DEPARTMENT OF CIVIL ENGINEERING,

JHARSUGUDA ENGINEERING SCHOOL, JHARSUGUDA

(A Govt. of Odisha Polytechnic)

PUBLIC HEALTH ENGINEERING LABORATORY

5TH SEMESTER

EXPERIMENT NO -1

Determination of Turbidity

Aim:

To determine the turbidity of the given sample using Nephelometer in NTU.

Principle

The method presented below is based on a comparison of the intensity of light scattered by the sample in specific conditions with the intensity of light scattered by standard reference suspension under the same condition. The higher the intensity of scattered lights, higher the turbidity . Formazine polymer , which has gained acceptance as the turbidity standard reference suspension is used as a reference turbidity standard suspension for water. It is easy to prepare and is more reproducible in its lights scattering properties than the clay or turbid natural water standards previously used. The turbidity of a given concentration of formazine has an approximate turbidity of 100 NTU, when measured on candle turbidity meter. Nephelomatric turbidity units based on formazine preparation will have approximate units derived from Jackson candle turbiditymeter but will not be identical to them.

Apparatus

Nephelometer with accessories.

Reagents

i. Turbidity free distilled water (for setting Zero).

ii. Formazine turbidity concentrate (hydrazine sulphate + hexamine)

iii. Formazine standard (for setting 100 of the instrument)

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Nephelometer

Preparation of Turbidity Free Distilled Water

Pass distilled water through a membrane filter having a precision pore size of less the 10 microns (Whatman filter No. 42). Rinse collecting flask at least twice with such filtered water and discard the next 200 ml. Use this filtered water for setting zero of the instrument.

Preparation of Formazine Turbidity Concentrate

(a) *Solution I*

Weigh accurately 5 g of ' Anal-R' quality hydrazine sulphate $(NH_2)_2H_2SO_4$ in to a 500 ml volumetric flask and add distilled water to make up to the mark . Leave the mixture to stand for 4 hours.

(b) Solution II

Weigh accurately 50g of 'Anal-R' quality hexamethylene tetramine $(CH_2)_6N_4$ (hexamine) in to a 500 ml volumetric flask and add distilled water to make up to the mark. Mix equal volume of solution I and II to form formazine turbidity concentrate. Allow it to stand in a closed container at 25°C to 30°C for 48 hours to produce insoluble white turbidity corresponding to 4000 NTU.

Note: Once prepared , formazine turbidity concentrate (which corresponds to 10000 ppm SiO2) is stable for 2 to 3 months.

Preparation of Formazine Standard

Dilute 25mL of the formazine turbidity concentrate to 1 litre with turbidity free distilled water to obtain 250 ppm or 100 NTU for setting '100' of the instrument.

Note: Formazine standard 100 NTU should be prepared weekly.

Procedure

1) Switch the instrument on.
2) Open the lid of the sample compartment.
3) Insert a test tube filled with distilled water into the sample compartment.
4) Adjust 'SET 0' control to get '0' displayed on the read out.
5) Open the lid. Replace the test tube filled with distilled water with a test tube filled with formazine standard. Close the lid.
6) Adjust the 'SET 100' control to get '100' displayed on the read out.
7) Repeat the above operation to get consistent values of 0 to 100 within 1% to 2%.

Measurement of turbidity less than 100 NTU

1. Thoroughly shake the sample.

2. Wait until air bubbles disappear and pour the sample into the nephelometer tube.

3. Read the turbidity directly from the instrument.

Measurement of turbidity above 100 NTU

Dilute the sample with one or more volume of turbidity free distilled water until the turbidity fall below 100 NTU.

$$\text{NTU of sample} = \frac{A(B+C)}{C}$$

A= NTU found in dilute sample

B= volume of dilution water in mL

C= sample volume taken for dilution in mL

Observation:

0-100 NTU		*>100 NTU*			
Sample No.	NTU	A mL	B mL	C mL	NTU= A(B=C)/C

Results:

Description of Sample	*Turbidity in NTU*

EXPERIMENT NO -2

Determination of pH of Water

Aim

To determine the pH of given samples using

1) Universal indicator
2) pH paper, and
3) Digital pH meter

Principle

pH value of water indicates the hydrogen ion concentration in water and concept of pH was put forward by Sorenson (1909). pH is expressed as the logarithm of the reciprocal of the hydrogen ion concentration in moles/litre at a given temperature . The pH scale extends from 0 (very acidic) to (very alkaline) with 7 corresponding to extract neutrality at 25° C. pH is used in the calculation of carbonate , bicarbonate and CO2 , corrosion and stability index etc. While the alkalinity or acidity measures the total resistance to the pH change or buffering capacity, the pH gives the hydrogen ion activity . pH can be measured calorimetrically or electrometrically.

Colorimetric method is used only for rough estimation. It can be done either by using universal indicator or by using pH paper. The hydrogen electrode is the absolute standard for the measurement of pH. Thy range from portable battery operated units to highly precise instruments. But glass electrode is less subjected to interferences and is used in combination with a calomel reference electrode. This system is based on the fact that a change of 1 ph unit produces an electric charge of 59.1 mV at 25° C.

Apparatus

1. pH meter with electrode
2. Beaker
3. Thermometer
4. Colour comparator with discs
5. Cuvettes

Reagents

1. Buffer solutions
2. pH paper
3. Universal indicator

Procedure

a. Using universal Indicator

(If comparators are not available , compare the colour with colours given in the chart.)

1. Using pH papers 10 mL of sample is taken in a cuvette.
2. Another 10 mL sample is taken in another cuvette and 0.2 mL of universal indicator is added and placed in the hole provided for.
3. A colour disc corresponding to this indicator is inserted in to the comparator and the disc rotated such that the 2 circles indicate identical colours.
4. The reading is noted.
5. The procedure can be repeated using an indicator whose range is near the value obtained.
6. The exact pH is obtained.

b. Using pH Meter

1. Follow the manufacturer's operating instructions.
2. Dip the electrode in the buffer solution of known pH.
3. Switch on the power supply and take the reading. Standardize the instrument using the calibrating knob.

4. After cleaning, again dip the electrodes in the buffer solution of pH 7. Note the reading. If it is 7, the instrument is calibrated. If not, correct the value and is manipulated so that the reading in the dial comes to 7.0.

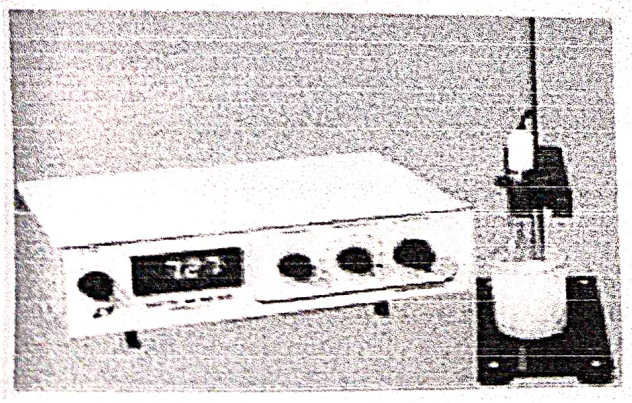
5. A solution whose pH is to be found is taken in a beaker and the temperature knob is adjust such that the temperature of solution is same as that in dial.

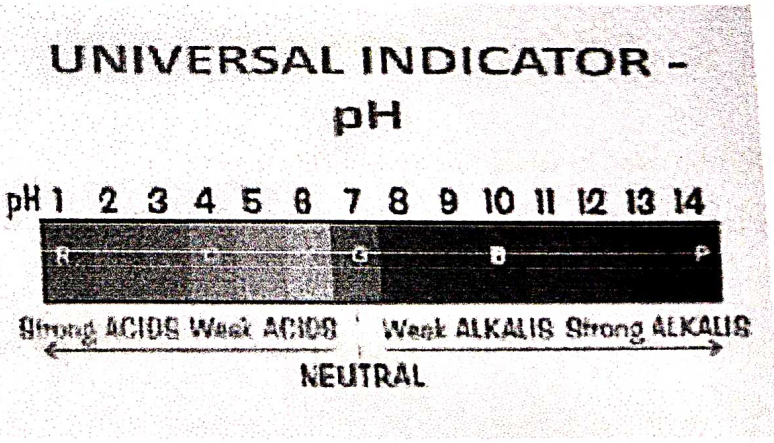
6. The electrode is washed with distilled water and reused with the solution and then it is dipped in the solution.

7. The reading on the dial indicates the ph of the solution.

Results

Sample	ph		
	Ph Paper	pH meter	Universal indicator





EXPERIMENT NO -3

Determination of Chloride in water

Aim

To determine the amount of chloride (in the form of Cl) present in the given water sample by Mohr's method.

Principle

If water containing chlorides is titrated with silver nitrate solution, chlorides are precipitated as white silver chloride. Potassium chromate is used as indicator, which supplies chromate ions. As the concentration of chloride ions approaches extinction, silver ion concentration increases to a level at which reddish brown precipitate of silver chromate is formed indicating the end point.

Apparatus

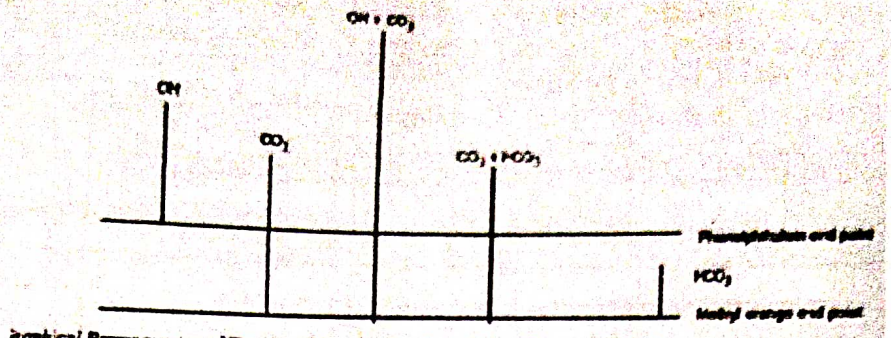
1. Burette
2. Pipettes
3. Erlenmeyer flasks
4. Measuring cylinder

Reagents:

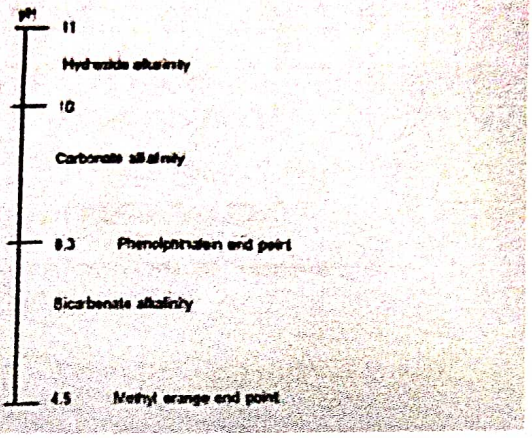
1. Chloride free distilled water.
2. Standard silver nitrate solution (0.0141N)
3. Potassium chromate indicator.
4. Acid or alkali for adjusting pH.
5. **Potassium chromate indicator:** Dissolve 50 g potassium chromate ($K_2Cr_2O_4$) in a little distilled water. Add silver nitrate solution until a definite red precipitate is formed. Let stand for 12 hours, filter and dilute the filtrate to 1 litre with distilled water.
6. **Phenolphthalein indicator:** Dissolve 5 g phenolphthalein in 500mL ethyl alcohol and add 500 mL distilled water. Then add 0.02 N sodium hydroxide drop-wise until a faint – pink colour appears.
7. **Sodium thiosulphate 0.1 N:** Dissolve 25 g $Na_2S_2O_3.5H_2O$ and dilute to 1 litre.

Procedure:

1. Pipette 50 mL of sample into a clean Erlenmeyer flask (V)
2. Add one drop of sodium thiosulphate solution, if residual chlorine is present.
3. Add two drops of phenolphthalein indicator; if the pH is above 8.3, colour of solution becomes pink.
4. Titrate against standard sulphuric acid in the burette, till the colour just disappears. Note doen the volume (Vl).
5. Then add two drops of methyl orange indicator, the colour turns yellow.
6. Again titrate against acid, until the colour turns to orange yellow. Note down the total volume (V2).



Graphical Representation of Titration of Samples Containing Various Forms of Alkalinity



Observation

0.02 N H2SO4 x sample (Methyl orange / phenolphthalein indicator)

Description of Sample	Trail no.	Burette reading (phenolphthalein indicator)		Volume of acid used v1	Burette reading (methyl orange indicator)		Volume of acid used v2
		Initial	Final		Initial	Final	

Calculation

1. Phenolphthalein alkalinity (p) as mg/L CaCO3 $\frac{V_1 \times 1000}{\text{mL of Sample}}$

2. Total alkalinity (T) as mg/L CaCO3= $\frac{V_2 \times 1000}{\text{mL of sample}}$

The types of alkalinity present in the samples are calculated using the equations given in the following table

And the results are tabulated.

Result of titration	Hydroxide alkalinity as CaCO3	Carbonate alkalinity as CaCO3	Bicarbonate alkalinity as CaCO3
P=0	O	O	T
$P<_{1/2}T$	O	2P	T-2P
$P=_{1/2}T$	O	2P	O
$P>_{1/2}T$	2P-T	2(T-P)	O
P=T	T	O	O

Results

Description of sample	Hydroxide alkalinity as CaCO3 in mg/L	Carbonate alkalinity as CaCO3 in mg/L	Bicarbonate alkalinity as CaCO3 in mg/L	Hydroxide carbonate alkalinity as CaCO3 in mg/L	Carbonate bicarbonate alkalinity as CaCO3 in mg/L

EXPERIMENT NO-4

Determination of Optimum Dose of Coagulant

Aim:

To determine the optimum coagulant dosage for clarifying the given sample of water by using alum as the coagulant and performing the jar test experiment.

Principle

Coagulant are used in water treatment plants

i. To remove natural suspended and colloidal matter,

ii. To remove material which do not settle in plain sedimentation, and

iii. To assist in filtration.

Alum [A12(SO4)3, 18H2O] is the most widely used coagulant. When alum solution is added to water, the molecules dissociate to yield SO2-4 and A13+. The +ve species combine with negatively charged colloidal to neutralize part of the charge on the colloidal particle. Thus, agglomeration takes place. Coagulation is a quite complex phenomenon and the coagulant should be distributed uniformly throughout the solution. A flash mix accomplishes this.

Jar test is simple device used to determine this optimum coagulant dose required . The jar test, device consists of a number of stirrers (4 to 6) provided with paddles. The paddles can be rotated with varying sped with the help of a motor and regulator. Samples will be taken in jars or beakers and varying dose of coagulant will be added simultaneously to all the jars. The paddles will be rotated at 100 rpm for 1 minute and at 40 rpm for 20 to 30 minutes, corresponding to the flash mixing and slow mixing in the flocculator of the treatment plant. After 30 minutes settling, supernatant will be taken carefully from all the jars to measure turbidity. The dose, which gives the least turbidity is taken as the optimum coagulant dose.

Apparatus :

1. Jar Test Apparatus
2. Glass Beakers

3. Pipette
4. Nephelometer
5. pH meter

Reagents

1. Alum solution (1mL containing 10 mg of alum)
2. Lime
3. Acid/alkali

Procedure

1. Take 1-litre beakers and fill them with sample up to the mark.
2. Keep each beaker below each paddle and lower the paddles, such that one is about 1 cm above the bottom.
3. Find the pH of the sample and adjust it to 6 to 8.5.
4. Pipette 1,2,3,4,5,6 mL of the alum solution in to the test samples.
5. Immediately run the paddles at 100 rpm for 1 minute.
6. Reduce the speed to 30-40 rpm and run at this rate for 30 minutes.
7. Stop the machine, lift out the paddles and allow to settle for 30 minutes.
8. Find the residual turbidity of the supernatant using nephelometer.
9. Plot a graph with alum dosage along x-axis and turbidity along y-axis.
10. The dosage of alum, which represents least turbidity , gives Optimum Coagulant Dosage (O.C.D).
11. Repeat steps 1-10 with higher dose of alum, if necessary.

Observation

Trail no.	Alum Dosage in mg/L	Turbidity in NTU

Results:

Optimum coagulant dosage=.....

EXPERIMENT NO-5

OBJECTIVE:- TO DETERMINE DISSOLVED OXYGEN IN A SAMPLE OF WATER.

Apparatus required: Burette , pipette, conical flask, beaker, measuring cylinder

Chemical required: MnSO4, KOH, KI, Na2S2O3, Starch, and NaN3

Theory:

It is based on oxidation of potassium iodide. The liberated iodine is titrated against standard hypo solution using starch as a final indicator. Since oxygen in water is in molecular state and not capable to react with KI, an oxygen carrier manganese hydroxide is used to bring about the reaction between KI and O2. Manganous hydroxide is produced by the action of potassium hydroxide and manganous sulphate.

Chemical reaction:

2KOH+MnSO4=Mn(OH)2+K2SO4

2Mn (OH)2+O2= 2MnO(OH)2

MnO(OH)2+H2SO4= MnSO4+2H2O+[O]

2KI+H2SO4+[O]= K2SO4+H20+12

12+2Na2S2O3= 2NaI+ Na2S4O6

Sodium tetrathionate

Starch+ 12 Starch iodide complex (Blue in colour)

Procedure:

1. Take 500ml of water in a D.O bottle.
2. Add 10ml of alkaline KI and 10 ml of Mn SO4 into it.
3. Stopper the bottle and shake it well.
4. Keep the bottle in dark for 5 min and add cone H2SO4 till the brown precipitates are dissolved.
5. Take 100 ml of the above solution in a conical flask. Titrate against hypo till the colour changes to light yellow.
6. Add 3-4 drops of starch in to it and the colour changes to blue.
7. The blue colour solution is titrated against hypo solution till blue colour disappear .
8. Stopper the bottle and shake it well.
9. Keep the bottle in dark for 5 min and add cone. H2SO4 till the brown precipitates are dissolved.

10. Take 100 ml of the above solution in a conical flask. Titrate against hypo till the colour changes to light Yellow.
11. Add 3-4 drops of starch in to it and the colour changes to blue.
12. The blue colour solution is titrated against hypo solution till blue colour disappeared.
13. This is end of the titration . Repeat this process till to get three concordant reading.

Tabulation

No of observation	Volume of water	IBR in ml	FBR in ml	Diff in ml	Remark

Calculation:

100 ml of N $Na_2S_2O_3$= 8 gm of O_2

V ml of N/40 $Na_2S_2O_3$= 8v/40x X gm of O_2= 8v x 1000/40x1000 mg of O_2=v/5 mg of O_2

100 ml of water sample contain V/5 mg of O_2

1 Lit of water sample contains = 2V mg of O_2= ppm

Conclusion

The amount of dissolved oxygen in a sample of water is found to be .....ppm.

EXPERIMENT NO-6

AIM:- TO DETERMINE BIOCHEMICAL OXYGEN DEMAND (BOD) OF GIVEN WATER/WASTE WATER SAMPLE

Introduction:

The biochemical oxygen demand determination is a chemical procedure for determining the amount of dissolved oxygen needed by aerobic organisms in a water body to breakthe organic materials present in the given water sample at certain temperature over a specific period of time. BOD of water or polluted water is the amount of oxygen required for the biological decomposition of dissolved organic matter to occur under standard condition at a standardized time and temperature. Usually, the time is taken as 5 days and the temperature is 20°C.

The test measures the molecular oxygen utilized during a specified incubation period for the biochemical degradation of organic material (carbonaceous demand) and the oxygen used to oxidize inorganic material such as sulfids and ferrous ion. It also may measure the amount of oxygen used to oxidize reduced forms of nitrogen (nitrogenous demand)

Environmental significance:

BOD is the principle test to give an idea of the biodegradability of any sample and strength of the waste. Hence the amount of pollution can be easily measured by it. Efficiency of any treatment plant can be judged by considering influent BOD and the sffluent BOD and so also the organic loading on the unit.

Application of the test to organic waste discharges allows calculation of the effect of the discharges on the oxygen resources of the receiving water. Data from BOD tests are used for the development of engineering criteria for the design of wastewater treatment plants. Ordinary domestic sewage may have a BOD of 200 mg/L. Any effluent to be discharged in to natural bodies of water should have BOD less than 30 mg/L. This is important parameter to assess the pollution of surface waters and ground waters where contamination occurred due to disposal of domestic and industrial effluents. Drinking water usually has a BOD of less than 1 mg/L. But, when BOD value reaches 5 mg/L, the water is doubtful in purity. The determination of BOD is used in studies to measure the self-purification capacity of strums and serves regulatory authorities as a means of checking on the quality of effluents discharged to stream waters.

The determination of the BOD of wastes is useful in the design of treatment facilities. It is the only parameter, to give an idea of the biodegradability of any sample and self-purification capacity of rivers and streams. The BOD test is among the most important method in sanitary

Analysis to determine the polluting power, or strength of Sewage , industrial waste or polluted water. It serves as a measure of the amount of clean diluting water required for the successful disposal of sewage by dilution.

Guideline:

According to Bangladesh Environment Conservation Rules (1997), drinking water standard for biochemical oxygen demand (BOD) is 0.2 mg/L (at 20° C)For wastewater effluent allowable concentration of BOD varies from 50-250 mg/L depending on discharge point of the effluent (e.g, inland water, irrigation land, public sewer etc.)

Principle:

The sample is filled in an bottle and incubated at specific temperature for 5 days. The dissolved oxygen (DO) content of the sample is determined before and after five days of incubation at 20° C

and the BOD is calculated from the difference between initial and final DO. The initial DO is determined shortly after the dilution is made; all oxygen uptake occurring after this measurement is included in the BOD measurement.

Since the oxygen demand of typical waste is sever hundred milligrams per litter, and since the saturated value of DO for water at 20uC is only 9.1 mg/L, it is usually necessary to dilute the sample to keep final DO above zero. If during the five days of experiment , the DO drops to zero, then the test is invalid since more oxygen would have been removed had more been available.

The five-day BOD of a diluted sample is given by,

BOD5= [Doi-Dof] x D.F.....(1)

Here,

Dilution factor (D.F.)=

In some cases , it becomes necessary to seed the dilution water with microorganisms to ensure that there is an adequate bacterial population to carry out the biodegradation . In such cases, two sets of BOD bottles must be prepared, one for just the seeded dilution water (called the "blank")

and the other for the mixture of wastewater and dilution water. The changes in DO in both are measured . The oxygen demand of waste water (BODw) is then determined from the following relationship:

BOD x Vm= BODw X Vw+ BOD X Vd.....(2)

Where, BODm, is the BOD of the mixture of wastewater and dilution water

BODd is the BOD of the dilution water alone;

Vw and Vd are the volumes of wastewater and dilution water respectively in the mixture and

Vm= Vw+Vd

Sample handling and preservation:

Preservation of sample is not practical. Because biological activity will continue after a sample has been taken, changes may occur during handling and storage.

If Analysis is to be carried out within two hours of collection, cool storage is not necessary. If analysis cannot be started with in two hours of sample collection to reduce the change in sdample, keep all samples at 4° C.

Do not allow samples to freeze . Do not open sample bottle before analysis. Begin analysis within six hours of sample collection.

Apparatus:

1. BOD bottle
2. Beaker (250 ml)
3. Measuring cylinder
4. Dropper
5. Stirrer

Reagents:

1. Manganese sulphate solution
2. Alkaline potassium iodide solution
3. 0.025N sodium thiosulfate
4. Starch solution (indicator)
5. Concentrated sulphuric acid

Procedure:

Fill two BOD bottles with sample (or dilute sample); the bottles should be completely filled. Determine initial D (Doi) in one bottle immediately after filling with sample (or diluted sample). Keep the other bottle in dark at 20°C and after particular days (usually 5-days) determine DO (Dof) in the

sample (or dilute sample) . Dissolved oxygen (DO) is determined according to the following procedure:

1. Add 1 mL of manganese sulphate solution to the BOD bottle by means of pipette, dipping in end of the pipette just below the surface of the water.
2. Add 1 mL of alkaline potassium iodide solution to the BOD bottle in a similar manner.
3. Insert the stopper and mix by inverting the bottle several times.
4. Allow the "precipitates" to settle halfway and mix again.
5. Again allow the "precipitates" to settle halfway.
6. Add 1 mL of concentrated sulphuric acid. Immediately insert the stopper and mix as before.
7. Allow the solution to stand at least 5 minutes.
8. Withdraw 100 mL of solution into an Erlenmeyer flask and immediately add 0.025N sodium thiosulfate drop by drop from a burette until the yellow colour almost disappear.
9. Add about 1 mL of starch solution and continue the addition of the thiosulfate until the blue colour just disappears. Record the mL of thiosulfate used (disregard any return of the blue colour)

Calculation:

Dissolved oxygen, DO (mg/L)

=mL of 0.025N sodium thiosulfate added X Multiplying Factor (M.F.)

Calculate BOD of the sample according to Eq. -1 or Eq.- 2

DATE SHEET:

Table Sample No.	Source of Sample	Temperature of Sample(^{o}C)	BOD (mg/L)