

ENVIRONMENTAL ENGINEERING

Notes by-

Pravin S Kolhe,

BE(Civil), Gold Medal, MTech (IIT-K)

Assistant Executive Engineer,

Water Resources Department,

www.pravinkolhe.com

QUALITY OF WATER

Tests of water :-

- a) Physical Test -
- b) Chemical Test -
- c) Bacteriological Test -

1) Physical Test :-

i) colour :-

Instrument : Tintometer.

No. of cobalt scale = 10-20 max.

2) Taste : Gsmoscope

Threshold No. = 3 max.

3) Odour.

4) Temp : Thermometer

Desirable temp. = 10°C

5) Turbidity :-

Desirable turbidity = 5-10 ppm.

Mtds. of measuring turbidity :- i) Visual mtd : Turbidity Rod

ii) Jackson's Turbidimeter

iii) Boylis Turbidimeter

iv) Nephelometric turbidimeter.

2) Chemical Test :-

a) Chloride :- (Sodium chloride or salt)

Desirable limit = 250 mg/lit

Max. permissible limit = 600 mg/lit

Procedure :- 50 c.c. of sample of water is taken.

Add 2-3 drops of potassium chromate solⁿ.

Titrate with std. solⁿ of silver nitrate.

Silver + chlorides $\rightarrow$ silver chloride

$\text{AgNO}_3 + \text{NaCl} \rightarrow \text{AgCl} + \text{NaNO}_3$

$2\text{AgCl} + \text{K}_2\text{Cr}_2\text{O}_7 \rightarrow \text{Ag}_2\text{Cr}_2\text{O}_7 + 2\text{KCl}$

Silver chloride + Potassium chromate $\rightarrow$ Silver chromate.

2) Dissolved Gases :-

NO_2 , Methane, H_2S , CO_2 , O_2 .

explosive

odour

corrosive

Desirable limit = 5-10 ppm.

5) Hardness :- Ability of water to cause precipitatⁿ of higher fatty acid from soap.

Types : a) Temporary Hardness :- / Carbonate Hardness :-

This is caused due to presence of bicarbonates of calcium & magnesium & can be removed by boiling or adding lime.

b) Permanent Hardness :- / Non-carbonate Hardness :-

Due to presence of sulphates, chlorides & nitrates of calcium & magnesium.

∴ Total Hardness = Carbonate Hardness + Non-carbonate Hardness.
= Associated with $\text{HCO}_3^- + (\text{SO}_4^{--}, \text{Cl}^-, \text{NO}_3^-)$

$$\text{Hardness (mg/Lit as CaCO}_3\text{)} = M^{++} \times \left[\frac{\text{Eq. wt. of CaCO}_3}{\text{Eq. wt. of } M^{++}} \right]$$

Where, M^{++} = Ion or Radical

Eq. wt = Molecular wt.

$X=2$

Hardness is caused by $\text{Ca}^{++}, \text{Mg}^{++}, \text{Sr}^{++}$

$\text{CO}_3^{--}, \text{HCO}_3^-$ ions only.

The readings of all other metals are ignored.

4) Hydrogen ion concentration (p^{H}) :-

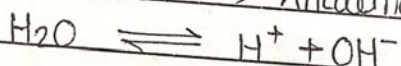
The acidity or alkalinity of water is measured in terms of its p^{H} value.

Pure water (H_2O) consist of - i) Positively charged H^+ ion & ii) Negatively charged OH^- ions (Hydroxyl).

While process of dissolving, water contains some uncombined H^+ ions & some OH^- ions.

Water becomes acidic when H^+ ions $>$ OH^- ions $\Rightarrow$ Acidic

H^+ ions $<$ OH^- ions $\Rightarrow$ Alkaline.



∴ From law of mass action,

$$K = \frac{[\text{H}^+][\text{OH}^-]}{[\text{H}_2\text{O}]}$$

& $k_w = [\text{H}^+][\text{OH}^-] = \text{Ionisat}^{\text{n}}$ constant

Experimentally, $K_w = 1 \times 10^{-14}$ at 25°C .

for pure water at 25°C ,

$$[H^+][OH^-] = 10^{-14} \quad \text{--- (i)}$$

$$\therefore 10^7 H^+ \times 10^7 OH^- = 10^{-14}$$

$$\left. \begin{aligned} p(H^+) &= -\log_{10} [H^+] \Rightarrow H^+ = 10^{-pH} \\ p(OH^-) &= -\log_{10} [OH^-] \Rightarrow OH^- = 10^{-pOH} \end{aligned} \right\} \text{--- (ii)}$$

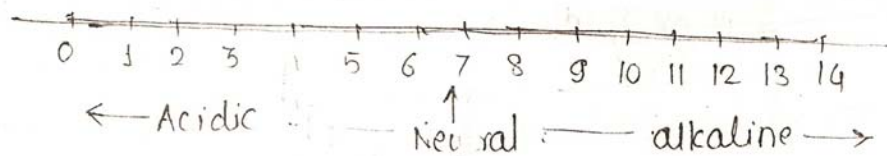
$$\therefore \frac{10^{-pH}}{10^7} \times \frac{10^{-pOH}}{10^7} = 10^{-14} \quad \text{--- from (i) \& (ii)}$$

$$\therefore \log_{10} (10^{-pH} \times 10^{-pOH}) = \log_{10} 10^{-14} \quad \rightarrow \text{Divide by } 10^7 \text{ on both sides}$$

$$\therefore -pH - pOH = -14$$

$$\therefore pH + pOH = 14$$

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



Desirable pH for portable water: 6.5 to 8.5

Measurement of pH :-

1) Electrometric mtd :- Potentiometer.

2) Colourimetric mtd

5) Alkalinity :-

6) Acidity :-

7) Metal & other chemical substances :-

8) Nitrogen & its compounds.

9) Total solids $\rightarrow$ Dissolved solids + suspended solids.

c) Bacteriological Tests:-

1) Total count or Agar plate count test

2) B-coli test:-

i) Presumptive test

ii) Confirmed test

iii) Completed test.

Permissible limits:-

Test	Apparatus	Desirable Permissible Limit.	per. Max. Limit.
Physical			
1) Colour	Tintometer	10 No. of Cobalt scale	20 No. of Cobalt scale
2) Taste	OR Osmoscope		Threshold No. = 3
3) Odour			
4) Temp.	Thermometer	10°C	
5) Turbidity	Turbidity Rod Jackson's Turbidimeter Baylis → Nephelometric →	5-10 ppm	
Chemical			
1) Chloride		250 mg/lit	600 mg/lit
2) Dissolved Gases		5-10 ppm	
3) Hardness		bet ⁿ 5-8 degree	
4) pH	Potentiometer	6.5-8.5	
	colourimetric mtd.		
5) Alkalinity		250 mg/l	
6) Acidity		50 mg/l	
7) Metal & other chemicals			
8) N ₂ & its compounds		0.15 ppm	
9) Total solids			
* Dissolved solids	}	BIS - 500 mg/l	1500 mg/l
* Suspended solids			