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XIII. Actual procedure followed

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XIV Precautions followed

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XV. Observations and Calculations

Observation table for Biochemical Oxygen Demand.

Sr. No.	Source of the sample	Bottle No.	Burette reading		Sodium thiosulphate (ml)	DO (mg/l)
			Initial (1) ml	Final (2) ml	(1-2)	
01		…..……..(blank) (First day)			(B_1)	
02		…….(sample) (First day)			(D_1)	
03		…..……..(blank) (Fifth day)			(B_2)	
04		…….(sample) (Fifth day)			(D_2)	

1 ml 0.025 N sodium thiosulphate is equivalent to 0.2 mg of O_2, since the volume of sample is 200 ml. Hence 1 ml of sodium thiosulphate is equal to 1 mg/l of DO.

BOD mg/l = $[(D_1-D_2) – (B_1-B_2)]$ x Volume of diluted sample / Volume of sample taken

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XVI. Results

BOD of given water sample = _____ mg/l.

XVII. Interpretation of results

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XVIII. Conclusions

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XIX. Practical related Questions

Below given are five sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO

1 Write temperature range available in BOD incubator
2 Write BOD limit of effluent for petrochemical industry as per CPCB norms.
3 Write significance of BOD test.
4 Mention the time required to attain temperature in incubator.
5 Write the dimensions of BOD incubator.

Space for Answer)

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XX. References / Suggestions for further Reading

1 https://water.usgs.gov/owq/FieldManual/Chapter7/NFMChap7_2_BOD.pdf
2 https://nptel.ac.in/courses/105105048/M9_L12.pdf
3 http://home.iitk.ac.in/~anubha/WQ.pdf
4 http://www.polyseed.com/misc/BODforwebsite.pdf

XXI. Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of Apparatus	20%
2	Observation of correct reading	20%
3	Calculation and result	20%
Product related (10 Marks)		**40%**
4	Interpretation of result & conclusions	20%
5	Answers to practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

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

Practical No. 09: Determine chemical oxygen demand of waste water

I. Practical Significance

The COD value indicates the amount of oxygen which is needed for the oxidation of all organic substances in water in mg/l. The COD (Chemical Oxygen Demand) is closely related to the laboratory standard method named Dichromate-Method. With this method the chemical oxygen demand is determined during chromic acid digestion of organic loads in waste water. Based on this method the COD became a commonly used sum parameter in waste water analysis. It is used for planning of waste water treatment plants, for controlling the cleaning efficiency and for the calculation of waste water taxes.

II. Relevant Program Outcomes (POs)

PO 2. ***Discipline knowledge:*** *Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.*

PO 3. ***Experiments and practice:*** *Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.*

PO 4. ***Engineering tools:*** *Apply relevant technologies and Chemical engineering tools with an understanding of the limitations.*

III. Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency '***Conserve environment using various pollution control measures'.***

1. To prepare solution of required concentration.
2. To perform titration.
3. To observe the end point of titration and record correct readings.

IV. Relevant Course Outcomes

Test the different properties of water

V. Practical Outcome

Determine chemical oxygen demand of waste water.

VI. Relevant Affective domain unrelated Outcome(s)

1. Follow safe practices
2. Practice good housekeeping
3. Work as a leader/a team member

VII. Minimum Theoretical Background

Oxidation of most organic compounds is up to 95-100% of the theoretical value. The organic matter gets oxidised completely by potassium dichromate ($K_2Cr_2O_7$) with silver sulphate as catalyst in the presence of concentrated H_2SO_4 to produce CO_2 and H_2O. The excess $K_2Cr_2O_7$ remaining after the reaction is titrated with ferrous ammonium sulphate $[Fe(NH_4)_2(SO_4)_2]$. The dichromate consumed gives the oxygen (O_2) required for

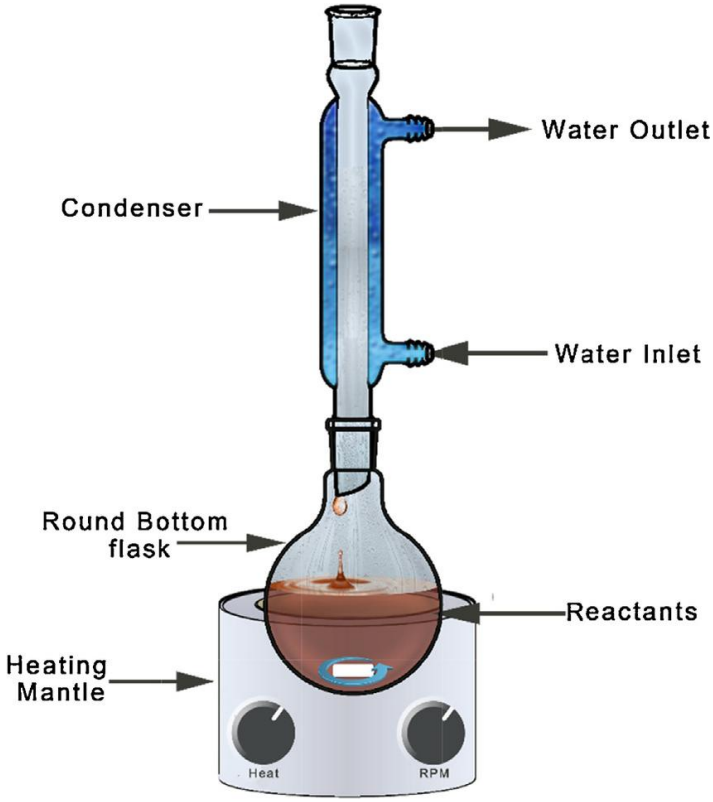
oxidation of the organic matter. The chemical reactions involved in the method are as under:

$2K_2Cr_2O_7 + 8H_2SO_4 \rightarrow 2K_2SO_4 + 2Cr_2(SO_4)_3 + 8H_2O + 3O_2$

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

$Cr_2O_7^{--} + 6Fe^{++} + 14H^{+} \rightarrow 6Fe^{+++} + 2Cr_3+ + 7H_2O$

VIII. Experimental set up used in laboratory



IX Resources required

S. No.	Instrumentation/components	Specification	Quantity
1	COD flask with reflux condenser	100 ml	1
2	Heating mantle		
3	Pipette	10 ml	1
4	Burette	25 ml	1
5	Conical Flask	250 ml	2
6	Glass beads		

7	Potassium dichromate	Dissolve 12.259 gm of potassium dichromate (dried at 103^{o}C for 24 hours) in distilled water and make up the volume 1 liter.	
8	Sulfuric acid with reagent	Add 10 gm of silver sulphate in 100 ml of concentrated sulfuric acid and keep overnight for dissolution.	100 ml
9	Ferrion indicator	Dissolve 1.485 gm of 1, 10-phenanthroline monohydrate and 695 mg of iron sulphate heptahydrate ($FeSO_4.7H_2O$) in distilled water and diluted up to 100 ml. (This Indicator is readily available in market)	10 ml
10	Mercuric Sulphate		5 gm

X. Precautions to be followed

1. Use the exact volume of sample required for in the procedure. A larger sample will dilute the acid concentration and lower the boiling point in the mixture.
2. Place a safety shield in front of the vessel while heating the flask. In the unlikely event of vial breakage, this precaution will minimize any resulting hazard.
3. Handle sulfuric acid carefully.
4. Wear safety glasses or goggles. When mixing the sample and reagent, hold the vial away from the face and body. A great deal of heat is generated, which can crack even borosilicate glass in some instances.

XI. Procedure

1. Take a reflux flask and place 0.4 gm of mercuric sulphate
2. Add 20 ml of sample.
3. Add 10 ml of concentrated dichromate solution.
4. Place some glass beads in the flask.
5. Add slowly 30 ml of sulfuric acid with reagent.
6. Mix the content thoroughly.
7. Place condenser on the reflux flask and place whole assembly on heater
8. Start heater and reflux for a minimum period for two hours. Add glass beads to avoid bumping of the solution.
9. Cool the content and wash with distilled water.
10. Dilute the sample to make up volume up to 150 ml.
11. Titrate excess dichromate with ferrous ammonium sulphate placed in burette using ferroin indicator.
12. Sharp color changes from blue green to wine red indicate end point.
13. Note down burette reading.
14. Repeat the above procedure using distilled water (blank) in place of sample.

XII. Resources used (with major specifications)

S. No.	Instrument /Components	Specification	Quantity
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XIII. Actual procedure followed

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XIV Precautions followed

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XV. Observations and Calculations

Observation table for Chemical Oxygen Demand.

Sr. No.	Sample details	Volume of sample (ml)	Initial burette reading (ml)	Final burette reading (ml)	Difference (ml)
1	Blank				
2	Waste water				

Quantity of ferrous ammonium sulphate added for blank (A) = ml.

Quantity of ferrous ammonium sulphate added in waste water (B) = ml.

COD = [(A – B) x normality of ferrous ammonium sulphate x 8 x 1000] / Volume of sample

XVI. Results

COD of given water sample = _____ mg/l

XVII. Interpretation of results

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XVIII. Conclusions

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XIX. Practical related Questions

Below given are five sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO

1 Describe the importance of glass beads in flask.
2 Write COD limit of effluent for petrochemical industry as per CPCB norms.
3 Explain significance of COD test.
4 Write necessity of condenser in COD test.
5 Explain why water inlet is at the bottom of condenser.

(Space for Answer)

XX. References / Suggestions for further Reading

1. https://camblab.info/wp/index.php/272/
2. https://www.lar.com/products/cod-analysis/cod-chemical-oxygen-demand.html
3. https://www.lar.com/products/cod-analysis/cod-chemical-oxygen-demand.html
4. http://www.envexp.com/technical/method-downloads/cod-method-410
5. https://nptel.ac.in/courses/105105048/M11L13.pdf

XXI. Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of Apparatus	20%
2	Observation of correct reading	20%
3	Calculation and Result	20%
Product related (10 Marks)		**40%**
4	Interpretation of result & conclusions	20%
5	Answers to practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

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

Practical No. 10: Determine the turbidity of waste water using turbidity meter

I. Practical Significance

Turbidity is an important indicator of the amount of suspended sediment in water, which can have many negative effects on aquatic life. The suspended sediments that cause turbidity can block light to aquatic plants, smother aquatic organisms, and carry contaminants and pathogens, such as lead, mercury, and bacteria. Turbidity describes the clarity of water. Suspended materials in water, such as clay, silt, and algae, reduce water clarity and cause turbidity.

II. Relevant Program Outcomes (POs)

PO 2. ***Discipline knowledge:*** *Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.*
PO 3. ***Experiments and practice:*** *Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.*
PO 4. ***Engineering tools:*** *Apply relevant technologies and Chemical engineering tools with an understanding of the limitations.*

III. Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency '***Conserve environment using various pollution control measures'.***

1. To Test sample of waste water
2. To caliber turbidity meter
3. To observe and record the reading

IV. Relevant Course Outcomes

Test the different properties of water

V. Practical Outcome

Determine turbidity of waste water using turbidity meter.

VI. Relevant Affective domain unrelated Outcome(s)

1. Follow safe practices
2. Practice good housekeeping
3. Work as a leader/a team member

VII. Minimum Theoretical Background

Turbidity often indicates the presence of dispersed and suspended solids like clay, organic matter, silt, algae and other microorganisms which makes the water turbid. . Human activities such as construction, mining, agriculture and high sediment level entering during rainy season increases turbidity of water. The colloidal material which exerts turbidity provides adsorption sites for chemical that may be harmful or cause undesirable tastes and odors and for biological organism that may be harmful. The

turbidity may interfere with light penetration and photo synthetic reaction in streams and lakes. Turbidity increases the load on slow sand filters.

The suspended matter in water which interferes with passage of light is called turbidity. Presence of suspended and colloidal solids particles scatters the part of incidence light. When light is passed through a sample having suspended particles, some of the light is scattered by the particles. The scattering of the light is generally proportional to the turbidity. Turbidity is a measure of the quality of water. A Nephelometric turbidimeter is an instrument for measuring concentration of suspended particulates in a liquid. A Nephelometer measures suspended particulates by employing a light beam (source beam) and a light detector set often at 90° to the source beam. Particle density is then a function of the light reflected into the detector from the particles.

VIII. Experimental set up used in laboratory

IX Resources required

S. No.	Instrumentation/components	Specification	Quantity
1	Nephlometric turbidity meter	Range: 0-10000NTU, Principle: Nephelometric, Ratio: Full time ON or OFF, Accuracy +/- 2% of reading + 0.01NTU, Resolution: 0.0001NTU	1
2	Sample cell	Standard	4
3	Flask	1000 ml	1
4	Funnel	50 mm	1
5	Hydrazine sulphate		10 gm
6	Hexamethylenetetramine		100 gm
7	Distilled water		2 lit

X. Precautions to be followed

1. Check the electrical connections properly.
2. Do not spill water on light source
3. Clean turbidity meter before using.

XI. Procedure

A. Reagent preparation

1. Dissolve 5 gm Hydrazine sulphate $H_6N_2O_4S$ in distilled water and dilute to 400 ml in a volumetric flask (solution-1).
2. Dissolve 50 g of pure (>99% purity) hexamethylenetetramine ($C_6H_{12}N_4$) in the 500-ml flask containing about 400 ml of ultra-filtered deionized water (solution-2).
3. Pour solution-2 into the 1-liter volumetric flask containing solution-1. Dilute to the mark with ultra-filtered deionized water.
4. Stopper the flask and gently invert several times to mix.
5. Allow the solution to stand for 48 hours at 25 ±1 °C (68 to 72 °F). During this time, the white polymer suspension will develop. The resulting standard is 4000 NTU.
6. Immediately before dilution, invert the flask containing the stock suspension to mix.
7. Dilute the stock suspension before use with ultra-filtered deionized water to achieve a standard of the desired NTU value.
8. Dilution rates for several standard suspensions are listed below.

NTU Value	ml of 4000 NTU stock per liter
400	100
100	25
50	12.5
20	5
10	2.5
4	1
2	0.5

B. Calibration of the apparatus

1. Switch on the equipment and keep it for 30 minutes.
2. Select range depending upon expected turbidity of given sample of water.
3. Set zero of the instrument with turbidity free distilled water.
4. In another sample cell, take standard solution of 400 NTU and adjust the reading 400 NTU value using knob.

C. Operation of instrument

1. Take water sample in sample cell.
2. Fill it upto the mark and wipe with tissue paper.
3. Insert cell in turbidimeter.
4. Note down the reading shown by meter.

XII. Resources used (with major specifications)

S. No.	Instrument /Components	Specification	Quantity
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XIII. Actual procedure followed

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XIV Precautions followed

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XV. Observations and Calculations

Observations for finding out turbidity of water sample

Sr. No	Sample Details	Turbidity (NTU)

XVI. Results

1. Turbidity of water sample -1(_____) is found to be …….. NTU
2. Turbidity of water sample -2(_____) is found to be …….. NTU
3. Turbidity of water sample -3(_____) is found to be …….. NTU

XVII. Interpretation of results

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XVIII. Conclusions

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XIX. Practical related Questions

Below given are five sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO

1 List of turbidity limits for different types of waters prescribed by CPCB
2 State the necessity of calibration of turbidity meter.
3 Write the functions of knobs available on turbidity meter.
4 Measure and write the capacity of sample cell.
5 Write maximum storage time of standard turbidity solution.

(**Space for Answer**)

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XX. References / Suggestions for further Reading

1. https://www.researchgate.net/profile/Rajnish_Sharma12/post/Does_anyone_have_any_documented_reference_for_the_calibration_of_turbidity_meters/attachment/59d6231c79197b80779816fd/AS%3A305447184076802%401449835691824/download/Experiment+on+determination+of+turbidity.pdf
2. https://static.fishersci.com/cmsassets/downloads/segment/Scientific/pdf/WaterAnalysis/Method_Turbidity_WW_Orion_Method_AQ4500.pdf
3. https://www.epa.gov/sites/production/files/2015-08/documents/method_180-1_1993.pdf
4. http://www.water-chemistry.in/2010/11/working-principle-of-nephelometric-turbidity-meter/

XXI. Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of Apparatus	20%
2	Observation of correct reading	20%
3	Calculation and result	20%
Product related (10 Marks)		**40%**
4	Interpretation of result & conclusions	20%
5	Answers to practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

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

Practical No. 11: Measure the appropriate dosage of alum for raw water using jar test method.

I. Practical Significance

Jar testing is a method of simulating a full scale water treatment process, providing system operators a reasonable idea of the way a treatment chemical will behave and operate with a particular type of raw water. Because it mimics full-scale operation, system operators can use jar testing to help determine which treatment chemical will work best with their system's raw water.

II. Relevant Program Outcomes (POs)

PO 2. ***Discipline knowledge:*** *Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.*
PO 3. ***Experiments and practice:*** *Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.*
PO 4. ***Engineering tools:*** *Apply relevant technologies and Chemical engineering tools with an understanding of the limitations.*

III. Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency '***Conserve environment using various pollution control measures'.***

1. To test sample of raw water
2. To observe the change in sample under consideration
3. To record the reading

IV. Relevant Course Outcomes

Test the different properties of waste water

V. Practical Outcome

Measure the appropriate dosage of alum for raw water using jar test method

VI. Relevant Affective domain unrelated Outcome(s)

1.Follow safe practices
2.Practice good housekeeping
3.Work as a leader/a team member

VII. Minimum Theoretical Background

Jar testing entails adjusting the amount of treatment chemicals and the sequence in which they are added to samples of raw water held in jars or beakers. The sample is then stirred so that the formation, development, and settlement of floc can be watched just as it would be in the full scale treatment plant. (Floc forms when treatment chemicals react with material in the raw water and clump together.) The operator then performs a series of tests to compare the effects of different amounts of flocculation agents at different pH values to determine the right size floc for a particular plant. (The right size of floc depends upon the system's filter dimensions and other considerations.)

VIII. Experimental set up used in laboratory

IX Resources required

S. No.	Instrumentation/components	Specification	Quantity
1	Glass beaker	1000 ml	6
2	Graduating cylinder	1000 ml	1
3	Stirrers	Adjustable speed	6
4	Turbidity meter	Specified in practical. no 10	1
5	Pipette	10 ml	1
6	Alum		10 gm

X. Precautions to be followed

1. Check the electrical connections properly.
2. Do not disturb water in beakers
3. Clean turbidity meter before using.

XI. Procedure

1. Using a 1000 ml (mL) graduated cylinder, add 1,000 mL of raw water to each of the six jar test beakers. Record the temperature, pH, turbidity, and alkalinity of the raw water before beginning.
2. Prepare a stock solution by dissolving 10.0 grams of alum into 1,000 mL distilled water. Each 1.0 mL of this stock solution will equal 10 mg\L (ppm) when added to 1,000 mL of water to be tested.
3. Using the prepared stock solution of alum, dose each beaker with increased amounts of the solution. Start with 1ml solution to first beaker, 1.5 in second, 2 ml in third and so on.

4. After dosing each beaker, turn on the stirrers. Operate the stirrers at a high RPM for 1 minute to simulate the static mixer. Then reduce the speed of the stirrers to match the conditions in the flocculator and allow them to operate for 30 minutes.
5. Observe the floc formation periodically during the 30 minutes.
6. At the end of the 30 minutes turn off the stirrers and allow settling. Most of the settling will be complete after one hour
7. Now, look at the beakers and determine which one has the best results (if any). If no results were noticeable, then increase the dosage using the table above for the next six jars.
8. If none of the beakers appear to have good results, then the procedure needs to be run again using different dosages until the correct dosage is found.
9. Find turbidity in each beaker and note the reading.
10. Plot the graph of Alum dosage vs residual turbidity

XII. Resources used (with major specifications)

S. No.	Instrument /Components	Specification	Quantity
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XIII. Actual procedure followed

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XIV Precautions followed

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XV. Observations and Calculations

Sr. No	Alum Dose (mg/l)	Turbidity (NTU)

XVI. Results

Optimum alum dose for given water sample is _____ mg/lit

XVII. Interpretation of results

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XVIII. Conclusions

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XIX. Practical related Questions

Below given are five sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO

1 Name various coagulant used for water treatment.
2 Write significance of jar test.
3 Write chemical formula of alum.
4 Write reason for reduction in speed in experiment.
5 State the importance of jar test in design of water treatment plant.

(Space for Answer)

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XX. References / Suggestions for further Reading

1. https://nptel.ac.in/courses/105104102/Lecture%209.htm
2. http://www.nesc.wvu.edu/pdf/dw/publications/ontap/2009_tb/jar_testing_DWFSOM73.pdf
3. https://static1.squarespace.com/static/54e2b7aee4b0902efd671f90/t/5bb672650d92975174ce3260/1538683493717/TSG-T-008+Jar+Testing+Procedure+RevB.pdf
4. http://mimoza.marmara.edu.tr/~kyapsakli/enve201/9_Coagulation-Flocculation-Jar%20Test.pdf.
5.

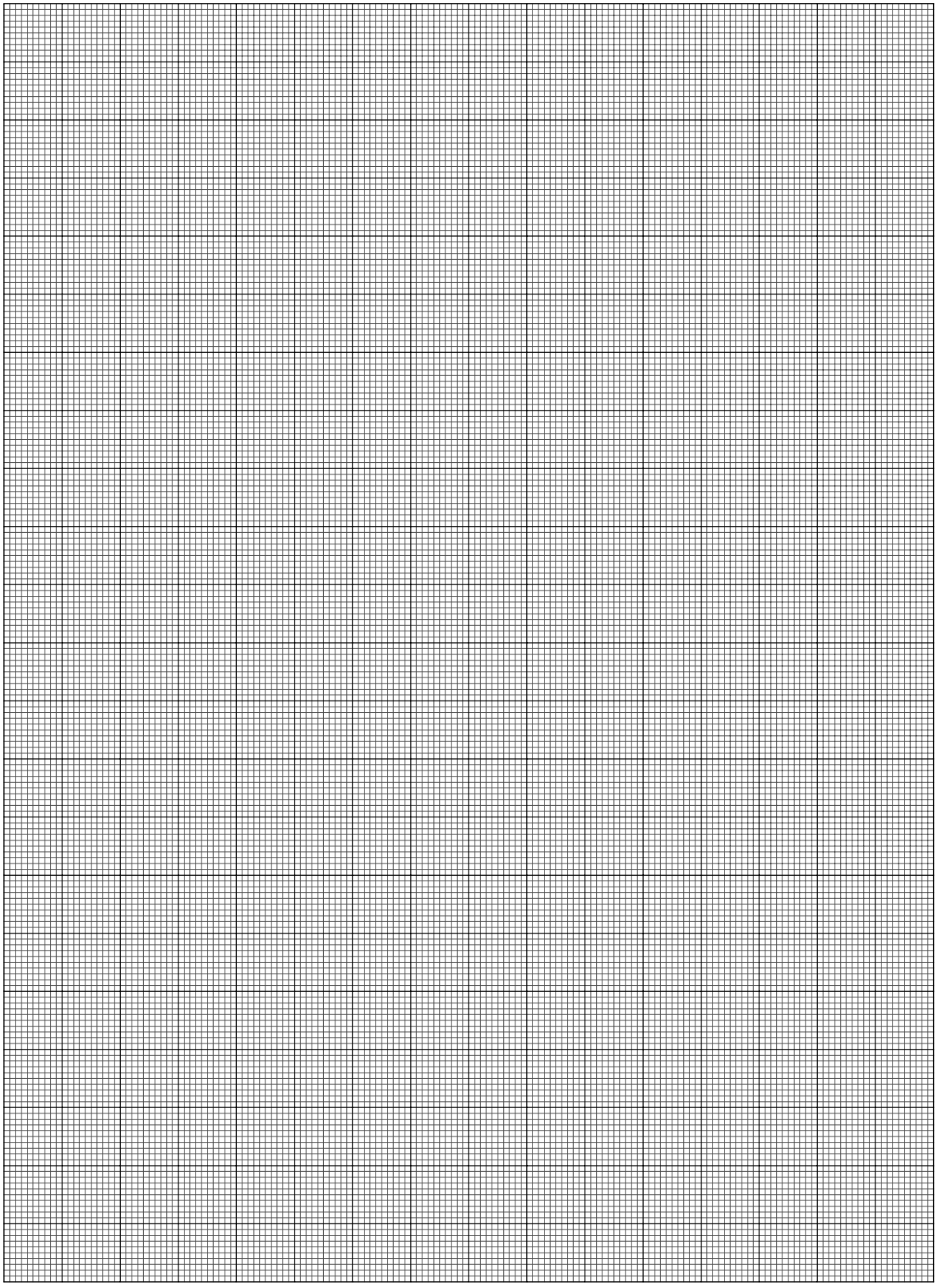
XXI. Assessment Scheme

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of Apparatus	20%
2	Observation of correct reading	20%
3	Calculation and Result	20%
Product related (10 Marks)		**40%**
4	Interpretation of result & conclusions	20%
5	Answers to practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

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



Practical No. 12: Determine Sulphate content in waste water

I. Practical Significance

The sulphate content of natural waters is an important consideration in determining their suitability for public and industrial water supplies. The amount of sulphate in waste waters is a factor of concern in determining the magnitude of problems that can arise from reduction of sulphates to hydrogen sulphide. Knowledge of the sulphate content of the sludge or waste fed to digestion units provides a means of estimating the hydrogen sulphide content of the gas produced.The design engineer can determine whether the scrubbing facilities will be needed to remove hydrogen sulphide and size of the units needed.

II. Relevant Program Outcomes (POs)

PO 2. ***Discipline knowledge:*** *Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.*
PO 3. ***Experiments and practice:*** *Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.*
PO 4. ***Engineering tools:*** *Apply relevant technologies and Chemical engineering tools with an understanding of the limitations.*

III. Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency '***Conserve environment using various pollution control measures'.***

1. To Test sample of raw water
2. To observe the change in sample under consideration
3. To record the reading

IV. Relevant Course Outcomes

Test the different properties of waste water

V. Practical Outcome

Determine sulphate content in waste water

VI. Relevant Affective domain unrelated Outcome(s)

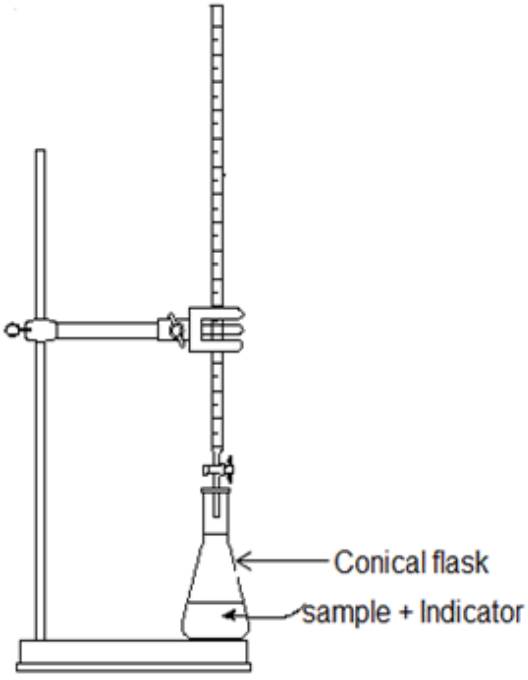
1. Follow safe practices
2. Practice good housekeeping
3. Work as a leader/a team member

VII. Minimum Theoretical Background

Sulphates in natural waters range from a few to thousand milligrams per liter. Excess Na2SO4 and Mg SO_4 should not be present in drinking waters as they became cathartic

action. Higher concentration of sodium sulphate in water can cause malfunctioning of the alimentary canal. So the recommended upper limit is 250mg/l in waters intended for human consumption. In anerobic decomposition of waste waters, sulphates are reduced to Hydrogen sulphides causing abnoxious odours and promote corrosion of sewers. Sulphates are reduced to sulphide in sludge digesters. .

VIII. Experimental set up used in laboratory



IX Resources required

S. No.	Instrumentation/components	Specification	Quantity
1	Filter Paper	whatman	1
2	Burette	25 ml	1
3	Pipette	10 ml	1
4	Beaker	100 ml	2
5	Hot plate	Variable temperature	1
6	Hydroxylamine chloride	10 gm of $NH_2OH.HCL$ in 100 ml distilled water	10 ml
7	Benzidine hydrochloride	Standard solution	20 ml
8	NaOH	0.05N	1 lit
9	Phenolpthalein Indicator		5 ml

X. Precautions to be followed

1. Check the electrical connections properly.
2. Do not handle chemicals without PPE
3. Pipette out chemicals using rubber sucker

XII. Procedure

1. Take 125 ml of sample in a 400 /500 ml beaker.
2. Add 5 ml of Hydroxylamine chloride and then add 10 ml Benzidine hydrochloride
3. Stir the mixture vigorously and allow the precipitate to settle.
4. Filter the solution and wash the beaker and the filter paper with cold distilled water.
5. Pierce the filter paper in the funnel and wash the precipitate formed on the filter paper to the original beaker with 100 to 150 ml distilled water.
6. Heat the beaker to dissolve the contents for 20 to 30minutes.
7. Add 2 drops of Phenolphthalein Indicator and titrate with 0.05 N NaOH until pink colour is developed

XII. Resources used (with major specifications)

S. No.	Instrument /Components	Specification	Quantity
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XIII. Actual procedure followed

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XIV Precautions followed

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XV. Observations and Calculations

Observations table

Sample details	Volume of sample taken (ml)	Initial Burette reading(ml)	Final Burette reading (ml)	ml of NaOH solution used

Concentration of sulphates(mg/l)

$$= \frac{volume\ of\ 0.05\ N\ NaOH * 38.4}{volume\ of\ the\ sample\ taken}$$

XVI. Results

Sulphate content in given sample of water is _____ mg/lit

XVII. Interpretation of results

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XVIII. Conclusions

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XIX. Practical related Questions

Below given are five sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO

1 Write necessity of sulphate removal from waste water.
2 List the sources of sulphate in waste water.
3 Write precaution necessary while handling filtrate.
4 Write value of temperature attained during heating of sample.
5 Heat is released or absorbed during preparation of NaOH solution? Write your observation.

(Space for Answer)

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XX. References / Suggestions for further Reading

1 http://www.fao.org/3/t0551e/t0551e03.htm
2 https://ocw.unihe.org/pluginfile.php/462/mod_resource/content/1/Urban_Drainage_and_Sewerage/5_Wet_Weather_and_Dry_Weather_Flow_Characterisation/DWF_characterization/Notes/Wastewater%20characterization.pdf
3 https://www.wateronline.com/doc/a-new-process-for-sulfate-removal-from-indust-0001
4 https://www.youtube.com/watch?v=1dsaz71BB8o

XXI. Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of Apparatus	20%
2	Observation of correct reading	20%
3	Calculation and result	20%
Product related (10 Marks)		**40%**
4	Interpretation of result & conclusions	20%
5	Answers to practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

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

Practical No. 13: Determine the neutralization point for charcoal treatment of acidic waste water.

I. Practical Significance

Bed of activated carbon is used to remove contaminants and impurities, using chemical adsorption. Each particle, or granule, of carbon provides a large surface area, or pore structure, allowing contaminants the maximum possible exposure to the active sites within the filter media. One gram of activated carbon has a surface area in excess of 3,000 m^2. Activated carbon works via a process called adsorption, whereby pollutant molecules in the fluid to be treated are trapped inside the pore structure of the carbon substrate. Carbon filtering is commonly used for water purification, air filtering and industrial gas processing, for example the removal of siloxanes and hydrogen sulfide from biogas. Active charcoal carbon filters are most effective at removing chlorine, particles such as sediment, volatile organic compounds (VOCs), taste and odor from water.

II. Relevant Program Outcomes (POs)

PO 2. ***Discipline knowledge:*** *Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.*
PO 3. ***Experiments and practice:*** *Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.*
PO 4. ***Engineering tools:*** *Apply relevant technologies and Chemical engineering tools with an understanding of the limitations.*

III. Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency '***Conserve environment using various pollution control measures'.***

1. To Test sample of raw water
2. To observe the change in sample under consideration
3. To record the reading

IV. Relevant Course Outcomes

Test the different properties of waste water

V. Practical Outcome

Determine the neutralization point for charcoal treatment of acidic waste water.

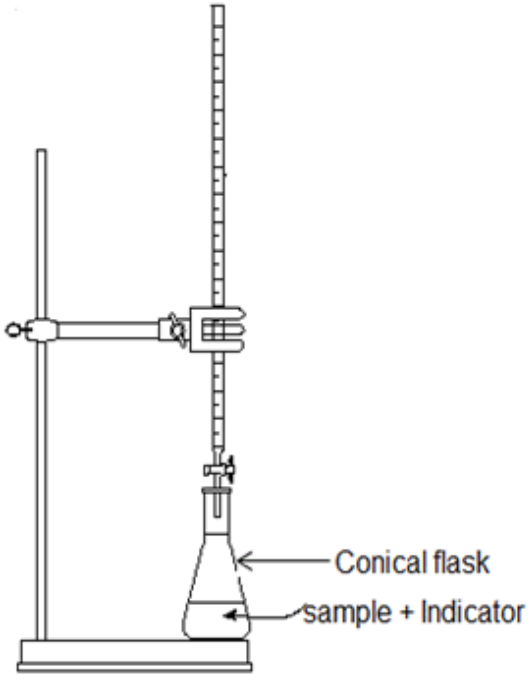
VI. Relevant Affective domain unrelated Outcome(s)

1. Follow safe practices
2. Practice good housekeeping
3. Work as a leader/a team member

VII. Minimum Theoretical Background

Acidity is the quantitative expression of water's capacity to neutralize a strong base to a designated pH and an indicator of how corrosive water is. Acidity can be caused by weak organic acids, such as acetic and tannic acids, and strong mineral acids including sulfuric and hydrochloric acids; however, the most common source of acidity in unpolluted water is carbon dioxide in the form of carbonic acid. Acidity is commonly determined using methyl orange as a color indicator of the pH end point. Because methyl orange undergoes a color change from red to orange at a pH of 3.7, the results of the titration are termed Methyl Orange Acidity. Total acidity includes acidity caused by mineral acids, weak organic acids, and carbon dioxide (in the form of carbonic acid). Acidity determined by titrating to a phenolphthalein end point pH of 8.3 corresponds to the neutralization of carbonic acid to bicarbonate. Because carbon dioxide is the major cause of acidity in natural waters, in most cases the phenolphthalein acidity is equal to the total acidity. Acidity tests can be performed using a pH meter to detect the end points; however, methyl orange acidity and phenolphthalein acidity are the terms used to describe the results. Results of the acidity tests are reported in mg/L $CaCO_3$.

VIII. Experimental set up used in laboratory



IX Resources required

S. No.	Instrumentation/components	Specification	Quantity
1	Burette	25 ml	1
2	Pipette	10 ml	1
3	Conical Flask	100 ml	2
4	Measuring cylinder	1000 ml	2
5	Magnetic stirrer		1
6	Glass rod		5
7	Sodium thiosulphate solution	0.1 N	100 ml
8	Sodium hydroxide solution	0.02 N	1000 ml
9	Phenolphthalein indicator		5 ml
10	Methyl orange indicator.		5 ml
11	Charcoal		50 gm

X. Precautions to be followed

1. Handle caustic soda carefully.
2. Use safety goggle and hand gloves while handling chemicals.

XIII. Procedure

Part (I):- For the untreated acidic waste water

1. Take 10 ml of given water sample in a conical flask.
2. Add 1 drop of 0.1 N sodium thiosulphate solution to remove the residual chlorine if present.
3. Add 2 drops of Methyl orange indicator. The sample color turns pink.
4. Titrate the solution against 0.02 N NaOH until yellow color appears.
5. Note down the volume of NaOH added (V_1)
6. Add 2 to 3 drops of Phenolphthalein indicator to the same solution in conical flask.
7. Continue the titration against 0.02 N NaOH until sample turns to pink .
8. Note down the total volume of NaOH added (V_2)

Part (II):- For the treated acidic waste water.

1. Tale 100 ml of acidic waste water in a beaker.
2. Add 5/10/15/20 grams of charcoal powder to the beaker containing waste water.
3. Stir the mixture continuously for 30 min. using a glass rod./ magnetic stirrer.
4. Allow the mixture to stand quiescent for 10 min.
5. Filter the mixture by using a funnel. Collect the filtrate in a separate beaker
6. Collect the charcoal on the filter paper.

7. Take 10ml of the filtrate in a conical flask. Add 1 drop of 0.1 N sodium thiosulphate solution to remove the residual chlorine if present.
8. Add 2 drops of Methyl orange indicator. The sample color turns pink.
9. Titrate the solution against 0.02 N NaOH until yellow color appears.
10. Note down the volume of NaOH added (V_1)
11. Add 2 to 3 drops of Phenolphthalein indicator to the same solution in conical flask.
12. Continue the titration against 0.02 N NaOH until sample turns to pink .
13. Note down the total volume of NaOH added(V_2)

XII. Resources used (with major specifications)

S. No.	Instrument /Components	Specification	Quantity
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XIII. Actual procedure followed

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XIV Precautions followed

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XV. Observations and Calculations

Sample details	Volume of sample (ml)	Methyl orange Indicator			Phenolphthalein indicator		
		Initial burette reading (ml)	Final burette reading (ml)	NaOH used V_1 (ml)	Initial burette reading (ml)	Final burette reading (ml)	NaOH used V_2 (ml)

Mineral acidity due to mineral acids (as $CaCO_3$) (mg/l)

$$= \frac{v_1 \ X \ 1000}{ml \ of \ effluent \ sample} =$$

= ----------mg/l or (ppm)

CO_2 acidity due to CO_2 (as $CaCO_3$)(mg/l)

$$= \frac{v_2 \ X \ 1000}{ml \ of \ an \ effluent \ sample} =$$

= ----------mg/l or (ppm)

Total acidity (as $CaCO_3$) = Mineral acidity + CO_2 acidity

= ---------- + ----------

= ----------mg/l or (ppm)

XVI. Results

XVII. Interpretation of results

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XVIII. Conclusions

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XIX. Practical related Questions

Below given are five sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO

1 Write the reason for the use of two indicators in titration.
2 Write important property of charcoal.
3 Describe use of sodium thiosulphate in this practical.
4 Write effect of acidity of waste water on equipmnets.
5 List the sources of acidic waste water.

(Space for Answer)

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XX. References / Suggestions for further Reading

1. https://www.youtube.com/watch?v=GjnnK99t4Mc
2. https://www.youtube.com/watch?v=IhEE5LawCkU
3. https://books.google.co.in/books?id=bw34EAcNgz8C&printsec=frontcover&dq=treatment+of+acidic+wastewater&hl=en&sa=X&ved=0ahUKEwiVkLHlrubgAhVMfH0KHb5TDe8Q6AEIKDAA#v=onepage&q=treatment%20of%20acidic%20wastewater&f=false
4. https://inspiredliving.com/cuzn-water-filtration/acid-water-low-pH.htm

XXI. Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of Apparatus	20%
2	Observation of correct reading	20%
3	Calculation and result	20%
Product related (10 Marks)		**40%**
4	Interpretation of result & conclusions	20%
5	Answers to practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

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

Practical No. 14: Determine the strength of alkaline material in waste water using acid base titration.

I. Practical Significance

Alkalinity is significant in the treatment processes for potable water and wastewater. The alkalinity acts as a pH buffer in coagulation and lime-soda softening of water. In wastewater treatment, alkalinity is an important parameter in determining the amenability of wastes to the treatment process and control of processes such as anaerobic digestion, where bicarbonate alkalinity, total alkalinity and any fraction contributed by volatile acid salts become considerations.

II. Relevant Program Outcomes (POs)

PO 2. ***Discipline knowledge:*** *Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.*
PO 3. ***Experiments and practice:*** *Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.*
PO 4. ***Engineering tools:*** *Apply relevant technologies and Chemical engineering tools with an understanding of the limitations.*

III. Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency '***Conserve environment using various pollution control measures'.***

1. To Test sample of raw water
2. To observe the change in sample during titration.
3. To record the reading

IV. Relevant Course Outcomes

Test the different properties of waste water

V. Practical Outcome

Determine the strength of alkaline material in waste water using acid base titration.

VI. Relevant Affective domain unrelated Outcome(s)

1. Follow safe practices
2. Practice good housekeeping
3. Work as a leader/a team member

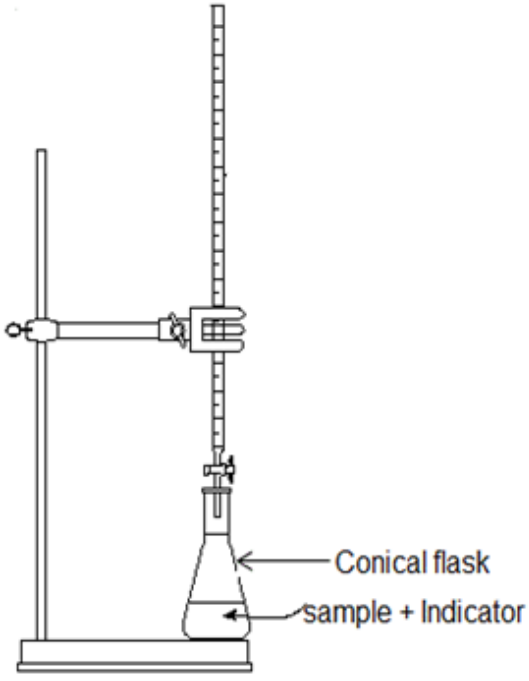
VII. Minimum Theoretical Background

Alkalinity is a measure of the capacity of water to neutralize acids. Alkalinity of water is due to the presence of bicarbonate, carbonate, and hydroxide ions. Salts of weak acids, such as borates, silicates and phosphates, may also contribute. Salts of certain organic

acids may contribute to alkalinity in polluted or anaerobic water, but their contribution usually is negligible. Bicarbonate is the major form of alkalinity. Carbonates and hydroxide may be significant when algal activity is high and in certain industrial water and wastewater, such as boiler water.

The bacteria and other biological entities which play an active role in wastewater treatment are most effective at a neutral to slightly alkaline pH of 7 to 8. In order to maintain these optimal pH conditions for biological activity there must be sufficient alkalinity present in the wastewater to neutralize acids generated by the active biomass during waste treatment. This ability to maintain the proper pH in the wastewater as it undergoes treatment is the reason why alkalinity is so important to the wastewater industry. The standard test for alkalinity measures quantity of acid neutralizing bases and represents this value in milligrams (mg) of $CaCO_3$ equivalents per liter (l) of wastewater. The term mg/l and the term p pm are used interchangeably in the wastewater industry. The amount of alkali that is added during waste treatment is determined by means of this standard test.

VIII. Experimental set up used in laboratory



IX Resources required

S. No.	Instrumentation/components	Specification	Quantity
1	Burette	25 ml	1
2	Pipette	10 ml	1
3	Conical Flask	100 ml	2
4	Measuring cylinder	1000 ml	2
5	Magnetic stirrer		1
6	Sulfuric Acid solution	0.02 N	1000 ml
7	Sodium thiosulphate solution	0.1 N	100 ml
8	Phenolphthalein indicator		5 ml
9	Methyl orange indicator.		5 ml

X. Precautions to be followed

1. Handle sulfuric acid carefully.
2. Use safety goggle and hand gloves while handling chemicals.

XIV. Procedure

1. Take 100 ml of the given sample in a conical flask.
2. Add one drop of 0.1 N sodium thiosulphate solution to remove the free residual chlorine if present.
3. Add 2 drops of phenolphthalein indicator. The sample turns pink.
4. Rundown 0.02N standard sulphuric acid till the solution turns to colorless.
5. Note down the volume of H_2SO_4added (V_1).
6. Add 2 drops of methyl orange indicator to the same flask till sample turns to yellow.
7. In case pink color does not appear after addition of phenolphthalein continue as above.
8. Note down the total volume of H_2SO_4 added (V_2).

XII. Resources used (with major specifications)

S. No.	Instrument /Components	Specification	Quantity
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XIII. Actual procedure followed

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XIV Precautions followed

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XV. Observations and Calculations

Sample details	Volume of sample (ml)	Phenolphthalein indicator			Methyl orange Indicator		
		Initial burette reading (ml)	Final burette reading (ml)	H_2SO_4 used (ml)	Initial burette reading (ml)	Final burette reading (ml)	H_2SO_4 used (ml)

1. Phenolphthalein alkalinity (P) (mg/l) as $CaCO_3$

$$= \frac{v_1 X\ normality\ of\ H_2SO_4 X\ 1000\ X50}{volume\ of\ sample\ taken} =$$

= ----------mg/l or (ppm)

2. Total alkalinity (T) as $CaCO_3$ mg/l

$$= \frac{v_2 X\ normality\ of\ H2SO4\ X\ 1000\ X\ 50}{volume\ of\ sample\ taken} =$$

= ----------mg/l or (ppm)

Refer following table for further calculations

Value of P and T	Alkalinity due to		
	OH^-	CO_3^{--}	HCO_3^-
P=0	0	0	T
P < 1/2 T	0	2P	T - 2P
P = 1/2 T	0	2P	0
P > 1/2 T	2P - T	2T – 2P	0
P = T	T	0	0

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XVI. Results

For given sample

Hydroxide alkalinity (mg/l) =

Carbonate alkalinity (mg/l) =

Bicarbonate alkalinity (mg/l) =

XVII. Interpretation of results

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XVIII. Conclusions

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XIX. Practical related Questions

Below given are five sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO

1 Write the reason for the use of two indicators in titration.
2 Write significance for the use of sodium thiosulphate solution.
3 Describe the procedure followed for preparing sulfuric acid solution.
4 Write the for the use of white tile during titration.
5 Name the compound causing alkalinity in water.

(Space for Answer)

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XX. References / Suggestions for further Reading

1 https://www.tpomag.com/editorial/2014/05/understanding_alkalinity
2 https://magnesiaspecialties.com/wp-content/uploads/Role-of-Alkalinity-in-Aerobic-Wastewater-Treatment-Plants-MgO-vs-Caustic-Soda1.pdf
3 https://www.epa.gov/sites/production/files/2015- 09/documents/2009_03_13_ estuaries_monitor_chap11.pdf

XXI. Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of Apparatus	20%
2	Observation of correct reading	20%
3	Calculation and result	20%
Product related (10 Marks)		**40%**
4	Interpretation of result & conclusions	20%
5	Answers to practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

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

Practical No. 15: Determine the density of municipal solid waste

II. Practical Significance

The density of MSW is important for selection of waste collection equipment. Usually density will increase by about 20-25 % during the transport step. Density varies depending on the composition of wastes, being higher in organic wastes and lower in commercial wastes containing mainly paper and cardboard .As transportation cost is important economical factor in MSW treatment it is necessary to calculate density at the source of generation.

II. Relevant Program Outcomes (POs)

PO 2. ***Discipline knowledge:*** *Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.*
PO 3. ***Experiments and practice:*** *Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.*
PO 4. ***Engineering tools:*** *Apply relevant technologies and Chemical engineering tools with an understanding of the limitations.*

III. Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency '***Conserve environment using various pollution control measures'.***

1. To characterize municipal solid waste
2. To segregate municipal solid waste
3. To record the reading

IV. Relevant Course Outcomes

Use land fill and incineration methods for treatment of industrial solid waste

V. Practical Outcome

Determine the density of municipal solid waste

VI. Relevant Affective domain unrelated Outcome(s)

1. Follow safe practices
2. Practice good housekeeping
3. Work as a leader/a team member

VII. Minimum theoretical Background

MSW consists of both materials and products. Materials in MSW include paper and paperboard, yard trimmings, glass, metal, plastics, wood, and food wastes. Each material category (except for food wastes and yard trimmings) is made up of many different products. Products in MSW are grouped into three main categories: (1) durable goods (e.g., appliances), (2) nondurable goods (e.g., newspapers), and (3) containers and packaging. These product categories generally contain each type of MSW material, with

some exceptions. The durable goods category contains no paper and paperboard. The nondurable goods category includes only small amounts of metals and essentially no glass or wood. The containers and packaging category includes only very small amounts of rubber, leather, and textiles. The density of MSW is important for selection of waste collection equipment. Usually density will increase by about 20-25 % during the transport step. Density varies depending on the composition of wastes, being higher in organic wastes and lower in commercial wastes containing mainly paper and cardboard .As transportation cost is important economical factor in MSW treatment it is necessary to calculate density at the source of generation.

VIII. Experimental set up used in laboratory

IX Resources required

S. No.	Instrumentation/components	Specification	Quantity
1	Beaker	100 ml	10
2	Weighing Balance	1 to 500 gm	1

X. Precautions to be followed

1. Handle digital balance carefully.
2. Use safety goggle and hand gloves while handling MSW.

XVI. Procedure

1. Take 1 kg of Municipal Solid Waste.
2. Segregate the waste and separate paper, plastic, metal, food waste etc.
3. Place each segregated item in separate beaker.
4. Weigh the content in each beaker and note the reading.

XII. Resources used (with major specifications)

S. No.	Instrument /Components	Specification	Quantity
1			
2			
3			

XIII. Actual procedure followed

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XIV Precautions followed

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XV Observations and Calculations

Sr. No.	Description	Weight (gm)	Wt % f_i	Typical Density (kg/m^3) D_i	f_iD_i

Average density

$$D_{avg}\left(\sum_{i=1}^{n} f_i D_i\right)$$

Note : Typical density of various material (kg/m^3)
Food waste =290, Yard waste = 240, Paper =85, Plastic = 65, Glass/ceramic =195, Metal =160, Textile =65, Leather =160, stone/bricks =480

XVI. Results

Average density of MSW = _____ kg/m^3

XVII. Interpretation of results

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XVIII. Conclusions

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XIX. Practical related Questions

Below given are five sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO

1 List the sources of MSW.
2 Write various characteristics of MSW.
3 Name the act applicable to every municipal authority responsible for collection, segregation, storage, transportation, processing and disposal of municipal solid.
4 Write the name of methods used to dispose MSW.
5 Name the materials having maximum and minimum wt % in your MSW sample.

(space for Answer)

XX. References / Suggestions for further Reading

1. http://cpcb.nic.in/municipal-solid-waste-rules/
2. https://nptel.ac.in/courses/105106056/Municipal_Solid_Waste_Management_Fundamentals_Presentation.pdf
3. https://nptel.ac.in/courses/105106056/Municipal_Solid_Waste_Management_Fundamentals.pdf

XXI. Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of Apparatus	20%
2	Observation of correct reading	20%
3	Calculations and result	20%
Product related (10 Marks)		**40%**
4	Interpretation of result & conclusions	20%
5	Answers to practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

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

Practical No. 16: Determine the density of hazardous waste

I. Practical Significance

A hazardous waste is a special type of waste because it cannot be disposed of by common means like other by-products of our everyday lives. Depending on the physical state of the waste, treatment and solidification processes might be required. Determination of its properties will be helpful for its handling.

II. Relevant Program Outcomes (POs)

PO 2. ***Discipline knowledge:*** *Apply Chemical engineering knowledge to solve industry based Chemical Engineering problems.*
PO 3. ***Experiments and practice:*** *Plan to perform experiments and practices to use the results to solve technical problems related to Chemical engineering.*
PO 4. ***Engineering tools:*** *Apply relevant technologies and Chemical engineering tools with an understanding of the limitations.*

III. Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency '***Conserve environment using various pollution control measures'.***

1. To characterize hazardous waste
2. To handle hazardous waste
3. To record the reading

IV. Relevant Course Outcomes

Apply ISO14000 environmental protection norms for chemical industry

V. Practical Outcome

Determine the density of hazardous waste.

VI. Relevant Affective domain unrelated Outcome(s)

1. Follow safe practices
2. Practice good housekeeping
3. Work as a leader/a team member

VII. Minimum Theoretical Background

Hazardous-waste management, the collection, treatment, and disposal of waste material that, when improperly handled, can cause substantial harm to human health and safety or to the environment. Hazardous wastes can take the form of solids, liquids, sludge, or contained gases, and they are generated primarily by chemical production, manufacturing, and other industrial activities. They may cause damage during storage, transportation, treatment, or disposal operations. Improper hazardous-waste storage or disposal frequently contaminates surface and groundwater supplies. People living in homes built near old and abandoned waste disposal sites may be in a particularly

vulnerable position. Hazardous wastes may be found in different physical states such as gaseous, liquids, or solids. A hazardous waste is a special type of waste because it cannot be disposed of by common means like other by-products of our everyday lives. Depending on the physical state of the waste, treatment and solidification processes might be required.

VIII. Experimental set up used in laboratory

IX Resources required

S. No.	Instrumentation/components	Specification	Quantity
1	Sp Gravity bottle	50 ml	1
2	Weighing Balance	1 to 500 gm	1

X. Precautions to be followed

1. Handle digital balance carefully.
2. Use safety goggle and hand gloves while handling hazardous waste.
3. Do not inhale the liquid hazardous waste.

XVII. Procedure

1. Take weight of empty specific gravity bottle (W_1)
2. Fill the bottle with liquid hazardous waste.
3. Weigh the specific gravity bottle with liquid waste (W_2)
4. Record the reading and do the calculation.

XII. Resources used (with major specifications)

S. No.	Instrument /Components	Specification	Quantity
1			
2			
3			

XIII. Actual procedure followed

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XIV Precautions followed

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XV Observations and Calculations

Weight of empty specific gravity bottle = W_1
Wight of specific gravity bottle with waste = W_2
Weight of hazardous waste = $W_1 - W_2$
Volume of specific gravity bottle = V

Density = Weight of hazardous waste/ Volume of sp gravity bottle

= _____ gm/cc =_____ kg/m^3

XVI. Results

Density of hazardous waste = _____ kg/m^3

XVII. Interpretation of results

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XVIII. Conclusions

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XIX. Practical related Questions

Below given are five sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO

1 List the sources of hazardous waste.
2 Write various characteristics of hazardous waste.
3 Name the rule applicable to management of hazardous waste.
4 List various methods for handling hazardous waste.
5 Define specific gravity.

(Space for Answer)

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XX. References / Suggestions for further Reading

1. https://www.britannica.com/technology/hazardous-waste-management
2. https://www.environment.gov.au/system/files/resources/a16491f5-6697-4f1b-bba0-074963e78957/files/hazardous-waste-unit-conversion-factors.pdf
3. https://www.epa.gov/sites/production/files/201511/documents/2015_hwr_instructions_forms.pdf
4. http://www.mfe.govt.nz/publications/waste/calculation-and-payment-waste-disposal-levy-guidance-waste-disposal-facility-8
5. https://www.epa.gov/sites/production/files/2014-12/documents/k01005.pdf

XXI. Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of Apparatus	20%
2	Observation of correct reading	20%
3	Calculation and result	20%
Product related (10 Marks)		**40%**
4	Interpretation of result & conclusions	20%
5	Answers to practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

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

List Of Laboratory Manuals Developed by MSBTE

First Semester:

1	Fundamentals of ICT	22001
2	English	22101
3	English Work Book	22101
4	Basic Science (Chemistry)	22102
5	Basic Science (Physics)	22102

Second Semester:

1	Bussiness Communication Using Computers	22009
2	Computer Peripherals & Hardware Maintenace	22013
3	Web Page Design with HTML	22014
4	Applied Science (Chemistry)	22202
5	Applied Science (Physics)	22202
6	Applied Machines	22203
7	Basic Surveying	22205
8	Applied Science (Chemistry)	22211
9	Applied Science (Physics)	22211
10	Fundamental of Electrical Engineering	22212
11	Elements of Electronics	22213
12	Elements of Electrical Engineering	22215
13	Basic Electronics	22216
14	'C' programming Language	22218
15	Basic Electronics	22225
16	Programming in "C"	22226
17	Fundamentals of Chemical Engineering	22231

Third Semester:

1	Applied Multimedia Techniques	22024
2	Advanced Serveying	22301
3	Highway Engineering	22302
4	Mechanics of Structures	22303
5	Building Construction	22304
6	Concrete Technology	22305
7	Strength Of Materials	22306
8	Automobile Engines	22308
9	Automobile Transmission System	22309
10	Mechanical Operations	22313
11	Technology Of Inorganic Chemicals	22314
12	Object Oriented Programming Using C++	22316
13	Data Structure Using 'C'	22317
14	Computer Graphics	22318
15	Database Management System	22319
16	Digital Techniques	22320
17	Principles Of Database	22321
18	Digital Techniques & Microprocessor	22323
19	Electrical Circuits	22324
20	Electrical & Electronic Measurment	22325
21	Fundamental Of Power Electronics	22326
22	Electrical Materials & Wiring Practice	22328
23	Applied Electronics	22329
24	Electrical Circuits & Networks	22330
25	Electronic Measurments & Instrumentation	22333
26	Principles Of Electronics Communication	22334
27	Thermal Engineering	22337
28	Engineering Matrology	22342
29	Mechanical Engineering Materials	22343
30	Theory Of Machines	22344

Fourth Semester:

1	Hydraulics	22401
2	Geo Technical Engineering	22404
3	Chemical Process Instrumentation & Control	22407
4	Fluid Flow Operation	22409
5	Technology Of Organic Chemicals	22410
6	Java Programming	22412
7	GUI Application Development Using VB.net	22034
8	Microprocessor	22415
9	Database Managment	22416
10	Electric Motors And Transformers	22418
11	Industrial Measurements	22420
12	Digital Electronics And Microcontroller Applications	22421
13	Linear Integrated Circuits	22423
14	Microcontroller & Applications	22426
15	Basic Power Electronics	22427
16	Digital Communication Systems	22428
17	Mechanical Engineering Measurments	22443
18	Fluid Mechanics and Machinery	22445
19	Fundamentals Of Mechatronics	22048

Fifth Semester:

1	Design of Steel and RCC Structures	22502
2	Public Health Engineering	22504
3	Heat Transfer Operation	22510
4	Environmental Technology	22511
5	Operating Systems	22516
6	Advanced Java Programming	22517
7	Software Testing	22518
8	Control Systems and PLC's	22531
9	Embedded Systems	22532
10	Mobile and Wireless Communication	22533
11	Industrial Machines	22523
12	Switchgear and Protection	22524
13	Energy Conservation and Audit	22525
14	Power Engineering and Refrigeration	22562
15	Solid Modeling and Additive Manufacturing	22053
16	Guidelines & Assessment Manual for Micro Projects & Industrial Training	22057

Sixth Semester:

1	Solid Modeling	17063
2	Highway Engineering	17602
3	Contracts & Accounts	17603
4	Design of R.C.C. Structures	17604
5	Industrial Fluid Power	17608
6	Design of Machine Elements	17610
7	Automotive Electrical and Electronic Systems	17617
8	Vehicle Systems Maintenance	17618
9	Software Testing	17624
10	Advanced Java Programming	17625
11	Mobile Computing	17632
12	System Programing	17634
13	Testing & Maintenance of Electrical Equipments	17637
14	Power Electronics	17638
15	Illumination Engineering	17639
16	Power System Operation & Control	17643
17	Environmental Technology	17646
18	Mass Transfer Operation	17648
19	Advanced Communication System	17656
20	Mobile Communication	17657
21	Embedded System	17658
22	Process Control System	17663
23	Industrial Automation	17664
24	Industrial Drives	17667
25	Video Engineering	17668
26	Optical Fiber & Mobile Communication	17669
27	Therapeutic Equipment	17671
28	Intensive Care Equipment	17672
29	Medical Imaging Equipment	17673

Pharmacy Lab Manual

First Year:

1	Pharmaceutics - I	0805
2	Pharmaceutical Chemistry - I	0806
3	Pharmacognosy	0807
4	Biochemistry and Clinical Pathology	0808
5	Human Anatomy and Physiology	0809

Second Year:

1	Pharmaceutics - II	0811
2	Pharmaceutical Chemistry - II	0812
3	Pharmacology & Toxicology	0813
4	Hospital and Clinical Pharmacy	0816

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