K.S. SCHOOL OF ENGINEERING AND MANAGEMENT, BANGALORE – 560109
No.15, Mallasandra, Off. Kanakapura Road, Bengaluru-560109,
Affiliated to VTU, Belagavi & Approved by AICTE, New Delhi.

DEPARTMENT OF CIVIL ENGINEERING

V SEMESTER

ENVIRONMENTAL ENGINEERING LABORATORY MANUAL

BCV504

ACADEMIC YEAR: 2024 - 2025

NAME OF THE STUDENT: ____________________________

UNIVERSITY SEAT NO. :____________________________

BATCH :____________________________

FACULTY :____________________________

K S SCHOOL OF ENGINEERING AND MANAGEMENT

Holiday Village Road, Vajarahalli Village, Mallasandra, off, Kanakapura Rd,
Bengaluru, Karnataka 560109

VISION

To impart quality education in engineering and management to meet technological business and societal needs through holistic education and research.

MISSION

K. S. School of Engineering and Management shall,

- Establish state-of-art infrastructure to facilitate effective dissemination of technical and managerial knowledge.
- Provide comprehensive educational experience through a combination of curricular and experiential learning, strengthened by industry-institute interaction.
- Pursue socially relevant research and disseminate knowledge.
- Inculcate leadership skills and foster entrepreneurial spirit among students.

DEPARTMENT OF CIVIL ENGINEERING

VISION

To emerge as one of the leading Civil Engineering Department by producing competent and quality ethical engineers with strong foot hold in the areas of Infrastructure development and research.

MISSION

- Provide industry oriented academic training with strong fundamentals and applied skills.
- Engage in research activities in Civil Engineering and allied fields and inculcate the desired perception and value system in the students.

SYLLABUS

Course Title: Environmental Engineering Laboratory
As per Choice Based Credit System (CBCS) scheme
SEMESTER:V

Subject Code	BCV504	IA Marks	50
Teaching Hours/Week (L:T:P)	(0:2:2)	Exam Marks	50
Total Number of Lecture Hours	40	Exam Hours	03
CREDITS –01		Total Marks- 100	

Course objectives: This course will enable students,

1. To learn different methods of water & waste water quality
2. To conduct experiments to determine the concentrations of water and waste water
3. To determine the degree and type of treatment
4. To understand the environmental significance and application in environmental engineering practice

Experiments	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
1. .Preparation chemical solutions required for analysis and sampling methodologies	02 Class	L1,L2,L3
2. Determination of pH, Conductivity, TDS and Turbidity	02 Class	L1,L2,L3
3. Determination of Acidity and Alkalinity	02 Class	L1,L2,L3
4. Determination of Calcium, Magnesium and Total Hardness	02 Class	L1,L2,L3
5. Determination of Dissolved Oxygen	01 Class	L1,L2,L3
6. Determination of BOD	01 Class	L1,L2,L3
7. Determination of Chlorides	01 Class	L1,L2,L3
8. Determination of percentage of % of available chlorine in bleaching powder sample, Determination of Residual Chlorine and chlorine demand	02 Class	L1,L2,L3
9. Determination of Solids in Sewage: i) Total Solids, ii) Suspended Solids, iii) Dissolved Solids, iv)Volatile Solids, Fixed Solids v) Settleable Solids	02 Class	L1,L2,L3
10. Determination of optimum coagulant dosage using Jar test apparatus	01Class	L1,L2,L3
11. Determination Nitrates and Iron by spectrophotometer	02 Class	L1,L2,L3
12. Determination of COD(Demonstration)	Demonstration	L1,L2,L3
13. Air Quality Monitoring (Demonstration)	Demonstration	L1,L2,L3
14. Determination of Sound by Sound level meter at different locations (Demonstration)	Demonstration	L1,L2,L3

Course Outcomes: After studying this course, students will be able to:

1. Acquire capability to conduct experiments and estimate the concentration of different parameters.
2. Compare the result with standards and discuss based on the purpose of analysis.
3. Determine type of treatment, degree of treatment for water and wastewater.
4. Identify the parameter to be analyzed for the student project work in environmental stream.

Program Objectives:

1. Evaluation of the test results and assesses the impact on water and waste water treatment.
2. Train student to undertake student project work in 8th semester in the field of environmental engineering.

Question paper pattern:

Two experiments shall be asked from the above set
One experiment to be conducted and for the other student should write detailed procedure

Reference Books:

1. Lab Manual, ISO 14001 Environmental Management, Regulatory Standards for Drinking Water and Sewage disposal
2. Clair Sawyer and Perry McCarty and Gene Parkin, “Chemistry for Environmental Engineering and Science”
, McGraw-Hill Series in Civil and Environmental Engineering

INSTRUCTIONS

1. This laboratory manual is ONLY for reference for those using the environmental engineering laboratory.

2. Discussion after each experiment should be based on the following points:

   (a) Limit prescribed for that constituent in drinking water standards.

   (b) The suitability of the sample for drinking purpose with respect to that particular constituent.

3. To Note:

   (a) In water and wastewater analysis, the results are usually reported in terms of mg/l of some particular ion, element or compound. It is most convenient to have the standard titrating agent of such strength, that 1mL is equivalent to 1mg of material being measured. Thus 1 litre of the standard solution is usually equivalent to 1g of the standard substance.

   (b) Rules listed by Worthing and Geffner are to be followed while plotting graphs.

4. Users may refer the following for writing the discussion after each experiment:

   (a) ―Standard Methods for the Examination of Water and Waste Water‖, American Public Health Association, 1015, 15th Street, N.W., Washington D.C., 2005.

   (b) ―Chemistry for Environmental Engineers‖, Sawyer and McCarty, Tata McGraw Hill.

   (c) ―Manual of Standards of Quality for Drinking Water Supplies‖, Indian Council of Medical Research, New Delhi.

   (d) ―International Standards for Drinking Water―World Health Organization.

   (e) ―IS 2490 - 1981, IS 3306 - 1974, IS 3307 - 19 77, IS 7968 - 1976, IS 2296 – 1974‖, Bureau of Indian Standards, New Delhi.

DOS AND DONOT'S IN THE LABORATORY

1. Do thoroughly clean the glassware before and after use.
2. Do handle the glassware carefully.
3. Do not handle chemicals with bare hands.
4. Do not blow out the last drop from the pipette. When the liquid has drained out completely, touch the tip of the pipette to the inner surface of the vessel.
5. Do not add water to acids. Do always add acid to water.
6. Do use large volumes of water, when a person is splashed with acid to prevent serious burns.
7. Do weigh the articles in a balance only at room temperature.
8. Do use different pipette for different reagents.
9. Do not pipette out acids and other toxic reagents by mouth.
10. Do read the level of the curve (meniscus), in all volumetric glassware, with the eye at approximately the same level as the curve of solution.
11. Always prohibit eating, drinking, or smoking near samples, sampling locations, and in the laboratory.

INTRODUCTION

Water that is available in nature is not fit drinking or domestic purposes. Hence, it has to be treated and made fit for domestic purposes. To be fit for domestic purposes the physical, chemical and bacteriological characteristic of the water should not exceed the permissible limits. Permissible limit are those values which if present in excessive amounts and present in water which is consumed, cause physiological problems to the human beings. The permissible limits are shown in the table 1

Indian Standard 10500: 2012

DRINKING WATER QUALITY STANDARDS

Sl. No.	**Characteristic**	**Acceptable Limit (Required)**	**Permissible Limit (in absence of Alternate Source)**
	Physical Characteristics		
1	Colour, Hazen units, Max	5	15
2	Odour	Agreeable	Agreeable
3	pH value	6.5-8.5	No Relaxation
4	Taste	Agreeable	Agreeable
5	Turbidity, NTU, Max	1	5
6	Total Dissolved Solids, mg/l, Max	500	2000
	Chemical Characteristics		
7	Aluminium (as Al), mg/l, Max	0.03	0.2
8	Ammonia (as total ammonia-N), mg/l, Max	0.5	No Relaxation
9	Anionic detergents (as MBAS), mg/l, Max	0.2	1.0
10	Barium (as Ba), mg/l, Max	0.7	No Relaxation
11	Boron (as B), mg/l, Max	0.7	No Relaxation
12	Calcium (as Ca), mg/l, Max	75	200
13	Chloramines (as Cl2), mg/l, Max	4.0	No Relaxation
14	Chloride (as Cl), mg/l, Max	250	1000
15	Copper (as Cu), mg/l, Max	0.05	1.5
16	Fluoride (as F) mg/l, Max	1.0	1.5

17	Free residual chlorine, mg/l, Min	0.2	1
18	Iron (as Fe), mg/l, Max	0.3	No Relaxation
19	Magnesium (as Mg), mg/l, Max	30	100
20	Manganese (as Mn), mg/l, Max	0.1	0.3
21	Mineral oil, mg/l, Max	0.5	No Relaxation
22	Nitrate (as NO_3), mg/l, max	45	No Relaxation
23	Phenolic compounds (as C_6H_5OH), mg/l, Max	0.001	0.002
24	Selenium (as Se), mg/l, Max	0.01	No Relaxation
25	Silver (as Ag), mg/l, Max	0.1	No Relaxation
26	Sulphate (as SO_4) mg/l, Max	200	400
27	Sulphide (as H_2S), mg/l, Max	0.05	No Relaxation
28	Total Alkalinity as calcium carbonate, mg/l, Max	200	600
29	Total Hardness as($CaCO_3$), mg/l, Max	200	600
30	Zinc (as Zn), mg/l, Max	5	15
Toxic Substances			
32	Cadmium (as Cd), mg/l, Max	0.003	No Relaxation
33	Cyanide (as CN), mg/l, Max	0.05	No Relaxation
34	Lead (as Pb), mg/l, Max	0.01	No Relaxation
35	Mercury (as Hg), mg/l, Max	0.001	No Relaxation
36	Molybdenum (as Mo), mg/l, Max	0.07	No Relaxation
37	Nickel (as Ni), mg/l, Max	0.02	No Relaxation
38	Polychlorinated biphenyls, mg/l, Max	0.0005	No Relaxation
39	Polynuclear aromatic hydrocarbons (as PAH), mg/l, Max	0.0001	No Relaxation
40	Total Arsenic (as As), mg/l, Max	0.01	0.05
41	Total chromium (as Cr), mg/l, Max	0.05	No Relaxation
42	Trihalomethanes:		No Relaxation
	a. Bromoform, mg/l, Max	0.1	No Relaxation
	b. Dibromochloromethane, mg/l, Max	0.1	No Relaxation
	c. Bromodichloromethane, mg/l, Max	0.06	No Relaxation

	d. Chloroform, mg/l, Max	0.2	No Relaxation
Bacteriological Characteristics			
43	All Water intended for drinking: a) E.coli or thermotolerant coliform bacteria	Shall not be detectable in any 100ml sample	
44	Treated water entering the distribution system a) E.coli or thermotolerant coliform bacteria b) Total coliform bacteria	Shall not be detectable in any 100ml sample	
45	Treated water in the distribution system a) E.coli or thermotolerant coliform bacteria b) Total coliform bacteria	Shall not be detectable in any 100ml sample	

The Environment (Protection) Rules, 1986
GENERAL STANDARDS FOR DISCHARGE OF ENVIRONMENTAL POLLUTANTS PART-A: EFFLUENTS

Sl. No.	**Parameter**	**Standards**			
		Inland surface water	**Public Sewers**	**Land for Irrigation**	**Marine coastal areas**
1	Colour and Odour	-	-	-	-
2	Suspended solids mg/l, Max	100	600	200	*For process waste water-100 *For cooling water effluent 10% above total suspended matter of influent.
3	Particulate size of suspended solids	Shall pass 850 microns IS sieve	-	-	*Floatable solids, max.3mm *Settleable solids, max.850microns.
4	pH value	5.5-9.0	5.5-9.0	5.5-9.0	5.5-9.0
5	Temperature	Shall not exceed 5^0C above the receiving water	-	-	Shall not exceed 5^0C above the receiving water temperature

		temperature			
6	Oil and Grease mg/l, Max	10	20	10	20
7	Total residual chlorine mg/l, Max	1.0	-	-	1.0
8	Ammonical nitrogen (as N), mg/l Max.	50	50	-	50
9	Total Kjeldahl Nitrogen (as NH_3) mg/l, Max	100	-	-	100
10	Free Ammonia (as NH_3) mg/l, Max	5.0	-	-	5.0
11	Biochemical Oxygen demand (3 days at 27^0C) NH_3) mg/l, Max	30	350	100	100
12	Chemical oxygen Demand, mg/l, Max	250	-	-	250
13	Arsenic (as As) mg/l, Max	0.2	0.2	0.2	0.2
14	Mercury (as Hg), mg/l, Max	0.01	0.01	-	0.01
15	Lead (as Pb) mg/l, Max	0.1	1.0	-	2.0
16	Cadmium (as Cd) mg/l, Max	2.0	1.0	-	2.0
17	Hexavalent chromium (as Cr+6) mg/l, Max	0.1	2.0	-	1.0
18	Total Chromium (as Cr) mg/l, Max	2.0	2.0	-	2.0
19	Copper (Cu) mg/l, Max	3.0	3.0	-	3.0
20	Zinc (as Zn) mg/l, Max	5.0	15	-	15
21	Selenium (as Se) mg/l, Max	0.05	0.05	-	0.05
22	Nickel (as Ni) mg/l, Max	3.0	3.0	-	5.0
23	Cyanide (as CN mg/l, Max	0.2	2.0	0.2	0.2
24	Fluoride (as F) mg/l, Max	2.0	15	-	15
25	Dissolved Phosphates (as P) mg/l, Max	5.0	-	-	-

26	Sulphide (as S) mg/l, Max	2.0	-	-	5.0
27	Phenoile compounds (as C_6H_5OH) mg/l, Max	1.0	5.0	-	5.0
28	Radioactive materials: a. Alpha emitter micro curie/ml b. Beta emitter micro curie/ml	10^{-7} 10^{-7}	10^{-7} 10^{-7}	10^{-8} 10^{-7}	10^{-7} 10^{-7}
29	Bio assay Test	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent
30	Manganese (as Mn) mg/l, Max	2	2	-	2
31	Iron (as Fe) mg/l, Max	3	3	-	3
32	Vanadium (as V) mg/l, Max	0.2	0.2	-	0.2
33	Nitrate Nitrogen mg/l, Max	10	-	-	20

Expt.No.1

DETERMINATION OF SOLIDS IN SEWAGE
(Total solids, Suspended solids, Dissolved solids, Volatile solids, fixed solids and Settleable solids)

Aim:

To determine various types of solids, present in a given sample of sewage.

Apparatus:

Evaporating dish, Gooch crucible, Burners, Hot air oven, muffle furnace, Imhoff cone, Desiccators.

Theory:

Solids can be defined as the substance that remains as the residue on evaporation and drying at definite temperature. Solids are present in both suspended and dissolved form in water Total Solids are those matters that are in suspension and dissolved form. The amount of suspended solids will be more in domestic sewage and industrial wastewater whereas dissolved solids renders the water unfit for drinking, agricultural and industrial purpose.

Principle:

Total Solids are determined as the residue left after evaporation and drying of the unfiltered sample.

Procedure:

1. A clean porcelain dish is ignited in a muffle furnace and after partial cooling in the air, it is cooled in a desiccator and weighed. Note down its weight W_1gms.
2. Fill the crucible with the wastewater sample of known quantity and place it on theburner and allow the water to evaporate completely and cool it in a desiccator.
3.Note down the final weight as W_2 gms.

$$\textbf{Total solids in } {}^{mg}/_{l} = \frac{\mathbf{W_2 - W_1}}{\textbf{ml of sample taken}} \times \mathbf{1000}$$

Total Dissolved Solids:

Total Dissolved Solids are the dissolved inorganic mineral matter in water.

Principle:

Total Dissolved Solids are determined as the residue left after evaporation and drying of the filtered sample.

Procedure:

1. A clean porcelain dish is ignited in a muffle furnace and after partial cooling in the air, it is cooled in a desiccator and weighed. Note down its weight W_1 gms.

2. Fill the crucible with the wastewater sample of known quantity after filtering it through the filter Paper and place it on the burner.

3. Allow the water to evaporate completely and cool it in desiccators. Note down the final weight as, W_3 gms.

$$\textbf{Total Dissolved solids in } {}^{mg}/_{l} = \frac{\mathbf{W_3 - W_1}}{\textbf{ml of sample taken}} \mathbf{8 \times 1000}$$

Settleable Solids:

Settleable Solids are those solids in suspension that settle down due to gravitational force under quiescent condition.

Principle:

The particles in suspension whose specific gravity greater than that of water will settle under quiescent condition.

Procedure:

1. Gently fill the Imhoff cone with thoroughly well mixed sample usually 1 liter and allow it to settle.

2. After 45 minutes, gently rotate the cone between hands to ensure that all solids adhering the sides are loosened.

3. Allow the solids to settle for 15minutes more to make up for a total period of 1 hour.

Note down the results by taking the graduation from bottom of Imhoff cone in ml/l of Settleable Solids.

$$\textbf{Total Settleable solids in } {}^{ml}/_{l} = \_\_\_\_\_\_ {}^{ml}/_{l}$$

Total Volatile and Fixed Solids:

Volatile solids are organic material which loses their weight on ignition at above 600^0Cand the remaining solids are the fixed solids which are considered as inorganic (mineral) matter.

Principle:

Total Volatile solids and fixed solids are determined as residue remaining after evaporation, drying at 103^0C and ignition at 600^0C in muffle furnace.

Procedure:

1. A clean porcelain dish is ignited in a muffle furnace and after partial cooling in the air; it is cooled in a desiccator and weighed. Note down its weight W_1 gms.
2. Fill the crucible with the wastewater sample of known quantity and place it on the burner and allow the water to evaporate completely and cool it in a desiccator. Note down the final weight as W_2 gms.
3. Now ignite the residue (total solids) left in the crucible allowing the crucible in a muffle furnace for 30 minutes at a temperature of 600^0C.
4. Cool it in a desiccator. Note down the final weight as W_4 gms.

$$\textbf{Total Volatile solids in } {}^{mg}/_{l} = \frac{W_2 - W_4}{\text{ml of sample taken}} \times 1000$$

$$\textbf{Total Fixed solids in } {}^{mg}/_{l} = \textbf{Total solids} - \textbf{Total Volatile solids}$$

Observation and Calculation:

1. $\mathbf{Total\ solids\ in}\ {}^{mg}/_{l} = \frac{W_2 - W_1}{\text{ml of sample taken}} \times 1000$

2. $\mathbf{Total\ Dissolved\ solids\ in}\ {}^{mg}/_{l} = \frac{W_3 - W_1}{\text{ml of sample taken}} \times 1000$

3. $\mathbf{Total\ Suspended\ solids\ in}\ {}^{mg}/_{l} = \mathbf{Total\ \ solids - Total\ Dissolved\ solids}$

4. $\mathbf{Total\ Settleable\ solids\ in}\ {}^{ml}/_{l} = \_\_\_\_\_\_\_\_ {}^{ml}/_{l}$

5. $\mathbf{Total\ Volatile\ solids\ in}\ {}^{mg}/_{l} = \frac{W_2 - W_4}{\text{ml of sample taken}} \times 1000$

6. $\mathbf{Total\ Fixed\ solids\ in}\ {}^{mg}/_{l} = \mathbf{Total\ \ solids - Total\ Volatile\ solids}$

Results:

1. Total Solids= ………mg/l
2. Total Dissolved Solids =………mg/l
3. Total Suspended Solids =………mg/l
4. Total Settleable Solids =………ml/l
5. Total Volatile Solids =………mg/l
6. Total Fixed Solids =………mg/l

Comments:

Environmental Significance of Solids:

1. Dissolved minerals, gases and organic constituents may produce aesthetically displeasing color, taste, and odor.
2. Some dissolved organic chemicals may deplete the dissolved oxygen in the receiving waters.
3. In industries, the use of water with high amount of dissolved solids may lead to scaling in boilers, corrosion and degraded quality of the productivity.

Application of Solids data in Environmental Engineering Practice:

1. The type of softening procedure used may be decided by the total solids content.
2. Estimation of total dissolved solids is useful to determine whether the water suitable for drinking purpose, agriculture and industrial purposes.
3. Volatile solids tests are normally applied to sludge. It is useful in the design and operation of sludge digester, vacuum filter and incineration plants.
4. Before development of COD test, it is used to find strength of industrial and domestic wastewater.
5. It is helpful in assessing the amount of biologically inert organic matter like lignin in case of wood pulping waste liquors.
6. Determination of Settleable solids is widely used in wastewater treatment plant operation to determine the efficiency of sedimentation units.
7. Suspended solids determination is extremely valuable in analysis of polluted waters. And to determine the strength of domestic wastewater.

Expt.No.2

DETERMINATION OF ELECTRICAL CONDUCTICITY

Aim:

To determine Electrical Conductivity of a given sample of water.

Apparatus:

Conductivity cell, Beakers.

Theory:

Conductivity of a solution is a measure of its ability to conduct an electrical current and varies with the numbers and type of ions the solution contains. Electrical conductivity indicates the amount of dissolved solids present in the water. Electrical conductivity directly varies with temperature of the sample; hence it is usually reported at 25˚C.

Irrigation water have been classified according to electrical conductivity data given in the following table.

Table: Classification of Irrigation waters

Conductivity in µmhos/cm	Category
250	Excellent
250-750	Good
750-2000	Permissible
2000-3000	Doubtful
3000	Unsuitable

Procedure:

Numerous conductivity cells are commercially available and using these the specific conductance of the sample can be recorded.

1. Take 50ml of the sample in the beaker.
2. Insert the electrode in the beaker.
3. Note the reading in the readout at 25 ˚C.

Observation and Tabulation:

Sl. No.	Description of sample	Conductivity in µmhos/cm

Results:

The Electrical Conductivity of a given sample is… ....µmhos/cm

Comments:

Environmental Significance of Electrical conductivity:

1. Conductivity is the measure of waters capability to pass electrical flow. This ability is directly related to the concentration of ions in the water. These conductive ions come from dissolved salts and inorganic materials such as alkalis, chlorides, sulfides and carbonate compounds.
2. Distilled water can act as an insulator due to its very low conductivity value. Sea water has a very high conductivity.

Applications of Electrical conductivity data in Environmental Engineering Practice:

1. Electrical conductivity measurements are often employed to monitor desalination plants.
2. It is useful to assess the source of pollution.
3. In coastal regions conductivity data can be used to decide the extent of intrusion of sea water into ground water.
4. Conductivity data is useful in determining the suitability of water and wastewater for disposal on land.
5. It is also used indirectly to find out the inorganic dissolved solids.

Expt.No.3

DETERMINATION OF CHLORIDES
(ARGENTOMETRIC METHOD)

Aim:

To determine Chloride Concentration in a given sample of water.

Apparatus:

250ml conical flask, volumetric flasks, pipette, burette.

Reagents:

Chloride free distilled water, Potassium chromate (K_2CrO_4), Standard Silver Nitrate ($AgNO_3$)

Theory:

Chloride is the major anion commonly found in all-natural waters and its concentration widely ranges from few milligrams to thousands of milligrams. Chloride concentration increases proportionality with mineral content. Fresh waters have low concentration of chlorides with comparison to marine waters. High concentration of chlorides in water are due to the anthropogenic activities such as discharge of sewage and industrial effluent; intrusion of sea water; leachates from Landfills etc. higher amount of chlorides causes a change in taste of drinking water, corrosion, and palatability. Chlorides are not harmful to human beings but the cations like calcium, sodium, magnesium or potassium associated with it may affect the health of individual who as a medical history of heart and kidney ailments.

Principle: **Argentometric (Silver Nitrate) Method**

Under neutral to slightly alkaline conditions silver nitrate reacts with chlorides and precipitates as silver chlorides. The complication of the reaction is indicated by formation of red silver chromate from excess silver nitrate and potassium chromate used as an indicator.

$$AgNO_3 + Cl^- \rightarrow AgCl\downarrow + NO_3^-$$

$$2AgNO_3 + K_2CrO_4 \rightarrow Ag_2CrO_4 + 2KNO_3$$

Procedure:

1. Take 50ml of water sample in a clean conical flask.
2. Adjust the pHbetween7 to 8 either by adding sulphuric acid or sodium hydroxide, otherwise Ag
3. OH will be formed at high pH level orCrO_4^{-2} is converted to$Cr_2O_7^{-2}$ at low pH levels.
4. Add 1ml of potassium chromate to get light yellow colour.
5. Titrate with standard silver nitrate solution till colour changes from yellow to brick red colour.
6. Note down the volume of titrant used (A ml).
7. For better accuracy titrate distillated water in the same manner and note down the column of titrant added (B ml).

Tabulation:

Sl. No.	Sample used	Volume of sample	Burette reading			Volume of titrant used in ml
			IR	FR	IR-FR	

Calculation:

$$\text{chloride concentration } \left(\frac{\text{mg}}{\text{l}}\right) = \frac{\text{vol. of titrant used} \times \text{Normality of titrant} \times \text{Eq. wt. of Cl}^{-} \times 1000}{\text{Ml of sample taken}}$$

$$\text{chloride concentration } \left(\frac{\text{mg}}{\text{l}}\right) = \frac{(\text{A} - \text{B}) \times \text{Normality of titrant} \times 35.46 \times 1000}{\text{ml of sample taken}}$$

Results:

Chloride Concentration in given water sample =............................mg/l

Comments:

Environmental significance of Chlorides:

1. Chlorides associated with sodium exert salty taste, when its concentration is more than 250 mg/l.
2. In many areas of the world where water is scarce, sources containing as much as 2000 mg/l are used for domestic purposes without the development of adverse effect.
3. It can also corrode concrete by extracting calcium in the form calcide.
4. Magnesium chloride in water generates hydrochloric acid after heating which is also highly corrosive and creates problems in boiler.

Applications of Chlorides data in Environmental Engineering Practice:

1. Chlorides determination in natural waters is useful in selection of water supplies.
2. It is used to determine the type of desalination apparatus to be used.
3. It is useful to control pumping of ground water from locations where intrusion of sea water is a problem.
4. Chlorides interfere in the determination of C.O.D. A correction must be made on the basis of the amount of chloride.

Expt.No.4

DETERMINATION OF ALKALINITY

Aim:

To determine Phenolphthalein alkalinity and methyl orange alkalinity in a given sample of water.

Apparatus:

250ml Conical flask, Volumetric Flasks, Pipette, Burettes

Reagents:

Sulphuric acid, Sodium thio sulphate solution, Phenolphthalein indicator solutionand Methyl orange solution.

Theory:

Alkalinity is the capacity of water to neutralize hydrogen ions. In natural waters, alkalinity is caused due to the presence of bicarbonates, carbonates and the hydroxylated compounds of calcium, magnesium, sodium, and potassium. However, hydroxide salts are present in low levels. Bicarbonates are the major forms of alkalinity due to the action carbon-di-oxide upon basic materials in soils. Highly alkaline waters are unsuitable for domestic, industrial and agricultural purposes.

Principle:

Alkalinity is determined by titrating against 0.02N Sulphuric acid using Phenolphthalein and methyl orange as indicators. For samples having pH > 8.3, titration is made in 2 steps. In the 1st step titration is carried out until pH reaches 8.3, the point at which Phenolphthalein indicator turns pink to colorless. The 2nd step of the titration is carried out till the pH is further lowered to 4.5, corresponding o which methyl orange indictor turns from faint orange. For samples having pH < 8.3 a single titration is conducted to pH 4.5

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

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

$$Ca(HCO_3)_2 + H_2SO_4 \rightarrow CaSO_4 + 2CO_2 + 2H_2$$

Procedure:

a) Phenolphthalein alkalinity:

1. Pipette out 50ml of given water sample into a 250ml conical flask.
2. Add 1 drop of 0.1N sodium thio sulphate solution to remove the residual chlorineif present
3. Add 2-3 drops of Phenolphthalein indicator, if the sample turns to pink color, then titrate with 0.02N standard H_2SO_4 , till pink color first disappears.
4. The end point is pink to colorless
5. Note down the volume of acid or titrant used (V_1).
6. If the pink color does not exist, it indicates that the Phenolphthalein alkalinity is absent. Then continue the titration with methyl orange indicator.

b) Methyl orange alkalinity or Total alkalinity:

1. Carryout the steps 1 and 2 in the above procedure.
2. Add 2-3 drops of methyl orange indicator to the sample.
3. If the solution turns to yellow, continue the titration with 0.02N standard H_2SO_4, till the solution turns from yellow to faint orange color
4. Note down the total volume of acid used (V_2).

Observations:

Conical flask: 50ml of water sample.

Burette: 50ml of 0.02N H_2SO_4 .

Indicator: Phenolphthalein and methyl orange

End point: a) Phenolphthalein – Pink to Colorless.

b) Methyl orange – Yellow to Faint orange.

Tabulation:

Sl. No.	Sample used	Indicator used	Burette reading			Volume of titrant used in ml
			IR	FR	IR-FR	
1		Phenolphthalein				V_1 = ……ml
2		Methyl orange				V_2 = ……ml

Calculation:

a) Phenolphthalein Alkalinity as $CaCO_3$ $\left(\frac{mg}{l}\right)$

$$P = \frac{\text{Vol. of titrant used } (V_1) \times \text{Normality of titrant} \times 50 \times 1000}{\text{Ml of sample taken}}$$

$$= \ldots\ldots\ldots\ldots \left(\frac{mg}{l}\right)$$

b) Methyl Orange Alkalinity as $CaCO_3$ $\left(\frac{mg}{l}\right)$

$$M = \frac{\text{vol. of titrant used } (V_2) \times 50 \times 1000}{\text{ml of sample taken}}$$

$$= \ldots\ldots\ldots\ldots\ldots\ldots \left(\frac{mg}{l}\right)$$

c) Total alkalinity as $CaCO_3$ $\left(\frac{mg}{l}\right)$

$$T = P + M$$

Calculation of different forms of alkalinity: (Alkalinity Table)

Sl. NO.	Relation	Hydroxide alkalinity	Carbonate alkalinity	Bicarbonate alkalinity
1	P = 0	0	0	T
2	P < 1/2 T	0	2P	T – 2P
3	P = 1/2 T	0	2P	0
4	P > 1/ 2 T	2P – T	2(T-P)	0
5	P = T	T	0	0

Results:

1. Phenolphthalein alkalinity as $CaCO_3$=.............................mg/l
2. Methyl orange alkalinity as $CaCO_3$ = ...mg/l
3. Total alkalinity as $CaCO_3$=........................... mg/l
4. Hydroxide alkalinity as $CaCO_3$=............................mg/l
5. Carbonate alkalinity as $CaCO_3$=............................mg/l
6. Bicarbonate alkalinity as $CaCO_3$=............................mg/l

Comments:

Environmental significance of Alkalinity:

1. Highly alkaline waters are usually unpalatable & consumers tend to seek other supplies.
2. Large amount of alkalinity imparts a bitter taste to water.
3. The reaction can occur between alkalinity and certain cautions in waters. The resultant precipitate can foul pipes and other appurtenances of water distribution systems.

Applications of Alkalinity data in Environmental Engineering Practice:

1. Chemical coagulation of water and wastewater: To neutralize acids produced during floc formation (either Al $(OH)_3$ or Fe $(OH)_3$) slowly ceases.
2. Water softening: To find out the quantity of lime and soda ash require for the removal of hardness, alkalinity should be found out.
3. Corrosion control: To control the corrosion due to acids, natural waters are rendered to alkalinity.
4. Effluents of wastewater: Wastewaters containing excess caustic (hydroxide) alkalinity are not to be discharged into natural water bodies or sewers. Excess alkalinity in water is harmful for irrigation which leads to soul damage and reduces crop yields water having an alkalinity content of less than 2250mg/l is desirable for domestic consumption.

Expt.No.5

DETERMINATION OF ACIDITY

Aim:

To determine Phenolphthalein acidity and Methyl orange acidity or total acidity in a given sample of water.

Apparatus:

250ml conical Flask, Volumetric Flasks, Pipette, Burettes

Reagents:

0.02N Sodium Hydroxide Solution, 0.1N Sodium thio sulphate Solution, Phenolphthalein Indicator Solution and Methyl Orange Solution.

Theory:

Acidity can be defined as the capacity to neutralize the hydroxyl ions. Most of the natural waters are buffered by carbon dioxide since carbon dioxide is a natural component of all natural waters. Acidity is mainly caused due to the presence of mineral acids and free carbon dioxide in water. Carbon dioxide can also be produced in water through biological oxidation of organic matter, especially in polluted waters. Acidity (both carbon dioxide and mineral) is estimated through titration with a base.

Principle:

Sodium hydroxide reacts with free carbon dioxide in water (carbonic acid) to form sodium bicarbonate and water (neutralization process). Acidity is measured as methyl orange acidity and Phenolphthalein acidity. Mineral acids measured by titration to pH 3.7 are methyl orange end point and titration to pH 8.3 is the measure of mineral acidity and acidity due to weak acids. This gives Phenolphthalein acidity or total acidity.

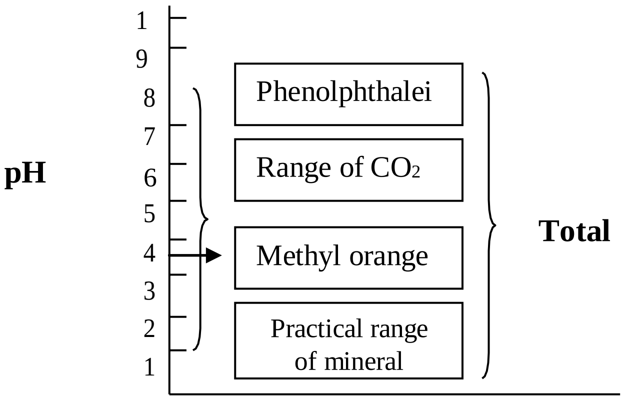

Fig.: pH range at which different types of acidity are significant.

Procedure:

a) Methyl orange acidity:

1. Pipette out 50ml of given water sample into a 250ml conical flask.
2. Add 1 drop of 0.1N sodium thio sulphate solution to remove the residual chlorineif present
3. Add 2-3 drops of methyl orange indicator, if the sample turns to yellow color, note down the pH value and stop the experiment.
4. If the solution changes to faint red, titrate it against 0.02N NaOH solution up to yellow color.
5. Note down the volume of titrant used (V_1).

b) Phenolphthalein acidity or Total acidity:

1. Pipette out 50ml of given water sample into a 250ml conical flask.
2. Add 1 drop of 0.1N sodium thio sulphate solution to remove the residual chlorineif present
3. Add 2-3 drops of Phenolphthalein indicator to the sample.
4. If the solution turns to pink color, it means that Phenolphthalein acidity is absent and stop the experiment.
5. If there is no color, then titrate with 0.02N standard NaOH solution till pink color appears the end point is colorless to faint pink.
6. Note down the total volume of titrant used (V_2).

Observations:

Conical flask: 50ml of water sample.

Burette: 50ml of 0.02N NaOH .

Indicator: Phenolphthalein and methyl orange.

End point: a) Phenolphthalein –colorless to pink.

b) Methyl orange –faint orange to yellow.

Tabulation:

Sl. No.	**Sample used**	**Indicator used**	**Burette reading**			**Volume of titrant used in ml**
			IR	**FR**	**IR-FR**	
1		Methyl orange				V_1 = ……ml
2		Phenolphthalein				V_2 = ……ml

Calculation:

a) Methyl Orange Acidity as $CaCO_3$ $(\frac{mg}{l})$

$$M = \frac{\text{Vol. of titrant used } (V_1) \times \text{Normality of titrant} \times 50 \times 1000}{\text{ml of sample taken}}$$

$$= \ldots\ldots\ldots\ldots\ldots\ldots (\frac{mg}{l})$$

b) Phenolphthalein acidity as $CaCO_3$ $(\frac{mg}{l})$

$$P = \frac{\text{Vol. oftitrantused } (V_2) \times 50 \times 1000}{\text{mlofsampletaken}}$$

$$= \ldots\ldots\ldots\ldots\ldots\ldots (\frac{mg}{l})$$

Results:

1. Methyl orange acidity as $CaCO_3$= .... mg/l
2. Phenolphthalein acidity as $CaCO_3$ = ... mg/l

Comments:

Environmental significance of Acidity:

1. Acidity interferes in the treatment of water such as softening.
2. It corrodes pipes(zinc coating of G I pipes gets dissolved)
3. Aquatic life will be affected.
4. pH is critical factor for bi-chemical reaction. The favorable pH is 6.8 to 7.5.
5. Water containing mineral acidity is so unpalatable.
6. Water having acidity more than 50mg/l cannot be used in R.C.C works.

Applications of Acidity data in Environmental Engineering Practice:

1. The amount of CO_2 present is an important factor in determining whether removal should be aeration or simple neutralization with lime or sodium hydroxide will be chosen as the treatment method.
2. The size of equipment, chemical requirements storage space, and cost of treatment all depend upon the amount of CO_2 present.
3. $CO_2$is an important consideration in lime or lime soda ash softening processes.
4. Most of industrial wastes containing mineral acidity must be neutralized before they are subjected to biological treatment or direct discharge into water body.

Expt.No.6

DETERMINATION OF pH

Aim:

To determine pH in a given sample of water.

Apparatus:

pH Meter, beaker

Reagents:

pH 7 buffer solution, pH 4 buffer solution, pH 9 buffer solution.

Theory:

pH is an important parameter used in water related studies. Most of the process involved in water supply and treatment are pH dependent. Potable waters if acidic lead to health problem and water supplied to industries if acidic or highly alkaline lead to corrosion of pipes or are unsuitable for industrial purposes. A slight change in pH of natural water has deleterious effects on physical, chemical and biological properties of water, pH can be determined calorimetrically or electrometrically.

Principle:

pH is generally used to indicate the intensity of the acidic or alkaline condition of a solution. It is defined as the negative logarithm of hydrogen ion concentration.

$$pH = - \log (H^+)$$

pH scale ranges from 0 to 14 where 7 at 25° are neutral, those with $pH < 7$ are termed as acid and $pH > 7$ are termed as alkaline in nature

Procedure:

1. Clean the pH electrode with distilled water thoroughly.
2. Switch on the instrument and standardize the pH meter with the standard buffer solution of pH that is near to that of the sample.
3. Then take a known aliquot of the sample in a thoroughly cleaned and rinsed beaker.
4. Dip the rinsed pH electrode in the sample.
5. Allow the value to standardize.
6. Note down the pH value from the read out.

Results:

Comments:

Applications of pH data in Environmental Engineering Practice:

1. In anaerobic treatment, if the pH goes below 5 due to excess accumulation of acids, the process is severally affected. Shifting of pH beyond 5 to 10 upsets the aerobic treatment of the wastewaters. In this circumstance, the pH can be adjusted by addition of suitable acid or alkaline to optimize the treatment of the wastewater.
2. pH value or range is important for any chemical reaction. A chemical shall be highly effective at particular pH. Chemical coagulation, disinfection, water softening & corrosion control are governed by pH adjustment.
3. Dewatering of sludge, oxidation of cyanides and reduction of hexavalent chromium into trivalent chromium also need a favorable pH range.
4. It is used in the calculation of carbonate, bicarbonate, Co_2 corrosion, stability index and acid base equality.

Expt.No. 7

DETERMINATION OF TOTAL HARDNESS

Aim:

To determine the Total Hardness, Calcium and Magnesium hardness in a given sample of water.

Apparatus:

250ml Capacity Conical Flask, 50ml Capacity Burette, Pipette, Measuring Jars.

Reagents:

Standard EDTA solution of 0.01N, Ammonia Buffer Solution, Standard Sodium Hydroxide Solution Of 2N, Murexide Indicator, Erichrome Black – T Indicator.

Theory:

Traditionally, water hardness is the capacity of water to react with soap to produce lather. Hardness of water is not a specific element but a variable accounted by a complex mixture of cations and anions.

Relative abundance of cations and anions causing hardness

Cations causing Hardness	Anions
Ca^{2+}	HCO_3^-
Mg^{2+}	SO_4^{2-}
Sr^{2+}	Cl^-
Fe^{2+}	NO_3^-
Mn^{2+}	SiO_3^{2-}

Hard waters are as satisfactory as soft waters from human consumption point of view. Due to adverse action with soap their use for cleansing purpose, hard water uses in generally avoided or used after treatment. Hard waters lead to scale formation in heaters, boilers and other units for industrial purposes.

Hardness as $CaCO_3$ in mg/l	Classification
0 – 75	Soft

75- 100	Moderately
150 – 300	Hard
>300	Very hard

Principle:

Under alkaline conditions, ethylene di amine tetra-acetic acid (EDTA) or its sodium alts as the titrating agent form soluble complexes with calcium and magnesium ions (pH

= 10.0 ± 0.1). When a small amount of Erichrome black-T (calmagnite), having blue color, is added to hard water with pH of about 10.0, it combines with a few of the $Ca^{2+}$and ions to form a weak complex ion wine red in color. Finally, EDTA disrupts the wine-red complex since it is capable of forming more stable complex with hardness causing ions. This act frees the Erichrome black – T indicator and the wine-red color changes to distinct blue color, indicating the end point of the titration.

Calcium:

Theory:

Calcium is the major component of most igneous, metamorphic and sedimentary rocks and is also present in the form of adsorbed ions on negatively charged mineral surfaces in soils and rocks. Calcium and magnesium cause by far the greatest portion of the hardness occurring in natural waters. Calcium does not have any physiological effects except for their actions with soap and encrustation in water supply structures, boilers and vessels used for storing water.

Principle:

Under highly alkaline conditions (pH = 12 – 13), Magnesium precipitates as Magnesium hydroxide and only Calcium complexes with, ethylene diamine tetra-acetic acid (EDTA) in presence of an indicator.

$$Mg^{2+} + 2NaOH \rightarrow Mg(OH)_2 + 2\ Na^+$$

$$Ca^{2+} + 2EDTA \rightarrow Ca(EDTA)_2 + 2\ Na^+$$

Magnesium:

Theory:

Magnesium is a significant constituent of basic igneous rocks like dunite, pyroxenites, volcanic rocks such as basalts, metamorphic rocks such as talc and

Sedimentary rocks such as dolomite and lime stone which also contains some amount of magnesium. Although in the igneous and metamorphic rocks magnesium occurs in the form of insoluble silicates, weathering breaks them down into more soluble carbonates, clay minerals and silica. In the presence of carbonic acid in water magnesium carbonate in converted into more soluble bicarbonate.

$$MgCO_3 + CO_2 + H_2O \leftrightarrow Mg(HCO_3)_2$$

In normal atmospheric conditions, the solubility of magnesium carbonate in water in presence of carbon dioxide is nearly ten times that of calcium carbonate. Magnesium does not have any physiological effects except for their action with soap and encrustation in water supply structures, boilers and vessels used for storing water.

Procedure:

a) Part A (Total hardness)

1. Pipette out 25ml of given water sample into a 250ml conical flask.
2. Add 0.5 ml of ammonia buffer solution to maintain a pH 10 ± 0.2 and mix well.
3. Add a pinch of Erichrome black-T indicator powder. The color of the solution turns to wine red.
4. Titrate immediately with standard EDTA solution by slowly mixing until the color changed from wine red to blue
5. Note down the volume of titrant used (V_1)

b) Part B (Calcium hardness)

1. Pipette out 25ml of given water sample into a 250ml conical flask.
2. Add 1ml of NaOH solution of 2N to rise pH value to about 12.
3. Add a pinch of murexide indicator powder and color changes to pink.
4. Titrate immediately with standard EDTA solution till pink color changes to purple.
5. Note down the volume of titrant used (V_2)

Observations:

Conical flask: 25ml of water sample.

Burette: 50ml of 0.01N ETDA solution.

Indicator: Erichrome black – T and Murexide

End point: a) Erichrome black – T indicator –wine red to blue

b) Murexide indicator –pink to purple.

Tabulation:

Sl. No.	Sample used	Indicator used	Burette reading			Volume of titrant used in ml
			IR	FR	IR-FR	
1		Erichrome black - T				V_1 = ……ml
2		Murexide				V_2 = ……ml

Calculation:

a) Total hardness as $CaCO_3$ $\left(\frac{mg}{l}\right)$

$$A = \frac{\text{vol .of titrant used}(V_1)\times B\times 1000}{\text{ml of sample taken}}$$

Where B = 1 1ml of EDTA = 1mg of $CaCO_3$

A = ……………… $\left(\frac{mg}{l}\right)$

b) Calcium hardness as $CaCO_3$ $\left(\frac{mg}{l}\right)$

$$B = \frac{\text{vol .oftitrantused}\quad(V_2)\times B\times 1000}{\text{mlofsampletaken}}$$

B = ……………… $\left(\frac{mg}{l}\right)$

c) Calcium hardness as Ca $\left(\frac{mg}{l}\right)$

$$C = B \times \frac{Molecular\ .of\ Ca}{Molecular\ .of\ CaCO_3}$$

C = B × 0.4

C = ……………… $\left(\frac{mg}{l}\right)$

d) Magenisum hardness as $CaCO_3$ $\left(\frac{mg}{l}\right)$

D = Total hardness − calcium hardness

D = A - B

D = ………………$\left(\frac{mg}{l}\right)$

e) Magnesium hardness as Mg $\left(\frac{mg}{l}\right)$

$$E = D \times \frac{Molecular\ wt.of\ Mg}{Molecular\ wt.of\ CaCO_3}$$

E = D× 0.24

E =……………… $\left(\frac{mg}{l}\right)$

Results:

1. Total hardness as $CaCO_3$= .... mg/l
2. Calcium hardness as $CaCO_3$ =.............................mg/l
3. Magnesium hardness as $CaCO_3$=.............................mg/l
4. Calcium hardness as Ca = ... mg/l
5. Magnesium hardness as Mg = ... mg/l

Comments:

Environmental significance of Total Hardness:

1. Absolutely soft waters are tasteless (e. g distilled water). On the other hand, hardness up to 600 mg/l can be relished if got acclimatized to.
2. Moderately hard water is preferred to soft water for irrigation purposes.
3. Scales are formed as inner coating of pipe lines prevents corrosion.
4. Absolutely soft waters are corrosive and dissolve the metals.
5. More cases of cardiovascular diseases are reported in soft water areas.
6. Hard water is useful to growth of children due to presence of calcium.

Applications of Total Hardness data in Environmental Engineering Practice:

1. Hardness of water is important in determining the suitability of water for domestic and industrial uses.
2. The relative amounts of calcium and magnesium hardness, carbonates and non – carbonates hardness present in water are the factors while determining the most economical type of softening process.
3. Determining of hardness serve as a basis for routine control of softening processes.

Expt.No.8

DETERMINATION OF DISSOLVED OXYGEN
(IODOMETRIC METHOD)

Aim:

To determine the Dissolved oxygen present in a given sample of water.

Apparatus:

BOD Bottles, Pipette, Burette, Measuring Jar, Conical Flask.

Reagents:

Alkaline Iodine Azide Solution, Manganese Sulphate Solution, Concentrated Sulphuric Acid, Sodium thiosulphate Solution, Starch Indicator.

Theory:

Oxygen in various forms is required for the very sustenance of all living organism and for the maintenance of all metabolic processes. Oxygen solubility also depends on temperature and salinity of water. Hence the solubility of oxygen at a given temperature decreases as one move from fresh water to estuary to the ocean.

The dissolved oxygen (DO) levels decrease due biological oxidation of organic matter changes in levels of DO in aquatic systems have a detrimental effect on biota in that system. High concentration of DO levels in waters used in industries led to corrosion of pipes. The analysis of DO plays an important role in water pollution, control and wastewater treatment processes.

Principle:

Manganese sulphate reacts with an alkali to form a white precipitate of manganese hydroxide, which in presence of oxygen gets oxidized to a brown colored compound. In acidic conditions, manganese ions reduced by iodide ions liberates iodine equivalent to the amount of DO present in the sample. The liberated iodine is titrated against sodium thiosulphate solution using starch as an indicator.

$$MnSO_4 + 2KOH \rightarrow Mn(OH)_2 + K_2SO_4$$

$$2Mn(OH)_2 + O_2 \rightarrow 2MnO(OH)_2$$

$$MnO(OH)_2 + 2H_2SO_4 \rightarrow Mn(SO_4)_2 + 3H_2O$$

$$Mn(SO_4)_2 + 2KI \rightarrow MnSO_4 + K_2SO_4 + I_2$$

$$2Na_2s_2O_3 + I_2 \rightarrow Na_2s_4O_6 + 2NaI$$

Procedure:

1. In a clean BOD bottle take 300ml of water sample.
2. Add 2ml of alkaline iodide azide solution and 2ml of Manganese sulphate solution and restopper the bottle.
3. Mix the solution by repeatedly inverting the BOD bottle 4 to 5 times.
4. If DO absent in the water sample the Manganese ions react hydroxide ions to form a white precipitate of Manganese hydroxide.
5. If DO is present some Mn^{++} is oxidized to Mn^{++}precipitate of brown color is obtained.
6. After shaking allow all oxygen to react with the precipitate and allow tosettle leaving clean liquid within the upper portion of the bottle.
7. Add 2ml of concentratedH_2SO_4 to bottle to dissolve the precipitate.
8. Restopper the bottle invert the bottle 4 to 5 times until yellow color is formed.
9. Take 203ml of this solution in a conical flask, add 2 to 3 drops of starch indicator to get blue color, titrate it against 0.025N $Na_2s_2O_3$ to get disappearanceof color.
10. Note down the final reading.

Observations:

Conical flask: 203ml of Water Sample.

Burette: Standard Sodium thiosulphate of 0.025N.

Indicator: Starch Solution.

End point: Blue to Colorless.

Tabulation:

Sl. No.	Volume of bottle(ml)	Volume of sample(ml)	Burette reading			Volume of titrant used in ml
			IR	FR	IR- FR	
1						R_1 = ……ml
2						R_2 = ……ml

Calculation:

a) $$\text{sample taken for titration} = \frac{\text{vol .of botle} \times 200}{\text{capacity of bottle} - 4}$$

$$= \frac{300 \times 200}{300 - 4}$$

$$= 202.70 \sim 203\text{ml}$$

b) Dissolved oxygen $\left(\frac{mg}{l}\right) = \frac{V \times N \times Eq.Wt. \times 1000}{\text{volume of sample}}$

$$= \frac{V \times 0.025 \times 8 \times 1000}{200}$$

$$= V \times 1$$

$$= \ldots\ldots\ldots\ldots\ldots \left(\frac{mg}{l}\right)$$

Results:

The DO of given Sample =................. $\left(\frac{mg}{l}\right)$

Comments:

Environmental significance of Dissolved Oxygen:

1. Oxygen is poorly soluble in water.

   Solubility is about 14.6 mg/l for pure water @ 0˚ C

   7 mg/l for pure water @ 35˚C
2. Aerobic condition does prevail when sufficient DO is available within water.
3. A minimum DO of 4 to 5 mg/l is desirable for the survival of aquatic life, high values of D.O. may cause corrosion of iron and steel.
4. Higher temperature, biological impurities, ammonia, nitrites, ferrous iron, chemicals such a hydrogen sulphide and organic matter reduce D.O. values
5. Algae growth in water may release oxygen during its photosynthesis and D.O. may even shoot up to 30mg/l.
6. Drinking water should be rich in D.O for good taste.

Applications of Dissolved Oxygen data in Environmental Engineering Practice:

1. To assess quality of raw water and to keep a check on stream pollution.
2. D.O. test is the basis for BOD test which is an important parameter to evaluate organic pollution of a waste.
3. Used to control oxygen in boiler feed water.
4. Used in control of the rate of corrosion.

Expt.No.9

DETERMINATION OF BIOCHEMICAL OXYGEN DEMAND

Aim:

To determine the Biochemical Oxygen Demand present in a given sample of wastewater.

Apparatus:

BOD Incubator, BOD Bottles, Titration Apparatus.

Reagents:

Phosphate Buffer Solution, Calcium Chloride Solution, Ferric Chloride Solution, Sodium thiosulphate (0.025N), Manganese Sulphate Solution, Alkaline Iodide Azide Reagent, Magnesium Sulphate, Concentrated Sulphuric Acid. Starch Indicator.

Theory:

BOD is the amount of oxygen required by micro-organisms while stabilizing decomposable organic matter under aerobic conditions. The BOD test is used to determine the amount of oxygen required by if domestic and industrial wastes if discharged into natural water bodies in which aerobic condition exist. The test is carried out for 15days incubation at 20° C as a major portion of organic matter is oxidised during this period. The organic matter has both carbonaceous and nitrogenous compounds. The carbonaceous matter within the 5 days, hence it is only carbonaceous matter that estimated in his test. In tropical countries like India due to the temperature being high, BOD is to be carried out for 3 days @ 37˚ as recommended by CPCB instead of 5 days @ 20^o.

Principle:

Estimation of DO is the core for BOD determination. DO content of the sample is determined before and after incubation of 3 days at 37^o C and is calculated from the difference b/w initial and final D/o levels. Samples having less or no DO are to diluted numerous times with dilution water saturated with oxygen such that sufficient amount of oxygen is available for oxidation to take place.

Procedure:

1. Place the desired volume of distilled water in a 5-liter conical flask. Aeration is done by bubbling compressed air through distilled water.
2. Add 1ml of phosphate buffer, 1ml of magnesium sulphate, 1ml of calcium chloride and 1 ml of ferric chloride solution for every liter of distilled water.
3. In the case of waste water samples, which are not accepted to have sufficient bacterial pollution add seed to the distilled water. Generally 2ml of settled sewage is sufficient for 1000ml of distilled water as seed.
4. Highly acidic or alkaline samples are to be neutralized to pH of around 7.0.
5. Add 2 or 3ml of sodium thiosulphate to destroy residual chlorine if any.
6. Take sample as under:
    - Strong wastes: 0.1, 0.5, or 1%
    - Settled domestic sewage: 0.1, 2.5, or 5%
    - Treated effluents: 5.0, 12.5, or 25%.
    - River water: 25 to 100 %
7. Dilute the sample with distilled water and mix the contents well.
    - Take samples in 3 BOD bottles of 300ml capacity.
    - Fill another 3 BOD bottles with distilled water (Blank)
    - Immediately find initial DO of 1 bottle with distilled water in it and1 bottle with diluted wastewater sample in it by modified azide method or Winkler's method.

Tabulation:

Sl. No.	**Initial DO of diluted wastewater sample**				
	Volume of sample (ml)	**Burette reading**			**Initial DO of diluted wastewater sample S_o mg/l**
		IR	**FR**	**FR - IR**	

Sl. No.	Initial DO of distilled water (Blank)				
	Volume of sample (ml)	Burette reading			Initial DO of diluted water(Blank) D_o mg/l
		IR	FR	FR - IR	

Sl. No.	DO at the end of 3 days for diluted wastewater sample				
	Volume of sample (ml)	Burette reading			DO at the end of 3 days for diluted wastewater sample S_3 mg/l
		IR	FR	FR - IR	

Sl. No.	DO at the end of 3 days for distilled water (Blank)				
	Volume of sample (ml)	Burette reading			DO at the end of 3 days for distilled water (Blank) D_3 mg/l
		IR	FR	FR - IR	

Calculation:

1. Initial DO of diluted wastewater samples = So =
2. DO at the end of 3 days for dilutes wastewaters sample = S_3 =
3. Initial DO of distilled water(Blank) = D_o =
4. DO at the end of 3 days for distilled water (Blank) = D_3 =
5. BOD of the sample $\left(\frac{\text{mg}}{\text{l}}\right) = (\text{Initial DO} - \text{Final DO}) \times \text{Dilute on ratio}$

$$= \frac{[(S_o - S_3) - (D_0 - D_3)] \times \text{Volume of BOD bottle}}{\text{ml of sample taken in BOD bottle}}$$

$$= \ldots\ldots\ldots\ldots\ldots \left(\frac{\text{mg}}{\text{l}}\right)$$

Results

The BOD of given Wastewater Sample = ... $\left(\frac{\text{mg}}{\text{l}}\right)$

Comments:

Environmental significance of Biochemical Oxygen Demand:

1. BOD is the principle test to give an idea of the biodegradability of any sample and strength of the waste. Hence the amount of pollution can be easily measured by it. It is the basic criteria for the control of stream pollution.
2. Efficiency of any treatment plant can be judged by considering influent BOD and effluent BOD and so also the organic loading on the unit.
3. If any industrial waste is to be let off a public or municipal sewer, it depends in volume and BOD of the waste water.
4. Ordinary domestic sewage may have a BOD of 200mg/l. any effluent to be discharged into natural bodies of water should have BOD less than 30mg/l. this is important parameter to assess the pollution of surface waters and groundwater whose contamination occurs due to disposal of domestic and industrial effluents.
5. Drinking water usually has a BOD of less than 1mg/l and water is considered fairly up to 3mg/l .but, when BOD value reaches 5 mg/l, the water is doubtful in purity.

Applications of Biochemical Oxygen Demand data in Environmental Engineering Practice:

1. To determine strength of domestic and industrial effluents.
2. Used to measure the self-purification capacity of streams and serves regulatory authorities as a means of checking on the quality of effluents discharged to such waters.
3. Useful in the design of treatment facilities.
4. It is a factor in the choice of treatment method particularly in design of trickling filters and activated sludge units.
5. Used to evaluate the efficiency of various treatment units.
6. It is the only parameter to give an idea of the biodegradability of any sample.

Expt.No.10

DETERMINATION OF CHEMICAL OXYGEN DEMAND

Aim:

To determine the Chemical Oxygen Demand present in a given sample of Wastewater.

Apparatus:

COD Digester, Glass wares, Measuring jars, etc.

Reagents:

Standard Potassium Dichromate, Ferrous Ammonium Sulphate, Concentrated Sulphuric Acid, Silver Sulphate, Ferroin Indicator, Mercuric Sulphate.

Theory:

COD is the quantitative estimation of oxygen equivalent to organic matter that is vulnerable to oxidation in presence of a strong oxidizing agent. The content of oxidisable inorganic matter is usually negligible in comparison with that of organic matter. Hence COD is the oxygen equivalent of amount of organic matter that is oxidisable by a strong oxidizing agent, like potassium dichromate. During the estimation of COD, all the organic matter is converted to carbon dioxide, and water regardless of the biological assimilability of the substances. Hence COD value always higher than that of BOD.

Principle:

Organic matter in the sample is oxidized to carbon dioxide, water and ammonia by refluxion with a potassium dichromate in presence of Sulphuric acid. The excess dichromate that remains after oxidation is then titrated with ferrous ammonium sulphate. The amount of potassium dichromate utilized for gives he oxygen required for the oxidation of organic matter.

$$6Fe^{2+}Cr_2O_7^{2-} + 14H^{\pm} \rightarrow 6Fe^{3+} + 2Cr^{3+} + 7H_2O$$

Procedure:

1. Take 20ml of sample in a clean conical flask.

2. Add 10ml $K_2Cr_2O_7$ to conical flask and add 30ml of concentrated sulphruic acid (H_2SO_4) containing silver sulphate(Ag_2SO_4) and mix thoroughly add 0.4 grams or pinch of mercuric sulphate ($HgSO_4$) mix the contents thoroughly.
3. Transfer the sample into the glass digester of COD apparatus and connect to the air vessel.
4. Reflux the sample for $2\frac{1}{2}$ hours at a temperature of $\pm 100°$. Allow it sometime for cooling to room temperature.
5. Dilute the sample with distilled water to make it up to 100 ml.
6. Titrate excess color changes from greenish blue to wine red indicating the end point of titration.
7. Note down the volume of titrant used for given sample as ‘B’ ml and for dilution water as ‘A’ ml.

Observation:

Conical flask: Test sample

Burette: 0.25N Ferrous Ammonium Sulphate.

Indicator: Ferroin.

Color: Greenish blue to Wine Red.

Tabulation

Sl. No	Sample details	Volume of sample (ml) taken	Burette reading			Volume of titrant used(ml)
			IR	FR	FR - IR	

Calculation

$$\text{COD in mg/l} = \frac{(\mathrm{A}-\mathrm{B})\times(\text{normality of titrant})\times(\mathrm{Eq.Wt.})\times 1000}{\text{quantity of sample taken}}$$

$$= \ldots\ldots\ldots\ldots \left(\frac{\mathrm{mg}}{\mathrm{l}}\right)$$

Results

The COD of given Wastewater sample = ... $\left(\frac{\mathrm{mg}}{\mathrm{l}}\right)$

Comments:

Environmental significance of Chemical Oxygen Demand:

1. BOD cannot be determined accurately when toxins are present and conditions are unfavorable for the growth of microbes.
2. BOD test consumes more time i.e. a minimum of 5 days, whereas COD test is relatively faster test taking only 3 hours completion.

Applications of Chemical Oxygen Demand data in Environmental Engineering Practice:

1. The COD test is used extensively in the analysis of industrial wastes.
2. It is particularly valuable in surveys designed to determine and control losses to sewer systems.
3. The test is widely used in the place of BOD in the operation of treatment facilities because of the speed with which the results can be obtained.
4. It is useful to assess strength of wastes which contain toxins and biologically resistant organic substances.
5. The ratio of BOD to COD is useful to assess the amenability of waste for biological treatment. Ratio of BOD to COD greater than o equal to 0.8 indicates that wastewaters are highly amenable to the biological treatment.

Expt.No.11

DETERMINATION OF CHLORINE
(IODOMETRIC METHOD)

Aim:

To determine the percentage of Chlorine present in a given sample of Bleaching Powder.

Apparatus:

250ml Conical Flask, 100ml & 1000ml Volumetric Flask, 50ml Burette, 10ml & 25ml Pipette.

Reagents:

Standard Potassium thiosulphate Solution (0.0.25N), Potassium Iodide Crystals (KI), Glacial Acetic Acid, Bleaching Powder (Chlorinates Sample).

Theory:

Disinfection of public water supplies and treated wastewaters by chlorine is a commonly employed to prevent the spread of water borne diseases such as cholera, typhoid etc. chlorine is used in the form of hypochlorite's and free chlorine. Chlorine in both the forms as a strong oxidizing agent and frequently dissipates rapidly that very less disinfection takes place until large amount of chlorine may be present in water as free available free chlorine and as combined chlorine, hypochlorous acid and hypochlorite ions are commonly referred as free chlorine residuals and the chloramines are called combined chlorine residual.

Principle:

The method depends on the oxidizing power of free and combined chlorine residuals to convert iodide ion to free iodine. Free and available chlorine residuals liberate free iodine on reacting potassium iodine and the released iodine is titrated with standard sodium thiosulphate solution (reducing agent) using starch as an indicator and he end point is indicated with disappearance of blue color. The reaction is preferably carried out at pH 3 to 4.

$$2KI + Cl_2 \rightarrow 2KCl + I_2$$

$$I_2 + 2Na_2S_2O_3 \rightarrow Na_2S_4O_6 + 2NaI$$

$$I_2 + 2S_2O_3^{2-} \rightarrow SO_4\,O_6^{2-} + 2I$$

Procedure:

1. Dissolve 2.5gm of given bleaching powder in 250ml of volumetric flask.
2. Take 25ml of bleaching powder solution in a conical flask.
3. Add 5ml of acetic acid (glacial) and mix well.
4. Add 0.5g of potassium iodide (KI) crystals.
5. Titrate immediately with standard sodium thiosulphate solution till light yellow color appears.
6. Now add 1ml of starch indicator the yellow color changes to dark blue.
7. Continue the titration till the blue color disappears. Note down the ml of $Na_2S_2O_3$ solution used (V).

Observation:

Conical flask: 25ml Of Chlorinated Water Sample.

Burette: 50ml of Standard Sodium thiosulphate Solution (0.025N).

Indicator: Starch.

Color: Blue to Colorless.

Tabulation:

Sl. No	Sample used	Indicator used	Burette reading			Volume of titrant used(ml)
			IR	FR	FR - IR	

Calculation

Normality of Bleaching Powder solution =

$$\frac{\text{Normalityof } Na_2S_2O_3 \times \text{Voiumeof } Na_2S_2O_3 \text{ consumed}}{\text{Volumeofbleachingpowdersolutiontaken}}$$

Wt. of chlorine in Bleaching Powder =

$$\frac{\text{Normality of bleaching powder} \times \text{Eq.Wt.of chlorine}}{4}$$

$$\% \text{ of available of Chlorine } = \frac{\text{Wt.ofchlorine} \times 100}{\text{Wt.of bleaching powder taken}}$$

Results

Percentage of chlorine present in a given sample of Bleaching Powder = ………. %

Comments:

Environmental significance of Chlorine:

1. Chlorine is available in different states, gaseous, liquid and also as a solid.
2. Bleaching powder is slaked lime through which chlorine is injected. Hence, it contains calcium, oxygen and chlorine ($CaOCl_2$). It is hydroscopic (i.e. absorbs moisture from the atmosphere)

$$CaOCl_2 + H_2 \rightarrow Ca(OH)_2 + Cl_2$$

3. This bleaching powder loss its chlorine content. If it is exposed to the atmosphere and due to prolonged storage. Hence the amount of chlorine contained by it needs to be decided before application of bleaching power to water.
4. Chlorination through bleaching powder is called ‘hypochlorination’.

Applications of Available Chlorine data in Environmental Engineering Practice:

1. This test is useful to assess the quality of bleaching powder.
2. It is useful to estimate the amount of bleaching powder required for effective disinfection of water.

Expt.No.12

DETERMINATION OF CHLORINE DEMAND

Aim:

To determine the Chlorine Demand by Breakpoint Chlorination for the given water sample.

Apparatus:

250ml Conical Flask, 1L Capacity Beaker, Volumetric Flask, Burette, Pipette.

Reagents:

Standard Potassium thiosulphate Solution (0.025N), Potassium Iodide, Glacial Acetic Acid (0.01N), Starch Indicator.

Theory:

Chlorine readily combines with chemically dissolved in water, kills microorganisms and oxidizes organic, inorganic impurities present in water. These components use added up chlorine and is called as chlorine demand of raw water. It is important to add sufficient chlorine to water to suit the chlorine demand and provide residual disinfection. The chlorine demand of the water is the difference b/w the amount of chlorine applied and amount of free chlorine remaining at the end of the contact period (10 to15min). When chlorine is added to water it first of all acts within organic impurities excess chlorine after this point is consumed by ammonia to form chloramines, and to destroy pathogenic organisms, once the chlorine demand gets satisfied the chlorine will appears as free chlorine his free chlorine as well as combined chlorine will cause germicidal action.

Factors affecting chlorine demand.

1. Form of chlorine (gaseous, liquid & solid)
2. pH of the water.
3. Concentration of impurities.
4. Contact time.
5. Type of organisms.
6. Temperature of water.

Procedure:

1. Take 10 glass beakers of 100ml capacity and add 1000ml of water to each beaker.
2. Add varying dosage of chlorine solution like 1,2,3,4…. Up to 10ml to each beaker. (The dosage may be raised by 10 times in case of pollutes water).
3. Stir all he jars with glass rod and then allow sit for contact period for 15min to 30minwithout disturbing the beakers.
4. Take a 200ml of sample in a clean conical flask and add 5ml of acetic acid, 0.5g of KI mix it well with glass rod then add 2ml of starch indictor to get blue color.
5. Titrate the sample with sodium thiosulphate till the color changes from blue to colorless note down the volume of titrant added in ml.

Observation:

Conical flask: 100ml of water sample.

Burette: 50ml of standard sodium thiosulphate solution (0.025N).

Indicator: Starch.

Color: Blue to colorless.

Tabulation:

Sl. No	**Sample used**	**Dosage**	**Burette reading**			**Volume of Titrant used(ml)**	**Residual chlorine**
			IR	**FR**	**FR - IR**		
1		4ml					
2		8ml					
3		12ml					
4		16ml					
5		20ml					
6		24ml					
7		28ml					
8		32ml					
9		36ml					
10		40ml					

Calculation:

$$\text{Residual chlorine} = \frac{\text{V}\times\text{N}\times 35.45\times 100}{\text{Sample taken}}$$

$$= \ldots\ldots\ldots\ldots\ldots\ldots \left(\frac{\text{mg}}{\text{l}}\right)$$

Results:

Comments:

Environmental significance of Chlorine Demand:

The treatment of water with chemicals to kill bacteria is termed as disinfection of water. Chlorination, ozonization, ultraviolentray's method, excess lime processes and application of silver or iodine and bromine method, are the principle methods used for disinfection of water. Out of all these, ozone and chlorine compounds are most commonly used in water and wastewater treatment systems.

Breakpoint chlorination involves the addition of sufficient chlorine so as to oxidize all the organic matter, reducing substances and free ammonia in raw water leaving behind mainly free available chlorine which possesses strong disinfection action against pathogens. The residual chlorine of 0.1 to 0.2mg/l is maintained in water distribution main in order to prevent further contamination and supply the wholesome water to the consumers

Expt.No.13

DETERMINATION OF RESIDUAL CHLORINE
(IODOMEETRIC METHOD)

Aim:

To determine the Residual Chlorine for the given water sample.

Apparatus:

Conical Flask, Volumetric Flask, Burette, Pipette.

Reagents:

Standard Potassium thiosulphate Solution (0.01N), Potassium Iodide 10% Solution, Acetic Acid Diluted, Starch Indicator.

Theory:

The presence of residual chlorine in drinking water after contact period of 10 minutes indicates that.

2. A sufficient amount of chlorine was added initially to the raw water to kill the bacteria and viruses that can cause water borne diseases.

3. The water is protected from contamination during storage and distribution. When filtered water is chlorinated by using chlorine or by bleaching powder, the chorine is consumed for killing the microorganisms, oxidizing the organic and inorganic impurities, and to form chlorines. When the oxidation is completed and all microorganisms are killed then whatever chlorine is added to the water it will appear as residual chlorine (breakpoint chlorination) usually a free chlorine residual of 0.2 to 0.3mg/l after contact period of 10 to 30min is considered to be sufficient and satisfactory to take care of the further recontamination of the water to be supplied to the consumers by the distribution network having different diameter pipes.

Procedure:

1. Take 200ml of water sample in a clean conical flask.
2. Add 0.5ml of acetic acid and 0.5g f potassium iodide crystals.
3. Mix it well with a glass rod.
4. Add 2ml of starch indictor to get blue color.

5. Titrate the sample with sodium thiosulphate (0.01N) till color changed from blue to colorless. Note down the volume of titrate added in ml.

Observation:

Conical flask: 200ml of chlorinated water sample.

Burette: 50ml of standard sodium thiosulphate solution.

Indicator: Starch solution.

End point: Blue to colorless.

Tabulation:

Sl. No	**Sample used**	**Indictor used**	**Burette reading**			**Volume of titrant used(ml)**
			IR	**FR**	**FR - IR**	
1	Water Sample Supplied in lab					**V=…….ml**

Calculation:

$$\text{Residual chlorine} = \frac{\text{V}\times\text{N}\times\text{Eq.Wt.ofchlorine} \times 1000}{\text{ml of sample taken}}$$

$$= \quad \ldots\ldots\ldots..(\frac{mg}{l})$$

Results:

Residual chlorine in a given Sample of Water = ……. mg/l

Comments:

Environmental significance of Residual Chlorine:

Active chlorine (free and combined) should be determined at each stage in the processing of drinking water and in the water mains in order to guarantee bacteriologically impeccable water. Active chlorine should be present in drinking water within range 0.1 to 0.2 mg/l. However, excessive chlorine content may give out odor and any change even taste of waters. Further, chlorine is said to be carcinogenous. Hence, except during epidemics 'Super Chlorination' is to be done.

Applications of Residual Chlorine data in Environmental Engineering Practice:

1. Chlorine residuals determination is used to control chlorination of domestic and industrial wastewaters.
2. Determination of chlorine residuals is used universally in disinfection practice to control addition of chlorine so as to ensure effective disinfection without waste.
3. Determination of chlorine residual in eater distribution is useful to find the source of contamination or leakage points, so as to supply wholesome water to the consumer.

Expt.No.14

DETERMINATION OF TURBIDITY
(TURBIDITIMETRI METHOD)

Aim:

To determine the Turbidity for the given water sample.

Apparatus:

Digital Nepheloturbidity Meter, Volumetric Flasks, Beakers, Pipettes.

Theory:

Inhibition of light transmission/scattering of light water due to the presence of suspended matter is termed as turbidity. Turbidity is a measure of optical property of light and depends on the presence of suspended matter (including their size, shape and refractive index) like finely divided organic and inorganic matter, silt, clay and microorganisms. The standard method used for turbidity measurements is the nephelometric method and the results are expressed in Nephelometric turbidity units (NTU).

Principle:

Nephelometric method for determining of turbidity is based on the comparison of intensity of light scattered by standard reference suspension (formazine) under the same conditions. Intensity of light scattered is proportional to the turbidity i.e. the higher the intensity of the light scattered, the higher is the turbidity. The colloidal particles causing turbidity to scatter the light such that the scattered light measured at right angles to the beam of the incident light is proportional to turbidity and forms of the v=basis for turbidity determinations.

The results are expressed in NTU (rounded off to the nearest value) and recorded as follows:

Turbidity (NTU)	Record to the nearest (NTU)
0 – 1.0	0.05
1 – 10	0.1
11 – 40	1
41 – 100	5
101 – 400	10

401 – 1000	50
>1000	>50

Procedure:

1. Switch on the instrument and allow to warm up for about 10min.
2. Set the standardized control calibration knob to maximum.
3. Insert the test tube with distilled water into cell holder with alignment mark and close with light shield.
4. Now using set zero control knob (coarse & fine control) adjust the meter indicator to zero.
5. Remove the test tube and replace with the test tube containing standard solution of say 50NTU.
6. Adjust the reading to 50 using calibration knob. Repeat the same procedure for calibration to 100NTU.
7. The instrument is calibrated to test the unknown sample.
8. Insert the test tube containing unknown samples in cell holder note down the reading on meter in NTU.

Observation and Tabulation:

Sl. No	**Sample detail**	**Turbidity (NTU)**

Results:

Comments:

Environmental significance of Turbidity:

1. Turbidity is objectionable because of Aesthetic considerations and Engineering considerations.
2. When turbid water in a small, transparent container, such as drinking glass is held up to the light, an aesthetically displeasing opaqueness or 'milky' coloration is apparent.
3. The colloidal material which exerts turbidity provides adsorption sites for chemicals that may be harmful or cause undesirable tastes and odors, and for biological organisms that may be harmful.
4. Disinfection of turbid waters is difficult because of the adsorptive characteristics of some colloids and because the solids may partially shield organisms from disinfection.
5. In natural water bodies, turbidity may impart a brown or other colour to water and may interfere with light penetration and photosynthetic reaction in streams and lakes.
6. Turbidity increases the load on slow sand filters. The filter may go out of operation, if excess turbidity exists.

Applications of Turbidity data in Environmental Engineering Practice:

Turbidity measurements are of particular importance in the field of water supply. They have limited use in the field of domestic an industrial waste treatment.

1. Knowledge of the turbidity variation in raw water supplies along with other information is useful to determine whether a supply requires special treatment by chemical coagulation and filtration before it may be used for a public water supply.
2. Turbidity measurements are used to determine the effectiveness of the treatment produced with different chemicals and the dosages method.
3. Turbidity measurements help to gauge the amount of chemicals needed from day-to-day in the operation of water treatment works.
4. Measurements of turbidity in settled water prior to filtration is useful in controlling chemical dosages so as to prevent excessive loading of rapid sand filters.
5. Turbidity measurements of the filtered water are needed to check on faulty filter operation.
6. Turbidity measurements are useful to determine the optimum dosage of coagulation to treat the domestic and industrial wastes.
7. Turbidity determination is used to evaluate the performance of water treatment plants.

Expt.No.15

JAR TEST

Aim:

To determine the optimum coagulation dosage for the given water sample.

Apparatus:

Jar test apparatus, turbidity meter, 5ml and 10ml pipettes, 1-liter capacity beaker.

Theory:

Alum is the name given to the aluminum sulphate with its chemical formula as$Al_2(SO_4)_3 18H_2O$. The alum when added to raw water reacts with the Bicarbonate Alkalinity, which are generally present in raw water. So as to form a gelatinous precipitate (floc) of Aluminum Hydroxide. This floc attracts pure suspended matter & colloids present in raw water, thereby growing in size. The floc formation is assisted by slow mixing, called flocculation. The floc finally settled down to the bottom of tank. The above process is known as coagulation.

$$Al_2(SO_4)_3 18H_2O + 3Ca(HCO_3) \xrightarrow{\text{pH 5.5 to 8}} 3CaSO_4 + 2Al(OH)_3 \downarrow + 6CO_2\ \text{t}$$

The amount of alum required for coagulation depends on the turbidity and color of raw water. The use of optimum amount of coagulation is indicated by the formation of large feathery flakes and can be determined in the laboratory by jar test. The optimum dose of alum is usually found to vary from 5mg/l for clear waters to about 85mg/l for higher turbid waters. The average normal dose is about 17mg/l.

Principle:

Metals salts hydrolyze in presence of the natural alkalinity to form metal hydroxides. The divalent cations can reduce the zeta-potential, while the metal hydroxides are good absorbents and hence remove the suspended particles by enmeshing them.

Procedure:

1. Take 1000ml of sample in 6 beakers. The pH of the sample is adjusted to alkaline range (6.5 - 11).
2. Add dosage of alum at a time to all beakers i.e. 2ml, 4ml, 6ml, 8ml, 10ml and 12ml.
3. Switch on the motor and adjust the speed initially to 100rpm for 1min, and later at 40rpm for 15 min to 30min, depending upon the turbidity of water sample.
4. Switch off the motor and allow the floc formation and their settlements.
5. Collect the supernatant liquor without disturbing the sediment and measure the turbidity of all the beakers using nephelometers.
6. The least residual turbidity will be the optimum dose.
7. Repeat the same for varying dosages with varying pH values.

Observation and Tabulation:

Jar No	**Dosage of coagulant(ml)**	**pH**	**Initial turbidity (NTU)**	**Residual turbidity (NTU)**	**Turbidity(NTU)**
1	2ml				
2	4ml				
3	6ml				
4	8ml				
5	10ml				
6	12ml				
7	14ml				
8	16ml				

Calculations:

Selected Optimum Dosage = 16ml

Strength of Alum = 14.28mg/l

Optimum Dosage = 14.28 mg/ml × .... ml/l

= .... mg/l

Results:

Comments:

Environmental significance of Jar Test:

Coagulation is not yet an exact science, although recent advances have been made in understanding the mechanism of the process. Therefore, selection and optimum dosages of coagulation are determined experimentally by the jar instead of quantitatively by formula. Excess dosages of alum may contribute excess aluminum is neurotoxic. Less dosage of alum does not remove turbidity in water which ultimately increases load on filters. So, the optimum dosage should be added in coagulation process to prevent the above problems. Coagulation removes not only turbidity, but also color, microorganisms, algae, phosphate, taste and odor producing substances.

Applications of Jar test data in Environmental Engineering Practice:

1. This test is useful to identify various natural coagulants.
2. It is useful to estimate optimum dosage of coagulant required for raw waters and waste waters.

Expt.No.16

DETERMINATION OF IRON

Aim:

To determine the Concentration of Iron present in a given sample of water.

Apparatus:

Nesslers Tube, Hotplate, Burner, Spectrophotometer etc.

Reagents:

Hydrochloric acid (HCl), hydroxyl amine hydrochloride solution ($Na_2OH.HCl$), ammonium acetate ($Na_4C_2H_3O_3$) buffer solution, phenanthroline solution, standard iron solution, sodium acetate solution.

Theory:

Iron is one of the main constitute of rocks, next only to oxygen, silicon and aluminum. Weathering of iron bearing minerals releases iron that usually forms relatively insoluble and stable oxides, carbonates, hydro carbonates, sulphates and chlorides. Since groundwater usually contains significant amounts of carbon-dioxide, substantial amounts of ferrous carbonate may be dissolved. Excessive amount of iron imparts taste to water, which is detectable at low concentrations. Moreover, it has adverse effect on domestic uses and water supply structures and promotes growth of iron bacteria.

Principle:

1, 10 phenanthroline combines with Fe^{2+} to form an orange red complex in acidic conditions (pH 3.2 – 3.3). The color produced measured photometrically. It should be made sure that all iron is in soluble form and hence ferric hydroxide, 1, 10 – phenanthroline is ferrous ion specific, and hence all iron in the form of ferric must be reduced to Fe^{2+} state and this is accomplished by using hydroxylamine as the reducing agent.

Procedure:

Standards

1. In 50ml volumetric flasks, pipette 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10ml standard iron solution.
2. To each flask, add 2ml concentrated HCl. Mix well and transfer the contents of each flask to 25ml beaker.
3. Boil on the water bath till the contents are reduced to half the original volume.
4. Cool the solution. Add 10ml ammonium acetate buffer solution and 2ml of phenanthroline solution.
5. Allow the solution to stand for 10min for color development.
6. Measure the absorbance of the standards at 510nm. Use distilled water as blank.
7. Plot the calibration curve with concentration on x - axis and absorbance on y – axis.

Samples:

8. Take 50ml of sample in 250ml conical flask.
9. Proceed from step-2 as described for standards.
10. Note the concentrations of iron in mg/l in the sample equivalent to the optical density from the calibration graph.

Tabulation:

Standards:

ml of Standard IronSolution	IronConcentration in mg/l	Absorbance at 510nm
0.0	0.0	
1.0	0.2	
2.0	0.4	
3.0	0.6	
4.0	0.8	
5.0	1.0	
6.0	1.2	
7.0	1.4	
8.0	1.6	
9.0	1.8	
10.0	2.0	

Sample:

Sample No.	Absorbance at 510nm	IronConcentration in mg/l
1		
2		
3		

Graph:

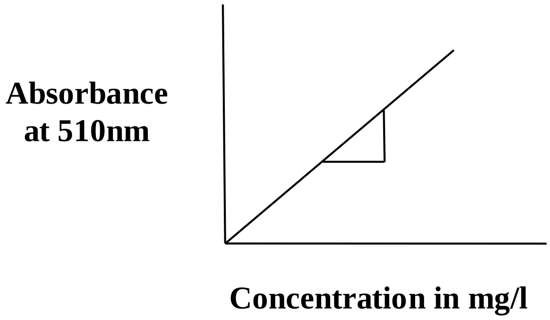

Fig.: Calibration Curve

Results:

Sulphate concentration in given water sample =.............................mg/l

Comments:

Environmental significance of Iron:

Excess presence of iron in drinking water supplies is objectionable for a number of reasons.

2. Although iron has got little concern as a health hazard but is still considered as a nuisance in excessive quantities. Long – time consumptions of drinking water with high concentration of iron can lead to liver diseases (hemosiderosis).
3. Iron rice water exposed to the air, become turbid and highly unacceptable from the aesthetic view point due to oxidation of soluble iron to insoluble ferric oxide which settles out as a rust colored salt. Such water often tastes unpalatable even at low concentrations (0.3 mg/l).
4. Iron excess of 0.3mg/l causes stains to wash basin and steel containers. They also form red spot on clothes
5. Iron also promotes the growth of iron- bacteria which derive their energy from the oxidation of ferrous to ferric. This gives rusty appearance to the waters. Colonies of these bacteria may also form a slime which causes problems in water closets, pipes, pumps and distributions systems.
6. High concentrations of iron in water is not suitable for processing of food, beverages, ice, dyeing, bleaching and many other items. Water with higher concentrations of iron when used in preparations of tea and coffee, interacts with tannins giving a black inky appearance with metallic taste. Coffee may even become unpalatable at concentration of iron more than 1mg/l.

Applications of Iron data in Environmental Engineering Practice:

1. Iron content of water is important in determining the suitability of water for domestic and industrial purposes.
2. Determination of iron is useful to select the treatment unit and design of treatment units.
3. It is used to determine the efficiency of treatment units.
4. The ratio of iron to manganese is a characteristics factor that determines the type of treatment unit used, as well as the amount of organic matter presence in the water.
5. It is also used to aid in the solution of problems in distribution systems where iron fixing bacteria are troublesome.
6. The iron determination is helpful in assessing the extent of corrosion and aiding in control of corrosion.

Expt.No.17

DETERMINATION OF NITRATES

Aim:

To determine the Concentration of Nitrates, present in a given sample of water.

Apparatus:

250ml Conical Flasks, 100ml & 1000ml Volumetric Flasks, Pipettes, Spectrophotometer, Nessler'sTube, Filtration Sand, What Man Filter Paper No 40, Porcelain Dish, Funnel.

Reagents:

Phenol Disulphonic Acid, Silver Sulphate Solution, Concentrated Ammonium Hydroxide Solution, Potassium Hydroxide, Stokes Nitrate Solution, Standard Nitrate Solution, EDTA, Aluminum Hydroxide.

Theory:

The source of nitrogen in natural water s is the rain and nitrogen fixing bacteria. In addition to agricultural applications, domestic and industrial waste discharges into water also contribute to high amount of nitrates in ground waters. Moreover, presence of nitrates in ground water is an indication of ground water pollution due to anyone or all the above source of nitrates.

Nitrates as such are not toxic to health and about 85% of ingestion nitrates are rapidly absorbed from gastrointestinal tract in normal health individuals and absorbed nitrates are excreted by the kidneys. It causes methemoglobinemia in infants.

Principle:

Nitrates react with phenol Disulphonic acid and produce a nitro derivation, which in alkaline solution develops yellow color due to rearrangement of its structure. The color produced follows Beer's law and is proportional to the concentration of NO_3 present in the sample can be determined spectrophotometrically at 410nm.

Procedure:

Standards

1. In porcelain dish pipette 1, 2, 4, 5, 10, 15, 20, 25, 30, 35, 40, 45, and 50ml Standard Nitrate Solution.
2. Evaporate to dryness on a water bath.
3. Cool and dissolve the residual in 2ml phenol Disulphonic acid using a glass rod.
4. Add 5ml and transfer to Nessler's tubes.
5. Add 8ml 12N KOH and stir the contents well and yellow color to develop.
6. Set the spectrophotometer to zero absorbance at 410nm with blank.
7. Measure the absorbance of standard immediately.
8. Plot the calibration curve with concentration on x - axis and absorbance on y – axis.
9. Take 20ml of the sample in a conical flask.
10. Add an equivalent amount of silver sulphate solution to remove chloride interference.
11. Heat the solution slightly and filter the silver chloride precipitate.
12. Proceed from step No. 2 as given under the procedure for standard. If turbidity is developed add the EDTA reagent drop wise till it dissolves. Filter (and make up to 100ml with DW if necessary). To avoid this, add 10ml concentrated NH_4OH instead of KOH.
13. Measure the absorbance of the sample in the previously standardized spectrophotometer.
14. Note the concentration of nitrates in mg/l as NO_3^- in the sample equivalent to the optical density from the calibration curve.

Tabulation:

Standards:

ml of standard nitrate solution	Nitrate concentration in mg/l	Absorbance at 410nm
0.0	0.0	
1.0	1.0	
2.0	2.0	
4.0	4.0	
5.0	5.0	
10.0	10.0	
15.0	15.0	

20.0	20.0	
25.0	25.0	
30.0	30.0	
35.0	35.0	
40.0	40.0	
45.0	45.0	
50.0	50.0	

Sample

sample No.	**Absorbance at 410nm**	**Nitrate concentration in mg/l**
1		
2		
3		

Graph:

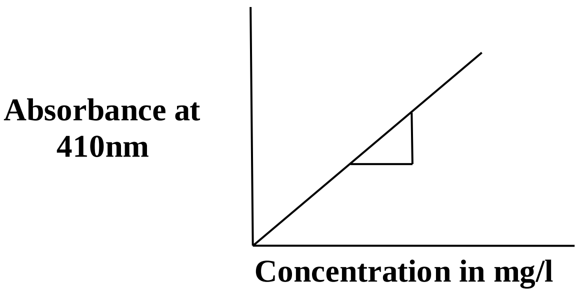

Fig.: Calibration Curve

Results:

Nitrate Concentration in given Water Sample = ... mg/l

Comments:

Environmental significance of Nitrates:

1. Ground water can contaminate by the sewage septic tank effluents and other wastes which are rich in nitrates.
2. High amounts of nitrates in ground waters are the indicators of pollution of domestic wastewater.
3. Nitrates poisoning to infants, animals including humans can cause serious health hazarding and even death.
4. Nitrate has a great affinity to hemoglobin than oxygen and this replaces oxygen in the blood. The skin of infants is converted into blue color due to the absence of oxygen. The nitrate poisoning is scientifically known as Methemoglobinemia.
5. This disease occurs in infants, only when the concentration of nitrates exceeds the permissible limits.

Applications of Nitrates data in Environmental Engineering Practice:

1. Nitrate determination is important whether water supplies meet the BIS for the metheglobinemia in infants.
2. It is used to assess the self-purification properties of water bodies and nutrient balance in surface waters and soil.
3. It is useful to find out the state of decomposition of organic matter present in waste waters.

Expt.No.18

AIR QUALITY MONITORING

Objective

To measure the ambient concentrations of gases and particulate matter by using High Volume Sampler (HVS).

Instruments

a. High volume sampler (HVS)
b. Whatman filter paper
c. Impingers

Principle

PM10 and TSPM are measured by passing air at flow rate of about 1 lpm through high efficiency cyclone which retains the dust particles greater than 10 micron size and allow only fines (less than 10 micron particles) to reach the glass microfibre filter where these particles are retained. The instrument provides instantaneous flow rate and the period of operation (on time) for calculation of air volume passed through the filter. Amount of particulates collected is determined by measuring the change in weight of the cyclone cup and filter paper.

Figure

Figure: High Volume Air sampler

Reagents for gaseous pollutants

a. 0.1 N Sodium tetra- chloratemercurate (SO2) b. Sodium hydroxide and sodium arsanite (NO2)

Procedure

i. For particulates

a. Perform leak check of the instrument before starting the sample.

b. Filter paper need to be inspected for pin holes.

c. Filter conditioning need to be done at 20-25ºC temperature and less than 50% Relative Humidity. d. Never fold filter completely.

e. Do not touch filters by dirty hands always use disposable hand glove.

f. Under take regular cleaning of key components of the machine.

g. Ensure stable power supply to the machine. Do not leave loose contact of supply wire to the machine.

h. Always fill up distilled water in manometer assembly.

i. Do not switch on and off machine using Timer Switch.

j. Clean impinge and rotameter regularly and also clean manifold once in two months.

k. Do not take flow reading immediately after switching on the machine. Give 5 minute for flow stabilization and for heat up the blower components.

l. Always attach a new weighed cyclone cup with every filter change.

m. Do not switch on machine without filter paper.

n. If machine is not expected to be operated within 48 hrs drain out the manometer water and store machine with water in the manometer tank.

o. Do not run machine during rain in open atmosphere. ii. For gaseous The increasing general awareness of atmospheric pollution and its hazards to the health and well-being of industrial workers, educational buildings, offices etc., is bound to result in greater stress on accurate, reliable and frequent assessment of work place pollution and worker-exposure. Use additionally impinge tray with HVS sampler simultaneously sample gaseous pollutants.

Calculation for particulates

a. Initial Manometer Reading =

b. Final Manometer Reading =

c. Initial Filter Paper Weight =

d. Final Filter Paper Weight =

e. Initial Cyclone Cup Weight =

f. Final Cyclone Cup Weight =

g. Total Suspended Particulate Matter Concentration =

Expt.No.19

Sound Level Meter

Objective

A sound level meter is used for acoustic (sound that travels through air) measurements. It is commonly a hand-held instrument with a microphone. The diaphragm of the microphone responds to changes in air pressure caused by sound waves.

Principle

The principle allows to periodically checking sound level meter performance, especially the microphone performance which is the sensing element of the instrument.

Instruments;

Sound Level Meter: A meter meeting the requirements of the Type 1 meter described in ANSI S1.4 is to be used. Frequency Analyzer. An octave or one-third octave band filter set meeting the requirements for Class II or III filters respectively, of ANSI S1.11 is to be used. 4.3 Calibration. During each series of measurements, an acoustical calibrator with an accuracy of ±0.5 dB shall be applied to the microphone for checking the calibration of the entire measuring system at one or more frequencies over the frequency range of interest. The calibrator shall be checked at the manufacturer's recommended intervals or at least once every year to verify that its output has not changed. In addition, an electrical calibration of the instrumentation system over the entire frequency range of interest shall be performed periodically as recommended by the manufacturer, but at intervals of not more than two years.

Figure

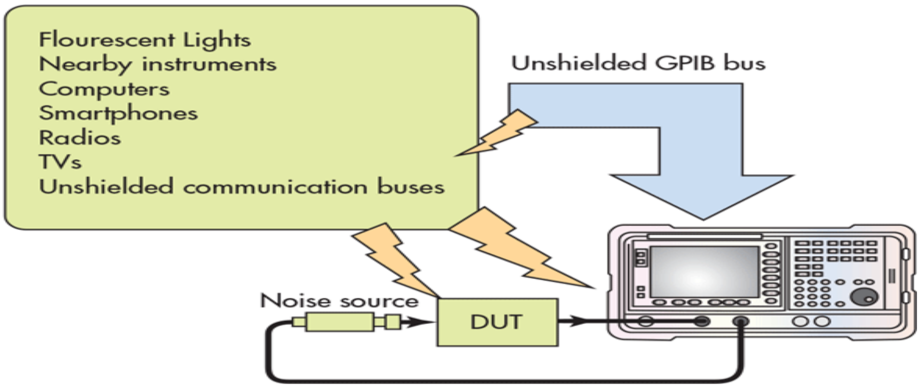

Figure: Sound Level Meter

Sound Measurements and Calculation Procedures

Measurement Points. The measurement points shall be determined relative to a reference parallelepiped, which is the smallest imaginary rectangular parallelepiped that will enclose the machine (Figure 1). Minor projections from the machine are disregarded in determining the size of the reference parallelepiped. The measurement points shall be positioned on the surface of a measurement parallelepiped whose planes are one meter out from the vertical sides of the reference parallelepiped. Key Measurement Points are located at the center of each vertical plane of the measurement parallelepiped. The remaining measurement points are at one meter intervals on the measurement planes starting from the key points. All measurement points are at a height of 1.5 meters from the floor. If the shortest distance between two measurement points at a corner of the measurement parallelepiped is less than one meter, the point nearest to the corner shall be eliminated. The total number of points on the measurement parallelepiped is N.

Environmental Engineering Lab Viva Questions

1) What is used as the standard unit of color?
When 1mg of potassium chloroplatinate (K_2PtCl_6) is added to 1 liter of colorless pure water is said to have one unit of color. Usually 500 mg of potassium chloroplatinate is added to 1 liter of colorless pure water to get 500 units of color. To this Cobaltous Chloride ($CoCl_26H_2O$) is added to provide proper tint.

2) What limit is generally placed on color & why are such standard set?
While 5 units of color is desirable in water to permit its natural color. Water should not have color greater than 20 units. This standard is set because deep color is obnoxious & one would not like to drink such water.

3) What is P_H value explain?
It is the logarithm of reciprocal of hydrogen ion concentration present in water. It is thus an indicator of the acidity or alkalinity of water sample.

4) What is hardness of water? What are the chemicals causing hardness?
Hardness is that characteristic which prevents the formation of leather or foam when such hard waters are mixed with soap. It is usually caused by the presence of calcium & magnesium salts present in water, which scum by reaction with soap.

5) Why is it required to maintain to a significant dissolved oxygen concentration in rivers and streams? Explain.
Aerobic bacteria need dissolved oxygen for their life. Depletion of dissolved oxygen indicates aerobic acidity. Fish and other aquatic life require dissolved oxygen for their survival. For the growth and reproduction aquatic organisms it is desirable to maintain significant dissolved oxygen concentration in rivers and streams.

6) State a few applications of BOD test data in Environmental Engineering practice.
BOD is the principal test applied test to domestic and industrial wastes to determine strength in terms of oxygen required for stabilization. BOD test is the only test available for control of pollution in reveres and streams where organic loading must be restricted to certain designed dissolved oxygen for desired aquatic life. BOD data is important in the design of treatment units, particularly in tricking filters and activated sludge units. Their efficiency of operation also tested by BOD data

7) What is the limitation of COD test?
The chief limitation of the COD is its inability to differentiate between biologically oxidisable and biologically inert organic matter. In addition it does not provide any evidence of the rate at which the biologically active materials would be stabilized under conditions that exist in nature.

8) What are the advantages of COD test over BOD test?
The major advantage of COD test is the short time required for evaluation. The determination can be made in about 3 hours rather than 5 days required for the measurement of BOD. For this reason it is used as a substitute for BOD test in much experience has been accumulated to establish reliable correction factors.

9) In what form does nitrogen normally occur in natural waters.
Nitrogen occurs in natural water as Nitrates, which are formed by bacterial action. The nitrates so formed may serve as fertilizer for plants. Nitrogen produced in excess of the needs of the plant life is carried away in water percolating through the soil which has

become unable to hold them. This frequently results in relatively high concentrations of nitrates in ground waters.

10) What is hardness of water? Explain.
Hardness of water is that characteristic which prevents the formation of sufficient leather or foam, when such hard waters are mixed with soap. Hard waters are undesirable as they may lead together soap consumption, scaling of boilers, causing corrosion and incrustation of pipes & making food tasteless etc.
If bicarbonates and carbonates of calcium and magnesium are present in water the water is rendered hard temporarily as this hardness can be removed to some extent by boiling or to full extent by adding lime to water. Such hard is known as temporary hardness or carbonate hardness.
On the other hand if sulphates, chlorides and nitrates of calcium or magnesium are present in water, they cannot be removed at all by simple boiling and such hardness is known as permanent hardness or non-carbonate hardness.

11) What are the methods of making hard water portable?
Temporary hardness can be removed by
i. Boiling
ii. Adding lime.
Permanent hardness can be removed by
i. Lime soda process
ii. Zeolite process.
iii. De-mineralization process.

22. What are toxic metals? List.
Metals, which are harmful to the human body, are regarded as toxic metals. Some of the toxic metals are: Iron Manganese Lead Copper etc.

23. What is the significance of fluoride in water?
A Fluoride concentration of less than 0.8-1ppm may be harmful & may cause dental caries (tooth with decay) due to the formation of excessive cavities in the teeth of young children during calcinations of their permanent teeth. Higher fluoride concentration greater than 1.5 ppm or so may again be harmful, causing spotting & discoloration of teeth, (a disease called fluorosis) which with continued consumption of fluorides may even cause deformation of bones.

24. What are water borne diseases?
Diseases, which spread primarily through contaminated waters, are called water borne diseases.

25. A decrease in pH of one unit represent how much of an increase in hydrogen ion concentration?
10 times

26. A 50% decrease in hydrogen ion concentration represent how much of an increase in pH units?
0.3 times

27. What principle is involved in pH meter?
The hydrogen ion concentration present in a sample is directly proportional to potential difference developed between two electrodes (glass electrode and calomel electrode).

28. What is meant by pH index?
The reactivity of water or pH index is an index of alkalinity or acidity is expressed quantitatively by concentration of hydrogen ions.

29. Define electrical conductivity of water.
Electrical conductivity is a measure of capacity of water to carry electrical current due to presence of dissolved dissociated substances.

30. What is the relationship between TDS and electrical conductivity?
TDS (mg/L) = 0.55 to 0.9 x specific conductance (micrompos/cm).
31. What is the value of TDS, if electrical conductivity of water is 2.35 mhos and constant 0.8?
1880 mg/l.

32. Conductivity data is used to assess source of pollution in water distribution. How?
Collect samples along the length of pipe at suitable distances, where pollution is likely to be occurred and measure the conductivity value at any point is considered as source of pollution at that point.

33. What is unit of measurement of electrical conductivity?
Mhos/cm.

34. What are the causes of turbidity in water?
Turbidity in water is due to presence of organic and inorganic suspend matter such as clay, silt, colloidal hydrolyzed (partially) metal ions and oxides of various cations, silica, humic and fulvic acids. Pigments of plant decay and metabolites may also cause turbidity in waters.

35. What units are generally used for measuring turbidity?
(a) mg/l or ppm (b) Jackson Turbidity Unit (c) Formazin Turbidity Unit and (d) Nephelo Turbidity Unit.

36. What is the difference between visual method and instrument method in turbidity measurement?
In visual method, amount of interference to the passage of light is directly proportional to turbidity. In instrument method, the amount of intensity of light scattered or absorption is directly proportional to turbidity.

37. Turbidity is not a direct quantitative measurement of suspended solids. Why?
Turbidity of water is measured based on absorption and scattering of light by particles. The absorption and scattering of particles are influenced by both size and surface characteristics of the suspended material. For example one small pebble in a glass of water would not produce any turbidity. If this pebble were crushed into thousands of colloidal size, a measurable turbidity would result, even though the mass of solids had not changed.

38. What is meant by coefficient of fitness? Mention its importance.
The ratio of the weight of suspended solids to the turbidity is called the coefficient of fitness. The ratio is directly proportional to the turbidity in water.

39. What limit is fixed on turbidity for drinking water by various organizations?
Bureau of Indian Standards 10 NTU
Indian Council of Medical Research 5 NTU

World Health Organization 5 NTU

40. What is basic difference in principle involved in Jackson turbidometer and Nephelo turbidometer?
Jackson turbidometer is based on light absorption, while Nephelo turbidometer on light scattering.
41. What is the desirable turbidity in alum coagulated, flocculated and clarified water before enter into rapid sand filter?
20 NTU.
42. Name the chemical added to the turbidity standards to prevent the growth of bacterial or algae.
$HgCl_2$ (mercuric chloride).
43. What is the general coagulation used for removal of turbidity in water?
Alum [$Al_2 (SO_4)_3 18 H_2O$].
44. Define a solid with reference to Environmental Engineering.
A solid is a residue remains in water after evaporation and drying at 103° C to 105° C.
45. The amount of undissolved, colloidal and suspended matter in water is increased with ....
Domestic and Industrial pollution.
46. Volatile solids are determined as loss of weight of dry residue at 600° C. Why?
At 600° C organic solids are converted into CO_2 and H_2O and inorganic salts are remained as ash.

47. The permissible total dissolved solids for drinking water according to Indian Standards is ------- mg/l and tolerable limit is---------- mg/l.
500, 1500.

48. What is the significance of determining settleable solids in water and wastewater by Imhoff cone?
To establish the need for provision of plain sedimentation units and space required for sludge occupation.

49. A domestic wastewater contains 400 mg/l of suspended solids. Primary sedimentation facilities to remove 65%. Approximately how many liters of sludge containing 5% solids will produce per million liters of wastewater settled?
5200 liters of sludge.

50. What is the normal size of colloid in water?
10^{-6} to 10^{-3} mm.

51. Colloidal solids in water are removed by -------
Alum coagulation, flocculation followed by clarification.

52. What methods are available for the removal of inorganic dissolved solids in water?
Reverse osomosis and electrodialysis.

53. What is the best available method for removal of dissolved organic solids from water and wastewater?
Biological treatment process.

54. What is meant by acidity in water and wastewater?
Acidity is defined as the capacity of substances contained in the water to take up hydroxyl ions (OH^-) to reach a defined pH value (0 to 8.2).

55. Can you estimate mineral acidity from sample, if added methyl organ indicator to sample turns to yellow?
Mineral acidity in the sample is absent.

56. In acidity and alkalinity measurements, the titrant used (NaOH or H_2SO_4) is usually N/50. Why?
Both acidity and alkalinity are expressed in terms of CaCO3, whose equivalent weight is 50. 1 ml of N/50 solution therefore corresponds to 1 mg acidity or alkalinity and the calculation becomes simple.

57. What is the range of pH where acidity is present in water?
0 to 8.2.

58. What are constituents that cause acidity in water?
Mineral acids and carbon dioxide.

59. Acidity in water is removed by neutralization with -------
Lime or NaOH.

60. Acid water are of concern because of their ----------characteristics.
Corrosive.

61. Mineral acidity is determined by ------- indicator with titration 0.02 N NaOH.
Methyl orange.

62. The permissible limit of total acidity, as CaCO3 in water used for R.C.C. works should be not more than ------- mg/l.

63. Name any four industries, which discharge acid effluents.
1) Electroplating industry
2) Fertilizer industry
3) Distillery industry
4) Mining industry.

64. What is meant by alkalinity in water and wastewater?
It is defined as the capacity of substances contained in water to take up hydroxium (H_3^+0) to reach a defined p_H value (4.3 to 14).

65. 200 ml of a sample of water required 20 ml of N/50 H2SO4 using methyl orange as indicator, but did not give any coloration with phenolphthalein what type of alkalinity you suspect to be present?
The sample did not turn pink on the addition of phenolphthalein, CO_3^{-2} is present.

66. What are constituents that cause alkalinity in water?
Bicarbonates, carbonates and hydroxides of calcium, magnesium, sodium and potassium.

67. At what p_H range the alkalinity is present in water?
4.3 to 14.0.

68. How is alkalinity removed from water?
Neutralization with H_2SO_4 or HCL.

69. The permissible limit of alkalinity in water to be used for R.C.C. works is less than ---- mg/l.
250.

70. What is the need for pH adjusts to 7 to 8 sample in chlorides estimation?
The pH must be in the range of 7 to 8 because Ag^+ is precipitated as AgOH at high pH levels and CrO_4^{-2} is converted to $Cr_2O_7^{-2}$ at low pH levels.

71. What is the effect of temperature on the determination of chlorides?
The solubility of Ag_2CrO_4 increases with rising temperature and more $AgNO_3$ will have to be added to get the end point. To avoid this, the titration should be performed at room temperature.

72. Would the analytical results by the Mohr method for chlorides be higher, lower, or the same as the true value if an excess of indicator were accidentally added to the sample? Why?
The analytic result is higher because Ag_2CrO_4 may form too soon enough.

73. What is meant by indicator blank correction?
The excess of the titrant that must be added before eye can detect the colour change due to the reaction between titrant and indicator is called the indicator blank correction. This must be determined and subtracted from all titrations.

74. What are the reasons for non-salty taste of water, even chlorides concentration more than 1000 mg/l?
The water sample contains chlorides of calcium and magnesium.

75. What process is to be used to remove excess chlorides in water?
1) Reverse osmosis method
2) Electrodialysis method
3) Solar distillation method.

76. What are the problems associated with handling and treatment of wastewater due to sulphates?
Odour and sewer corrosion problems are occurred due to conversion of sulphates to sulphates.

77. What will be the effect on human beings due to excess of sulphates in drinking water?
If the sulphate present in drinking is more than 250 mg/l, it shows cathartic effect on human beings.

78. What is the purpose of digestion of the sample in gravimetric analysis for sulphates?
Ans: The colloidal state of barium sulphates precipitate is converted into crystalline form of barium sulphates due to digestion of the sample.

79. What methods are to be used for determination of sulphates?
(i) Gravimetric method
(ii) Turbidimetric method
(iii) Volumetric method (titration).

80. What is the permissible limit of sulphates in drinking water according to B.I.S.?
150 mg/l.