SCHEME : K

Name : _____

Roll No. : _____ Year : 20___ 20___

Exam Seat No. : _____

LABORATORY MANUAL FOR

WATER AND WASTEWATER ENGINEERING (314314)

CIVIL ENGINEERING GROUP

MAHARASHTRA STATE BOARD OF
TECHNICAL EDUCATION, MUMBAI
(Autonomous) (ISO 9001: 2015) (ISO/IEC 27001:2013)

VISION:

To ensure that the Diploma level Technical Education constantly matches the latest requirements of Technology and industry and includes the all-round personal development of students including social concerns and to become globally competitive, technology led organization.

MISSION:

To provide high quality technical and managerial manpower, information and consultancy services to the industry and community to enable the industry and community to face the challenging technological & environmental challenges.

QUALITY POLICY:

We, at MSBTE are committed to offer the best in class academic services to the students and institutes to enhance the delight of industry and society. This will be achieved through continual improvement in management practices adopted in the process of curriculum design, development, implementation, evaluation and monitoring system along with adequate faculty development programmes.

CORE VALUES:

MSBTE believes in the following:

- Skill development in line with industry requirements
- Industry readiness and improved employability of Diploma holders
- Synergistic relationship with industry
- Collective and Cooperative development of all stake holders
- Technological interventions in societal development
- Access to uniform quality technical education.

A Laboratory Manual

For

WATER AND WASTE WATER ENGINEERING

(314314)

SEMESER-IV

“K-SCHEME”

(CE/CR/CS/LE)

Maharashtra State

Board of Technical Education, Mumbai.

(Autonomous) (ISO: 9001: 2015) (ISO/IEC 27001:2013)

Maharashtra State Board of Technical Education, Mumbai
(Autonomous) (ISO: 9001: 2015) (ISO/IEC 27001:2013)
4th Floor, Government Polytechnic Building, 49, Kherwadi,
Bandra (East), Mumbai – 400051,
(Printed On _____, 2024)

Maharashtra State
Board of Technical Education, Mumbai.

Certificate

This is to certify that Mr./Ms. ……Roll No……of Fourth semester of Diploma in ……..……of Institute,……..…… ……(Code:……)has completed the term work satisfactorily in course **Water And Waste Water Engineering (314314)** for the academic year 20…… to 20…… as prescribed in the curriculum**.**

Place: …… Enrollment No: ……..

Date: ……. Exam. Seat No: ……

Subject teacher **Head of the Department** **Principal**

Seal of Institution

PREFACE

The development of the critically important industry-relevant abilities and skills is the main goal of any engineering laboratory or field work in the technical education system. In light of this, MSBTE developed the most recent "K" Scheme curricula for engineering diploma programs, emphasizing outcome-based learning. As a result, a sizable portion of the program is dedicated to practical work. This demonstrates how crucial laboratory work is in helping teachers, instructors, and students understand that every minute of lab time must be used efficiently to create these outcomes rather than wasting it on unnecessary activities. Every practical has thus been created to operate as a "vehicle" to help each student acquire this industry-identified capability in order to ensure the effective implementation of this outcome-based curriculum. The "chalk and duster" practice in the classroom is a challenging way to build practical skills. As a result, the development team of the "K" scheme laboratory manual focused on the intended results when creating the practical, as opposed to the customary approach of performing practical's to "verify the theory".

This lab manual is intended to support all parties involved, particularly the students, instructors, and teachers, in helping the students achieve the pre-established goals. It is required of every student to read through the relevant practical process in its entirety and comprehend the bare minimum of theoretical background related to the practical at least one day in advance of the practical. As a crucial starting point for carrying out the practical, each exercise in this handbook starts with establishing the competency, industry-relevant skills, course outcomes, and practical results. After that, the students will learn about the abilities they will acquire through the process outlined there and the safety measures that must be followed, which will enable them to use in addressing real-world situations in their professional life.

This manual also offers guidance to educators on how to manage resources so that students follow protocols and safety measures methodically and meet learning objectives. This allows teachers and instructors to effectively support student-centered lab activities through each practical exercise.

Today's globalized world has witnessed tremendous technological breakthroughs in surveying equipment and technology. Currently available accurate digital surveying tools are employed because of their speed, precision, and ease of use. The disciplines of civil engineering, mining engineering, environmental engineering, transportation engineering, and marine engineering heavily rely on these tools and applications. Given the importance of remote sensing and Geographic Information Systems (GIS) and their widespread usage in mapping and storing spatial data, it is expected that students will have a basic understanding of these subjects in order to use them in the field. Students who complete this course will have the necessary abilities and competences to perform tasks linked to surveys.

Although best possible care has been taken to check for errors (if any) in this laboratory manual, perfection may elude us as this is the first edition of this manual. Any errors and suggestions for improvement are solicited and highly welcome.

Program outcome (POs)

PO 1. Basic & Discipline specific knowledge: Apply knowledge of basic mathematics, sciences and engineering fundamentals and engineering specialization to solve the engineering problems.

PO 2. Problem Analysis: Identify and analyze well defined engineering problems using codified standard methods.

PO 3. Design /Development Solutions: Design solutions for well-defined technical problems and assist with the design of systems components or processes to meet specified needs.

PO 4. Engineering tools experimentation and testing: Apply modern engineering tools and appropriate technique to conduct standard tests and measurements.

PO 5. Engineering practices for society sustainability and environment: Apply appropriate technology in context of society, sustainability, environment and ethical practices.

PO 6. Project Management: Use engineering management principles individually, as a team member or a leader to manage projects and effectively communicate about well-defined engineering activities.

PO 7. Lifelong learning: Ability to analyze individual needs and engage in updating in context of technological changes.

List of Relevant Skills

On the successful completion of the course the students will acquire the required industry relevant skills and they will be able to:

1. Interpret the water demand and quality of water
2. Apply the water purification processes.
3. Select the distribution system and pipe network for water supply.
4. Interpret the plumbing system and sewer appurtenances.
5. Apply the waste water treatment processes.
6. How to use digital instrument for checking quality of water.

Guidelines to teachers

1. Teacher should provide the guideline with demonstration of practical to the students with all features.
2. Teacher shall explain prior concepts to the students before starting of each practical.
3. Involve students in performance of each practical.
4. Teacher should ensure that the respective skills and competencies are developed in the students after the completion of the practical exercise.
5. Teachers should give opportunity to students for hands on experience after the demonstration.
6. Teacher is expected to share the skills and competencies to be developed in the students.
7. Teacher may provide additional knowledge and skills to the students even though not covered in the manual but are expected the students by the industry.
8. Finally give practical assignment and assess the performance of students based on task assigned to check whether it is as per the instructions.

Instructions to Students

1. Organize the work in the group and make record all programs.
2. Students shall develop maintenance skill as expected by industries.
3. Student shall attempt to develop related hand-on skills and gain confidence.
4. Student shall develop the habits of evolving more ideas, innovations, skills etc. those included in scope of manual
5. Student shall refer technical magazines.
6. Student should develop habit to submit the practical on date and time.
7. Student should well prepare while submitting write-up of exercise.
8. Attach /paste separate papers wherever necessary.

Practical Course outcome matrix:

- CO1 - Interpret the water demand and quality of water.
- CO2 - Apply the water purification processes.
- CO3 -Select the distribution system and pipe network for water supply.
- CO4 - Interpret the plumbing system and sewer appurtenances.
- CO5 - Apply the waste water treatment processes.

Pr. No.	Title of the Practical	Mapped Course Outcome				
		CO 01	CO 02	CO 03	CO 04	CO 05
01	*Determination of pH value of water sample.	√	--	--	--	--
02	*Determination of the turbidity of the sample of water.	√	--	--	--	--
03	*Determination of suspended solids, dissolved solids and total solids of a water sample.	√	--	--	--	--
04	Determination of the TDS by using a portable digital TDS meter.	√	--	--	--	--
05	Determination of the dissolved oxygen in a given sample of water.	√	--	--	--	--
06	*Determination of residual chlorine in the sample of water.	--	√	--	--	--
07	*Preparation of report on-site visit to the nearby water treatment plant.	--	√	--	--	--
08	*Determination of the optimum dose of coagulant in the given raw water sample by jar test.	--	√	--	--	--
09	Demonstration of water purifier based on its components and working, (RO purifier).	--	√	--	--	--
10	*Illustration of various joints used in water supply pipeline through sketches.	--	--	√	--	--
11	Preparation of a sketch of one pipe, two pipe system and layout plan for drainage for a residential building.	--	--	--	√	--
12	Determination of BOD of a given sample of wastewater.	--	--	--	--	√
13	*Determination of the dissolved oxygen in the given sample of wastewater.	--	--	--	--	√
14	Determination of COD of a given sample of wastewater.	--	--	--	--	√
15	Preparation of a report on a field visit to the wastewater treatment plant.	--	--	--	--	√

CONTENTPAGE

List of Practical's and Formative Assessment sheet.

Pr. No	Title of the Practical	Page No.	Date of performance	Date of Submission	Assessment marks	Dated sign of teacher	Remarks (if any)
01	*Determination of pH value of water sample.	01					
02	*Determination of the turbidity of the sample of water.	12					
03	*Determination of suspended solids, dissolved solids and total solids of a water sample.	18					
04	Determination of the TDS by using a portable digital TDS meter.	25					
05	Determination of the dissolved oxygen in a given sample of water.	30					
06	*Determination of residual chlorine in the sample of water.	36					
07	*Preparation of report on-site visit to the nearby water treatment plant.	42					
08	*Determination of the optimum dose of coagulant in the given raw water sample by jar test.	49					
09	Demonstration of water purifier based on its components and working, (RO purifier).	54					
10	*Illustration of various joints used in water supply pipeline through sketches.	59					
11	Preparation of a sketch of one pipe, two pipe system and layout plan for drainage for a residential building.	65					
12	Determination of BOD of a given sample of wastewater.	71					
13	*Determination of the dissolved oxygen in the given sample of wastewater.	79					
14	Determination of COD of a given sample of wastewater.	85					
15	Preparation of a report on a field visit to the wastewater treatment plant.	91					
Total marks :							

These marks are to be transferred in pro-forma published by MSBTE.

- '*' Marked Practical (LLOs) are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

Practical No: 01 Determination of pH value of water sample.

I. Practical Significance:

The pH level of water indicates the hydrogen potential present in water. This practical is significant to identify the alkanity and acidity of the water under consideration. This practical is important to decide the suitability of water for various purposes including drinking, manufacturing etc. It is also important to decide the treatment method to change the acidic and basic nature of water. The determination pH of water present in water sources helps engineers to design the water carriage system i.e. pipe network by ensuring corrosion control.

II. Industry/Employer expected outcome(s):

- Identify the sources and characteristics of water and wastewater.

III. Course Level Learning Outcome (COs):

- CO 1- Interpret the water demand and quality of water.

IV. Laboratory Learning Outcome (LLO):

- LLO 1.1 - Determine the pH value of the given sample of water.

V. Relevant Affective Domain related Outcome(s):

- Follow safety practices.
- Practice good housekeeping.
- Demonstrate working as leader or a team leader.
- Maintain tools and equipment.
- Follow ethical practices

VI. Relevant Theoretical Background:

The pH value shows the potential of hydrogen ion concentration present in water sample. The term pH refers to the measure of hydrogen ion concentration in a solution and defined as the negative log of H^+ ions concentration in water. It is an indicator of acidity and alkalinity of water sample. The value of pH is inversely proportional to the temperature.

$$\mathbf{pH = - \log (H)}$$

Where H^+ is the concentration of hydrogen ions in moles per liter of water.

The value of pH, 0 to little less than 7 are termed as acidic and values of pH little above 7 to 14 are termed as alkaline. When the concentration of H+ and OH – are equal then it is termed as neutral (pH =7). Acceptable limit of pH for drinking water is 6.5 to 8.5 as per WHO. For pH values greater than pH 10, the rusting rate seems to fall as pH is increased. Low pH value will cause acidosis of kidneys and lungs.

Generally the pH of water is determined by using digital pH meter effectively than other methods. It requires less time to obtain the value. The accuracy of this method is more than other methods.

VII. Experimental Set-up:

Figure 1:Digital pH meter.

VIII. Required resources/equipment:

Sr. No.	Particulars	Specification	Quantity	Remark
01	Digital pH meter	4 Digit display (LED), D to 1000 mV, Resolution: 0.01 pH manual temp., Compensation :O^0C to 80^0C	1 No.	Per batch
02	Beaker	Standard glassware beaker of 500 ml. capacity	3 No	Per batch

IX. Precautions to be followed:

1. Use clean and dry beakers.
2. The Standardization of pH meter is essential before use.
3. Clean and wipe out electrode every time of immersion.
4. Record reading in steady condition.

X. Procedure:

(A) Preparation of Buffer solution:

1. Take 100 m1of distilled water ina beaker.
2. Put the buffer tablet in the distilled water.
3. Disperse the buffer tablet in the distilled water by continuously stirring action.
4. Prepare the buffer solution of pH 4.0, 7.0 and 9.2

(B) Calibration of the instrument:

1. First rinse the electrode with distilled water and dries its bulb by using tissue paper.
2. Dip the electrode ina buffer solution of pH 7.
3. Set the temperature control to the room temperature i.e. 27°C.
4. Set the function selector to pH position and adjust the CALIBRATE control until the meter displays the precise pH of buffer solution.
5. Now the set the function selector switched to STAND BY position.
6. Remove the electrode from buffer solution. Wash it with distilled water and wipe out with tissue paper. Repeat the above procedure for calibration with buffer solution of 4.0 and 9.2 pH values.

(C) Operation of Instrument:

1. Calibrate the pH meter with two standard buffer solutions as per the above procedure.
2. Clean and rinse the electrode thoroughly with distilled water and carefully wipe with tissue paper.
3. Dip the electrode into the sample of solution. Stir the solution by keeping on magnetic stirrer or stir it manually.
4. Wait up to 1minute for steady reading +0.1pH units.
5. Record reading in steady condition after one minute.

XI. Observation:

Sr. No.	Particulars	Observed pH value for sample No.		Average value of pH of water
	Type of Sample	1	2	
1	Treated water (Tap water)			
2	Untreated Surface water (Lake, River etc.)			
3	Untreated Subsurface water (Bore well water)			

Sample Calculation

For Observation No.....

Average pH = (pH (1) +pH (2)) /2 =.....

Average pH of Tap water =·.....

XII. Result:

The average value of untreated or raw water is observed as..... .

The average pH value of untreated bore well water is observed as.....

The average pH value of untreated surface water is observed as.....

XIII. Interpretation of results *(Give meaning of the above obtained results)***:**

XIV. Conclusions and Recommendations *(Actions/decisions to be taken based on the interpretation of results):*

XV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. State the general values of pH of bore well and surface water.
2. Give the reason of variation in pH value due to temperature.
3. Justify the difference in pH values of above samples.
4. Write other methods to determine the pH value of water.
5. Suggest the treatment for pH to obtain it in acceptable limit.
6. State how pH value will effect on the other treatment processes of purification.
7. Write effects of water having pH less or more than limiting value on distribution network and human being.
8. Comment on seasonal variation in pH value of surface and subsurface water.
9. Suggest chemicals used for adjustment of pH of water.
10. State the importance of pH value of water to be used in industrial use.

Space for Answer

XVI. Assessment Scheme

Sr. No.	Performance Indicators	Weightage	Marks Obtained
A.	**Process Related (15 marks)**	**60%**	
1.	Preparation of buffer solution	10%	
2.	Calibration of Instrument	20%	
3.	Operation of Instrument	30%	
B.	**Product Related (10 marks)**	**40%**	
3.	Conclusion of practical	10%	
4.	Answers to practical based questions	20%	
5.	Submission of Report in time	10%	
C.	**Total marks (25 marks)**	**100%**	

Marks Obtained			**Dated sign of Teacher**
Process Related(15)	**Product Related (10)**	**Total (25)**	

Practical No: 02 **Determination of the turbidity of the sample of water**.

I. Practical Significance:

The suspended solid and colloidal particles present causes turbidity in water. Turbid water containing high bacteria levels, pathogens, or particles promotes growth of harmful organisms. This practical is important to find turbidity of given water sample, which further facilitate to decide necessary treatments i.e. chemical coagulation, clariflocculation, filtration, disinfection etc. The determination of turbidity is applicable in water treatment, sewage treatment, dairy and brewing industries. Thus this practical is significant in monitoring the turbidity nature of various fluids.

II. Industry/Employer expected outcome(s):

- Identify the sources and characteristics of water and wastewater.

III. Course Level Learning Outcome (COs):

- CO 1- Interpret the water demand and quality of water.

IV. Laboratory Learning Outcome (LLO):

- LLO 2.1 - Determine the turbidity of the given sample of water.

V. Relevant Affective Domain related Outcome(s):

- Follow safety practices.
- Practice good housekeeping.
- Demonstrate working as leader or a team leader.
- Maintain tools and equipment.
- Follow ethical practices

VI. Relevant Theoretical Background:

Turbidity is the degree to which a transparent liquid scatters light, usually a measure of the amount of suspended material in the liquid. Even after settlement of heavy particles, small tiny particles remain in suspension and water appears turbid. The following types of solids are present in water causing turbidity.

1. **Total Solids (TS):** This is the matter that remains as residue upon evaporation and drying of water sample at 103°C - 105°C in an oven. This is called Total solids.
2. **Suspended Solids (SS):** These are the solids in raw water/wastewater that remain present on filter paper after filtering the sample through a fine filter.(Whatman's Filter paper No.42).The suspended solids contain much of the organic matter.
3. **Dissolved Solids (DS):** The filtrate remaining in beaker after filtering the sample through filter contains dissolved solids. It includes mainly inorganic salts, small amount of organic matter and dissolved gases.
4. **Fixed Solids:** The residue remain after the ignition of the sample in muffle furnace at 550^{o}c represents the fixed solids. These represent the organic matter in water.
5. **Volatile Solids:** The difference between the suspended solids and fixed solids represent the amount of organic matter present in water.

VII. Experimental Set-up:

Figure 1: Digital Turbidity Meter.

VIII. Required resources/equipment:

Sr. No.	Particulars	Specification	Quantity	Remark
01	Digital Turbidity Meter	Range O to 200NTU, Resolution lNTU, Accuracy:±3% FS, ± lDigit, Display$3^{1/2}$ Digit 7- Segment LED Light Source6V, 0.3Amp tungsten Lamp, Detector: Photodiode, Sample System:30 mm Clear Glass Test Tubes, Power230 V ± 10% AC, 50 Hz, Accessories Test tube Set of 5, operation Manual, Dust Cover	1 No.	Per batch
02	Beaker	Standard glassware beaker of 500 ml. capacity	3 No	Per batch

IX. Precautions to be followed:

1. Use clean and dry beakers for accuracy.
2. The standardization of turbidity meter is essential before use.
3. Clean and wipe out electrode before immersion for each observation.
4. Record reading in steady state condition of sample.

X. Procedure:

(A) Calibration and Standardization:

Turbidity Meter calibration: The manufacturer's operating instructions should be followed. Measure standards on the turbidity meter covering the range of interest. If the instrument is already calibrated in standard turbidity units, this procedure will check the accuracy of the calibration scales. At least one standard should run in each instrument range to be used. Some instruments permit adjustments of sensitivity so that scale values will correspond to turbidities. Solid standards, such as those made of Lucite blocks, should never be used due to potential calibration changes caused by surface scratches. If a pre-calibrated scale is not supplied, calibration curves should be prepared for each range of the instrument.

(B) Measurement:

1. Turbidities less than 40 units: lf possible, allow samples to come to room temperature before analysis. Mix the sample to thoroughly disperse the solids present in it. Wait until air bubbles disappear and then pour the sample into the turbid meter tube. Read the turbidity directly from the instrument scale or from the appropriate calibration curve.
2. Turbidities exceeding 40 units: Dilute the sample with one or more volumes of turbidity-free water until the turbidity falls below 40 units. The turbidity of the original sample is then computed from the turbidity of the diluted sample and the dilution factor. For example, if 5 volumes of turbidity-free water were added to 1 volume of sample, and the diluted sample showed a turbidity of 30 units, then the turbidity of the original sample was 180 units.
3. Some Turbidity Meters are equipped with several separate scales. The higher scales are to be used only as indicators of required dilution volumes to reduce readings to less than 40 NTU.

XI. Observation:

Sr. No.	Particulars	Observed turbidity value for sample No.		Average Turbidity value (NTU/JTU)
	Type of Sample	1	2	
1	Standard water (Distilled water)			
2	Treated water (Tap water)			
3	Untreated Surface water (Lake, River etc.)			
4	Untreated Subsurface water (Borewell water)			

Sample Calculation

For Observation No.....

Average Turbidity = (Reading (1)+Reading (2)) /2 = ...

Average Turbidity of water sample l.=.....NTU

XII. Result:

The average turbidity value of untreated or standard water is observed as.....NTU.

The average turbidity value of untreated or raw water is observed as.....NTU

The average turbidity value of untreated bore well water is observed as .....NTU

The average turbidity value of untreated surface water is observed as .....NTU

XIII. Interpretation of results *(Give meaning of the above obtained results)***:**

XIV. Conclusions and Recommendations *(Actions/decisions to be taken based on the interpretation of results):*

XV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. State the location of bore and surface water sample.
2. Write the practical applications of determination of turbidity.
3. Explain the importance of calibration of equipment before measurement of turbidity.
4. State the acceptable limit of turbidity value for drinking water.
5. Suggest the treatment to reduce turbidity so as to obtain it in acceptable limit.
6. State how high turbidity will effect on the other treatment processes of purification.
7. Give the reason of high turbidity during rainy season.
8. Mention the ill effect of high turbid water.
9. State the standard permissible values of turbidity for potable water.

Space for Answer

XVI. Assessment Scheme

Sr. No.	Performance Indicators	Weightage	Marks Obtained
A.	**Process Related (15 marks)**	**60%**	
1.	Calibration of instrument	30%	
2.	Measurement of turbidity	30%	
B.	**Product Related (10 marks)**	**40%**	
3.	Conclusion of practical	10%	
4.	Answers to practical based questions	20%	
5.	Submission of Report in time	10%	
C.	**Total marks (25 marks)**	**100%**	

Marks Obtained			**Dated sign of Teacher**
Process Related(15)	**Product Related (10)**	**Total (25)**	

Practical No: 03 **Determination of suspended solids, dissolved solids and total solids of a water sample.**

I. Practical Significance:

Estimation of total dissolved solids is useful to determine whether the water is suitable for drinking purpose, agriculture and industrial purpose. The term "solids" is generally used when referring to any material suspended or dissolved in water that can be physically isolated either through filtration or through evaporation. Total solids are dissolved solids plus suspended and settle able solids in water. Dissolved solids consist of calcium, chlorides, nitrate, phosphorus, iron, sulfur, and other ions particles. Suspended solids include silt and clay particles, plankton, algae, fine organic debris,and other particulate matter.

II. Industry/Employer expected outcome(s):

- Identify the sources and characteristics of water and waste water.

III. Course Level Learning Outcome (COs):

- CO 1- Interpret the water demand and quality of water.

IV. Laboratory Learning Outcome (LLO):

- LLO 3.1 -Use the Whatman's filter paper to determine the suspended solids, dissolved solids and total solids of given sample of water.

V. Relevant Affective Domain related Outcome(s):

- Follow safety practices.
- Practice good housekeeping.
- Demonstrate working as leader or a team leader.
- Maintain tools and equipment.
- Follow ethical practices

VI. Relevant Theoretical Background:

1. **Total Solids (TS):** This is the matter that remains as residue upon evaporation and drying of water sample at 103°C - 105°C in an oven. This is called Total solids.
2. **Suspended Solids (SS):** These are the solids in raw water/wastewater that remain present on filter paper after filtering the sample through a fine filter. (Whatman's Filter paper No.42).The suspended solids contain much of the organic matter.
3. **Dissolved Solids (DS):** The filtrate remaining in beaker after filtering the sample through filter contains dissolved solids. It includes mainly inorganic salts, small amount of organic matter and dissolved gases.
4. **Fixed Solids:** The residue remain after the ignition of the sample in muffle furnace at 550ºc represents the fixed solids. These represent the organic matter in water.
5. **Volatile Solids:** The difference between the suspended solids and fixed solids represent the amount of organic matter present in water.

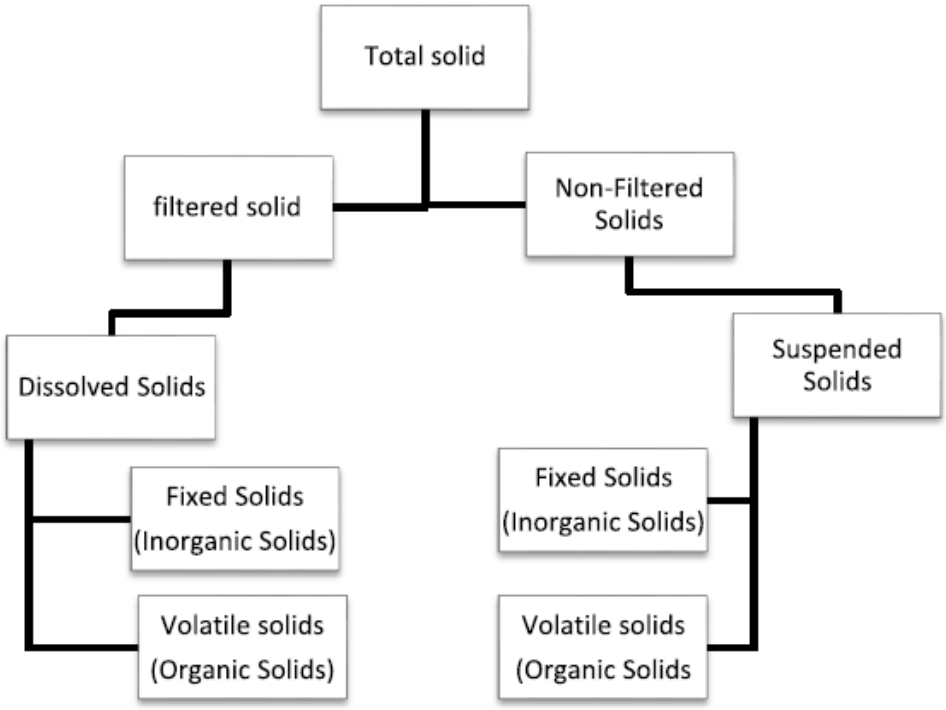


Figure 1: Classification of Total solids

VII. Experimental Set-up:

		
Whatman's Filter Paper	**Evaporating Dish**	**Hot Air Oven**

Figure 2: Apparatus and accessories for determination of solids

VIII. Required resources/equipment:

Sr. No.	Particulars	Specification	Quantity	Remark
01	Hot Air Oven	Electric Oven with digital control (Tempertature:300°C. 25 kg capacity)	1 No.	Per batch
02	Evaporating Dish	Standard glassware or Porcelain dish of 90 mm diameter and 100 m1 capacity.	3 Nos.	Per batch
03	Filter Papers	Whatman' s filter paper No.42	1 No.	Per batch
04	Weighing Balance	Electronic weighing balance of accuracy 0.01g	1 No.	Per batch

IX. Precautions to be followed:

1. Use clean and dry evaporating dish to avoid addition of accidental impurities.
2. Take weight and record carefully.
3. Maintain temperature of oven as per requirement.
4. Record reading in steady state condition of sample.

X. Procedure:

• For Total Solids:

1. Weigh the given porcelain dish (clean & dry) and record its weight (W1) gm.
2. Take 100m1of sample in porcelain dish.
3. Place the dish in an oven.
4. Evaporate to dryness in an oven at I03°C to 105°C for about 24 hrs.
5. Cool the dish and weight it (W4).

• For suspended solids.

1. Take a Whatman' s filter paper no. 42 and record its weight (W3) gm.
2. Filter 100 ml sample of water by using above filter paper.
3. Place the filter paper with residue in an oven and evaporate it to dryness.
4. Read the weight of the filter paper and residue (W4).

XI. Observation:

• For Total Solids (TS)

Sr. No.	Name of Water / Type of Sample	Volume of Sample(mL)	Weight of dish (gm)		
			Initial (W1)	Final (W2)	Difference (W2-W1)
1	Treated water (Tap water)				
2	Untreated Surface water (Lake, River etc.)				
3	Untreated Subsurface water (Borewell water)				

• For Suspended Solids (SS)

Sr. No.	Name of Water / Type of Sample	Volume of Sample(mL)	Weight of filter paper (gm)		
			Initial (W3)	Final (W4)	Difference (W4-W3)
1	Treated water (Tap water)				
2	Untreated Surface water (Lake, River etc.)				
3	Untreated Subsurface water (Borewell water)				

Sample Calculation

1. Concentration of Total Solids,(mg/L) = $\frac{(W2-W1)\ X\ 1000\ X\ 1000}{Volume\ of\ Sample\ in\ mL}$

   =_____

   =_____ mg/L

2. Concentration of Total Suspended Solids,(mg/L) = $\frac{(W4-W3)\ X\ 1000\ X\ 1000}{Volume\ of\ Sample\ in\ mL}$

   =_____

   =_____ mg/L

3. Concentration of Total Dissolved Solids,(mg/L) = (Conc. of TS) -(Conc. of SS)

=_____

=_____ mg/L

XII. Result:

The concentration of Total Solids and Suspended Solids in Treated water (Tap water) is observed as .....mg/L respectively.

The concentration of Total Solids and Suspended Solids in Untreated Surface water (Lake, River etc.)is observed as .....mg/L respectively.

The concentration of Total Solids and Suspended Solids in Untreated Subsurface water (Borewell water) is observed as .....mg/L respectively.

XIII. Interpretation of results *(Give meaning of the above obtained results)***:**

XIV. Conclusions and Recommendations *(Actions/decisions to be taken based on the interpretation of results):*

XV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. State the permissible limit of total solids in drinking water as per WHO guidelines.
2. Write the difference between "fixed “and "volatile" solids in water.
3. State the effects of high concentration of dissolved solids in water for domestic use.
4. State the effects of high concentration of dissolved solids in water for industrial use.
5. Explain the effects of solids in water treatment.
6. Suggest the treatment for bringing total solids in acceptable limit.
7. State the reason of high concentration of total solid in water.
8. Comment on seasonal variation in TS value of drinking water.
9. Suggest physical and chemical treatment for reducing TS, SS and TDS of water.

Space for Answer

XVI. Assessment Scheme

Sr. No.	Performance Indicators	Weightage	Marks Obtained
A.	**Process Related (15 marks)**	**60%**	
1.	Calibration of instrument	30%	
2.	Recording of observation	30%	
B.	**Product Related (10 marks)**	**40%**	
3.	Conclusion of practical	10%	
4.	Practical Question Answer	20%	
5.	Submission of Report in time	10%	
C.	**Total marks (25 marks)**	**100%**	

Marks Obtained			Dated sign of Teacher
Process Related(15)	**Product Related (10)**	**Total (25)**	

Practical No: 04 **Determination of the TDS by using a portable digital TDS meter.**

I. Practical Significance:

A TDS meter is a small handheld tool used to suggest the Total Dissolved Solids in a solution, typically water. Since dissolved ionized solids, including salts and minerals, boom the conductivity of an answer, a TDS meter measures the conductivity of the answer and estimates the TDS from that analyzing.

II. Industry/Employer expected outcome(s):

- Identify the sources and characteristics of water and waste water.

III. Course Level Learning Outcome (COs):

- CO 1- Interpret the water demand and quality of water.

IV. Laboratory Learning Outcome (LLO):

- LLO 4.1 - Use digital TDS meter to determine the TDS (Total Dissolved Solids).

V. Relevant Affective Domain related Outcome(s):

- Follow safety practices.
- Practice good housekeeping.
- Demonstrate working as leader or a team leader.
- Maintain tools and equipment.
- Follow ethical practices

VI. Relevant Theoretical Background:

- **Checking Drinking Water Quality:** Water with very low TDS will have flat taste and lacks in minerals. Water with high TDS is unsafe due to contamination and should not be used for drinking. TDS measurement helps in maintaining water with right TDS for cooking as well as drinking.
- **Checking Water Quality for Flowers and plants:** TDS measurement helps in making sure that you water vegetable and flowers plants with water having the appropriate nutrients.
- **Checking Tap Water Quality:** Helps to decide on the appropriate water purifier for your needs and can help avoid unnecessary expenditure.
- **Checking Filtered Water Quality:** Helps check water output from the purifier or filter so that you know when to replace the purifier or change its parts.
- **Checking Aquarium Water Quality:** Helps maintain proper TDS level of water in your fish tanks and aquariums similar to natural habitats.
- **Checking for Hard Water:** High TDS water has high levels of magnesium and calcium and is known as hard water. Hard water gets collected in pipes and may lead to expensive replacement of pipes and reduced lifetime of home appliances.

VII. Experimental Set-up:

Figure 1: Digital TDS meter.

VIII. Required resources/equipment:

Sr. No.	Particulars	Specification	Quantity	Remark
01	Digital TDS meter	12V DC using Adapter 110 to 250V AC,50 Hz, TDS Cell , Operation Manual, Cell Stand, Dust Cover, 12V Adapter	1 No.	Per batch
02	Beaker	Standard glassware beaker of 500 ml. capacity	3 No	Per batch

IX. Precautions to be followed:

1. Use clean and dry beakers.
2. The Standardization of TDS meter is essential before use.
3. Clean and wipe out electrode every time of immersion.
4. Record the temperature of room.
5. Record reading in steady condition.

X. Procedure:

1. Dip the meter's electrodes into the water Sample.
2. Making sure they may be completely submerged without touching the sides or backside of the field.
3. After some seconds, the meter will display a reading in ppm. (parts per million)
4. Indicating the TDS stage of the water sample.

XI. Observation:

Sr. No.	Particulars	Observed TDS value for Sample No.		Average value of TDS of water Sample
	Type of Sample	1	2	
1	Treated water (Tap water)			
2	Untreated Surface water (Lake, River etc.)			
3	Untreated Subsurface water (Borewell water)			

Sample Calculation

For Observation No.....

Average TDS = (TDS (1) + TDS (2)) /2 =.....

Average TDS of ……. water =·.....

XII. Result:

The TDS value of Treated water (Tap water) is observed as..... .

The TDS value of Untreated Surface water (Lake, River etc.)is observed as..... .

The TDS value of Untreated Subsurface water (Borewell water) is observed as..... .

XIII. Interpretation of results *(Give meaning of the above obtained results)***:**

XIV. Conclusions and Recommendations *(Actions/decisions to be taken based on the interpretation of results):*

XV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. Give the reason of variation in TDS due to temperature.
2. Justify the difference in TDS values of above samples.
3. State the acceptable limit of TDS value for drinking water.
4. Suggest the treatment for TDS to obtain it in acceptable limit.
5. State how TDS value will effect on the other treatment processes of purification.
6. Write effects of water having TDS less or more than limiting value on distribution network and human being.
7. Comment on seasonal variation in TDS value of surface and subsurface water.
8. Comment on the hardness of water based on TDS value.
9. Suggest chemicals used for adjustment of TDS of water.
10. State the importance of TDS value of water to be used in industrial use.

Space for Answer

XVI. Assessment Scheme

Sr. No.	Performance Indicators	Weightage	Marks Obtained
A.	**Process Related (15 marks)**	**60%**	
1.	Conduction of practical	30%	
2.	Recording of observation	30%	
B.	**Product Related (10 marks)**	**40%**	
3.	Conclusion of practical	10%	
4.	Practical Question Answer	20%	
5.	Submission of Report in time	10%	
C.	**Total marks (25 marks)**	**100%**	

Marks Obtained			**Dated sign of Teacher**
Process Related(15)	**Product Related (10)**	**Total (25)**	

Practical No: 05 Determination of the dissolved oxygen in a given sample of water.

I. Practical Significance:

Dissolved oxygen (DO) refers to the amount of oxygen dissolved in water and is particularly important in aquatic ecology. Dissolved oxygen (DO) is one of the most important indicators of water quality. It is essential for the survival of fish and other aquatic organisms. This practical helps to know the dissolved oxygen content in surface water from atmosphere. Dissolved oxygen concentrations are constantly affected by diffusion and aeration, photosynthesis, respiration and decomposition. While water equilibrates toward 100% air saturation, dissolved oxygen levels will also fluctuate with temperature, salinity and pressure changes

II. Industry/Employer expected outcome(s):

- Identify the sources and characteristics of water and wastewater.

III. Course Level Learning Outcome (COs):

- CO 1- Interpret the water demand and quality of water.

IV. Laboratory Learning Outcome (LLO):

- LLO 5.1 - Use mechanical/digital DO meter to find the dissolved oxygen content present in a given sample of water.

V. Relevant Affective Domain related Outcome(s):

- Follow safety practices.
- Practice good housekeeping.
- Demonstrate working as leader or a team leader.
- Maintain tools and equipment.
- Follow ethical practices

VI. Relevant Theoretical Background:

This practical is expected to develop following skills for the industry identified competency **"Determination of dissolved oxygen decides suitability of water for aquatic life also for Domestic drinking water supply. Low dissolved oxygen levels indicate an excessive demand of the oxygen in the system. A high DO level in a source water supply is good for community because it makes drinking water taste better. However, high DO levels speed up corrosion in water pipes."**

a. Determination of dissolved oxygen in given sample of water
b. Comparing two water sources based on their DO content.

Dissolved oxygen is used as an indicator of water quality and eutrophication status of surface water. The term Dissolved Oxygen (DO) refers to the amount of free oxygen dissolved in water which is readily available to respiring aquatic organisms. As dissolved oxygen levels in drinking water should be 5.0 mg/1.Aquatic life is put under stress if the lower the concentration. Oxygen levels that remain below 1-2 mg/1 for a few hours can result in large fish kills. For the conclusion, Dissolved oxygen content is direct measure of freshness of water and hence determination of its presence is

VII. Experimental Set-up:

Figure 1: Digital DO meter.

VIII. Required resources/equipment:

Sr. No.	Particulars	Specification	Quantity	Remark
01	Digital DO meter	Range: 0 to 20 ppm, Resolution: 0.1 ppm, Temperature Compensation: 0 to 5o °c.	1 No.	Per batch
02	Beaker	Standard glassware beaker of 500 ml. capacity	3 No	Per batch

IX. Precautions to be followed:

1. Use clean and dry beakers.
2. The Standardization of DO meter is essential before use.
3. Clean and wipe out electrode every time of immersion.
4. Maintain the temperature of room.
5. Record reading in steady condition.

X. Procedure:

(A) Calibration of the instrument.

1. Disconnect the "OXYGEN PROBE plug 11 from the main instrument" Input socket"
2. Power on the instrument by selects the "On/Off Switch "to the "On" position. Slide the "DO I CAL Switch "to the "CAL" position. Adjust the "ZERO Adj. VR "until the display shows zero value.
3. Power off; connect the "OXYGEN PROBE plug "to the main instrument "Input Socket "then power on. Wait 5 minutes at least until the display reading values become stable & no fluctuation.
4. Adjust the "CAL Adj. VR" until the display reading shows the values exact same as 20.9 (As the oxygen in air is 20.9 % typically) (Calibration consideration: Please make calibration procedures under wide and ventilating environment for best effect.)

(B) Dissolved Oxygen (DO) measurement

1. After the meter be calibrated, don't adjust the "CAL Adj. VR 11 & "ZERO Adj. VR" again until next calibration procedures be done
2. Slide the "DO / CAL Switch "to the "DO" position.
3. Immersed the probe to a depth at least 1O cm of the measured liquid in order for the probe to be influenced by the temp. &automatic temperature compensation to take place. As for the thermal equilibrium to occur between the probe & the measurement sample must be allowed to pass, which usually amounts to a few minutes if the temp. Difference between the two is only several c degrees.
4. In order to measure the dissolved oxygen content in any given liquid, it is sufficient to immerse the tip of the probe in the solution, making sure that velocity of the liquid coming into contact with the probe is at least 0.2 - 0.3 min or shake the probe. During laboratory measurements, the use of a magnetic agitator to ensure a certain velocity in the fluid is recommended. In this way, errors due to the diffusion of the oxygen present in the air in the solution are reducing to a minimum.
5. Rinsed the probe accurately with normal tap water after each series of measurement.

XI. Observation:

Sr. No	Particulars	Observed DO value in mg/L for Sample No.		Average DO of water (mg/L)
	Type of Sample	1	2	
1	Treated water (Tap water)			
2	Untreated Surface water (Lake, River etc.)			
3	Untreated Subsurface water (Borewell water)			

Sample Calculation

For Observation No.....

Average DO = (DO (1) +DO (2)) /2 =.....

XII. Result:

The dissolved oxygen of Treated water (Tap water) is observed as.....mg / l.

The dissolved oxygen of Untreated Surface water (Lake, River etc.)is observed as.....mg / l.

The dissolved oxygen of Untreated Subsurface water (Borewell water) is observed as.....mg / l.

XIII. Interpretation of results *(Give meaning of the above obtained results)***:**

XIV. Conclusions and Recommendations *(Actions/decisions to be taken based on the interpretation of results):*

XV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

l. Write practical application of DO value of water.
2. Give the reason of variation in DO due to temperature.
3. Justify the difference in DO values for above samples.
4. Give the acceptable limit of DO value for drinking water.
5. Suggest the treatment for DO to obtain it in acceptable limit.
6. State how DO value will effect on the other treatment processes of purification.
7. State the effects on aquatic life if water is having DO less than 2 mg/L.
8. Suggest treatment for increasing dissolved oxygen in water.
9. Comment on variation in DO due to its location.

Space for Answer

XVI. Assessment Scheme

Sr. No.	Performance Indicators	Weightage	Marks Obtained
A.	**Process Related (15 marks)**	**60%**	
1.	Calibration of instrument	30%	
2.	Recording of observation	30%	
B.	**Product Related (10 marks)**	**40%**	
3.	Conclusion of practical	10%	
4.	Practical Question Answer	20%	
5.	Submission of Report in time	10%	
C.	**Total marks (25 marks)**	**100%**	

Marks Obtained			Dated sign of Teacher
Process Related(15)	**Product Related (10)**	**Total (25)**	

Practical No: 06 Determination of residual chlorine in the sample of water.

I. Practical Significance:

Chlorine and chlorine-based disinfectants are used worldwide to destroy germs in drinking water and swimming pools. One of the reasons for the widespread use of chlorine disinfectants is that they provide a "residual" level of protection against water borne pathogens. Chlorine residual is a low level of chlorine remaining in water after its initial application. It constitutes an important safeguard against the risk of subsequent microbial contamination after treatment-a unique and significant benefit

II. Industry/Employer expected outcome(s):

- Identify the sources and characteristics of water and wastewater.

III. Course Level Learning Outcome (COs):

- CO 2- Apply the water purification processes.

IV. Laboratory Learning Outcome (LLO):

- LLO 6.1 - Undertake the test to detect the presence of residual chlorine in a given sample of water using orthotolidine testing kit.

V. Relevant Affective Domain related Outcome(s):

- Follow safety practices.
- Practice good housekeeping.
- Demonstrate working as leader or a team leader.
- Maintain tools and equipment.
- Follow ethical practices

VI. Relevant Theoretical Background:

This practical is expected to develop following skills for the industry identified competency "The presence of chlorine residual in drinking water indicates that: **1) a sufficient amount of chlorine was added initially to the water to inactivate the bacteria and some viruses that cause water bone disease; and, 2) the water is protected from recontamination during distribution"**

a. Determination of presence of residual chlorine in sample of water
b. Comparing two water samples based on presence of residual chlorine.

Chlorination is the process of adding chlorine to drinking water to disinfect it and kill germs. Different processes can be used to achieve safe levels of chlorine in drinking water. When chlorine is added to water, it forms hypochlorous acid and hypochloric acids within few seconds at temperature between 49°F and 212°F.

$$Cl_2 + H_2O \xrightarrow{pH \geq 5} HOCl + HCl$$

(Hypochlorous acid)

The hypochlorous acid is unstable and may break into hydrogen ion and hypochlorite ions.

$$HOCl \underset{pH < 7}{\overset{pH > 8}{\rightleftharpoons}} H^{+} + OCl^{-}$$

(Hydrogen ions) (Hypochlorite ions) pH

The above reaction is reversible and depends upon the pH value of water, which controls the amount of dissociation at pH > 5; Chlorine exists as elemental or molecular chlorine and does not react with water at pH < 5. At pH value between 5 to 7, HOCI will generally exist without dissociating into OCI - ions and at pH greater than 1O only OCI - ions are found. As the hypochlorous acid is destructive hence pH value of water during chlorination is generally maintained slightly less than 7, so as to keep the dissociation of HOCI to minimum. The chlorine will immediately react with ammonia present in water to form various chloramines.

$$NH_3 + HOCl \longrightarrow NH_2Cl + H_2O$$

Mono-chloramines

$$NH_2Cl + HOCl \longrightarrow NHCl_2 + H_2O$$

Di-chloramines

$$NHCl_2 + HOCl \longrightarrow NCl_3 + H_2O$$

Nitrogen- Trichloramine

VII. Experimental Set-up:

Figure 1:Chloroscope

VIII. Required resources/equipment:

Sr. No.	Particulars	Specification	Quantity	Remark
01	Chloroscope	Orthohotolodine test kit(free and total chlorine testing for EPA reporting over range of 0-4mg/L)	1 No.	Per batch
02	Beaker	Standard glassware beaker of 500 ml. capacity	3 No	Per batch

IX. Precautions to be followed:

1. Use clean and dry tubes.
2. After adding orthotolidine solution mixes it thoroughly.
3. Place distilled water in central tube of back row.
4. Observation should be done against sufficient white or natural light.

X. Procedure:

1. Fill the three test cubes in the front row of the comparator box with the given water sample up to the given marking
2. Add 6 drop or 5ml of standard orthotolidine solution in middle test tube and mix with stirrer
3. A yellow color will be developed in first 5 seconds indicating the presence of free chlorine.
4. Fill distilled water in central tube of the back row.
5. Take two standard color samples in side tube of back row.
6. Observe from front side against sufficient white or natural light.
7. Compare the color developed in the water sample with standard color, after 5 minutes of addition of orthotolidine solution.
8. The standard colors in two sides of back row may be replaced to obtain a good matching.
9. The known value of chlorine in mg/lit contained in standard color, which matches with color developed in water sample, will indicate the contained residual chlorine in given water sample.

XI. Observations:

Sr. No.	Sample Details	Sample No.	Residual Chlorine (mg/L)

XII. Result:

The residual chlorine for given water sample is observed as.....mg/L

XIII. Interpretation of results *(Give meaning of the above obtained results)***:**

XIV. Conclusions and Recommendations *(Actions/decisions to be taken based on the interpretation of results):*

XV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. List out the different methods of disinfection.
2. Write the importance of residual chlorine in water.
3. State the minimum concentration of residual chlorine in water at the consumer end.
4. State the various methods to determine the residual chlorine in water.
5. Write effects of excessive residual chlorine in water.
6. Give essential qualities of disinfectant.
7. Write various forms of chlorination.
8. Define break point chlorination.
9. How the color changes after addition of orthotolidine solution in water sample?
10. Suggest suitable method of disinfection in swimming pool water.

Space for Answer

XVI. Assessment Scheme

Sr. No.	Performance Indicators	Weightage	Marks Obtained
A.	**Process Related (15 marks)**	**60%**	
1.	Conduction of practical	30%	
2.	Recording of observation	30%	
B.	**Product Related (10 marks)**	**40%**	
3.	Conclusion of practical	10%	
4.	Practical Question Answer	20%	
5.	Submission of Report in time	10%	
C.	**Total marks (25 marks)**	**100%**	

Marks Obtained			Dated sign of Teacher
Process Related(15)	**Product Related (10)**	**Total (25)**	

Practical No: 07 **Preparation of report on-site visit to the nearby water treatment plant.**

I. Practical Significance:

The treatment given to water before supplying to the public for domestic use is called water treatment i.e. complete process of removing impurities / objectionable matter in order to make the water acceptable for drinking purpose.

II. Industry/Employer expected outcome(s):

- Draw the flow diagram for process of treatment of water and wastewater.

III. Course Level Learning Outcome (COs):

- CO 2- Apply the water purification processes.

IV. Laboratory Learning Outcome (LLO):

- LLO 7.1 - Undertake a field visits to water treatment plant.

V. Relevant Affective Domain related Outcome(s):

- Follow safety practices.
- Practice good housekeeping.
- Demonstrate working as leader or a team leader.
- Maintain tools and equipment.
- Follow ethical practices

VI. Relevant Theoretical Background:

This practical expected to understand operation and maintenance of water treatment plant. **"Study of different units and process of water purification executed at water treatment plant."**

a. Collection of information for technical report on W.T.P.

b. Preparing a report using different process diagrams and collected information.

Water treatment plant has different units through which raw water get clarified in the successive order. Process of treatment of raw water is

l. Screening 2. Aeration 3.Sedimentation4. Filtration 5.Disinfection

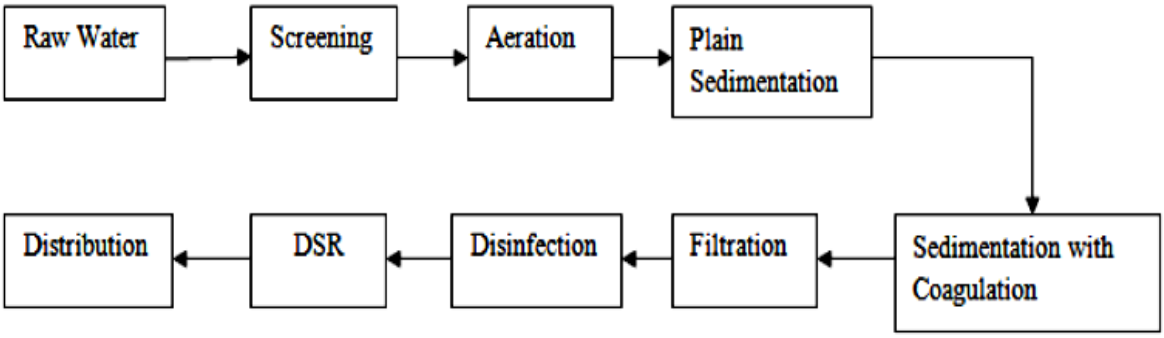


Figure 1:F1ow diagram of water treatment plant.

VII. Experimental Set-up:

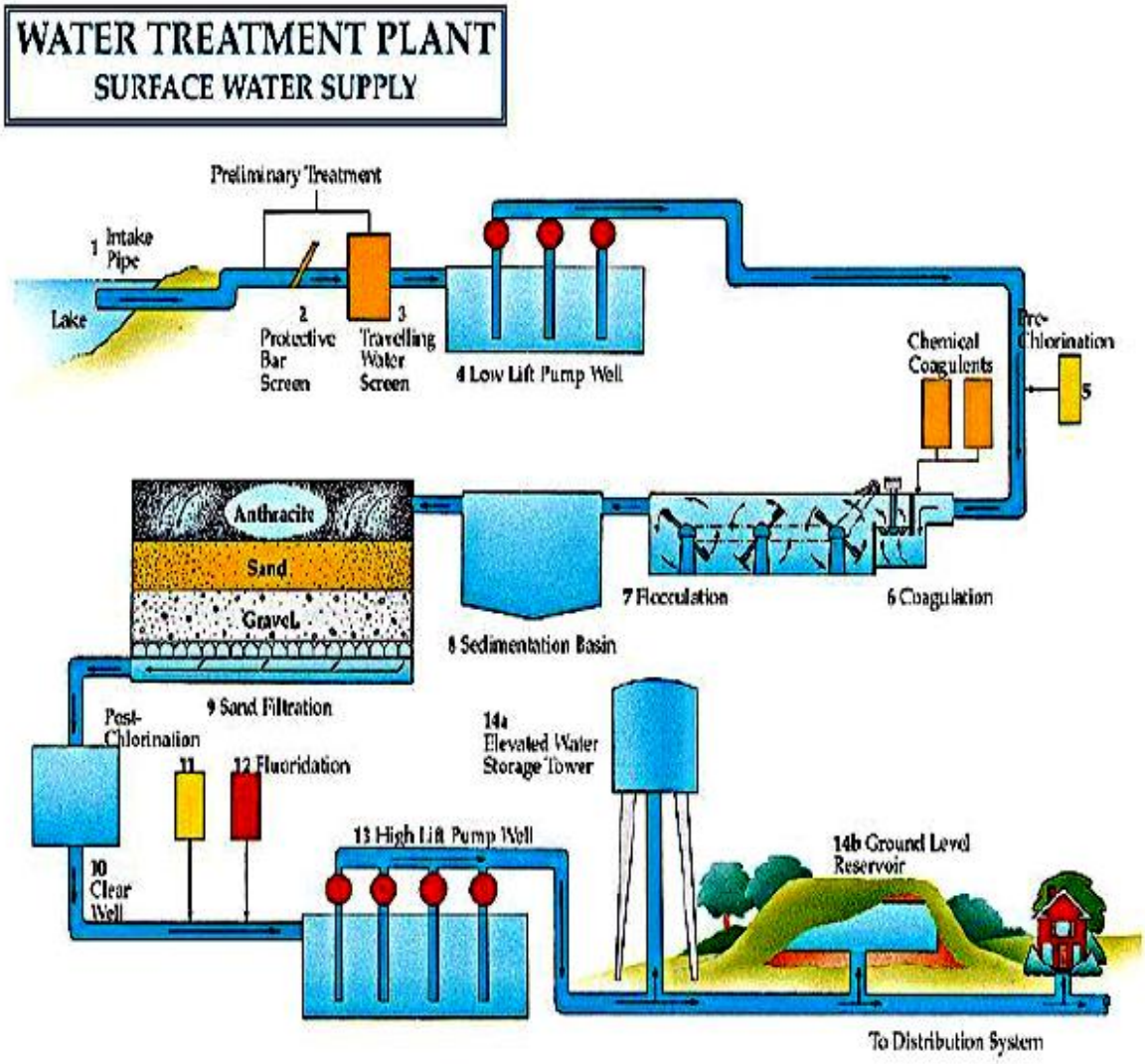


Figure 2: Layout of water treatment plant.

VIII. Required resources/equipment:

Sr. No.	Particulars	Specification	Quantity	Remark
01	Water Treatment Plant	Any accessible working plant available nearby the college premises.	1 No.	Per batch
02	Recording accessories	Recording notebook/notepad, pen, pencil etc.	1 each	Per group of 4-5 students
03	Camera	Mobile or DSLR camera for taking photographs (If permitted)	1 No.	Per batch

IX. Precautions to be followed:

1. Take prior permission from concern department(MJP/Nagarpalika/Municipal corporation) well in advance
2. Maintain discipline during journey and visit at WTP.
3. Record all necessary information in note book.
4. Wear college uniform, shoes, cap, dupatta, sun- glass during visit.
5. Keep safe distance from moving parts/ machines at site.

X. Procedure:

1. Identify feasible site of Water Treatment Plant (WTP) available nearby and accessible from you college premises.
2. Plan suitable date and time for visit for the above identified site with prior permission of head of department/institute.
3. Observe the general layout of water treatment plant at the site visit carefully.
4. Record the position and connection of component parts of WTP to draw the flow diagram of actual site visit.
5. Record the functions of each component parts of WTP to understand the complete process of treatment.
6. Prepare the visit report as per the format given below.

XI. Observations: Student should write the visit report as per the following after completing the visit to water treatment plant.

Format of Visit Report to Water Treatment Plant

Aim/Objective of visit:.....

Day, Date and Time of visit: …….

Name and complete address of visited site: …….

……..

Name and designation of guide at site: ……

Governing body of W.T.P.....

Daily raw water intake (m3/day or MLD).....

Source of water.....

Out flow of plant……..

Intake water characteristics .....

Daily out flow.....

Frequency of suspended particles removed per day.....

Type and dosage of coagulant.....

Type and dosage of disinfectant.....

List of components parts and their functions.....

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

Draw flow diagram of W.T.P.....

Photograph of Visit: (Student should paste 2 photographs of site visit)

XII. Result:

1. The layout of the water treatment plant (WTP) observed was ……. (same / somewhat different / excessively different) as compared to theoretical layout of WTP.
2. The working of the water treatment plant (WTP) observed was ……. (same / somewhat different / excessively different) as compared to theoretical working of WTP.

XIII. Interpretation of results *(Give meaning of the above obtained results)***:**

XIV. Conclusions and Recommendations *(Actions/decisions to be taken based on the interpretation of results):*

XV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. Name the component useful to take the water into plant for treatment process.
2. State different types of aerators.
3. Give reasons of non-functioning of water treatment plant.
4. Describe the process of filtration observed in brief.
5. State function of clariflocculator.
6. State difference between rapid sand filter and slow sand filter.
7. Write drawbacks of slow sand filter.
8. Write materials to be used for of chlorination.
9. Suggest the capacity of water treatment plant for village of 5000-10000 population.
10. Write the final products of water treatment plant.

Space for Answer

XVI. Assessment Scheme

Sr. No.	Performance Indicators	Weightage	Marks Obtained
A.	**Process Related (15 marks)**	**60%**	
1.	Conduction of visit	40%	
2.	Recording of observations	20%	
B.	**Product Related (10 marks)**	**40%**	
3.	Interpretation and report writing	10%	
4.	Answers to practical/visit based questions	20%	
5.	Submission of report in time	10%	
C.	**Total marks (25 marks)**	**100%**	

Marks Obtained			**Dated sign of Teacher**
Process Related(15)	**Product Related (10)**	**Total (25)**	

Practical No: 08 **Determination of the optimum dose of coagulant in the given raw water sample by jar test.**

I. Practical Significance:

Jar testing simulates a full-scale water treatment process to help operators determine the best chemical treatment and optimal dosage of coagulant for raw water. This practical helps to identify the required coagulant and/or flocculant dosage for effective precipitation, simulating the coagulation/flocculation process to find appropriate dosages.

II. Industry/Employer Expected Outcome(s):

- Identification of the most effective chemical treatment and the optimal dosage of coagulants and/or flocculants.

III. Course Level Learning Outcome (COs):

- CO2 - Apply the water purification processes.

IV. Laboratory Learning Outcome (LLO):

- LLO 8.1:- Deploy the jar test method to find the optimum dose of coagulant in the given raw water sample.

V. Relevant Affective Domain related Outcome(s):

- Using Safe behaviors effectively.
- Maintain high standards of hygiene.
- Efficient application of tools, equipment's and machinery.
- Professional and ethical standards.

VI. Relevant Theoretical Background:

Precipitation converts soluble substances into insoluble particles. Coagulation and flocculation cause these particles to clump together for easier removal. Lab-scale results optimize coagulant concentration for water treatment. First, coagulants are added and mixed with water to form precipitates. Then, the water goes to a sedimentation tank where fine and colloidal particles settle through the precipitates.

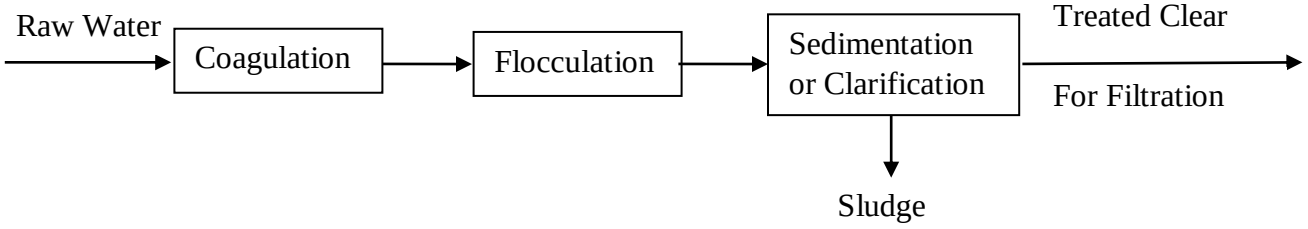


Figure 8.1: Flow diagram of optimization of coagulation

Figure 8.2: Jar Test Apparatus.

VII. Required Resources:

Sr. No.	Resource required	Particulars	Quantity
01	Jar Test Apparatus	Jar Test Apparatus (Digital timer: 1 to 99 minutes, material: Stainless steel, Power: Electric supply, Range: 25 to 250 r. p. m.,	1 nos.
02	Beaker	6 glass jars (of 1000 mL) of Standard glassware.	3 nos.
03	Reagents	Alum ($Al_2(SO_4)_3.18H_2O$) Solution (Made by dissolving 14.28 gm of alum in one liter distilled water.)	10 ml (Approx.)

VIII. Precautions to be followed:

1. Use clean and dry beakers.
2. Recording of pH value is essential before adding coagulant.
3. Take dose of coagulant precisely.
4. Record the temperature of room.
5. Observe floc after complete settlement in steady condition.

IX. Procedure:

1. Fill 1 liter water sample in each of the six jars.
2. Find the pH of the samples and adjust it to 6 to 8.5.
3. Attach the sample jars to stirring device by lifting the paddles in the right upward direction.
4. Add coagulant solution in progressive volumes of 0.25ml, 0.5ml, 0.75ml, 1.0ml and 1.5ml into the series of the six sample jars.

5. Flocculate the sample rapidly for about one minute with mechanically operated paddles @ 60-80 r.p.m., followed by gentle stirring @ 30r.p.m. for 15 minutes.
6. Stop the machine, lift out paddles and let the sample stand for 30 minutes for settling of floc.
7. Select the minimum dosage giving the best floc formation and clear water.

X. Observation Table:

Jar No.	Sample of Raw Water (liter)	Amount of Coagulant Added in ml	Observation in Regard of Quality of Floc Formed
1			
2			
3			
4			
5			
6			
Selected optimum dosage (y) = ... ml/Litre			

Sample Calculation:

- Selected optimum dosage (y) = ... ml/Litre
- Strength of alum prepared = ... gm/l

  = ... mg/l
- Optimum dosage in mg/L = ... mg/ml X . . . . . ml/Litre

  = ... mg/ml

XI. Result:

The optimum dosage of coagulant for given water sample is …… mg/ml.

XII. Interpretation of Results:

XIII. Conclusions:

XIV. Practical Related Questions:

1. Name the details (company, body, timer, range etc.) of jar test apparatus used by you in this practical.
2. Write the difference between sedimentation with coagulation.
3. Write the relation between dosages of coagulant added with quality of floc formed in this practical.
4. List common coagulants used in water treatment.
5. State the factors affecting the process of coagulation.
6. State advantages of alum as commonly used coagulant.
7. State the pH value of water sample used by you in this practical.
8. Define flocculation. Write factors affecting it.
9. Write the effect on value of dosage of coagulant, if rate of flocculation is 30-40 rpm and rate if stirring is 10 rpm.
10. Comment on floc formation if water sample is allowed to set only for 5 minutes after flocculation.
11. Describe the characteristics of best floc.

Space for Answer

XV. Assessment Scheme

Sr. No.	Performance Indicators	Weightage	Marks Obtained
A.	**Process Related (15 marks)**	**60%**	
1.	Preparation of sample	20%	
2.	Conduction of practical	20%	
3.	Recording of observations	20%	
B.	**Product Related (10 marks)**	**40%**	
3.	Conclusion of practical	20%	
4.	Answer to practical related questions	20%	
C.	**Total marks (25 marks)**	**100%**	

Marks Obtained			**Dated sign of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 09 **Demonstration of water purifier based on its components and working, (RO purifier).**

I. Practical Significance:

Water purification removes harmful contaminants and improves the taste, smell, and appearance of drinking water by reducing chlorine, soil residue, and organic and inorganic substances. This practical helps to understand the process of water purification in a portable water purifier machine. It is also significant to compare the RO and UV process involved.

II. Industry/Employer expected outcome(s):

- Understand how the water purifier works and ensure it provides safe drinking water.

III. Course Level Learning Outcome (COs):

- CO 2 - Apply the water purification processes.

IV. Laboratory Learning Outcome (LLO):

- LLO 9.1 Write a report on working of water purifier, (RO purifier).

V. Relevant Affective Domain related Outcome(s):

- Follow safe practices.
- Practice good housekeeping.
- Efficient application of tools, equipment's and machinery.
- Professional and ethical standards.

VI. Relevant Theoretical Background:

Combined Purification Systems

Many modern water purifiers combine multiple technologies to enhance purification efficiency. For instance, a purifier may integrate RO, UV, and UF systems to tackle a wide range of contaminants, ensuring comprehensive water purification. These multi-stage purifiers typically include:

- **Sediment Filter**: Removes large particles and sediment.
- **Activated Carbon Filter**: Eliminates chlorine, organic compounds, and improves taste.
- **RO Membrane**: Removes dissolved salts and heavy metals.
- **UV Chamber**: Disinfects the water by killing microorganisms.
- **Post-carbon Filter**: Polishes the water to improve taste and remove any remaining odors.

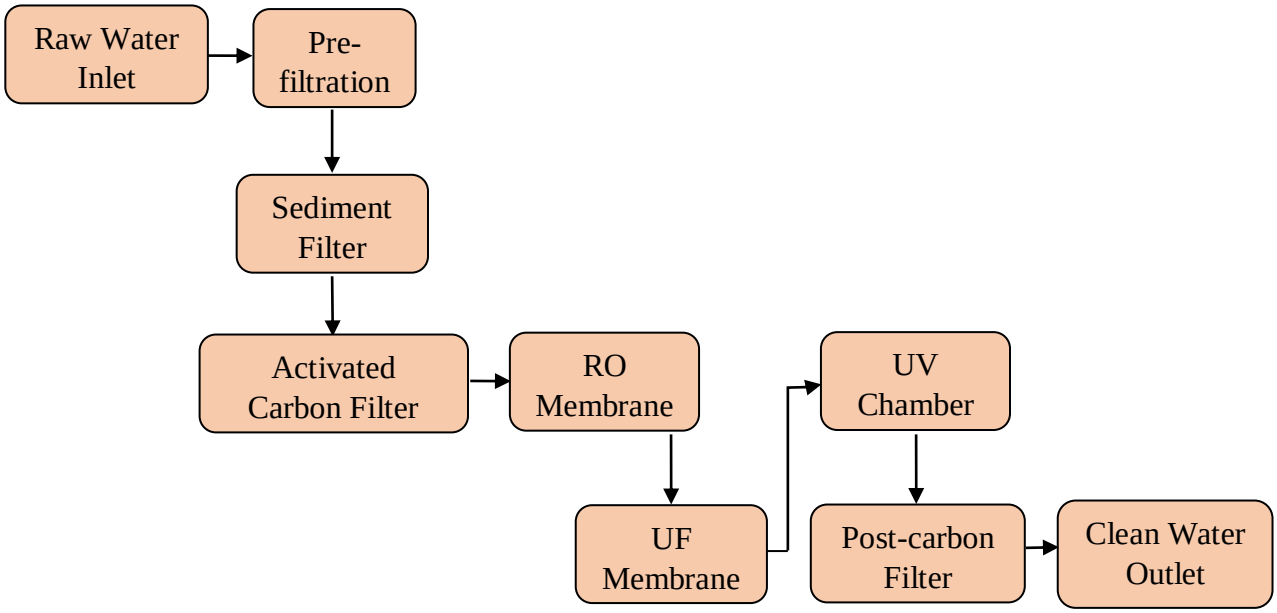


Figure 9.1 Flow Diagram of Water Purifier

VII. Required resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
01	Combined Water purifier	RO+UV functions	1 No.

VIII. Precautions to be followed:

1. Read the user manual.
2. Keep hands dry for electrical.
3. Clear demonstration area.
4. Monitor flow rate sequence.
5. Follow shutdown procedures properly.

IX. Procedure:

1. **Preparation:** Gather materials including the purifier, manual, raw water source, and protective gear, then check equipment for damage and ensure proper assembly.
2. **Initial Setup:** Position the water purifier on a stable, level surface in a clear demonstration area, and securely attach the inlet hose to the raw water source.
3. **Pre-Demonstration Checks:** Before you begin, review the manual for familiarity and ensure dry hands when handling electrical components. If needed, pre-flush the system as instructed to remove any preservatives or residues.
4. **Demonstration:** Start the purifier, monitor flow rate alignment with specifications, briefly explain purification stages, and collect purified water at the outlet.
5. **Quality Check:** Test the output water quality using a TDS meter or relevant testing kit, and highlight any improvements in taste and odor.

6. **Shutdown Procedure:** Disconnect the purifier from the power source, shut off the water supply and valves, and drain any residual water as per the user manual.
7. **Post-Demonstration:** Clean the demonstration area, ensuring it's dry, and properly store the purifier and all components.

X. Observation Table:

Sr. No.	Name of Component	Function
01	Pre-filtration	
02	Sediment Filter	
03	Activated Carbon Filter	
04	RO Membrane	
05	UF Membrane	
06	UV Chamber	
07	Post-carbon Filter	

XI. Result:

XII. Interpretation of results:

XIII. Conclusions:

XIV. Practical Related Questions:

1. Write the difference between RO and UV process in used by water purifier.
2. Name the company details of water purifier observed by you.
3. Write the rate of filtration of water purified demonstrated to you.
4. Write the capacity of storage tank of water purifier.
5. Name the component of water purifier useful to kill insects/bacteria i.e. disinfection.
6. List the advantages of water purifier.
7. Give the necessity of use of water purifier with its area of applications.
8. Write ill effects of water purifier if any.
9. Suggest the type of water purifier for highly impure water containing more amounts of suspended and dissolved solids.
10. Suggest the lowest possible cost purifier for ordinary family having 4 persons.

Space for Answer

XV. Assessment Scheme

Sr. No.	Performance Indicators	Weightage	Marks Obtained
A.	**Process Related (15 marks)**	**60%**	
1.	Handling of Instrument	10%	
2.	Observation of working of Instrument	30%	
B.	**Product Related (10 marks)**	**40%**	
3.	Conclusion of practical	20%	
4.	Answer to practical related questions	20%	
C.	**Total marks (25 marks)**	**100%**	

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 10 Illustration of various joints used in water supply pipeline through sketches.

I. Practical Significance:

Joints in water supply pipelines are essential for connecting sections, allowing for direction changes, and accommodating expansion. They prevent leaks and contamination, maintains water pressure and quality, and facilitates maintenance. Reliable joints ensure the efficient and safe delivery of clean water, supporting public health and infrastructure durability. This practical helps to know different types of joints required in plumbing technology. It plays a vital role in maintaining the effective water carriage and distribution pipe system.

II. Industry/Employer Expected Outcome(s):

- To study the various types of joints, their working and suitability.

III. Course Level Learning Outcome (COs):

- CO3 - Select the distribution system and pipe network for water supply

IV. Laboratory Learning Outcome (LLO):

- LLO 10.1 Draw sketches of various joints used in the water supply pipeline.

V. Relevant Affective Domain related Outcome(s):

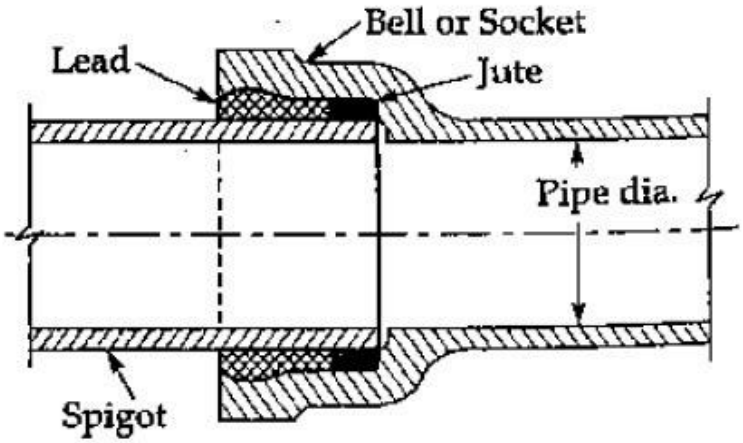
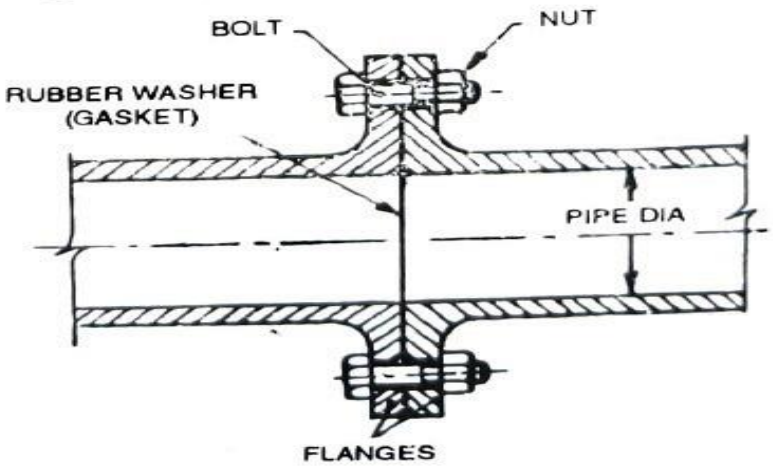
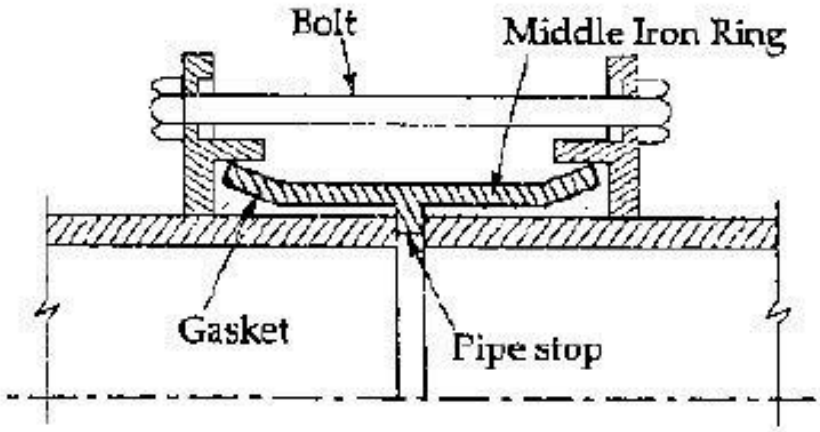
- Follow safe practices.
- Maintain high standards of hygiene.
- Efficient application of tools, equipment's and machinery.
- Professional and ethical standards.

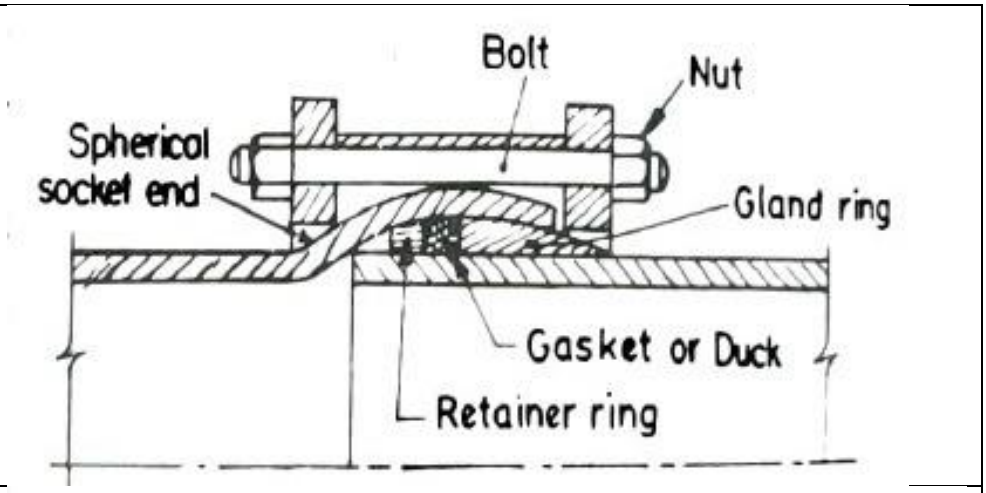
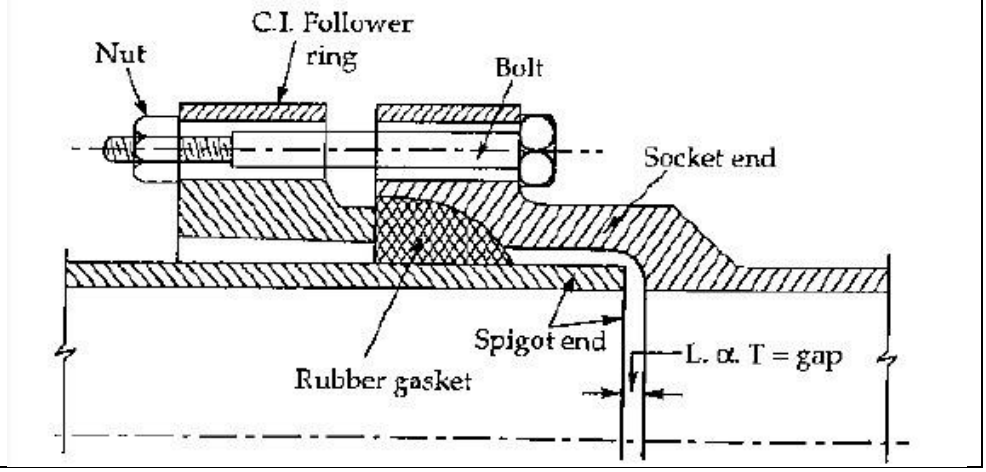
VI. Relevant Theoretical Background:

Understanding water supply pipeline joints involves knowing how water flows in pipes, the materials used for pipes, recognizing the different parts of a pipe system, understanding the various types of joints used to connect pipes, their role in preventing leaks, and the importance of proper installation and maintenance for a reliable water supply.

- **Connecting Pipe Sections:** They link various pipe segments to form a continuous pipeline.
- **Allowing Directional Changes:** Joints facilitate bends and turns in the pipeline.
- **Accommodating Expansion and Contraction:** They enable the pipeline to adjust to temperature changes and ground movements.
- **Transitioning between Different Diameters or Materials:** Joints allow for seamless transitions in pipe size or material type.
- **Facilitating Maintenance and Repairs:** They make it easier to isolate sections of the pipeline for maintenance or repair work.

Different Types of Joints:

Sr. No.	Name of Joint	Diagram
01	Socket and spigot joint	
02	Flanged joint	
03	Mechanical joint called dresser coupling.	

04	Flexible joint	
05	Expansion joint.	

VII. Required Resources:

Sr. No.	Resource required	Particulars	Quantity
01	Drawing Plates	A4 Size Sheet	2 Nos.
02	Drawing accessories	Scale, Roller, 2H Pencil, Eraser, Set Square, French Curve (if required)	1No. each
03	Typical drawings of joints	Ready made available from	1 Set.

VIII. Precautions to be followed:

1. Handle the drawing sheets properly.
2. Maintain the cleanliness while drawing the joints.
3. Ensure appropriate labeling as per typical or reference drawings of joints.

IX. Procedure:

1. Select the typical sketch of joints.
2. Select the time slot for drawing purpose.
3. Get the proper instructions from the teacher.
4. Observe the typical or reference sketch carefully.
5. Analyze the accessories and arrangement provided in that specific sketch related to joints.
6. Draw the proper / neat / labeled sketch of minimum 5 joints. (may not be to the scale)
7. Prepare the table joints with its suitability, function. (table is optional)

X. Observation Table:

Sr. No.	Name of joint	Suitability	Function
01	Socket and spigot joint		
02	Flanged joint		
03	Mechanical joint		
04	Flexible joint		
05	Expansion joint.		

XI. Result:

XII. Interpretation of Results:

XIII. Conclusions:

XIV. Practical Related Questions:

1. List the factors affecting selection of pipe material.
2. Name any four types of pipe joints.
3. Write the requirements of an ideal joint in pipe system.
4. List the materials required for ensuring a perfect joint in pipe works.
5. Suggest the joint for the pipe network exposed to high atmospheric temperature.
6. Name the pipe joint provided to carry wastewater from bathroom.
7. Name the type of joint requires lesser maintenance as compared to other joints.
8. Write the function of rubber gasket in pipe joint.
9. Enlist the possible reasons of leakages through joints.

Space for Answer

XV. Assessment Scheme

Sr. No.	Performance Indicators	Weightage	Marks Obtained
A.	**Process Related (15 marks)**	**60%**	
1.	Handling and use of drawing accessories	30%	
2.	Appropriateness and neatness of drawing	30%	
B.	**Product Related (10 marks)**	**40%**	
3.	Appropriateness and neatness of drawing	20%	
4.	Answer to practical related questions	20%	
C.	**Total marks (25 marks)**	**100%**	

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 11 **Preparation of a sketch of one pipe, two pipe system and layout plan for drainage for a residential building.**

I. Practical Significance:

Liquid waste from any part of the building should be drained quickly with pipes having self-cleaning velocity. The drainage system must be well-ventilated, with ventilation pipes extending high above the building and fresh air inlets provided. This practical elaborated the one pipe and two pipe systems to be provided in drainage system of a residential building. It becomes significant in installation and maintenance work of the same for the given building. It gives clear idea about the layout and connections involved in both these systems required in several multi-storeyed building.

II. Industry/Employer Expected Outcome(s):

- A plumbing system to be cost-effective, efficient, compliant with regulations, and reliable, customized to the building's needs.

III. Course Level Learning Outcome (COs):

- CO4 - Interpret the plumbing system and sewer appurtenances

IV. Laboratory Learning Outcome (LLO):

- LLO 11.1 Draw a labeled sketch of the one pipe, two pipe system and layout plan for drainage for a residential building.

V. Relevant Affective Domain related Outcome(s):

- Using Safe behaviors effectively.
- Maintain high standards of hygiene.
- Efficient application of tools, equipment's and machinery.
- Professional and ethical standards.

VI. Relevant Theoretical Background:

There are different types of plumbing systems adopted according to the need and situation; they are

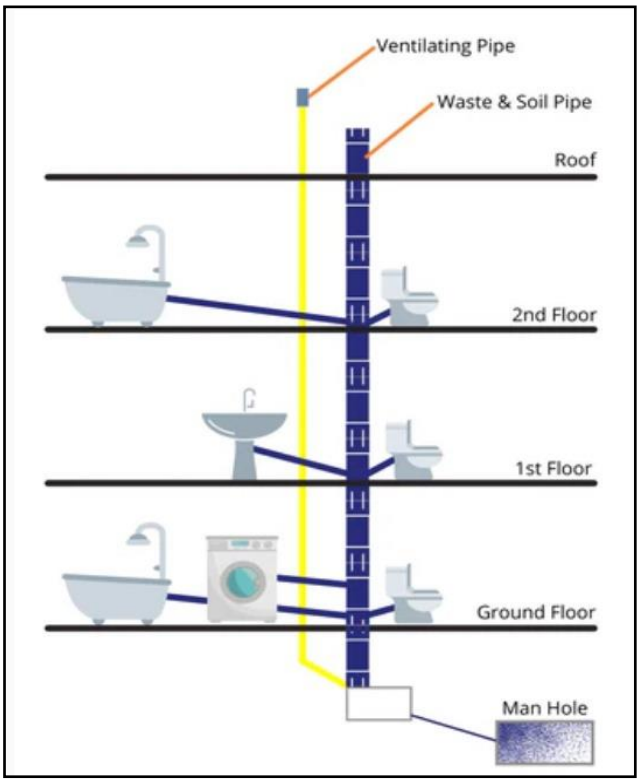
a) One-pipe system
b) Two-pipe system
c) Single stack system
d) Single stack partially ventilated system

One-pipe system: This system utilizes a single main pipe to collect both foul soil waste and un foul waste from buildings. The main pipe directly connects to the drainage system. In multi-storey buildings, lavatory blocks are stacked vertically, allowing waste water from different units to flow through common vertical stacks connected via short branch drains. Traps for basins and sinks are fully ventilated and linked to the ventilation pipe, while gully traps and waste pipes are eliminated entirely.

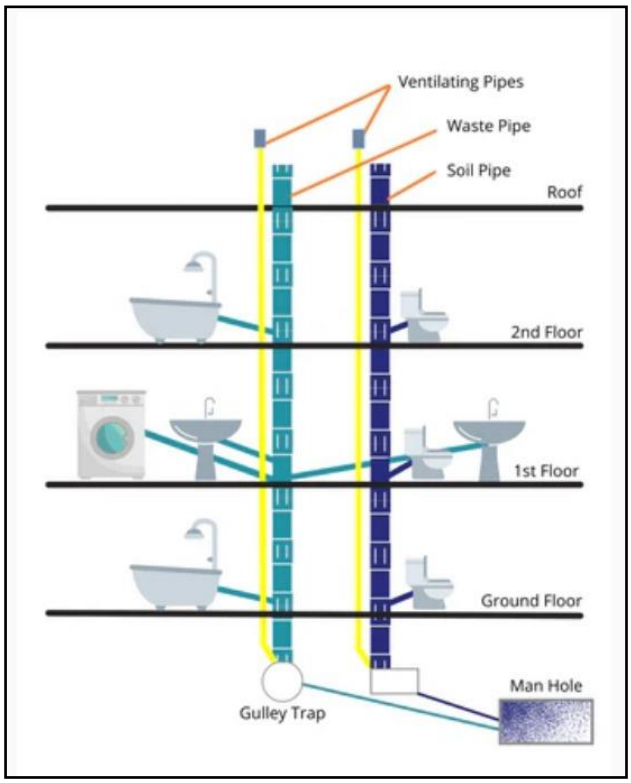
Two-pipe system: This common Indian system employs two pipes: one for foul waste and the other for un foul water like kitchen and bathroom runoff. Soil pipes directly connect to the drain, while waste pipes connect via traps. All traps in this system are fully ventilated.

Single-stack system: This is similar to single pipe system, the only difference being that no ventilation is provided even in the traps too.

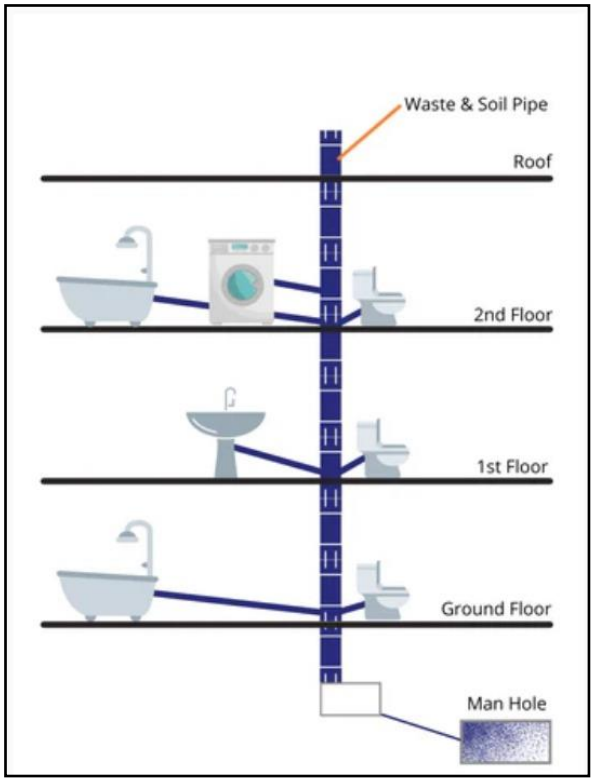
Single-stack partially ventilated system: This system is in between the one and single-stack system. In this system only one pipe is provided to collect all types of waste water foul as well as unfoul. A relief vent pipe is provided for ventilating only the water closet-traps.



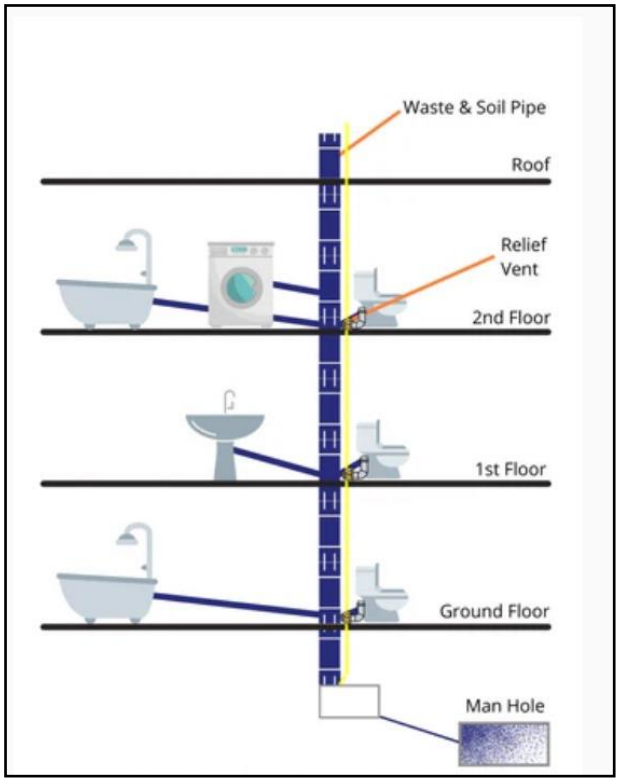
One Pipe Plumbing System



Two Pipe Plumbing System



Single Stack Plumbing System



Single Stack with Partially Ventilated Plumbing System

*Source.: https://seaqual.co.za/blogs/news/plumbing-systems-in-buildings

Figure* 11.1 Plumbing Systems

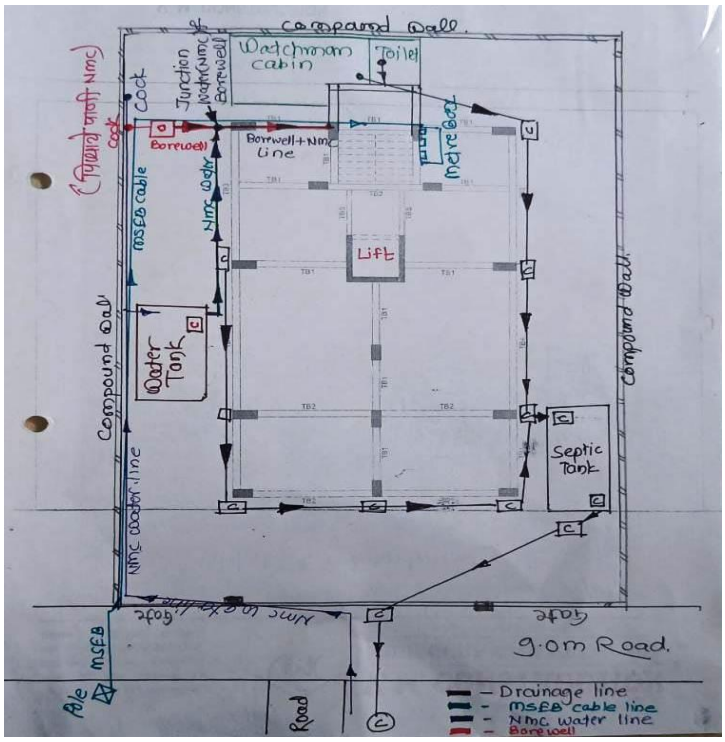


Figure 11.2 Drainage Layout Plan

VII. Required Resources:

Sr. No.	Resource required	Particulars	Quantity
01	Drawing Sheet or Drawing Plate	A3 Plate/A4 Size Sheet	1 nos.
02	Drawing accessories	2H pencils, Mini Drafter, Scale, Roller, Eraser, Set Square, Drawing Clips, French Curve (if required)	1 nos.
03	Typical drawings	One pipe and two pipe plumbing system.	1 No. each

VIII. Precautions to be followed:

1. Handle the drawing sheets properly.
2. Maintain the cleanliness while drawing the pipe systems.
3. Ensure appropriate labeling as per typical or reference drawings of pipe systems.

IX. Procedure:

1. Select the typical sketch of One pipe plumbing system or Two pipe plumbing system
2. Select the time slot for drawing purpose.
3. Get the proper instructions from the teacher.
4. Observe the obtained sketch carefully.
5. Analyze the accessories and arrangement provided in that specific sketch related to one pipe or two pipe plumbing system.
6. Draw the proper / neat / labeled sketch (may not be to the scale)
7. Prepare the table of accessories provided for the plumbing arrangement with its specification, quantity, remarks if any (table is optional)

X. Observation Table:

Sr. No.	Particulars			Remark
	Types of Plumbing System	1	2	

XI. Result:

XII. Interpretation of Results:

XIII. Conclusions:

XIV. Practical Related Questions:

1. State the types of plumbing system proposed for the buildings.
2. List the various types of pipes provided in the plumbing arrangement.
3. State the purpose of gully trap.
4. State the purpose of Nahani trap. Where it is provided in the plumbing system.
5. State the purpose of anti-siphonage pipe.
6. State importance of gradient of drain pipe provided in the plumbing arrangement.
7. What are the specific precautions to be taken during the plumbing arrangement in multi-storeyed buildings?
8. Compare one pipe and two pipe system. (Minimum 2 points)
9. How the following possibilities can be avoided in the plumbing arrangement
   i) Formation of air locks
   ii) Siphonage

Space for Answer

XV. Assessment Scheme

Sr. No.	Performance Indicators	Weightage	Marks Obtained
A.	**Process Related (15 marks)**	**60%**	
1.	Handling and use of drawing accessories	30%	
2.	Appropriateness and neatness of drawing	30%	
B.	**Product Related (10 marks)**	**40%**	
3.	Appropriateness and neatness of drawing	20%	
4.	Answer to practical related questions	20%	
C.	**Total marks (25 marks)**	**100%**	

Marks Obtained			**Dated sign of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 12 Determination of BOD of a given sample of wastewater.

I. Practical Significance:

Biochemical Oxygen Demand (BOD) is defined as the amount of Oxygen required by heterotrophic aerobic microorganisms, in stabilizing the biologically degradable organic matter under aerobic condition. This practical helps to determine BOD, which serves as an indicator of pollution strength in wastewater, aiding in treatment plant design and assessing treatment efficiency. BOD tests are vital in ensuring treated effluents meet standards, conducting stream sanitation studies, and enforcing water pollution control measures.

II. Industry/Employer Expected Outcome(s):

- To determine the quality of wastewater and decide on the appropriate treatment process.

III. Course Level Learning Outcome (COs):

- CO5 - Apply the wastewater treatment processes.

IV. Laboratory Learning Outcome (LLO):

- LLO 12.1- Calculate BOD of given sample of wastewater.

V. Relevant Affective Domain related Outcome(s):

- Demonstrate working as a leader/a team member.
- Practice good housekeeping.
- Efficient application of tools, equipment's and machinery.
- Professional and ethical standards.

VI. Relevant Theoretical Background:

The organic matter which is biologically oxidized or reduced is called biologically active material. The organic matter which cannot be biologically oxidized is called biologically in- active or biologically non-degradable.

Biochemical Oxygen Demand is the amount of oxygen required by microorganisms (aerobic bacteria) in stabilizing the biologically degradable organic matter under aerobic conditions. After stabilization the end product of aerobic reactions are CO_2 and H_2O.

$$\text{Wastewater} \xrightarrow{\text{Aerobic Reaction}} CO_2 + H_2O$$

Polluted water will continue to absorb oxygen for many months to decompose the organic matter present in it. It is not practically feasible to determine the ultimate oxygen demand. Hence the B.O.D. of water during 5 days at 20°C is generally taken as the standard demand which is known as BOD, and is about 68 to 80% of the total demand. A 10 day BOD is about 90% of the total oxygen demand.

Digitally Controlled BOD Incubator

BOD Bottles

Figure 12.1 BOD Incubator with BOD Bottles

VII. Required Resources:

Sr. No.	Resource required	Particulars	Quantity
01	Aerator	--	1 No.
02	BOD Incubator	Inner working chamber size- 3 Cu.Ft. Temperature Rang- 5°C TO 60°C Accuracy - +/- 0.5°C Power Supply- 230 Volts, 50 Hz PID Digital Temp Controller CumIndicator	1No.
03	BOD Bottles	Standard capacity 300 ml. capacity	1 Set of 5 Nos.

VIII. Precautions to be followed:

1. Use clean and dry Beakers, Burette, Pipette, Flask, BOD Bottles.
2. Proper reagents should be used.
3. Preparation of dilution water and Dilution of sample should be done properly.
4. Determination of DO for the blank and sample should be done with due care.

IX. Procedure:

Reagents:

1. **Diluted water saturated with air:** Sufficient quantity of distilled water is aerated with aerator air compressor for more than 8-10 hours, and the aerated water is kept at low temperature till use. At the time experiment this water is used for preparation of different dilution of the sample.
2. **Seed:** Sewage (fresh) is settled for 20 hrs. The supernatant is used as seed. Quantity of seed should be chosen such that it won't exert more than 20% depletion of DO.
3. **Buffers and Nutrients:** Dissolve 8.5 gm. KH_2PO_4, 21.75 gm. K_2HPO_4, 33.4 gm. $Na_2HPO_47H_2O$ and 1.7gm NH_4Cl in 500 ml distilled water to prepare Phosphate buffer. **OR** Dilute to 1 liter. pH of the solution is 7.5; **OR** Magnesium sulphate ($MgSO_4$); **OR** Dissolve 27.5 gm. Anhydrous $CaCl_2$, in distilled water and make the volume to 1 liter to prepare Calcium chloride solution. **OR** Dissolve 0.25 gm. of $FeCl_3.H_2O$ in distilled water and make the volume to 1 liter to prepare Ferric chloride solutions.
4. Alkali iodide solution
5. Concentrated H_2SO_4
6. Sodium thiosulphate 0.025 N
7. Starch Indicator.

Stepwise Procedure:

A. Preparation of dilution water.

1. Prepare dilution water saturated with air as discussed earlier.
2. Add 1 ml. each of phosphate buffer, magnesium sulphate and calcium chlorideand ferric chloride solution for each litre of dilution water and mix it well.
3. In case of the waste which is not expected to have sufficient bacterial population add seed.

B. Dilution of sample.

1. Neutralize the sample to pH around 7.0, if it is highly alkaline or acidic. For acidifying do not use organic acid, use only mineral acid.
2. Sample having high DO content i. e. DO 9 mg/l due to either algal growth or some other reason, reduce the DO content by aerating and agitating samples.
3. Make the several dilution of sample to obtain required depletion. Following dilutions are suggested.
    - For strong treated waste- 0.1 to 1 %
    - For raw settled waste- 1.0 to 5.0 %
    - For oxidized effluent - 5 to 25.0 %
    - For polluted river waters- 25.0 to 100 %
4. Prepare the desired mixture by adding sample in dilution water.
5. Fill up one 300 ml bottle with the mixture and other one with dilution water (blank) in two sets.
6. Keep one set in BOD incubator for 5 days for incubation at 20°C
7. Determine the DO of blank and sample immediately before incubation (i.e. first day)
8. Determine the DO of blank and sample after incubation for 5 days (i.e. fifth day)

C. Determination of DO for blank and sample on first day

1. Take BOD bottle containing blank.
2. Add 2 ml of manganese sulphate solution by means of pipette, dipping the end of the pipette just below the surface of water in BOD bottle containing blank.
3. Add 2 ml Azide alkali potassium iodide in a similar manner.
4. Inset the stopper with care to extrude bubble and mix by repeatedly inverting and shaking the bottle vigorously.
5. Red precipitate will form if DO is present in water. Allow the precipitate to settle half way, and mix again.
6. Again allow the precipitate to settle half way.
7. Add 2ml of concentrated H_2SO_4 in the same manner as done in step 2 and 3 and insert the stopper and mix up thoroughly as before.
8. Allow the solution to stand for at last 5 minutes to ensure formation of I_2, which is to be titrated against sodium thiosulphate.
9. Take 203 ml of solution in the conical flask.
10. Fill the burette with 0.025 N sodium thiosulphate solution and note the initial burette reading.
11. Titrate the sample immediately with 0.025 N sodium thiosulphate solution, until the yellow colour becomes very light.
12. Add 1 ml of starch solution. This will give blue colour. Now continue the titration by adding sodium thiosulphate drop by drop, till the blue colour just disappears. Record the fine burette reading (B1).
13. Take BOD bottle containing sample.
14. Repeat the procedure from step 2 to 12 and note down the initial and final burette reading (D1).

D. Determination of DO for blank and sample on 5 day after incubation

1. Take BOD bottle containing blank.
2. Repeat the procedure from step 2 to step 12 as done earlier. Note down the initial and final burette reading (B2)
3. Take BOD bottle containing sample.
4. Repeat the procedure from step 2 to step 12 as done earlier. Note down the initial and final burette reading (D2).

   Note: *For 200 ml of sample the difference in initial and final burette reading in ml directly gives the amount of Oxygen (DO)*

X. Observation Table:

Observation table for Biochemical Oxygen Demand for Dilution Factor D.F. =.....

Volume of sample = 200 ml (for calculation) and 203 ml (actual)

Sr. No.	Source of the sample	Bottle No.	Burette Reading		DO (mg/l)	BOD5 (mg/l)
			Initial (1) ml	Final (2) ml	(1-2)	
01	Domestic waste water					
02	Industrial waste water from *any specific industry e.g. i) Sugar Industry ii) Food & Beverages iii) Paint Industry iv) Paper & Pulp Mill etc.					
03	Stagnant surface wastewater (i.e. pond)					

* Any specific industry in the area

Sample Calculation:

Calculation of DO

$$DO = \frac{ml\ of\ sodium\ Thiosulpate\ x\ N\ x\ 1000\ x\ 8}{ml of water sample}(mg/l)$$

$$DO = \frac{ml\ of\ sodium\ Thiosulpate\ x\ 0.025\ x\ 1000\ x\ 8}{200}(mg/l)$$

$$DO = \frac{\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ x N x\ 1000\ x\ 8}{200}(mg/l)$$

$$DO\ ) = \ldots\ldots\ldots\ldots\ldots\ldots mg/l$$

By using above formula find out DO for blank and sample on first and fifth day (after incubation) so,

DO of blank before incubation (i.e. first day), B_1= …….mg/l

DO of blank before incubation (i.e. fifth day), B_2= …….mg/l

DO of the diluted sample before incubation (i.e. first day), D_1= …….mg/l

DO of the diluted sample after incubation (i.e. fifth day), D_1= …….mg/l

Dilution factor, D.F. = ……..

Calculation of BOD

BOD in mg/l $= [(D_1 - D_2) - (B_1 - B_2)]XD.F.$

BOD in mg/l = ⋯ …

XI. Result:

- BOD of the given sample obtained from Domestic waste water is found to be ……. .
- BOD of the given sample obtained from Industrial waste water from ……..…….industry is found to be ……. .
- BOD of the given sample obtained from stagnant surface waste water sample is found to be ……. .

XII. Interpretation of Results:

XIII. Conclusions:

XIV. Practical Related Questions:

1. State the exact location or source of wastewater sample taken for the testing purpose.
2. Name the reagent used by you in this practical.
3. Explain the process for dilution of water sample followed in this practical.
4. State significance of BOD, at 20°C.
5. State importance of BOD value in wastewater treatment.
6. State the effect of temperature on the rate of oxidation reaction.
7. State the necessity of dilution of sample.
8. Give the recommended values of BODs for the disposal of wastewater
    a. In surface water body
    b. On land for irrigation
9. Write the capacity BOD bottle used by you in this practical.
10. Mention the total time required to conduct this test.

Space for Answer

XV. Assessment Scheme

Sr. No.	Performance Indicators	Weightage	Marks Obtained
A.	**Process Related (15 marks)**	**60%**	
1.	Handling of equipment's & Survey Conduction	40%	
2.	Accuracy in length measurement.	20%	
B.	**Product Related (10 marks)**	**40%**	
3.	Conclusion of practical	20%	
4.	Answer to practical related questions	20%	
C.	**Total marks (25 marks)**	**100%**	

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 13 Determination of the Dissolved Oxygen in the given sample of wastewater.

I. Practical Significance:

Dissolved Oxygen (D.O.) measurements along a river determine its pollution status. A D.O. level above 3 mg/L (40% saturation) supports aquatic life, with 6-8 mg/L being typical in healthy rivers. This practical measurements are crucial for maintaining aerobic conditions in biological treatment units, form the basis of the BOD test. This practical is significant in helping to control corrosion in water distribution systems and steam boilers.

II. Industry/Employer expected outcome(s):

- To determine the quality of wastewater and decide on the appropriate treatment process.

III. Course Level Learning Outcome (COs):

- CO5 -Apply the wastewater treatment processes.

IV. Laboratory Learning Outcome (LLO):

- LLO 13.1 Calculate the dissolved oxygen content in the given sample of wastewater.

V. Relevant Affective Domain related Outcome(s):

- Using Safe behaviors effectively.
- Maintain high standards of hygiene.
- Efficient application of tools, equipment's and machinery.
- Professional and ethical standards.

VI. Relevant Theoretical Background:

The D.O. value varies with temperature, pressure, and chloride concentration. As temperature increases, oxygen solubility decreases from 14.6 mg/L at 0°C to 7 mg/L at 35°C at atmospheric pressure. Higher chloride concentrations also reduce D.O. The minimum D.O. required for aquatic life is 4 mg/L. Organic pollution lowers D.O. as bacteria consume oxygen to decompose the matter. Adequate D.O. in wastewater ensures complete decomposition without foul smells.

Ref.:https://www.gainexpress.com/products/8403

Figure No. 13.1 Digital D. O. Meter

VII. Required Resources:

Sr. No.	Resource required	Particulars	Quantity
01	Digital DO meter	Range: 0 to 20 ppm, Resolution: 0.1 ppm, Temperature Compensation: 0 to 50°C.	01 No
02	Beaker	Standard glassware beaker of 500 ml. capacity	03 No

VIII. Precautions to be followed:

1. Use clean and dry beakers.
2. The Standardization of DO meter is essential before use.
3. Clean and wipe out electrode every time of immersion.
4. Record the temperature of room.
5. Record the reading in steady condition.
6. The use of electrode should be done very carefully as it is very sensitive and breakable.

IX. Procedure:

1. Calibration Before measurement:

- Disconnect the "OXYGEN PROBE plug" from the main instrument "Input socket".
- Power on the instrument by selects the "On/Off Switch" to the "On" position. Slide the "DO / CAL Switch" to the "CAL" position. Adjust the "ZERO Adj. VR" until the display shows zero value.
- Power off; connect the "OXYGEN PROBE plug" to the main instrument "Input Socket" then power on. Wait 5 minutes at least until the display reading values become stable & no fluctuation. Adjust the "CAL Adj. VR" until the display reading shows the values exact same as 20.9 (As the oxygen in air is 20.9% typically) (Calibration consideration: Please make calibration procedures under wide and ventilating environment for best effects.)

2. Dissolved Oxygen (DO) measurement:

- After the meter is calibrated, don't adjust the "CAL Adj. VR" & "ZERO Adj. VR" again until next calibration procedure is done.
- Slide the "DO/CAL Switch" to the "DO" position.
- Immersed the probe to a depth at least 10 cm of the measured liquid in order for the probe to be influenced by the temp. & automatic temperature compensation to take place. As for the thermal equilibrium to occur between the probe & the measurement sample must be allowed to pass, which usually amounts to a few minutes if the temp. Difference between the two is only several C degrees.
- In order to measure the dissolved oxygen content in any given liquid, it is sufficient to immerse the tip of the probe in the solution, making sure that velocity of the liquid coming into contact with the probe is at least 0.2-0.3 m/s or shake the probe. During laboratory measurements, the use of a magnetic agitator to ensure a certain velocity in the fluid is recommended. In this way,

errors due to the diffusion of the oxygen present in the air in the solution are reducing to a minimum.

X. Observation Table:

Sr. No.	Source of the sample	Sample No.		Average DO (mg/l)
		1 (mg/l)	2 (mg/l)	
01	Domestic waste water			
02	Industrial waste water from *any specific industry e.g. i) Sugar Industry ii) Food & Beverages iii) Paint Industry iv) Paper & Pulp Mill etc.			
03	Stagnant surface wastewater (i.e. pond)			

* Any specific industry in the area

Sample Calculation:

For Observation No……

- Observed Average value of D.O. for Domestic waste water sample

$$Average\ D.O. = \frac{\text{D. O. of sample No. (1)} + \text{D. O. of sample No. (2)}}{2}$$

- Observed Average value of D.O. for Industrial wastewater sample

(i) $\frac{\text{D.O.of sample No. (1)} + \text{D.O.of sample No. (2)}}{2} =$ .....

(ii) $\frac{\text{D.O.of sample No. (1)} + \text{D.O.of sample No. (2)}}{2} =$ .....

(iii) $\frac{\text{D.O.of sample No. (1)} + \text{D.O.of sample No. (2)}}{2} =$ .....

(iv) $\frac{\text{D.O.of sample No. (1)} + \text{D.O.of sample No. (2)}}{2} =$ .....

- Observed Average value of D.O. for Stagnant surface water (i.e. pond) water sample

$$\frac{\text{D.O.of sample No. (1)} + \text{D.O.of sample No. (2)}}{2} = \text{.....}$$

XI. Results:

- The average value of D.O. for Domestic waste water sample is found to be …….
- The average value of D.O. for Industrial waste water sample from ……industry is found to be …….
- The average value of D.O. for Stagnant Surface waste water sample is found to be …….

XII. Interpretation of results:

XIII. Conclusions:

XIV. Practical Related Questions:

1. State the exact location of wastewater sample taken for the testing purpose.
2. Give the reasons for variation in D.O. value of wastewater sample from variouslocations.
3. Justify the difference in D.O. values of wastewater sample tested.
4. Suggest the treatment for the wastewater to bring it to the acceptable limit for aquatic life, drinking water and industrial processing.
5. Justify for the difference in DO values of three types of samples taken for testing purpose
6. State the acceptable limit of D.O. value for the aquatic life to survive.
7. State the effect on D.O. values of wastewater with the passage of time after its generation.
8. State how D.O. value will affect the treatment process to be adopted for particular wastewater or sewage.
9. State various methods to find D.O. value of wastewater in a laboratory.
10. Give the specific pollutants responsible for reduction in D.O. value in wastewater.
11. State D.O. Fixation.

Space for Answer

XV. Assessment Scheme.

Sr. No.	Performance Indicators	Weightage	Marks Obtained
A.	**Process Related (15 marks)**	**60%**	
1.	Calibration of instrument	20%	
2.	Conduction of practical	20%	
3.	Recording of observations	20%	
B.	**Product Related (10 marks)**	**40%**	
3.	Conclusion of practical	20%	
4.	Answer to practical related questions	20%	
C.	**Total marks (25 marks)**	**100%**	

Marks Obtained			**Dated sign of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 14 Determination of COD of a given sample of wastewater.

I. Practical Significance:

As COD gives a broader picture of the oxidizable matter present, while BOD specifically focuses on the biodegradable organic component. This practical result is helpful to determine Treatability Index, which further significant in adopting appropriate treatment methods for different types of waste. Prioritizing biological treatment, when feasible, seems not only environmentally friendly but also economically advantageous. It's crucial for assessing water quality in sewage treatment and industrial monitoring.

II. Industry/Employer Expected Outcome(s):

- To determine the quality of wastewater and decide on the appropriate treatment process.

III. Course Level Learning Outcome (COs):

- CO5 - Apply the wastewater treatment processes.

IV. Laboratory Learning Outcome (LLO):

- LLO 14.1 - Calculate COD of a given sample of wastewater.

V. Relevant Affective Domain related Outcome(s):

- Follow safety practices.
- Practice good housekeeping.
- Demonstrate working as leader or a team leader.
- Maintain tools and equipment.
- Follow ethical practices

VI. Relevant Theoretical Background:

COD i.e. Chemical Oxygen Demand, measures the oxygen needed to oxidize organic matter in water. Unlike BOD tests, COD results are quick i.e. within 5 hours and less prone to interference. It's valuable for process efficiency evaluation and industrial wastewater strength assessment. However, COD can't differentiate between biodegradable and inert materials.

Chemical Oxygen Demand by the following formula

$$\text{COD} = \frac{8\ X\ 1000\ X\ DF\ X\ M\ X\ (V_B - V_S)}{\text{Volume of sample (in ml)}}$$

Where, DF- Dilution factor (if applicable)

M - Molarity of standardized Ferrous Ammonium Sulphate solution.

V_B - Volume consumed in titration with blank preparation.

V_S - Volume consumed in titration with sample preparation.

Figure No. 14.1 COD Reflux Apparatus

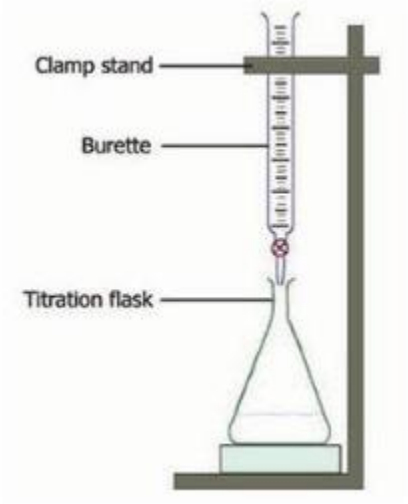


Figure No. 14.2Titration Set

VII. Required resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
1.	COD Reflux Apparatus	Temperature Range: Above amb. To180°C Resolution: 1°C, Display: Digital 12mm RedLED Control: Digital electronic Temp Controller. Heater rating: 750 Watts, Sensor: PT - 100 Timer: Selectable, 15,30,45,60,90 or 120min with alarm, Hole Size: 40mm Dia. 80mmDepth Glass Tube: 38mm dial 5 no's (5 X 3 rows) Sample Volume: 20ml each. Dimension : 500 W X 270 D X 210mm H	1 No.
2.	Titration Set	Consisting of Stand, Beaker of requisite capacity, pipette	1 No.
3.	Hot Plate	Of requisite quality	1 No.

VIII. Precautions to be followed:

1. Use clean and dry Beakers, Burette, Pipette, Flask,
2. Proper reagents should be used.
3. Preparation of Dilution of sample should be done properly.
4. Determination of COD for the blank and sample should be done with due care.

IX. Procedure:

Reagents:

Standard potassium dichromate (0.25N) ($K_2Cr_2O_7$), Sulphuric acid reagent, standard ferrous ammonium sulphate (0.25N), Ferroin indicator, Mercuric sulphate ($HgSO_4$), Glass Bids.

1) Standard potassium dichromate (0.250N) - Dissolve 12.259 gm ($K_2Cr_2O_7$) dried at 103°C for 24 hours in distilled water and dilute to 1000 m. add about 120 mg sulphuric acid to take care of 6mg/l NO_2-N.
2) Sulphuric acid reagent 10 gm of Ag_2SO_4 to 1000 ml concentrated H_2SO_4 and keep overnight for dissolution.
3) Standard ferrous ammonium sulphate 0.25N Dissolve 39 gm. $Fe(NH_4)_2(SO_4)_2$ and dilute to 1000 ml.
4) Ferroin indicator - Dissolve 1.485 gm 1.10 phenanthroline monohydrate and 695 mg $FeSO_4$ $7H_2O$ and dilute to 100 ml with distilled water.
5) Mercuric sulphate: $HgSO_4$ crystals

Stepwise Procedure:

1. Prepare standard solutions of potassium dichromate, sulphuric acid reagent, and ferrous ammonium sulphate.
2. Prepare ferroin indicator and mercuric sulphate solution.
3. Take 10 ml of sample into a round bottom reflex flask.
4. Add some glass beads to prevent the solution from bumping into the flask while heating.
5. Add 1 ml of mercury sulphate ($HgSO_4$) solution to the flask and mix by swirling the flask.
6. Add 5 ml of standard Potassium dichromate ($K_2Cr_2O_7$) solution.
7. Now add slowly and carefully 15 ml Silver sulphate- sulphuric acid solution.
8. Connect the reflux condenser and digest the content using a hot plate for 2 hours.
9. After digestion cools the flask and rinses the condenser with 25 ml of distilled water collecting in the same flask.
10. Add 2-4 drops of ferroin indicator to the flask and titrate with 0.025 M ferrous ammonium sulphate solution to the end point.
11. Make the blank preparation in the same manner as sample using distilled water instead of sample.

X. Observation Table:

Observation for chemical oxygen demand

For dilution factor (……..),

Sr. No.	Sample (Collection sources)	Ml of ferrous Ammonium sulphate		
		Flask 1	Flask 2	Flask 3
1	Blank			
2	Spent wash			
3	Domestic sewage			
4	Industrial Sewage			
5	Stagnant waste water			

Sample Calculation:

Calculate the chemical oxygen demand by the following formula

$$\text{COD} = \frac{8\ X\ 1000\ X\ DF\ X\ M\ X\ (V_B - V_S)}{\text{Volume of sample (in ml)}}$$

COD = ……..

COD = ……..

XI. Result:

- COD of the given sample obtained from Domestic waste water is found to be.....
- COD of the given sample obtained from spent wash is found to be.....
- COD of the given sample obtained from waste water from industry (any specific) is found to be.....
- COD of the given sample obtained from stagnant surface waste water sample is found to be.....

XII. Interpretation of Results:

XIII. Conclusions and Recommendation:

XIV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. Write four uses of COD.
2. Define dilution factor.
3. Explain why BOD value is always less than COD value.
4. State the significance of COD in wastewater treatment.
5. Give comparison between BOD and COD test.
6. State the importance of BOD/COD ratio.
7. Give the time required for COD test.
8. State the correlation between COD value and organic matter of sample.
9. Name the chemical reagents used in COD test.
10. Write the value of COD for following industrial wastes
    (a) Dairy (b) Tannery (c) Textile (d) Distillery

Space for Answer

XV. Assessment Scheme

Sr. No.	Performance Indicators	Weightage	Marks Obtained
A.	**Process Related (15 marks)**	**60%**	
1.	Calibration of instrument	20%	
2.	Conduction of practical	20%	
3.	Recording of observations	20%	
B.	**Product Related (10 marks)**	**40%**	
3.	Conclusion of practical	20%	
4.	Answer to practical related questions	20%	
C.	**Total marks (25 marks)**	**100%**	

Marks Obtained			**Dated sign of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 15 Preparation of a report on a field visit to the Wastewater Treatment Plant.

I. Practical Significance:

Wastewater treatment before disposal is crucial for preventing pollution and safeguarding the environment. This process removes harmful impurities, ensuring that discharged water does not adversely affect surrounding ecosystems or communities dependent on clean water sources. This practical helps to understand the layout of waste water treatment plant. It also becomes necessary to verify the theoretical process of waste water treatment. This practical is necessary to compare the waste water treatment plant or sewage treatment plant (STP) with water treatment plant (WTP).

II. Industry/Employer Expected Outcome(s):

To undertake field visit to conventional Wastewater Treatment Plant.

III. Course Level Learning Outcome (COs):

- CO5 - Apply the wastewater treatment processes.

IV. Laboratory Learning Outcome (LLO):

- LLO 15.1 Write a report on Wastewater Treatment Plant.

V. Relevant Affective Domain related Outcome(s):

- Follow safety practices.
- Practice good housekeeping.
- Demonstrate working as leader or a team leader.
- Maintain tools and equipment.
- Follow ethical practices.

VI. Relevant Theoretical Background:

Wastewater treatment plant has different units through which wastewater gets treated in the successive order.

Process of treatment of waste water is

1) Screening
2) Grit removal
3) Skimming
4) Primary sedimentation of waste water
5) Aeration of waste water
6) Secondary Sedimentation
7) Sludge Digestion
8) Trickling Filter

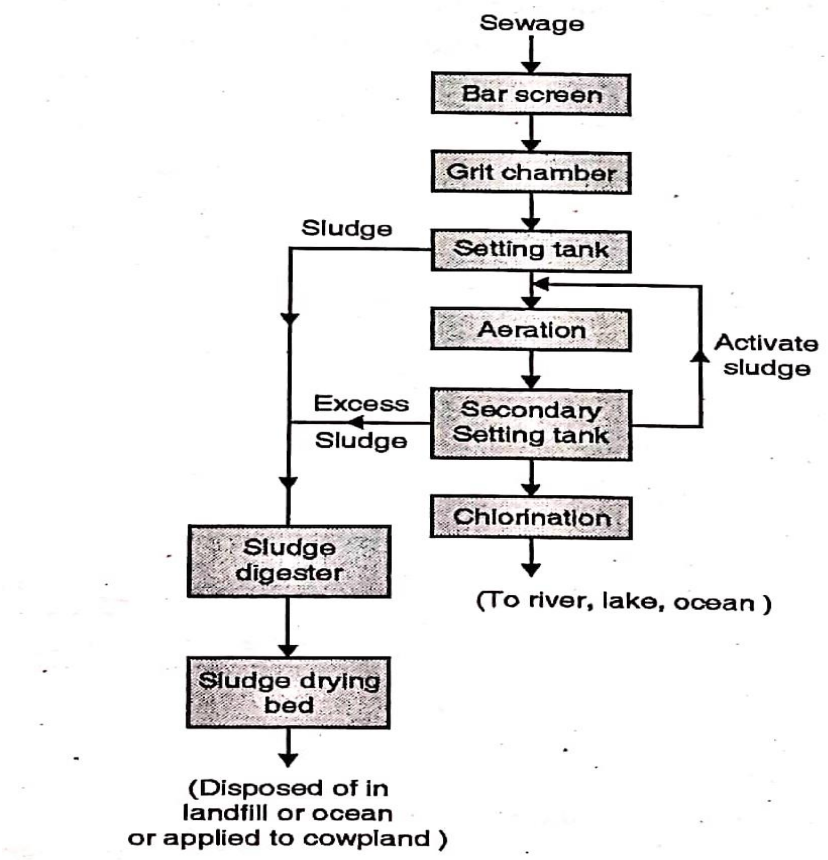


Figure 15.1 Flow diagram of Waste Water Treatment Plant

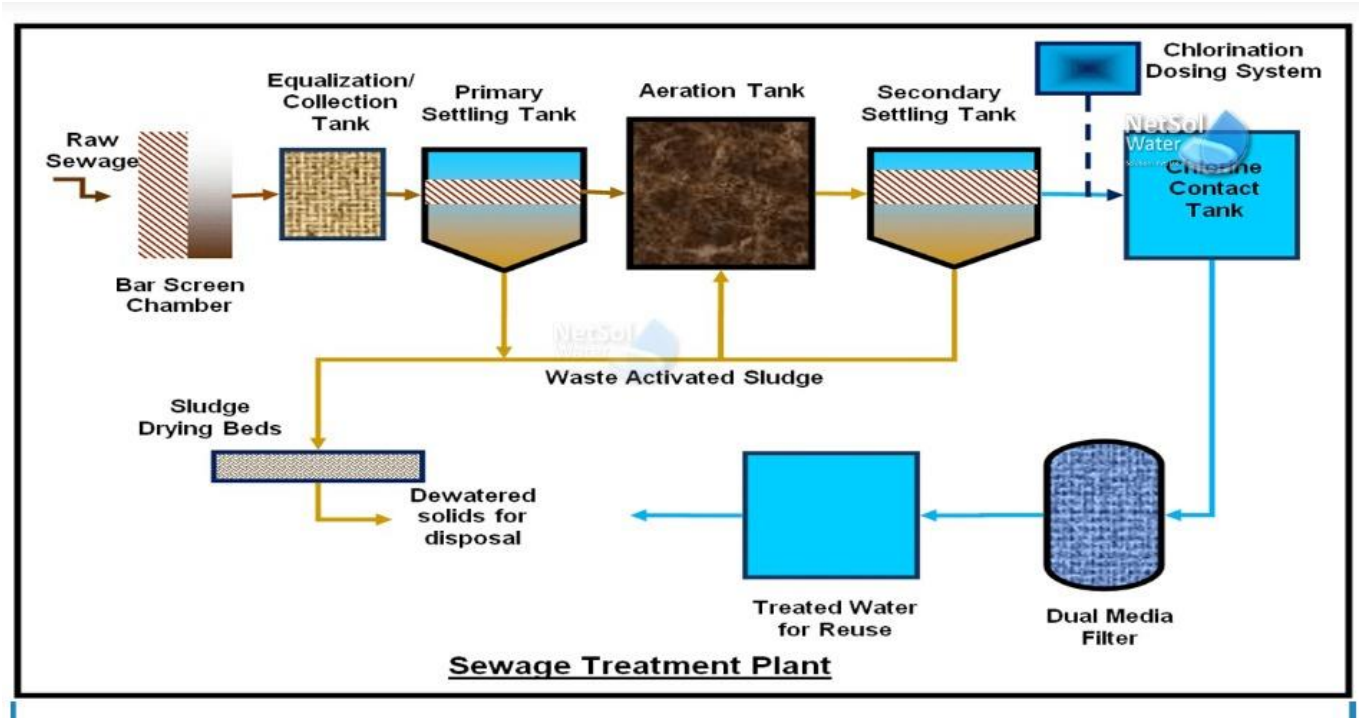


Figure 15.2 Layout of Waste Water Treatment Plant

VIII. Required resources/equipment:

Sr. No.	Particulars	Specification	Quantity	Remark
01	Waste Water Treatment Plant	Any accessible working plant available nearby the college premises.	1 No.	Per Class
02	Recording accessories	Recording notebook/notepad, pen, pencil etc.	1 each	Per group of 4-5 students
03	Camera	Mobile or DSLR camera for taking photographs (If permitted)	1 No.	Per Class

IX. Precautions to be followed:

6. Take prior permission from concern department (MJP/Nagarpalika/Municipal Corporation) well in advance.
7. Adopt Safety measures during the visit.
8. Maintain discipline during journey and visit at WTP.
9. Record all necessary information in note book.
10. Wear college uniform, shoes, cap, dupatta, sun- glass during visit.
11. Keep safe distance from moving parts/ machines at site.

X. Procedure:

7. Identify feasible site of Wastewater Treatment Plant available nearby and accessible from you college premises.
8. Plan suitable date and time for visit for the above identified site with prior permission of head of department/institute.
9. Observe the general layout of water treatment plant at the site visit carefully.
10. Record the position and connection of component parts of Wastewater Treatment Plant to draw the flow diagram of actual site visit.
11. Record the functions of each component parts of Wastewater Treatment Plant to understand the complete process of treatment.
12. Prepare the visit report as per the format given below.

XI. Observations: Student should write the visit report as per the following after completing the visit to water treatment plant.

Format of Visit Report to Wastewater Treatment Plant

Aim/Objective of visit:.....

Day, Date and Time of visit: …….

Name and complete address of visited site: …….

……..

Name and designation of guide at site: ……

Governing body of Wastewater Treatment Plant….....

Daily raw water intake (m^3/day or MLD).....

Source of water.....

Out flow of plant……..

Intake water characteristics .....

Daily out flow.....

List of various parts and their function…….

Frequency of suspended particles removed per day……..

Removal of Oil and Grease from the waste water…….

Removal B.O. D. Value from the waste water……....

Dimensions of different units of waste water treatment plant…….....

……..

Capacity of each of treatment unit……

……..

Details of Energy recovery units (if any)……

List of components parts and their functions.....

……..

……..

……..

……..

……..

……..

Draw flow diagram of Wastewater Treatment Plant:

Photograph of Visit: (Student should paste 2 photographs of site visit)

XII. Result:

3. The layout of the wastewater treatment plant observed was ……. (Same / somewhat different / excessively different) as compared to theoretical layout of wastewater treatment plant.
4. The working of the wastewater treatment plant observed was ……. (Same / somewhat different / excessively different) as compared to theoretical working of wastewater treatment plant.

XI. Result:

XII. Interpretation of results:

XIII. Conclusions:

XI. Practical Related Questions:

1. Write the criteria of selecting the location site for establishing new wastewater treatment plant.
2. State different types of sewage from the community considering its nature.
3. State the exact treatment carried in Primary sedimentation tank and Secondary sedimentation tank.
4. Give the reasons of non-functioning of sewage treatment plant.
5. State the purpose of providing sludge drying beds.
6. State about different types of screens provided in screen chamber.
7. Explain the activated sludge process.
8. Suggest the type of process (aerobic or anaerobic) of treatment of wastewater collected in village area.
9. Write the Influent and Effluent for the visited waste water treatment plant.

Space for Answer

XV. Assessment Scheme

Sr. No.	Performance Indicators	Weightage	Marks Obtained
A.	**Process Related (15 marks)**	**60%**	
1.	Handling of equipment's & Survey Conduction	40%	
2.	Accuracy in length measurement.	20%	
B.	**Product Related (10 marks)**	**40%**	
3.	Conclusion of practical	20%	
4.	Answer to practical related questions	20%	
C.	**Total marks (25 marks)**	**100%**	

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	