



Experiment No. 1

pH of Water Samples

Submitted By:

Student Name:	
ID:	Submission Date:

For Official Use Only:

Sub-title No.	1	2	3	4	5	6	7	8	9	10	Total
CLO Focused:	3.1	4.1	5.1	5.2	-	-	-	-	-	-	-
Max. Points:	2.0	3.0	3.0	2.0	-	-	-	-	-	-	10
Points Obtained:					-	-	-	-	-	-	



1- Objective

The objective of the experiment is to determine the pH of given different samples like tap water, well water,etc

2- Significance and Use:

Buffering capacity in accommodating H^+ and OH^- ions in order to maintain the neutrality.

3-Relevant Theory:

pH is measure of hydrogen ion concentration present in water and indicates its acidic or basic character. The range of water pH is from 0 to 14.0 [0 acidic, 7 Neutral (pure or distilled water), and 14 alkaline]. pH is a very important water parameter and must be controlled in chemical and biological processes of water and wastewater treatment plants. High pH values in nature may be caused by algae which removes carbon dioxide from water through photosynthesis. pH is calculated from hydrogen $[H^+]$ or hydroxyl $[OH^-]$ ion concentrations by the following relations:

$$pH = - \log [H^+] \quad \text{or} \quad [H^+] = 10^{-pH}$$

$$[H^+][OH^-] = 10^{-14} \quad \dots\dots\dots \text{In neutral } [H^+] = [OH^-], \text{ so } [H^+] = 10^{-7} \text{ then } pH= 7.0$$

4- Apparatus:

- pH meter
- Beakers
- Stirring bar
- Magnetic stirrer

5- Reagents:

- pH calibration standards

6- Procedure:

6.1-Calibration of pH meter:

1. Rinse combined electrode thoroughly with distilled water, dry with tissue paper and immerse in pH 7.0 buffer solutions.
2. If the meter reading is $pH 7 \pm 0.2$, the meter calibration is OK. If not calibrate the pH meter according to the instrument manual.



3. Remove electrode from standard solution and rinse thoroughly with distilled water, dry with tissue. Now, the instrument is ready for measurement

6.2-pH measurement

1. Pour about 100 mL mixed sample in 250 mL beaker. Stir the sample using stirrer and magnetic bar.
2. Dip cleaned and dried pH electrode into the beaker and wait for few minutes until the reading stabilize. Record the pH reading.

7- Observations and Results:

Sample No.	Source	Volume (mL)	pH meter reading
1			
2			
3			
4			
5			

8- Discussion:



9- Conclusions:

10- References:



Experiment No. 2

Alkalinity of Water Samples

Submitted By:

Student Name:	
ID:	Submission Date:

For Official Use Only:

Sub-title No.	1	2	3	4	5	6	7	8	9	10	Total
CLO Focused:	1.1	2.1	5.1	5.2	-	-	-	-	-	-	-
Max. Points:	1.5	1.5	3.5	3.5	-	-	-	-	-	-	10
Points Obtained:					-	-	-	-	-	-	



3- Objective

The objective of the experiment is to determine the total alkalinity for given different samples like tap water, well water,etc

4- Significance and Use:

It has the significance in many treatment ways of neutral water and wastewater. Alkalinity measurements are used in the interpretation of water and wastewater treatment processes (coagulation and softening).

3-Relevant Theory:

Alkalinity of water is its acid neutralizing capacity (donate OH^- i.e. hydrate ions or accept H^+ ions or hydrogen ions). It also can be define by the quantitative capacity of water to neutralize strong acid to a designated pH. Water alkalinity results from presence of hydroxide (OH^-), carbonate (CO_3^-), and bicarbonate (HCO_3^-). Alkalinity compounds originate from chemical compounds dissolved from rock and soil, also from CO_2 from atmosphere and microbial decomposition of organic matter. Carbonate and bicarbonate alkalinity complex some heave metals and thus reduces their toxicity. High alkalinity often has high pH and contains high levels of dissolved solids.

Without this acid-neutralizing capacity, any acid added to a stream would cause an immediate change in the pH. Measuring alkalinity is important in determining a stream's ability to neutralize acidic pollution from rainfall or wastewater. It's one of the best measures of the sensitivity of the stream to acid inputs.

Total alkalinity is measured by measuring the amount of acid (e.g., sulfuric acid) needed to bring the sample to a pH of 4.5. At this pH all the alkaline compounds in the sample are "used up." The result is reported as milligrams per liter of calcium carbonate (mg/L CaCO_3).

Typical alkalinity ranges.

	(mg/L CaCO_3)
Rainwater	<10
Typical surface water	20 – 200
Surface water in regions with alkaline soils	100 – 500
Groundwater	50 – 1000
Seawater	100 – 500



4- Apparatus:

- pH meter
- Beakers
- Stirring bar
- Magnetic stirrer
- Measuring cylinder (100 ml)
- Burette

5- Reagents:

- pH calibration standards solutions
- Sulfuric acid, 0.02 N

6- Procedure:

6.1-Calibration of pH meter:

4. Rinse combined electrode thoroughly with distilled water, dry with tissue paper and immerse in pH 7.0 buffer solution.
5. If the meter reading is pH 7 ± 0.2 , the meter calibration is OK. If not calibrate the pH meter according to the instrument manual.
6. Remove electrode from standard solution and rinse thoroughly with distilled water, dry with tissue. Now, the instrument is ready for measurement

6.2- Alkalinity measurement

3. Take 100 mL mixed sample in 250 mL beaker. Stir the sample using stirrer and magnetic bar.
4. Dip cleaned and dried pH electrode into the beaker and wait until the reading stabilize.
5. Slowly add 0.02 N H_2SO_4 until the reading stabilize to pH 4.5. Record the burette reading and calculate total alkalinity.

7- Results and calculations:

Sample No.	Source	Sample Volume (mL)	Initial burette reading	Final burette reading	Total Alkalinity (mg/L as $CaCO_3$)
1					
2					
3					
4					



Total alkalinity (mg/L as CaCO_3) = $A \cdot 1000 / \text{sample volume in mL}$

Where, A is the net volume of 0.02 N H_2SO_4 (difference between final and initial burette reading) in mL.

8- Discussion:

9- Conclusions:

10- References:



Experiment No. 3

Turbidity

Submitted By:

Student Name:	
ID:	Submission Date:

For Official Use Only:

Sub-title No.	1	2	3	4	5	6	7	8	9	10	Total
CLO Focused:	3.1	4.1	5.1	5.2	-	-	-	-	-	-	-
Max. Points:	2.0	3.0	3.0	2.0	-	-	-	-	-	-	10



Points Obtained:					-	-	-	-	-	-	
---------------------	--	--	--	--	---	---	---	---	---	---	--

5- Objective

The objective of the experiment is to determine the turbidity and in given water samples.

6- Significance and Use:

Turbidity indicates the water purity by measures presence of non-settle able suspended matter (Colloidal) e.g. clay, silt, finely divided inorganic and organic matter. So, its value decides water is safe to use or not.

3-Relevant Theory:

Turbidity is a characteristic of water that makes it appear cloudy. It is caused by colloidal materials like clay, silt, microorganisms, fibers, oil, soaps, and metal oxides. High turbidity usually has high suspended solids (SS). Turbidity can be measured using either an electronic turbidity meter or turbidity tube. Usually, it measured by nephelometric meter that measures the intensity of light scattered at right angles to the incident of light. The unit for turbidity is nephelometer turbidity units (NTUs) or Jackson turbidity units (JTLJs) or Foral turbidity units (FTUs), and all units are roughly equal.

4- Apparatus:

- Turbidity meter
- Measuring cylinder (100 ml)
- Pipette
- Stirring bar
- Magnetic stirrer

5- Reagents:

- Turbidity standard solutions

6- Procedure:

6.1-Turbidity test:



6. Place clean and dry standard turbidity cell in the cell holder, close the shutter and read turbidity value. Repeat that for six standard solutions.
7. If the meter reading is $\pm 10\%$ of the standard value, the meter calibration is OK. If not calibrate the conductivity meter according to the instrument manual.
8. Insert clean and dry turbidity cell with thoroughly mixed sample in the cell holder, close the shutter and read turbidity value and record it.

7- Results and calculations:

Sample No.	Source	Temperature (°C)	Turbidity (NTU)
1			
2			
3			
4			

8- Discussion:



9- Conclusions:

10- References:



Experiment No. 4

Conductivity

Submitted By:

Student Name:	
ID:	Submission Date:

For Official Use Only:

Sub-title No.	1	2	3	4	5	6	7	8	9	10	Total
CLO Focused:	3.1	4.1	5.1	5.2	-	-	-	-	-	-	-



Max. Points:	2.0	3.0	3.0	2.0	-	-	-	-	-	-	10
Points Obtained:					-	-	-	-	-	-	

7- Objective

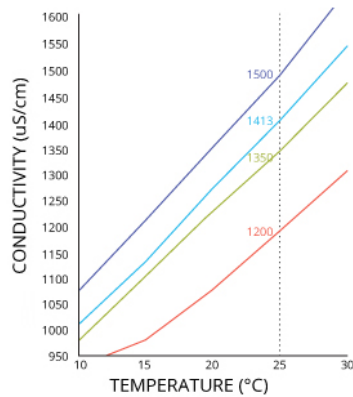
The objective of the experiment is to determine the conductivity of given water samples.

8- Significance and Use:

Conductivity indicates the purity of water by measures the solubility of ions in water. It is useful to asses the pollution source and monitor the desalination plant. It can be used as a rough measure of the concentration of total dissolved solids (TDS) and inorganic materials such as alkalis, chlorides, sulfides and carbonate. It also indicates the salinity degree of water.

3-Relevant Theory:

Conductivity is the ability of water to carry an electrical current; the current is carried by cations and anions. It is a function of the concentration of ions. Increasing the level of ions will increase the conductivity. Most conductivity measurements are made in aqueous solutions, and the ions responsible for the conductivity come from electrolytes dissolved in the water. Not all aqueous solutions have conductivity. Solutions of non-electrolytes, for example sugar or alcohol, have no conductivity because neither sugar nor alcohol contains ions nor do they produce ions when dissolved in water. Distilled or deionized water can act as an insulator due to its very low (if not negligible) conductivity value. Sea water, on the other hand, has a very high conductivity. Salinity and TDS are important in particular as it affect dissolved oxygen solubility.



	uS/cm
DISTILLED WATER	0.5 - 3
MELTED SNOW	2 - 42
TAP WATER	50 - 800
POTABLE WATER IN THE US	30 - 1500
FRESHWATER STREAMS	100 - 2000
INDUSTRIAL WASTEWATER	10000
SEAWATER	55000

The units of conductivity are Siemens per cm (S/cm). Derived units are $\mu\text{S}/\text{cm}$ (one millionth of a S/cm) and mS/cm (one thousandth of a S/cm). S/cm is the same as the older unit mhos/cm.

Increasing the temperature of an electrolyte solution always increases the conductivity. The increase is significant, between 1.5 and 5.0% per $^{\circ}\text{C}$.

4- Apparatus:

- Conductivity meter
- Measuring cylinder (100 ml)
- Stirring bar
- Magnetic stirrer

5- Reagents:

- Conductivity standard

6- Procedure:

7. Remove conductivity probe from storage solution and rinse thoroughly with distilled water, dry with tissue paper and immerse in standard conductivity solution (1413 $\mu\text{mhos}/\text{cm}$).
8. If the meter reading is $\pm 10\%$ of the standard value, the meter calibration is OK. If not calibrate the conductivity meter according to the instrument manual.
9. Remove probe from standard solution and rinse thoroughly with distilled water, dry with tissue. Now, the instrument is ready for measurement.
10. Immerse the probe in unknown sample, allow some time for equilibrium and read the conductivity value.



7- Results and calculations:

Sample No.	Source	Temperature	Conductivity ($\mu\text{mhos/cm}$)
1			
2			
3			
4			

8- Discussion:

9- Conclusions:



10- References:

Experiment No. 5

Total Organic and Inorganic Solids

Submitted By:

Student Name:	
ID:	Submission Date:



For Official Use Only:

Sub-title No.	1	2	3	4	5	6	7	8	9	10	Total
CLO Focused:	3.1	4.1	5.1	5.2	-	-	-	-	-	-	-
Max. Points:	2.0	3.0	3.0	2.0	-	-	-	-	-	-	10
Points Obtained:					-	-	-	-	-	-	

9- Objective

The objective of the experiment is to determine the total fixed solids (TFS) and, total volatile solids (TVS) in given water samples.

10- Significance and Use:

- a. The water which consists of high volatile solids is not suitable for drinking purpose and indicates that the water may have been polluted by domestic wastes or other organic wastes.
- b. The determination of volatile and fixed components in the residue is useful in the control of waste water plant operation because it offers an approximate amount of organic matter present in the solid fraction of wastewater.
- c. It is used to find out the strength of industrial and domestic wastewater.
- d. Volatile solids test is normally applied to sludges. It is indispensable in the design and operation of sludge digest, vacuum filter and incineration plants.

3-Relevant Theory:

The term total volatile solids refer to materials that are completely volatilized from water at higher temperature (550°C). These solids are often referred to the organic content of the water. The term total fixed solids can be referred to materials which are not volatilized from water at higher temperature (550°C). These solids are often referred to the inorganic content of the water.



The sample is evaporated in a weighed dish on a steam bath and is dried to a constant mass in an oven at 103-105°C. The residue obtained is ignited to constant weight at 550°C. The remaining solids represent the total fixed solids and the weight lost during the ignition represents the total volatile solids.

4- Apparatus:

- Drying oven
- Desiccators
- Analytical Balance
- Crucible or dish
- Magnetic stirrer
- Measuring cylinder

5- Precautions:

- Analysis should begin as soon as possible, and to reduce the change in taken samples, keep all samples at 4°C. Do not allow samples to freeze.
- Samples need to be measured accurately, weighed carefully, and dried and cooled completely.
- Volume of sample should be adjusted to have residue left after drying.

6- Procedure:

11. Take a clean crucible which has been washed and dried in a hot air oven at 105°C for one hour and ignited at 550°C to remove all organic materials present in it.
12. Now weigh the empty crucible in analytical balance. Let's denote the weight measured as W_1
13. Using pipette transfer 50 mL of unfiltered sample in the dish.
14. Switch on the oven and allowed to reach 105°C. Check and regulate oven and furnace temperatures frequently to maintain the desired temperature range.
15. Place the crucible in the hot air oven and dry it to get constant mass (about 24 hours).
16. Cool the container in a desiccator. Desiccators are designed to provide an environment of standard dryness. This is maintained by the desiccant found inside. Don't leave the lid off for prolonged periods or the desiccant will soon be exhausted.
17. We should weigh the dish as soon as it has cooled to avoid absorption of moisture due to its hygroscopic nature. Note the weight with residue as W_2



18. Switch on the furnace and allow it to reach 550°C. Check and regulate the furnace temperatures frequently to maintain the desired temperature range.
19. Place the crucible in the furnace and care should be taken while keep the crucible inside the furnace since it will be too hot. Allow it to ignite for 20 minutes to get constant mass.
20. As above, cool the crucible in a desiccator to room temperature.
21. Weigh the dish as soon as it has cooled to avoid absorption of moisture due to its hygroscopic nature. Note the weight with residue as W_3

6- Results and calculations:

Sample No.	Source	Volume of sample	Weight of empty dish (g) (W_1)	Weight of dish + dried sample (105°C) (g) (W_2)	Weight of dish + dried sample (550°C) (g) (W_3)
1					
2					
3					

Weight of volatile solids = $W_2 - W_3$, Weight of fixed solids = $W_3 - W_1$

Total volatile solids = $(W_2 - W_3) * 1000 * 1000 / \text{volume of the sample}$ (mg/L)

Total fixed solids = $(W_3 - W_1) * 1000 * 1000 / \text{volume of the sample}$ (mg/L)

Sample No.	Source	TVS (mg/L)	TFS (mg/L)
1			
2			
3			



7- Discussion:

8- Conclusions:

9- References:



Experiment No. 6

Total Suspended Solids (TSS), and Total Dissolved Solids (TDS)

Submitted By:

Student Name:



ID:	Submission Date:
------------	-------------------------

For Official Use Only:

Sub-title No.	1	2	3	4	5	6	7	8	9	10	Total
CLO Focused:	3.1	4.1	5.1	5.2	-	-	-	-	-	-	-
Max. Points:	2.0	3.0	3.0	2.0	-	-	-	-	-	-	10
Points Obtained:					-	-	-	-	-	-	

11- Objective

The objective of the experiment is to determine the total suspended solids (TSS), total Dissolved solids (TDS), and hence total solids content (TS) in given water samples.

12- Significance and Use:

- Dissolved minerals, gases and organic constituents may produce aesthetically displeasing colour, taste and odour.
- Estimation of total dissolved solids is useful to determine whether the water is suitable for drinking purpose, agriculture and industrial purpose. Generally potable water has TDS below 500 mg
- Some dissolved organic chemicals may deplete the dissolved oxygen in the receiving waters and some may be inert to biological oxidation.
- Water with higher solids content often has a laxative and sometimes the reverse effect upon people whose bodies are not adjusted to them.
- High concentration of dissolved solids about 3000 mg/L may also produce distress in livestock. In industries, the use of water with high amount of dissolved solids may lead to scaling in boilers, corrosion and degraded quality of the product.



- The suspended and volatile solids parameters are used to measure the quality of wastewater influent and effluent.
- Suspended solids exclude light, thus reducing the growth of oxygen producing plants.

3-Relevant Theory:

The term of total dissolved solids (TDS) refer to materials that are completely dissolved in water. These solids are filterable in nature. It is defined as residue upon evaporation of filterable sample. The term total suspended solids (TSS) can be referred to materials which are not dissolved in water and are non filterable in nature. It is defined as residue upon evaporation of non filterable sample on a filter paper.

4- Apparatus:

- Draying oven
- Desiccators
- Analytical Balance
- Vacuum Pumps
- Crucible
- Muffle furnace
- Crucible Tongs
- Magnetic stirrer
- Measuring cylinder
- Filter paper
- Forceps

5- Procedure:

5.1- Total suspended solids (TSS):

22. Take a clean filter paper which has been washed and dried in a hot air oven at 105°C. Let's denote the weight measured as W1
23. Place filtration apparatus with weighed filter in filter flask.
24. Mix sample well and pour into a graduated cylinder to the selected volume (50-100 mL).
25. Continue suction for three minutes after filtration of final rinse is completed.
26. Dry filter in an oven at 103-105°C for at least 1 hour.
27. Cool filter in desiccators to room temperature. When cool, weigh the filter and support. Note the weight as W2



5.2- Total dissolved solids (TDS):

1. Take a clean porcelain dish which has been washed and dried in a hot air oven at 105°C for one hour. Let's denote the weight measured as W1
2. Using pipette transfer 50-100 mL of **filtrated sample** in the porcelain dish.
3. Switch on the oven and allowed to reach 105°C. Dry the sample to get constant mass. Drying for long duration usually 1 to 2 hours is done to eliminate necessity of checking for constant mass.
4. Cool the container in a desiccators, weigh the dish as soon as it has cooled to avoid absorption of moisture. Note the weight with residue as W2

6- Results and calculations:

6.1- Total suspended solids (TSS):

Sample No.	Source	Volume of sample (mL)	Weight of filter paper (g) (W ₁)	Weight of filter paper+ dried sample (105°C) (g) (W ₂)
1				
2				
3				

Total suspended solids = $(W_2 - W_1) * 1000 * 1000 / \text{volume of the sample}$ (mg/L)

6.2- Total dissolved solids (TDS):



Sample No.	Source	Volume of sample (mL)	Weight of empty dish (g) (W ₁)	Weight of dish + dried sample (105°C) (g) (W ₂)
1				
2				
3				

Total dissolved solids = $(W_2 - W_1) * 1000 * 1000 / \text{volume of the sample}$ (mg/L)

7- Discussion:

8- Conclusions:



9- References:

Experiment No. 7

Determination of Chlorides

Submitted By:

Student Name:



ID:	Submission Date:
------------	-------------------------

For Official Use Only:

Sub-title No.	1	2	3	4	5	6	7	8	9	10	Total
CLO Focused:	3.1	4.1	5.1	5.2	-	-	-	-	-	-	-
Max. Points:	2.0	3.0	3.0	2.0	-	-	-	-	-	-	10
Points Obtained:					-	-	-	-	-	-	

13- Objective

The objective of the experiment is to determine the chlorides of given water samples.

14- Significance and Use:

- Chlorides associated with sodium (Sodium Chloride) exert salty taste when its concentration is more than 250 mg/L. These impact a salty taste to water. Chlorides are generally limited to 250 mg/L in water supplies intended for public water supply.
- It can also corrode concrete. Magnesium chloride in water generates hydrochloric acid after heating which is also highly corrosive and creates problem in boilers.
- Chloride determinations in natural waters are useful in the selection of water supplies for human use.
- Chloride determination is used to determine the type of desalting apparatus to be used.
- Chloride determination is used to control pumping of ground water from locations where intrusion of seawater is a problem.
- Chlorides interfere in the determination of chemical oxygen demand (COD).



3. Relevant Theory:

Chlorides are widely distributed as salts of calcium, sodium and potassium in water and wastewater. In potable water, the salty taste produced by chloride concentrations is variable and dependent on the chemical composition of water. The major taste producing salts in water are sodium chloride and calcium chloride. The salty taste is due to chloride anions and associated cations in water. In some water which is having only 250 mg/L of chloride may have a detectable salty taste if the cation present in the water is sodium. On the other hand, a typical salty taste may be absent even if the water is having very high chloride concentration for example 1000 mg/L. This is because the predominant cation present in the water is not sodium but either calcium or magnesium may be present.

When chlorine is added to water, some of the chlorine reacts first with organic materials and metals in the water and is not available for disinfection (this is called the *chlorine demand* of the water). The remaining chlorine concentration after the chlorine demand is accounted for is called **total chlorine**. Total chlorine is further divided into: 1) the amount of chlorine that has combined with nitrogen in water and is unavailable for disinfection which is called *combined chlorine* and, 2) the **free chlorine**, which is the chlorine available to inactivate disease-causing organisms (disinfection), and thus a measure to determine the portability of water. For example, if using completing clean water the chlorine demand will be zero, and there will be no nitrates present, so no combined chlorine will be present. Thus, the free chlorine concentration will be equal to the concentration of chlorine initially added. In natural waters, especially surface water supplies such as rivers, organic material will exert a chlorine demand, and nitrates will form combined chlorine. Thus, the free chlorine concentration will be less than the concentration of chlorine initially added.

4- Apparatus:

- Colorimeter
- Beakers
- Stirring bar
- Magnetic stirrer

5- Reagents:

- DPD Total reagent
- DPD Free reagent

6- Procedure:

6.1- Free Chloride:



28. Place clean and dry blank sample in the cell holder, close the shutter and read zero after choose mode (Cl- F).
29. Remove blank sample and put free DPD reagent and ensuring to shake it totally.
30. Put it again in cell holder and press (read/enter) key within two minutes from the time the DPD free reagent was added to the sample.

6.2- Total Chloride:

1. Place clean and dry blank sample in the cell holder, close the shutter and read zero after choose mode (Cl- T).
2. Remove blank sample and put total DPD reagent and ensuring to shake it totally. And wait two minutes.
3. Put it again in cell holder and press (read/enter) key within two minutes from the time the DPD total reagent was added to the sample.

7- Results and calculations:

Sample No.	Source	Chlorides (ppm)
1		
2		
3		
4		

8- Discussion:



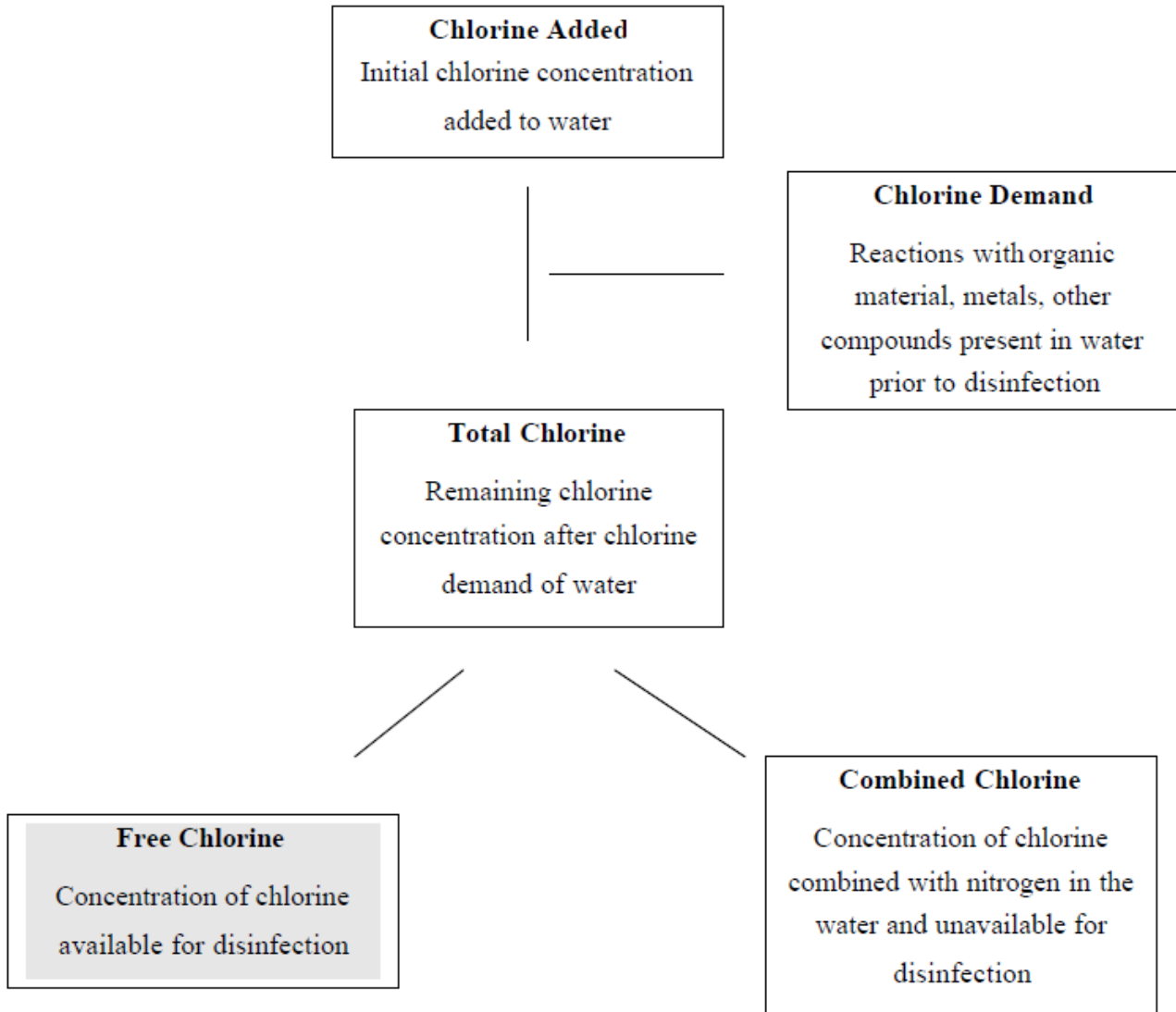
9- Conclusions:

10- References:

11- Appendix



Chlorine Addition Flow Chart





Experiment No. 8

Jar test (Coagulation & Flocculation)

Submitted By:

Student Name:	
ID:	Submission Date:

For Official Use Only:

Sub-title No.	1	2	3	4	5	6	7	8	9	10	Total
CLO Focused:	3.1	4.1	5.1	5.2	-	-	-	-	-	-	-



Max. Points:	2.0	3.0	3.0	2.0	-	-	-	-	-	-	10
Points Obtained:					-	-	-	-	-	-	

15- Objective

To understand the coagulation-flocculation process and to determine the optimum dosage of alum solution added to water sample

16- Significance and Use:

- It is a method of measuring the effect of coagulation, flocculation, and sedimentation on turbidity.
- Used in most water treatment plants to find the best coagulant dosages under varying conditions.

3-Relevant Theory:

Raw water, after screening, continues to have impurities in suspension and in solution. One of the objectives of water treatment is to promote the settling of suspended particulate matter. The coagulation process utilizes what is known as a chemical coagulant (aluminum or iron salts) to promote particle agglomeration, most used are aluminum sulfate or ferric chloride. Most suspended particles carry a negative electrostatic charge. This means that they repulse each other and thus stay in suspension. If their electrostatic charge can be neutralized, they would become destabilized, attract each other, agglomerate and settle. Chemical coagulants are added to the raw water and for a brief period rapid mixing is carried out. Having produced the micro floc, the objective is then to produce a floc of adequate size that will settle under gravity.

The next process is to subject the micro floc solution to a slow flocculation procedure. Removal of turbidity by coagulation depends on the type of colloids in suspension, the temperature, pH, and chemical composition of the water, the type and dosage of coagulants, and the degree and time of mixing provided for chemical dispersion and floc formation.

4- Apparatus:



- Jar testing apparatus
- Turbidimeter
- Stirrer
- Pipette
- Beakers

5- Reagents:

- Alum (Aluminum Sulfate) $Al_2(SO_4)_3 \cdot 18H_2O$

6- Procedure:

31. Label six jars from 0 to 5 with measuring and fill each with one liter or 0.8 L of well mixed sample.
32. Place the filled jars on the gang stirrer, with the paddles positioned identically in each beaker.
33. Mix the beakers at 40 – 50 rpm.
34. Leave the first beaker as a blank, and add different doses of the alum (20; 40; 60; 80; and 100 mg/L) to jar from 1 to 5 respectively
35. Increase the mixing speed to 100-125 rpm for 60 seconds (rapid mix).
36. Reduce the mixing to 25-50 rpm and continue the slow mix for 15-20 minute, during slow mixing observe the nature, formation and sedimentation characteristics of flocs and record your observation as poor, fair, good and excellent in each beaker..
37. Turn the mixer off and allow settling to occur (typically 30 or 45 min).
38. Using a turbidimeter to measure the turbidity for each jars with the help of pipette.

7- Results and calculations:

Beaker No.	Alum Dose		Floc Formation (bad, fair, good, excellent)	Turbidity (NTU)
	mg/L	mL		
0	0			
1	20			
2	40			
3	60			



4	80			
5	100			

8- Discussion:

9- Conclusions:



10- References:

Experiment No. 9
**Dissolved Oxygen (DO)
and
Biochemical Oxygen Demand (BOD)**

Submitted By:

Student Name:	
ID:	Submission Date:

For Official Use Only:



Sub-title No.	1	2	3	4	5	6	7	8	9	10	Total
CLO Focused:	3.1	4.1	5.1	5.2	-	-	-	-	-	-	-
Max. Points:	2.0	3.0	3.0	2.0	-	-	-	-	-	-	10
Points Obtained:					-	-	-	-	-	-	

17- Objective

The objective of the experiment is to determine the DO and BOD of given different samples like tap water, well water, wastewater and treated water

18- Significance and Use:

- Drinking water should be rich in dissolved oxygen for good taste.
- DO test is used to evaluate the pollution strength of domestic and industrial waste.
- Higher values of DO may cause corrosion of Iron and Steel.
- Aerobic conditions do prevail when sufficient DO is available within water.
- It is necessary to know DO levels to assess quality of raw water and to keep a check on stream pollution.
- DO test is the basis for BOD test which is an important parameter to evaluate organic pollution potential of a waste.
- DO test is necessary for all aerobic biological wastewater treatment processes to control the rate of aeration.
- BOD test is an important parameter to evaluate organic pollution potential of a waste.

3-Relevant Theory:

The term Dissolved Oxygen (DO) is used to describe the amount of oxygen dissolved in a unit volume of water. DO is essential for the maintenance of healthy lakes and rivers. It is a measure of the ability of water to sustain aquatic life. The dissolved oxygen content of water is influenced by the source, raw water temperature, treatment and chemical or biological processes taking place in the distribution system. The presence of oxygen in water is a good sign. Depletion of dissolved oxygen in water supplies can encourage the microbial reduction of nitrate to nitrite and sulfate to



sulfide. It can also cause an increase in the concentration of ferrous iron in solution, with subsequent discoloration at the tap when the water is aerated.

The conc. of DO rises as the river recovers oxygen from the atmosphere and aquatic plants. Algae growth in water may release oxygen during its photosynthesis and DO may even shoot up to 30 mg/L. Oxygen is poorly soluble in water, its solubility is about 14.6 for pure water at 0°C under normal atmospheric pressure and it drops to 7 mg/l at 35°C. Higher temperature, biological impurities, Ammonia, Nitrates, ferrous iron, chemicals such as hydrogen sulphide and organic matter reduce DO values. Aerobic bacteria thrive when oxygen is available in plenty. End products of aerobiosis are stable and are not foul smelling. In a healthy body of water such as a lake, river, or stream, the dissolved oxygen is about 8 parts per million. The minimum DO level of 4 to 5 mg/L or ppm is desirable for survival of aquatic life. Hence, analysis of dissolved oxygen is an important step in water pollution control and wastewater treatment process control.

The term Biochemical Oxygen Demand (BOD) is used to describe the amount of oxygen consumed by bacteria during degradation of wastes under aerobic condition. The wastes serve as the food for certain aerobic bacteria. Because these bacteria remove oxygen from water, their population increase causes a decline in the amount of DO. So, the increases the BOD results the decreasing of DO in the waters downstream.

4- Apparatus:

- DO meter
- Beakers
- Stirring bar
- Magnetic stirrer

5- Reagents:

- Sodium sulphate (concentration 20 ppm)

6- Procedure:

6.1-Calibration of DO meter:

39. Rinse the DO meter electrode thoroughly with distilled water, dry with tissue paper and immerse in sodium sulphate solution with a concentration 20 ppm.
40. If the meter reading is zero, the meter calibration is OK. If not calibrate the pH meter according to the instrument manual.



41. Remove electrode from sodium sulphate solution and rinse thoroughly with distilled water, dry with tissue. Now, the instrument is ready for measurement

6.2- DO measurement

9. Pour about 100 mL mixed sample in 250 mL beaker. Stir the sample using stirrer and magnetic bar.
10. Dip cleaned and dried DO electrode into the beaker and wait for few minutes until the reading stabilize (end point). Record the DO reading.
11. By choosing the measurement display mode, you can have the value by percent (%) or in ppm (mg/L).

6.2- BOD measurement (for wastewater)

1. Take 1.0 L of wastewater sample (Diluted or not) in standard bottle (stopper black bottle).
2. Stir the sample using stirrer and magnetic bar.
3. Using heat water bath in order to keep sample temperature 20°C.
4. Dip cleaned and dried DO electrode into the bottle.
5. By choosing the measurement display mode 'BOD' you can record DO at several times during a day and save it in the DO meter memory or in a PC.
6. The duration of the test is 5 days.

7- Observations and Results:

Sample No.	Source	Temperature (°C)	DO meter reading
1			
2			
3			

8- Discussion:



9- Conclusions:



10- References:

Experiment No. 10

Total Hardness

Submitted By:

Student Name:	
ID:	Submission Date:



For Official Use Only:

Sub-title No.	1	2	3	4	5	6	7	8	9	10	Total
CLO Focused:	3.1	4.1	5.1	5.2	-	-	-	-	-	-	-
Max. Points:	2.0	3.0	3.0	2.0	-	-	-	-	-	-	10
Points Obtained:					-	-	-	-	-	-	

19- Objective

The objective of the experiment is to determine the total hardness of given water samples.

20- Significance and Use:

- Formed metal rust and caused corruptions.
- In washing issues, the use of hard water causes high consumption of insoluble mineral soap that is deposited on the surfaces to be washed.
- Hard water forms “scale”; it is a slight accumulative layer due to precipitation of the calcium and magnesium salts. Inside water pipes eventually reduces water carrying capacity. In boilers and heaters, it is reduce thermal conductivity and then increases water heating costs.
- Hard water is useful to growth of children due to the presence of calcium.

3-Relevant Theory:

Hardness was originally defined as the capacity of water to precipitate soap. It is defined as the concentration of all multivalent metallic cations in water. The two main cations that cause water hardness are calcium (Ca^{2+}) and magnesium (Mg^{2+}). **Hard water** contains bicarbonate, chlorides and sulphates of calcium and magnesium. When treated hard water with soap, it gets precipitated in the form of insoluble salts of calcium and magnesium. Hardness of water is a measure of the total concentration of the calcium and magnesium ions. There are two types of hardness;



Temporary (carbonate) hardness, and *Permanent (non-carbonate) hardness*. **Temporary Hardness** is due to the presence of bicarbonates of calcium and magnesium. It can be easily removed by boiling or by lime (CaO). **Permanent Hardness** is due to the presence of chlorides and sulphates of calcium and magnesium. This type of hardness cannot be removed by boiling; it requires soda ash (Na₂CO₃) in addition to lime. Total hardness is the sum of temporary and permanent hardness, normally expressed as calcium carbonate (CaCO₃). Removing hardness from water is called “softening”

4- Apparatus:

- Graduated cylinders
- Conical flask
- Pipette bulb
- Burette with Burette stand and porcelain tile
- Beaker
- Pipettes with elongated tips

5- Reagents:

- Disodium salt of EDTA
- Erichrome Black T indicator

6- Procedure:

42. Pipette 50 mL of water sample and transfer it to a clean 250 mL conical flask.
43. Add few drops (2 mL) of EBT indicator to the conical flask and the sample turns to wine red in color.
44. Before starting the titration rinse the burette with few mL of EDTA. Fill the burette with 0.02M EDTA solution and adjust to zero then fix it in burette stand.
45. Titrate the sample against the EDTA solution in the burette till all calcium and magnesium ions present in the sample reacts with the EDTA. The appearance of blue color indicates that all Ca & Mg ions are complexed with EDTA i.e., the end point of the titration.
46. Note down the burette reading.



7- Results and calculations:

Sample No.	Source	Sample Volume (mL)	Burette reading		Volume of EDTA (mL)
			Initial	Final	
1					
2					
3					
4					

. Total hardness = Volume of EDTA *N*50*1000/ sample volume (mg/L as CaCO₃)

8- Discussion:

9- Conclusions:



10- References:

