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VISVESVARAYA TECHNOLOGICAL UNIVERSITY

B.G.S. INSTITUTE OF TECHNOLOGY



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ENVIRONMENTAL ENGINEERING LABORATORY MANUAL

Prepared by,

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Course Title: ENVIRONMENTAL ENGINEERING LABORATORY**As per Choice Based Credit System (CBCS) scheme****SEMESTER:VII**

Subject Code	17CVL76	IA Marks	40
Number of Lecture Hours/Week	1I+2P	Exam Marks	60
Total Number of Lecture Hours	40	Exam Hours	03
CREDITS -02		Total Marks- 100	

Course objectives: This course will enable students,

1. To learn different methods of water & waste water quality
2. To conduct experiments to determine the concentrations of water and waste water
3. To determine the degree and type of treatment
4. To understand the environmental significance and application in environmental engineering practice

Revised Bloom's Taxonomy (RBT) Level**L1,L2,L3**

1. Determination of pH, Acidity and Alkalinity
2. Determination of Calcium, Magnesium and Total Hardness.
3. Determination of Dissolved Oxygen.
4. Determination of BOD.
5. Determination of Chlorides
6. Determination of percentage of available chlorine in bleaching powder,
7. Determination of Residual Chlorine
8. Determination of Solids in Sewage:
 - I) Total Solids,
 - II) Suspended Solids,
 - III) Dissolved Solids,
 - IV) Volatile Solids, Fixed Solids,
 - V) Settle able Solids.
9. Determination of Turbidity by Nephelometer
10. Determination of Optimum Dosage of Alum using Jar test apparatus.
11. Determination of sodium and potassium using flame photometer.
12. Determination Nitrates by spectrophotometer.
13. Determination of Iron & Manganese.
14. Determination of COD. (Demonstration)
15. Air Quality Monitoring (Ambient, stack monitoring , Indoor air pollution)
(Demonstration)
16. Determination of Sound by Sound level meter at different location(Demonstration)

Course Outcomes: After studying this course, students will be able to:

1. Acquire capability to conduct experiments and estimate the concentration of different parameters.
2. Compare the result with standards and discuss based on the purpose of analysis.

3. Determine type of treatment, degree of treatment for water and waste water.
4. Identify the parameter to be analyzed for the student project work in environmental stream.

Program Objectives:

1. Evaluation of the test results and assesses the impact on water and waste water treatment.
2. Train student to undertake student project work in 8th semester in the field of environmental engineering.

Question paper pattern:

1. Two experiments shall be asked from the above set
2. One experiment to be conducted and for the other student should write detailed procedure.

Reference Books:

1. Lab Manual, ISO 14001 Environmental Management, Regulatory Standards for Drinking Water and Sewage disposal
2. Clair Sawyer and Perry McCarty and Gene Parkin, "Chemistry for Environmental Engineering and Science", McGraw-Hill Series in Civil and Environmental Engineering

INTRODUCTION

The reserves of water on earth are immense, but this is mostly salt water which is unfit for drinking or for irrigation purpose. The amount of fresh water is huge as well, but its distribution over the globe is uneven. The demand for drinking water and other domestic needs in a modern town varies from 100 to 500 liters a day per person. As man uses water he pollutes it inevitably and when the water is returned to open bodies it contaminates the natural waters.

The quality of water is now concern of experts in all the countries of the world. The decision of WHO's 29th session (May 1976) emphasis that water delivered to the consumer should meet the high requirements of modern hygiene and should at least be free from pathogenic organisms and toxic substances. The quality of water depends on the location of source and state of environmental protection in a given area. High content of total dissolved solids (salinity), fluorides, iron and manganese are the special characteristics of some ground waters acquired though geo contamination and sea water intrusion. For effective management of water resource, continuous monitoring and appropriate strategies are immense.

Goals for examination of water and wastewater:

The specification of the analytical methods for water and waste water must of course depend on the related aims and expectations. The goals must be well defined before embarking on extensive and costly measurement programs in order to attain an optimal on cost-benefit relationship and a rapid supply of information. In general, the following goals may be formulated for the examination of water and waste water.

Water:

1. Determination of physical, chemical and biological characteristics of water.
2. Determination of pollution sources.
3. Assessment of suitability of water for various purposes such as drinking, industrial, irrigation, fishery and concrete etc.
4. Establishment of size of various treatment units.
5. Preparation for water technical processes.
6. Determination of amount of chemicals required for purification and conditioning of water for industrial usage.

Wastewater:

1. Estimation of pollution load and their potential damaged caused by introduction into the water bodies and on land for irrigation
2. Estimation of potential damage to sewers and sewage treatment plants.
3. Preliminary assessment for planning and operation of waste water treatment plants.
4. Testing of selected detrimental parameters for calculation of discharge cess by regulating authorities.
5. To find out the presence of toxic constituents such as cyanide, cadmium, mercury etc., and to evaluate the degree of toxicity in the treatment system.

6. To find out the substance that causes difficulties in treatment as foam, non-biodegradable organics.
7. To find out the treatability constants and to arrive design parameters for an effective treatment plant unit sizes for a specific wastes.

General:

Fresh water on the earth is received through hydrological cycle. This water is quite pure, but coming down from atmosphere and flowing along the earth surface as run-off, it gathers impurities and gets polluted. These substances thus entered into the water may be either dissolved or suspended forms which alter the water quality. Part of this water percolates into the ground and slowly moves through the strata establishing rock-water-interactions.

The net result is that many of dissolved mineral matter appear in the ground water. Untreated and partially treated domestic and industrial waste water discharged further intensify the degree of deterioration of surface water quality. Agricultural return waters especially with high plant nutrients contaminate the natural waters. Major uses of waters are drinking, industrial, irrigation, recreation, fishery culture etc. The water supplied to the specific tools should follow certain standards.

Drinking Water Standards:

Water supplied to the consumer should not have any impurities, which cause taste and odour, colour, toxicity and injuries substances to human health. The different impurities in water which cause undesirable effects may be classified into Physical, chemical, biological, radiological parameters.

The standards prescribed for potable water supplies by different authorities usually give two types of norms e.g. permissible and tolerable concentration for the different impurities. Indian council of medical research (ICMR), bureau of Indian standards have published standards for portable waters different countries have published similar standards which can be used for all gives the standards for the different impurities.

Sampling

The collection of water samples may seem a relatively simple task. However to obtain representative water samples and to preserve their integrity until they are analyzed in the laboratory requires a series of steps, procedures and practices. A representative sample can easily be obtained from rivers and lakes which are relatively homogeneous, whereas many water-bodies have significant spatial and temporal variations and the collection of a representative sample becomes much more complex.

The objective of the sampling is to collect a portion of material small enough in volume to be conveniently transported to and handled in the laboratory while still accurately representing the material being sampled. This implies, first, that the relative portions of the concentrations of all pertinent components must be the same in the samples as in the material being sampled and second, that the sample must be handled in such a way that no significant changes in composition occurs before the tests are performed.

The analysis is generally intended to reveal the composition of the waters at the time or over the period of sampling. Consequently errors are introduced if changes take place between taking of the sample and analysis being carried out. There is in fact, a strong likelihood that such changes will occur in most of the waters. The arrangement should be such that these are prevented or at least minimized.

Planning Of Sampling

The monitoring of water quality to give reliable and usable data requires the analytical and other resources are employed to the best advantage.

The first step in the planning of water monitoring is to decide what data is needed and how it is useful. The type of investigation, purpose of study and anticipated variations are other points to be considered. The first stage of planning of the sampling programme is the selection of the most suitable site to provide the required data.

Site Selection :

The objectives of water quality monitoring system are

- 1) To assess the impact of activities by man upon the quality of water and its suitability for required uses
- 2) To determine the quality of water in its natural state which might be available to meet the future needs and
- 3) To keep under observation the sources and path way of specified hazardous substances.

The selection of sampling site is decided by the various uses of the water and by their location, relative magnitude and importance. The chances of accidental pollution is also an important factor and should be considered. The location of a river used down stream of large urban or industrial area, imposes greater risk and requires more supervision than similar uses located upstream.

Type Of Samples:

1. Grab or catch samples:

A sample collected at a particular time and place can represent only the composition of the source at that time and place. However, when a source is known to be fairly constant in composition over a considerable period of time or over substantial distances in all directions, then the sample may be said to represent a larger time period or larger volume or both, than the specific point at which it was collected. In such circumstances same source may be quite well represented by single grab samples.

When a source is known to vary with time, grab samples collected at suitable intervals can be of great value in documenting the extent, frequency, and duration of these variations. In case the composition of a source varies in space rather than in time, a set of samples collected from appropriate locations with less emphasis on timing may provide the most useful information.

2. Composite samples:

The term composite refers to a mixture of grab samples collected at the same sampling point at different times. Sometimes the term time composite is used when it is necessary to distinguish this type of sample from other. Time composite samples are most

useful for observing average concentrations, as an alternative to the separate analysis of a large number of samples, followed by computation of average and total results.

A composite sample of 24 hr. period is considered standard for most determinations. Composite samples cannot be used for determinations, of components or characteristics subject to significant and unavoidable changes on storage.

3. Integrated samples:

Mixture of grab samples collected from different points simultaneously or as nearly as possible is called integrated sample. Such samples are useful for river or stream that varies in composition across its width and depth. The need for integrated samples also may exist if combined treatment is proposed for several separate waste water stream. The preparation of integrated samples requires special equipment to collect samples from a known depth, without contamination by over lying water. Prior knowledge about volume, movement and composition of the various parameters of the water being sampled is also required.

Sampling Frequency:

Water samples should be collected at intervals so that no change in quality could pass unnoticed. The quality of water in various water bodies is rarely if ever constant in time but is subjected to change.

The larger the number of samples from which the mean is derived, the narrower will be the limits of the probable difference between observed and true values. However, the sampling schedule is a compromise between accuracy and the funds, personnel for the work.

Number Of Samples :

Number of samples and how often should samples be collected, are calculated by statistical considerations. The following frequencies of sampling may be adopted provisionally.

- a) Weekly samples for one year
- b) Daily samples for 7 days consecutively (4 times/year)
- c) Round the hour sampling for 24 hours
- d) 4-hourly samples for 7 days - and 4 times/year

The parameters may be limited during these samplings but should be pertinent to the source/sampling station. The analytical data collected as per the above procedure will help to lay proper emphasis on parameters of relative importance; their ranges, interferences, and frequencies of their occurrence. This is applicable to rivers, lakes, industrial effluent outfall.

Sample Containers :

It is advantageous to measure the quantity of water in situ by means of sensors which are lowered into position rather than by withdrawing samples. However, it is not always possible. Water samples are, therefore, collected in suitable containers. A sample container must satisfy the following requirements.

1. It could easily be freed from contamination.
2. It should not change the relevant water characteristics.
3. It should have adequate capacity for storing the samples.

4. It should be resistant to impact and to internal pressure which is increased by expansion of water or by release of dissolved gases at elevated temperature on storage.

The sample bottle may be made of either glass or plastic usually polyethylene. It must be capable of being tightly sealed either by stopper or cap. The bottles should be soaked with 10% HCl for 24 hours and then thoroughly cleaned and rinsed with distilled water. The specific situation will determine the use of the bsg or pec (bsg- Borosilicate glass bottle, pec-polyethylene container). Rinse with chromic acid solution (35 ml saturated $\text{K}_2\text{Cr}_2\text{O}_7$ in 100 ml cone H_2SO_4) followed by tap and distilled water and then invert them to dry.

Table 1: Standards for Drinking Water

Parameter	Indian Standards (Is 10500-2012)		ICMR		WHO	
	(R)	(P)	(R)	(P)	(R)	(P)
Physical:						
Colour (units)	5	15	5	25	5	50
Taste and odour	Agreeable		Nothing disagreeable		Unobjectionable	
Turbidity(NTU)	1	5	5	25	5	25
Chemical:						
pH	6.5-8.5	6.5-9.2	7-8.5	6.5-9.2	7-8.5	6.5-9.2
Total Alkalinity	200	600				
Total dissolved solids	5000	2000	--	--	500	1500
Total hardness	200	600	300	600	--	--
Calcium	75	200	75	200	75	200
Magnesium	30	100	50	150	50	150
Copper	0.05	1.5	1.0	3.0	1.0	1.5
Iron	0.3	1.0	0.3	1.0	0.3	1.0
Manganese	0.3	1.0	0.1	0.5	0.1	0.5
Chlorides	250	1000	250	1000	200	600
Sulphates	200	400	200	400	200	400
Nitrate	45	--	20	50	--	50-100
Fluoride	1.0	1.5	1.0	2.0	0.5	1.0-1.5
Free residual Chlorine	0.2	1				
Phenol substances	0.001	0.002	0.001	0.002	0.001	0.002
Toxic:						
Arsenic	0.01	--	--	0.2	--	0.2
Cadmium	0.003	--	--	0.05	--	0.05
Cyanide	0.05	--	--	0.01	--	0.01
Lead	0.01	--	--	0.1	--	0.1
Selenium	0.01	--	--	0.05	--	0.01

Zinc	5.0	15.0	--	--	--	--
Mercury	0.01	--	--	--	--	--
Bacteriological E Coli	Shall not be detectable in any 100 ml sample		1 coliform per 100ml		1 coliform per 100ml	
Radioactivity:						
Alpha emitters(Bq/l)	0.1	No relaxation	--			
Beta emitters(Bq/l)	1.0	No relaxation	--			

A = Requirable Limit E = Permissible limit

Note: All units except otherwise mentioned and pH, specific conductance are in mg/L.

Table 2: Standards for Irrigation Water (BIS 11624)

Sl no	Parameter	Tolerable concentration
1.	Total salts	2000
2.	sulphates	480
3.	Chlorides	355
4.	Sodium percentage	60
5.	Boron	2
6.	Electrical conductivity	2250 × 10 ⁻⁵ mhos
7.	Aluminium	1.0 (20 c)
8.	Arsenic	1.0 (10 c)
9.	Cadmium	0.005 (0.05)
10.	Chromium	5.0 (20.0)
11.	Beryllium	0.5 (20.0)
12.	Cobalt	0.2 (10.0)
13.	Copper	0.2 (10.0)
14.	Fluoride	1.0 (1.0)
15.	Iron	1.0 (1.0)
16.	Lead	5.0 (20.0)
17.	Manganese	2.0 (20.0)
18.	Nickel	0.5 (2.0)
19.	Zinc	5.0 (10.0)
20.	Vanadium	10.0 (10.0)

- All parameters are expressed in mg/L except EC
- The values of metal ions which are given in brackets represent tolerance concentration for short term use in fine textured soils only.

Table 3: Tolerable Concentration of Impurities in Mixing Water of Concrete IS 456

Sl no	Parameter	Tolerable concentration
1.	pH	6 to 8
2.	Acidity (as CaCO ₃)	50
3.	Alkalinity (as CaCO ₃)	250
4.	Organic solids	200
5.	Inorganic solids	3000
6.	Sulphates	500
7.	Chlorides	2000 for plane concrete 3000 for R.C.C
8.	Suspended matter	2000
9.	Free CO ₂	25
10.	Sodium and potassium	1000
11.	Carbonates and bicarbonates	100
12.	Magnesium	200
13.	Sulphide	no detectable
14.	Humid acids and hydrocarbons	no detectable

Note: All parameters are expressed in mg/L except pH

1. Determination of pH, Acidity, Alkalinity

1a pH

Aim: To determine pH of the given sample.

Principle:

pH is measured by a pH meter using a glass electrode which generates a potential varying linearly with the pH of the solution in which it is immersed. It is a Nernstian concentration cell with potential controlled by the activities of H^+ on either side of a thin glass membrane. The latter is the bottom part of a bulb at the end of a glass tube containing a reference solution of fixed a^+_{H} .

$$E = \text{constant} + \ln$$
$$= \text{constant} + 0.058 \text{ pH at } 20^\circ$$

A calomel or Ag/AgCl/KCl reference electrode is usually located around the glass electrode stem for sample operation.

Apparatus:

1. pH meter along with electrodes.
2. Thermometer.
3. Universal indicator.

Reagents

1. pH Standard Buffer solution. 7, 4.01 & 9.2

Interfering factors:

At pH values above 10, so called alkali errors may occur. In such cases, the use of an alkali resistant electrode is recommended. Changes in glass structure can occur in older electrodes, so that the errors may appear when measuring in weakly buffered waters. In such cases, the electrode should be renewed.

The sensitivity can be reduced by the presence of oil in the samples. Measurement errors in oil-containing waters may be prevented by washing the electrode before each measurement using soaps or detergents followed by water, dilute hydrochloric acid and finally with more water.

Preparation of reagents

Buffer solution of pH 4.01: take 100ml standard measuring flask and place a funnel over it. Using the forceps carefully transfer one buffer tablet of pH value 4.01 to the funnel. Add little amount of distilled water, crush the tablet and dissolve it. Make up the volume to 100ml using distilled water. This solution should preferably be stored in a plastic bottle in cool place.

Buffer solution of pH 7: take 100ml standard measuring flask and place a funnel over it. Using the forceps carefully transfer one buffer tablet of pH value 7 to the

funnel. Add little amount of distilled water, crush the tablet and dissolve it. Make up the volume to 100ml using distilled water. This solution should preferably be stored in a plastic bottle in cool place.

Buffer solution of pH 9.2: take 100ml standard measuring flask and place a funnel over it. Using the forceps carefully transfer one buffer tablet of pH value 9.2 to the funnel. Add little amount of distilled water, crush the tablet and dissolve it. Make up the volume to 100ml using distilled water. This solution should preferably be stored in a plastic bottle in cool place.

Procedure:

1. Calibrate the electrode with any 2 standard buffer solutions of pH 4.0 and 9.2. (A buffer solution is a solution offering resistance to change in pH and whose pH value is known.)
2. The sample temperature is determined at the same time and is entered into the meter to allow for a temperature correction.
3. Rinse the electrode thoroughly with de-ionized distilled water and carefully wipe with a tissue paper.
4. Dip the electrodes into the sample solution, swirl the solution and wait up to one minute for steady reading. A pH meter reading within ± 0.1 pH unit will be adequate for such work.
5. The reading is taken after the indicated value remains constant for about a minute.

Using Universal indicator

1. Take 10 ml sample in a beaker add 2 drops of universal indicator allow one minute developing constant colour.
2. Compare the colour of the water sample with the colour code given on the indicator bottle and find out the pH

Environmental significance:

pH (6.5 to 8.5) has no direct adverse effect on health, however a lower value below 4 will produce sour taste and higher value above 8.5 a bitter taste. Higher value of pH hastens the scale formation in water heating apparatus and also reduces the germicidal potential of chlorine. High pH induces the formation of trihalomethanes which are causing cancer in human beings.

pH below 6.5 starts corrosion in pipes, thereby releasing toxic metals such as Zn, Pb, Cd and Cu etc. According to BIS, water for domestic consumption should have pH range 6.5 to 8.5.

Application of pH data in Environmental engineering practice:

1. Determination of pH is one of the important objectives in biological treatment of waste waters. In anaerobic treatment, if the pH goes below 5 due to excess accumulation of acids, the process is severely affected. Shifting of pH beyond 5 to 10 upsets the aerobic treatment of the waste waters. In these circumstances, the pH

can be adjusted by addition of suitable acid or alkali to optimize the treatment of the waste waters.

2. pH value or range is of immense value for any chemical reaction. A chemical shall be highly effective at a particular pH. Chemical coagulation, disinfection, water softening and corrosion control are governed by pH adjustment.
3. Dewatering of sludges, oxidation of cyanides and reduction of hexavalent chromium into trivalent chromium also need a favorable pH range.
4. It is used in the calculation of the carbonate, bicarbonate, CO₂ corrosion, stability index and acid base equilibria.

Observations and calculations:

Description of sample	pH	
	pH meter	Universal indicator

Result:

Comments:

1.B : Acidity

Aim: To determine Acidity (base capacity) of the given sample.

Principle:

The mineral acids present in the sample which are contributing mineral acidity can be calculated by titrating or neutralizing samples with strong base NaOH to pH 4.3. The CO₂ and bicarbonates (carbonic acid) present and contribute CO₂ acidity in the sample can be neutralized completely by continuing the titration to pH 8.2.

Theory

Acidity is a measure of the capacity of water to neutralize bases. Acidity is the sum of all titrable acid present in the water sample. Strong mineral acids, weak mineral acids such as carbonic acid, acetic acid present in the water sample contributes to acidity of water. Usually CO₂ is the major acidic component present in the unpolluted surface waters. Acidity of sample is its quantitative capacity to react with a strong base to a designated pH. Acidity is of two types i.e. Mineral acidity and Total Acidity. Mineral acidity is due to presence of carbon di-oxide present in water /waste sample. Total acidity is due to the presence of sulphuric acid, hydrochloric acid present in a water sample. The acidity in natural water is primarily due to carbon di-oxide dissolved in water. In water polluted by industrial effluents acidity may reduce to mineral acids

Interference:

Colour, turbidity, iron, aluminium or manganese and residual chlorine are prime sources of interference. Colour and turbidity can be avoided using potentiometric titrations. Residual chlorine can be removed by adding sodium thiosulphate, iron, aluminium and manganese is prevented by the addition of Na-K tartrate.

Apparatus:

1. Burette
2. Conical flask
3. Pipettes.

Reagents:

1. Standard sodium hydroxide (0.02N):
2. Phenolphthalein indicator
3. Methyl orange indicator
4. Sodium thiosulphate (0.1N)
5. Carbon dioxide free distilled water.

Procedure:

CO₂ acidity (Phenolphthalein acidity)

1. Pipette out 100ml of sample in a conical flask.
2. Add 3 drops of phenolphthalein indicator.
3. If the colour doesn't change, titrate against 0.02N NaOH from a burette until colour changes from colourless to permanent pink

4. If the sample gives a pink colour on addition of phenolphthalein indicator, acidity is not available.
 5. Record the amount of 0.02N NaOH used in ml (V1)
- 2. Mineral acidity (methyl orange acidity)**
1. Pipette out 100ml of sample in a conical flask.
 2. Add 2 drops of methyl orange indicator.
 3. If it gives orange colour mineral acidity is present.
 4. Titrate against 0.02N NaOH from a burette until the colour changes from orange to pale yellow (V2).

Environmental significance of carbon dioxide and mineral acidity:

1. Acidity interferes in the treatment of water (as in softening).
2. It corrodes pipes (zinc coating of G.I. pipes got dissolved).
3. Aquatic life will be affected.
4. pH is critical factor for bi-chemical reaction. The favorable pH is 6.8 to 7.5.
5. Water contains mineral acidity are so unpalatable.
6. Water having acidity more than 50mg/L cannot be used in R.C.C. works.

Application of acidity data in Environmental engineering practice:

1. The amount of CO₂ present is an important factor in determining whether removal by aeration or simple neutralization with lime or sodium hydroxide will be chosen as the treatment method.
2. The size of equipment, chemical requirement, storage space and cost of treatment all depend upon amount CO₂ present.
3. CO₂ is an important consideration in estimating chemical requirements for lime or lime soda-ash softening processes.
4. Most industrial wastes containing mineral acidity must be neutralized before they are subjected to biological treatment or direct discharge into water courses or sewers. Quantities of chemicals, size of chemical feeders, storage space and costs are determined from the laboratory data of acidity.

Result:

Mineral acidity of the given sample (mg/L) =

CO₂ acidity of the given sample (mg/L) =

Total acidity of the given water sample (mg/L) =

Observations and calculations:**Tabular column:**

Sample details	Vol. of sample taken (ml)	Methyl orange indicator			Phenolphthalein indicator		
		I.B.R (ml)	F.B.R (ml)	Vol. of NaOH (ml) V ₁	I.B.R (ml)	F.B.R (ml)	Vol. of NaOH (ml) V ₂

Total acidity = Mineral Acidity + CO₂ Acidity

Calculations:

Mineral acidity due to mineral acids (as CaCO₃) (mg/L) = $V_1 \times N \times 50 \times 1000 / \text{ml of Sample taken}$

CO₂ acidity due to CO₂ (as CaCO₃) (mg/L) = $V_2 \times N \times 50 \times 1000 / \text{ml of Sample taken}$

Total acidity as (CaCO₃) = Mineral acidity + CO₂ acidity.

1.C : Alkalinity

Aim: To determine the alkalinity of the given water sample.

Principle:

Alkalinity can be obtained by neutralizing OH^- , CO_3^{2-} and HCO_3^- with standard H_2SO_4 . Titration to pH 8.3 or decolourization of phenolphthalein indicator will show complete neutralization of OH^- and $\frac{1}{2}$ of CO_3^{2-} , while to pH 4.4 or sharp change from yellow to pink of methyl orange indicator will indicate total alkalinity i.e. OH^- , CO_3^{2-} and HCO_3^- .

Interference factors:

Interference caused by color, turbidity or free chlorine have already been discussed in acidity test. In addition, absorption or loss of carbon dioxide during or after sample collection can falsify the Result.

Apparatus:

1. Burette
2. Conical flask
3. Pipettes

Reagents

1. Standard sulphuric acid (0.02N)
2. Phenolphthalein indicator
3. Methyl orange
4. Carbon dioxide free distilled water
5. Sodium thiosulphate(0.1N)

Preparation of Reagents:

1. Standard sulphuric acid (0.02N): Prepare 0.1N H_2SO_4 by diluting 3ml concentrated sulphuric acid to 1000ml in a volumetric flask. Standardize it against standard 0.1N sodium hydroxide. Pipette 20mL of concentrated 0.1N sulphuric acid and add slowly along the sides of the standard flask. Then make up the volume up to 1000mL mark. Now the strength of this solution is 0.02N

Procedure:

1. Partial Alkalinity (Phenolphthalein Alkalinity)

1. Take 100 ml of the given sample in a conical flask.
2. Add 1 drop of 0.1N sodium thiosulphate solution to remove the free residual chlorine if present.
3. Add 2 drops of phenolphthalein indicator. The sample turns pink.
4. Run down 0.02N standard sulphuric acid till the solution turns to colourless.
5. Note down the volume of H_2SO_4 added (V_1).

2. Total Alkalinity (Methyl Orange Alkalinity)

6. Add 2 drops of methyl orange indicator to the same above sample .
7. The sample turns to yellow.
8. Resume titration till the colour of the solution changes from yellow to orange.
9. Note down the total volume of H_2SO_4 added (V_2).

Public health significance:

1. Highly alkaline water is usually unpalatable and consumers tend to seek other supplies.
2. Chemically treated waters sometimes have rather high pH values which have met some objection on the part of consumers.
3. Large amount of alkalinity imparts a bitter taste to water.
4. The principle objection of alkaline water is the reactions that can occur between alkalinity and certain cations in waters. The resultant precipitate can foul pipes and other appurtenances of water distributions systems.

Application of alkalinity data in E.E. practice:

1. **Chemical coagulation of water and waste water:** To neutralize acids produced during flocculation. The sample should be alkaline as otherwise further flock formation [either $Al(OH)_3$ or $Fe(OH)_3$] slowly ceases.
2. **Water softening:** To find out the quantity of lime and soda-ash required for the removal of hardness, alkalinity should be found out.
3. **Corrosion control:** To control the corrosion due to acids, natural waters are rendered to alkaline.
4. **Effluents of waste water:** Waste waters containing excess caustic (hydroxide) alkalinity are not to be discharged into natural water bodies of sewers.

Excess alkalinity in water is harmful for irrigation which leads to soil damage and reduce crop yields. Water having an alkalinity content of <250 mg/L is desirable for domestic consumption.

Result

Hydroxide alkalinity of the given sample is =

Carbonate alkalinity of the given sample is =

Bicarbonate alkalinity of the given sample is =

Partial alkalinity of the given sample is =

Total alkalinity of the given sample is =

Observations and calculations:**Tabular column:**

Sample details	Vol of sample Taken (ml)	Phenolphthalein			Methyl orange		
		I.B.R (ml)	F.B.R (ml)	H ₂ SO ₄ used V ₁ (ml)	I.B.R (ml)	F.B.R (ml)	H ₂ SO ₄ Used V ₂ (ml)

Phenolphthalein alkalinity (P) in mg/L as CaCO₃ = $V_1 \times N \times 50 \times 1000 / \text{ml of sample taken}$

Total alkalinity (T) in mg/L as CaCO₃ = $V_2 \times N \times 50 \times 1000 / \text{ml of sample taken}$

Data interpretation table.

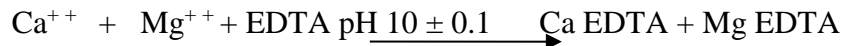
Value of P and T	Alkalinity due to		
	OH ⁻	CO ₃ ^{- -}	HCO ₃ ⁻
P=0	0	0	T
P < 1/2 T	0	2P	T-2P
P = 1/2 T	0	2P	0
P > 1/2 T	2P-T	2T-2P	0
P=T	T	0	0

2.Determination Magnesium & Total Hardness of Calcium,

Aim: To determine the total hardness, Calcium and Magnesium of the given sample.

Principle:

In alkaline condition, EDTA reacts with Ca and Mg to form a soluble chelated complex. Ca and Mg ions develop wine-red colour with Erio Chrome black T under alkaline condition. When EDTA is added as a titrant, Ca and Mg divalent ions get complexed resulting in sharp change from wine-red to blue which indicates end point of the reaction.



The pH for this titration has to be maintained at 10.0 ± 0.1 . At a higher pH i.e. at about 12 Mg^{++} ion precipitates and only Ca^{++} ion remain in solution. At this pH Murexide indicator forms a pink colour with Ca^{++} . When EDTA is added Ca^{++} gets complexed resulting in a change from pink to purple which indicates end point of reaction.

Interference:

The presence of various heavy metals can cause the colour change to be unclear. Metal ions interference can be overcome by addition of inhibitors.

Reagents:

1. Standard EDTA solution (0.01M)
2. Ammonia Buffer solution.
3. Erio chrome black T indicator.
4. Murexide indicator.
5. Sodium hydroxide 2N.

Preparation of reagents

Buffer solution: Dissolve 16.9g of ammonium Chloride with 143ml ammonium hydroxide in a beaker. Add 1.179g of EDTA and 780mg of Magnesium Sulphate to the same beaker. Transfer all the contents to 250ml volumetric flask. Make the volume 250ml by adding distilled water up to the mark.

Erichrome black T: Mix 0.5g of Erichrome Black - T with 100 g of NaCl. Use it as dry powder.

Standard EDTA solution: weigh 3.726g of EDTA and transfer it into a 1000ml volumetric flask. Make the volume 1000ml by adding distilled water up to the mark.

Standardisation of EDTA: Weigh 0.25g of anhydrous CaCO_3 into a 250 ml Std. Flask. Add HCl till the effervescence ceases. Make up to the volume with distilled water. (0.01 M). Titrate 25 ml of the above CaCO_3 solution with 2 ml buffer against EDTA solution using Erichrome Black - T as indicator.

4. Magnesium hardness, particularly associated with sulphate ion has laxative effects on persons unaccustomed to it.
5. It makes food tasteless.
6. It affords the working of dyeing process.
7. It also precipitates protein of meat and make tasteless.

Application of hardness data in E.E. practice:

1. Hardness of water is important in determining the suitability of water for domestic and industrial uses.
2. The relative amounts of calcium and magnesium hardness, carbonate and non-carbonate hardness present in water are the factors while determining the most economical type of softening process.
3. Determination of hardness serves as a basis for routine control of softening processes.

Result :

1. Total hardness of the given water sample is
2. Calcium hardness of the given water sample is
3. Magnesium hardness of the given water sample is
4. Calcium content of the given water sample is
5. Magnesium content of the given water sample is

Observations and Calculations:

Hardness	ml of sample taken	Sample details	I.B.R (ml)	F.B.R (ml)	Vol. of EDTA (ml)	Hardness (mg/L)
Total hardness						
Calcium hardness						

Volume of sample taken =

Calculations:

Total Hardness (mg/L) = $(A-B) \times \text{Molarity of EDTA} \times \text{Mol. Wt of CaCO}_3 \times 1000 / \text{ml of sample taken}$
as CaCO_3

Calcium Hardness (mg/L) as $\text{CaCO}_3 = A_1 * 1000 / \text{ml of sample taken}$

where $A_1 = \text{volume of EDTA used by sample}$

Magnesium Hardness (mg/L) as CaCO_3

$\text{CaCO}_3 = \text{Total Hardness (mg/L) as } \text{CaCO}_3 - \text{Calcium Hardness (mg/L) as } \text{CaCO}_3$

3. Determination of Dissolved Oxygen

Aim: To find the quantity of Dissolved oxygen present in the given sample.

Principle:

Oxygen present in sample oxidizes the divalent manganese to its higher valency which precipitates as a brown hydrated oxide after addition of NaOH and KI. Upon acidification, manganese reverts to divalent state and liberates iodine from KI equivalent to D.O. content in the sample. The liberated iodine is titrated against $\text{Na}_2\text{S}_2\text{O}_3$ (0.25N), using starch as an indicator. If oxygen absent in sample, the MnSO_4 react with the alkali to form white precipitate $\text{Mn}(\text{OH})_2$.

Theory

Oxygen is poorly soluble in water. Its solubility is about 14.6 mg/L for pure water at 00 C under normal atmospheric pressure and it drops to 7 mg/L at 350 C. Aerobic bacteria thrive when free oxygen is available in plenty. Aerobic conditions do prevail when sufficient D.O. is available within water. End product of airo-biosis is stable and is not foul smelling. While a minimum DO of 4 to 5 mg/L is desirable for the survival of aquatic life, higher values of DO may cause corrosion of steel and iron. High temperature, biological impurities, ammonia, nitrates, ferrous iron, chemicals such as hydrogen sulphide and organic matter reduce DO values. Algae growth in water may release oxygen during its photosynthesis and DO may even shoot up to 30 mg/L. Drinking water should be rich in DO for good taste.

Interference: Ferrous ion, ferric ion, nitrate, microbial mass and high suspended solid constitute the main source of interferences.

Apparatus:

1. BOD bottles (capacity 300 ml)
2. Burette
3. Pipettes.

Reagents:

1. Standard sodium thiosulphate (0.025 N)
2. Manganous sulphate
3. Alkali iodide-azide reagent
4. Starch indicator
5. Concentrated sulphuric acid

Preparation of reagents

Standard Sodium Thiosulphate Solution (0.025N) : Dissolve 6.205 g. ($\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$) sodium thiosulphate powder in 1 litre distilled water and add 0.4 g NaOH powder.

Manganous Sulphate Solution: (Dissolve 480 g. $\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$ or 400 g. $\text{MnSO}_4 \cdot 2\text{H}_2\text{O}$ or) 364 g $\text{MnSO}_4 \cdot \text{H}_2\text{O}$ in distilled water, filter it and dilute it 1 litre.

Alkali-Iodide-Azide Reagent: Dissolve 10 g. NaN_3 (Sodium Azide) in 500 ml distilled water and Add 480 g. NaOH and 750 g Sodium Iodide (NaI) and until dissolved

or

Dissolve 500 g. of NaOH in distilled water, add 20 g. NaN_3 and 150 g. of KI and dilute it to 1 litre.

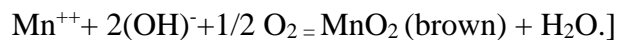
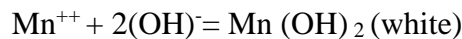
To prepare this reagent, take 700 g of potassium hydroxide/500 g of sodium hydroxide and add 150 g of potassium iodide/ 135 g of sodium iodide and dissolve in freshly boiled and cooled water and make up to 1000 ml.

Starch Indicator Solution: Make a thin paste of 2 g. starch in cold water. Pour this into a conical flask and dilute into 200 ml and boil it until this starch dissolve.

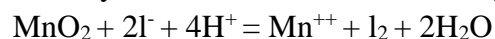
Procedure (Winkler methods):

1. Take a 300ml BOD bottle and collect water sample in it completely.
2. Add 2 ml of manganous sulphate and 2 ml of alkali iodide-azide solution to the BOD bottle. The tip of the pipette should be below the liquid level, while adding these reagents.
3. Restopper with care to exclude air bubbles and mix by repeatedly inverting the bottle 2-3 times.

[If no oxygen is present, the manganous ion reacts with hydroxide ion to form white precipitate of $\text{Mn}(\text{OH})_2$. If oxygen is present, some Mn^{++} is oxidized to M^{++} and precipitates as a brown coloured manganic oxide.



4. After shaking and allowing sufficient time for all oxygen to react, the chemical precipitates are allowed to settle leaving clear liquid within the upper portion.
5. Add 2 ml of concentrated sulphuric acid.
6. The bottle is restoppered and mixed by inverting until the suspension is completely dissolved and yellow colour is uniform throughout the bottle.



7. A volume of 203 ml is taken into the conical flask to get actual volume of sample 200 ml and titrated with 0.025N sodium thiosulphate solution until yellow coloured iodine turns to pale straw colour.

Gross sample ml (sample+ reagent)	Actual sample
300	296
X	200

$$X = \frac{200 \times 300}{(300 - 4)} = 203\text{ml}$$

8. Since it is impossible to accurately titrate the sample from pale yellow to a colourless liquid, 1 drop of starch solution is added.
9. Continue titration till colour changes from blue to colourless.

Environmental significance:

Oxygen is poorly soluble in water. Its solubility is about 14.6 mg/L for pure water at 0^oC under normal atmospheric pressure and it drops to 7 mg/L at 35^oC. Aerobic bacteria thrive when free oxygen is available in plenty. Aerobic condition does prevail when sufficient D.O. is available within water. End product of airobiosis is stable and is not foul smelling.

While a minimum D.O. of 4 to 5 mg/L is desirable for the survival of aquatic life, higher values of D.O. may cause corrosion of steel and iron.

High temperature, biological impurities, ammonia, nitrates, ferrous iron, chemicals such as hydrogen sulphide and organic matter reduce D.O. values.

Algae growth in water may release oxygen during its photosynthesis and D.O. may even shoot up to 30 mg/L.

Drinking water should be rich in D.O. for good taste.

Application of dissolved oxygen data in Environmental engineering practice:

1. It is necessary to know D.O. levels to assess quality of raw water and to keep a check on stream pollution.
2. D.O. test is the basis for BOD test which is an important parameter to evaluate organic pollution potential of a waste.
3. D.O. test is necessary for all aerobic biological waste water treatment processes to control the rate of aeration.
4. Oxygen is an important factor in the corrosion iron and steel. D.O. test is used to control oxygen in boiler feed water.
5. D.O. test is used to evaluate the pollution strength of domestic and industrial wastes.
6. Determination of D.O. in waste water is useful to identify the nature of biochemical reactions – whether aerobic which gives out stable end products (H₂O and CO₂) and do not produce any foul smells or anaerobic whose end products are unstable and produce foul smells (H₂S).

Result: Dissolved Oxygen Content of the given water sample is

Calculations:

1 ml of 0.025 N Na₂S₂O₃ is equivalent to 0.2 mg of O₂, since the volume of the sample is 200 ml.

1 ml of solution thiosulphate is equivalent to

$$\frac{0.2 \times 1000}{200} \text{ mg/L} = 1 \text{ mg/L}$$

Observation:

Sample Details	Vol. of Sample taken Ml	Initial burette reading ml	Final burette reading ml	ml of Na ₂ S ₂ O ₃ solution used	D.O. in mg/L

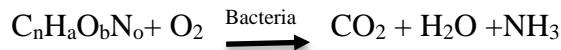
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4. Determination of BOD

Aim: To determine Biological Oxygen Demand (BOD) exerted by the given waste water sample.

Principle:

The BOD is an empirical biological test. This BOD test may be considered as wet oxidation procedure in which the living organisms serve as the medium for oxidation of the organic matter to carbon-dioxide and water.



On the basis of the above relationship, it is possible to interpret BOD data in terms of organic matter as well as the amount of oxygen used during its oxidation.

Interference:

Undesirable oxygen consumption via nitrification can be prevented by addition of 1ml of an N-allylthourea solution. Free chlorine, present in some waste waters after chlorination reacts with organic components within about 2 hours and does not interfere. Compounds which use up oxygen without the presence of micro-organisms (e.g. iron, sulphite or sulphide ions) are oxidized by leaving the original sample for 2 hours with occasional shaking. Lack of nutrient in dilution water, lack of an acclimated seed organisms and the presence of toxic substances can result in very low BOD values despite the presence of sufficient degradable organic materials. In such cases a series of measurements should be carried out at greater solution.

Reagents:

1. Sodium thiosulphate solution (0.025N)
2. Distilled water
3. Phosphate buffer solution
4. Magnesium sulphate solution
5. Calcium chloride solution
6. Ferric chloride solution
7. Reagents used for DO

Preparation of reagents

Phosphate Buffer Solution: Dissolve 8.5 g. KH₂PO₄, 21.75 g. K₂HPO₄, 33.4 g. Na₂HPO₄, and 1.7 g. NH₄Cl in a liter of distilled water. This solution gives a pH of 7.2

MgSO₄ Solution: Dissolve 22.5 g. of MgSO₄.7H₂O in a liter of distilled H₂O

CaCl₂ Solution: Dissolve 27.5 g. of calcium chloride in a liter of distilled water

Ferric Chloride Solution: Dissolve 0.25 FeCl₃.6H₂O in a liter of distilled water.

Quantity of Distilled Water: Decide number of BOD bottles used for the test. Generally, we give 2 blanks in the beginning and 2 blanks at the end and number of BOD bottles required for the sample of various proportions, say 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5% etc. In this case let us take 4 blanks and 6 BOD bottles (in duplicate). Hence, it requires about 3.0 liters of distilled water. Measure about 4.0 liters of distilled water

Procedure:

1. Place the desired volume of distilled water in a 5litre flask. Aeration is done by bubbling compressed air through water.
2. Add 1ml of phosphate buffer, 1ml of magnesium sulphate solution, 1ml of calcium chloride solution and 1ml of ferric chloride solution for every liter of distilled water to get dilution water.
3. In the case of the waste waters which are not expected to have sufficient bacterial population, add seed to the dilution water. Generally 2ml of settled sewage is sufficient for 100ml of dilution water.
4. Highly acidic or alkaline samples are to be neutralized to a pH of 7.
5. Add 2 or 3ml of sodium thiosulphate solution to destroy residual chlorine if any.
6. Take the samples as follows:
Strong wastes: 0.1, 0.5 or 1%
Settle domestic sewage: 1, 2.5 or 5%
Treated effluents: 5, 12.5 or 25%
River water: 25% to 100%.
7. Dilute the sample with the diluted water and mix the contents well.
8. Take diluted sample into 2 BOD bottles.
9. Fill another two BOD bottles with diluted (distilled) water alone.
10. Immediately find D.O. of a diluted wastewater C_0 and diluted water D_0 as per DO determination
11. Incubate the other two BOD bottles i.e., C_5 and D_5 at 20°C for 5 days. They are to be tightly stopper to prevent any air entry into the bottles.
12. Determine D.O. content in the incubated bottles at the end of 5 days (120 hours).

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. It is the basic criteria for control of stream pollution.

Efficiency of any treatment plant can be judged by considering influent BOD and so also the organic loading on the unit.

If any industrial waste is to be let off into a public sewer, municipal cess depends on volume and BOD of waste water.

Ordinary domestic sewage may have a BOD 200mg/L. Any effluent to be discharged into natural bodies of water should have BOD less than 30mg/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 1mg/L and water is considered fairly up to 3mg/L of BOD, when BOD value reaches 5mg/L, the water is doubtful in purity.

Application of BOD data in E.E. practice:

1. To determine strength of domestic and industrial sewage.
2. The determination of BOD is used in studies to measure the self purification capacity of streams and serves regulatory authorities as a means of checking on quality of effluents discharged to such waters.

3. BOD of wastes is useful in the design of treatment facilities.
4. It is a factor in the choice of treatment method and is used to determine the size of certain units, particularly trickling filters and activated sludge units.
5. It is used to evaluate the efficiency of various treatment units.
6. It is useful to estimate population equivalent of any industrial wastes which is useful to collect cess from industrialist for purification industrial wastes in municipal sewage treatment plant.
7. It is only the parameter to give an idea of the biodegradability of any sample and self purification capacity of rivers and streams.

Observations and calculations:

Let initial D.O. of dilute sample = C_0

D.O. at the end of 5 days for the diluted sample = C_5

Initial D.O. of dilution water (blank) = D_0

D.O at the end of 5 days for the distilled water (blank) = D_5

$$\text{BOD at } 20^\circ\text{C of the sample} = \left[\frac{(C_0 - C_5) \text{ Volume of sample}}{\text{ml of raw sample taken}} \right] - (D_0 - D_5)$$

Observations and calculations:

Sl. No	Vol. of sample (ml)	Dilution ratio	Initial D.O. of sample mg/L	Final D.O. of sample mg/L	Initial D.O. of blank mg/L	Final D.O. of blank mg/L	5days BOD @ 20°C mg/L

Result:

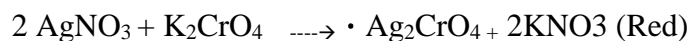
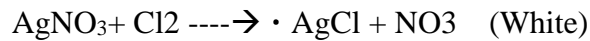
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5.Determination of Chlorides

Aim: To estimate the content of *chlorides* in the given water sample.

Principle:

Chlorine ion is determined by Mohr's method, titration with standard silver nitrate solution in which silver chloride is precipitated at first. The end of titration is indicated by formation of red silver chromate from excess AgNO_3 and potassium chromate used as an indicator in neutral to slightly alkaline solution.



Theory

Chlorides occurs in all natural water in widely varying concentration, the chloride content normally increases as the mineral content increases upland and mountain supplies are usually quite low in chlorides, where as river and ground water usually have a considerable amount. Sea and ocean water represents the residues resulting from partial evaporation of natural water that flow into them and chloride levels are high underground seepage, sewage and industrial wastes and a considerable amount of chloride.

Interference:

Bromide, iodide, cyanide, sulphide, thiosulphate, sulphate, iron and phosphates are prime sources of interference.

Apparatus:

1. Burette
2. Conical flask
3. Pipettes

Reagents:

1. Chloride free distilled water.
2. Potassium chromate indicator 0.25 N.
3. Standard silver nitrate. (0.0141N).

Preparation of reagents

Silver nitrate, 0.0141N: Dissolve 2.395g AgNO_3 and dilute to 1000mL. Standardise against NaCl, 0.0141N; 1mL of 0.0141N $\text{AgNO}_3 = 0.5 \text{ mg Cl}^-$.

Potassium chromate Indicator: Dissolve 25g of potassium chromate in 250ml distilled water. Add silver nitrate solution till red precipitate is formed. Allow it to stand for 12hours. After 12hours filter the solution using filter paper and dilute the filtrate to 1000ml using distilled water.

Procedure:

1. Take 25ml of the sample in conical flask.
[Adjust its pH to be between 7.0 and 8.0 either with sulphuric acid or sodium hydroxide solution. Otherwise AgOH is formed at high pH level or CrO_4^{-2} is converted $\text{Cr}_2\text{O}_7^{-2}$ at low pH levels.]
2. Add 2 drops of potassium chromate indicator solution to get light yellow colour.

3. Titrate with standard silver nitrate solution till colour change from yellow to brick red.
4. Note the volume of silver nitrate added (A).
5. For better accuracy, titrate distilled water in the same manner.
6. Note the volume of silver nitrate added for distilled water (B).

Environmental significance of chlorides:

Chlorides associated with sodium exert salty taste, when its concentration is more than 250 mg/L. There is no known evidence that chlorides constitute any human health hazard. For this reason, chlorides are generally limited to 250 mg/L in supplies intended for public use. In many areas of the world where water supplies are scarce, sources containing as much as 2000mg/L are used for domestic purposes without the development of adverse effect, once the human system becomes adapted to water.

It can also corrode concrete by extracting calcium in the form of calcide, magnesium chloride in water generates hydrochloric acid after heating which is also highly corrosive and create problems in boilers.

Application of chloride in E.E practice:

1. Chlorides determination in natural waters is useful in the selection of water supplies for human use.
2. Chlorides determination is used to determining the type of desalting apparatus to be used.
3. The chloride determination is used to control pumping of ground water from locations where intrusion of sea water is a problem.

Fluorides interfere in the determination of chemical oxygen demand (COD). A correction must be made on the basis of the amount of chlorides present.

Result:

The chloride content of the given water sample is

Observations:

Sample details	Vol of sample Taken (ml)	Observation			Chlorides mg/L
		Initial burette reading (ml)	Final burette reading (ml)	AgNO ₃ Used (ml)	

Calculation:

Chloride in (mg/L) = (A-B) x35.45xNx1000/ml of sample

6. Determination of Percentage of Available Chlorine in Bleaching Powder

Aim: To determine the % Available chlorine in the given sample of Bleaching Powder.

Apparatus: Conical flask, Pipette, Burette.

Reagents: Concentrated acetic acid, Potassium iodide crystals, Sodium thiosulphate (0.025N), Bleaching powder solution (Concentration = 1mg/ml)

Preparation of Reagent:

Standard Sodium Thiosulphate Solution (0.025N) : Dissolve 6.205 g. ($\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$) sodium thiosulphate powder in 1 litre distilled water and add 0.4 g NaOH powder.

Principle:

Chlorine is a strong oxidizing agent and liberates iodine from iodide ion.

$\text{Cl}_2 + 2\text{KI} \rightarrow \text{I}_2 + 2\text{KCl}$ (scratch gives blue colour with iodine).

$\text{I}_2 + \text{starch} \rightarrow \text{Blue colour.}$

The liberated iodine is titrated against with standard sodium thiosulphate which is a reducing agent.

$\text{I}_2 + 2\text{Na}_2\text{S}_2\text{O}_4 \rightarrow \text{Na}_2\text{S}_4\text{O}_4 + 2\text{NaI}$

The disappearance of blue colour indicates the completion of reaction with free iodine is converted back to iodide.

Theory

Even after filtration water is found to have certain impurities. Hence to remove pathogenic bacteria water is disinfected. The universally used disinfectant is chlorine. Chlorine is used in water treatment not only for disinfection but also for other purposes such as to control algae and other growth in reservoirs.

Bleaching powder is one such form of applying chlorine to water this process of applying chlorine to water is called as "chlorination". The chlorine present in the bleaching powder gets reduced with time. So, to find the exact quantity of bleaching powder required, the amount of available chlorine in the sample must be found out.

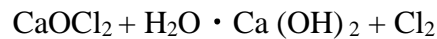
Procedure:

1. Take 1g of fresh bleaching powder add small quantity of water to it and prepare fine paste add some more water. Stir and allow to settle for a few minutes dilute it with distilled water to make upto 1 liter and stopper the container.
2. Take 10 ml of bleaching powder solution in a conical flask and pinch of KI.
3. Add 2 ml of acetic acid and allow the reaction to complete.
4. Titrate the sample with standard sodium thiosulphate solution until the yellow colour of the liberated iodine is almost faded out.

5. Add 1ml of starch solution and titrate until the blue colour disappears.
6. Note down the quantity of sodium thiosulphate added V_1 .
7. Repeat the same procedure for distilled water.
8. Note down the volume of sodium thiosulphate added V_2 .

Environmental Significance:

Chlorine is available in different states gaseous, liquid and also as solid. Bleaching powder is a slaked lime through which chlorine is injected hence it contains calcium oxygen and chlorine (CaOCl_2), it is hydroscopic i.e. absorbs moisture from the atmosphere.



This bleaching powder loses its chlorine content if it is exposed to the atmosphere and due to prolonged storage hence the amount of chlorine contained by decided before application of bleaching powder to water. Chlorination through bleaching powder is called *hydro chlorination*.

Result:

The percentage of available chlorine present in bleaching powder is

Observation and Calculation:

Sample details	Burette readings		Volume of sodium thiosulphate consumed (ml)
	Initial (ml)	Final (ml)	
Bleaching powder solution (V_1)			
Blank solution (V_2)			

Concentration of Available Chlorine (mg/l) = $(V_1 - V_2) \cdot 0.025N \cdot 1000 / \text{ml of sample}$

$$\% \text{ available chlorine} = x = \frac{\text{Concentration of Available Chlorine (mg/l)}}{\text{Concentration of Bleaching powder (mg/l)}} * 100$$

7. Determination of Residual Chlorine

Aim: To find out the amount of residual chlorine available in the given water sample.

Apparatus: Conical flask, pipette, Burette.

Reagent: Acetic acid, starch indicator, Potassium iodide crystals, Sodium thiosulphate (0.0025N),

Preparation of Reagent:

Standard sodium thiosulphate 0.0025 N : Dilute 100 ml stock 0.025N $\text{Na}_2\text{S}_2\text{O}_3$ solution to 1000 ml with freshly boiled and cooled distilled water. Preserve by adding 5 ml chloroform per litre.

Theory

The prime purpose of chlorinating public water supplied and waste water effluents is to prevent the spread of water borne diseases. The proper dosage depends upon the quantity and quality of organic impurities and bacteria present and also upon pH value, temperature, contact period, etc. If chlorine is insufficient the disinfection will not be complete. If in excess it causes bad smell and taste. Therefore the dosage of chlorine is to be worked out with precision.

Total residual chlorine – Free residual chlorine = Combined residual chlorine

Procedure:

1. Take 100ml of Water Sample in a conical flask and pinch of KI
2. Add 5 ml of acetic acid and allow the reaction to complete.
3. Titrate the sample with standard sodium thiosulphate solution until the yellow colour of the liberated iodine is almost fading out.
4. Add 1ml of starch solution and titrate until the blue colour disappears.
5. Note down the quantity of sodium thiosulphate added V_1
6. Repeat the same procedure for distilled water.
7. Note down the volume of sodium thiosulphate added V_2 .

Environmental significance:

Active or residual chlorine (free and combined) should be determined at each stage in the processing of drinking water and in the water. Mains in order to guarantee bacteriologically impeccable water. Active chlorine should be present in drinking water within the range 0.1 to 0.2 mg/L. However, excessive chlorine content may give out bad odour and may change even taste of waters. Further, chlorine is said to be carcinogenic. Hence, except during epidemics 'super chlorination' is not to be done.

Application of residual chlorine data in Environmental engineering practice:

1. Chlorine residual determines is used to control chlorination of domestic and industrial waste waters.
2. Determines of chlorine residual is used universally in disinfection practice to control addition of chlorine so as to ensure effective disinfection without wastes.
3. Determination of chlorine residual in water distribution is useful to find the source of contamination or leakage points, so as to supply wholesome water to the consumer.

Results:

Amount of the residual chlorine in the given sample is =

Observation and Calculation:

Sample details	Burette readings		Volume of sodium thiosulphate consumed in ml
	Initial ml	Final ml	
Chlorinated water (V ₁)			
Blank solution (V ₂)			

Concentration of chlorine = $(V_1 - V_2) * 0.0025N * 1000 / \text{ml of sample taken}$

8.Determination of Solids in Sewage

8. A Total Solids, B. Volatile Solids, Fixed Solids

Aim: To determine the total solids, total volatile and fixed solids of the given sample.

Principle:

Total solids are determined as the residue left after evaporation and drying of the unfiltered sample.

Apparatus:

1. Evaporating dishes (Pyrex, porcelain or platinum)
2. Hot Air Oven
3. Desiccators
4. Water bath

Theory

In potable water, most of the matter is in dissolved form and consists of mainly inorganic salts, small amounts of organic matter and dissolved gasses. Normally sewage contains about 99.9% of water and 0.01% of solids. „Total solids“ is the term applied to the material left in the vessel after evaporation of a sample of water/waste water and its subsequent drying in an oven at a definite temperature. Total solids include “total suspended solids” the portion of total solids retained by a filter and “total dissolved solids” the portion that passes through the filter. Fixed solids are the residue remaining after ignition for 1 hour at 550°C. The solid portion that is volatilised during ignition is called volatile solids. It will be mostly organic matter. Water that is low in organic matter and total mineral content and is intended for human consumption may be examined under 103–105°C or 179–181°C. But water containing considerable organic matter or those with pH over 9.0 should be dried at 179–181°C.

The sample is filtered and the filtrate evaporate in a weighed dish on a steam bath, the residue left after evaporation is dried to constant weight in an oven at either 103–105°C or 179–181°C. The increase in weight over that of the empty dish represents total dissolved solids and includes all materials, liquid or solid, in solution or otherwise, which passes through the filter and not volatilized during the drying process. The difference between the total solids and the total dissolved solids will give the total suspended solids. The dishes with the residue retained after completion of the tests for total solids and total dissolved solids are subjected to heat for 1 hour in a muffle furnace held at 550°C. The increase in weight over that of the ignited empty vessel represents fixed solids in each instance. The difference between the total dissolved/total suspended solids and the corresponding fixed solids will give volatile solids in each instance. All the quantities should be expressed in mg/L. Settleable matter in surface and saline waters as well as domestic and industrial wastes may be determined and reported on a volume basis as milliliter per liter.

Procedure:

A. Total solids

1. A clean porcelain dish is ignited in a muffle furnace and after cooling in the desiccators and weighed(W_1)
2. A 50/100ml of well mixed sample (graduated cylinder is rinsed to ensure transfer of all suspended matter) is placed in the dish and evaporated at 103°C for 24 hour and cool in a desiccators and weigh(W_2)
3. Keep the W_2 porcelain dish in the muffle furnace and Ignite the residue at 600°C to constant weight in 10-15 minutes.
4. Allow the dish to cool and moisten the ash with few drops of distilled water.
5. Dry to a constant weight at 103°C , cool in a desiccators and weigh (W_3).

Application in Environmental engineering practice:

1. Total solids

1. Total solids determination is used to assess the suitability of potential supply of water for various uses. In cases, in which water softening is needed, the type of softening procedure used may be dictated by the total solids content.

2. Corrosion control is frequently accomplished by the production of stabilized waters through pH adjustment. The pH at stabilization depends to some extent upon the total solids present as well as the alkalinity and temperature.

2. Fixed and volatile solids

The water which consists of high volatile solids is not suitable for drinking purpose. The presence of high volatile solids indicates that the water may have been polluted by domestic wastes or other organic wastes. In general, ground water is free from volatile solids unless they have been polluted by waste seepages. But, well waters may have high volatile solids due to lack of proper protection around well to prevent seepage of used water. Surface waters also have high volatile solids due to disposal of domestic and other wastes.

Environmental Significance:

1. Total solids are important as they indicate the strength of the sewage, higher the amount of solids, higher the degree of treatment.
2. Total solids determination decides suitability of potential supply of water for various uses.
3. It is one of the criteria to select the type of softening procedure in water softening treatment.
4. Dissolved solids produce aesthetically displeasing colour, taste and odour.
5. Some dissolved solids may deplete the dissolved oxygen in the receiving waters.
6. Water with higher solids content often has laxative and sometimes the reverse effect upon people whose bodies are not adjusted to them.
7. 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.

8. Suspended solids hinder photosynthetic reaction in a surface water body such as pond, lake, etc.
9. It is also used to evaluate strength of domestic wastewater and to determine the efficiency of treatment units.

Calculations:

Initial weight of the dish = W_1 =

Final weight of the dish = W_2 =

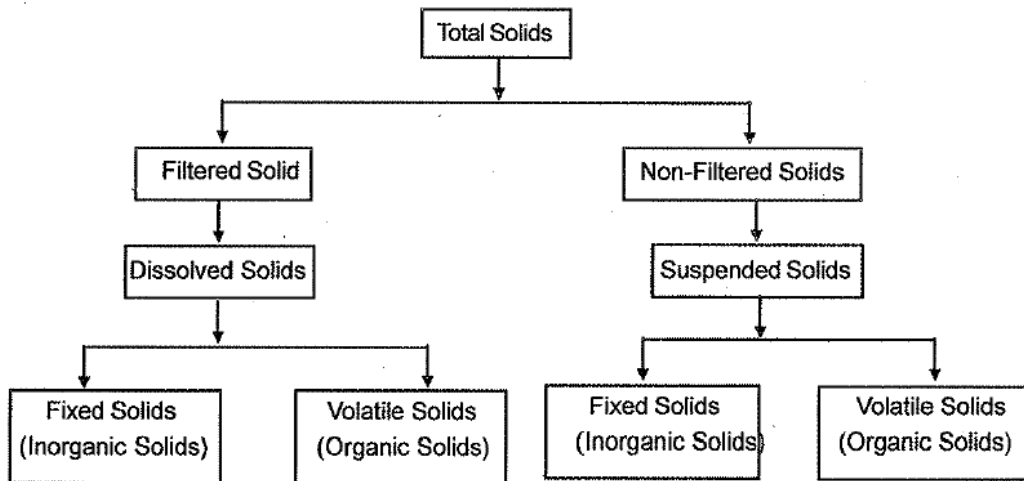
Final weight of the dish after evaporation in muffle furnace in mg= W_3 =

$$(a) \text{ Total solids (T.S) mg/L} = (W_2 - W_1) * 1000 * 1000 / \text{ml of sample taken}$$

$$(b) \text{ Total volatile solids (T.V.S) mg/L} = (W_2 - W_3) * 1000 * 1000 / \text{ml of sample taken}$$

$$(c) \text{ Total fixed solids (T.F.S) mg/L} = T.S - T.V.S$$

Concept Structure



8. C Total Suspended Solids D :Total Dissolved Solids

Aim: To find out Total dissolved solids of the given sample.

Principle:

Total dissolved solids are determined as the residue left after evaporation and drying of the filtered sample.

Apparatus:

1. Evaporating dishes
2. Hot Air Oven
3. Desiccators
4. Whatman filter paper no. 44
5. Water bath.

Procedure:

1. A clean porcelain dish is ignited in a muffle furnace and after partial cooling in the air; it is cooled in a desiccators and weighed. (W4)
2. A 100ml of filtered sample is placed in the dish and evaporated at 100°C on water bath, followed by drying in oven at 103°C for 24 hour.
3. Dry to a constant weight at 103°C, cool in a desiccators and weigh. (W5)

Environmental significance of dissolved solids determination:

Many dissolved substances are undesirable in water. Dissolved minerals, gases and organic constituents may produce aesthetically displeasing colour, taste and odour.

Some dissolved organic chemicals may deplete the dissolved oxygen in the receiving waters and some may be inert to biological oxidation, yet others have been identified as carcinogens.

Water with higher solids content often has a laxative and sometimes the reverse effect on people whose bodies are not adjusted to them.

High concentration of dissolved solids about 3000mg/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.

Result:

The dissolved solids of the given water sample is

Calculations:

Total dissolved solids T.D.S (mg/L) = $(W_4 - W_5) \times 1000 \times 1000 / \text{ml of sample taken}$

Final weight of the dish = W_4

Initial weight of the dish = W_5

Total suspended solids T.S.S in the given water sample is (mg/L) = $T.S - T.D.S$

8 .E Total Settleable Solids

Aim: To find out Total settleable solids of the given sample.

Principle:

The particles in suspension whose specific gravity greater than that of water will settle under quiescent conditions.

Apparatus:

1. Imhoff cone
2. Holding device.

Procedure:

1. Gently fill the imhoff cone with the thoroughly well mixed sample usually one liter and allow it to settle.
2. After 45 minutes, gently rotate the cone between hands to ensure that all solids adhering to the sides are loosened.
3. Allow the solids to settle for 15 minutes more, to make up for a total period of 1 hour.
4. Read the volume of the sludge which has settled in the apex.
5. Express the Result in ml settleable solids per liter of sample per hour.

Precautions:

1. The imhoff cones must be cleaned with a strong soap and hot water using a brush.
2. Wetting the cone with water before use, helps in preventing adherence of the solids to the sides.
3. The method is subjected to considerable in, accuracy if the solids contain large fragments.
4. The determination of total settleable solids should be carried out soon after sampling in order to avoid errors through flocculation.

Application of Total settleable solids data in Environmental engineering practice:

1. The settleable solids determination is used extensively in the analysis of industrial wastes to determine the need for and design of plain settling tanks in plants employing biological treatment processes.
2. It is also widely used in waste water treatment plant operation to determine the efficiency of sedimentation units.

Calculations:

Total settleable solids in the given water sample is (ml/l) =

Observations:

9. Determination of Turbidity by Nephelometer

Aim: To find out Turbidity of the given samples.

Principle:

When light is passed through a sample having suspended particles, some of the light is scattered by the particles. The scattering of the light is generally proportional to the turbidity. The turbidity of sample is thus measured from the amount of light scattered by the sample taking a reference with standard turbidity suspension.

Apparatus:

1. Nephelo-turbidity meter
2. Sample tubes.

Reagents:

1. Standard turbid solution : 40 NTU

Interferences:

The determination of turbidity is interfered by the presence of debris and other rapidly settleable matter. The true colour in the sample reduces the value of turbidity.

Preparation of Reagents:

1. Dissolve 1.0 gm Hydrazine sulphate and dilute to 100ml.
2. Dissolve 10 gm Hexamethylenetetramine and dilute to 100ml.
3. Mix 5 ml of each of the above solution (1 and 2) in a 100ml volumetric flask and allow standing for 24 hours at $25 \pm 3^\circ\text{C}$ and diluting to 1000ml. This solution has a turbidity of 40 NTU.
4. This solution can be kept for about a month.

Procedure:

a) Calibration

1. Switch on the Nephelo-turbidity meter and allow for 10 to 15 minutes warm up.
Set the calibration to maximum in clockwise
2. Fill the sample tube with distilled water and insert into cell holder and close the cap
3. Adjust set zero control to get on the display
4. Remove the sample tube and replace the content of it by standard solution of appropriate range
5. Adjust calibration control such that it displays the appropriate standard solution value

b) Measurement of turbidity of the sample

6. Remove the sample tube containing standard and wash with turbid free water and fill the sample to be analyze and insert in sample chamber and note down the reading.

7. If the value is out of range, dilute the sample with turbidity free water and again read the turbidity.

Environmental significance: Turbidity is objectionable because of

- (a) Aesthetic considerations and
- (b) Engineering considerations.

When turbid water in a small, transparent container, such as drinking glass is held up to the light, an aesthetically displeasing opaqueness or 'milky' colouration is apparent.

The colloidal material which exerts turbidity provides adsorption sites for chemicals that may be harmful or cause undesirable tastes and odours, and for biological organism that may be harmful. Disinfection of turbid waters is difficult because of the adsorptive characteristics of some colloids and because the solids may partially shield organisms from disinfectant. In natural water bodies, turbidity may impart a brown or other colour to water and may interfere with light penetration and photosynthetic reaction in streams and lakes. Turbidity increases the load on slow sand filters. The filter may go out of operation, if excess turbidity exists.

Application of turbidity data in Environmental Engineering practice:

Turbidity measurements are of particular importance in the field of water supply. They have limited use in the field of domestic and industrial waste treatment.

1. Knowledge of the turbidity variation in raw water supplies along with other information is useful to determine whether a supply requires special treatment by chemical coagulation and filtration before it may be used for a public water supply.
2. Turbidity measurements are used to determine the effectiveness of the treatment produced with different chemicals and the dosages needed.
3. Turbidity measurements help to gauge the amount of chemicals needed from day-to-day in the operation of water treatment works.
4. Measurement of turbidity in settled water prior to filtration is useful in controlling chemical dosages so as to prevent excessive loading of rapid sand filters.
5. Turbidity measurements of the filtered water are needed to check on faulty filter operation.
6. Turbidity measurements are useful to determine the optimum dosage of coagulants to treat the domestic and industrial wastes.
7. Turbidity determination is used to evaluate the performance of water treatment plants.

Result:

Turbidity of the given water sample is

Observations and calculations:

Sample details	Turbidity (NTU)	Remarks

10.Determination of Optimum Dosage of Alum using Jar Test

Apparatus

Aim: To find the optimum amount of coagulant required to treat the turbid waters.

Apparatus:

1. Jar test apparatus
2. Beakers
3. Pipettes
4. Turbidity meter
5. pH meter

Reagents:

1. Alum solution ($\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$) (coagulant concentration of 10g/L)

Principle:

Metal salts hydrolyze in presence of the natural alkalinity to form metal hydroxides. The divalent cations can reduce the zeta-potential, while the metal hydroxides are good absorbents and hence remove the suspended particles by enmeshing them.

Theory

As water varies widely in quality, to aid sedimentation coagulants are used, the optimum dosages are determined in practice by trial. Normally a single coagulant is applied. Its dosages being regulated to minimum amount necessary for rapid, adequate coagulation. Coagulants 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.

Procedure:

1. Take 1 liter of sample into each of the 6 beakers.
2. Add varying doses of alum solution i.e., 1 ml, 2ml, 3ml, 4ml or 6ml to different beakers simultaneously. (The doses vary with turbidity in water sample).
3. Switch on the motor and adjust the speed of paddles 100 rpm allow for 1 minute.
4. Reduce the speed paddles to 40 rpm and continue mixing for 10 minutes.
5. Switch of the motors and allow 20 minutes for settling.
6. Collect the supernatant without disturbing the sediment and find the turbidity of each.
7. Repeat the experiment with high doses of alum, if satisfactory Result is not obtained.
8. Plot the graph of final turbidity verses alum dosage and find out the ideal (optimum) dose of the coagulant for excellent flock formation.

Environmental Significance:

Coagulation is not yet an exact science, although recent advantages have been made in understanding the mechanism of the processes. Therefore, selection and optimum

dosages of coagulants are determined experimentally by the Jar test instead of quantitative formula. Excess dosage of alum may contribute excess aluminium is neurotoxin. Less dosage of alum does not remove turbidity in water which ultimately increase load on filters. So, the optimum dosage should be added in coagulation process to prevent the above problems. Coagulation removes not only turbidity, but also colour, micro-organisms, algae, phosphates, taste and odour producing substances. The jar test must be performed on each water that is to be coagulated and must be repeated with each significant change in quality of given water.

Result:

The Optimum dosage of the coagulant for the given water is

Observations:

Concentration of Coagulant/ Alum solution= (10mg/ml)

Sample details Jar no	Dosage of coagulant(ml)	Dosage of Coagulant(mg/L)	Initial turbidity A (NTU)	Final turbidity B (NTU)	% Removal
1					
2					
3					
4					
5					
6					

% Removal= (Initial turbidity- Final turbidity) / Initial turbidity* 100

11.Determination of Sodium & Potassium using Flame Photometer

11.A Sodium

Aim: To determine the sodium content in the given sample.

Apparatus: Photo cell, flame photo meter with accessories.

Reagents:

Stock sodium solution: Dissolve 2.542 g dry sodium Fluoride in 1000 ml distilled water.
(1 ml = 1.0 mg Na)

Working sodium solution 10 mg/L, 20 mg/L and 50 mg/L.

Theory:

Sodium ranks sixth among the elements in the order of abundance and is present in most natural water. The level may vary from less than 1mg Na/L to more than 500mg Na/L. Relatively high concentration may be found in brine and hard water softened by the sodium exchange process. A limiting concentration of 2mg/L to 3mg/L is recommended in feed water designed for high pressure boiler when necessary sodium is removed by the hydrogen exchange process or by distillation.

Procedure:

1. Follow manufactures recommendation for selecting the proper photo cell and wave length appropriate fuel and air [589nm for Na,] or oxygen pressure and the steps for warm up corrections for frame background igniting sample.
2. Prepare a blank and sodium calibration standards of 0 to 10mg/L <for low concentration maximum 2 standards> and 0 to 100mg/L <for high concentration maximum 5 standards>.
3. After entering the concentration values of series of prepared standards feed corresponding standards.
4. Feed the sample of which concentration is to be determining after feeding reference solution <distilled water>.
5. Note down the concentration value which is in mg/L.

Result:

Sodium content in the given water sample is

11.B Potassium

Aim: To determine the potassium content in the given sample.

Apparatus: Photo cell, flame photo meter with accessories.

Reagents:

Stock potassium solution : Dissolve 1.907 of Pottasium Chloride (KCl) dry (110°C) 1 ml = 1 mg K

Working potassium solution : 10 mg/L, 20 mg/L and 50 mg/L

Theory:

Potassium ranks seventh among the element in order of abundance yet its concentration in most drinking water seldom reaches 20mg/L however occasional brine may contain more than 100mg/L. Trace amount of potassium in either a direct reading or international standard type flame photometer at a wavelength of 766.5nm.

Procedure:

1. Follow manufacture recommendation for selecting the proper photo cell and wavelength, appropriate fuel and air [wavelength 766.5nm for K] or oxygen pressure and the steps for warm up correcting for frame background igniting sample.
2. Prepare a blank and potassium calibration standards of 0 to 100mg/L <for low concentration maximum of 2 standards> and 0 to 100mg/L <for high concentration maximum 5 standards>.
3. After entering the concentration values of series of prepared standards feed corresponding standards.
4. Feed the sample of which concentration is to be determining after feeding reference solution [distilled water].
5. Note down the concentration value which is in mg/L.

Result:

Potassium content in the given water sample is

12.Determination of Nitrates by Spectrophotometer

Aim: To find out nitrate present in a given sample by phenol disulphonic acid method.

Apparatus: Spectrophotometer.

Reagents:

1. Phenoldisulphonic acid (PDA)
2. Ammonium hydroxide
3. Standard nitrate solution (0.01mg)

Principle:

Nitrate reacts with PDA and produces a nitro-derivative in alkaline medium which intern develops a yellow color. The color produced follows the Beer's law and this directly proportional to the concentration of nitrate present in the sample.

Interferences:

Interferences caused by the presence of more than 200mg/l of chloride can be prevented by dilution or addition of silver sulphate. Nitrate values exceeding 1mg/l also interfere and may be eliminated by the addition of sulphonic acid.

Theory:

The compounds of nitrogen are of great importance in water resources, in the atmosphere and in the life processes of all plants and animals. The chemistry of nitrogen is complex because of the several oxidation states that nitrogen can assume and the fact that changes in oxidation state can be brought about by living organisms.

Determination of nitrate (NO₃⁻) is difficult because of the relatively complex procedures required, the high probability that interfering constituents will be present and the limited concentration ranges of the various techniques. Nitrate is the most highly oxidized form of nitrogen compounds commonly present in natural waters. Significant sources of nitrate are chemical fertilizers, decayed vegetable and animal matter, domestic effluents, sewage sludge disposal to land, industrial discharge, leachates from refuse dumps and atmospheric washout. Depending on the situation, these sources can contaminate streams, rivers, lakes and ground water. Unpolluted natural water contains minute amounts of nitrate. Excessive concentration in drinking water is considered hazardous for infants because of its reduction to nitrite in intestinal track causing methemoglobinaemia. In surface water, nitrate is a nutrient taken up by plants and converted into cell protein. The growth stimulation of plants, especially of algae may cause objectionable eutrophication

Preparation of reagents

Phenol Disulphonic Acid [PDA]: Dissolve 25gm white phenol in 235 ml Concentrated Sulphuric acid and stir well for 1 hr.

Potassium Hydroxide Solution: Dissolve 673 g of Potassium Hydroxide in 1000 ml distilled water [12 N].

Stock Nitrate Solution: Dissolve 721.8 mg Potassium Nitrate in 1000 ml distilled water.

Standard Nitrate Solution: Evaporate 50 ml Stock Nitrate Solution by boiling and add 2 ml of PDA and make it to 500 ml [1 ml = 0.01 mg Nitrogen / or 0.0443 mg of Nitrite].

Procedure:

1. Pipette 1, 2,3,4,5 ml of standard solution into Nessler's tube.
2. Add 2ml of PDA, 6ml of ammonium hydroxide and dilute to 50ml with distilled water and mix well.
3. Prepare blank solution adding 2ml of PDA, 6ml of ammonium hydroxide and dilute to 50ml with distilled water and mix well.
4. Measure the absorbance at 400nm to 410nm using spectrophotometer.
5. The value of absorbance obtained for different concentration in mg versus
6. Absorbance.
7. Prepare the sample in the same manner i.e., 2ml of PDA, 6ml of ammonium hydroxide. Dilute to 50ml with the given sample. Measure the absorbance using spectrophotometer at 410nm.
8. Estimate the concentration of nitrate using calibration graph.

Environmental Significance:

Nitrate in ground water is primarily derived from mineralization of soil organic matter or from use of excess nitrogen fertilizer. The limit of 15mg nitrate per liter was originally set to protect babies against methanoglobinemia. It is observed that a high nitrate can reduce the body assimilation of iodine.

Nitrate data are important in connection with waste water treatment by controlling nitrification when not required, aerobic treatment cost can be kept at a minimum. Ammonia & organic nitrogen analysis are important in determining whether sufficient available nitrogen is present for biological treatment. Where waste water sludges are sold for their fertilizing value, the nitrogen content of the sludge is major consideration. Also reduced form of nitrogen is oxidized in natural waters, thereby affecting the dissolved O₂ unknown. For these reasons, nitrogen data are offer part of the information needed in stream pollution control program.

Result:

The concentration of nitrate is=.....

Comments:

Observation And Calculation

Sl no.	Volume of standard nitrate	Concentration of nitrate in mg	Absorbance

$$\text{Concentration of NO}_3 \text{ in mg/l} = \frac{\text{Conc. of NO}_3 \text{ from graph}}{\text{Volume of sample}} * 1000$$

13.Determination of Iron & Manganese

13.A Iron

Aim: To determine the quantity of Iron present in the given sample.

Principle:

Iron is brought into solution, reduced to the ferrous state by boiling with acid and hydroxylamine, and treated with 1, 10-phenanthroline at pH 3.2 to 3.3. Three molecules of Phenanthroline chelate each atom of ferrous iron to form an orange-red complex. The coloured solution obeys Beer's law; its intensity is independent of pH from 3 to 9. A pH between 2.9 and 3.5 insures rapid colour development in the presence of an excess of Phenanthroline. Colour standards are stable for at least 6 months.

The initial boiling with acid converts polyphosphates to orthophosphate and removes cyanide and nitrite that otherwise would interfere. Adding excess hydroxylamine eliminates errors caused by excessive concentrations of strong oxidising reagents. In the presence of interfering metal ions, use a larger excess of Phenanthroline to replace that complexes by the interfering metals. Where excessive concentrations of interfering metal ions are present, the extraction method may be used. If noticeable amounts of colour or organic matter are present, it may be necessary to evaporate the sample, gently ash residue, and redissolve in acid. Ashing may be carried out in silica, porcelain crucibles that have been boiled for several hours in 1+1 HCl. The presence of excessive amounts of organic matter may necessitate digestion before use of the extraction procedure.

Minimum detectable concentration: Dissolved or total concentrations of iron as low as 10µg/L can be determined with a spectrophotometer using cells with a 5 cm or longer light path. Carry a blank through the entire procedure to allow for correction.

Apparatus: Nessler's tube, conical flask, pipette.

Theory:

In the Phenanthroline method the ferric form of iron is reduced to ferrous form by boiling with H₂SO₄ and Hydroxylamine solution the reduced iron chelate with 1 to 10 Phenanthroline at PH3.2 to 3.3 to form a complex of orange red colour in proportional to the concentration of iron and Obeys Beer's law.

Reagents:

1. Concentrated HCl
2. Hydroxyl amine solution
3. Sodium acetate solution
4. Phenanthroline solution
5. Standard iron solution (0.01 mg/L)

Preparation of reagents

Hydroxylamine HCl Solution: Dissolve 10 gm of Hydroxylamine HCl in 100 ml distilled water in a 100ml volumetric flask.

Stock Iron Solution: Dissolve 1.404 g of Ferrous Ammonium Sulphate in 50 ml distilled water; add 20ml Sulphuric Acid and about 3-6 drops of 0.1N Potassium Permanganate Solution. Make up to 1000 ml [200 mg/l].

Standard Iron Solution: Dilute 12.5 ml Stock Iron Solution in 250 ml distilled water [1 ml = 0.01 mg of Iron, 10 mg/l].

Ammonium Acetate Buffer: Dissolve 250gm of Ammonium Acetate in 150 ml Distilled water add 700 ml of Acetic acid.

Phenanthroline Solution: Dissolve 100 mg of 1, 10- Phenanthroline in 100 ml distilled water.

Procedure:

1. Take 0, 1, 2, 3, 4 and 5 ml of (0, 0.2, 0.4, 0.6, 0.8 and 1 mg/l) Standard solution.
2. Add 1ml of conc.HCl and 1ml of Hydroxyl amine solution, make up to 50 ml by distilled water
3. Add a few glass beads and heat to boiling. To insure dissolution of all the iron, continue boiling until volume is reduced to 15 to 20mL. (If the sample is ashed, take up residue in 2mL conc. HCl and 5mL water).
4. Cool to room temperature and transfer to a 50 or 100 mL volumetric flask or Nessler's tube.
5. Add 5 ml of sodium acetate/ Ammonium acetate solution and 2ml of phenanthraline solution indicator which imparts red colour with iron and dilute to 100ml mark with distilled water.
6. Mix thoroughly and allow at least 10 to 15 min to maximum colour development.
7. Take 50ml of water sample in a conical flask. Follow the same procedure for sample for maximum color development.
8. Set the wavelength of spectrophotometer to 510nm and note down the absorbance.
9. Plot the graph of concentration of iron verses absorbance obtained
10. Find out the concentration of iron in mg/L using standard graph.

Environmental Significance:

1. Excess of presence of iron in drinking water supplies, are objectionable for number of reasons.
2. Although iron has got little concern as health hazard but is still considered as a nuisance in excessive qualities long time consumption of drinking water with the a high concentration of iron can lead to liver diseases [hemosiderosis].

Iron in excess of 0.3mg/L causes stain to wash basin of steel container, they also form red spot on clothes.

Iron concentration of the given water sample is=

Sl. no	Volume of Standard added, ml	Concentration of Fe ,mg(<i>X</i>)	Absorbance (<i>Y</i>)
1			
2			
3			
4			
5	Sample		

Observation and calculations:

$$\text{Concentration of Iron in mg/l} = \frac{\text{Conc. of Iron from graph (mg)}}{\text{Volume of sample (ml)}} * (1000 \text{ ml/l})$$

Concentration of Iron solution = 0.01mg/ml

Tabular column:

13.B. Manganese

Aim: To determine the concentration of Manganese in the given water sample

Scope and application

Manganese is associated with iron minerals and occurs in nodules in ocean, fresh water and soils. The common ores are pyrolusite and psilomelane. Manganese is used in steel alloys, batteries and food additives. The FAO-recommended maximum level for manganese in standard is 50 μ g/L. BIS desirable limit is 0.1 mg/L.

Methods for analysis:

Inductively coupled plasma method
Persulphate Method

Sampling and storage

Manganese may exist in a soluble form in neutral water when first collected, but it oxidises to a higher oxidation state and precipitates or becomes absorbed on the container walls. Determine very soon after sample collection. When delay is unavoidable, total manganese can be determined if the sample is acidified at the first time of collection with HNO₃ to pH <2.

A. Inductively coupled plasma method

Please refer section 28.6 A.

B. Persulphate method

Summary of the method

Principle: Persulphate oxidation of soluble manganous compounds to form permanganate is carried out in the presence of silver nitrate. The resulting colour is stable for at least 24h if excess Persulphate is present and organic matter is absent.

Interferences: As much as 0.1g chloride (Cl) in a 50-mL sample can be prevented from interfering by adding 1g mercuric sulphate (HgSO₄) to form slightly dissociated complexes. Bromide and iodine still will interfere and only trace amounts may be present. The Persulphate procedure can be used for potable water with trace to small amounts of organic matter, if the period of heating is increased after more Persulphate has been added.

For wastewater containing organic matter, use preliminary digestion with nitric and sulphuric acids (HNO₃ and H₂SO₄). If large amounts of Cl⁻ interfering traces of Cl⁻ in the special reagent.

Coloured solutions from other inorganic ions are compensated for in the final colorimetric step. Samples that have been exposed to air may give low results due to precipitation of manganese dioxide (MnO_2). Add 1 drop of 30% hydrogen peroxide (H_2O_2) to the sample, after adding the special reagent, to redissolve precipitated manganese.

Minimum detectable concentration:

The molar absorptivity of permanganate ion is about $2300 \text{ Lg}^{-1} \text{ cm}^{-1}$. This corresponds to a minimum detectable concentration (98% transmittance) of $210 \mu\text{g Mn/L}$ when a 1cm cell is used or $42 \mu\text{g Mn/L}$ when a 5cm cell is used.

Apparatus and equipment

Colorimetric equipment: One of the following is required: Spectrophotometer: for use at 525nm, providing a light path of 21cm or longer. Filter photometer: providing a light path of 1cm or longer and equipped with a green filter having maximum transmittance near 525nm. Nessler tubes: matched, 100mL, tall form.

Reagents and standards

Use reagents and distilled water free from manganese contamination. Special reagent: Dissolve 75g HgSO_4 in 400mL conc. HNO_3 and 200mL distilled water. Add 200mL 85% phosphoric acid (H_3PO_4) and 35mg silver nitrate (AgNO_3). Dilute the cooled solution to 1L.

Ammonium Persulphate: $(\text{NH}_4)_2\text{S}_2\text{O}_8$ solid.

Standard manganese solution: Prepare a 0.1N potassium permanganate (KMnO_4) solution by dissolving 3.2g KMnO_4 in distilled water and making up to 1L. Age for several weeks in sunlight or heat for several hours near the boiling point, then filter through a fine fritted-glass filter crucible and standardise against sodium oxalate as follows:

Weigh several 100 to 200mg samples of $\text{Na}_2\text{C}_2\text{O}_4$ to 0.1mg and transfer to 400mL beakers. To each beaker, add 100mL distilled water and stir to dissolve. Add 10mL of (1+1) H_2SO_4 and heat rapidly to 90 to 95°C. Titrate rapidly with the KMnO_4 solution to be standardised, while stirring, to a slight pink endpoint colour that persists for at least 1 min. Do not let temperature fall below 85°C. If necessary, warm beaker contents during titration; 100mg $\text{Na}_2\text{C}_2\text{O}_4$ will consume about 15mL, permanganate solution. Run a blank on distilled water and H_2SO_4 .

Normality of $\text{KMnO}_4 = \frac{\text{g Na}_2\text{C}_2\text{O}_4}{(\text{A} - \text{B}) \times 0.06701}$

Where:

A = mL titrant for sample and

B = mL titrant for blank

Average results of several titrations; calculate volume of this solution necessary to prepare 1L of solution so that 1.00mL = 50 μ g Mn as follows:

$$\text{mL KMnO}_4 = 4.55 / \text{Normality, KMnO}_4$$

To this volume, add 2 to 3 mL conc. H₂SO₄ and NaHSO₃ solution drop wise, with stirring, until the permanganate colour disappears. Boil to remove excess SO₂, cool and dilute to 100mL with distilled water. Dilute this solution further to measure small amounts of manganese.

Standard manganese solution (alternate): Dissolve 1g manganese metal (99.8% min) in 10mL redistilled HNO₃. Dilute to 1000mL with 1% (v/v) HCl; 1mL = 1mg Mn. Dilute 10mL to 200mL with distilled water; 1mL = 0.05mg Mn. Prepare dilute solution daily.

Hydrogen peroxide: H₂O₂, 30%

Nitric acid: HNO₃, conc.

Sulphuric acid: H₂SO₄, conc.

Sodium nitrite solution: Dissolve 5g NaNO₂ in 95mL distilled water.

Sodium oxalate: Na₂C₂O₄, primary standard

Sodium bisulphate: Dissolve 10g NaHSO₃ in 100mL distilled water.

Procedure

Treatment of sample: If a digested sample has been prepared according to directions for reducing organic matter and/or excessive chlorides, pipette a portion containing 0.05 to 2mg Mn into a 250mL conical flask. Add distilled water, if necessary, to 90mL and proceed.

To a suitable sample portion add 5mL special reagent and 1 drop H₂O₂. Concentrate to 90mL by boiling or dilute to 90mL. Add 1g (NH₄)₂S₂O₈, bring to a boil and boil for 1min. Do not heat on a water bath. Remove from heat source, let stand 1 min and then cool under the tap (boiling too long) results in decomposition of excess Persulphate and subsequent loss of permanganate colour; cooling too slowly has the same effect). Dilute to 100mL with distilled water free from reducing substances and mix. Prepare standards containing 0, 5, to 1500 μ g Mn by treating various amounts of standard

Mn solution in the same way.

Photometric determination:

Use a series of standards from 0 to 1500 μ g Mn/100 ml. final volume. Make photometric measurements against a distilled water blank. The following table shows light path length appropriate for various amounts of manganese in 100ml. final volume:

Mn Range

Light Path

µg	cm
5-200	15
20-400	5
50-1000	2
100+1500	1

Prepare a calibration curve of manganese concentration vs. absorbance from the standards and elements and determine Mn in the samples from the curve.

Correction for turbidity or interfering colour:

Avoid filtration because of possible retention of some permanganate on the filter paper. If visual comparison is used, the effect of turbidity only can be estimated and no correction can be made for interfering coloured ions. When photometric measurements are made, use the following 'bleaching' method, which also corrects for interfering colour. As soon as the photometer reading has been made, add 0.05mL H₂O₂ solution permanganate colour has faded completely and no bubbles remain, absorbance to obtain absorbance due to Mn.

Calculation

When the entire original sample is taken for analysis:

$$\text{Mn, mg/L} = \{ \mu\text{g Mn (in 100mL final volume)} / \text{mL sample} \} \times \{ 100 / \text{mL portion} \}$$

When a portion of the digested sample (100mL final volume) is taken for analysis: $\text{Mn, mg/L} = \mu\text{g Mn} / 100\text{mL} / \text{mL sample}$

15.Determination of COD – Demonstration

Aim: To find out Chemical oxygen demand (COD) of given wastewater sample.

Theory

Chemical Oxygen Demand (COD) test determines the oxygen requirement equivalent of organic matter that is susceptible to oxidation with the help of a strong chemical oxidant. It is important, rapidly measured parameters as a means of measuring organic strength for streams and polluted water bodies. The test can be related empirically to BOD, organic carbon or organic matter in samples from a specific source taking into account its limitations. The test is useful in studying performance evaluation of wastewater treatment plants and monitoring relatively polluted water bodies. COD determination has advantage over BOD determination. COD results can be obtained in 3-4 hrs as compared to 3-5days required for BOD test. Further, the test is relatively easy, precise, and is unaffected by interferences as in the BOD test. The intrinsic limitation of the test lies in its inability to differentiate between the biologically oxidisable and biologically inert material and to find out the system rate constant of aerobic biological stabilization. COD test is widely used for measuring the pollution strength of wastewater.

Principle:

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

Apparatus

1. Autoclave
2. BOD Bottle
3. burette

Reagents

1. Standard potassium dichromate 0.25 N
2. Sulphuric acid with reagent (Conc. H_2SO_4 + Ag SO_4)
3. Standard ferrous ammonium sulphate 0.1 N
4. Ferroin indicator
5. Mercuric sulphate

Preparation of reagents

Standard potassium dichromate reagent-digestion solution: weigh accurately 4.913g of potassium dichromate, previously dried at $103^\circ C$ for 2 hours and transfer it to a beaker. Weigh accurately 33.3g of mercuric sulphate and add it to the same beaker. Measure accurately 167ml of concentrated sulphuric acid using clean dry measuring cylinder and transfer it to the beaker. Dissolve the contents and cool to room temperature. Take 1000ml standard measuring flask and place a funnel over it. Carefully transfer the contents to the 1000ml volumetric flask and make up to 1000ml using distilled water. This is the standard potassium dichromate solution to be used for digestion.

Sulphuric acid reagent-catalyst solution: weigh accurately 5.5g silver sulphate crystals to a dry clean 1000ml beaker. To this carefully add about 500ml of concentrated sulphuric acid and allow standing for 24 hours (so that the silver sulphate crystals dissolve completely).

Standard ferrous ammonium sulphate solution: weigh accurately 39.2g of ferrous ammonium sulphate crystals and dissolve it in distilled water. Take 1000ml standard measuring flask and place funnel over it. Carefully transfer the contents to the 1000ml volumetric flask and make up to 1000ml mark using distilled water.

Procedure

1. Place 0.4 g of HgSO_4 in the BOD bottle
2. Add 2 ml of sample for an aliquot diluted to 20 ml
3. 10 ml of more concentrated dichromate solution are added together with glass beads
4. Add slowly 30 ml of H_2SO_4 containing Ag_2SO_4 and mix thoroughly
5. Reflux for a minimum period of 2 hour in Autoclave. Cool and open the autoclave
6. Dilute the sample with distilled water to make up to 140 ml and cool
7. Titrate excess $\text{K}_2\text{Cr}_2\text{O}_7$ with 0.1 N Ferrous ammonium sulfate, $\text{Fe}(\text{NH}_4)_2\text{SO}_4$ using ferroin indicator. Sharp colour changes from blue green to wine red indicates the end point
8. Reflux the blank in the same manner using distilled water instead of sample

Calculation

Quantity of FAS added for blank = A ml

Quantity of FAS added for the sample = B ml

Normality of FAS solution N=

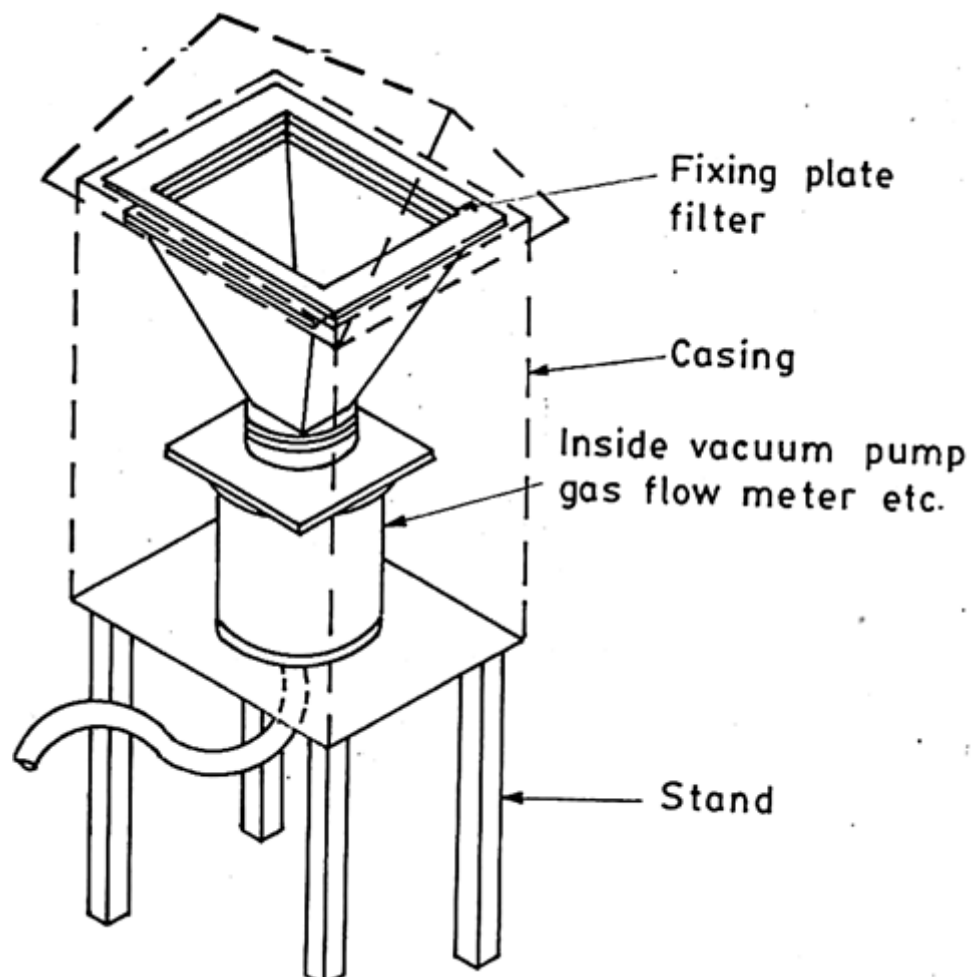
$$\text{COD} = \frac{(A - B) * N * 8 * 1000}{\text{ml of sample taken}}$$

16. Air Quality Monitoring Determination (Ambient, Stack monitoring, Indoor Air) – Determination - Demonstration

Aim : To determine the Ambient Air Quality Monitoring using High Volume Air Sampler unit

Theory: The high volume air sampler is a popular and frequently used equipment for the determination of suspended particulate matter (SPM) in air. The principle involved in this method is that the particles are filtered from known volume of an air sample by a suction apparatus (a vacuum pump) and the particles are made to deposit on a porous filter paper. The commonly used high volume sample ('Micrometal' make, Bombay and other similar makes).

The high volume air sampler consists of the following, as shown in Figure



- (a) Face plate and gasket
- (b) Filter paper (preferably Whatman make), and fitting assembly
- (c) Vacuum pump (air sucker) with air flow measuring device and
- (d) Casing with a roof lpm

Procedure :

1. The filter plate provides the base for sitting the filter paper of size 200 mm x 250 mm, through which air sample is collected by creating suction in the filter area.
2. This suction is created by a vacuum pump with a flow rate of 25 lpm. These conditions will permit the sampling of ambient air for a period of 8-h.
3. The suspended particles of size less than 10 microns and greater than 3 microns are retained on the filter.
4. The duration of sampling is measured in an elapsed time meter which is placed in series with the blower.
5. A rotameter or a manometer is provided to measure the volume of air passed through the filter. Generally 'Whatman make' filter papers are widely used.
6. The concentration of the pollutants is expressed as micrograms per cubic meter which is calculated from the observed data as given below.

Calculation of the result:

$$C = \frac{W_t - W_i}{V} \times 10^6$$

where

C = Concentration of suspended particulate matter (SPM) in micrograms per cubic meter

W_i = Weight of filter paper before sampling, or Initial mass of filter, g

W_t = Weight of filter paper after sampling, g (keep the filter paper in a desiccator for 24-h after sampling)

V = Volume of air sampled in cubic meter at STP

$$= \frac{(Q_i + Q_t)}{2} \times t$$

Q_i = Air flow rate through clean filter (initial flow rate, cubic meter per minute)

Q_t = Air flow rate at the end of the sampling, cubic meter per minute

t = Sampling period, minutes

16. Determination of Sound by Sound level meter at different location- Demonstration

Aim: To determine Sound by Sound Level Meter at different location

Theory: Noise level measurement procedure are processes which are followed while monitoring sound level or acoustic energy level in specified area. These days annoying noise levels have started to become a major threat to public health. Noise in simple terms can be defined as unwanted or unpleasant sound which disturbs the environment and has a significant impact on the quality of life. We all very well know how exposure to high noise level can result in hearing impairment, headache, sleep disturbance and impaired task performance.

Why Noise Monitoring is required?

- Compliance with noise regulation
- Hearing loss prevention
- Noise control
- Community Annoyance
- To find out the location or place or areas where noise is high than the TLV and problematic
- Workers or people are complaining about noise or are affected

Noise Measurement

Three techniques are used to measure noise in the work place and community environment

- (1) Personal sound exposure meter or also known as dosimeter
- (2) Sound Level Meter
- (3) Tape recorders, data recorders and level recorders

Types of Noise:

- **Steady or Continuous Noise:** It is uninterrupted noise that varies less than 5 dB-A during the period of measurement eg Noise from house hold fan , boiler in a power house, lathes, diesel engine ,grinder etc
- **Impulsive or Impact noise :**When source causes vibration for a short time eg firing from the gun or hammer
- **Intermittent/Fluctuating Noise:** Large workshop number of machines are in operation, noise levels varies from time to time or dentists drilling

Sound Level Meter

Sound level meter SLM consist of a microphone, electric circuit and digital display. Microphone detects and reads minimal air pressure changes and convert them into electric signals.

- These signals are processed by electric circuits and converted into decibels. SLM can read noise level for one location at a time.
- While measuring noise levels it is held in an arm's length at the ear height. It does not matter whether microphone is point towards source.
- Sound level monitor must be calibrated before and after use.
- Every sound level meter has two modes and those are SLOW and FAST.

- It is the response rate which SLM averages before showing on screen.
- For workplace noise level monitoring it should be taken as SLOW.

Sound Level Meter

Information required for noise survey/monitoring

- Location and Nature of work (Sketch of the measurement site, including size of the room, machine dimensions etc.)
- Nature of work process and task
- No of workers working in noisy area
- Current control including protection devices (e.g. Personal Protection devices like ear plugs or ear muffs)
- Community noise monitoring is required? If yes, Status of Community monitoring, whether higher than permissible level?
- Type of sound level meter
- Operating condition during the measurement and job description
- Results of the noise assessment
- Date of assessment or monitoring
- Name and signature of the person conducting the monitoring.

Noise Level measurement Procedure

- Must be check the battery full before goes onsite monitoring.
- Switch ON of equipment and wait for one minute.
- SLM has two modes of operation selection via the menu key.
- Two mode:(1) In continuous Mode (2) In Recording Mode
 - In continuous Mode: For only onsite observation.
 - In Recording Mode: For recording the data in sound level meter.
- Select the appropriate mode of sound level.
- Set the slow or fast time as per site condition. Slow time is applicable for normal measurement. Fast time is applicable for specific measurement of noise like moving train, heavy traffic etc.
- Adequate Distance (1 to 3 meter) maintain between source and equipment.
- Take reading for at least one minute at one location. Number of reading can take for one minute intervals.
- Monitoring period should be decided in such a manner that one reading is available after one minute of monitoring at one location.
- When we change the location, off the machine and again Switch ON of equipment.

Place of the Instrument

Many factors need to be taken into account when measuring because sound levels vary at different heights above ground level. They will also vary depending on the distance between the measurement point and facades and obstacles. These are some important factors for doing monitoring:

- a. Away from facades
- b. Away from obstacles
- c. With the microphone 1.2 - 1.5 meter above ground level
- d. Monitoring inside Industrial facility distance from source shall be 1.5 meter

Monitoring Locations

The locations for monitoring to assess the ambient noise levels shall be mix up of all zones i.e. Residential, Commercial and Industrial to find the variations with different zones. The monitoring schedule carried out on working days and weekend to differentiate the noise levels between normal days to weekend days. The Sampling locations should be sufficient enough provide representative samples for the project.

Comparison with Noise standards

Once we get the monitoring records then we can compare them with standards to understand if noise levels are exceeding the standards and if they are then by how much. In India, the standards extensively used are prescribed by Central Pollution Control Board (CPCB).

Noise level Measurement Standards

Limits or noise level standards defined by pollution control board during Day time for Residential Noise < 55 dB and Limits during Night time for Residential Noise < 45 dB

In industry, there are of two types Sound Monitoring & testing or Noise Level Measurement: (A) Ambient Noise level Monitoring & (B) In-plant Noise level Monitoring

A) Ambient Noise level standards

Ambient Noise level Monitoring or Noise pollution Measurement within industrial zone at ambient conditions.(e.g. Near Main Gate, Near Canteen, Near Manufacturing plant etc.) As per Central Pollution control Board (as per Factory act 1948).

Limits or acceptable noise level during Day time for Ambient Noise < 75 dB and Limits during Night time for Ambient Noise < 70 dB.

B) In-plant Noise level Standards

In-plant Noise level means Sound level measurement allocated in the plant. As per Central Pollution control Board (as per Factory act 1948) Limits for In-plant Noise level < 90 dB.

The below table shows the Noise level Monitoring standards prescribed by Central Pollution Control Board (CPCB). Noise Pollution (Regulation & Control) Rules 2000 under the provision of the Environment (Protection) Act, 1986. These rules provides standards in respect of noise for different areas/zones of a city/town

Area code	Category of area/Zone	Limits in db (A)	
		Day Time	Night Time
(A)	Industrial area	75	70
(B)	Commercial area	65	55
(C)	Residential area	55	45
(D)	Silence zone	50	40

Day time : 6:00 AM to 10:00 PM

Night time : 10:00 PM to 6:00 AM

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