[WSSE] [Sarjita Sahoo]

Module-2 Characteristics of Water

5th sem 28th Aug

The raw or treated waters can be checked and analysed by studying and testing their physical, chemical and microscopial / biological characteristics.

Physical Characteristic :-

→ Physical analysis of water is carried out in order to determine the physical characteristics of water.

→ This includes tests for determining

(i) Turbidity
(ii) Suspended solids
(iii) Colour
(iv) Taste or odour
(v) Temperature
~~(vi) Specific conductivity~~

(i) Turbidity :-

→ Opqueness of water is called turbidity.

→ It is the measure of extent to which light is either scattered or absorbed by suspended matter in water.

→ It is also defined the resistance to passage of light through water by the particle.

Impact :-

→ Disinfection of turbid water is difficult because suspended solids may partially shield the organism from disinfectants

→ In natural water bodies turbidity interfere with light penetration and hence with photosynthesis reaction.

Measurement :-

→ Turbidity is measured by,

(i) Turbidity Rod
(ii) Jackson's turbidity meter
(iii) Baylis turbidity meter
(iv) Nephelometer

Turbidity Rod :-

It has platinum needle at the depth. The rod is inserted inside the turbid water and the depth at which platinum needle will become invisible gives turbidity in ppm (Parts per meter).

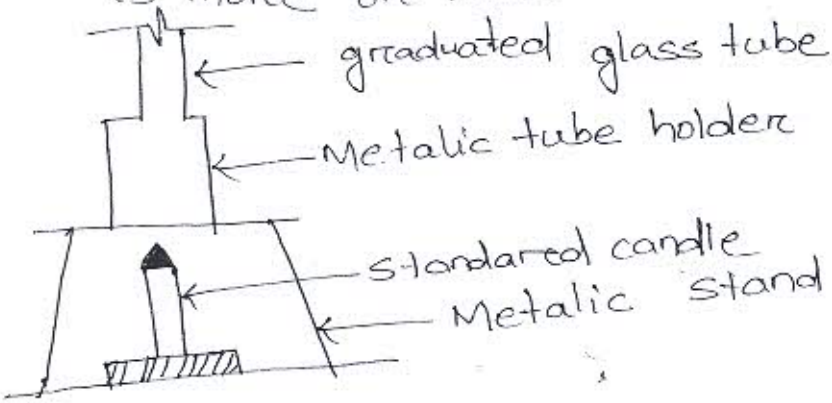
Jackson's Turbidimeter :-

It can be used to measure turbidities in the range between 25-1000 mg/l.

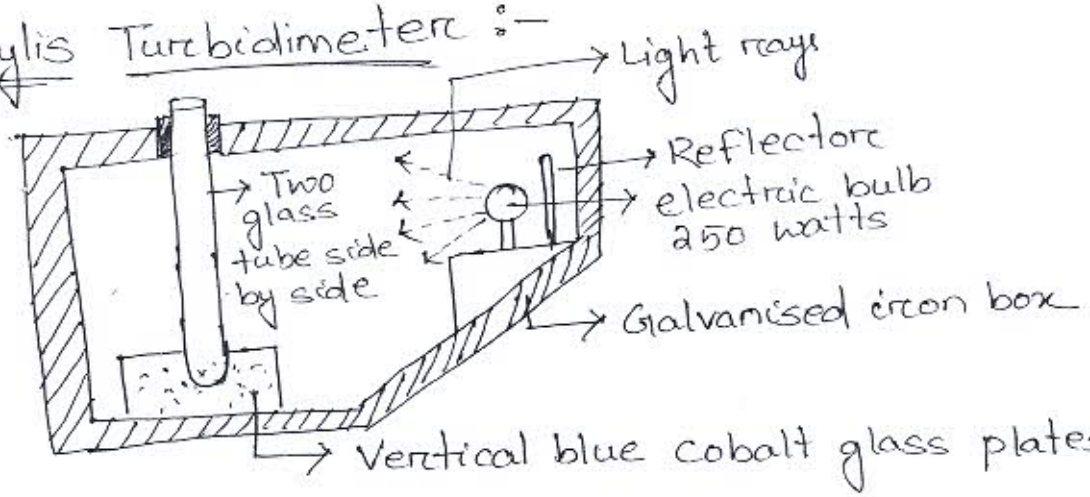
⇒ With the glass tube is placed over a lighted candle the water sample is gradually added to the glass tube.

⇒ The addition of water has stopped as soon as the image of candle flame is invisible.

⇒ This height of water column thus determined the tubidity is more or less.



Baylis Turbidimeter :-



⇒ Light is incident on the sample as well as standared pure water.

⇒ Both tubes are compared by the colour of cobalt glass plates.

⇒ In Baylis turbidimeter light intensity is measured in the direction of light.

⇒ Whereas in Nephelometer light intensity is measured in perpendicular direction of light.

Accept limit :- 1 NTU Cause of rejection → 10 NTU

ii) Suspended Solids :-

⇒ It is asthetically displeasing and may contain disease causing organism.

⇒ These are measured by gravimetric technique, It means by weighing them.

⇒ Suspended solids are calculated by filtering the water sample.

⇒ Acceptable limit ⇒ 500 mg/l
Cause of rejection ⇒ 2000 mg/l

i) Colour :-

Two types of colour are visible.

(a) Apparent colour ⇒ due to suspended solids

(b) True colour ⇒ dye to dissolved solids

Impact ⇒

Organic compound causing colour must exerted chlorine demand. Hence reduces the effectiveness of chlorine as a disinfectant.

⇒ Some of the colour causing organism when mixed with chlorine, produces carcenogenic.

fumic acid produces yellow colour

Iron oxide produces reddish colour

Manganese oxide produces brown/blackish colour.

measurements :-

⇒ Colour is measured by colour matching technique called tintometer.

⇒ The result is expressed as 'TCU' (True colour unit).

⇒ 1 TCU = Colour produced by 1 mg/lit of platinum in the form of choloroplatinate ion.

Acceptable limit → 5 TCU

Cause of rejection ⇒ 25 TCU

(iv) Taste and odour :-

Taste and odour may be caused by the presence of dissolved gases such as H_2S, CH_4, CO_2, O_2 etc.

⇒ For measurement of taste and odour chromatography is used. But this test is very costly, so, Somoscope is used for the measurement.

⇒ The measurement is expressed as TON (Threshold odour Number)

⇒ TON is generally represented by the dilution ratio.

$$A + B \longrightarrow C$$

A ⇒ Vol. of water sample

B ⇒ Vol. of distilled water

$$\text{Dilution ratio} = \frac{C}{A}$$

Acceptable limit ⇒ 1 TON

Cause of rejection ⇒ 3 TON

(v) Temperature :-

It affects chemical and biological reactions.

Allowable limit ⇒ 10 - 25°C

31st Aug

Chemical Characteristics

⇒ Chemical analysis of water is carried out in order to determine the chemical characteristics of water.

⇒ This involves tests for determining

(i) Dissolved solids
(ii) pH value
(iii) Chloride content
(iv) Nitrogen content
(v) Phosphorous content
(vi) Fluoride content
(vii) Other metals
(viii) Iron and Manganese
(ix) Copper
(x) Dissolved gases
(xi) Hardness
(xii) Alkalinity

Total Dissolved Solids (TDS)

⇒ It is determined by electrical conductivity of water.

⇒ Electrical conductivity is ~~measured~~ measured by di-ionic water tester.

⇒ Limits ⇒ 500 - 2000 mg / lit

pH

pH value of water indicates the logarithm of reciprocal of hydrogen ion concentration present in water.

⇒ It is expressed as $pH = -\log_{10}[H^+]$

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

$$\boxed{pH + pOH = 14}$$

⇒ It is measured by potentiometer.

Permissible value of pH in water is 7 - 8.5

Cause of rejection,

$pH < 6.5$ and $pH > 9.2$

Impact :-

Acidic water causes corrosion of pipes and alkaline water causes incrustation / scaling of pipes (ions/ compounds gradually deposits in the inner layer of pipes causing less discharge).

Measurement :-

It is measured by colour indicator which is compared with the standard colour of pH.

⇒ The indicators used are methyl orange and phenopthalin.

methyl orange ⇓ pH range 2.8-4.4

phenopthalin ⇓ pH range :- 8.6-10.3

Chloride Content :-

Presence of chloride in water in high concentration indicates pollution of water due to sewage or Industrial sewage.

Measurement :-

Chlorides are estimated by titrating the water sample with $AgNO_3$ solution using K_2CrO_4 (Potassium chromate)

limits :-

Acceptable ⇒ 200 mg/lit

Cause of rejection ⇒ 1000 mg/lit

1st Sept

Nitrogen ~~Meas~~ Content :-

The presence of nitrogen in water is an indication of the presence of the organic matter.

⇒ It occurs in form of
- (i) free ammonia } combinely known as Kjedahl nitrogen
- (ii) Organic ammonia }
- (iii) Nitrite (NO_2^-)
- (iv) Nitrate (NO_3^-)

⇒ free ammonia indicates very recent pollution.

⇒ Organic ammonia represents quantity of nitrogen present in water in the form of undecomposed organic matter.

⇒ Nitrites indicates the presence of partly decomposed (not fully oxidised) organic matter.

⇒ Nitrates indicates the presence of fully oxidised organic matter in water (thus representing the old pollution).

Limits :-

⇒ free ammonia should not be more than 0.15 mg/l and it can be measured by simple boiling of water. and measuring the libercated ammonia by distillation process.

⇒ Organic ammonia should not be more than 0.3 mg/lit. It can be measured by boiling the already boiled water by adding $KMnO_4$ (Potassium Permanganate)

⇒ Nitrite is highly dangerous. Its permissible limit should be zero. It is measured by colour matching technique, whereas colour is developed by sulphonic acid + Nepthomine.

⇒ Nitrate is not harmful because it is fully oxidised but large quantity of nitrates affect infants because it causes blue baby disease (Mathemoglobine min)

⇒ Nitrate concentration should not be more than 4mg/lit and it's measured by colour matching technique where colour is produced by phenol-di-sulphonic acid.

Phosphorous Content :-

⇒ Phosphorous itself is not toxic but its presence indicate the pollution of water.

⇒ It facillitate the growth of aquatic plants and interferes in the water treatment process of coagulation.

⇒ Even in Low concentration of 0.2 mg/lit it interferes with the process.

Fluoride Content :-

⇒ Fluoride upto 1mg/lit helps to prevent dental cavities and also helps in the formation of permanent teeth.

⇒ fluoride value greater than 1.5-2 mg/lit results in decolourisation of teeth called mottling of teeth.

⇒ If its value is greater than 5 mg/l it causes bone flurosis.

Limits :-

Acceptable - 1 mg/l
cause of rejection - 1 mg/l.

Other Metals :-

Toxic :- Hg, Arsenic, Cadmium, chromium, cyanide
↓↓
mercury

Non toxic :- Calcium, potassium, Manganese, Iron, zinc, Magnesium.

1) In a water treatment plant, the pH values of incoming and outgoing waters are 7.2 and 8.4 respectively. Assuming a lineart variation of pH with time, determine the average pH value of water.

→ Given, $pH_1 = 7.2$

$pH_2 = 8.4$

$-\log_{10} H_1^+ = 7.2$

$\Rightarrow H_1^+ = 10^{-7.2}$

$-\log_{10} H_2^+ = 8.4$

$\Rightarrow H_2^+ = 10^{-8.4}$

Average value of $H^+ = \frac{H_1^+ + H_2^+}{2}$

$= \frac{10^{-7.2} + 10^{-8.4}}{2}$

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

$pH = -\log_{10}(8.42 \times 10^{-8.4})$

$= 7.474$

2) Total alkalinity is equal to 200 mg/lit expressed as $CaCO_3$.

$Ca^{+2} = 60$ $Mg^{+2} = 30$

Find total hardness, carbonate and non carbonate hardness.

⇒ Total hardness = $\frac{Ca^{2+}}{20} \times 50 + \frac{Mg^{2+}}{12} \times 50 = \frac{60}{20} \times 50 + \frac{30}{12} \times 5$

$= 275$ mg/lit

TH > total alkalinity = 200

So CH = TA = 200 mg/lit

NCH = 275 − 200 mg/lit

= 75 mg/lit