

4 Assessment of Water Quality

4.1 Introduction:

Water is one of the abundantly available substances in nature. It is an essential constituent of all animals and vegetable matter. It forms about 75% of the matter of earth crust. It also occupies a unique position in industries.

In nature water occurs as

1. Water vapor in the atmosphere
2. As liquid water in islands and oceans
3. As ice in polar regions
4. As water of hydration in many rocks and minerals in the earth crust

4.2 Sources of Water:

The sources of water are divided into two classes they are

1. Surface waters
2. Under Ground waters

Surface Water These are further classified into following types

Rain Water: It is the purest form of natural water because it is obtained as a result of evaporation from the surface of water. During its passes through the atmosphere it dissolves a considerable amount of industrial gases like CO_2 , SO_2 , NO_2 etc., and suspended solid particles

River Water: River and canal waters are fed by rains these are less pure than rain water because they contain dissolved chemicals their composition depends on the areas over which they are following and the soluble chemicals salts present in the rocks and soil. The impurities in river water are generally chlorides, sulphate, carbonates and bicarbonates of Ca and Mg are formed by the action of dissolved CO_2 upon insoluble carbonates the presence of soluble Ca and Mg salts in river water makes it hard besides this river and canal water are contaminated with sewage and sludge's of cities by which their flow

Lake water: It has a more constant chemical composition it contains much lesser amount of dissolved minerals but the quantity of organic matter in quite high

Sea Water: It is the most impure form of nature water because rivers carry a large volume of water with dissolved impurities into the sea thus the sea contains maximum amount of dissolved impurities due to continuous evaporation of water from the surface. The sea water is richer in dissolved impurities it contains an average of 3.4% dissolved salts out of which about 2.6% is NaCl other salts are Na_2SO_4 bicarbonates of potassium, magnesium and calcium. Bromides of potassium, magnesium and no of other compounds

Under Ground Water: A part of rain water which reaches the surface of the earth percolates into the earth when it passes through the soil it dissolves the soluble salts of soil. This water is extremely clear as a result of natural filtration through sand beds water continuous it downward journey till it meet a hard rock when it retards upwards and it may even come out in the form of spring and well water in general is clear in the appearance due to the filtering action of the soil but it contains more of the dissolved salts therefore the water from these source possesses the hardness.

4.3 Uses of Water:

Water is used for industrial and municipal purposes the largest water requirement is for municipal use. The standard of purity required for municipal use is different from that of industrial and commercial use

In industry more than half the water is used in chemical plants for the purpose of cooling it is used in the steam generation it is also used as coolant in power and chemical plants. In addition to its water is widely used in other fields such as production of steel paper, atomic energy, textiles, chemicals, ice and for air conditioning drinking, bathing, sanitary, washing, irrigation, fire fighting etc., a large volume of water is also used for the purpose of dilution and making solutions.

Water for Industry: The quality and quantity of available water are important in the location of the chemical plant both surface and ground water should be considered supply of water must be adequate throughout the year this supply should not be disturbed the municipal water supply of the area

Over half the water used in chemical plants is for cooling water is of no great importance its function is to carry away heat by warming or by evaporation considerable water is used in chemical plants for solutions and dilution reasonably pure water is necessary for this purpose.

The most important factors deciding the location of a chemical industry are raw materials, power water and transport each industry has its own water requirements and sometimes adequate supply of water may be suitable for one industry but the same may be dangerous for other. The principle requirements of water for certain important industries are

Boiler feed Water: It should be as soft as possible it should contain least amount of nitrates and organic matter to avoid corrosion of boiler plates.

Water for Alcoholic Distillation: It should be as pure as possible it should contain few micro organisms along with trace of NaCl and MgCl₂

Water for Sugar Industries: The crystallization becomes more difficult if water contains sulphate, alkaline carbonates and nitrates more over molasses is obtained in much greater amount and sugar formed becomes deliquescent. On exposure to air and moisture if water is rich in microorganisms they may decompose sugar partially.

Water for Dyeing: Water should be free from iron and should possess little hardness.

Water for Cooking: Water should possess little hardness otherwise the vegetables do not cook easily.

Water for Laundries: Water should be as soft as possible.

3

Applied Analysis [Paper – III] [Semester – III]

4.4 Water Pollution:

The water pollution can be defined in number of ways as follows

Any distortion in physical, chemical or biological properties of water is called water pollution [Or]

The presence of any foreign material which changes either physical or chemical properties of water is called water pollution [Or]

Water pollution may be defined as the presence of any toxic substances which effects temporary or permanently the quality of its usefulness.

4.5 Types of Water Pollution:

Water pollution can be divided into eight categories they are.

1. Physical Pollution
2. Inorganic Pollution
3. Organic Pollution
4. Biological Pollution
5. Oil Pollution
6. Garbage Pollution
7. Pesticide Pollution
8. Radio Active Pollution

Physical Pollution: This type of pollution changes the physical properties of water for example if color is added to water it becomes colored. Then the water is said to be polluted. But acceptable value of color is 5 on "Pt-Co" scale. Similarly any change in odour or some pollutants sometimes colloidal particles changes in the turbidity of water and make it polluted. If the value of turbidity is higher the prescribed limit it can be removed by treating the water with alum.

Inorganic Pollution: There are many industrial units which discharge sulphide, nitrides, sulphate, phosphates etc., in river water making it unfit for drinking. These inorganic substances decompose slowly in water to release foul gases and some byproducts these products change the properties of water and also it's P^H . When P^H is decreased the water becomes acidic and it is responsible for the killing aquatic life. The acceptable P^H of drinking water is 7-8.5. Inorganic pollutants change the chemical oxygen demand of water.

Organic Pollution: Organic compounds which are discharged from industries and other sources change P^H of water they also change dissolved oxygen and bio chemical oxygen demand and produce several byproducts. These byproducts pollute the water.

The pesticides, fungicides, bactericides etc., are organic substances which are mainly used for killing small insects etc., they change B.O.D and D.O values these substances make water unfit for human consumption permanently. The biodegradable substance such as proteins, oils, carbohydrates, starch, sugars etc., also pollutes water this is temporary effect.

Biological Pollution: This type of pollution is caused by plants toxins, coli form bacteria, multi organisms, viruses etc., the micro organisms and viruses are responsible for various water diseases like cholera, typhoid, polio, hepatitis, gastroenteinritis, dysentery etc.,

Oil Pollution: The pollution of water by oil is called oil pollution. It is due to the transport of oil from one place to another or from one country to another through sea oil tanker either explodes due to enemies attack or due to leakage in ports.

Oil is made up of about 40 components. The upper components like petrol and kerosene evaporates to cause air pollution. The lower components like naphtha destroy the plant and animal life of the sea. Oil is thicker in nature it neither allows sunlight to enter into the lower portion of the sea nor allows the oxygen thus oil in water is responsible for reducing light penetration and reducing dissolved oxygen.

Garbage Pollution: Garbage [Scraps of food to be thrown away] is the major source of pollution of rivers like Ganga, Yamuna, Godavari, Krishna etc., the garbage is thrown into the rivers by villages without any treatment. The human and animals etc., have become a common part of neighborhood seen in the cities. The high concentration of various toxic elements may also create problems for rivers and other sources of drinking water for human beings.

Pesticide Pollution: Generally pesticides are transmitted through water in the environment. Pesticides affect the aquatic life and polluting water for a long time. Poultry also gets affected by pesticides. Domestic animals like cows, pets etc., and human beings ingest the remains of pesticides through food, eggs, milk, curd, meat, are effected by pesticides many vegetables like potatoes, onions, cauliflower etc., also contain small quantity of pesticides absorbed through soil. The pesticide are also found in food grains, wheat etc., sometimes they causes failure of liver functioning and kidney functioning in human beings.

Radio Active Pollution: Radioactive pollution is caused by the uses of radioactive pollution is caused by the use of radioactive materials. The radioactive substances enter into environment and mix in river and other water bodies and contaminated them. The major source of radioactive substance is

1. Through mining and processing of ores
2. Through Nuclear Power Plants
3. Through Production of Isotopes
4. Through Nuclear Reactors
5. Through Explosion of Nuclear Bombs and Weapons

The radioactive substances in water may causes DNA breakage, eye cataract and blood cancers. The radioactive substances in water react with proteins of animals and deactivate enzymes. The Radioactive splits the water into H^+ and OH^- and H^+ and OH^- free radicals these free radicals reacts with cells and damage them completely in humans and animals. The Rn^{226} , Rn^{228} , Rn^{232} , in drinking water causes stomach disorders birth abnormalities, genetic changes etc., Sr^{90} , Fe^{65} in water causes death of fish and breaking the food chain testing of bomb and waste materials of labs causes skin cancer deformity in bones, loss of hair etc.,

4.6 Sources of Water Pollution:

Although water pollution is an old problem but in this modern age the problems like population increases. Sewage disposals, industrial waste, radioactive waste etc., have polluted our water resources some common sources of water pollution along with the constituents which pollutes the rivers, streams, wells etc., are

1. Natural Sources
2. Domestic Sewage
3. Industrial Waste
4. Agricultural Waste
5. Radioactive Sources

Natural Sources: The natural entry of pollutant in water can take place through rain periodic submergence of surrounding vegetation and falling of dry parts of nearby vegetation directly on the surface of water.

Domestic Sewages: It is very serious pollutant of wells and rivers which are important sources of our drinking water. These rivers and wells are polluted with our own excretions besides that of animals and birds. The drinking water from these sources contains high amount of nitrates, nitrites, B.O.D, C.O.D, chloride, sulphide and total dissolved solids the effluents in high concentration are toxic and destroyed plants and fish life.

Industrial Waster: The waste and effluents of industries play significant role in the pollution of water.

The industries which are responsible for water pollution

- | | | |
|-------------------------|---------------|-------------------------------|
| 1. Paper and pulp | 5. Alcohol | 9. Oils |
| 2. Distillery | 6. Detergents | 10. Pesticides and Herbicides |
| 3. Fertilizers | 7. Steel | |
| 4. Electroplating plant | 8. Cane Sugar | |

The industrial waste may have pollutants of almost all kinds ranging from simple nutrients and organic matter to complex toxic substances the waste from the industries like sugar factories, paper and pulp tanneries and distillers are rich sources of organic matter metal plating industries release high quantities of heavy metals and cyanides in their waste. The waste from fertilizer analysis can also be rich sources of nutrient causing eutrophication the chemical industries release wastes with highly variable composition which are acidic or alkaline in nature

Agricultural Waste: Modern agriculture uses a large number of chemicals called "agrochemicals" these are used in the form of fertilizers, organic menu pesticides etc., all residual forms of the chemicals are trapped by run of water is rich in nutrients like "N₂ and P" organic matters and pesticides nutrients create the problem of eutrophication pesticides have been reported to get bio accumulated and bio magnified through for chains this results in the secondary poisoning to man and birds.

Radioactive Sources: The radioactive substances are used for power industry. Preserving food and as medicines for curing diseases. They can also be used to prepare bombs. The waste from atomic reactors, Hospitals etc. are most dangerous because their radio activity cannot be destroyed easily these wastes effect the aquatic plants and animals to a great extent.

7

Applied Analysis [Paper – III] [Semester – III]

4.7 Analytical Methods For the determination of Ions Present in Water:

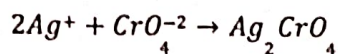
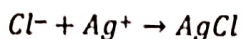
4.7.1 Anions:

4.7.1.1 Chloride Ion: [Cl⁻]

Mohr's Method:

Chloride in drinking water is relatively harmless if it is present in amount below 250ppm if it present more than that then it is harm full to bodies harms metallic pipes and structures as well as agricultural crops.

Chloride is simply determined by titration with AgNO₃ solution using K₂CrO₄ as an indicator. The end point of this titration is appearance of permanent reddish brown color. This method is valid for 0.15 to 10mg chloride present.



Reagents Required:

1. Standard NaCl Solution
2. 0.0282N AgNO₃ Solution
3. K₂CrO₄ indicator
4. Aluminum Hydroxide

Preparation of Reagents:

Standard NaCl Solution: Dry AR NaCl at 140°C for 1hour and cool it in a desiccators prepare 0.02N NaCl solution in distilled water.

Prepare 0.0282N AgNO₃ Solution: 282ml of 0.1N AgNO₃ diluted to 1liter

Potassium Chromate Indicator [5%]: 5g of potassium chromate dissolved in 100ml of water

Water Sample Preparation: Adjust P^H of 100ml sample to 7-10 with H₂SO₄ or NaOH and add 0.5g of Na₂B₄O₇ will keep the P^H at 9

Aluminum Hydroxide Solution: Dissolved 12gms of potassium or ammonium alum in 1liter of distilled water precipitate the aluminum by adding ammonium hydroxide slowly and with stirring was the precipitate with distilled water until last washing should be free from sulphate.

Procedure: 100ml of water sample is taken in a conical flask and adjust the P^H 7-10 with H₂SO₄ or NaOH and add 1ml of 5% potassium chromate indicator then titrate the solution with 0.0282N silver nitrate solution until reddish brown color is appeared it is the end point.

1ml of 0.0282N AgNO₃ = 1ml of Chloride ion

For smaller quantities of chloride is determined by potentiometer titration using silver nitrate solution with glass and Ag – AgCl electrode system

Applied Analysis [Paper – III] [Semester – III]

4.7.1.2 Sulphate Ion [SO₄²⁻]

It occurs in natural water in concentration range from few to thousand milligrams per liter. Excess of sulphate should not be present in drinking water if it present it causes cathartic action.

It can be determined either gravimetrically or turbidimetry.

Gravimetric Method:

In gravimetric method the sulphate is precipitated as barium sulphate by addition of BaCl₂ in the presence of HCl it is carried out near the boiling temperature and after a period of digestion, the precipitate is filtered and washes the precipitate with water until it is free from chloride. It is ignited and weighed as BaSO₄

Turbidimetry:

In turbidimetry method white light is passed through the suspension of the substance to be determined the light transmitted by suspension of known concentration then the concentration of the sample is determined.

The sulphate ions present in water sample are converted to a suspension of BaSO₄ reagent by turbidimetry method the concentration of BaSO₄ is estimated.

Reagents:

Standard Sulphate Solution: Dissolve 0.3698g of AR sodium sulphate [Na₂SO₄] in water and make up to 250ml

BaCl₂ Solution: Dissolve 10g of AR Barium Chloride in 100ml of water

NaCl – HCl Reagent: Dissolve 24g of NaCl in 100ml of water containing 2ml of ConHCl

Procedure: Take five 50ml volumetric flasks and pipette out 2,4,6,8 and 10ml of standard sulphate solution to this solution add 10ml of NaCl HCl solution to each flask and stirred then add 10ml of barium chloride solution and make up to mark with distilled water and shake well then measure the absorbance of the suspension at 380-425nm draw the calibration curve between absorbance and sulphate concentration.

Into another 50ml standard flask pipette out 20ml of the water sample and prepare the suspension in the similar manner measure its absorbance and read its concentration from the calibration curve.

4.7.1.3 Phosphate: [PO₄³⁻]

It occurs in natural and waste water as inorganic and organic bonds as phosphate. Phosphates are largely used for laundry purpose, treatment of boiler water and agriculture. Organic phosphates are formed primarily by biological processes, but are also contributed by domestic sewage, industrial effluents and agriculture waste.

Spectrophotometric Method:

Phospho vanado Molybdate Method: The Phospho vanado Molybdate complex formed between the phosphate, ammonium vanadate and ammonium Molybdate it is bright yellow in color and its absorbance can be measured between 460-480nm.

Reagents:

Ammonium Vanadate Solution: Dissolve 2.5g of ammonium vanadate in 500ml hot water and diluted with water to 1liter graduated flask.

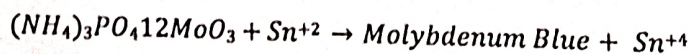
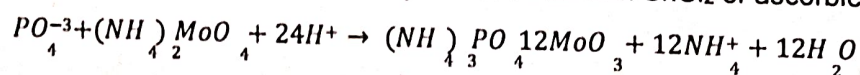
Ammonium Molybdate solution: Dissolve 50mg of ammonium Molybdate in warm water and dilute to 1liter in a graduated flask filter the solution before use.

Standard solution of phosphate:**Procedure:**

Take 100ml of sample in a beaker and digested with 1ml of conH₂SO₄ and 5ml of Con HNO₃ and evaporate to dryness repeat the digestion and evaporation. Then take 10ml of sample solution is taken in 50ml VF and add 5ml of 10% ammonium Molybdate and then 5ml of 0.25N Ammonium vanadate then dilute to mark with distilled water wait for 10min then measure the absorbance of the yellow reaction product i.e. vanado molybdo phosphate at 460nm

Prepare a calibration curve using a series of standard solution of phosphate.

Molybdenum Blue Method: Phosphate can be quantitatively determined by colorimetric method. Phosphate ions combine with ammonium Molybdate under the acid condition to form ammonium Phospho Molybdate complex it is reduced to molybdenum blue with SnCl₂ or ascorbic acid



The intensity of blue color is proportional to the amount of phosphate.

Reagent:

Sulphuric Acid [1:3] Add 250ml of con H₂SO₄ to 500ml distilled water slowly with cooling and stirring cool this solution and add to this 5ml of con HNO₃ dilute the solution to 1liter

Standard Phosphorous Solution: Weigh 0.07165g of pure potassium dihydrogen phosphate dissolve it in water make the solution up to 100ml flask and make up to mark with distilled water.

Ammonium Molybdate Solution [2%]: Dissolve 6g of ammonium Molybdate in 50ml of distilled water in a beaker in another beaker take 100ml of distilled water and add 100ml of con H₂SO₄ with cooling into this pour ammonium Molybdate solution and stirred well

SnCl₂ solution: Add 2.5g of SnCl₂ · 2H₂O to 100ml of glycerol taken in a beaker heat the beaker in a water bath with constant stirring to get a clear solution

Applied Analysis [Paper – III] [Semester – III]

Phenolphthalein Indicator

Procedure:

Take 5, 20ml volumetric flasks pipette out 1,2,4,8 and 10ml of the diluted standard phosphate solution into these flasks to each flask add a drop of phenolphthalein indicator. If a pink color develops add a few drops of H_2SO_4 to discharge the color then add 5ml of ammonium Molybdate reagent and 0.5ml $SnCl_2$ solution and make up to the mark with distilled water and shake well then measure the absorbance of the solution at 690nm in spectrophotometer then plot the graph between absorbance and phosphate concentration.

Pipette out 10ml of the water sample into another 25ml volumetric flask add the reagents in the similar manners as that of standard solutions and measure the absorbance and read the concentration from the calibration curve.

4.7.1.4 Nitrates:

Spectrophotometric Method: The nitrates in water can be determined by phenol disulphonic acid method.

Principle: Nitrate in contact with H_2SO_4 produces HNO_3 . In dry condition it brings about nitration of phenol disulphonic acid. This nitro phenolic product gives intense yellow color in alkaline medium.

Reagents:

Phenol disulphonic Acid: Dissolve 25g of white phenol in 150ml of $ConH_2SO_4$ and heat it for about 2hours on water bath cool and keep the solution in a dark bottle

1:1 Ammonia Solution:

Standard Nitrate Solution: Dissolve 0.722g of anhydrous potassium nitrate in distilled water and diluted to 1liter. This stock solution contains 100mg of nitrite per liter

Procedure:

Take 25ml of sample in a porcelain dish and evaporate it to dryness on a water bath. Add 3ml of phenol disulphonic acid and dissolve the residue by rotating the dish after 10min add 15ml of distilled water stir with a glass rod. After cooling the contents are washed down into 100ml volumetric flask then add ammonium slowly until the solution is alkaline as indicated by the formation of yellow color due to the presence of nitrate. Then add another 2ml of ammonia and make up to 100ml with distilled water and measure the absorbance at 420nm. A calibration curve is drawn against absorbance and concentration of the standard nitrate solution. The water sample is also treated in similar manner and the absorbance value is measured. The concentration of nitrate present in the water sample can calculate by using calibration curve.

70
Applied Analysis [Paper – III] [Semester – III]

4.7.1.5 Nitrites:

In this method two organic reagents sulphanilic acid and α -naphthyl amine hydrochloride are used to estimate the nitrite ion under acidic condition. The nitrite ions as nitrous acid reacts with amino group of sulphanilic acid to form a diazonium salt. This salt combines with α naphthyl amine hydrochloride to form a bright pinkish red azo dye.

Reagents:

Sulphanilic Acid Solution: Dissolve 0.6g of Sulphanilic acid in about 70ml of warmed distilled water cool and add 20ml of con HCl and make up to the mark of 250ml VF with distilled water.

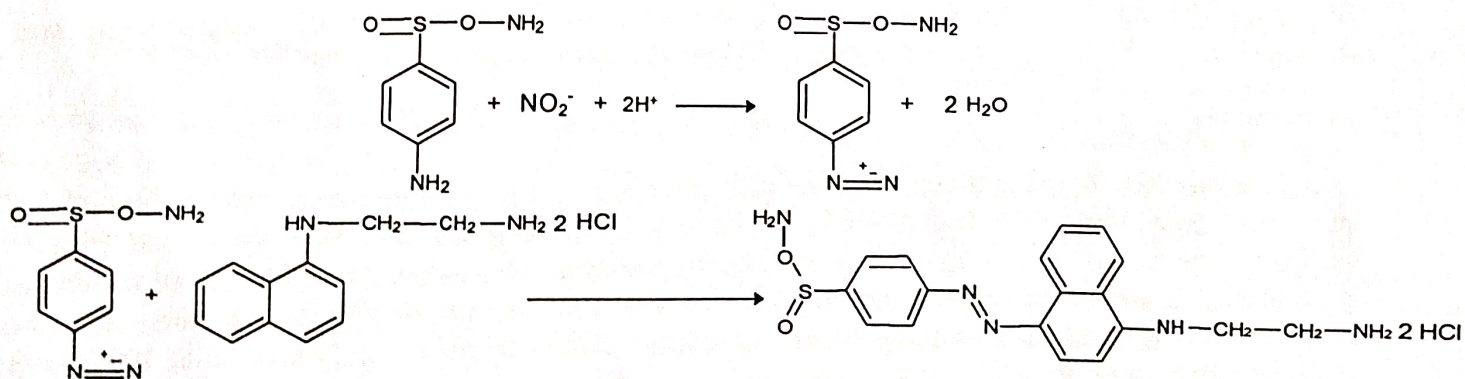
α – Naphthyl Amino Hydro Chloride Solution: Dissolve 0.6g of α Naphthyl Amine hydrochloride in a distilled water and add 1ml of con HCl and make the solution to 100ml volumetric flask.

Sodium Acetate Solution: Dissolve 27.2g of sodium acetate in distilled water and make up to 100ml volumetric flask

Standard Nitrite Solution: Dissolve 1.232g of sodium nitrite in distilled water and make up to 1liter take 4ml of this solution and again make up to 1lit with distilled water this stock solution has 1mg Nitrite per liter

Procedure:

Take 40ml of sample in a volumetric flask and adjust the P^H 7 with sodium acetate, to this add 2ml of sulphanilamide solution and shake well and allowed to stand for 10min. then add 2ml of N (1-Naphthylethylene diamine) Di hydro chloride and diluted to 50ml with distilled water. Measure the absorbance at 543nm for purple azo dye. Measure the absorbance for series of standards solution. The concentration of nitrite present in the water sample can calculate by using calibration curve.



Applied Analysis [Paper – III] [Semester – III]

4.7.1.6 Cyanide:

Free Cyanide is a very toxic water pollutant arising from metal refining and cleaning, electroplating, coke ovens and various industrial processes.

Cyanide in water can be determined by four methods

1. Gravimetric Method
2. Spectrophotometric Method
3. Titration Method
4. Ion Selective Method

Gravimetric Method:

The cold solution of alkaline cyanide is treated with excess of silver nitrate solution acidified with nitric acid in order to precipitate. The precipitate is filtered and washed with water, dry at 100°C and weighed by using the weight of residue we calculate the concentration of cyanide.

Spectrophotometric Method:

Take 250ml of sample in a distillation flask in fume chamber add 50ml of 1:1 sulphuric acid and 20ml of 50% MgCl_2 . Reflux the content for about 1hour. Collect the HCN gas in 500ml of 1N NaOH in gas washer with distilled water, then determine the strength of cyanide present in the water sample.

Cyanide ion in alkaline is converted into CNCl by reaction with chloramines -T at pH less than 8. Then CNCl is mixed with pyridine barbutaric acid reagent [75g of pyridine + 15g of Barbutaric acid + 15ml of ConHCl and diluted to 250ml] and measure absorbance of the resultant dye at 578nm

Prepare a series of standard solution as discussed above and measure the absorbance and draw the calibration curve. The concentration of cyanide present in the water sample can calculate by using calibration curve.

4.7.1.7 Fluoride:

These are two methods in determination of fluorides

1. Gravimetric Method
2. Spectrophotometric Method

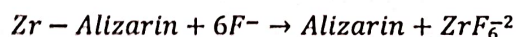
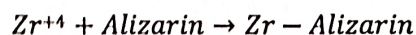
Gravimetric Method:

Prepare the reagent tri phenyl tin chloride by shaking vigorously 4g of solid substance with 200ml of 90% ethanol. So that the aqueous solution compresses 60-70% of the final volume by heating and allowed to stand for few hours and then cool for 1hour in a ice and filter and wash the precipitate with 95% ethanol and then dry in a oven at 110°C and weighed as tri phenyl tin fluoride.

Spectrophotometric Method:

Principle:

Zirconium ion reacts with alizarin dye to form a colored complex. Then fluoride ion combines with "Zr" ion to form a stable complex of ZrF_4 or ZrF_6^{2-} then reaction between the zirconium ion and the fluoride ion decreases the color intensity of the complex. The decrease in intensity of color indicates the concentration of the fluoride.



Reagents:

Standard Fluoride Solution: Dry AR solution fluoride at 110°C for 2hours and cool it in a desiccators. Dissolve 221mg of sodium fluoride in distilled water and make the volume to 1liter. This stock solution contains 10mg of fluoride per liter prepare a series of standard fluoride solution by taking 0,10,15,20,25,30,35,40,45 and 50ml of stock solution in volumetric flasks and diluted it to 100ml

Sodium Thio Sulphate Solution: Dissolve 1g in water and diluted to 250ml

Zirconium Alizarin Reagent: Add 100ml of con HCl to 300ml distilled water in a beaker in another beaker take 400ml of distilled water and add to it 30ml of con H_2SO_4 and carefully mix them.

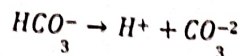
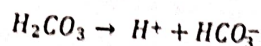
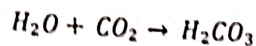
Add 0.3g of $ZrOCl_2 \cdot 8H_2O$ in 50ml distilled water dissolve separately 0.07g of alizarin red in 50ml water and stirring the solution for 5min and add HCl- H_2SO_4 mixture to the zirconium alizarin solution dilute the solution to 1lit mix this reagent thoroughly and use it after 1hour

Procedure: Prepare a series of standard NaF solution from the diluted stock solution add 1drop of $NaHSO_4$ to each flask then add 5ml of zirconium alizarin reagent dilute it with distilled water up to mark and shake well and measure the absorbance at 520nm construct a calibration curve by plotting absorbance values against concentration of fluoride solution.

Treat the water sample in similar manner and measure the absorbance from the calibration curve we can determine the concentration of the fluoride in water sample.

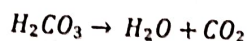
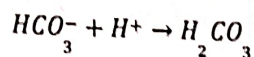
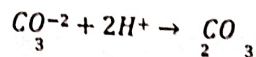
4.7.1.8 Determination of Carbonates and Bicarbonates

These are formed due to the dissolution of CO_2 in water at lower P^H bicarbonates and at higher P^H carbonates are formed the level of carbonate and bicarbonates in water is 40-400mg/liter

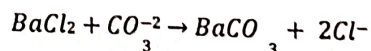
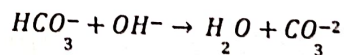


Proceduro:

Total Alkali: Total alkali is determined by titrating with standard 0.1M HCl using Methyl Orange as indicator until color changes from yellow to pink then read the volume of HCl as 'V' ml



Determiration of HCO₃⁻: Take the sample in another flask and a known excess volume standard NaOH It is read as [v] It is required to transform the hydrogen carbonate to carbonate. Then add excess of 10% BaCl₂ solution is added to the hot solution to precipitate the carbonate as barium carbonate and the excess of NaOH is determined without filtering off the precipitate by titration with the standard HCl using phenolphthalein as indicator until color changes from pink to color less the titrant value corresponds to the excess volume of NaOH it is noted as v¹. then [v-v¹] = volume of hydrogen carbonate and V- [v-v¹] = volume of carbonate.



4.7.1.9 Determiration of Sulphide:

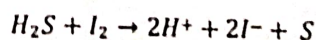
It is generally present in ground water particularly in hot springs and in common in waste water the source of these pollution are from industries but mostly from reduction of sulphate. H₂S is very toxic and has killed numerous work men in sewers. It attacks metal directly and indirectly has caused serious corrosion of concrete sewers since it is oxidized biologically to sulphuric acid on the pipe wall.

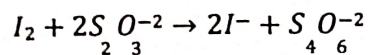
Required Reagents:

1. H₂SO₄
2. Starch Solution
3. Zinc Acetate Solution [2N]
4. Iodine Solution [0.05N]
5. Hypo [0.05N]

Proceduro:

Take 500ml of sample in a 1liter distillation flask then add 200ml of zinc acetate and 2ml of 1N NaOH. Then add 20ml of 18N H₂SO₄ and quickly distill the solution then ZnS is dissolved and converted to H₂S then add Known excess of 0.05N I₂ solution and 10ml of ConHCl stir the solution thoroughly then titrate the unreacted iodine with standard hypo using starch as indicator until the color changes form blue to color less then conduct the blank titration in similar conditions. By using the blank titrate value and the volume of hypo consumed by the sample we can calculate the amount of sulphide present in the water sample.

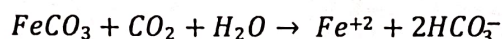




4.7.2 Determination of Cations:

4.7.2.1 Determination of Iron:

Iron is present in soils and minerals mainly as insoluble ferric oxide and iron sulphide in some places it occurs as ferrous carbonate which is very slightly soluble the carbon dioxide present in ground water can react ferrous carbonate to form soluble ferrous salts.

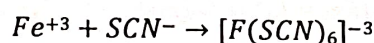
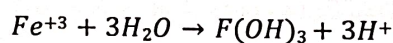


This ferrous iron dissolved in water is slowly oxidized to ferric iron under aerobic conditions. Therefore natural water may contain Fe^{+2} and Fe^{+3} . The permissible limit for filterable Fe in drinking water is 0.3ppm

4.7.2.2 Determination of Fe^{+3}

Thiocyanate Method:

Ferric iron reacts with ammonium Thiocyanate to form a blood red color complex ion. Depending upon a Thiocyanate concentration a series of complexes can be obtained at very high concentration of thiocyanide it is $[Fe(SCN)_6]^{-3}$. This colored complex formed can be estimated either by colorimetric or Spectrophotometric. In the determination a large excess of Thiocyanide should be used. Since this increases the intensity and also the stability of the color strong acids [HCl or HNO_3] should be present to suppress the hydrolysis.



Reagents:

1. Ammonium Thiocyanide solution [20%]
2. 5N HCl
3. Standard Ferric Solution

Procedure:

Take 5, 50ml volumetric flask than take 1,2,3,4,6,8 and 10ml of the standard Fe^{+3} solution and to each flask and add 4ml of 5N HCl and 5ml of ammonium thiocyanide solution. Make up the solution up to the mark with distilled water and shake the flask measure the absorbance of each solution at 480nm draw the calibration curve by plotting absorbance against iron concentration

Take another 50ml of volumetric flask and pipette out 20ml of water sample and to it add 4ml of HCl and 5ml of ammonium thiocyanide solution make up to the mark with distilled water and measure the absorbance of the solution using this absorbance value we can find the concentration of Fe^{+3} in water sample by using calibration curve.

4.7.2.3 Determination of Fe^{+2}

Iron [II] reacts with 1,10 phenanthroline to form an orange red complex $[(C_{12}H_8N_2)_3Fe]^{+2}$. The color intensity is independent of the acidity in the P^H range 2-9 and it is stable for long period. This reddish orange $Fe(II)$ complex absorbs at 515nm

Reagents:

1. 1,10 phenanthroline [0.25%]
2. Buffer [P^H 4-5]: Mix 65ml of 0.1N CH_3COOH and 35ml of 0.1N CH_3COONa solution

3. Standard Fe^{+2} solutions: dissolve 0.7022g of ferrous ammonium sulphate in 100ml of water and add 5ml of 5N H_2SO_4 and make up to 1liter with distilled water. This solution corresponds to 1ml = 0.1mg Fe^{+2}

Procedure:

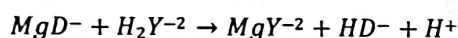
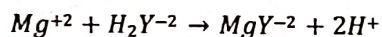
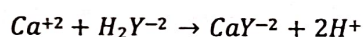
Take six 50ml volumetric flasks and pipette out 2,4,6,8, and 10ml of standard Fe^{+2} solution to this add 4ml of buffer solution and 4ml of 1,10 phenanthroline solution make the solution up to the mark with distilled water then measure the absorbance of the solution at 515nm draw a calibration curve between absorbance and concentration

Pipette out 20ml of water sample in another 50ml volumetric flask to this add 4ml of ConHCl and 4ml of 1,10 phenanthroline solution and measure the absorbance at 515nm calculate the concentration of the Fe(II) in water sample by using the calibration curve.

4.7.2.4 Determination of Calcium and Magnesium:

Principle:

The concentration of calcium and magnesium is determined by titrating the water sample with EDTA during titration with EDTA calcium first reacts to form a relatively stable CaY^{-2} followed by magnesium to give MgY^{-2} complex releasing the free indicator the color changes from wine red to blue at the end point this gives total calcium and magnesium



Take another portion of the sample calcium is estimated selectively at P^{H} 12 magnesium is precipitated as magnesium hydroxide in presence of murexide or calicon indicator the color changes from orange to violet.

Procedure:

Take 20-50ml of water sample in a Conical flask in presence of organic matter in natural and waster water add 2-4drops of 30% H_2O_2 then adjust the P^{H} 10 with buffer and add 2 drops of EBT indicator and titrate the standard EDTA solution until the color changes to blue color this gives the total calcium and magnesium

Only Calcium:

Take water sample and add 5ml of 3N KOH or NaOH solution to precipitate magnesium as magnesium hydroxide. Then adjust the P^{H} 10-12 by using buffer and add 5drops of murexide indicator and titrate with standard EDTA solution until the color changes from orange to violet this gives calcium only.

4.7.2.5 Lead:

Tetra valiant lead forms a red chelate complex with dithizone this complex is soluble in CCl_4 the red complex can be extracted with CCl_4 and its concentration is determined spectrophotmetrically at 515nm interfering ions such as Cu , Cd , Zn , etc., can be masked by cyanide ion.

Reagents:

Standard Lead Solution: Dissolve 0.2497g of A.R. lead nitrate in distilled water and make up this solution to 250ml. pipette out 10ml of this solution and dilute it to 250ml from this diluted solution pipette out 10ml and dilute to 250ml this solution contains 1microgram of lead contain per 1ml of it

Dithizone Solution: Dissolve 0.05g of dithizone in 1liter CCl_4

$NH_4OH - Na_2SO_3 - KCN$ solution: Dissolve 3.5g of KCN and 12g of Na_2SO_3 in water to this solution add 400ml of con NH_3 solution and diluted to 1liter

Procedure:

Pipette out 10ml of final diluted lead solution into a 100ml VF add 40ml of distilled water and add 25ml of mask reagent and add 10ml of dithizone shake the contents vigorously separate the CCl_4 layer into clean dry test tube then measure the absorbance of the solution at 515nm prepare different standard solution and measure the absorbance values construct the calibration curve by plotting the absorbance values against lead concentration

Pipette out 10ml of water sample into a reparatory funnel add 25ml of masking reagent and 10ml of dithizone shake the contents vigorously and separate the CCl_4 layer measure the absorbance of this solution at 515nm calculate the concentration of lead in the water sample from the calibration curve.

4.7.2.6 Determination of Cobalt:

It is determined by tetra Thiocyanate mercurate [II] method this method is based upon the fact that cobalt [II] in neutral solution forms a new complex $[Hg(SCN)_4]^{-2}$ with the reagents mercuric chloride and ammonium thio cyanide in water.

Procedure:

To the neutral solution of cobalt add mercuric chloride and ammonium thiocyanide reagents. A dark blue precipitate forms after stirring for 3min and allows standing for 2hours at room temperature collect the precipitate in weighed porcelain crucible dry at $100^\circ C$ and weighed the precipitate. Form the weight of the precipitate we can calculate the amount of cobalt present in the water sample.

4.7.2.7 Determination of Chromium:

Chromium salts are used in industrial processes and enter water bodies through discharges of waste. Chromate compounds are often added to cooling water for corrosion control. The normal level of Cr (VI) in drinking water is 3 to 40ppb the permissible level being 50ppb.

Principle:

Chromium reacts with diphenylcarbazide in acid medium to form a red violet color which is measured at 540nm

The interfering elements Mo, V, Fe and Cu are removed by preliminary extraction with cupferron.

Reagents:

Standard Potassium Dichromate Solution: Dissolve 0.3535g of potassium dichromate solution in water and make up the solution up to 100ml volumetric flask pipette out 10ml of this solution and diluted to 100ml of pipette out 5ml of second solution and make up to 2560ml this diluted solution contains 0.001g of chromium per ml

1:1 H_2SO_4

Applied Analysis [Paper – III] [Semester – III]

Diphenylcarbazide Reagent: Dissolve 0.21g of the reagent in 100ml of 95% ethyl alcohol add to this 4N H₂SO₄ and mix well

KMnO₄ solution [0.01N]

Sodium Azide Solution [0.5%]

Procedure:

Take 50-100ml of sample [10-100μg] in conical flask add 5ml of conHNO₃ + 2ml of 30% H₂O₂ [to reduce Cr(IV)] and evaporate on a steam bath. Again add 5ml of ConHNO₃ and 10ml of H₂SO₄ and evaporate to dense white fumes of SO₃. Repeat evaporation with HNO₃ – H₂SO₄ cool to room temperature slowly dilute to 50ml with redistilled water and heat nearly to boiling. Filter through a sintered glass crucible and transfer the filtration with washings to a 100ml volumetric flask. Make up to 100ml with distilled water and mix thoroughly.

Separation of Mo, V, Fe and Cu:

This process is continued only Mo, V, Fe, and Cu are present other wise proceed to next step

Take the sample into 125ml separating funnel. Dilute to 40ml and chill in ice bath add 5ml of ice cold cupferron solution and after 1minute extract with 3x5ml portions of CHCl₃ transfer the aqueous layer to 125ml conical flasks. Boil for 5min to expel CHCl₃ and cool. Add 5ml of ConHNO₃ and 5ml of H₂SO₄ and heat to SO₃ fumes.

Take the sample and acidify with H₂SO₄[1:1] using methyl orange. Add 4% KMnO₄ solution drop by drop till pale pink color appears boil the solution for 2min. add 2ml of NaN₃ sodium Azide solution and boil till the color fades completely cool and add 0.25 ml H₃PO₄. Transfer into a 100ml volumetric flasks and dilute to 100ml with distilled water. Then add 2ml of diphenylcarbazide solution and mix thoroughly allow standing for 10min and measuring the absorbance at 540nm.

The same procedures is repeated with standard solution and blank then measure the absorbance and draw the calibration curve. By using calibration curve we can calculate the concentration of chromium present in the water sample.

4.7.2.8 Cadmium:

Cadmium is highly toxic and responsible for several cases of poisoning through food. Small quantities of Cd cause adverse changes in the arteries of human kidneys. At concentrations more than 200ppb it is toxic to certain fish. In potable water the normal level of Cd is from 0.4 to 60ppb. Cd enters water through industrial discharges.

Principle:

Cadmium reacts with dithizone under optimum conditions to form a pink to red color which can be extracted with CHCl₃. The organic extract can be measured spectrophotometrically at 518nm.

Procedure:

Take the sample [1-10μg of Cd] in a separatory funnel and dilute to with 25ml distilled water. In case water sample containing 10ppb or less add 0.5ml of con HCl to 200ml sample and evaporate to 20ml. then adjust the P^H 2.8 with thymol blue indicator. Add 1ml of sodium potassium tartarate solution and 5ml of NaOH – KCN solution, 1ml NH₂OH HCl and 15ml dithizone mix well. Then transfer the CHCl₃ layer into a second funnel congaing 25ml of cold tartaric acid add 10ml of CHCl₃ to first funnel shake for 1min and drain into the second funnel again and shake for few seconds and remove the organic layer and measure the absorbance at 518nm

4.7.2.9 Copper:

Divalent Copper forms a color complex with cuperthiol. It can be determined spectrophotometrically.

Reagents:

Standard Copper Solution: Dissolve 3.929g of copper sulphate in water and make up to 100ml pipette out 10ml of this solution into another 100ml volumetric flask and make up to the mark this solution contains 1mg per ml.

Cuperthiol Solution: Dissolve 2g of diethanol amine in 100ml methanol, add to it a solution of 1ml carbon disulphide in 100ml methanol this reagent is called cuperthiol reagent.

1:1HCl

CH₃COONa Solution: Dissolve 60g of sodium acetate in 100ml water

Sodium Pyrophosphate: Dissolve 3g of sodium thio phosphate in water and make up to the mark of 100ml VF

Procedure:

Take five flasks and pipette out 2,4,6,8 and 10ml of diluted standard copper sulphate solution to each add 0.5ml HCl, 2ml pyrophosphate solution and 5ml sodium acetate solution to maintain the PH at 5-6 stir the solution after 10min add 1ml of cuperthiol reagent and make up to the mark with distilled water and measure the absorbance at 435nm and construct the calibration curve by plotting the absorbance against the concentration

Take 100ml sample and proceed the procedure as done above and measure the absorbance at 435nm. Calculate the concentration of copper in the water sample from the calibration curve.

Gravimetric Method:

Take 50ml of water sample in a beaker and add few drops of dil HCl and slight excess of freshly prepared saturated sulphuric acid or 25ml ammonium hydrogen sulphite solution then copper (II) is reduced to copper (I) on dilution heat the solution until it boils then add freshly prepared 10% ammonium Thiocyanate solution then copper present in the sample is precipitated as copper thio cyanide. Then filtered the precipitate and dry in a oven at 120°C and weighed as CUSCN

Neocuproine Method:

In neutral or weakly acidic solution copper reacts with 2,9 dimethyl 1,10 phenanthroline [Neocuproine] to form a complex which is extractable in to a CHCl₃ – CH₃OH mixture to produce a yellow solution it is measured at 457nm by using spectrophotometrically.

Procedure:

Take 100ml sample [20-200µg of cu] in a 250ml beaker add 1ml con H₂SO₄ and 5ml of Con HNO₃. Heat to SO₃ fumes. Repeat addition of 5ml con HNO₃ and heating to fumes or till the solution becomes color less. Cool and add 80ml distilled water and boil. Cool and filter into a volumetric flask and make upto the mark with distilled water

Take 50ml aliquot sample into 125ml separatory funnel and diluted to 50ml with distilled water and add 5ml of NH₂OH HCl, 10ml sodium citrate solution and mix thoroughly and adjust the PH 4-6 and add 10ml of Neocuproine reagent and shake for 30second. With draw CHCl₃ extract in a 25ml volumetric flask and dilute with water up to the mark and measure the absorbance at 450-460nm. The

same procedure is repeated with standard solution and draw the calibration curve by using it we can determine the concentration of the copper present in the water sample.

4.7.2.10 Arsenic:

Arsenic is reduced to AsH_3 by zinc in acid solution in a Gutzeit generator AsH_3 is then passed through a scrubber containing a glass wool impregnated with lead acetate solution into a absorbed tube contain silver diethyl dithiocarbamate $[\text{Ag SCSN}(\text{C}_2\text{H}_5)_2]$ dissolved in pyridine arsenic reacts with this silver salt to form a soluble red complex which is measured at 535nm

Procedure:

Take 25-35ml sample in to a Gutzeit generator then add 5ml of Con HCl, 2ml KI and 0.5ml of 40% SnCl_2 reagent allow 15min for reduction of As(V) to As(III) then add 3g of zinc to the solution in the generator allow 30min to complete the evolution of AsH_3 warmed the generator slightly to ensure that all AsH_3 is released then AsH_3 passes through the scrubber and then to the absorber containing 4ml of 0.05% silver salt in pyridine then measure the absorbance of red solution at 535nm prepare a calibration curve by using a known concentration by using calibration curve we can calculate the concentration of Arsenic present in the sample.

4.7.2.11 Mercury:

Organic compounds of mercury are very toxic the permissible limit of mercury in drinking water is 2ppb. 2 to 10 micrograms of mercury can be estimated by Spectrophotometric method mercury reacts with dithizone in acid medium i.e. sulphuric acid to produce an orange colored complex it is extracted with CCl_4 and measure the absorbance at 490nm

Procedure:

Take a 100ml of sample in a 500ml distillation flask and add 5-10ml of 5% KMnO_4 and mix thoroughly reflux for 4hours with ice cold water circulation in the condenser cool and add few ml of 30% hydrogen peroxide to remove the KMnO_4 and boil to remove excess of H_2O_2 cool and add few drops of 1N H_2SO_4 . Extract with 10ml dithizone solution combine the extracts, make up to 25ml in a volumetric flask and measure the absorbance at 490nm. The same procedure is repeated with the standard solutions and draws the calibration curve. We can determine the concentration of mercury by using the calibration curve.

4.7.2.12 Zinc:

Gravimetric Method:

Take water sample and add dil aq NH_3 until a white precipitate is formed it zinc hydroxide. It is re dissolved in acetic acid then add 8 hydroxy quinaldin the p^{H} should be maintain 5.5 heat the solution at 60°C and allow to stand for 10-20min then zinc present in the sample is precipitated as $[\text{Zn}(\text{C}_{10}\text{H}_8\text{ON})_2]$ the precipitate is filtered and dry in oven at $130\text{-}140^\circ\text{C}$ and weighed as $[\text{Zn}(\text{C}_{10}\text{H}_8\text{ON})_2]$

Spectrophotometric Method:

Reagents:

Standard Zinc Solution: Dissolve 0.1g of pure zinc meta in a slight excess of 1:1HCl and dilute to 1liter pipette out 10ml of this solution and diluted to 100ml this solution corresponds to 0.01mg of zinc per ml

Dithizone Solution: Dissolved 50mg of Dithizone in 1liter CCl_4 it is stored in the refrigerator

Sodium Acetate Solution: [0.5]

Na₂S₂O₃ solution: Dissolved 50g of Na₂S₂O₃ in 100ml of water

Thio sulphate Acetate Wash Solution: Mix 225ml of 0.5N sodium acetate solution and 10ml of sodium thio sulphate solution and 40ml 1:9 HNO₃ dilute to 500ml with distilled water.

Sodium Sulphide Solution: Dissolve 1g in 100ml of water and diluted to 1 liter with distilled water.

Bromo Cresol Green Indicator:

HCl

CCl₄

Sodium Sulphate

Procedure:

Select a volume of sample containing 0.01 to 0.04mg of zinc then acidify the solution with 0.1N HCl. Adjust the P^H 4.6 – 5.5 with 0.5N sodium acetate solution using bromo cresol green indicator add 5ml of sodium thio sulphate solution and mix thoroughly and transfer in to a separatory funnel then add 10ml dithizone solution and shake vigorously for 2min. Separate the organic layer and transfer in to a second separatory funnel shake the solution with thio sulphate acetate wash solution. Then wash with 5ml of water finally shake the solution with sodium sulphide solution separate the red zinc dithizonate layer into a 50ml volumetric flask and make up to the mark with CCl₄ then measure the absorbance at 535nm.

The same procedure is repeated with standard solution and draw the calibration curve by using it we can calculate the concentration of zinc present in the sample.

4.7.2.13 Determination of Dissolved Oxygen [D.O]

The amount of oxygen present in water is called dissolved oxygen. It is expressed in mg/liter. The optimum value of D.O for water quality is 4-6ppm. Lower D.O value indicates water pollution.

The D.O Level depends on

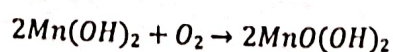
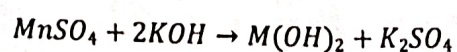
1. Biological Activity Example: Micro Organisms by using O₂ activate the degradation of organic matter.
2. Chemical Activity Example: Reducing the toxic nature of Chemicals.
3. Physical Activity Example: Transportation

There are two methods for the determination of D.O

1. Winkler Method or Iodometric Method
2. Electro Metric Method Using a Membrane Electrode

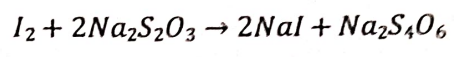
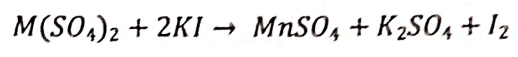
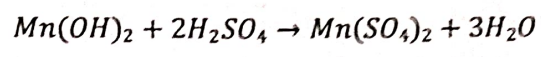
Principle:

This method is based on the fact that the dissolved oxygen oxidizes Mn⁺² to higher oxidation state under alkaline conditions. The oxidized "Mn" then reacts with KI to liberate Iodine the amount of Iodine liberated is equivalent to the dissolved oxygen originally present in water. The liberated iodine is titrated with standard sodium thio sulphate solution. The important reactions are.



21

Applied Analysis [Paper – III] [Semester – III]



Reagents:

1. B.O.D. Bottles[100-300ml]
2. Manganese Sulphate Solution: Dissolve 100g of MnSO₄ in 200ml of boiling distilled water.
3. Alkaline KI Solution: Weighed 50g of KI and 100g of KOH dissolved in 200ml of boiled distilled water.
4. Na₂S₂O₃ solution: Dissolve 6.205g of Na₂S₂O₃ in boiled distilled water and make up to 1liter.
5. Starch Indicator
6. Con H₂SO₄

Procedure:

Take a glass stopper B.O.D bottle of known volume and filled it with sample avoiding any bubbling open the bottle and pour in each one ml of MnSO₄ and alkaline KI solution then formed precipitate is dissolved by adding 2ml of H₂SO₄ transfer the contents into a conical flask and then add 2drops of starch indicator then titrate the liberated iodine with standard hypo solution.

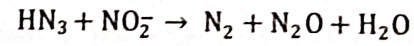
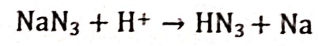
$$Dissolved\ Oxygen = \frac{V_2 \times N \times 1000 \times 8}{V_1}$$

Where V₁ = Volume of watr sample in ml

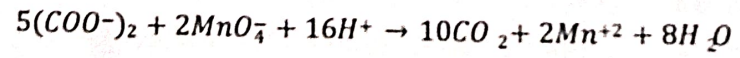
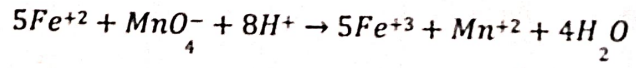
V₂ = Volume of titrate value in ml

N = Normality of Hypo solution

Note: In case of excess of nitrite is present in H₂O the Winkler's Method is modified by adding sodium Azide in alkaline KI solution the Azide destroy the nitrite ion



The interfering ion like Fe⁺² is eliminated by adding KMnO₄ solution the excess of KMnO₄ is removed with potassium oxalate solution.

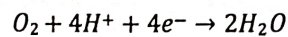
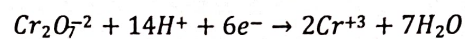
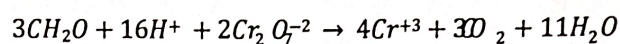


4.7.2.14 Determination of Chemical Oxygen Demand: [C.O.D]

The chemical oxygen demand measures the amount of oxygen required for oxidation of organic compounds which are present in water sample.

Principle:

Most of the organic matter decomposes and produces CO₂ and water when it is boiled with a mixture of potassium dichromate [K₂Cr₂O₇] and sulphuric acid [H₂SO₄]. Then excess of potassium dichromate is determined by titrating with standard ferrous ammonium sulphate. The amount of dichromate consumed is proportional to the oxygen required to oxidize the organic matter in the sample the basic reaction that occur during the C.O.D determination can be represented by the following chemical equation.

**Procedure:**

Take 20ml of the sample and add 30ml of dil H₂SO₄. Add 10ml of standard potassium dichromate solution [0.25N] and add 2 or 3 drops of boiling chips i.e. 1g of Ag₂SO₄ and 1g of HgSO₄ and reflux for 2 hours cool the solution and diluted the solution with 150ml distilled water. Then the unreacted potassium dichromate is titrated with ferrous ammonium sulphate by using ferroin indicator until the color changes from bluish green to wine red it is the end point. The volume of ferrous ammonium sulphate consumed in the titration is recorded

A blank titration is performed by taking distilled water in the place of sample is to be determined in the same manner the amount of oxidizable organic matter present in the sample in terms of the C.O.D. Value can be calculated by using the following equation.

$$C O D = \frac{[V_1 - V_2] N \times 8 \times 1000}{X}$$

Where V₁ = Volume of ferrous ammonium sulphate used for Blank

V₂ = Volume of Ferrous ammonium sulphate used for sample

N = Normality of ferrous ammonium sulphate

X = Volume of Sample taken.

4.7.2.15 Determination of B.O.D

The quantity of O₂ required by bacteria and other microorganisms during the process of chemical degradation and transformation of organic matter present in 1 liter waste water for 5 days under aerobic condition is called B.O.D. it is carried in incubation the time of incubation depends on the type of microorganisms and the type of organic matter.

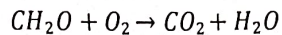
The quantity of oxygen utilized is proportional to the quantity of organic matter oxidized.

Degree of oxidation depends on

1. Nature of micro organisms
2. Nature of Organic matter
3. Availability of D.O

23

Applied Analysis [Paper – III] [Semester – III]



Determination:

The D.O Content of the sample is determined before and after 5days in incubation at 20°C the B.O.D is calculated by using the formula

$$B.O.D = \frac{[[D.O_0 - D.O_5] - B] \times 100}{Volume\ of\ sample\ taken}$$

D.O₀ = Initial dissolved Oxygen content

D.O₅ = D.O Content after incubation for 5 days

B = Blank correction determined by the difference between the D.O content of blank on the initial day that after 5days incubation

Type of Water	B.O.D
Pure water	1-3ppm
Municipality water	1-4ppm
Sewage discharge from houses	165mg/liter
Industrial waste water	200mg/liter
Waste water from paper industry	372mg/liter
Food processing water	747mg/liter
Diary water	2000-5000ppm

4.7.2.16 Standards for Drinking Water

The permissible limits which have been prescribed by the Indian standard state [I.S.I] and united state public health drinking water standards [U.S.P.H] have been given for comparison these refers to domestic water supplies for drinking water. The I.S.I value have been found to be higher than those for U.S.P.H

Parameter	U.S.P.H	I.S.I
Physical Characteristics:		
Color	Colorless	Colorless
Odour	Odourless	Odourless
Taste		Taste less
pH		6-9
Specific Conductance	Taste less	---
D.O	6-8.5	---
T.D.S [Total Dissolved Solids]	300mmho/cm Or 4.0-6.0ppm	---
Suspended Solid	500 or 5ppm	---
Inorganic Chemicals:		
Chloride ion	250ppm	600ppm
Sulphate ion	250	1000
Cyanide ion	0.05	0.1
NO ₃ ⁻ + NO ₂ ⁻	<10	---
Fluoride ion	1.5	3.0
Phosphate	0.1	---
Sulphide	0.1ppb	---
NH ₃	0.5	---
B	1.0	---
Ca	100	---
Mg	30	---
As	0.05	0.2
Ba	1.0	---
Cd	0.01	---
Cr(IV)	0.05	0.05
Cu	1.0	---
Iron	<0.3	---
Pb	<0.05	0.1
Mn	<0.05	---
Hg	0.001	---
Se	0.01	0.05
Ag	0.05	---
U	5.0	---
Zn	5.5	---
Na	---	41.5mg/liter
K	---	15mg/liter
CO ₃ ²⁻	---	5mg/liter
HCO ₃ ¹⁻	---	100mg/liter
Organic Matter:		
C.O.D	4.0	---
Carbon CHCl ₃ extract	0.15	---
Methylene blue active substances	0.5	---
Phenols	0.001	0.005
Pesticides	0.005	---
Polycyclic Aromatic Hydrocarbon	0.002PPm	---
Radio activity	200ppm	---
Radium		
Strontium	220	3pc/lit
Bacteriological parameters		
Coliform cell/100ml	90	10pc/liter
Total Bacteria Count /100ml	1000	---
	1x10 ⁶	<5000