Bangladesh University of Engineering and Technology

Course No : CE - 332

Course Title : Environmental Engineering Laboratory

Name : Mehedi Hasan

Student Id : 1304166

INDEX

ID: 130416G

Exp No.	Name of the experiment	Date of perform	Date of submission	Remarks
1	Determination of pH of water	03-09-16	24-09-16	
2	Determination of color of water	03-09-16	24-09-16	
3	Determination of turbidity of water	03-09-16	24-09-16	
4	Determination of total solids, dissolved solids and Suspended solids in water	03-09-16	24-09-16	
5	Determination of carbon dioxide in water	24-09-16	01-10-16	
6	Determination of alkalinity of water	24-09-16	01-10-16	
7	Determination of hardness of water	24-09-16	01-10-16	
8	Determination of chloride in water	01-10-16	15-10-16	
9	Determination of iron in water	01-10-16	15-10-16	
10	Determination of biochemical oxygen demand	05-11-16	19-11-16	
11	Determination of chemical oxygen demand	05-11-16	19-11-16	
12	Chemical coagulation of water: alum coagulation	12-11-16	19-11-16	
13	Determination of residual chlorine and chlorine demand: break point chlorination	19-11-16	03-12-16	
14	Microbiological quality of water: determination of total coliform and fecal coliform	03-12-16	12-12-16	
15	Determination of arsenic in water	15-10-16	24-10-16	

Bangladesh University of Engineering

and Technology

Course No: CE-322 Group no: 01

Course Title: Environment Engineering Laboratory

Exp. No: 13

Name of the Experiment: Microbiological quality of water: Determination of total coliform and fecal coliform.

Name: Mehedi Hasan

Date of performance: 03-12-16

Student Id: 1304166

Date of submission: 12-12-16

Section: C2

CE 332 : ENVIRONMENTAL ENGINEERING SESSIONAL

Lab Experiment Report

Experiment No: - 13

Microbiological Quality of Water: Determination of Total Coliform and Fecal Coliform

---

Objective of the Tests:

Determination of Total Coliform and Fecal coliform.

Water Sampling Information (source, location, date and time of collection etc.):

Mamun Knitwear Ltd.

Apparatus & Reagents used:

Apparatus:

i) Erlenmeyer flask
ii) Vacuum pump
iii) Petri Dish
iv) Membrane filter paper
v) Incubator
vi) Measuring cylinder, beaker

Reagents:

i) Distilled water
ii) Appropiate culture medium (broth).
iii) Silver nitrate solution (0.0141N)

Data Table:

Determination of Total Coliform and Fecal Coliform (Menbrane Filter Method)

Sl No.	Water Quality Parameter	Unit	Concentration Present	Bangladesh Standard for Drinking Water (ECR'97)	WHO Guideline Values 2011 (or 2004)
01	Total Coliform	nos./100ml	6	0	0
02	Fecal Coliform	nos./100ml	2	0	0

created

b lactose

Sample Calculation:

$$\text{Total coliform (nos./100mL)} = \frac{3\times100}{50}$$
$$= 6$$

Total coliform = Fecal coliform + non-fecal coliform

omL)

$$\text{Fecal coliform (nos./100mL)} = \frac{1\times100}{50}$$
$$= 2$$

and

ld be

h respect

Discussion on obtained results:

As the coliform bacteria fulfil most of the characteristics of indicator organisms, so in our experiment coliform bacteria was indicator organism.

ii) There are two methods of bacteriological analysis of water. We have followed Membrane Filter (MF) method. Because it gives direct result and takes less time.

iii) Although using coliform as indicators sometimes may cause some drawbacks, it is the most effective indicator until today.

iv) Membran filter method is not suitable for turbid water, as it can cause clogging of the filter.

v) In determination of coliform bacteria, metallic surface sheen colonies are counted only because this is created for the presence of aldehyde which is a bi-product of lactose fermentation by coliform bacteria

vi) As in our experiment total coliform (nos/100mL) is 6 and fecal coliform (nos/100mL) = 2 and according ECR'97 and WHO guideline there should be zero, so our supplied water is not drinkable with respect to total coliform and fecal coliform value.

Assignment Question & Answer:

Q-1: What is the significance of conducting total coliform test particularly for treated/ chlorinated water supplies?

Conducting total coliform test particularly for treated/chlorinated water supplies is very important because in this case the absence of total coliform would normally indicate that the water has been sufficiently treated/ disinfected to destroy various pathogens.

Q-2: What are differences between indicator organisms and pathogens?

i) Indicator organisms do not create any disease but pathogens create diseases.

ii) Indicator organisms are greater in number than pathogens.

Q-3: In bacterial count for total coliform only those colonies having greenish gold or metallic surface sheen should be considered/ counted as coliform bacteria– why?

The greenish gold or metallic surface sheen is created from the presence of aldehyde (indole) which is a by-product of ~~lactose~~ tryptophan fermentation by coliform bacteria. As other bacteria do not have the property so this particularly property is considered as coliform bacteria.

Q-4: A water sample (diluted in the ratio of 1:25) is tested for determination of TC & FC. After incubation it is observed that the colonies (with golden sheen) in the petri dish for TC are overlapped where as number of colonies in the petri dish for FC (blue colonies) are 7. Calculate TC & FC and also comment on the results. (Assume sample size = 50 mL).

TC = TNTC (Too number to count)

as the colonies (with golden sheen) in the petri dish for TC are overlapped.

$$FC_{(nos./100\,ml)} = \frac{\text{no. of coliform colonies counted} \times 100}{\text{mL of sample filtered}} \times DF$$

$$= \frac{7 * 100}{50} \times 26$$

$$= 364$$

Bangladesh University Engineering and Technology

Course No : CE-332

Course Title : Environmental Engineering Sessional-1

Topic : Determination of Residual Chlorine and Chlorine Demand.

Date : 03-12-16

Submitted by :

Mehedi Hasan

Student ID: 201304166

Section: C-2

Department of Civil Engineering

CE 332 : ENVIRONMENTAL ENGINEERING SESSIONAL

Lab Experiment Report

Experiment No: - 12

Name of the Experiment: Determination of Residual Chlorine and Chlorine Demand: Break Point Chlorination

---

Objective of the Tests:

Determination of Residual Chlorine and Chlorine Demand

Water Sampling Information (source, location, date and time of collection etc.):

Provided by lab.

Apparatus & Reagents used:

Apparatus:

i) Erlenmeyer flask

ii) Measuring cylinder

iii) Dropper

iv) Stirrer

Reagents:

i) Starch Indicator

ii) Standard 0.025 N sodium thiosulphate

iii) Potassium Iodine crystal

iv) Concentrated Acetic Acid

v) Chlorine water

Lab Data Sheet:

Experiment No- 12: Name of the Experiment: Determination of Residual Chlorine and Chlorine Demand: Break Point Chlorination

Initial pH of sample: 3

Cl_2 concentration in BP stock solution (mg/L): 1000

Sample size (mL): 200

Sl No.	Cl_2 dose added (mg/L)	Amount of BP stock solution added (mL)	Titration with $Na_2S_2O_3$ (mL)			Residual Cl_2 (mg/L)	Breakpoint Cl_2 concertation (mg/L)
			Initial reading	Initial reading	$Na_2S_2O_3$ added		
1	0	0			0	0	
2	5	1	0	0.6	0.6	2.6	
3	10	2	0.6	2.1	1.5	6.8	
4	20	4	2.1	5.3	3.2	14.2	
5	30	6	5.3	11.0	5.7	25.3	40
6	35	7	11.0	14.5	3.5	15.5	
7	40	8	14.5	14.8	0.3	1.33	
8	45	9	14.8	15.8	1.0	4.44	
9	50	10	15.8	18.1	2.3	10.2	
10	60	12	18.1	22.6	4.5	19.9	
11	70	14	22.6	30.1	7.5	33	
12	80	16	30.1	40.3	10.2	44.88	

Sample Calculation:

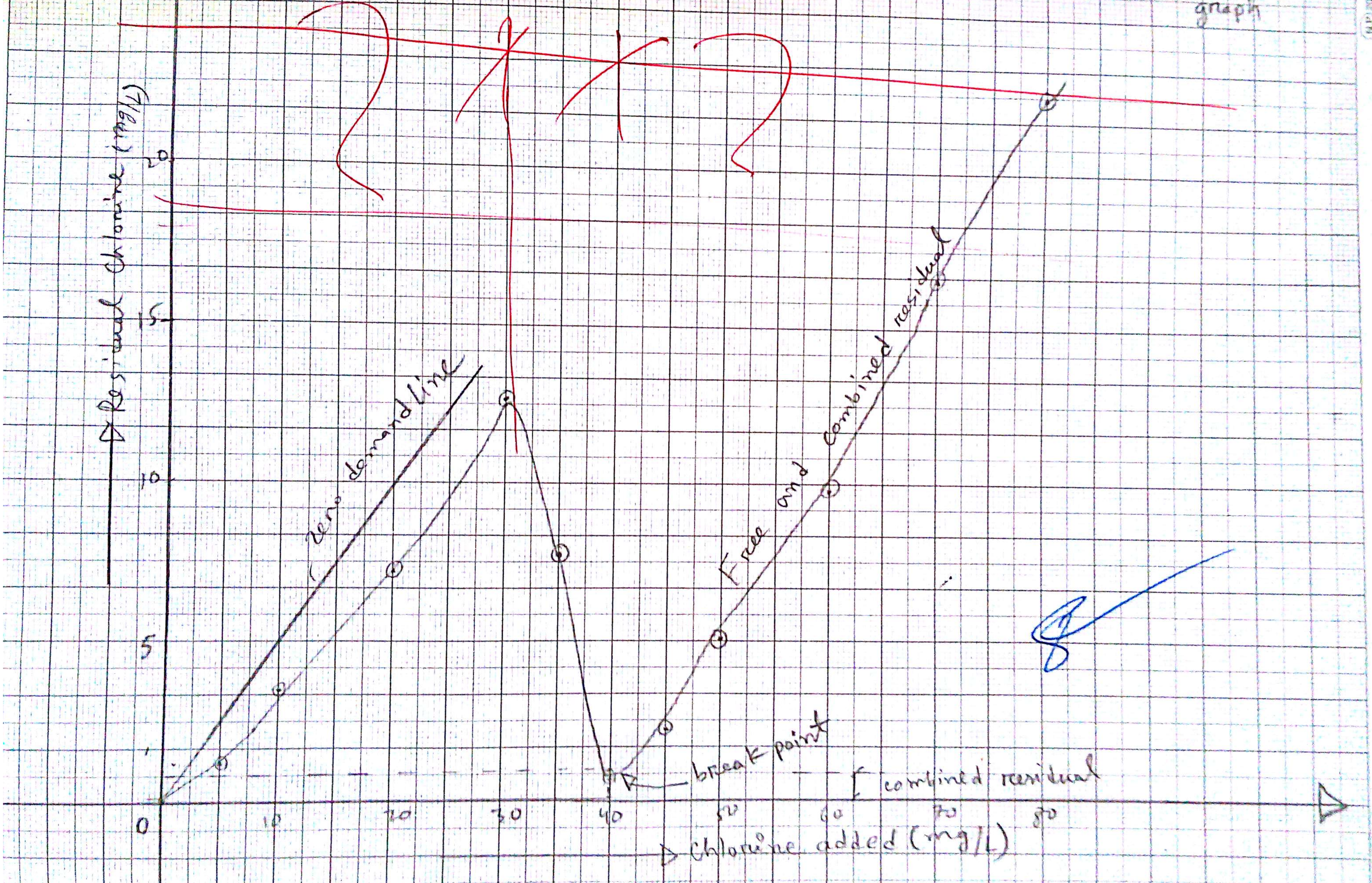
$$MF = \frac{0.025 \times 35.5 \times 1000}{200} = 4.4$$

$$\text{Residual } Cl_2 = (0.6) \times 4.4$$

$$= 2.6 \text{ mg/L}$$

Scanned by CamScanner

Residual chlorine (mg/L) vs. chlorine added (mg/L) graph



Discussion of obtained result(s) and graph:

As our Residual chlorine vs. Chlorine added graph has started from the origin, so we can say that, the sample water had no reducing agents, organic substances etc

Upto 30mg/L $Cl_2 : NH_3-N = 1:1$ was maintained, so residual chlorine increased as combined chlorine. When $Cl_2 : NH_3-N = 1.5:1$ was started NCl_3 was producing and residual chlorine decreased.

After Chlorine added (mg/L) = 40, free and combined residual started to increase. So Break point Cl_2 concentration is 40 (mg/L) for our experiment

To know this break point is very important, because we have to know which concentration of Cl_2 will not be used as disinfectant.

Assignment Question & Answer:

Q-1: Why it is necessary to determine the concentration of available active chlorine at each stage in the treatment process of drinking water and in the water mains?

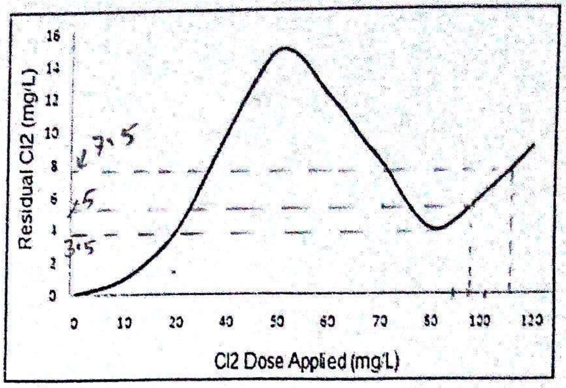
We know all amount of Cl_2 which are provided is not used as disinfectant. Certain portion of Cl_2 is used to react with organic substances, reducing agents. After reacting there available free and combined Cl_2 reacts as disinfectants. So at each stage available active chlorine must be enough for disinfectant. To know it it is necessary to determine the available active chlorine at each stages.

Q-2: While chlorinating a water sample containing ammonia, with gradual increase in chlorine dose why the concentration residual chlorine increases up to a certain limit and then decreases?

Upto $Cl_2 : NH_3-N = 1:1$ was maintained, NH_2Cl, $NHCl_2$ are produced. NH_2Cl, $NHCl_2$ are disinfectants. But when $Cl_2 : NH_3-N = 1.5:1$ then NCl_3 started to produce. But NCl_3 has no disinfectants property. As a result chlorine increases up to a certain limit and then decreases.

Q-3: In a lab test of break point chlorination the following curve is obtained using 10 water samples (sample size = 250 mL). Determine:

i. Chlorine demand for a Cl_2 dose of 95 mg/L.
ii. Free residual chlorine available at a Cl_2 dose of 110 mg/L.
iii. How much chlorine is exhausted during reaction with reducing agents present in water?
iv. If chlorine concentration in the stock solution is 1.5 g/L, what is the amount of stock solution (in mL) is need to be added to the sample to maintain a chlorine dose of 104 mg/L?



(i) chlorine demand = (95 − 5) mg/L = 90 mg/L (Ans:)

ken-

(ii) Residual Cl_2 for Cl_2 dose of 110 mg/L = 7.5 mg/L
combined residual Cl_2 = 3.5 mg/L

∴ free residual chlorine = (7.5 − 3.5) mg/L
= 4 mg/L (Ans)

11-16

(iii) In this graph, the residual Cl_2 starts forming from 0 mg/L Cl_2 dose.

.16

so, the amount of chlorine exhausted during reaction with reducing agent = 0 mg/L (Ans:)

(iv) Cl_2 concentration in stock soln = 1.5 g/L = 1500 mg/L
= 1.5 mg/mL

∴ Sample is 1 L then we have to add = $\frac{104}{1.5}$ = 69.33 mL stock soln

As sample is 250 mL

we have to add stock soln = $\frac{69.33 \times 250}{1000}$ = 17.33 mL

Or,

$M_1V_1 = M_2V_2$

$\Rightarrow 1500 \text{ (mg/L)} * V_1 = 104 \text{ (mg/L)} * 250 \text{ (mL)}$ ∴ $V_1 = 17.33$ mL

Bangladesh University of Engineering and Technology

Course No: CE-332 Group no: 01

Course Title: Environment Engineering Laboratory.

Exp. No: 11

Name of the Experiment: Chemical Coagulation of Water-Alum Coagulation.

Name: Mehedi Hasan

Student Id: 1304166

Section: C_2

Date of performance: 12-11-16

Date of submission: 19-11-16

CE 332: ENVIRONMENTAL ENGINEERING SESSIONAL

Lab Experiment Report

Experiment No: - 11

Chemical Coagulation of Water - Alum Coagulation

Objectives of the Tests:

To determine Optimum Alum Dose (mg/L) by Alum Coagulation

Water Sampling Information (source, location, date and time of collection etc.):

Source: Surface water

location: Jagannath hall pond

date: 03-09-16

time: 1:53 Pm

Rain status: Yes

77

Apparatus & Reagents used:

Apparatus:

i) Jar test apparatus

ii) pH meter

iii) Turbidity meter

iv) Glass beakers (1000mL - 6 nos)

Reagents:

- Standard Alum solution

Lab Data Sheet

Experiment No. 11: Chemical Coagulation of Water - Alum Coagulation

Initial pH of sample: 8.25

Initial Turbidity (NTU): 90.3

Alum stock Solution concentration (mg/L): 1000

Sample Size (mL): 500

Plot it

Beaker No.	Alum dose added (mg/L)	Amount of Alum Stock Solution added (mL)	pH of treated sample	Turbidity of treated sample (NTU)	Optimum Alum Dose (mg/L)
01	10	5.0	7.99	3.85	~~195~~
02	50	25	7.40	0.58	
03	75.0	37.5	7.19	0.40	
04	125	62.5	6.84	0.5	
05	175	87.5	6.53	0.54	
06	225	112.5	6.27	0.72	

Sample Calculation:

Amount of alum stock solution (mL) = 5
and stock soln concentration = 1 mg/mL

∴ For 500 mL sample alum dose = 5 mg.
∴ 1000 mL " " " = ($\frac{5}{500}$ × 1000) mg
= 10 mg

∴ Our sample ~~stock~~ dose = 10 mg/L

12/11

Discussion on obtained results and graphs:

From theoretical knowledge, we know that if alum is added into the sample, the pH decreases. From our experimental result, we also see that our sample's pH decreased with adding alum

2) From our result we see that, Turbidity of our samples decreased with increasing alum dose amount. But If an excess amount of alum does is added, then charge reversal that means re-suspension of colloidal

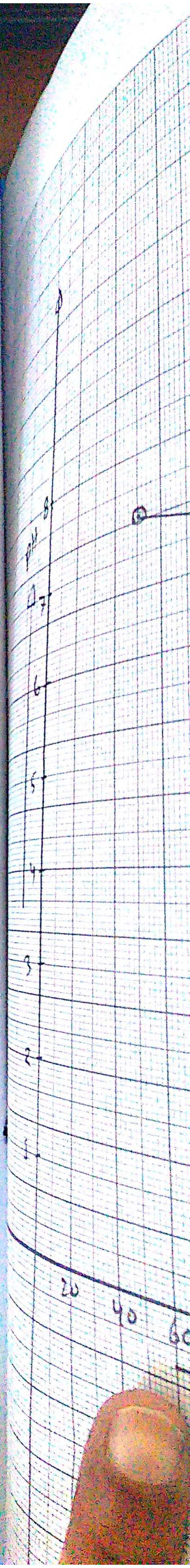
particles will occur.

3) For different purposes, different turbidity value is required. So optimum alum dose(mg/L) depends on its requirement of sample water. turbidity must be within in which range.

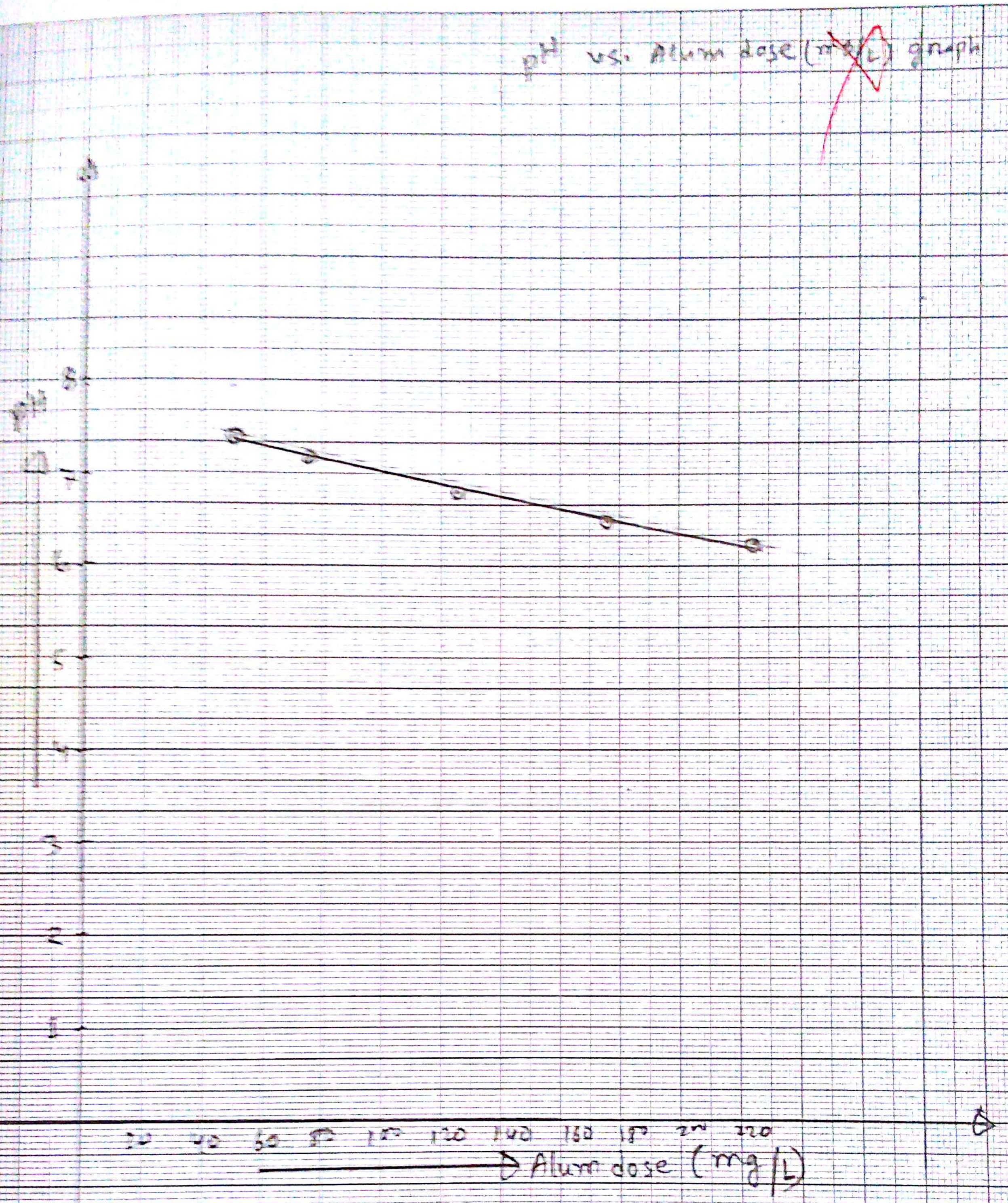
From graph:

4) From our Turbidity vs. alum dose (mg/L) graph we see that Turbidity decreases with increasing alum dose and after adding certain amount of alum turbidity again increases. Our required alum dose (mg/L) for 0.6 (NTU) Turbidity is 195 mg/L

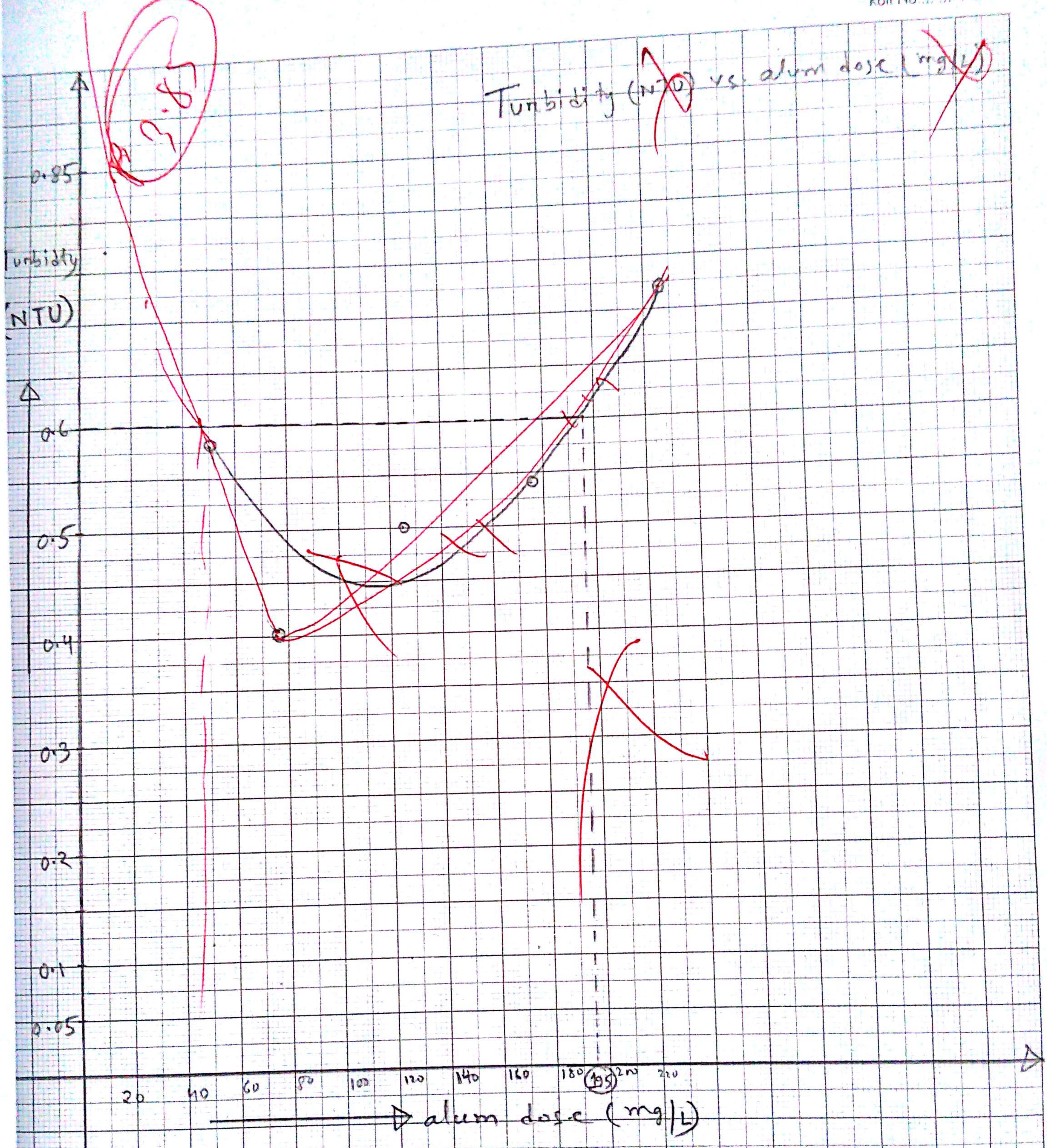
5) From, pH vs. Alum dose (mg/L) graph. it also represents that pH will decrease with increasing Alum dose (mg/L). Because alum by dissolving forms $Al(OH)_{3}(s)$, $Al(OH)^{2+}$, $Al(OH)_2^{+}$, $Al(OH)_4^{-}$. These are alkaline. So pH decreases.



Roll No. 1304166



Roll No 1304166



MICRO

N.P 20 cm x 25 cm

Assignment Question & Answer:

Q-1: What is jar test? Why it is done? What is the significance of optimum coagulant dose?

Jar test is a test by which optimum coagulant dose is determined. It is done to accelerate the mixing and flocculate the particles. If higher coagulation doses are applied then charge reversal occurs and it will result in re-suspension of the colloids in the water.

Q-2: Why addition of alum may result in a drop in pH value. Discuss the effect of alum dose on pH from your experimental results.

When alum is dissolved in water, aluminum forms $Al(OH)_3(s)$, $Al(OH)^{2+}$, $Al(OH)_2^+$, $Al(OH)_4^-$. So pH value drops.

From our experimental results, it also shows the value of pH decreases with increasing alum dose.

ation

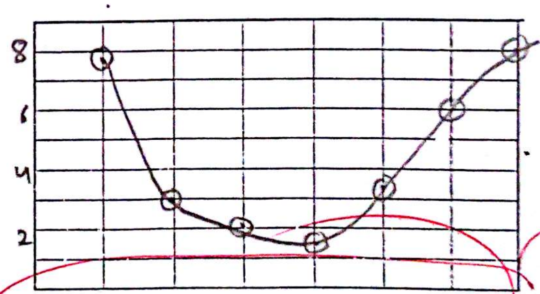
emand

Q-3: Laboratory alum coagulation was done to raw water sample from a newly installed water treatment plant of 10,000 liter per day capacity in Khulna town. Laboratory result is shown below.
Laboratory sample size = 400 mL; Stock solution alum concentration in the lab= 10g /L. If commercially available stock solution has alum concentration of 15 g/L, determine the amount of stock solution needed per day (in Liter) in that treatment plant to maintain the optimum alum dose.

-11-16

-16

stock sol. added (mL)	Final Turbidity (NTU)
0.4	7.5
0.8	3.0
1.2	2.0
1.6	1.5
2	4.5
2.4	6.5
3.2	8.0



Stock solⁿ = 10 g/L
= 10 mg/mL

Now, 0.4 mL was added in 1st data

So, 1 mL solⁿ = 10 mg Alum

∴ 0.4 mL solⁿ = (0.4×10)
= 4 mg alum

sample size = 400 mL = 0.4 L

∴ 10 mg Alum

Here
Alum dose = 10 mg/L

If required turbidity is 2 NTU then optimum alum dose = 30 mg/L

for 10.000 L → 300 gm Alum

commercially 15 g — 1 L

∴ 300 — 300/15 = 20 L

Bangladesh University of Engineering and Technology

Course No: CE-332

Group no: 01

Course Title: Environmental Engineering Laboratory

Exp. No: 10

Name of the Experiment: Estimation of Organic Pollution Load through determination of Biological Oxygen Demand (BOD) & Chemical Oxygen Demand (COD)

Name: Mehedi Hasan

Date of performance: 05-11-16

Student Id: 1304166

Date of submission: 19-11-16

Section: C2

CE 332 : ENVIRONMENTAL ENGINEERING SESSIONAL

Lab Experiment Report

Experiment No: - 10

Name of the Experiment: Estimation of Organic Pollution Load through determination of Biological Oxygen Demand (BOD) & Chemical Oxygen Demand (COD)

Objectives of the Tests:

Estimation of Organic Pollution Load through determination of Biological Oxygen Demand (BOD) & Chemical Oxygen Demand (COD)

Water Sampling Information (source, location, date and time of collection etc.):

Source: Surface water
location: Jagannath hall
date: 03-09-16
Time: 1:53 Pm
Rain status: Yes

Apparatus & Reagents used:

BOD test:

Reagents:

i) Manganous sulfate solution
ii) Akaline KI solution
iii) 0.025 N sodium thiosulfate
iv) Starch solution
v) Concentrated sulfuric acid

Apparatus:

i) BOD bottle
ii) Beaker
iii) Measuring cylinder

COD test:

Reagents:

i) Diluted sulphuric acid solution
ii) Standard potassium permangante solution
iii) Standard Ammonium Oxalate solution

Apparatus:

i) Beaker (250 mL)
ii) Dropper
iii) Stirrer

Lab Data Sheet

Experiment No. 12: Name of the Experiment: Estimation of Organic Pollution Load through determination of Biological Oxygen Demand (BOD) & Chemical Oxygen Demand (COD)

Sl No.	Water Quality Parameter		Unit	Concentration Present	ECR 1997 Standards		
					Discharge in Inland Water	Discharge into Public Sewer	Discharge on Irrigated Land
	BOD (non-aerated sample)		mg/L	17.5			
	BOD (aerated sample)		mg/L	14.4			
	BOD loading rate (discharged into river)						
	COD (non-aerated sample)	$KMnO_4$	mg/L	56			
		$K_2Cr_2O_7$					
	COD (aerated sample)	$KMnO_4$	mg/L	25			
		$K_2Cr_2O_7$					

Sample Calculation:

COD calculation

COD (mg/L) = mL of $KMnO_4$ added × MF

$MF = \frac{0.0125 \times 8 \times 1000}{100} = 1$

for aerated water, COD = 10 × (2.5 − 0) = 25 mg/L

for non-aerated water, COD = 20 × (2.8 − 0) = 56 mg/L

BOD

For non aerated sample, DF = 12.5

" aerated sample, DF = 8

$MF = \frac{0.025 \times 1000}{100} = 2$

For blank sample, BOD = 2 × (3.9 − 0)

= 7.8 mg/L

For non-aerated sample, BOD = 8 mg/L

" aerated sample, BOD = 2 (11.9 − 7.9)

= 8 mg/L

∴ aerated BOD_5 = [(8 − 5.8) − (9.8 − 7.9)] × 8 = 14.4 mg/L

Scanned by CamScanner

non aerated BOD$_5$ = [(8 − 6.2) − 0.4] × 12.5

= 17.5 mg/L

[final B.O.D
= 2 (39.5 − 36.1)
= 7.4 mg/L)

final B.O.D
= 2(43.1 − 40)
= 6.2 mg/L

and
final B.O.D
= 2 × (46 − 43.1)
= 5.8 mg/L

CE 332: Environmental Engine

Discussion on obtained resul

1) We know
BOD consider
consider tot
will be high
the value o
than BOD (

2) According
standard for
non-aerated
experiment)
with respect

3) If aeration
decrease. From m
our BOD value
the BOD value

Discussion on obtained results:

1) We know all organic substances are not degradable. BOD consider only degradable substances. But COD consider total organic substances. So COD value always will be higher than COD. In our experiment the value of COD (56 mg/L) is also greater than BOD (17.5) mg/L.

2) According to ECR (1997) drinking water standard for BOD_5 value is 0.2 mg/L for non-aerated sample. BOD_5 is 17.5 mg/L (from experiment). So our sample is not drinkable with respect to BOD_5 value.

Wrong Stds

3) If aeration is done, then value of BOD will decrease. From our experiment we also see that our BOD value of aerated sample is (14.7 mg/L) less than the BOD value (17.5 mg/L) of non-aerated sample.

5) We know for Domestic water,

$$BOD_U = 0.9 * COD$$

and,

$$BOD_5 = \frac{2}{3} BOD_U$$

6

water,

CE 332: Environmental Engineering Sessional

Assignment Question & Answer:

Q-1: 2. A test bottle containing just seeded dilution water has its DO level drop by 0.8 mg/L in a 5-day test. A 300 mL BOD bottle filled with 30 mL of wastewater and the rest with seeded dilution water experiences a drop of 6.1 mg/L in the same period (5-day). Calculate the BOD5 of the wastewater

$BOD_d = 0.8$ mg/L

$BOD_m = 6.1$ mg/L

$BOD_m V_m = BOD_w V_w + BOD_d V_d$

$\Rightarrow BOD_w = \frac{6.1 \times 300 - 0.8 \times 270}{30}$

$= 53.8$ mg/L

$V_w = 30$ mL

$V_d = 270$ mL

$V_m = 300$ mL

$D_F = \frac{300}{30} = 10$

Q-2: Wastewater from two different industrial sources as discharged into a river as described in the following table.

Source	Effluent Flow Rate (ft³/sec)	Daily Discharge Period	BOD₅ (mg/L)
Industry A	30	8.00 AM - 5.00 PM	215
Industry B	45	2.00 PM - 8.00 PM	130

Estimate the total daily BOD5 load discharge into the river.

10-16

For A industry, total discharge $= 30 \times 11 \times 60 \times 60$

10-16

$= 1188000$ ft³

$= 33640414$ L

" B " " " $= 45 \times 6 \times 60 \times 60$

$= 972000$ ft³

$= 27546284$ L

Total waste load discharge

For A industry $= 215 \times 33640414$

$= 7.23 \times 10^3$ mg

" B " $= 3.58 \times 10^7$ mg

∴ For A and B industry $= 10.87 \times 10^3$ kg

Q-3: In a BOD test on a diluted wastewater sample (1:25 dilution, but not seeded), the initial DO is 8.2 mg/L and final DO after 5 days is 3.9 mg/L. If the reaction rate constant is 0.21/day, calculate:
(a) 5-day BOD of the wastewater, (b) Ultimate carbonaceous BOD of the wastewater, (c) Remaining Oxygen demand after 5-days.

(a) $BOD_5 = (DOI - DOF) \times D.F$

$= (8.2 - 3.9) \times 25$

$= 107.5$ mg/L

(b) $BOD_t = L_0 (1 - e^{-kt})$

$\Rightarrow 107.5 = L_0 (1 - e^{-0.2 \times 5})$

$\Rightarrow L_0 = 165.37$ mg/L

(c) $L_0 = BOD_5 + L_5$

$L_5 = L_0 - BOD_5$

$= 164.59 - 107.50$

$= 57.09$ mg/L

10-16

Q-4: What are the principal advantages and disadvantages of the COD test over the BOD test?

10-16

The principal advantages of the COD test is the short time required for evaluation.
The principal disadvantages of the COD test is its inability to differentiate between biodegradable and non-biodegradable organic matter.

Q-5: Explain why COD (dichromate) values are greater than BOD values.

All organic substances are not degradable by microorganisms (biologically inert substances). But BOD values are determined by considering degradable substances. COD values are determined by considering all organic substances. So COD is greater than BOD.

Bangladesh University of Engineering and Technology

Course No: CE-332 Group no: 01

Course Title: Environmental Engineering Laboratory

Exp. No: 15

Name of the Experiment: Determination of arsenic in water

Name: Mehedi Hasan

Date of performance: 15-10-16

Student Id: 1304166

Date of submission: 24-10-16

Section: C_2

Objectives:

Determination of this experiment is to determine arsenic in water.
In addition, Total organic carbon and Mn is determined.

Scope of the test:

Presence of arsenic more than the allowable value in amount is now a major concern in Bangladesh. Arsenic pollution of ground water is particularly challenging in Bangladesh since tubewell water extracted from shallow aquifers is the major source of drinking water of most of its population.

Weathering of arsenic-rich base metal sulfides in the upstream of the Ganges basin appears to be a major source. In ground water arsenic primarily exists as inorganic trivalent and pentavalent arsenic in which trivalent arsenic is 10 times more toxic than As (V)

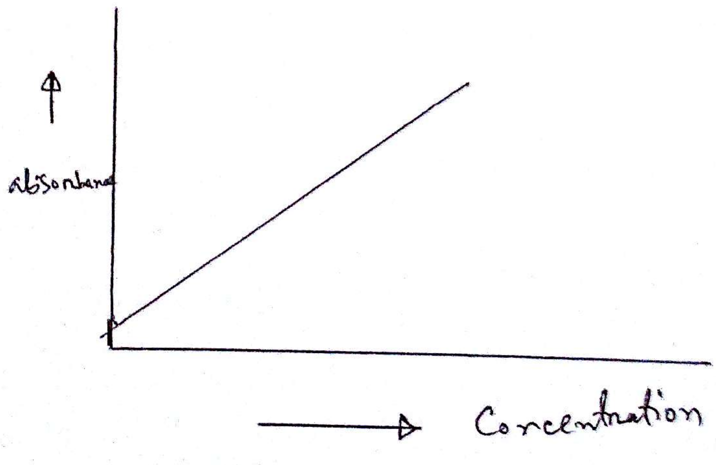
Apparatus:

- Atomic absorption spectophotometer
- Glass tube
- Micro pipette

Re-agents: Nickel Nitrate (as Matrix Modifier)

Matrix modifier is used for avoiding the non-interested elements to be atomised.

Calibration Curve:



brief description:

We use graphite furnace.

193.7 nm (wavelength) light is used.

2500°C temperature is created

The sample then will be atomised and create atomic cloud. Then It will absorb the light. It is called absorbance.

For determining the concentration of the arrenic in the sample, a calibration curve of absorbance vs. known concentration is created.

Results:

Arrenic, Absorbance = 0.1982

Arrenic, Concentration = 19.7232 ppb

= 19.7232 μg/L

TOC in the sample = 15.917 ppm

Concentration of Mn. = 2.2142 ppm

Discussions

i) The actual concentration of As of our sample is 19.7232 µg/L. According to ECR-1997, the guide-line value for Arsenic of drinking water is 0.05 mg/L or 50 µg/L.

ii) As our sample contain less arsenic than the allowable limit so our sample is drinkable with respect to arsenic value

iii) Our arsenic value of the sample is determined by Atomic Absorption Spectrophotometer (AAS) method. It is Sophisticated and expensive. It can not be performed in the field. It has to be performed in the laboratory.

iv) As our sample water has 2.2142 mg/L > 0.1, so it is not drinkable with respect to manganese concentration.

v) Our sample's total organic carbon concentration is 19.7232 µg/L

Discussions on different determined test results.

—— o ——

Group No.	Water source	SW/GW	pH	True color	Apparent color	Turbidity (NTU)	Total dissolved solid (mg/L)	Total suspend solid (mg/L)	Total solid (mg/L)	Free CO_2 (mg/L)	Alkalinity (mg/L) as $CaCO_3$	Hardness (mg/L) as $CaCO_3$	Chloride (mg/L)	Iron
1	Jagannath hall Pond	SW	7.60	27	107	5.68	258	02	260	9	139	110	55	
2	Dhanmondi Lake	SW	7.20	23	40	3.04	184	09	193	12	96	80	36	
3	Tap Water Mohammadpur	G.W	6.80	6	7	0.54	217	06	223	21	181	104	18	
4	Suhrawardy hall	GW	6.60	3	8	0.96	109	5	414	42	226	226	80	
5	Nazrul Hall	GW	6.71	4	17	1.27	395	11	406	42	265	236	76	

Discussion:

We have determined different water quality parameters for different sample of water from different sources. From the test results and comparing these results we have can gain some knowledge about the nature of water of different sources

Comment on pH:

We know ground water is often found to be slightly acidic due to the presence of excess carbon dioxide. So for ground water pH should be with the range 0 to 7. In our experiments, groups 3, 4, 5 hade ground water sample. Their found pH value were 6.80, 6.60 and 6.71 which represents slightly acidic nature. Group 1 and 2 had surface water. So their result of pH value is not under 7.00.

Comment on Color:

From our experimental results we see that for group 1 and 2 i.e for ~~ground~~ surface water the value of colour both true and apparent is higher than the colour of the water of ground water sources.

Comment on total dissolved solid:

We know ground water usually has higher dissolved solids. Our experimental results also approve it. Because TDS value for group 3,5 i.e. su for ground water is high. Although group 1 had surface water sample the TDS value for the sample of group 1 was also high in value and It represents the nature of the ground water, the other results show the theoretical knowledge is right.

Comment on total suspended solid:

As in our experiment group 1 had surface water but higher TDS content so it had lower TSS. Our experimental result also show it.

Comment on total solid:

From our experimental results, we see that total solid content is high for ground water sources.

Comment on Free CO_2:

We know ground water has a high content of free CO_2. In our experiment water from ground sources have the value of free CO_2 as (21, 42, 42) mg/L which is higher than the value of CO_2 content (9, 12) mg/L for surface water.

Comment on Alkalinity and Hardness:

From typical alkalinity value for different water sources we know that for ground water alkalinity ~~sh~~ lie within 50 – 100 mg/L as $CaCO_3$ and for surface water 20 – 200 mg/L.

Our group 1 and 2 had surface water. Their alkalinity value also represent this.

And for group 3,4,5 alkalinity has a value greater than 200 but less than 1000.

Because there were ground water sample.

We know generally surface water is generally softer than ground water. Our experimental results of hardness for surface water ~~is~~ are 139 and 96 mg/L as $CaCO_3$ where for ground water are 181, 226 and 265 which represents the theoretical concept.

Comment on Chloride:

From our experimental results we see that for both sources, chloride is found low or high in value. We know chloride content ~~can~~ depends on many factors. As example sources of human waste, industrial wastes, nearness to sea water etc. So chloride content varies in our experimental result.

Bangladesh University of Engineering and Technology

Course No: CE-332 Group no: 01

Course Title: Environmental Engineering Laboratory

Exp. No: 8,9

Name of the Experiment:

Determination of Chloride & Total Iron Concentration in water.

Name: Mehedi Hasan Date of performance:

Student Id: 1304166 Date of submission: 15-10-16

Section: C_2

CE 332 : ENVIRONMENTAL ENGINEERING SESSIONAL
Lab Experiment Report

Experiment No: - 8 & 9
Determination of Chloride & Total Iron Concentration in Water

Objective of the Tests:

Determination of Chloride & Total Iron Concentration in Water.

Water Sampling Information (source, location, date and time of collection etc.):

Source : surface water

Location : Jagannath Hall pond.

Date : 03-09-16 n

Time : 1:53 Pm

Apparatus & Reagents used:

Apparatus:
i) Measuring cylinder (100 mL)
ii) Beaker 09-16
iii) Dropper 10-16
iv) Stirrer
v) Nessler tube

Reagents:
i) Potassium chromate indicator
ii) Silver nitrate solution (0.0141 N)
iii) Hydrochloric acid
iv) Potassium thiocyanate & $KMnO_4$ solution
v) Standard iron solution.

Lab Data Sheet

Experiment No. 8 &9: Determination of Chloride & Total Iron Concentration in Water

Sl No.	Water Quality Parameter	Unit	Concentration Present	Bangladesh Standard for Drinking Water (ECR'97)	WHO Guideline Values 2011 (or 2004)
01	Chloride	mg/L	55	150 – 600	250
02	Iron	mg/L	4.4	0.3–1.0	0.3

8 1/10

Sample Calculation:

Chloride

$$MF = \frac{\frac{1}{71} \times 35.5 \times 1000}{50} = 10$$

Chlorite, Cl^- (mg/L) = (mL of $AgNO_3$ used – "error") × MF

$$= \{(21.2 - 15.5) - 0.2\} \times 10$$

$$= 55$$

Iron

$$DF = \frac{100}{5} = 20$$

$$\text{Iron concentration} = \frac{0.22 \times 100}{100} \times 20$$

$$= 4.4 \text{ mg/L}$$

09-16

10-16

Discussion on obtained results:

We know river and groundwater usually have a considerable amount of chlorides. Our sample water source was a pond, so our concentration of chloride in our sample (55 mg/L) is not harmful to human according to ECR'97 with respect to chloride concentration in water.

According to ECR'97 Iron concentration in water should be within the range 0.3 to 1.0. But our sample water has a high concentration of water (4.4 mg/L). So our sample water is not drinkable with respect to iron concentration.

Assignment Question & Answer:

Q-1: "Chlorides are used to some extent as tracers in sanitary engineering practice" - how?

A) First chloride concentration is determined. Then if it is low in value it means the source of human waste is fan away from the sampling source. If chloride concentration in sample is high, it means that the source of human waste is near to the sampling source.

Q-2: Write down the function of the following chemicals in determination of iron content in water: i) hydrochloric acid; ii) standard iron solution; iii) potassium thiocyanate.

i) Function of hydrochloric acid: To dissolve the insoluble ferric forms.

ii) Standard iron solution: As reagent, for comparing color.

iii) Potassium thiocyanate: For determining Ferric iron. As it produces $Fe(CNS)_3$ reacting with Fe^{3+}.

Q-3: Why we should dilute the sample if end point is not achieved even after adding 7/8 mL of silver nitrate to the solution? 09-16

Reason: 10-16

i) Silver nitrate ($AgNO_3$) is very expensive

ii) 7/8 mL means the concentration of Cl^- is high. So we should dilute the sample.

Q-4: 50 mL sample is diluted to make a 300 mL mixture and 50 mL of that diluted sample used for determination of iron in water If 0.8 mL standard iron solution [strength of the std. iron solution = 0.4 mg/mL] is needed to match with the color of the test water sample, calculate the iron concentration of the test sample

$$DF = \frac{\text{Vol}^m \text{ of mix}}{\text{Vol}^m \text{ of original sample}} = \frac{300}{50} = 6$$

$$\therefore \text{Total iron concentration of test sample (mg/L)} = \frac{0.8 \times 0.4}{50} \times 6$$

$$= 0.0384$$

(Ans.)

Bangladesh University of Engineering and Technology

Course No: CE-332

Group no: 01

Course Title: Environmental Engineering Laboratory

Exp. No: 5, 6, 7

Name of the Experiment: Determination of Carbon Dioxide, Alkalinity & Hardness in water

Name: Mehedi Hasan

Date of performance: 24-09-16

Student Id: 1304166

Date of submission: 01-10-16

Section: C2

CE 332 : ENVIRONMENTAL ENGINEERING SESSIONAL

Lab Experiment Report

Experiment No: - 5, 6 & 7

Determination of Carbon Dioxide, Alkalinity & Hardness in Water

---

Objective of the Tests:

To determine Carbon Dioxide, Alkalinity & Hardness in Water.

Water Sampling Information (source, location, date and time of collection etc.):

Source: surface water

Location: Jagannath Hall pond

date and time: 03-09-16, 1:53 pm

Rain status: Yes

Apparatus & Reagents used:

(i) Beaker

(ii) Measuring cylinder

(iii) Dropper

(iv) Stirrer

(v) Burette

(vi) Phenolphthalein indicator

(vii) Standard $\frac{1}{44}$ N sodium hydroxide

(viii) Standard 0.02N sulfuric acid

(ix) Methyl orange indicator

(x) Buffer sol^n, EBT, Standard EDTA sol^n.

CE 332: Environmental Engineering Sessional

Lab Data Sheet

Experiment No. 5, 6 & 7: Determination of Carbon Dioxide, Alkalinity & Hardness in Water

Sl No.	Water Quality Parameter	~~Unit~~ Concentration Present	~~Concentration Present~~ Unit	Bangladesh Standard for Drinking Water (ECR'97)	WHO Guideline Values 2011 / 2004
			mg/L		
01	Carbon Dioxide (CO_2)	9	mg/L as $CaCO_3$		
02	CO_2 -Acidity	10.22	mg/L as $CaCO_3$		
03	P-Alkalinity	0	mg/L as $CaCO_3$		
04	Total Alkalinity	139	mg/L as $CaCO_3$		
05	Total Hardness	110	mg/L as $CaCO_3$	200-500	500
06	CO_3 - Hardness	110	mg/L as $CaCO_3$		
07	Non-CO_3 Hardness	0	mg/L as $CaCO_3$		

8

Sample Calculation:

Free CO_2 in water (mg/L) = MF × (6.7 − 5.8)
= 10 × 0.9
= 10

Total hardness = MF × (55 − 0)
= 2 × 55
= 110 mg/L as $CaCO_3$

Total alkalinity = MF × (13.9 − 0)
= 10 × 13.9
= 139 mg/L as $CaCO_3$

∴ CO_3- Hardness = 110 mg/L

∴ Non-CO_3 hardness = (110 − 110) = 0 mg/L

As pH of our sample was below 8.3
so P-Alkalinity = 0 mg/L as $CaCO_3$

CO_2 acidity = $\frac{9 \times 50}{44}$ = 10.22 mg/L as $CaCO_3$

9-16

9-16

Scanned by CamScanner

Discussion on obtained results:

(i) We know, surface waters usually contain less than 10 mg/L of free CO_2. Our experimental result 9 mg/L also represents it.

(ii) As pH of our sample was below 8.3, so p-alkalinity of our sample is zero.

(iii) Our sample's total hardness (110 mg/L as $CaCO_3$) was less than total alkalinity (139 mg/L as $CaCO_3$).

So CO_3-Hardness of our sample was 110 mg/L as $CaCO_3$ and Non-CO_3 Hardness of our sample was 0

(iv) We have done one titration. So there may be some errors are present. So for most accurate result we should titrate again for determining amount of free CO_2.

Assignment Question & Answer:

Q-1: How the accuracy of CO_2 concentration measurement by titration method can be checked in the lab?

To check, a secured second sample is needed. After completing the titration of first sample it is required to add the used amount of $\frac{1}{44}$ N NaOH in first sample. Then Adding of 10 drops of Phenolphthalein indicator is done. If sample remains colorless then it is required to add additional NaOH (till the pink color appears) 9-16 9-16

Q-2: Two water sample are examined in the lab having pH 8.1 (sample-A) and 11.0 (sample-B). Write down the possible forms of acidity, alkalinity causing anions and hardness causing cations that may exist in those water samples.

Sample -A

Given, pH = 8.1 < 8.3

S.i) If Alkalinity and hardness is high then there may be Ca^{2+}, Mg^{2+}, HCO_3^- ions are present in the sample.

ii) if alkalinity is high but hardness is low then there may be Na^+, K^+, HCO_3^- are present in the sample.

iii) if alkalinity is low but hardness is high then there may be Ca^{2+}, Mg^{2+}, Cl^-, SO_4^{2-} are present.

iv) If both are negligible then there may be Na^+, Cl^-, SO_4^{2-} are present

Sample — B :

Given, pH = 11.0

So, i) if alkalinity and hardness both are high then there may be Ca^{2+}, Mg^{2+}, CO_3^{2-} ion are present

ii) If alkalinity is high but hardness is low then there may be Na^+, K^+, CO_3^{2-} ion are present

iii) If alkalinity is low but hardness is high then there may be Ca^{2+}, Mg^{2+}, Cl^-, SO_4^{2-} are present

iv) If both are negligible than there may be Na^+, Cl^-, K^+, SO_4^{2-} are present.

Q-3: Define P- alkalinity and M- alkalinity.

P-alkalinity: The amount of acid required to reduce the pH value of a sample from present to 8.3 is called P-alkalinity of the sample.

M-alkalinity: The amount of acid required to reduce the pH value of a sample from present to 4.5 is called m-alkalinity.

Q-4: What is chelating agent? What is its use?

A chemical compound in the form of a heterocyclic ring, containing a metal ion attached by co-ordinate bonds to at least two non-metal ions and then form extremely stable complexes with Ca^{2+}, Mg^{2+} are chelating agents. It is used in determining hardness of a sol^n.

Q-5: A water sample has the following analysis:

Na^+	: 20 mg/L	Cl^-	: 40 mg/L
K^+	: 30 mg/L	HCO_3^-	: 67 mg/L
Ca^{2+}	: 5 mg/L	CO_3^{2-}	: 0 mg/L
Mg^{2+}	: 10 mg/L	SO_4^{2-}	: 5 mg/L
Sr^{2+}	: 2 mg/L	NO_3^-	: 10 mg/L

Calculate total hardness, carbonate hardness, and non-carbonate hardness. Assume alkalinity of the water sample is 250 mg/L as $CaCO_3$.

9-16

Hardness of cations using following formula

9-16

$$\text{Hardness (mg/L as } CaCO_3) = \frac{M^{2+}(mg/L) \times 50}{eq.\ wt\ of\ M^{2+}}$$

Ca^{2+} – 12.5
Mg^{2+} – 41.15
Sr^{2+} – 2.28
HCO_3^- – 54.44
CO_3^{2-} – 0

Now total Hardness = (12.5 + 41.15 + 2.28)
= 55.89 mg/L as $CaCO_3$

CO_3-hardness = 54.94 mg/L as $CaCO_3$

Non-CO_3 hardness = (55.89 − 54.94)
= 0.97 mg/L as $CaCO_3$

hardness is ... $^{2+}$, Cl^-, SO_4^{2-} ... there may ... hardness both ... Mg^{2+}, CO_3^{2-} ion ... hardness is ... ions are p... hardness is ... Mg^{2+}, Cl^-, SO_4 ... than there are present

Q-8: Calculate hydroxide, bicarbonate, and carbonate alkalinities of a water sample with a total alkalinity of 280 mg/L as $CaCO_3$ and a pH of 7.9. Which type of alkalinity dominates the total alkalinity? Also calculate the concentrations of carbonate (CO_3^{2-}) and bicarbonate (HCO_3^-) ions in water. [Hint: Use Eqs. 10 – 15].

Total Alkalinity = 280 mg/L as $CaCO_3$

$$pH = -\log[H^+]$$

$$\Rightarrow [H^+] = 10^{-7.9} =$$

Carbonate alkalinity (mg/L as $CaCO_3$) $= \dfrac{50,000\left\{\left(\dfrac{\text{Alkalinity}}{50,000} + H^+\right) - \left(\dfrac{K_w}{H^+}\right)\right\}}{\left[1 + \left(\dfrac{H^+}{2K_{A2}}\right)\right]}$

$$= \frac{50,000 \times \left\{\left(\frac{280}{50,000} + 10^{-7.9}\right) - \frac{10^{-14}}{10^{-7.9}}\right\}}{\left[1 + \frac{10^{-7.9}}{2 * 10^{-10.3}}\right]}$$

$= 2.21$ mg/L as $CaCO_3$

Bicarbonate alkalinity (mg/L as $CaCO_3$)

$$= \frac{50,000\left\{\left(\frac{\text{alkalinity}}{50,000} + H^+\right) - \left(\frac{K_w}{H^+}\right)\right\}}{\left[1 + \left(\frac{2K_{A2}}{H^+}\right)\right]}$$

$$= \frac{50,000\left\{\left(\frac{280}{50,000} + 10^{-7.9}\right) - \frac{10^{-14}}{10^{-7.9}}\right\}}{\left[1 + \frac{2 \times 10^{-10.3}}{10^{-7.9}}\right]}$$

$= 277.75$ mg/L as $CaCO_3$

Hardness alkalinity = $[280 - (2.21 + 277.75)]$ mg/L as $CaCO_3$

$= 0.04$ mg/L as $CaCO_3$

So, Bi-carbonates alkalinity dominates the total alkalinity.

Actual concentration of (CO_3^{2-}) ion,

$= 2.21 \times 0.6 = 1.326$ mg/L

Actual concentration of (HCO_3^-) ion,

$= 277.75 \times 1.22$

$= 338.86$ mg/L

Molar concentration of (CO_3^{2-}) ion m,

$= \frac{2.21}{60,000} = 0.0000368$ M

Molar concentration of (HCO_3^-)

$= \frac{338.86}{61,000} = 0.0056$ m

Bangladesh University of Engineering and Technology

Course No: CE-332 Group no: 01

Course Title: Environmental Engineering Laboratory

Exp. No: 1, 2, 3, 4

Name of the Experiment: Determination of pH, Colour, Turbidity and Solids in Water.

Name: Mehedi Hasan

Student Id: 1304166

Section: C_2

Date of performance: 03-09-16

Date of submission: 24-09-16

CE 332 : ENVIRONMENTAL ENGINEERING SESSIONAL

Lab Experiment Report

Experiment No: - 1,2,3 & 4

Name of the Experiment: Determination of pH, Color, Turbidity & Solids in Water

Objective of the Tests:

To determine pH, Colore, Turbidity and Solids in Watere

Water Sampling Information (source, location, date and time of collection etc.):

Sourece: Jagannath hall pond

location: Jagannath hall. p.

Date: 03-09-16

Time: 1:53 pm

Rain status: Yes

Environment: clean

Apparatus & Reagents used:

For determination of pH: pH metere, Standard pH solutions.

For determination of Colore: Spectrophotometere, filtere paper, funnel, holdere, beaker and standard potassium Chloro- platinate solution.

For determination of Turbidity of watere: DR LANGE Turbidimetere instrument set and Formazin polymere standards.

Determination of TS, TDS, TSS: Beakere (150 mL), Measuring cylindere (100 mL), Funnel, Droppere, Filtere paper (<2μm)

Lab Data Sheet

Experiment No. 1, 2,3 & 4: Determination of pH, Color, Turbidity & Solids in Water

Sl No.	Water Quality Parameter	Unit	Concentration Present	Bangladesh Standard for Drinking Water (ECR'97)	WHO Guideline Values 2011 (or 2004)
1	pH	–	7.60	6.5-8.5	6.5-8.5
2	Color (yellowish)	Pt-Co	27 — T 107 — A	15	15
3	Turbidity	NTU	5.68	10	5
4	TS – elaborated form	mg/L	0.25		
	TDS	mg/L	0.25	≯1000	1000
	TSS	mg/L	0	10	- -
5	Odour		Odorless	Odorless	- -

Sample Calculation:

TS Determination:

solid residue (mg) = 55.0592 − 55.0322

= 0.027

∴ total solid, TS (mg/L) = $\frac{0.025 \times 1000}{100}$

= 0.27

TDS Determination:

solid residue (mg) = 50.5367 − 50.5109 = 0.025

∴ TDS (mg/L) = $\frac{0.025 \times 1000}{100}$ = 0.25

∴ TSS (mg/L) = TS (mg/L) − TDS (mg/L)

= 0.27 − 0.25

= 0.02 mg/L

Results

...ing	Water source	pH	Color Pt-Co unit		Turbidity (NTU)	TS (mg/L)	TDS (mg/L)	TSS (mg/L)
			True Color	Apparent Color				
	Jagannath hall pond (S.W)	7.60	27 (yellowish)	107 (yellowish)	5.68	0.27	0.25	0.02
2	Dhanmondi lake (S.W)	7.20	23	40	3.04	0.5	0.18	0.32
3	Tap water – Mohammadpur (G.W)	6.80	6	7	0.54	0.22	0.21	0.01
4	Sulimanady hall (G.W)	6.60	3	8	0.96	0.41	0.409	0.001
5	Nazrul hall (G.W)	6.71	4	17	1.27	0.406	0.395	0.011

$\frac{TDS}{EC}$ = ??

Discussion on obtained results:

Ground water is slightly acidic. Our experimental results also represent it. For ground water source, we have found the pH value less than 7.

Our surface water color shows yellowish color. The difference of True color and apparent color for surface water is found very high in our experiment.

Ground water represents less turbidity and surface water represents relatively high turbidity in our experiment.

In our experiment TSS in surface water is greater than TSS in ground water. In reality it is also true because groundwater usually has higher dissolved solids.

Assignment Question & Answer:

Q-1: Groundwater is often found to be slightly acidic -Why?

Ground water is often found to be slightly acidic due to the presence of excess carbon dioxide (CO_2).

Q-2: How the pH meter is calibrated in the lab?

In the lab using Standard pH solutions (buffers), pH meter is calibrated.

Q-3: What is the basic principle of measuring color using spectrophotometer?

The color of water is usually measured using spectrophotometer which uses light intensity of a specific wavelength (455 nm). The color test measures (inversely) an optical property of water sample which result from the absorption of light of specific wavelength by the soluble color substances.

Q-4: Write down some water treatment processes used for removal of turbidity from water.

"Cloth filtration", "Filtration through clean-sand", are part of pre-treatment option. It can be done by "sedimentation by coagulation". "Alum Floccu-lation" is another process which reduces the turbidity of water significantly.

Q-5: How presence of turbidity interferes with the filtration process in water treatment system?

In water treatment system, turbid water causes quick clogging of filter bed and thus requires the use of pre-treatment plant. So turbid water is not suitable for filtration process.

Q-6: In determination of Dissolved Solids in a 50-mL water sample, the weights of empty beaker and beaker with solids (after heating at 103 °C for 24 hours) are 54.7066 g and 54.7196 g, respectively. Determine the Specific Conductance of the water in μS/cm assuming a multiplying factor of 0.64. Also comment on your result.

Given,

water sample is = 50 mL

$$\text{Solid residue (mg)} = (54.7196 - 54.7066) \times 1000$$

$$= 13$$

We know,

$$\text{TDS (mg/L)} = \frac{\text{solid residue (mg)} \times 1000}{\text{Volume of sample (mL)}}$$

$$\therefore \text{TDS} = \frac{13 \times 1000}{50} = 260$$

Again,

$$\text{specific conductance } (\mu S/cm) = \frac{260}{0.64}$$

$$= 406.25$$

The capacity of the sample to carry an electrical current which in turn is related to the concentration of ionized substances in the water.