VAISHNO COLLEGE OF ENGINEERING

Affliated to HPTU, Hamirpur and approved by AICTE

Water Supply and Treatment Engineering
Lab Manual
CE-415P (NEP Syllabus)

Department of Civil Engineering

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Vision of Institute

To emerge as an institute of eminence in the fields of engineering, technology and management in serving the industry and the nation by empowering students with a high degree of technical managerial and practical competence.

Mission of Institute

M1 To strengthen the theoretical, practical and ethical dimensions of the learning process by fostering a cultural of research and innovation among faculty members and students.

M2 To encourage long term interaction between academia and industry through the involvement of industry for hands on implementation of the curriculum.

M3 To strengthen and molding students in professional ethical, social and environmental dimensions by encouraging participation in co-curricular extracurricular and CSR activities.

Vision of the Department

To produce engineers having professional and leadership qualities with capacity to take up professional and research assignments in Civil Engineering and allied fields with focus on inter-disciplinary and innovative approach and to compete at the global level.

Mission of the department

1. To impart quality and real time education to contribute to the field of Civil Engineering.

2. To impart soft skills, leadership qualities and professional ethics among the graduates to handle projects independently.

3. To develop graduates to compete at the global level.

Program Educational Objectives (PEOs) of the department

PE01:- To impart quality education and knowledge in contemporary science and technology to meet the challenges in the field of Civil Engineering and to serve the society.

PEO2:- To impart the knowledge of analysis and design using the codes of practice and software packages.

PEO3:-To inculcate the sense of ethics, morality, creativity, leadership, professionalism, self confidence and independent thinking.

PEO4:- To motivate the students to take up higher studies and innovative research projects.

PROGRAM OUTCOMES

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcome (PSOs)

PSO 1: The graduates of this program will be able to meet the needs of public in the design
and execution of quality construction work considering principles of mechanics, mathematics
and physics to construct sustainable buildings that will ensure safety and durability till the
service period.

PSO 2: The graduates will calculate the loads and the stresses acting on the building, analysis for
the loads and design sections of structures to sustain the loads using building analysis software
packages.

PSO 3: The graduates will be able to work effectively as an individual or in a team having
acquired leadership skills and manage projects in multidisciplinary environments.

Lab Syllabus & List of Experiments

CEPC-415P Water Supply & Treatment Technology Laboratory							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P		Internal Assessment	End Semester Examination	Total	
0	0	2	1	Maximum Marks: 30	Maximum Marks: 20	50	2 Hours
				Minimum Marks: 12	Minimum Marks: 8	20	

Course Objectives:

- Explain the fundamental theory of various experiments and their application in the real field applications.
- Conduct various experiments on water samples as per standard procedures individually & within a team.
- Interpret various data/results and analyze them along with the precautionary measures to be taken.
- Evaluate the test results & provide solutions/suggestions according to their quality for various usagesaccording to the standard guidelines.

Sr. No.	List of Experiments
	To determine the following parameters for the given sample of water: -
1	Color, pH and turbidity.
2	Electrical Conductivity.
3	Total Solids, Suspended Solids and Dissolved Solids.
4	Concentration of major anions (Carbonate, Bi-carbonate, Chloride, Sulphate, Nitrate, Nitrite, Phosphate)
5	Concentration of major cations (Iron, Fluoride, Sodium, Potassium, Calcium, Magnesium)
6	Hardness.
7	Optimum Alum Dose through Jar Test.
8	Chlorine Demand & Residual Chlorine.
9	Available Chlorine Percentage in a given sample of bleaching powder.
10	Amount of Dissolved Oxygen (DO).
11	Biochemical Oxygen Demand (BOD) .
12	Chemical Oxygen Demand (COD).
13	Bacteriological quality of water: presumptive test, confirmatory test and determination of MPN.

<u>Evaluation Scheme</u>

Internal Assessment: 30 marks (pass marks:12)

Distribution of marks for internal assessment:

- Written/presentation/Demonstration: 05
- Viva-voice: 05
- Teacher assessment: Lab Work performance/Report/File Work:15
- Attendance: 05

External Assessment: 20 marks (pass marks: 08)

Total marks 30+20=50, Pass marks = 20

Note: Student has to pass internal & external assessment separately.

GENERAL GUIDELINES AND SAFETY INSTRUCTIONS

1. Sign in the log register as soon as you enter the lab and strictly observe your lab timings.

2. Strictly follow the written and verbal instructions given by the teacher / Lab Instructor. If you do not understand the instructions, the handouts and the procedures, ask the instructor or teacher.

3. Never work alone! You should be accompanied by your laboratory partner and / or the instructors / teaching assistants all the time.

4. It is mandatory to come to lab in uniform and wear your ID cards.

5. Do not wear loose-fitting clothing or jewellery in the lab. Rings and necklaces are usual excellent conductors of electricity.

6. Mobile phones should be switched off in the lab.

7. Keep the labs clean at all times, no food and drinks allowed inside the lab.

8. Intentional misconduct will lead to expulsion from the lab.

9. Do not handle any equipment without reading the safety instructions. Read the handout and procedures in the Lab Manual before starting the experiments.

10. Do your wiring, setup, and a careful circuit checkout before applying power. Do not make circuit changes or perform any wiring when power is on.

11. Avoid contact with energized electrical circuits.

12. Do not insert connectors forcefully into the sockets.

13. Never try to experiment with the power from the wall plug.

14. Immediately report dangerous or exceptional conditions to the Lab instructor / teacher: Equipment that is not working as expected, wires or connectors are broken, the equipment that smells or “smokes”. If you are not sure what the problem is or what's going on, switch off the Emergency shutdown.

15. Never use damaged instruments, wires or connectors. Hand over these parts to the Lab instructor/Teacher.

16. Be sure of location of fire extinguishers and first aid kits in the laboratory.

17. After completion of Experiment, return the bread board, trainer kits, wires, CRO probes and other components to lab staff. Do not take any item from the lab without permission.

18. Observation book and lab record should be carried to each lab. Readings of current lab experiment are to be entered in Observation book and previous lab experiment should be written in Lab record book. Both the books should be corrected by the faculty in each lab.

20**. Special Precautions during soldering practice**

a. Hold the soldering iron away from your body. Don't point the iron towards you.

b. Don't use a spread solder on the board as it may cause short circuit.

c. Do not overheat the components as excess heat may damage the components/board.

d. In case of burn or injury seek first aid available in the lab or at the college dispensary.

Experiment No: 1

Aim: To find the pH present in the given water sample.

Apparatus Required: pH meter, Electrode, Buffer solutions, filter papers etc.

Principle:

pH refers to the hydrogen ion activity and is expressed as the logarithm of reciprocal of hydrogen ion activity in molar per litre. It can be measured by calorimetric methods using various indicators or electrometrically by using pH meter employing hydrogen ion-sensitive electrodes. The basic principle of electrometric pH measurement is determination of activity of the hydrogen ion by potentiometric measurement using a standard hydrogen electrode and a reference electrode.

Interference:

pH measurements are affected by temperature. In the pH meter, provision is made for setting the instrument to room temperature before taking the pH readings. The Buffer solutions used for standardization must be kept in the refrigerator. Always report the temperature at which pH is measured.

Procedure:

1. Connect the pH electrode to the pH meter input terminal. Adjust the manual temperature setting to room temperature.

2. Wash the pH electrode with distilled water and wipe dry using filter paper. Insert the pH electrode into a known buffer of 7.0 pH. If it is different from 7.0 pH, adjust the reading to
7.0 pH by varying the AP control.

3. Wash the electrode with distilled water and wipe dry. Insert the electrode into another known buffer, 4.0 pH.If it is different from 4.0 pH, adjust the reading to 4.0 pH.

4. Wash the electrode with distilled water and wipe dry. Repeat the procedure with 7.0 pH and 4.0 pH until consecutive correct readings are obtained.

5. Now the pH electrode and the pH meter have been matched calibrated.

6. Wash the electrode with distilled water and wipe dry. Insert the electrode into the unknown sample and take the displayed reading.

Result:

The pH of the given water sample is -------------------

Tabulation:

S.NO	SAMPLES	pH

Aim:-

To determine the turbidity of the given sample water by Nephelometric method

Apparatus required: -

Nephelo turbidity meter.

Principle: -

Turbidity is a measure of the extent to which light is either absorbed or scattered by suspended material present in the water. Turbidity is surface waters results from the erosion of colloidal material such as clay, slit, rock fragments and metal oxides from soil, vegetable fibers and micro-organisms may also contribute to turbidity. Drinking water supplies requires special treatment by chemical coagulation and filtration before it may be used for public water supply.

This turbidity can be brought down to required level by adding coagulants. Coagulants when added to water it will form a geletaneous substance known as floc and this will arrest the fine suspended and colloidal particles. These arrested particles will settle down rapidly because of increase in their size.

Interference: -

Turbidity waters are aesthetically displeasant and are not accepted for domestic use. The colloidal matter associated with turbidity provides adsorption sites for chemicals and biological organisms that may be harmful or cause undesirable tastes and odour. Disinfection of the turbid waters is difficult and unsatisfactory, since the colloids partially shield organisms from the disinfectant. This IS values for drinking water is 10 to 25 NTU.

Reagents: -

1. Turbidity free water: - Pass distilled water through a lower turbidity than distilled water, discard the first 200ml, collected. If filtration does not reduce turbidity use distilled water.
2. Stock turbidity solutions:

   i) **Solution 1**: - Dissolve 1.0 grams hydrazine suplate $(NH_2)_2.H_2SO_4$ in distilled water and dilute it to 100 ml in a makeup flask.

   ii) **Solution 2**: - Dissolve 10.0 grams hexamethylene tetramine $(CH_2)_6N_4$ in distilled water and dilute it to 100ml.

   iii) **Solution 3**: - In a 100ml flask, mix 5ml. each of solution 1 and 2. Allow it to stand 24 hours, then dilute it to 100ml and mix thoroughly. The turbidity of this solution is 400 NTU.

   iv) **Standard Turbidity Solution**: - Take 10.0ml of solution 3 in a 100ml make up flask and dilute it to 100ml with turbid free water. The turbidity of this suspension is 40 NTU.

PROCEDURE:-

a) Calibration of Nephelometer:-

i) Select proper range of NTU on Nephelometer.

ii) By placing distilled water in Nephelometer test tube, set the Nephelometer reading to zero by using the knobs provided for zero setting.

iii) Using the standard turbid solution (i.e. 40 NTU), calibrate the Nephelometer (i.e. adjust the Nephelometer reading to 40 NTU using calibration knob).

OBSERVATIONS:-

S.No	SAMPLE	NTU

a) Determination of turbidity of sample water:

i) For samples having turbidities less than 40 NTU: Thoroughly shake the sample so as to remove any air bubbles and pour it into meter cell. Read out the turbidity of the sample from the digital display.

ii) For samples having turbidities above 40 NTU: Dilute sample with 1,2 or 3 volumes of turbidity free water and convert the value obtained as below.

If five volumes of turbidity free water were added to one volume of sample and the diluted sample showed a turbidity of 30 NTU, then the actual value is equal to 180 units. i.e.

$$\text{Nephelometric turbidity units (NTU)} = \frac{A\,(B + C)}{C}$$

Wher
e

A = Turbidity found in diluted sample, B = Volume of dilution water in ml C = Sample volume for dilution in ml.

RESULTS: -

Experiment No: 2

Aim:

To determine the Conductivity of the given sample

Apparatus required:

Conductivity Meter, Flask, Beaker, Wash Bottle

Principle:

Conductivity is the capacity of water to carry an electrical current and varies both with number and types of ions the solution contains, which in turn is related to the concentration of ionized substances in the water. Most dissolved inorganic substances in water are in the ionized form and hence contribute to conductance. Conductivity measurement gives rapid and practical estimate of the variations in the dissolved contents of water.

Environmental Significance:

Electrical conductivity measurements are often employed to monitor desalination plants. It is useful for detection of impurities in water. Used for quantitative measurement of ionic constituents dissolved in water, which are important for boiler feed water and cooling water etc.; Used for checking correctness of water analysis as there is a distinct relationship between conductivity and total dissolved solids (TDS). Conductivity data is useful in determining the suitability of water and wastewater for disposal on land. Irrigation waters up to 2 millisiemens/cm conductance have been found to be suitable for irrigation depending on soils and climatic characteristics.

Reagents:

0.01 N, KCL solution: Dissolve 0.746 grams of potassium chloride in 1 litre of distilled water.

Procedure:

1. Rinse the electrode thoroughly blot and dry.
2. Immerse the electrode in 0.01 N KCL solution and the conductivity should be 1413 micro mhos at 25°C Temperature.
3. Now the instrument is calibrated.
4. Remove the cell from KCL solution and wash it thoroughly with distilled water.
5. Immerse the electrode/cell in the unknown sample whose conductivity is to be determined.
6. Note down the instrument reading. If the cell constant is given on the cell itself, then the measured value of conductivity = Cell Constant C X Screen reading

Result:

Tabulation:

Sl.No	Sample	Conductivity(mS/cm)	Temperature(^{O}C)

Experiment No: 3

Aim:

To determine the total hardness present in the given water sample.

Apparatus Required:

Burette, Conical flask, Pipette, Measuring jar.

Principle:

Hardness is generally caused by the Calcium and Magnesium ions present in water. Polyvalent ions of some other metals like Strontium. Iron, Aluminium, Zinc and Manganese are also capable of precipitating soap and thus contributing to hardness. However, the concentration of these ions is very low in natural waters, therefore hardness is generally measured as concentration of only Calcium and Magnesium (as Calcium Carbonate), which are far higher in quantity over other hardness producing ions. Calcium and Magnesium form a complex of wine red colour with Eriochrome Black-T at pH of 10.0 ± 0.1. The EDTA has got a stronger affinity to Ca^{2+} and Mg^{2+} and therefore by EDTA, the former complex is broken down and a new complex of blue colour is formed.

Reagents:

1. EDTA solution 0.01N (Ethylene Diamine tetra Acetic Acid)
2. Buffer solution
3. Eriochrome Black-T Indicator.

Procedure:

1. Take 50ml water sample in a conical flask. If the sample is having higher Calcium, take a small volume and dilute to 50ml.
2. Add 1 ml of buffer solution.

3. If the sample is having higher amount of heavy metals add 1 ml of Na2 S solution.
4. Add 100-200 mg of Eriochrome Black-T indicator, the solution turns wine red.
5. Titrate the contents against EDTA solution. The end point colour changes from wine red to blue. Repeat the titrations to get concurrent values.

Result:

The total hardness present in the given water sample is -------------------

Inference:

The water containing 0 to 60 mg/L (milligrams per liter) as calcium carbonate is classified as soft; 61 to 120 mg/L as moderately hard; 121 to 180 mg/L as hard; and more than 180 mg/L as very hard.

Tabulation:

Sl.No	Volume of water sample (ml)	Burette Reading (ml)		Concurrent Burette Reading (ml)	Volume of EDTA (ml)
		Initial Reading	Final Reading		

Calculation:

Hardness in mg/l of $Caco_3$ =

$$\frac{\text{Volume of EDTA used} \times 1000}{\text{Volume of Sample}}$$

Experiment No: 4

Aim:

To determine the available chlorine in the given sample of bleaching powder.

Apparatus Required:

Conical flask, Burette, Pipettes .

Principle:

Chlorine is a strong oxidizing agent and liberates Iodine from

Iodide ions. $Cl_2 + 2\,KI \longrightarrow I_2 + 2KCl$

Starch gives blue colour with

Iodine i.e., I_2 + starch $\longrightarrow$ Blue

Colour

The liberated Iodine is titrated against standard Sodium Thiosulphate-

reducing agent $I_2 + 2Na_2S_2O_2 \longrightarrow Na_2S_4O_6\ 2NaI$

The disappearance of blue colour indicates the completion of reaction with free iodine converted black to iodine.

Reagents:

1. Conc.Acetic Acid
2. Potassium Iodide Crystals
3. Sodium Thiosulphate, 0.025N
4. Starch Indicator

Procedure:

1. 1 gm of fresh bleaching powder is taken and is added to a small quantity of water and made into a fine paste. Some more water is added, stirred well and allowed to settle for a few minutes. It is diluted with distilled water to make upto 1 L and the container is stoppered.

2. 25 ml of the bleaching powder solution is taken in a conical flask and a pinch of Potassium Iodide is added.

3. 2 ml of acetic acid is added and is allowed for the reaction to complete.

4. 1 ml of starch solution is added and the titration is continued till the disappearance of blue colour.

Tabulation:

Sl.No	Volume of water sample (ml)	Burette Reading (ml)		Concurrent Burette Reading (ml)	Volume of Sodium Thiosulphate (ml)
		Initial Reading	Final Reading		

Calculation:

Concentration of chlorine, mg/l = (V1-V2) x Normality of titrant x 1000 x Eq.wt of chlorine

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Volume of Sample

Percentage of chlorine = Concentration of chlorine x 100

12

Result: 1. The available chlorine in the given sample of bleaching powder is =

--- mg/l

2. Percentage of chlorine content in bleaching powder is = ----------------------

Inference:

If the bleaching powder consisted wholly of Ca(OCl)Cl it contains 55% of available chlorine—that is, chlorine which can be liberated by treatment with dilute acid; but the commercial variety generally contains other substances, and does not yield more than 36% available chlorine.

Experiment No: 5

Aim:

To determine the total solids, dissolved solids and settleable solids

Apparatus and equipment:

a.Electrically heated temperature controlled
oven b.Weighing balance
c.Evaporating dish
d.Pipettes
e.Measuring cylinder (100mL)
f.Muffle furnace
g.Whatmann filter paper (No. 42)

Introduction:

The term 'solid' refers to the matter either filtrable or non-filtrable that remains as residue upon evaporation and subsequent drying at a defined temperature. Further categorisation depends upon depends upon the temperature employed for drying and ignition. Different forms of solids are defined on the basis of method applied for their determination. Solids may affect water or effluent quality adversely in number of ways. Water with high dissolved solids may include an unfavourable physiological reaction in the transient consumer and generally are of inferior palatability. Highly mineralized waters are unsuitable for many industrial applications. High suspended solids in waters may be aesthetically unsatisfactory for such purposes as bathing. Analysis of total solids are important to decide upon the various unit operations and processes in physical and biological wastewater treatment and to assess its performance evaluation. For assessing compliance with regulatory agency, wastewater effluent limitations for various forms of solids act as indicating parameters.

A. Total solids Principle

Residue left after the evaporation and subsequent drying in oven at specific temperature 103-105°C of a known volume of sample are total solids. Total solids include "Total suspected solids" (TSS) and "Total dissolved solids" (TDS). Whereas loss in weight on ignition of the same sample at 500°C, in which organic matter is converted to CO2 volatilisation of inorganic matter as much as consistent with complete oxidation of organic matter, are volatile solids.

Sample collection, preservation and storage

The water samples may be collected in resistant glass or plastic bottle. Water has considerable solvent property. There is possibility of increase in mineral content of sample, if water is collected and stored in non-resistant glass bottle. The effect is pronounced with alkaline water. Exclude particles such as leaves, sticks, fish and lump of feacal matter in the sample. Begin analysis as soon as possible due to impracticality of preservation of sample.

Procedure

1. Take the empty weight of the thoroughly cleaned dish.(W1)
2. Take 20 ml of a well-mixed sample in the same dish.
3. Evaporate the sample to dryness at 103-105°C in hot air oven.(4-5h)
4. Cool in desiccator, weigh and record the reading (W2)
5. Take the same crucible and ignite the dish for 30 minutes in a muffle furnace maintained at 550°C.
6. Cool the dish in a desiccator and record final weight (W3).
7. The concentration is to be calculated in percent by weight.

Procedure for dissolved solids

1. Take the empty weight of the dish (W4)
2. Take 25 ml of sample and filter it using whatmann filter paper (No. 42) using the filtration assembly.
3. Pour the filtrate into the dish and . Evaporate the sample to dryness at 103-105°C in hot air oven.(4-5 h).
4. Cool in desiccator, weigh and record the reading (W5)

Procedure for settleable solids

1. Fill an Imhoff cone to the H mark with a well-mixed sample.
2. Settle for 45-min, gently agitate sample near the sides of the cone with a rod or by spinning, settle 15 min longer, and record volume of settleable solids in the cone as ml/L.

3. If the settled matter contains pockets of liquid between large settled particles, estimate volume of these and subtract from volume of settled solids.
4. The practical lower limit of measurement depends on sample composition and generally is in the range of 0.1 to 1.0 ml/L. where a separation of settleable and floating materials occurs, do not estimate the floating material as settleable matter.
5. Replicates usually are not required.

Observation:

S.No	Details	Notations	Weight(g)
1	Weight of empty crucible	W1	
2	Weight of crucible with water sample after ovendrying	W2	
3	Weight of crucible with water sample after taking it from muffle furnace.	W3	
4	Weight of empty crucible	W4	
5	Weight of crucible with filtrate after ovendrying	W5	

Calculation:

Total solids (**TS**) = (w2-w1)/volume of sample
Total dissolved solids (**TDS**)= (w5-w4) /volume of
sample Total suspended solids (**TSS**) = **TS-TDS**
Total fixed solids (**TFS**) = (w3-w1) / volume of
sample Total volatile solids = (**TVS**) = **TS- TFS** =
Total Settleable solids =

Results:

The solids present in the given wastewater are reported below

1. Total solids =
2. Dissolved Solids =

3. Suspended solids =
4. Fixed solids =
5. Volatile solids =
6. Settleable solids =

Inference:

Water can be classified by the amount of TDS per liter:

- Fresh water < 1500 mg/l TDS
- Brackish water = 1500 to 5000 mg/l TDS
- Saline water > 5000 mg/l TDS

Experiment No: 6

Aim:

To determine the BOD in the given wastewater sample.

Apparatus Required:

BOD incubator BOD bottle (300ml)

Principle:

If sufficient oxygen is available in wastewater, the useful aerobic bacteria will flourish and cause the aerobic biological decomposition of wastewater which will continue until oxidation is completed.
The amount of oxygen consumed in this process is the BOD. Polluted waters will continue to absorb oxygen for many months, and it is not practically feasible to determine this ultimate oxygen demand.

Chemicals Required:

1. Sodium Hydroxide
2. Manganous Sulphate
3. Potassium iodide
4. Sodium thiosulphate
5. Conc.H2SO4
6. Starch

Reagent Preparation:

1. ManganousSulphate:

12 g of ManganousSulphate is dissolved in 25ml of distilled water.

2. Alkali-Iodide Azide Solution

9 g of Sodium Hydroxide and 2.5 g of Potassium iodide are dissolved in 25ml of distilled water.

3. Sodium thiosulphate Solution (0.025 N)

6.2 g of Sodium thiosulphate is dissolved in 1 litre of water.

4. Starch Solution

Take 1 gm of starch. Prepare paste with distilled water. Make 100 ml with water and boil by stirring and cool it.

Procedure:

1. Distilled water is aerated for 4 hours to attain saturated Dissolved Oxygen (DO) level. In distilled water 1 ml of each nutrients (Phosphate buffer, Magnesium Sulphate, Calcium Chloride and Ferric Chloride) and 1 ml of pre-acclimatized seed per 1 litre of distilled water is added.
2. Two BOD bottles are taken. The wastewater sample 1 ml is taken in the BOD bottles and the aerated water is filled. DO test is conducted for the one BOD bottle sample by

CALCULATION

DO Calculation

Sodium thiosulphate Vs given sample

S.No	Volume of given sample (ml)	Burette reading (ml)		Indicator	End point
		Initial	Final		

Calculation:

DO in (mg/l) = (V2 x N x 8 x 1000)/V1 V1 = Volume of water sample in ml.

V2 = Volume of Sodium thiosulphate consumed in ml. N = Normality of Sodium thiosulphate

Initial DO

Final DO

BOD Calculation

BOD5 (mg/L) = [(Initial DO – Final DO) x dilution factor] Where

$$\text{Dilution factor} = \frac{Volume of diluted sample}{Volume of wastewater sample added}$$

the following steps and initial DO is noted.

3. Distilled water is aerated for 4 hours to attain saturated Dissolved Oxygen (DO) level. In distilled water 1 ml of each nutrients (Phosphate buffer, Magnesium Sulphate, Calcium Chloride and Ferric Chloride) and 1 ml of pre-acclimatized seed per 1 litre of distilled water is added.
4. Two BOD bottles are taken. The wastewater sample 1 ml is taken in the BOD bottles and the aerated water is filled. DO test is conducted for the one BOD bottle sample by the following steps and initial DO is noted
5. 1 ml of Manganese Sulphate solution is added, followed by 1 ml of Alkali Iodide Azide reagent. Then the bottle is mixed twice and allowed to precipitate settle.
6. 1 ml of Sulphuric Acid is added and mixed twice. 200 ml of sample is taken and titrated against Sodium thiosulphate solution with starch indicator.

the following steps and initial DO is noted.

5. Distilled water is aerated for 4 hours to attain saturated Dissolved Oxygen (DO) level. In distilled water 1 ml of each nutrients (Phosphate buffer, Magnesium Sulphate, Calcium Chloride and Ferric Chloride) and 1 ml of pre-acclimatized seed per 1 litre of distilled water is added.

6. Two BOD bottles are taken. The wastewater sample 1 ml is taken in the BOD bottles and the aerated water is filled. DO test is conducted for the one BOD bottle sample by the following steps and initial DO is noted

5.2 ml of Manganese Sulphate solution is added, followed by 1 ml of Alkali Iodide Azide reagent. Then the bottle is mixed twice and allowed to precipitate settle.

6.2 ml of Sulphuric Acid is added and mixed twice. 200 ml of sample is taken and titrated against Sodium thiosulphate solution with starch indicator.

7. Disappearance of blue colour is taken as end point. Volume of Sodium thiosulphate consumed is noted.

8. Another bottle is placed in incubator at 20^{o} C. After 5 days DO test is conducted and final DO is noted.

Result:

BOD5 of given sample at 20^{o}C = mg/l

Inference:

BIS Standard of wastewater effluent BOD to be discharged on land for irrigation purpose is 500 mg/l. The amount of BOD obtained at 20°C is

.So, this wastewater can/cannot be used for irrigation purpose.

Experiment No: 7

To determine the chemical oxygen demand (COD) exerted by the given waste water sample.

Apparatus Required:

Reflux Apparatus, Burette, Hot plate/Heating mantle

Principle:

The organic matter present in sample gets oxidized completely by $K_2Cr_2O_7$ in the presence of H_2SO_4 to produce CO_2 and H_2O. The excess of $K_2Cr_2O_7$ remaining after the reaction is titrated with $Fe(NH_4)_2(SO_4)_2$. The dichromate consumed gives the oxygen required for the oxidation of organic matter.

Reagents:

1. Standard Potassium Dichromate 0.2N
2. Sulphuric Acid with reagent (Conc.$AgSo_4$ + H_2SO_4)
3. Std.Ferrous Ammonium Sulphate (0.1N)
4. Ferroin Indicator
5. Mercuric Sulphate
6. Silver Sulphate

Procedure:

1. Take 10 ml of sample.
2. 5 ml of more Conc Dichromate solution are placed in a flask together with glass beads.
3. Add slowly 15 ml of H_2SO_4 containing $AgSo_4$ and mix thoroughly.
4. Add pinch of mercurous sulphate ($Hgso_4$) and silver sulphate (Ag_2So_4).
5. Connect the flask to condenser. Mix the contents thoroughly before heating. Improper mixing may result in bumping and the sample may be

blown out.

6. Reflux for a minimum period of 2 hours. Cool and wash down the condenser with distilled water.

7. Dilute the sample to make up to 40 ml with distilled and cool.

Tabulation:

Sl.No	Volume of water sample (ml)	Burette Reading (ml)		Concurrent Burette Reading (ml)	Volume of FAS (ml)
		Initial Reading	Final Reading		

Calculation:

Quantity of $Fe (NH_4)_2 (SO_4)_2$ added for blank (A) =

Quantity of $Fe (NH_4)_2 (SO_4)_2$ added for sample (B) =

$$\text{Chemical Oxygen Demand (COD)} = \frac{(A-B) \times N \times 8 \times 1000 \times \text{Dilution factor}}{\text{Volume of Sample}}$$

8. Add 2-3 drops of Ferroin indicator. Mix thoroughly and titrate it against 0.1N $Fe (NH_4)_2 (SO_4)_2$. Sharp color changes from blue-green to wine red indicate the end point.
9. Reflux the blank solution in the same manner using distilled water instead of sample.

Result:

The COD for the given water sample is -----------

Inference:

The BIS standard for COD of wastewater effluent to be discharged into marine coast is
250 mg/l. The amount of COD obtained in the given sample is
So,this water can/cannot be disposed in the marine coast.

Laboratory Experiment Evaluation Rubric

Category	Outstanding (Up to 100%)	Accomplished (Up to 75%)	Developing (Up to 50%)	Beginner (Up to 25%)
Written/Presentation/Demonstration	The write-up is clear, well-organized, and follows the prescribed format. All required sections (aim, apparatus, theory, procedure, diagram, etc.) are present and well-written. Demonstration is clear and thorough.	The report follows the specified format, but some sections (like the diagram or theory) are missing or incomplete. The demonstration is understandable but lacks depth.	The report includes most sections but lacks clarity, coherence, or completeness in some parts (e.g., diagram missing, unclear theoretical explanation). The demonstration is incomplete or unclear.	The report is poorly written and organized. Many sections are missing or incorrect (e.g., no diagram, incomplete procedure). The demonstration lacks clarity or is missing.
Viva-Voice	Demonstrates a deep understanding of the experiment, underlying principles, and outcomes. Answers questions confidently and accurately.	Demonstrates a general understanding of the experiment and principles but struggles with some aspects. Provides correct answers to most questions.	Struggles with some fundamental concepts and principles. Answering questions requires additional prompts, with a few errors in understanding.	Lacks a basic understanding of the experiment. Unable to answer most questions accurately. Demonstrates significant gaps in knowledge.

Category	Outstanding (Up to 100%)	Accomplished (Up to 75%)	Developing (Up to 50%)	Beginner (Up to 25%)
Performance/Report/File Work	Performs the experiment accurately and efficiently. The report is thorough, with correct observations, calculations, and analysis. Data is recorded neatly and with appropriate units. All relevant calculations and interpretations are included.	Performs the experiment well with minor errors or delays. The report is complete but may contain some inaccuracies or missing components in calculations or observations.	Completes the experiment but with notable mistakes, either in the setup or the data. The report has several missing or inaccurate components, including incorrect or incomplete calculations.	Struggles to perform the experiment correctly. Significant errors in setup, data collection, and analysis. The report is poorly structured with major inaccuracies or missing sections.
Attendance	Consistently attends all lab sessions, actively participates, and engages with the experiment and group discussions.	Attends most lab sessions with occasional absences. Participation is generally good but lacks consistency or depth.	Attends some lab sessions but has frequent absences or minimal participation.	Misses several lab sessions and shows minimal to no participation in class or group activities.