TESTING & ANALYSIS OF WATER AND WASTE WATER IN INDIA

Principles, Methods and Laboratory Techniques

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BlueRose ONE .com
Stories Matter
NewDelhi • London

BLUEROSE PUBLISHERS
India | U.K.

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ISBN: 978-81-6744-356-4

Cover design: Deepak Katheria
Typesetting: Manisha Rawat

First Edition: August 2026

Preface

As in first edition, the general objective of this book is to survey the practical method of the analysis and testing of water and waste water in india. Emphasis is placed on the possibilities limitations inherent in the various methods.

It Is difficult to decide what to include and what to omit. The word 'analytical' is not amenable to its practices. I have attempted to include just enough analytical methods in the areas in which these can be useful.

With respect to detailed coverage, I have tried to be led primarily by usefulness in practical methods in laboratory to check the purity of water and waste water in north india. Thus it is assumed the analytical methods have been treated in daily routine purposes.

The aim is to provide a typical methods possessing some special features of interest, not to write a complete catalog of analytical procedures.

I wish to express my sincere appreciation to my colleagues and students over the years, who have offered advice. Particularly thanks go to those who helped me in writing and encouraging me for this book. I am greatly indebted also to the personnel of publishing company and distributers, without whose cooperation the book could not be a success.

Some of the work on this edition was performed from my personal experiences in different scientific laboratory in different place in north india and I wish to acknowledge the use of scientific liabrary other facilities in laboratory during my stay here.

Introduction

Water is one of the most essential natural resources for sustaining life, supporting ecosystems, agriculture, industry, and human development. The quality of water directly affects public health, environmental sustainability, and economic growth. Rapid urbanization, industrialization, and population growth have increased the pressure on water resources, making regular monitoring and analysis of water and wastewater an important environmental responsibility.

Water and wastewater analysis involves the examination of physical, chemical, biological, and microbiological parameters to assess water quality and determine its suitability for drinking, domestic, industrial, agricultural, and environmental purposes. Accurate testing helps identify pollutants, evaluate treatment processes, ensure compliance with regulatory standards, and protect aquatic ecosystems and public health.

This book provides practical guidance on water and wastewater testing procedures commonly used in environmental laboratories. It covers laboratory safety practices, sample collection and preservation, preparation of reagents and standards, analytical methods for major water quality parameters, heavy metal analysis, microbiological testing, instrument operation, quality assurance, and result interpretation.

The procedures described are based on standard methods recommended by organizations such as the American Public Health Association (APHA), the Bureau of Indian Standards (BIS), and other recognized environmental agencies. Emphasis is placed on accuracy, precision, proper calibration, quality control, and safe laboratory practices, which are essential for obtaining reliable analytical results.

This book is intended for students, researchers, laboratory analysts, environmental scientists, engineers, and professionals involved in water quality monitoring and wastewater management. It serves as a

practical reference for understanding analytical techniques and maintaining high standards in environmental laboratory operations.

Ultimately, effective water and wastewater analysis contributes to pollution control, sustainable water resource management, regulatory compliance, and the protection of human health and the environment.

Contents

Testing and Analysis of Water & Wastewater

Water and wastewater testing involves collecting samples and analyzing them to determine their physical, chemical, and biological characteristics. The results help assess water quality, ensure compliance with environmental regulations, and evaluate treatment process performance.

1. Objectives of Water and Wastewater Analysis

Determine suitability of water for drinking, industrial, agricultural, or recreational use.

Monitor pollution levels in wastewater.

Evaluate efficiency of water and wastewater treatment plants.

Ensure compliance with environmental standards and regulations.

Protect public health and aquatic ecosystems.

2. Physical Parameters

These parameters describe the observable characteristics of water.

Parameter Parameter	Significance Significance	Common Method
Temperature	Affects chemical reactions andbiological activity	Thermometer
Color	Indicates dissolved substances or contamination	Visual/Colorimeter
Turbidity	Measures suspended particles	Nephelometer

Odour & Taste	Indicates contamination	Sensory evaluation
Total Solids (TS)	Overall solid content	Gravimetric method
Total Dissolved Solids(TDS)	Dissolved minerals and salts	Conductivity meter
Total Suspended Solids	Suspended particles	Filtration and weighing

Parameter	Desirable Limit
pH	6.5–8.5
TDS	500 mg/L
Hardness	200 mg/L
Chloride	250 mg/L
Fluoride	1.0 mg/L
Nitrate	45 mg/L
E. coli	Absent

3. Chemical Parameters

General Water Quality

pH: Indicates acidity or alkalinity.

Alkalinity: Water's buffering capacity.

Acidity: Ability to neutralize bases.

Electrical Conductivity (EC): Indicates dissolved ionic content.

Hardness: Due to calcium and magnesium salts.

Oxygen-Related Parameters

Dissolved Oxygen (DO): Essential for aquatic life.

Biochemical Oxygen Demand (BOD): Oxygen required by microorganisms todecompose organic matter.

Chemical Oxygen Demand (COD): Oxygen equivalent required for chemical oxidationof pollutants.

Nutrients

Ammonia (NH_3)

Nitrite (NO_2^-)

Nitrate (NO_3^-)

Phosphate (PO_4^{3-})

Major Ions

Chloride

Sulfate

Fluoride

Sodium

Potassium

Heavy Metals

Lead (Pb)

Cadmium (Cd)

Chromium (Cr)

Mercury (Hg)

Arsenic (As)

Common instruments include spectrophotometers, titration setups, flame photometers,and atomic absorption spectrometers (AAS).

4. Biological/Microbiological Parameters

Indicator Organisms

Total Coliforms

Fecal Coliforms

Escherichia coli (E. coli)

Pathogens

Bacteria

Viruses

Protozoa

Helminths

Common Methods

Multiple Tube Fermentation (MPN)

Membrane Filtration

Plate Count Method

Molecular techniques (PCR)

5. Important Wastewater Tests

BOD Test

Measures biodegradable organic matter.

Standard incubation: 5 days at 20°C.

Unit: mg/L.

COD Test

Measures total chemically oxidizable matter.

Faster than BOD.

Unit: mg/L.

TSS Test

Indicates particulate pollution.

Important for treatment plant performance monitoring.

Oil and Grease

Determined by solvent extraction methods.

6. Sampling Procedures

Select representative sampling locations.

Use clean and sterilized containers.

Preserve samples when required.

Label samples properly.

Transport to the laboratory promptly.

Types of samples:

Grab sample

Composite sample

7. Standard Methods and Guidelines

Common standards include:

American Public Health Association Standard Methods for the Examination of Waterand Wastewater.

World Health Organization drinking water guidelines.

Bureau of Indian Standards IS 10500 for drinking water quality in India.

Central Pollution Control Board wastewater discharge standards.

8. Typical Drinking Water Standards (Examples)

Conclusion

Water and wastewater analysis combines physical, chemical, and microbiological testing to assess quality, monitor pollution, and ensure safe water use. Key tests such as pH, DO,BOD, COD, TDS, and microbial analysis are fundamental for environmental engineering, public health, and treatment plant operation.

Testing of Water Quality Parameters

Water quality testing involves analyzing **physical, chemical, and biological parameters** to determine whether water is suitable for drinking, domestic, industrial, or agricultural use.

1. Physical Parameters

Parameter	Purpose	Test Method
Temperature	Affects chemical and biological reactions	Thermometer
Color	Indicates dissolved organic matter or contamination	Visual comparison/Colorimeter
Odor	Detects contamination	Sensory test
Turbidity	Measures suspended particles	Nephelometer (NTU)
Total Solids (TS)	Total suspended and dissolved matter	Gravimetric method
Total Dissolved Solids (TDS)	Dissolved salts and minerals	TDS meter
Total Suspended Solids (TSS)	Suspended particles	Filtration and weighing

2. Chemical Parameters

pH

- Measures acidity or alkalinity.
- Tested using a pH meter.
- Acceptable range for drinking water: **6.5–8.5**.

Alkalinity

- Indicates buffering capacity.
- Determined by acid titration.

Acidity

- Measures acid content.
- Determined by base titration.

Hardness

- Caused by calcium and magnesium ions.
- Measured by EDTA titration.

Chloride

- High levels affect taste and corrosion.
- Determined by argentometric titration.

Sulfate

- Excess amounts may cause scaling and taste issues.
- Measured using spectrophotometric methods.

Fluoride

- Beneficial in small amounts; harmful in excess.
- Measured using ion-selective electrodes or spectrophotometry.

Nitrate

- High concentrations may cause health problems.
- Measured using UV spectrophotometry.

Iron and Manganese

- Cause staining and taste problems.
- Determined using spectrophotometry or atomic absorption spectroscopy.

3. Oxygen-Related Parameters

Dissolved Oxygen (DO)

- Essential for aquatic life.
- Measured by DO meter or Winkler method.

Biochemical Oxygen Demand (BOD)

- Measures biodegradable organic pollution.
- Standard test: 5 days incubation.

Chemical Oxygen Demand (COD)

- Measures chemically oxidizable pollutants.
- Determined using dichromate digestion method.

4. Microbiological Parameters

Parameter	Significance	Test Method
Total Coliform	Indicator of contamination	MPN or Membrane Filtration
Fecal Coliform	Indicates fecal pollution	MPN Method
Escherichia coli	Indicates recent fecal contamination	Membrane Filtration/PCR

Drinking Water Requirement

- Total coliform: Absent
- E. coli: Absent

5. Heavy Metal Analysis

Metal	Common Method
Lead (Pb)	Atomic Absorption Spectroscopy (AAS)
Cadmium (Cd)	AAS
Chromium (Cr)	AAS/ICP-OES
Mercury (Hg)	Cold Vapor AAS
Arsenic (As)	AAS/ICP-MS

6. Sampling Procedure

1. Use clean, sterilized sampling bottles.
2. Collect representative samples.
3. Label with date, time, and location.
4. Preserve samples if required.
5. Analyze as soon as possible.

7. Important Drinking Water Standards

According to Bureau of Indian Standards IS 10500:

Parameter	Acceptable Limit
pH	6.5–8.5
Turbidity	1 NTU (desirable)
TDS	500 mg/L
Total Hardness	200 mg/L
Chloride	250 mg/L
Fluoride	1.0 mg/L
Nitrate	45 mg/L
Iron	0.3 mg/L
E. coli	Absent

Conclusion

Testing water quality involves measuring **physical parameters (turbidity, TDS, temperature), chemical parameters (pH, hardness, chloride, nitrate, fluoride), oxygen-related parameters (DO, BOD, COD), microbiological indicators (coliforms, E. coli), and heavy metals**. The results are compared with standards such as **BIS IS 10500** to determine the suitability of water for drinking and other uses.

Monitoring of Pollution Levels in Wastewater in North India

Overview

North India faces significant wastewater pollution challenges due to rapid urbanization, industrial growth, population increase, and inadequate sewage treatment infrastructure. Major river systems affected include the Ganga River, Yamuna River, Ghaghara River, and Ramganga River.

Key Pollution Sources

Domestic sewage

Untreated municipal wastewater.

Open drains discharging into rivers.

Industrial effluents

Tanneries, textile industries, paper mills, sugar mills, distilleries, and chemicalplants.

Heavy metals and toxic chemicals.

Agricultural runoff

Fertilizers and pesticides entering water bodies.

Solid waste dumping

Plastics and organic waste entering drains and rivers.

Monitoring Parameters

Physical Parameters

Temperature

Turbidity

Total Suspended Solids (TSS)

Total Dissolved Solids (TDS)

Chemical Parameters

pH

Dissolved Oxygen (DO)

Biochemical Oxygen Demand (BOD)

Chemical Oxygen Demand (COD)

Nitrate and Phosphate

Heavy metals (Cr, Pb, Cd, Hg)

Microbiological Parameters

Total Coliform

Fecal Coliform

Escherichia coli

Current Status in North India

Yamuna River (Delhi–Haryana Region)

The Yamuna remains one of the most polluted rivers in North India due to sewagedischarge and industrial effluents. According to government data, Delhi generates about3,596 MLD of sewage, while approximately 641 MLD remained untreated and entered theriver system in 2025. Monitoring focuses on BOD, DO, and fecal coliform levels.

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Ganga Basin

Large-scale monitoring under the Namami Gange Programme and the National WaterQuality Monitoring Programme (NWMP) tracks

wastewater pollution throughout UttarPradesh, Uttarakhand, Bihar, and West Bengal. Additional sewage treatment capacityexceeding 500 MLD was added during FY 2025–26 to reduce wastewater discharge intothe river system.

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Polluted River Stretches

The Central Pollution Control Board identified 296 polluted river stretches across Indiabased on BOD levels. Although conditions have improved compared with 2018, severalstretches in North India continue to show high organic pollution due to untreatedwastewater discharges.

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Monitoring Agencies

Central Pollution Control Board (CPCB)

National Mission for Clean Ganga (NMCG)

State Pollution Control Boards (SPCBs)

Urban Local Bodies and Municipal Corporations

Monitoring Methods

Laboratory Analysis

APHA standard methods

Spectrophotometry

Titration methods

Atomic Absorption Spectroscopy (AAS)

Field Monitoring

Portable water quality meters

Automatic monitoring stations

Remote sensing and GIS mapping

Biological Monitoring

Coliform testing

Aquatic biodiversity assessment

Bio-indicator species studies

Challenges

Insufficient sewage treatment capacity.

Illegal industrial discharge.

Poor operation and maintenance of STPs.

Rapid urban expansion.

Lack of continuous real-time monitoring in some regions.

Recommendations

Expand sewage treatment infrastructure.

Install real-time water quality monitoring systems.

Strengthen industrial effluent regulation.

Promote wastewater reuse and recycling.

Increase monitoring frequency at pollution hotspots.

Improve public awareness and community participation.

Conclusion

Monitoring of wastewater pollution in North India primarily relies on indicators such as BOD, COD, DO, nutrients, heavy metals, and microbial contamination. While recent data show improvements in several river stretches due to increased sewage treatment capacity and pollution-control programs, untreated sewage and industrial effluents remain major contributors to water pollution, particularly in the Yamuna and Ganga basins.

Evaluation of Efficiency of Water and Wastewater Treatment Plants in North India

The efficiency of a water or wastewater treatment plant is evaluated by comparing the quality of influent (incoming water) and effluent (treated water) and determining the percentage removal of contaminants.

Objectives

- Assess treatment performance.
- Ensure compliance with discharge and drinking-water standards.
- Identify operational problems.
- Optimize treatment processes.
- Protect public health and the environment.

Key Performance Indicators (KPIs)

For Water Treatment Plants (WTPs)

Parameter	Purpose
Turbidity Removal	Measures filtration efficiency
pH	Indicates chemical balance
TDS	Assesses dissolved solids removal
Residual Chlorine	Verifies disinfection effectiveness
Total Coliform/E. coli	Confirms microbiological safety

Efficiency Calculation

$$
\text{Removal Efficiency (\%)} = \frac{\text{Influent} - \text{Effluent}}{\text{Influent}} \times 100
$$

Example:

- Raw water turbidity = 100 NTU
- Treated water turbidity = 2 NTU

$$
\text{Efficiency} = \frac{100-2}{100}\times100 = 98\%
$$

For Wastewater Treatment Plants (WWTPs)

Important Parameters

Parameter	Significance
BOD	Organic pollution
COD	Total oxidizable matter
TSS	Suspended solids
Total Nitrogen	Nutrient pollution
Total Phosphorus	Eutrophication potential
Fecal Coliform	Pathogen indicator

Typical Expected Removal Efficiencies

Parameter	Good Performance
BOD	85–95%
COD	70–90%
TSS	85–95%
Fecal Coliform	>99% after disinfection

Evaluation Methods

Physical Evaluation

- Flow measurement
- Sludge production
- Turbidity monitoring
- Settling tests

Chemical Evaluation

- pH analysis
- DO measurement
- BOD and COD tests
- Nutrient analysis

Biological Evaluation

- Coliform testing
- Activated sludge microscopic examination
- Biomass activity assessment

Status in North India

Delhi (Yamuna Basin)

Several sewage treatment plants have improved wastewater quality before discharge into the Yamuna River, but performance varies because of hydraulic overloading, sewer connectivity gaps, and maintenance issues. Major parameters monitored include BOD, COD, TSS, and fecal coliform.

Uttar Pradesh

Cities such as Kanpur, Varanasi, and Prayagraj have expanded wastewater treatment infrastructure under the National Mission for Clean Ganga. Treatment efficiency is generally evaluated through

reductions in BOD and coliform levels before discharge into the Ganga.

Haryana and Punjab

Municipal wastewater treatment plants commonly use activated sludge processes, sequencing batch reactors (SBR), and oxidation ponds. Performance assessment focuses on compliance with standards established by the Central Pollution Control Board.

Factors Affecting Treatment Efficiency

Technical Factors

- Hydraulic overloading
- Inadequate aeration
- Equipment malfunction
- Poor sludge management

Operational Factors

- Insufficient skilled operators
- Irregular maintenance
- Power interruptions
- Improper chemical dosing

Environmental Factors

- Seasonal flow variations
- High industrial pollutant loads
- Stormwater infiltration

Performance Assessment Example

Parameter	Influent (mg/L)	Effluent (mg/L)	Removal Efficiency
BOD	250	20	92%
COD	500	80	84%
TSS	300	25	91.7%

These values indicate a well-performing wastewater treatment plant.

Recommendations for North India

1. Upgrade aging treatment infrastructure.
2. Increase real-time water quality monitoring.
3. Improve sewer network connectivity.
4. Strengthen industrial pretreatment requirements.
5. Adopt energy-efficient treatment technologies.
6. Enhance operator training and maintenance programs.
7. Promote treated wastewater reuse for irrigation and industry.

Conclusion

The efficiency of water and wastewater treatment plants in North India is evaluated through removal of contaminants such as turbidity, BOD, COD, TSS, nutrients, and pathogens. Well-operated plants typically achieve **85–95% BOD removal and 85–95% TSS removal**, while drinking-water treatment plants should consistently produce water meeting drinking-water standards. Continuous monitoring, infrastructure upgrades, and improved operation and maintenance are essential for sustaining treatment performance in the region.

Environmental Standards and Regulations for Water and Wastewater in India

Environmental standards and regulations are legal requirements established to protect human health, water resources, and ecosystems from pollution. In India, these standards are primarily enforced by the Central Pollution Control Board (CPCB), State Pollution Control Boards, and the Ministry of Environment, Forest and Climate Change (MoEFCC).

1. Major Environmental Acts

Water (Prevention and Control of Pollution) Act, 1974

- Prevents and controls water pollution.
- Establishes CPCB and State Pollution Control Boards.
- Requires industries to obtain consent before discharging wastewater.

Environment (Protection) Act, 1986

- Umbrella legislation for environmental protection.
- Empowers the central government to prescribe environmental standards.

Air (Prevention and Control of Pollution) Act, 1981

- Controls air pollution from industries and other sources.

National Green Tribunal Act, 2010

- Establishes the National Green Tribunal for environmental dispute resolution.

2. Drinking Water Standards

The Bureau of Indian Standards specifies drinking-water quality requirements under **IS 10500**.

Important Limits

Parameter	Acceptable Limit
pH	6.5–8.5
TDS	500 mg/L
Total Hardness	200 mg/L
Chloride	250 mg/L
Fluoride	1.0 mg/L
Nitrate	45 mg/L
Iron	0.3 mg/L
E. coli	Absent

3. Wastewater Discharge Standards

Industries and sewage treatment plants must comply with CPCB discharge standards.

General Standards for Inland Surface Water Discharge

Parameter	Maximum Limit
pH	5.5–9.0
BOD (3 days, 27°C)	30 mg/L
COD	Typically regulated sector-wise
Total Suspended Solids (TSS)	100 mg/L
Oil and Grease	10 mg/L

4. Water Quality Criteria for Rivers

CPCB classifies river water according to its best designated use.

Class	Intended Use
A	Drinking water source without conventional treatment
B	Outdoor bathing
C	Drinking water source after conventional treatment
D	Wildlife and fisheries
E	Irrigation and industrial cooling

Example Criteria for Class C Water

- pH: 6.0–9.0
- DO: ≥ 4 mg/L
- BOD: ≤ 3 mg/L

5. Irrigation Water Standards

Commonly based on guidelines from the Food and Agriculture Organization (FAO).

Key Parameters

- Electrical Conductivity (EC)
- Sodium Adsorption Ratio (SAR)
- Residual Sodium Carbonate (RSC)
- Boron concentration
- Chloride concentration

6. Industrial Effluent Standards

Specific industries have sector-wise discharge limits, including:

- Textile industries
- Tanneries
- Distilleries
- Paper and pulp mills
- Sugar industries

- Thermal power plants

Parameters monitored include:

- BOD
- COD
- TSS
- Heavy metals
- Oil and grease
- Toxic chemicals

7. Environmental Monitoring Requirements

Industries and treatment plants are generally required to:

- Conduct periodic water-quality monitoring.
- Maintain effluent treatment plants (ETPs) or sewage treatment plants (STPs).
- Submit compliance reports to pollution-control authorities.
- Install online continuous monitoring systems where mandated.

8. Standards Commonly Used in Research

- American Public Health Association Standard Methods for Examination of Water and Wastewater.
- World Health Organization Guidelines for Drinking-water Quality.
- International Organization for Standardization environmental and laboratory standards.
- CPCB and BIS standards for Indian conditions.

Importance of Compliance

Environmental standards help:

- Protect public health.
- Prevent contamination of rivers, lakes, and groundwater.
- Maintain agricultural productivity.

- Support sustainable industrial development.
- Reduce ecological damage and biodiversity loss.

For a project, dissertation, or research study on **water and wastewater treatment plants in North India**, the most frequently cited standards are **BIS IS 10500 (Drinking Water Standards)**, **CPCB Effluent Discharge Standards**, and **APHA Standard Methods for Water and Wastewater Analysis**.

Determination of pH

Definition

pH is a measure of the acidity or alkalinity of a solution. It is defined as:

pH=−log⁡[H+]\boxed{\text{pH} = -\log [\text{H}^+]}pH=−log[H+]

where [H+][H^+][H+] is the hydrogen ion concentration in moles per liter (mol/L).

Methods for Determining pH

1. **Using Indicator Paper (Litmus or Universal Indicator)**
   - Dip the indicator paper into the solution.
   - Compare the color obtained with the standard color chart.
   - Estimate the pH value.
2. **Using pH Indicator Solutions**
   - Add a few drops of a suitable indicator (e.g., phenolphthalein, methyl orange, universal indicator) to the solution.
   - Observe the color change and compare it with the indicator chart to determine the pH.
3. **Using a pH Meter (Most Accurate Method)**
   - Calibrate the pH meter using standard buffer solutions.
   - Rinse the electrode with distilled water and immerse it in the test solution.
   - Wait until the reading stabilizes and record the pH displayed.

pH Scale

- **pH < 7:** Acidic solution
- **pH = 7:** Neutral solution (pure water)

- **pH > 7:** Basic (alkaline) solution

The pH meter provides the most precise and reliable measurement of pH, while indicator papers and solutions are suitable for approximate determination.

Determination of Acidity is the process of measuring the amount of acid present in a substance

Determination of Acidity is the process of measuring the amount of acid present in a substance. It is commonly done by **acid-base titration**.

Principle

The acid in the sample is neutralized by a standard alkali solution (usually sodium hydroxide, NaOH). The endpoint is detected using an appropriate indicator such as phenolphthalein.

Procedure

1. Measure a known volume of the sample into a conical flask.
2. Add 2–3 drops of a suitable indicator.
3. Fill a burette with standard NaOH solution.
4. Titrate until the indicator changes color, indicating the endpoint.
5. Record the volume of NaOH used.

Calculation

The acidity is calculated using:

N1V1=N2V2N_1V_1 = N_2V_2N1V1=N2V2

Where:

- N1N_1N1 = Normality of the acid
- V1V_1V1 = Volume of the acid
- N2N_2N2 = Normality of the NaOH
- V2V_2V2 = Volume of the NaOH used

Acidity may be expressed as a percentage of a specific acid (e.g., citric acid, acetic acid, or lactic acid), depending on the sample.

Applications

- Food and beverage quality control
- Water quality analysis
- Pharmaceutical testing
- Chemical and industrial process monitoring

If you meant **determination of acidity in a specific sample** (such as milk, fruit juice, vinegar, wine, or water), let me know and I can provide the specific procedure and calculation.

Yesterday 3:24 PM

Determination of basicity in water

Determination of Basicity (Alkalinity) in Water

Aim

To determine the **basicity (alkalinity)** of a water sample by titration with a standard acid.

Principle

Basicity (alkalinity) is due to the presence of **hydroxides (OH^-), carbonates (CO_3^{2-}), and bicarbonates (HCO_3^-)** in water. These are neutralized by a standard acid (usually H_2SO_4 or HCl). The endpoint is detected using indicators.

Apparatus

- Burette
- Pipette
- Conical flask
- Measuring cylinder

Reagents

- Standard 0.02 N sulfuric acid (H_2SO_4) or hydrochloric acid (HCl)
- Phenolphthalein indicator
- Methyl orange indicator

Procedure

- Pipette **100 mL** of the water sample into a conical flask.
- Add **2–3 drops of phenolphthalein**.
- If the solution turns pink, titrate with standard acid until the pink color disappears. Record the volume (**P alkalinity**).

- Add **2–3 drops of methyl orange** to the same flask.
- Continue titration until the color changes from yellow to orange/red. Record the total volume of acid used (**T alkalinity**).

Calculation

Total Alkalinity (as CaCO3, mg/L)=A×N×50,000V\text{Total Alkalinity (as CaCO}_3\text{, mg/L)} = \frac{A \times N \times 50{,}000}{V}Total Alkalinity (as CaCO3, mg/L)=VA×N×50,000

Where:

- **A** = Volume of acid used (mL)
- **N** = Normality of acid
- **V** = Volume of water sample (mL)

Result

Report the alkalinity (basicity) of the water sample as **mg/L (ppm) as $CaCO_3$**.

Determination of Hardness of Water (EDTA Method)

Aim

To determine the **total hardness of a water sample** by the EDTA titration method.

Principle

Hardness in water is mainly caused by **calcium (Ca^{2+})** and **magnesium (Mg^{2+})** ions. These ions react with **EDTA (Ethylenediaminetetraacetic acid)** to form stable complexes. In the presence of **Eriochrome Black T (EBT)** indicator at **pH 10**, the solution changes from **wine red to blue** at the end point.

Apparatus

- Burette
- Pipette
- Conical flask
- Measuring cylinder

Reagents

- Standard EDTA solution (0.01 M)
- Ammonia-ammonium chloride buffer solution (pH 10)
- Eriochrome Black T (EBT) indicator

Procedure

1. Pipette **50 mL** of the water sample into a conical flask.
2. Add **1–2 mL of buffer solution (pH 10)**.
3. Add **2–3 drops of EBT indicator**. The solution turns **wine red**.

4. Fill the burette with standard EDTA solution.
5. Titrate until the color changes from **wine red to pure blue**.
6. Record the volume of EDTA used.

Calculation

Total Hardness (as CaCO3, mg/L)=A×M×100,000V\text{Total Hardness (as CaCO}_3\text{, mg/L)} = \frac{A \times M \times 100{,}000}{V}Total Hardness (as CaCO3, mg/L)=VA×M×100,000

Where:

- **A** = Volume of EDTA used (mL)
- **M** = Molarity of EDTA
- **V** = Volume of water sample (mL)

For **0.01 M EDTA** and a **50 mL sample**:

Hardness (mg/L as CaCO3)=A×20\text{Hardness (mg/L as CaCO}_3) = A \times 20Hardness (mg/L as CaCO3)=A×20

Result

Report the **total hardness of the water sample as mg/L (ppm) as $CaCO_3$**.

Determination of chlorides

Determination of Chlorides in Water (Mohr's Method)

Aim

To determine the **chloride content** of a water sample by **Mohr's argentometric titration method**.

Principle

Chloride ions (Cl^-) react with **standard silver nitrate ($AgNO_3$)** solution to form a white precipitate of **silver chloride (AgCl)**. After all chloride ions have reacted, the first excess of silver ions reacts with **potassium chromate (K_2CrO_4)** indicator to form a **reddish-brown precipitate of silver chromate (Ag_2CrO_4)**, indicating the end point.

Apparatus

- Burette
- Pipette
- Conical flask

Reagents

- Standard silver nitrate ($AgNO_3$) solution (0.0141 N)
- Potassium chromate (K_2CrO_4) indicator (5%)

Procedure

1. Pipette **50 mL** of the water sample into a conical flask.
2. Add **1 mL (2–3 drops)** of potassium chromate indicator.
3. Fill the burette with standard $AgNO_3$ solution.
4. Titrate until the color changes from **yellow to a permanent reddish-brown**.
5. Record the volume of $AgNO_3$ used.

Calculation

Chlorides (mg/L as Cl−)=A×N×35.45×1000V\text{Chlorides (mg/L as Cl}^-)= \frac{A \times N \times 35.45 \times 1000}{V}Chlorides (mg/L as Cl−)=VA×N×35.45×1000

Where:

- **A** = Volume of $AgNO_3$ used (mL)
- **N** = Normality of $AgNO_3$
- **V** = Volume of water sample (mL)

For **0.0141 N $AgNO_3$** and a **50 mL sample**:

Chlorides (mg/L)=A×10\text{Chlorides (mg/L)} = A \times 10Chlorides (mg/L)=A×10

Result

Report the **chloride concentration of the water sample as mg/L (ppm) of Cl^-**.

Determination of total Dissolved acids

It appears you mean **Determination of Total Dissolved Solids (TDS)**, since "Total Dissolved Acids" is not a standard water quality parameter.

Determination of Turbidity

Definition

Turbidity is the cloudiness or haziness of water caused by suspended particles such as clay, silt, organic matter, and microorganisms.

Methods of Determination

1. Nephelometric Method (Most Common)

- Instrument used: **Nephelometer (Turbidity Meter)**
- Principle: Measures the intensity of light scattered at **90°** by suspended particles in the sample.
- Unit: **NTU (Nephelometric Turbidity Unit)**

Procedure:

1. Calibrate the nephelometer using standard turbidity solutions.
2. Fill a clean sample cell with the water sample.
3. Wipe the outside of the cell to remove fingerprints and water droplets.
4. Place the cell in the instrument.
5. Record the turbidity reading directly in NTU.

2. Jackson Candle Turbidimeter (Older Method)

- Principle: Turbidity is determined by observing the disappearance of a candle flame through a water column.
- Unit: **JTU (Jackson Turbidity Unit)**

Significance

- Indicates water quality and effectiveness of filtration.
- High turbidity may harbor pathogens and reduce disinfection efficiency.

- Drinking water generally should have turbidity below **5 NTU**, and preferably below **1 NTU**.

Precautions

- Use clean and scratch-free sample cells.
- Avoid air bubbles in the sample.
- Analyze samples as soon as possible after collection.

Result: Turbidity is reported as **NTU** using a nephelometer or **JTU** using a Jackson candle turbidimeter.

Determination of Total Dissolved Solids (TDS)

Aim

To determine the **Total Dissolved Solids (TDS)** present in a water sample by the gravimetric method.

Principle

A filtered water sample is evaporated to dryness in a pre-weighed dish. The residue left after evaporation and drying represents the **total dissolved solids**. The increase in the weight of the dish is used to calculate TDS.

Apparatus

- Evaporating dish
- Hot plate or water bath
- Drying oven (103–105°C)
- Desiccator
- Analytical balance
- Filter paper

Procedure

1. Clean, dry, and weigh the evaporating dish (W_1).
2. Filter the water sample to remove suspended solids.
3. Measure **100 mL** of the filtered sample into the dish.
4. Evaporate the sample to dryness.
5. Dry the dish in an oven at **103–105°C** for about **1 hour**.
6. Cool the dish in a desiccator and weigh it (W_2).
7. Repeat drying and weighing until a constant weight is obtained.

Calculation

TDS (mg/L)=(W2−W1)×1000×1000V\text{TDS (mg/L)}=\frac{(W_2-W_1)\times1000\times1000}{V}TDS (mg/L)=V(W2−W1)×1000×1000

Where:

- $\mathbf{W_1}$ = Weight of empty dish (g)
- $\mathbf{W_2}$ = Weight of dish + residue (g)
- **V** = Volume of sample (mL)

For a **100 mL** sample:

TDS (mg/L)=(W2−W1)×106\text{TDS (mg/L)}=(W_2-W_1)\times10^6TDS (mg/L)=(W2−W1)×106

(where the weight difference is in grams).

Result

Report the **Total Dissolved Solids (TDS)** of the water sample as **mg/L (ppm)**.

OCC

Determination of Chemical Oxygen Demand (COD)

Aim

To determine the Chemical Oxygen Demand (COD) of a water sample.

Principle

COD is the amount of oxygen required to chemically oxidize the organic matter present in water using a strong oxidizing agent, usually **potassium dichromate ($K_2Cr_2O_7$)** in acidic medium. The excess dichromate remaining after digestion is titrated with **ferrous ammonium sulfate (FAS)**.

Apparatus:

- COD digestion flask/reflux apparatus
- Burette, pipettes, conical flask
- Heating mantle or COD digester

Reagents:

- Standard potassium dichromate ($K_2Cr_2O_7$) solution
- Concentrated sulfuric acid (H_2SO_4) containing silver sulfate catalyst
- Mercuric sulfate ($HgSO_4$) (to remove chloride interference)
- Ferrous ammonium sulfate (FAS) solution
- Ferroin indicator

Procedure:

1. Pipette **50 mL** of the water sample into a COD flask.
2. Add **1 g mercuric sulfate** and mix.
3. Add **5 mL potassium dichromate** solution.

4. Carefully add **15 mL sulfuric acid–silver sulfate reagent**.
5. Reflux the mixture for **2 hours**.
6. Cool the solution and dilute with distilled water.
7. Add **2–3 drops of ferroin indicator**.
8. Titrate the excess dichromate with standard **FAS** until the color changes from **blue-green to reddish-brown**.
9. Perform a blank determination in the same manner.

Calculation:

COD (mg/L)=(A−B)×N×8000V\text{COD (mg/L)}=\frac{(A-B)\times N\times 8000}{V}COD (mg/L)=V(A−B)×N×8000

Where:

- **A** = Volume of FAS used for the blank (mL)
- **B** = Volume of FAS used for the sample (mL)
- **N** = Normality of FAS
- **V** = Volume of sample (mL)

Result:
The Chemical Oxygen Demand (COD) of the given water sample is **_____ mg/L**.

Precautions:

- Handle concentrated sulfuric acid with care.
- Ensure complete reflux for 2 hours.
- Use clean glassware and perform a blank determination.
- Mercuric sulfate should be used to minimize chloride interference.

Determination of Biological Oxygen Demand (BOD)

Aim

To determine the Biological Oxygen Demand (BOD) of a water sample over **5 days at 20°C (BOD_5)**.

Principle

BOD is the amount of dissolved oxygen consumed by microorganisms while decomposing biodegradable organic matter in water under aerobic conditions. It is determined by measuring the dissolved oxygen (DO) before and after incubating the sample for 5 days at 20°C.

Apparatus:

- BOD bottles (300 mL)
- DO meter or Winkler titration apparatus
- Incubator maintained at 20°C
- Pipettes and measuring cylinder

Reagents:

- Dilution water (oxygen-saturated)
- Phosphate buffer solution
- Magnesium sulfate solution
- Calcium chloride solution
- Ferric chloride solution
- Seed microorganisms (if required)

Procedure:

1. Prepare dilution water by adding the nutrient solutions and saturating it with oxygen.

2. Dilute the water sample appropriately if necessary.
3. Fill two BOD bottles with the diluted sample without trapping air bubbles.
4. Measure the initial dissolved oxygen (DO_1) in one bottle.
5. Incubate the second bottle at **20°C for 5 days** in the dark.
6. After 5 days, measure the final dissolved oxygen (DO_2).
7. Calculate the BOD.

Calculation:

BOD5 (mg/L)=(DO1−DO2)×Dilution Factor\text{BOD}_5 \, (\text{mg/L}) = (DO_1 - DO_2) \times \text{Dilution Factor}BOD5 (mg/L)=(DO1−DO2)×Dilution Factor

Where:

- **DO_1** = Initial dissolved oxygen (mg/L)
- **DO_2** = Final dissolved oxygen after 5 days (mg/L)

Result:
The Biological Oxygen Demand (BOD_5) of the given water sample is **_____ mg/L**.

Precautions:

- Avoid air bubbles while filling the BOD bottles.
- Incubate at **20°C** in complete darkness.
- Use clean, contamination-free glassware.
- Analyze DO immediately before and after incubation.

CCCCC

Determination of Fecal Coliform in Water and Wastewater

Aim

To determine the presence and number of **Fecal Coliform bacteria** in a water or wastewater sample using the **Most Probable Number (MPN) Method** or **Membrane Filtration Method**.

Principle

Fecal coliform bacteria are a subgroup of total coliforms that originate from the intestines of humans and warm-blooded animals. They ferment lactose and produce acid and gas at an elevated temperature of **44.5 ± 0.2°C**.

Their presence indicates recent fecal contamination and a potential risk of disease-causing microorganisms.

Method 1: Most Probable Number (MPN) Method

Apparatus Required

- Incubator
- Water bath (44.5 ± 0.2°C)
- Durham tubes
- Test tubes
- Pipettes
- Sterile sample bottles

Media Required

1. Lauryl Tryptose Broth (LTB)
2. EC Broth (Escherichia coli Broth)
3. Brilliant Green Lactose Bile Broth (optional)

4. Sterile distilled water

Procedure

Step 1: Presumptive Test

1. Inoculate lactose broth tubes with:
   - 10 mL sample
   - 1 mL sample
   - 0.1 mL sample
2. Incubate at **35–37°C for 24–48 hours**.
3. Observe gas production in Durham tubes.

Positive tubes are used for confirmation.

Step 2: Confirmed Fecal Coliform Test

1. Transfer a loopful from each positive presumptive tube into EC broth.
2. Incubate in a water bath at **44.5 ± 0.2°C for 24 hours**.
3. Observe gas production.

Positive Result

Gas production in EC broth confirms fecal coliform bacteria.

Observation Table

Sample Volume	Positive Tubes
10 mL	
1 mL	
0.1 mL	

Example:

Sample Volume	Positive Tubes
10 mL	5
1 mL	4
0.1 mL	2

MPN Combination = **5-4-2**

Determine the value from standard MPN tables.

Calculation

Fecal Coliform Count=MPN Index per 100 mL\text{Fecal Coliform Count} = \text{MPN Index per 100 mL}Fecal Coliform Count=MPN Index per 100 mL

Results are reported as:

MPN/100 mL\text{MPN/100 mL}MPN/100 mL

Method 2: Membrane Filtration Method

Principle

A known volume of water is filtered through a **0.45 µm membrane filter**, which retains bacteria. The filter is then incubated on selective media at elevated temperature.

Procedure

1. Filter **100 mL** of sample through a sterile membrane filter.
2. Place membrane on m-FC agar or equivalent selective medium.
3. Incubate at **44.5°C for 24 hours**.
4. Count characteristic blue colonies.

Calculation

Fecal Coliform (CFU/100 mL)=Number of Colonies×100Volume Filte red (mL)\text{Fecal Coliform (CFU/100 mL)} = \frac{\text{Number of Colonies} \times 100} {\text{Volume Filtered (mL)}}Fecal Coliform (CFU/100 mL)=Volume Filtered (mL)Number of Colonies×100

Example:

- Colonies counted = 45
- Volume filtered = 100 mL

Fecal Coliform=45 CFU/100 mL\text{Fecal Coliform} = 45 \, \text{CFU/100 mL}Fecal Coliform=45CFU/100 mL

Significance

Fecal coliforms indicate:

- Recent sewage contamination.
- Animal waste contamination.
- Potential presence of pathogens.

Important fecal coliform organisms include:

- Escherichia coli
- Klebsiella pneumoniae (occasionally)

Drinking Water Standard

According to Bureau of Indian Standards IS 10500:

Parameter	Requirement
Fecal Coliform	Absent in 100 mL

The ideal result for drinking water is:

0 MPN/100 mL0 \, \text{MPN/100 mL}0MPN/100 mL

Precautions

1. Use sterile sampling bottles.
2. Analyze samples as soon as possible (preferably within 6 hours).
3. Maintain incubation temperature at **44.5 ± 0.2°C**.
4. Avoid contamination during handling.
5. Use properly sterilized media and equipment.

Result

Fecal Coliform Count in the given water/wastewater sample = _____ MPN/100 mL (or CFU/100 mL by membrane filtration method).

Escheriachia coli

Enzyme-Substrate Method (Rapid Method)

Principle

E. coli produces the enzyme **β-glucuronidase**, which reacts with specific substrates to produce fluorescence or color.

Procedure

1. Add reagent to sample.
2. Incubate according to instructions.
3. Observe fluorescence under UV light.

Significance

E. coli is considered the most reliable indicator of:

- Recent fecal contamination.
- Sewage pollution.
- Potential presence of pathogens such as:
  - Salmonella
  - Shigella
  - Vibrio cholerae

Drinking Water Standard

According to Bureau of Indian Standards IS 10500:

Parameter	Requirement
E. coli	Absent in 100 mL

Acceptable result:

0 CFU/100 mL0 \, \text{CFU/100 mL}0CFU/100 mL

or

0 MPN/100 mL0 \, \text{MPN/100 mL}0MPN/100 mL

Precautions

1. Use sterile equipment and media.
2. Analyze samples promptly (preferably within 6 hours).
3. Maintain proper incubation temperature.
4. Avoid contamination during filtration and handling.
5. Use quality-control cultures for validation.

Result

E. coli count in the given water/wastewater sample = _____ CFU/100 mL (or MPN/100 mL).

Interpretation

E. coli Count	Water Quality
0 CFU/100 mL	Safe for drinking
1–10 CFU/100 mL	Indicates contamination
>10 CFU/100 mL	Unsatisfactory water quality
High counts	Strong evidence of fecal pollution

Preparations of reagents and standards used in water analysis

Determination of *Escherichia coli* (E. coli) in Water and Wastewater

Aim

To detect and enumerate **Escherichia coli (E. coli)** in water and wastewater samples.

Principle

E. coli is a specific indicator of **fecal contamination**. Its presence suggests contamination by human or animal waste and indicates a potential risk of pathogenic microorganisms.

E. coli can be detected by:

1. **Membrane Filtration (MF) Method –** most common.
2. **Most Probable Number (MPN) Method.**
3. Enzyme-substrate methods (e.g., Colilert).
4. Molecular methods (PCR).

Method 1: Membrane Filtration Method

Apparatus Required

- Membrane filtration unit
- Sterile membrane filters (0.45 μm)
- Vacuum pump
- Incubator
- Sterile forceps
- Petri dishes

Media Required

- m-FC agar

- Chromogenic E. coli agar (e.g., Chromocult agar)
- Sterile dilution water

Procedure

Sample Filtration

1. Mix the sample thoroughly.
2. Filter **100 mL** of water through a sterile 0.45 µm membrane filter.
3. Using sterile forceps, place the membrane on the selective culture medium.

Incubation

1. Incubate at:
   - 44.5 ± 0.2°C for fecal E. coli detection.
   - Or according to the medium manufacturer's instructions.
2. Incubate for 18–24 hours.

Colony Counting

1. Observe characteristic colonies.
2. Count E. coli colonies.

Typical appearance:

- Blue colonies on chromogenic media.
- Blue-black colonies on m-FC media (depending on medium used).

Calculation

E. coli (CFU/100 mL)=Number of Colonies×100Volume Filtered (mL) \text{E. coli (CFU/100 mL)} = \frac{\text{Number of Colonies} \times 100} {\text{Volume Filtered (mL)}}E. coli (CFU/100 mL)=Volume Filtered (mL)Number of Colonies×100

Example

- Colonies counted = 12
- Volume filtered = 100 mL

E. coli=12 CFU/100 mL\text{E. coli} = 12 \, \text{CFU/100 mL}E. coli=12CFU/100 mL

Method 2: MPN Method

Procedure

Presumptive Test

1. Inoculate lactose broth tubes with sample.
2. Incubate at 35–37°C.
3. Observe gas production.

Confirmed Test

1. Transfer positive cultures to EC broth.
2. Incubate at **44.5°C**.
3. Observe gas formation.

Completed Test

1. Streak positive cultures onto selective agar.
2. Incubate for 24 hours.
3. Confirm typical E. coli colonies using biochemical tests.

Biochemical Confirmation Tests

Test	E. coli Result
Indole Test	Positive
Methyl Red Test	Positive
Voges-Proskauer Test	Negative
Citrate Utilization Test	Negative

This pattern is often called the **IMViC pattern (++--)**.

Enzyme-Substrate Method (Rapid Method)

Principle

E. coli produces the enzyme **β-glucuronidase**, which reacts with specific substrates to produce fluorescence or color.

Procedure

1. Add reagent to sample.
2. Incubate according to instructions.
3. Observe fluorescence under UV light.

Significance

E. coli is considered the most reliable indicator of:

- Recent fecal contamination.
- Sewage pollution.
- Potential presence of pathogens such as:
  - Salmonella
  - Shigella
  - Vibrio cholerae

Drinking Water Standard

According to Bureau of Indian Standards IS 10500:

Parameter	Requirement
E. coli	Absent in 100 mL

Acceptable result:

0 CFU/100 mL0 \, \text{CFU/100 mL}0CFU/100 mL

or

0 MPN/100 mL0 \, \text{MPN/100 mL}0MPN/100 mL

Precautions

1. Use sterile equipment and media.
2. Analyze samples promptly (preferably within 6 hours).
3. Maintain proper incubation temperature.
4. Avoid contamination during filtration and handling.
5. Use quality-control cultures for validation.

Result

E. coli count in the given water/wastewater sample = _____ CFU/100 mL (or MPN/100 mL).

Interpretation

E. coli Count	Water Quality
0 CFU/100 mL	Safe for drinking
1–10 CFU/100 mL	Indicates contamination
>10 CFU/100 mL	Unsatisfactory water quality
High counts	Strong evidence of fecal pollution

Preparations of reagents and standards used in water analysis

General Laboratory Instructions and Precautions for Water & Wastewater Analysis

1. Personal Safety

- Always wear a **lab coat, safety goggles, and gloves**.
- Wear closed-toe shoes in the laboratory.
- Tie back long hair and avoid loose clothing.
- Do not eat, drink, or smoke in the laboratory.
- Wash hands thoroughly after handling chemicals and samples.

2. Sample Collection and Handling

- Use clean, contamination-free sampling bottles.
- Label all samples properly with:
  - Sample ID
  - Location
  - Date and time of collection
  - Analyst name
- Preserve samples according to standard methods.
- Analyze samples as soon as possible after collection.
- Store samples at **4°C** when required.

3. Glassware Precautions

- Use clean and dry glassware.
- Rinse glassware with distilled water before use.
- For trace metal analysis, use acid-washed glassware.
- Check glassware for cracks or damage before use.
- Avoid touching the inside surfaces of containers and pipettes.

4. Reagent Preparation

- Use only analytical reagent (AR) grade chemicals.
- Use distilled or deionized water for reagent preparation.
- Prepare reagents according to standard procedures.
- Label reagents with:
  - Name
  - Concentration
  - Date of preparation
  - Expiry date
- Store reagents in appropriate containers.

5. Instrument Handling

pH Meter

- Calibrate daily using standard buffer solutions.
- Rinse electrode with distilled water before and after use.

Conductivity Meter

- Calibrate using standard KCl solution.
- Ensure the probe is clean and free from deposits.

Spectrophotometer

- Warm up the instrument before use.
- Use clean cuvettes.
- Avoid fingerprints on optical surfaces.

Flame Photometer

- Use filtered samples.
- Ensure a stable gas supply.
- Run standards before analyzing samples.

AAS/ICP Instruments

- Use properly digested samples.
- Run blanks and standards regularly.
- Follow instrument-specific operating procedures.

6. Chemical Handling

- Read chemical labels and safety information before use.
- Never pipette by mouth; use pipette fillers.
- Add acid to water, never water to acid.
- Handle concentrated acids and alkalis carefully.
- Store incompatible chemicals separately.

7. Microbiological Analysis Precautions

- Maintain aseptic conditions.
- Use sterile glassware and media.
- Sterilize equipment before and after use.
- Avoid contamination during sample handling.
- Incubate cultures at specified temperatures.

8. Quality Control Measures

- Run reagent blanks with every batch of samples.
- Analyze standards and calibration solutions regularly.
- Perform duplicate analyses when required.
- Maintain calibration records.
- Record all observations immediately.

9. Waste Disposal

- Dispose of chemical wastes according to laboratory guidelines.
- Collect heavy-metal wastes separately.
- Autoclave microbiological wastes before disposal.

- Never pour hazardous chemicals directly into sinks.
- Use designated waste containers.

10. Emergency Procedures

Chemical Spill

- Inform the laboratory supervisor immediately.
- Use appropriate spill kits.
- Neutralize acids or alkalis if trained to do so.

Fire

- Know the location of fire extinguishers.
- Switch off gas and electrical equipment if safe.
- Follow emergency evacuation procedures.

Chemical Exposure

- Flush affected area with water for at least 15 minutes.
- Seek medical attention if necessary.
- Report all accidents immediately.

Good Laboratory Practices (GLP)

1. Follow standard operating procedures (SOPs).
2. Keep the work area clean and organized.
3. Record data neatly in laboratory notebooks.
4. Calibrate instruments regularly.
5. Verify calculations before reporting results.
6. Maintain chain-of-custody records for samples.
7. Follow APHA, BIS, and regulatory guidelines.
8. Never report results without proper verification.

Important Rule

Accuracy, cleanliness, proper calibration, and safety are the four pillars of a good water and wastewater laboratory.

Preparation of Common Reagents and Standards Used in Water and Wastewater Analysis

The following reagent preparations are widely used according to APHA, BIS, and standard environmental laboratory practices.

1. Standard Silver Nitrate Solution (0.0141 N)

Used For:

- Chloride determination (Mohr Method)

Preparation

1. Dry analytical-grade silver nitrate at 105°C.
2. Weigh **2.395 g $AgNO_3$**.
3. Dissolve in distilled water.
4. Transfer to a 1 L volumetric flask.
5. Make up to 1 L with distilled water.

Store in an amber bottle.

2. Potassium Chromate Indicator (5%)

Used For:

- Chloride analysis

Preparation

1. Dissolve **5 g K_2CrO_4** in distilled water.
2. Dilute to **100 mL**.

Store in a dark bottle.

3. EDTA Solution (0.01 M)

Used For:

- Total hardness determination

Preparation

1. Weigh 3.723 g disodium EDTA ($Na_2H_2Y \cdot 2H_2O$).
2. Dissolve in distilled water.
3. Dilute to 1 L.

4. Eriochrome Black T Indicator

Used For:

- Hardness determination

Preparation

1. Mix:
   - 0.5 g Eriochrome Black T
   - 100 g sodium chloride (NaCl)

Store in an airtight bottle.

5. Ammonia Stock Standard Solution (1000 mg/L NH_3-N)

Used For:

- Ammonia analysis

Preparation

1. Dry ammonium chloride (NH_4Cl).
2. Weigh **3.819 g NH_4Cl**.
3. Dissolve and dilute to **1 L**.

6. Nessler Reagent

Used For:

- Ammonia determination

Preparation

Contains:

- Mercuric iodide (HgI_2)
- Potassium iodide (KI)
- Potassium hydroxide (KOH)

Usually purchased commercially due to toxicity and preparation complexity.

7. Nitrate Stock Standard (1000 mg/L NO_3^-)

Used For:

- Nitrate determination

Preparation

1. Dry potassium nitrate (KNO_3).
2. Weigh **1.631 g KNO_3**.
3. Dissolve and dilute to **1 L**.

8. Nitrite Stock Standard (1000 mg/L NO_2^-)

Used For:

- Nitrite determination

Preparation

1. Weigh 1.500 g $NaNO_2$.
2. Dissolve and dilute to 1 L.

9. Sulfanilamide Reagent

Used For:

- Nitrite analysis

Preparation

1. Dissolve **10 g sulfanilamide**.
2. Add **100 mL concentrated HCl**.
3. Dilute to **1 L** with distilled water.

10. NED Reagent

Used For:

- Nitrite analysis

Preparation

1. Dissolve **0.5 g N-(1-naphthyl)ethylenediamine dihydrochloride**.
2. Dilute to **500 mL**.

Store in a dark bottle.

11. Phosphate Stock Standard (1000 mg/L PO_4^{3-}-P)

Used For:

- Phosphate determination

Preparation

1. Dry KH_2PO_4.
2. Weigh **4.393 g KH_2PO_4**.
3. Dissolve and dilute to **1 L**.

12. Ascorbic Acid Reagent

Used For:

- Phosphate determination

Preparation

1. Dissolve **1.76 g ascorbic acid**.
2. Dilute to **100 mL**.

Prepare fresh daily.

13. Fluoride Stock Standard (1000 mg/L F^-)

Used For:

- Fluoride analysis

Preparation

1. Dry sodium fluoride (NaF).
2. Weigh **2.210 g NaF**.
3. Dissolve and dilute to **1 L**.

14. Sodium Standard Solution (1000 mg/L Na^+)

Used For:

- Flame photometer calibration

Preparation

1. Dry sodium chloride (NaCl).
2. Weigh **2.542 g NaCl**.
3. Dissolve and dilute to **1 L**.

15. Potassium Standard Solution (1000 mg/L K^+)

Used For:

- Flame photometer calibration

Preparation

1. Dry potassium chloride (KCl).
2. Weigh **1.907 g KCl**.
3. Dissolve and dilute to **1 L**.

16. Chromium Standard Solution (1000 mg/L Cr)

Used For:

- Chromium analysis

Preparation

1. Weigh **2.829 g potassium dichromate ($K_2Cr_2O_7$)**.
2. Dissolve and dilute to **1 L**.

17. Lead Standard Solution (1000 mg/L Pb)

Used For:

- Lead analysis

Preparation

1. Dissolve **1.599 g lead nitrate [$Pb(NO_3)_2$]**.
2. Add a few drops of nitric acid.
3. Dilute to **1 L**.

18. Cadmium Standard Solution (1000 mg/L Cd)

Used For:

- Cadmium analysis

Preparation

1. Dissolve **2.744 g cadmium nitrate tetrahydrate**.
2. Dilute to **1 L**.

19. Mercury Standard Solution (1000 mg/L Hg)

Used For:

- Mercury analysis

Preparation

1. Dissolve **1.354 g mercuric chloride ($HgCl_2$)**.
2. Add nitric acid.
3. Dilute to **1 L**.

Handle with extreme care.

20. Conductivity Standard (0.01 M KCl)

Used For:

- Calibration of conductivity meter

Preparation

1. Dry potassium chloride.
2. Weigh **0.7456 g KCl**.
3. Dissolve and dilute to **1 L**.

Expected conductivity at 25°C:

- **1413 µS/cm**

Important Laboratory Practices

- Use analytical reagent (AR) grade chemicals.
- Use distilled or deionized water.
- Label all reagents with preparation date and expiry date.
- Store light-sensitive reagents in amber bottles.

- Standardize titrants before use.
- Follow APHA Standard Methods and BIS laboratory guidelines.

Common Stock Standards Used in Water Laboratories

Parameter	Stock Concentration
Ammonia	1000 mg/L
Nitrate	1000 mg/L
Nitrite	1000 mg/L
Phosphate	1000 mg/L
Fluoride	1000 mg/L
Sodium	1000 mg/L
Potassium	1000 mg/L
Chromium	1000 mg/L
Lead	1000 mg/L
Cadmium	1000 mg/L
Mercury	1000 mg/L

These stock solutions are then diluted to prepare working standards for calibration curves in routine water and wastewater analysis.

Instructions and precautions taken in laboratory