

## 8.0 EXPERIMENT ON DETERMINATION OF ACIDITY OF WATER

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## 8.0 EXPERIMENT ON DETERMINATION OF ACIDITY OF WATER

### PREAMBLE:

**“How to determine acidity in Water and Wastewater”.**

Test procedure is in accordance to IS: 3025 (Part 22) - Reaffirmed 2003.

In addition to our Indian Standard, we also discuss in brief regarding the procedure stated in

- (1) APHA Standard Methods for the Examination of Water and Wastewater - 20<sup>th</sup> Edition. Method 2310.
- (2) Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, USEPA, Method 305.1.

### 8.1 AIM

To determine the acidity of given water sample with the stipulations as per **IS: 3025 (Part 22) - Reaffirmed 2003.**

### 8.2 INTRODUCTION

Acidity is a measure of the capacity of water to neutralise bases. Acidity is the sum of all titrable acid present in the water sample. Strong mineral acids, weak acids such as carbonic acid, acetic acid present in the water sample contributes to acidity of the water. Usually dissolved carbon dioxide (CO<sub>2</sub>) is the major acidic component present in the unpolluted surface waters.

The volume of standard alkali required to titrate a specific volume of the sample to pH 8.3 is called phenolphthalein acidity (Total Acidity).

The volume of standard alkali required to titrate a specific volume of the water sample (wastewater and highly polluted water) to pH 3.7 is called methyl orange acidity (Mineral Acidity).

#### 8.2.1 ENVIRONMENTAL SIGNIFICANCE

Acidity interferes in the treatment of water. Carbon dioxide is of important considerations in determining whether removal by aeration or simple neutralisation with lime /lime soda ash or NaOH will be chosen as the water treatment method.

The size of the equipment, chemical requirements, storage spaces and cost of the treatment all depends on the carbon dioxide present.

Aquatic life is affected by high water acidity. The organisms present are prone to death with low pH of water.

High acidity water is not used for construction purposes. Especially in reinforced concrete construction due to the corrosive nature of high acidity water.

Water containing mineral acidity is not fit for drinking purposes.

Industrial wastewaters containing high mineral acidity must be neutralized before they are subjected to biological treatment or direct discharge to water sources.

### **8.3 PRINCIPLE**

Hydrogen ions present in a sample as a result of dissociation or hydrolysis of solutes reacts with additions of standard alkali (NaOH). Acidity thus depends on end point of the indicator used.

The colour change of phenolphthalein indicator is close to pH 8.3 at 25°C corresponds to stoichiometric neutralisation of carbonic acid to bicarbonate.

### **8.4 MATERIALS REQUIRED**

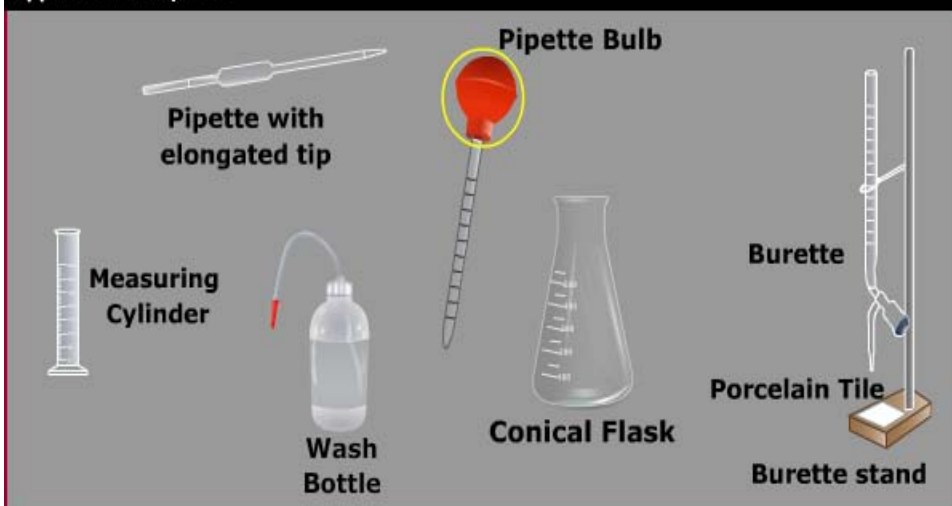
#### **8.4.1 APPARATUS REQUIRED**

1. Burette with Burette stand
2. porcelain tile
3. 500 mL conical flask
4. Pipette with elongated tips
5. Pipette bulb
6. Conical flask
7. Measuring cylinders
8. Wash Bottle and Beakers

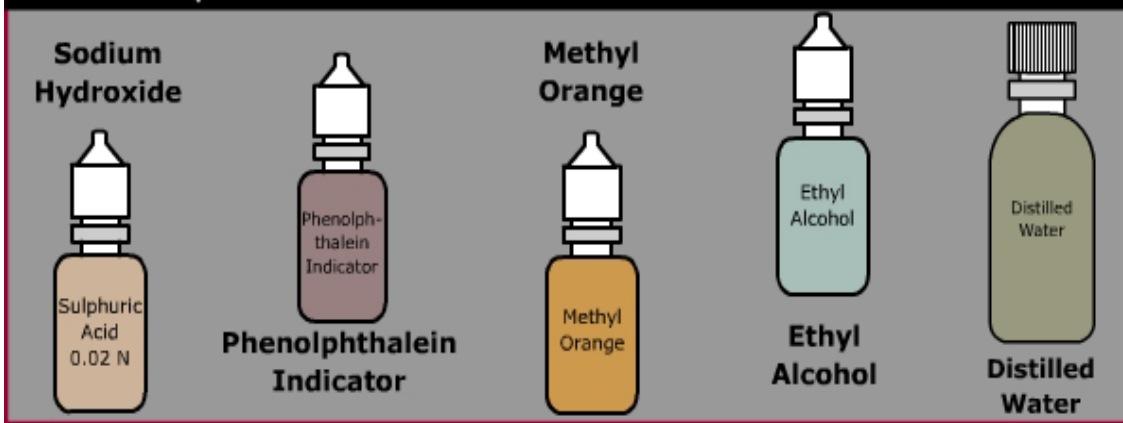
#### **8.4.2 CHEMICALS REQUIRED**

1. Sodium Hydroxide
2. Phenolphthalein
3. Methyl Orange
4. Ethyl alcohol
5. Distilled Water

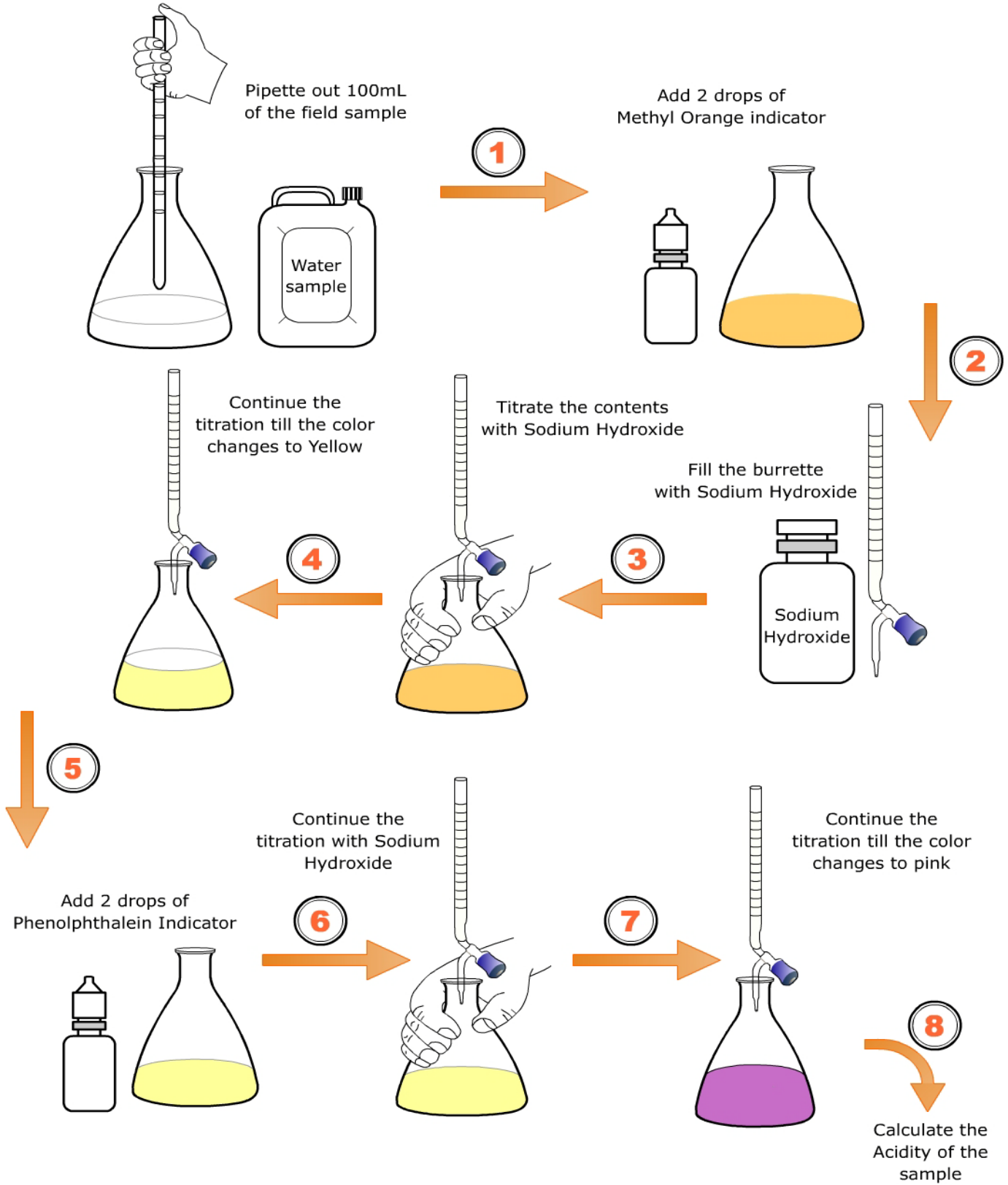
### Apparatus Required



### Chemicals Required



# PROCEDURE CHART



## 8.5 SAMPLE HANDLING AND PRESERVATION

- Preservation of sample is not practical. Because biological activity will continue after a sample has been taken, changes may occur during handling and storage.
- To reduce the change in samples, keep all samples at 4° C. Do not allow samples to Freeze.
- Analysis should begin as soon as possible.
- Do not open sample bottle before analysis.

### 8.5.1 PRECAUTIONS

- Colored and turbid samples may interfere in end point. Those samples may be analyzed electrometrically, using pH meter.
- Do not keep the indicator solution open since it contains the alcohol which tends to evaporate. The mixed indicator solution is containing dye in it. Care should be taken so that it is not spill to your skin. If it spills on your skin the stain will remain for at least 2 to 3 days.
- Presence of residual chlorine may interfere in the colour response, which can be nullified by addition of small amount of sodium thiosulphate or destroy it with ultraviolet radiation.
- Presence of iron and aluminum sulphate may interfere in the colour response while titrating in room temperature, which can be nullified by titrating the sample at boiling temperature.
- Dissolved gases contributing to acidity such as CO<sub>2</sub>, H<sub>2</sub>S may interfere in the titration, hence avoid vigorous shaking.
- Samples suspected to have hydrolysable metal ions or reduced forms of polyvalent cations need hydrogen peroxide treatment.

## 8.6 PROCEDURE

### 8.6.1 PREPARATION OF REAGENTS

#### Sodium Hydroxide (0.02 N)

- Take 1000 mL standard measuring flask and fill 3/4<sup>th</sup> of it with distilled water.
- Accurately measure 20 mL of 1N sulphuric acid solution using a pipette and transfer to 1000 mL standard flask containing the distilled water. Make up to 1000 mL using distilled water.

### **Phenolphthalein Indicator**

- Weigh accurately 1 g of phenolphthalein and dissolve it in 95% ethyl alcohol.
- Take 100 mL standard measuring flask and place a funnel over it.
- Transfer it to the 100 mL standard flask and make up to 100 mL using 95% ethyl alcohol.

### **Methyl Orange Indicator**

- Weigh accurately 1 g of methyl and dissolve it in distilled water.
- Take 100 mL standard measuring flask and place a funnel over it.
- Transfer it to the 100 mL standard flask and make up to 100 mL using distilled water.

### **8.6.2 TESTING OF SAMPLE**

- Rinse the burette with 0.02N sodium hydroxide and then discard the solution.
- Fill the burette with 0.02N sodium hydroxide and adjust the burette.
- Fix the burette to the stand.
- A sample size is chosen as the titre value does not exceed 20mL of the titrant. For highly concentrated samples, dilute the sample. Usually, take 100 mL of a given sample in a conical flask using pipette.
- Add few drops of methyl orange indicator in the conical flask.
- The colour changes to orange. Now titrate the sample against the 0.02N sodium hydroxide solution until the orange colour faints.
- Note down the volume ( $V_1$ ) consumed for titration 0.4mL. This volume is used for calculating the mineral acidity.
- To the same solution in the conical flask add few drops of phenolphthalein indicator.
- Continue the titration, until the colour changes to faint pink colour.
- Note down the total volume ( $V_2$ ) consumed for titration 2.3 mL. This volume is used for calculating the total acidity.
- Repeat the titration for concordant values.

## 8.7 CALCULATION

### 8.7.1 TABLE

Table -1 Mineral Acidity:

Sl.No.	Volume of Sample (mL)	Burette Reading (mL)		Volume of NaOH (mL)
		Initial	Final	
1.				
2.				
3.				

**Burette Solution:** Sodium Hydroxide

**Pipette Solution:** Sample

**Indicator:** Methyl Orange

**End Point:** Faint of Orange Color

For the calculation of Mineral Acidity:

- The Sodium Hydroxide is taken in the burette.
- For the First titration the volume of water sample taken is 100 mL. The initial reading is 00, the final reading is 0.5 mL.
- The volume of NaOH consumed to get the end point is 0.5mL.
- For Second titration the volume of water sample taken is 100 mL. The initial reading is 00, the final reading is 0.4mL.
- The volume of NaOH consumed to get the end point is 0.4 mL.
- For third titration the volume of water sample taken is 100mL. The initial reading is 00, the final reading is 0.4 mL.
- The volume of NaOH ( $V_1$ ) consumed to get the end point is 0.4 mL.
- For second and third titration the burette reading is same so we have achieved concordant values. We can go for the calculations.



**Table -2 Total Acidity:**

Sl.No.	Volume of Sample (mL)	Burette Reading (mL)		Volume of NaOH (mL)
		Initial	Final	
1.				
2.				
3.				

**Burette Solution:** Sodium Hydroxide

**Pipette Solution:** Sample

**Indicator:** Phenolphthalein

**End Point:** Faint Pink Color

For the calculation of Total Acidity:

- The Sodium Hydroxide is taken in the burette.
- For the First titration the volume of water sample taken is 100 mL. The initial reading is 00, the final reading is 2.2 mL.
- The volume of NaOH consumed to get the end point is 2.2 mL.
- For Second titration the volume of water sample taken is 100 mL. The initial reading is 00, the final reading is 2.3 mL.
- The volume of NaOH consumed to get the end point is 2.3 mL.
- For third titration the volume of water sample taken is 100 mL. The initial reading is 00, the final reading is 2.3 mL.
- The volume of NaOH ( $V_2$ ) consumed to get the end point is 2.3 mL.
- For second and third titration the burette reading is same so we have achieved concordant values. We can go for the calculations.

## 8.7.2 DATA SHEET

### DETERMINATION OF ACIDITY DATA SHEET

Date Tested : August 30, 2010  
Tested By : CEM Class, Group A  
Project Name : CEM, NITTTR Lab  
Sample Number : BH1  
Sample Location : Perungudi (Lat 12' 57'' 31.74 & Long 80'14'' 8.82)  
Sample Description : Surface water

Table - 1 for Mineral Acidity:

Sl.No.	Volume of Sample (mL)	Burette Reading (mL)		Volume of NaOH (mL)
		Initial	Final	
4.	100	0	0.5	0.5
5.	100	0	0.4	0.4
6.	100	0	0.4	0.4

Table - 2 for Total Acidity:

Sl.No.	Volume of Sample (mL)	Burette Reading (mL)		Volume of NaOH (mL)
		Initial	Final	
1.	100	0	2.2	2.2
2.	100	0	2.3	2.3
3.	100	0	2.3	2.3

Model Calculation:

Volume of NaOH for Mineral Acidity ( $V_1$ ) = 0.5 mL  
Volume of NaOH for Total Acidity ( $V_2$ ) = 8.3 mL  
Normality of Sulphuric Acid = 0.02 N  
Volume of Sample = 100.0 mL  
Equivalent weight of  $\text{CaCO}_3$  = 50

$$\text{Mineral Acidity} = \frac{\text{Volume of NaOH } (V_1) * N * 50 * 1000}{\text{Volume of sample taken}}$$

To convert the sample size from mL to L, multiply the result by 1,000 mL/L

$$\begin{aligned}\text{Mineral Acidity as CaCO}_3 \text{ equivalent (mg/L)} &= 0.4 \times 0.02 \times 50 \times 1000/100 \\ &= 4 \text{ mg/L as CaCO}_3 \text{ equivalent}\end{aligned}$$

$$\text{Total Acidity} = \frac{\text{Volume of NaOH (V}_2) * N * 50 * 1000}{\text{volume of sample taken}}$$

To convert the sample size from mL to L, multiply the result by 1,000 mL/L

$$\begin{aligned}\text{Total Acidity as CaCO}_3 \text{ equivalent (mg/L)} &= 2.3 \times 0.02 \times 50 \times 1000/100 \\ &= 23 \text{ mg/L as CaCO}_3 \text{ equivalent}\end{aligned}$$

## 8.8 INTERPRETATION OF RESULTS

The Mineral Acidity as  $\text{CaCO}_3$  equivalent is = **4 mg/L**

The Total Acidity as  $\text{CaCO}_3$  equivalent is = **23 mg/L**.

## 8.9 INFERENCE

Acidity is a measure of an aggregate property of water and can be interpreted in terms of specific substances only when the chemical composition of the sample is known. Acidity may contribute to corrosiveness and influence chemical reaction rates, chemical speciation and biological process. The measurement also reflects a change in the quality of the source water. Strong mineral acids, weak acids such as carbonic acid, acetic acid and hydrolyzing salts such as iron or aluminum sulphates may contribute to the measured acidity

## 8.10 EVALUATION

1. Acidity is \_\_\_\_\_.

- a) Base neutralizing capacity
- b) Acid neutralizing capacity
- c) Quantity of acid present
- d) Quality of acid present

2. An Indicator is a substance that facilitate colour change at the end point.

- a) True
- b) False

3. The indicators used in the titration are

- a) Methyl orange and phenolphthalein
- b) Methyl red and phenolphthalein
- c) Methyl orange and Methyl red
- d) Bromocresol green and Methyl red

4. To prepare 100 mL of 0.02 N of NaOH from 1 N NaOH, dilute \_\_\_\_\_ of NaOH.

- a) 20 mL
- b) 2 mL
- c) 0.2 mL
- d) 0.02 mL

5. The major acidic component of surface water is

- a) Dissolved oxygen
- b) Dissolved carbon dioxide
- c) Dissolved sulphur dioxide
- d) Dissolved nitrous oxide

6. The end point determination in titration will be based on the \_\_\_\_\_.

- a) Temperature
- b) Hardness
- c) Residual Chlorine
- d) Conductivity

7. The methyl orange acidity is at pH \_\_\_\_\_.

- a) 3.7
- b) 3.9
- c) 4.5
- d) 4.7

8. The phenolphthalein acidity is at pH is 8.3

- a) 8.3
- b) 9.3
- c) 4.3
- d) 7.3

9. For dilution purposes, \_\_\_\_\_ type of distilled water is used.

- a) Organic free
- b) CO<sub>2</sub> free
- c) O<sub>2</sub> free
- d) Ordinary

10. Acidity can be electrometrically measured by \_\_\_\_\_

- a) pH meter
- b) Conductivity meter
- c) Turbidity meter
- d) Spectrometer

## KEY TO ITEMS:

- 1) a
- 2) True
- 3) a
- 4) b
- 5) b
- 6) c
- 7) a
- 8) a
- 9) b
- 10) a