- It is asthetically displeasing.
- It has a psychological effect.
- S.S. s provides adsorption sites for chemical & biological agents. Hence may interfare with the treatment of water.
- S.S. may be biologically active. Hence may form disease causing organics.

* Measurement of suspended solids:-
- S.S. are measured by Graviometric method (method in which wt is called).



(S.S)
104-110°C

Ts = SS + D.S.

TS < VS (organic) < SS / DS
TS < nVS (inorganic) < SS / DS

- Suspended & Disolved solids (TS = SS + D.S)
  ~~S.S~~ Soli are calculated by evaporating water sample at 104°C.
- S.S. are calculated first by passing the water through a filter & heating residue on the filter at 104° C.

- D.S = T.S − S.S.
- Organic content (Both suspended & dissolved) ~~means~~ Vola can be measured by firing the residue at 550°c to 600°c. Under these conditions organic matter gets converted into water vapour, carbon dioxide & other gases. Remaining solids are inorganic solids or fixed solids.

* Permissible limits :−

- For Total solids :− (As per G.O.I manual) :−

	Acceptable limit	Cause for Rejection Value.
T.S.	500 mg/l	2000 mg/l.

Note :−
S.S. smaller than the size of filter ~~coarse~~ pores will be measured as Dissolved solids.
Hence to avoid this we classify the solids as filteroble solids & Nonfilteroble solids.
Filterable solids can be filtered by filters.
Hence filterable solids comusponds to D.S.
& Non filterable solids comusponds to S.S.

2) Turbidity :-

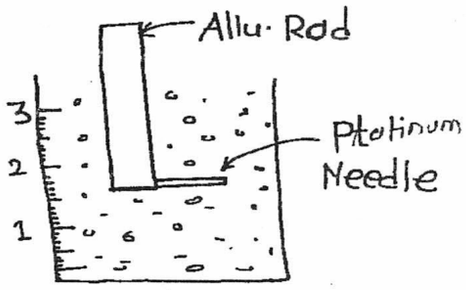
- Is the measure of extend to which light is either absorbed or scattered by the water sample.
- S.S. can not be quantitatively measured by turbidity. Means it will only represents the quality.
- More s.s more turbidity.

* Impacts :-

- Turbid water is difficult to Disinfect due to the presence of suspended solids which may partially shield the micro-organisms from disinfectants.
- In natural water body turbidity interfares with the penetration of ~~life~~ light & hence retard photosynthesis reaction.

* Measurement of Turbidity :-

1) Turbidity Rod Method :-



- In this method an alluminium rod having platinum needle at its tip is inserted inside the water sample & the depth at which needle becomes invisible is noted which further gives turbidity of soln - mg/lit (ppm).
- Turbidity is expressed with the standard unit which is obtained by 1 mg of finely divided silica (SiO_2). Which is also known as Fuller's Earth. In 1 lit of pure water.
- This method is a field method.

2) Jackson Turbid Meter :-

In this method the level of water is raised inside a metalic container having glass base. till the image of the flame placed at the bottom of container ceases to be seen. & the depth of water indicates the turbidity meter.

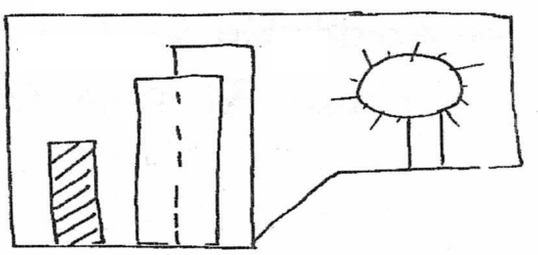
Note :- This method can be used only when turbidity of water is greater than 25 ppm. (Hence this method is not used in treatment of raw water.)

- This method is a laboratory method & it is used to measure turbidity of natural water body.
- In both the above test principle involved is same. i.e. the longer is the light path, smaller is the turbidity.

1 JTU :- 1 mg of finely divide silical (SiO_2) in 1 litre of pure water.

3) Baylis Turbidmeter / Nephlometer :-

- Both these methods are based upon color matching techniques.
- These methods can measure turbidity < 1 Unit.



- Hence. these methods are widely used ~~for~~ to meosure turbidity of domestic water sample.

- In this method light is incident on sample as well as standard solution & the flow of current produced in the photometer placed behind the sample is noted.
- Turbidity of sample is same as that of standard solution if the same current flow is noted in both the photometer.
- In Bayli's turbidmeter the light intensity is measured in the direction of incident (adsorption). Whereas in Nephelometer light intensity is measured at right angle to the incident (scattering) plane. (Hence Bayli's method is based upon adsorption principle & Nephlometer is based upon scattering principal.
- Baylis Turbid Meter measure of turbidity → JTU
  But in Nephlometer turbidity measure in → NTU
  Where 1 NTU = Turbidity produced by 1 mg of formazine (silica) in 1 ltr of pure water.
- There is no direct relationship betn JTU & NTU.
  We can not convert JTU & in NTU.

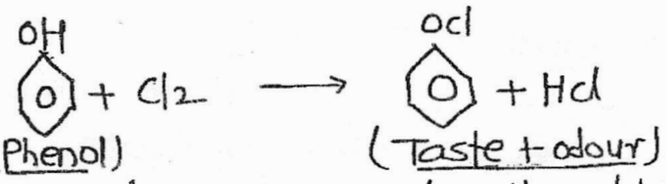
* Acceptable limit for Turbidity = 1 NTU
  Cause for Rejection = 10 NTU

3) Colour:-

Colour — Appearant (S.S + D.S)
Colour — True (D.S)

* Effects of colour in water:-

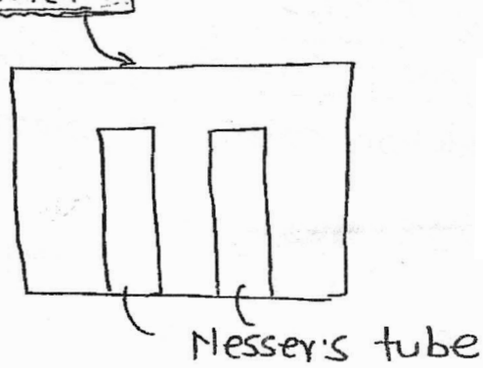
- Color is objectionable as it may spoil the ~~geo~~ clothes which are washed by it.
- It is objectionable from asthetic & psychological point of view.
- Coloured water is not used for dying purpose.
- Colour causing compounds may exert chlorine demond hence reduces the efficiency of chlorination.



- Colour causing compound with chlorine may form carcinogenic compounds (which may cause cancer).
- Phendic compounds with chlorine produces bad taste & odour.

* Measurement of Colour:-

- Colour is measured by colour matching technique & instrument is used is **Tintometer**
- The Result is expresed in std unit is known as TCU (True color unit)
- 1 TCU = Color produced by 1mg of **Platinum** as ~~chloride~~



~~Chloro platinate ion in 1 ltr of pure water~~

The above method is used only if color of the water sample is yellow-brown.

If color other than yellow-brown is to be measured then 'Spectro Photometry' technique is used.

* Acceptable unit = 5 TCU
  & cause for Rejection = 25 TCU

4) Taste & Odour :-

*Sources :-

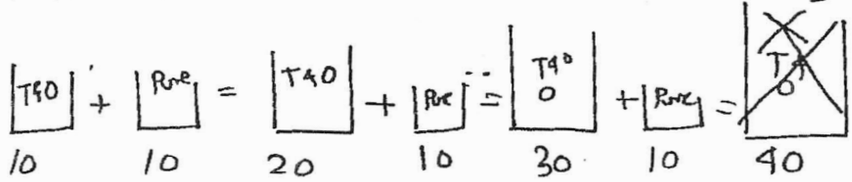
- Taste & odour comes from dissolved organic matter, inorganic salts & dissolved gases.
- H_2S gives rotten eggs smell
- Algae is (organic matter) releases oil like substance which may impart taste & odour in water.
- Inorganic salts-

* Impact :-

- Taste & odour components may be so carsenogenic.

* Measurement :-

- Osmoscope is instrument used for measure taste & odour.
- In routine taste & odoure is measured by TON (Threshold odour No) which represents the dilution ratio at which odour is hardly detectable.



TON = 4

· Testing of T&O should be done at normal temp condition. Because increase in temp alters taste & odour.

* Allowable limit = 1 TON
  Cause for rejection = 3 TON

· With increase in temp biological activity increases & also taste & odoure increases.

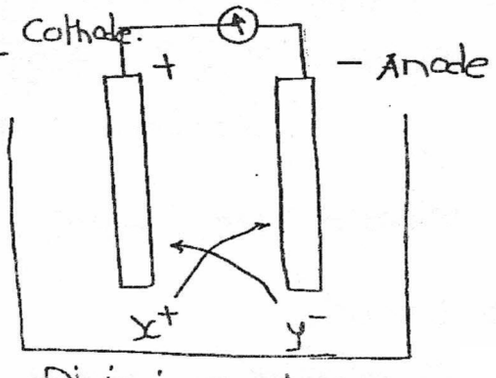
Tempreture :-

· Temp. affects chemical & biological reaction.
· With increase in every 10°c bidogical activity almost doubles.
· For water supply temp should be in the range of 10 to 25°C.

* Chemical Parameters :-

1) TDS - (Total Dissolved solids) :-

TDS can also be measure approximately by measuring electrical conductivity or specific conductance of the water.



Di-ionic Tester.

· Instrument - Di ionic Tester.

· Electical conductivity at 25° C in $\left(\frac{\mu \text{ Mho}}{\text{cm}}\right)$.

$$\left(\frac{\mu \cdot \text{Mho}}{\text{cm}}\right) \times 0.65 = \text{Total Dissolved solids (mg/lit)}$$

· The above method is an approximate method since certain organic compounds dissolved in water without getting converted into ionic forms Hence these are.

not accounted in above calculation.

*Source of D.S in water:-

· Major Sources:- Ca^{2+}, Mg^{2+}, Na^{+}, HCO_3^{-} (hydrogen carbonate), Cl^{-}, SO_4^{-} (sulphate) } common ions.

· Minor Sources:- K^{+}, Fe^{2+}, CO_3^{-} (carbonate ion), silicon, Boron.

2) Alkalinity:-

Alkalinity is defⁿ as quantity of ions present in water that will react to neutralise Hydronium (H^{+}) ions or It is the measure of the ability of water to neutralise the acids.

* Sources of Alkalinity:-

Major:- CO_3^{2-}, HCO_3^{-}, OH^{-} (caustic Alkalinity)
CO_3^{2-} → Carbonate Alkalinity
HCO_3^{-} → Bicarbonate Alkality.

Minor:- HS^{-}, HPO_4^{-}, $HSiO_3^{-}$, $HBrO_3^{-}$

* Impacts

Phosphorus is mixed in water because of fertilizers, detergents, & insecticides.

* Impacts:-

· It imparts bitter taste to water.

· Incrustation of in pipes takes place due to alkaline water. (Incrustation → Deposition of ppt)

$$CO_3^{2-} + Ca^{2+} \longrightarrow CaCO_3 \downarrow$$

(Whereas, acidity leads to corrosion).

- Alklinity in water is produced due to anions which may be of mineral origin, or which may come from dissolved gases or may be added due to microvial decomposition of organic matter.

$$CO_2 + H_2O \longrightarrow H_2CO_3$$

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

$$HCO_3^- \rightleftharpoons CO_3^- + H^+$$

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

The last reaction is very weak reaction. But the consumption of bicarbonate ion by the algie present in the water ~~bi~~drives the reaction in the forward direction leading to accumulation of hydroxide ion in the water. Thereby increasing the alkalinity in water. Hence. if Algie is present in water, water becomes alkaline pH = (8 to 10)

* Measurement of Algie:-

Molecular Wt:-

Sumation of atomic wt. present in water

$CaCO_3 = 40 + 12 + 3(16)$

$= 100$

Mol. Wt. of 1 mol of $CaCO_3$ = 100 gm

$CO_3^{2-} = 12 + 16 \times 3 = 60$ gm

$H_2SO_4 = 2 \times 1 + 32 + 4 \times 16 = 98$ gm

$HCO_3^- = 1 + 12 + 16 \times 3 = 61$ gm

$SO_4^{-2} = 32 + 16 \times 4 = 96\ gm$

- No. of moles $= \frac{\text{Given Wt}}{\text{Molecular Wt}}$

exa. 200 kg – $CaCO_3$

$= \frac{200 \times 10^3}{100}$

$= 2000$ (No. of moles)

* Equivalent Wt :-

$= \frac{\text{Molecular Weight}}{\text{Valency}}$

$Ca^{+2}\ CO_3^{-2}$

$CaCO_3 = \frac{100}{2}$

$= 50\ gm.$

Wt. of 1 gm eq. wt. of $CaCO_3$ = 50 gm = eq. wt. of $CaCO_3$

$CO_3^{-2} = \frac{60}{2} = 30\ gm$

$H_2SO_4^{-2} = 98/2 = 49\ gm$

$HCO_3^{-} = 61/1 = 61\ gm$

$SO_4^{2} = 96/2 = 43\ gm$

- No of equivalent $= \frac{\text{Given Wt}}{\text{Eq. Wt.}}$

exa :- 200 kg of $CaCO_3$

$= \frac{200 \times 10^3}{50}$

$= 4000\ gm$

- 1gm equivalent of anything reacts with 1gm eq. of any other thing to produce 1 eq. of produced thing.

$$2H^+ + SO_4^{2-} \longrightarrow H_2SO_4$$

$$2gm + 96gm \longrightarrow 98gm$$

$$2eq + 2eq \longrightarrow 2eq.$$

- 1gm of eq. of anything is equivalent to 1gm eq. of any other thing.

Q. If sample of water contains 200 gm of Carbonates 122 gm of Bicarbonats & 68 gm of hydroxid (OH) Find Alkalinity of water & express as in calcium carbonate.

i) Carbonates $= \frac{200}{30} \times 50 = 350$ gms.

ii) Bicarbonates $= \frac{12200}{61} \times 50 = 100$ gms

iii) Hydroxide $= \frac{68}{17} \times 50 = 200$ gms.

Eq. of $CO_3^{2-} = \frac{\text{Given wt of } CO_3}{\text{Valency Eq. Wt}}$

$= \frac{210}{30}$

$= 7 =$ eq. of $CaCO_3$

$\therefore$ Total Alk. as $CaCO_3 = 650$ gm.

* Molarity :- No. of moles / lit.

exa. 100 gm of $CaCO_3$ in 2000 lit $\frac{100}{100} \times \frac{1}{2000} = 5 \times 10^{-4}$

$= 5 \times 10^{-4}$ M. $CaCO_3$.

* Normality :- No. of equivalents / lit.

exa 100 kg in 5000 lit $CaCO_3$

$\frac{100 \times 10^3}{50} = 2000/5000 = 0.4N\ CaCO_3$.

ex. 20 ml of 2N H_2SO_4 will have H_2SO_4 equivalents = ?

$= \frac{2}{1000} \times 20 = 0.04$ eq

2 eq $\longrightarrow$ 1000 ml.

eq. 1 in 1 ml = $\frac{1000}{2}$

eq in 20 ml = $\frac{1000}{2} \times 20 = 0.04$ eq.

If 0.2N H_2SO_4 is used as a titrant & its 1ml is used its corresponds to 1mg of Alkinity as $CaCO_3$.

1 ml . 0.02 N H_2SO_4

1000 ml —— 0.02 eq. of H_2SO_4

$\therefore$ 1 ml $= \frac{0.02}{1000} = 2 \times 10^{-5}$ eq. of H_2SO_4.

1 mg of Alk of $CaCO_3$

$= \frac{1 \times 10^{-3}}{50}$

$= 2 \times 10^{-5}$ eq. of $CaCO_3$

Alklinity :-

Alk. of water sample is calculated using titration & relative qty. of alkline species (CO_3^{2-}, HCO_3^-, OH^-) is pH dependant.