LECTURE-14

Laboratory Techniques in Water Quality Analysis

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The quality of water is determined by studying its various properties, broadly categorized as physical, chemical and biological. As far as the physical quality of water is concerned, it should be colourless, odourless and free from visibly floating particles, chemically it should contain major and trace elements within permissible limits and microbiologically it should meet the requirements specified by the various agencies (World Health Organisation Environmental Protection Agency etc.).

PHYSICAL PARAMETERS

Temperature

Temperature, which is known to have its effect on the rate of chemical reactions, dissolution of gases etc., can be measured with the help of a digital thermometer.

Colour and Turbidity

The colour and turbidity of the samples are related to the amount and the type of suspended matter present in them.

CHEMICAL PARAMETERS

Water samples in the laboratory can be analysed for pH, electrical conductivity and chemical parameters such as carbonate, bicarbonate, chloride, calcium, magnesium, total hardness, sodium and potassium ions. A summary of analytical methods used for chemical analysis of water is given in (Table 1).

Hydrogen Ion Composition (pH)

pH is term used rather universally to express the intensity of the acid or alkaline condition of a solution. It is a way to express the hydrogen-ion concentration, or more precisely, the hydrogen-ion activity. The term may be represented by

$$pH = - \log(H^+) \text{ or } pH = \log 1/(H^+)$$

And the pH scale is usually represented as ranging from 0 to 14, with pH 7 at 25°C representing absolute neutrality. pH measurement is done by first calibrating the instrument (Soil and Water Analysis Kit) with standards of pH 4.0 and 9.2 buffer

solutions at room temperature in the laboratory. According to W.H.O. (1984), the pH limits are 6.5-8.5 for potable water.

Table 1. Summary of analytical methods used for chemical analysis of water samples.

S.No.	Parameters	Analytical Methods
1	pH	Water and Soil Analysis Kit (Electronics India, Model 161)
2	Electrical Conductance (EC) micromhos/cm at 25°C	Water and Soil Analysis Kit (Electronics India, Model 161)
3	Carbonates and Bicarbonates (mg/l)	Titrimetric method using standard sulphuric acid with phenolphthalein and methyl orange as indicators
4	Chloride (ppm)	Argentiometric method with potassium chromate as indicator
5	Calcium (mg/l)	Titration with EDTA
6	Total Hardness (mg/l)	Titration with EDTA
7	Sodium (mg/l)	Flame Photometer
8	Potassium (mg/l)	Flame Photometer
9	Trace Elements	AAS

Electrical Conductivity

Electrical Conductivity determines the total concentration of soluble salts or ionized constituents in water. It denotes the characteristics of a medium to passage of electricity (a reciprocal of resistance) and is a function of temperature, type of ions present and concentration of various ions (Walton, 1970). The EC of water samples is measured in micro mhos/cm at 25 degree Celsius with necessary corrections for variation in temperature (Lab.) of water sample using the standard curve by soil and water analysis kit. The quality of groundwater for irrigation use, based on the electrical conductivity values, can be rated according to following three classes (Table 2).

Carbonate and Bicarbonate

Carbonate and Bicarbonate are estimated by titrimetric methods using phenolphthalein and methyl orange as indicators and N/10 standard sulphuric acid as a

titrant. When the colour of the phenolphathalein disappears, it shows the conversion of carbonate in to bicarbonate. Now methyl red is added which gives yellow colour. The change is colour from yellow to rose red gives an indication of the neutralization of bicarbonates. According to ISI: 10500 (1991) drinking water quality standards, the desirable limit for Alkalinity is 200mg/l and permissible limit as 600mg/l.

Table 2. Water classes based on EC values

EC in micromhos/cm at 25°C	Water Class
0-2000	Fresh
2000-6000	Marginal Fit
>6000	Saline and Unfit

Chloride

Chloride is one of the major inorganic anions in water and it occurs in all the natural waters in widely varying concentration. The chloride content normally increases as the mineral content increases. Chloride in the ground water samples is determined by titrmetric method using potassium chromate as an indicator and standard silver nitrate as a titrant. According to Indian Standards for drinking water (1991) the desirable and the maximum permissible limits of chloride for drinking water are 250mg/l and 1000mg/l, respectively and as per WHO (1971) drinking water standards, the highest desirable limit and maximum permissible limits are 200mg/l and 1000mg/l. At concentrations above 250mg/l it gives a salty taste to water. Chloride is not strictly a pollutant but concentration above 1000 mg/l may harm agricultural crops and corrode the metallic pipes.

Calcium

The presence of calcium in water supplies results from passage through or over deposits of limestone, dolomite, gypsum and gypsiferous scale. Calcium is determined by titrmetric method using murexide as an indicator. The sample solution is titrated against Ethylene diammine tetra acetic acid (EDTA) solution until the colour changed from pink to purple. The EDTA solution (.01M) is prepared by dissolving 3.723g of disodium salt of EDTA in triple distilled water and diluted to 1 litre. As per ISI (1991) and WHO (1971) drinking standards, the desirable limit of calcium is 75mg/l and permissible limit is 200mg/l (Table 3).

Hard waters are generally considered to be those waters that require considerable amounts of soap to produce a foam or lather and that also produce scale in hot-water pipes, heaters, boilers and other units in which the temperature of water is increased materially. The hardness of water reflects the nature of the geological formations with which it has been in contact. Hardness is normally expressed in terms of calcium carbonate. Calcium and magnesium cause by far the greatest portion of the hardness occurring in natural waters. Total hardness is estimated by titrimetric method

using eriochrome black –T as an indicator and using EDTA (Ethylene diammine tetra acetic acid) solution as a titrant. Change of colour from wine red to blue gives an end – point. The highest desirable and maximum permissible limit of total hardness are 300mg/l and 600 mg/l (as CaCO3) as prescribed by I.S.I. (1983, 1991) and WHO (1971) (Table 3).

Magnesium

Magnesium, as calcium is also a common constituent of the natural water. It is one of the important contributors of the hardness of water. Magnesium concentration in water may vary from zero to several hundreds mg/l depending upon the source of water. Concentrations greater than 125 mg/l can exert a cathertic and diuretic action, chemical softening or ion exchange reduces the magnesium and associated hardness to acceptable levels.

Mg hardness (mg/l) = Total hardness – Calcium hardness

In expression as Mg^{2+} = Magnesium hardness x 0.243 mg/l

According to Indian standards (1991) for drinking water, the desirable and maximum permissible limit of magnesium of drinking water is 30mg/l and 100mg/l, respectively and as per WHO(1971) drinking water quality standards maximum permissible limit for Mg (as mg) is 100mg/l (Table 3).

Table 3. Drinking water quality standards

		ISI (1983)		ISI:10500(1991)		WHO (1971)	
S.No.	Substance or Characteristic	Highest desirable limit	Maximum permissible limit	Require-ment (desirable limit)	Permissible limit	Highest Desirable limit	Maximum Permissible limit
1	PH	6.5-8.5	6.5-9.2	6.5-8.5	No relaxation	7.0-8.5	6.5-9.2
2	Total Hardness as $CaCO_3$ (Mg/l)	300	600	300	600	300	600
3	Calcium (as Ca) Mg/l, max.	75	200	75	200	75	200
4	Magnesium (as Mg) mg/l, max.	30	100	30	100	Xxx	100
5	Chloride mg/l	250	1000	250	1000	200	1000
6	Alkalinity mg/l, max.			200	600		

Sodium and Potassium

The sodium and potassium ions in the water samples are determined by Flame photometric method. Standard Calibration graph is prepared for determination of sodium and potassium of the unknown sample (water). The guidelines for drinking water (W.H.O., 1984) give the limiting value of 200 mg/l for sodium and for sodium in potable waters, a desirable limit of 10 mg/l is recommended but only very high concentration of potassium above 2000 mg/l may be harmful to human nervous and digestive systems.

Trace Elements

Trace elements such as Cu, Co, Cr, Ni, Zn, Pb, Fe, Cd, Mn, V and Sr can be determined from filtered and acidified water samples with the help of Perkin-Elmer Atomic Absorption Spectrophotometer 2100. Each trace element is determined on the AAS using the corresponding lamp.

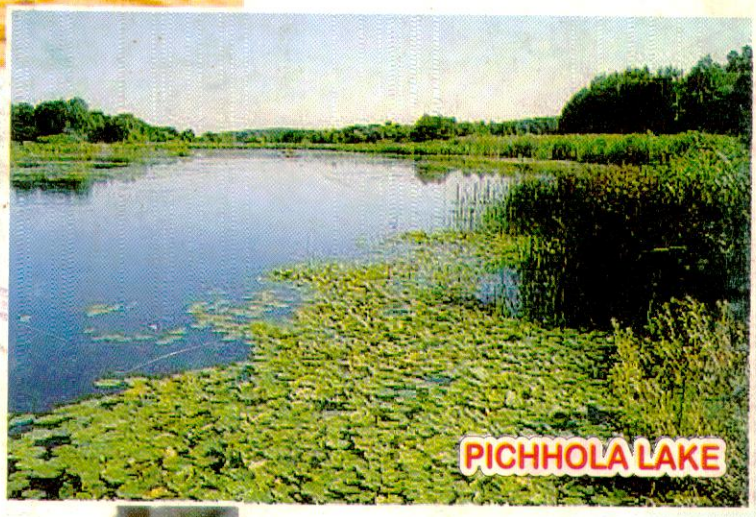
REFERENCES

I.S.I. (1983), Indian Standard Specification for Drinking Water, IS: 10500, I.S.I., New Delhi, pp.1-22.

Walton, W. C. (1970), Ground Water Resource Evolution. McGraw Hill, Kongakusha Ltd., Japan, 664p.

W.H.O. (1971), International Standards for Drinking Water, WHO, Geneva, pp.31-41.


DAL LAKE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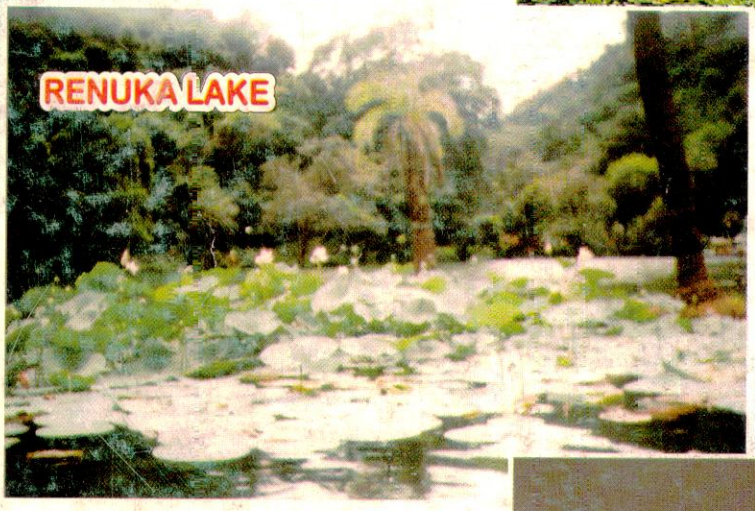
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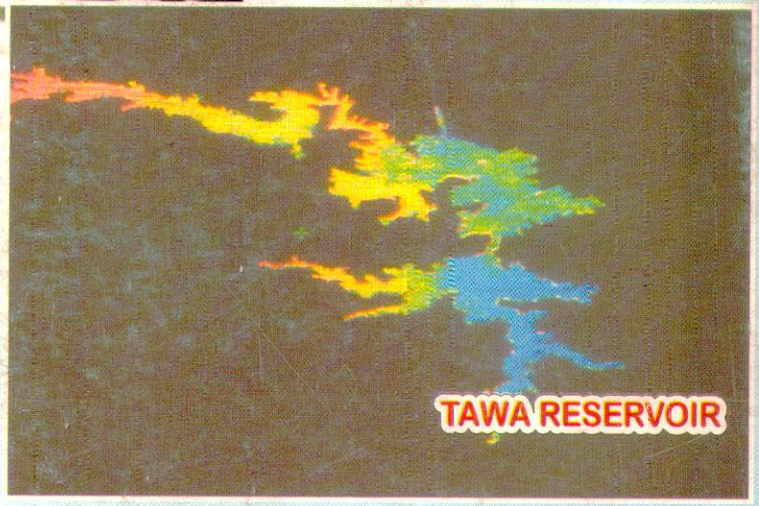
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