higher pH.

Remaining part of Measurement of Water quality by Physical examination of Water

## ELECTRICAL CONDUCTIVITY

Electrical conductivity is a measure of a water's capacity to convey electric current. Its unit is **micromhos/cm or micro Siemns/cm$^3$.** Conductivity of water varies directly with the temperature and is proportional to its dissolved mineral matter content. Electrical conductivity determination is very rapid, so the quantity of dissolved salts in water sample can be ascertained quickly. It is an important guide to check the purity of distilled water and is applied for evaluation of steam purity in power industry. Distilled water with conductivity more than 2 should not be used for water analysis.

## SOLIDS

The term solids refers to the matter that remains as residue upon evaporation. Total solids

include both dissolved solids and suspended solids. Potable waters contain mineral matters in dissolved conditions whereas industrial effluents and sewage contain huge amount of undissolved matter.

## SUSPENDED SOLIDS (SS)

500 mL of a sample is taken exactly in a volumetric flask and allowed to filter through a dried and weighed Gooch crucible containing an asbestos mat. The suspended solids retained in the crucible are washed with distilled water to remove chloride. The crucible is finally dried, cooled in a desiccator and weighed. The increase in the weight of the crucible is equivalent to the suspended impurities present. The total solid contents of 500 mL sample can also be calculated by evaporating it to dryness on a steam bath and drying at about 100–110°C in an oven for about one hour. From this, subtract the dissolved solids to get the quantity of suspended solids.

## DISSOLVED SOLIDS (DS)

Filter 500 mL sample in a Gooch crucible to free it from suspended matter. The filtrate is collected in a beaker and evaporated to about 50 mL volume. It should be noted that any deposit on the walls of the beaker due to evaporation of water should not touch the flame of the burner. The 50 mL liquid is carefully transferred to a weighed platinum dish with the help of a policemen and with distilled water. Evaporate the solution to dryness on steam bath and dry the dish in an oven at about 100- 110°C for about an hour. Cool it in a desiccator, and weigh.

**Calculation –**

$$\text{Weight of solids} \times \frac{10^6}{500} = \text{ppm. dissolved solids.}$$

**Results** : Disposal of industrial effluents and sewage contributes suspended solids to the water bodies. The ISI has specified a maximum limit of 30 mg/L for suspended solids discharged into rivers. Solid determination is particularly useful in the analysis of sewage and other waste waters. It is as significant as BOD determination. It is used to evaluate the strength of domestic waste waters and to determine the efficiency of treated units.

## ACIDITY

Acidity is a measure of the effects of combination of compounds and conditions in water. It is the power of water to neutralise hydroxyl ions and is expressed in terms of calcium carbonate.

**Water attains acidity from industrial effluents, acid mine drainage, pickling liquors and from humic acid.**

**Measurement of acidity by titration method –**

**Principle –** Acidity of water can be determined by titration with sodium hydroxide solution. The amount of sodium hydroxide required for the sample (pH below 4.5) to reach pH 4.5 (methyl orange end point) is a measure of mineral acidity while the amount of sodium hydroxide to reach pH 8.3 (phenolphathlein end point) is a measure of total acidity. Samples containing acidic wastes (pH below 4.5) correspond to both mineral and $CO_2$ acidity.

**Procedure –**

**Mineral acidity-** Take 50 mL or suitable dechlorinated aliquot of the sample in a 250 mL conical flask. Add 2 drops of methyl orange indicator and titrate with 0.02 N–NaOH solution till faint orange colour.

**Total acidity at room temperature-** Place suitable aliquot of the sample is 250 mL flask.

Add 2 drops of phenolphthalein indicator and titrate with 0.02 N–NaOH solution to light colour.

**Total acidity at boiling temperature-** To 50 mL of the sample, add 5 drops phenolphthalein indicator. Heat to boil for 2 minutes. Titrate with 0.02 N-NaOH solution to colour.

**Calculations –**

$$\text{Acidity as } CaCO_3 \text{ mg/L} = \frac{\text{mL titrant (NaOH)} \times 1 \times 1000}{\text{mL sample taken for titration}}$$

**Results** – Methyl orange acidity value shows mineral acidity. In absence of mineral acid total acidity is only the $CO_2$ acidity of the sample.

## TOTAL ACIDITY

Total acidity can also be determined in the following manner. Take 100 mL. of a sample a tall cylinder to decrease the surface of the sample and minimize loss of dissolved carbon acid during titration. Now add few drops of phenolphthalein indicator and titrate the solution very rapidly against 0.02 N NaOH with constant stirring until a faint pink colour is obtained.

Calculation—

$$\text{mL alkali titration} \times \text{normality} \times 0.05 \times \frac{10^6}{\text{Vol. of sample}} = \text{ppm}$$

Total acidity expressed as $CaCO_3$.

**Free mineral acids**—Take 100 mL. of the sample in a conical flask and add few drops aqueous methyl orange indicator to it. Now titrate the solution against 0.02 N NaOH till orange yellow colour is obtained at the end point. The calculation is exactly the same as total acidity.

## ALKALINITY

Alkalinity of water is generally due to the presence of carbonate and hydroxide ions.

**Determination of alkalinity by titrimetric method –**

**Principle** – Alkalinity is determined by titration with 0.02 $H_2SO_4$ using methyl orange and phenol-phthalein as indicators.

**Reactions -**

$$2CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + Ca(HCO_3)_2$$

$$Ca(HCO_3)_2 + H_2SO_4 \rightarrow CaSO_4 + 2CO_2 + 2H_2O$$

$$Ca(OH)_2 + H_2SO_4 \rightarrow CaSO_4 + 2H_2O$$

**Reagents –**

**(i) Sulphuric acid 0.02 N-** Dilute 20 mL of 1 N – $H_2SO_4$ to 1000 mL with distilled water.

**(ii) Sodium carbonate solution-** Dissolve 13.25 g $Na_2CO_3$ in distilled water to 250 mL.

**(iii) Phenolphthalein indicator solution -** Dissolve 500 mg phenolphthalein in 50 mL alcohol and 50 mL distilled water. Add 0.02 N-NaOH solution till light pink colour appears.

**Procedure-** Take 50 mL of the sample in a 250 mL conical flask. Add 2 drops of phenolphthalein indicator. Titrate the pink colour with 0.02 N–$H_2SO_4$ till it becomes colourless. If the sample contains waste waters, then remove the suspended matter by filtration or centrifugation and then determine alkalinity.

**Calculations -** If $H_2SO_4$ used for titration is 0.02N, phenolphthalein alkalinity (as $CaCO_3$) mg/L.

$$= \frac{\text{mL } 0.02\text{ N} - H_2SO_4 \text{ for phenolphthalein end point} \times 1 \times 1000}{\text{mL sample taken for titration}}$$

Total alkalinity (as $CaCO_3$) mg/L

$$= \frac{\text{mL } 0.02\text{ N} - H_2SO_4 \text{ total alkalinity end point} \times 1 \times 1000}{\text{mL sample taken for titration}}$$

**Result** – Alkalinity measurements are used as the means of evaluating the buffering capacity of waste waters and sludges. It is also significant in determining the suitability of a water for irrigation, in the treatments of natural and waste waters and to **calculate the Langelier Saturation Index. Alkalinity provides an idea of the nature of salts present in water.**

If it is equal to hardness, calcium and magnesium salts are only present in water. If alkalinity is less than hardness, sulphates of calcium and magnesium must be there. Greater alkalinity shows the presence of alkali salts of sodium and potassium in addition to those of calcium and magnesium.

Alkalinity can also be predicted in the following manner. Take 100 mL of the filtered sample in a conical flask and add few drops of alcoholic phenolphthalein indicator to it. Now titrate the solution with 0.02N HCl until colourless. If the sample is colourless after the phenolphthalein indicator is added, add few drops of aqueous methyl orange indicator till an orange pink colour is obtained at the end point. The nature of alkalinity is then predicted from the titration as follows:

*(a) If the titration to the phenolphthalein end point is zero, the alkalinity may be regarded as due to bicarbonate alone. (b) When there is no further titration to the methyl orange end point after the phenolphthalein end point, the alkalinity is solely due to the hydroxide. (c) When the phenolphthalein end point titration is half the total titration, only carbonate alkalinity is expected to be present. (d) When the phenolphthalein end point titration is greater than half the total titration, the alkalinity is due to both carbonate and hydroxide. (e) When the phenolphthalein end point titration is less than half the total titration, the alkalinity is due to carbonate and bicarbonate.*

Those waters that have been softened with orthophosphate do not obey the above rules. All kinds of alkalinity are expressed in terms of $CaCO_3$.

## FREE CARBON DIOXIDE