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PROJECT REPORT ON

"ANALYSIS OF THE GROUND WATER SAMPLES OF GUWAHATI BY ION CHROMATOGRAPHY"

Carried out at

NATIONAL INSTITUTE OF HYDROLOGY (NIH), ROORKEE

Submitted in partial fulfillment of the requirement for the award of

The degree of
MASTER OF SCIENCE
IN
CHEMISTRY

(Commercial Methods of Chemical Analysis)

of

GURUKULA KANGRI VISHWAVIDYALAYA, HARIDWAR

CO-ORDINATOR
KANYA GURUKUL CAMPUS
JWALAPUR-HARIDWAR

गुरुकुल काँगड़ी विश्वविद्यालय, हरिद्वार

31/8/17

Department of Chemistry
Kanya Gurukul Campus
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Jwalapur, Haridwar-249407

Submitted by

AAKANKSHA SAINI

UNDER THE SUPERVISION OF

PROFESSOR ANJALI GOEL
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KANYA GURUKUL CAMPUS
GURUKULA KANGRI VISHWAVIDYALAYA
HARIDWAR-249407(U.K)

SESSION:- 2016-2017

DECLARATION

I here by declare that the work done in the project report entitled **"ANALYSIS OF THE GROUND WATER SAMPLESOF GUWAHATI BY ION CHROMATOGRAPHY "** has been carried out by me during January to march 2017 at **NATIONAL INSTITUTE OF HYDROLOGY ROORKEE.** It is submitted in partial fulfillment of requirement for the award of Master's Degree in Chemistry (Commercial Methods of Chemical Analysis) of Gurukula kangri Vishwavidyalaya, Haridwar. It is an authentic record of my own work carried out under the guidance of Professor Anjali Goel, Head of Chemistry Department, Kanya Gurukula Campus, Jwalapur,Haridwar.

Aakanksha Saini.

Date : 31|March|2017

Aakanksha saini

C. K. Jain
tist 'G' & Head
onmental Hydrology Divison

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TO WHOM IT MAY CONCERN

This is to certify that **Ms. Aakanksha Saini**, Student of M.Sc. (Chemistry),4th Semester, **Kanya Gurukul Campus of Gurukul Kangri Vishwavidyalaya, Haridwar** has carried out the Project Work on the topic **"Analysis of the Ground Water Samples of Guwahati by Ion Chromatography "** during the period from 10th January, 2017 to 30th March, 2017 under my guidance and supervision.

She took full interest in her work and I sure that this training will help her in taking up related assignment in her career.

I wish her all success in life.

(C. K. Jain)

॥ ओ३म् ॥

Department of Chemistry
KANYA GURUKUL CAMPUS, HARIDWAR
Gurukul Kangri Vishwavidyalaya, Haridwar
(NAAC 'A' Grade Accredited Deemed To Be University u/s 3 of UGC Act 1956)

Ref. No. 165 Date 25/3/17

CERTIFICATE

This is to certify that Ms. **Aakanksha Saini** student of M.Sc., Chemistry, **(Commercial Methods of Chemical Analysis), Kanya Gurukul Campus of Gurukul Kangri Vishwavidyalaya, Haridwar** has carried out her project work entitled **"Analysis of the Ground Water samples of Guwahati by Ion Chromatography"** under my supervision at **National Institute of Hydrology (NIH) Roorkee** for the partial fulfillment of the requirement for the award of the degree of Master of Science in Chemistry of Gurukul Kangri Vishwavidyalaya, Hardwar.

It is also certified that she has made pre submission presentation in the department.

Date :

Anjali

(Prof. Anjali Goel)
Supervisor

ACKNOWLEDGEMENT

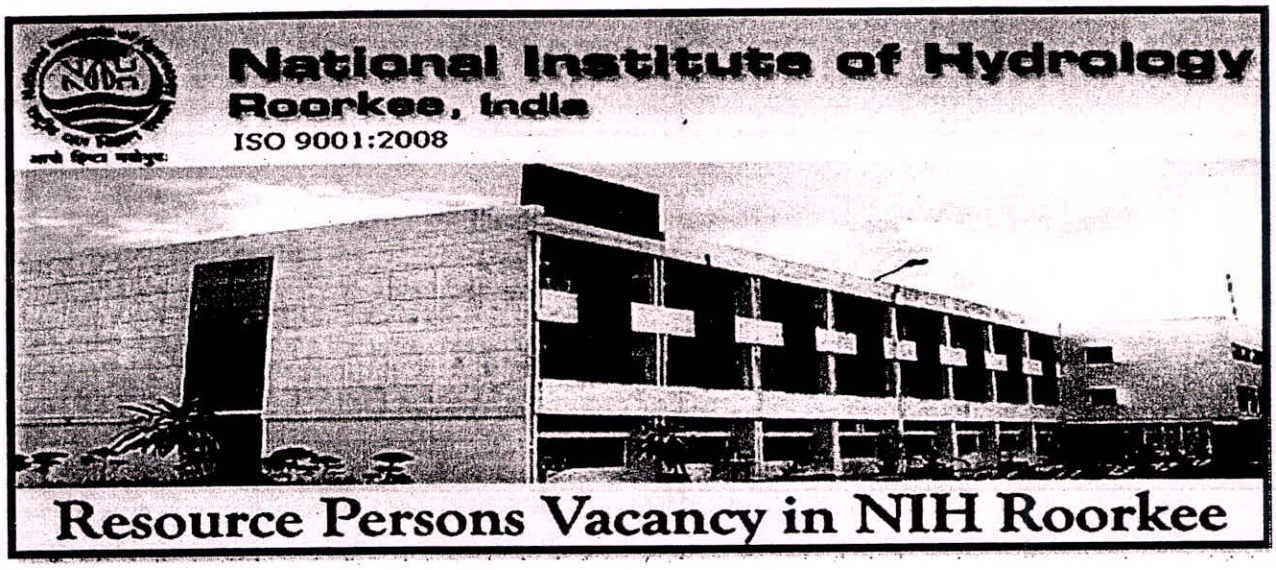
It is the matter of immense pleasure to make and submit this project work. Many people have assisted me and offered their support during the completion of this project work. It give me great pleasure to confer my profound sense of gratitude to **Professor Anjali Goel, kanya Gurukula Campus, Gurukula kangri Vishwavidyalaya, Haridwar** for her valuable guidance and giving valuable time during the preparation of this project work.

I owe my sincere thanks to my respected guide **Dr.C.K.Jain, Scientist 'G' and Head, Environmental Hydrology Division at NATIONAL INSTITUTE OF HYDROLOGY ROORKEE,** who allowed me to complete my project work and rendered his co-operation and help in preparing on the bases of practical. I am also grateful to the working staff of National Institute of Hyrdology. Who helped me at the time of my project work.

Lastly, I am thankful to my parents and family for being a constant source of inspiration.

Aakanksha saini

BRIEF OVERVIEW OF NIH



NATIONAL INSTITUTE OF HYDROLOGY, the premier institute in the area of hydrology and water resources in India. The institute was established in 1978 with the main objective of undertaking, aiding, promoting and co-ordinating systemating and scientific work in all aspect of hydrology. The institute is well equipped to carry out computer, laboratory and field oriented studies.

The institute is located at Roorkee in Haridwar District, Uttarkhand, India .Roorkee, the historic town, is a well known education and research centre with the I.I.T.Roorkee and a number of R & D organization viz. central building research institute, irrigation research institute and army's Bengal engineering group. The studies and research activities at the NIH Roorkee are carried out under five scientific division. As part of the technology transfer program of institute, various training courses/workshop are also organized by the division. The five division are as follow:

1.Hydrology division.

2.Groundwater hydrology division.

3.Hydrological investigations division

4.Surface water hydrology division.

CONTENTS

CHAPTER- 1

- WATER
- GROUND WATER
- WATER QUALITY
- WATER QUALITY ANALYSIS

Water is an important part of human life. Without water no one can survive on the earth. It is the medium of life. About 97% of total water are in saline form in oceans and remaining 3% in fresh form. On land more then 74.9% of fresh water is in the form of ice at the two poles [north and south] and about 30% is in the form of underground water. About 0.115% of fresh water is in the form of atmospheric moisture, river, streams, lakes, pools, artificial, reservoirs etc. In which 0.035% in standing form as ponds, lakes and reservoirs.

People are forgetting the importance of aquatic bodies and show ignorance in their maintenance, conservation and management even in rural areas where people are found to their religious faith even now.

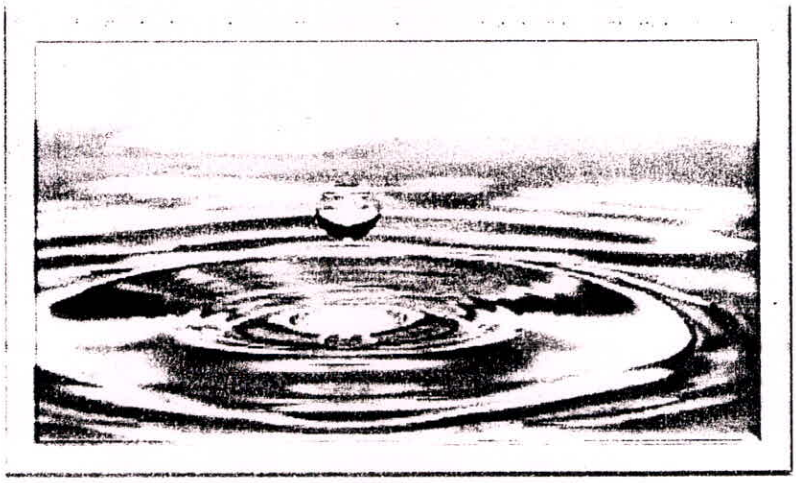


fig.1.1 - water

Water is a transparent and nearly colorless chemical substance, i.e. the main constituent of earth's streams, lakes and oceans and the fluids of most living organism.

It 's chemical formula is H_2O meaning that it's molecule contain one oxygen and two hydrogen atom that are connected by covalent bond .It also occurs in nature as show glaciers , icepacks and clouds , fog ,atmospheric humidity .

Water is our most precious resource. All plants animal must have water to survive. If there is no water there would be no life on earth.

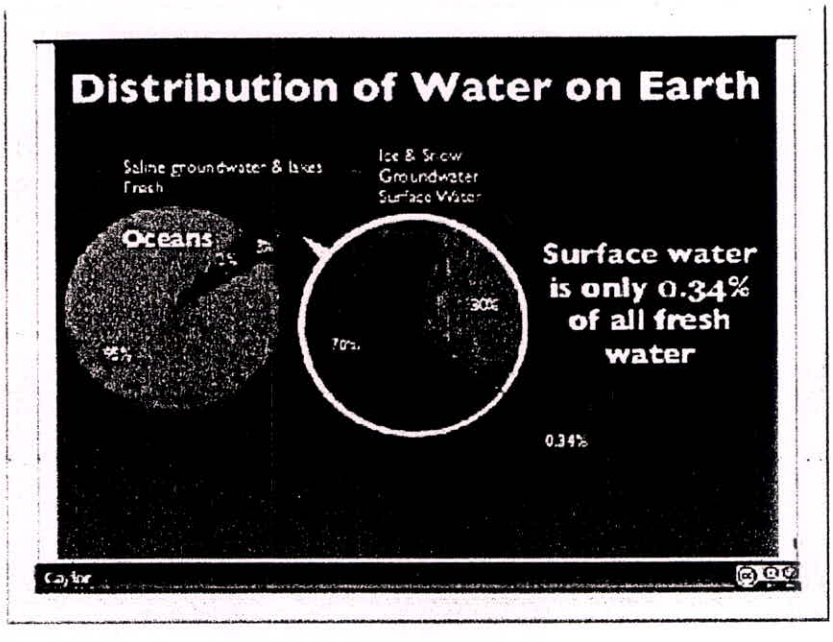


Fig: 1.2- Distribution of water on earth

The earth is some time called as water plants because water covers 71% of the earth surface but most of this water is salt water. Fresh water makes up only about 3% of the water on this earth. We use water for drinking, cooking, washing and growing our food as well as many other things.

Water strictly refers to the liquid state of that substance,that prevails at standard ambient temprature and pressure, but it often refers also to its solid states [ice] or its gaseous state [steam or water vapour].

Even water is used by industries to generate the electricity, manufacture things and transport. The decreased mass of the shrinking glacier also spells water supply shortage in the near future. Infact, people living in the places near Himalayas are already facing water shortage.

GROUND WATER

Ground water is water that exist in the pore spaces between sand, gravel and rock in the earth and can be brought to the surface using wells. The natural constituents result from dissolution caused by long term contact between the water and the rocks and minerals. Some major ground water contaminants are described below.

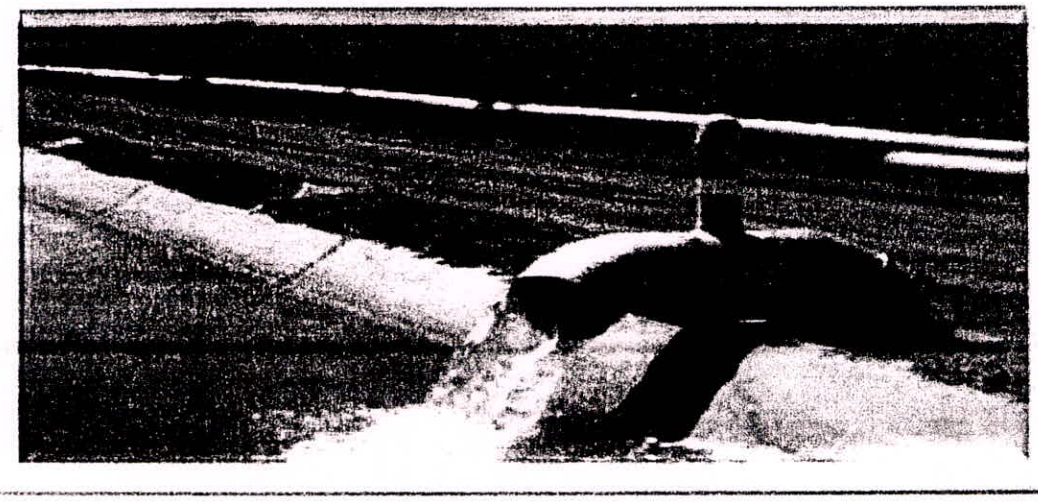


Fig.1.3 – Ground water

Iron and manganese: Depending on local condition, ground water can be aerobic i.e. in the presence of oxygen gas, or anaerobic i.e. in the absence of oxygen– containing acceptors. In anaerobic conditions, iron and manganese–containing minerals are relatively and should be dissolved into the water. When water is aerated and chlorinated, the iron and manganese react to form insoluble species and precipitate and cause rust and black – colored stains or laundry and plumbing fixture.

Hardness: Hardness is a characteristic of water caused by the presence of calcium and magnesium, which are abundant in the earth's crust. Hard water does not cause negative health impacts , but it reacts with soap to form a Precipitates i.e. soap scum, leaves water sports on surfaces, and forms precipitates in the water hearts, tea pots, heat exchanger, and pipes, reducing their efficiency.

Trace inorganic: Minerals can contain many trace elements, including, arsenic, barium, chromium, fluoride, selenium, and species that exhibit radioactivity such as radium, radon, and uranium. Many trace inorganic exhibit or other adverse health effects, if concentrations are too high.

Salinity: Brackish ground water with low to moderate salinity, ranging from about 1000 to 5000 mg/L total dissolved solids, is relatively common. Brackish water is too salty for potable, industrial or agricultural applications.

In addition to these natural constituents, ground water can contain variety of anthropogenic contaminants.

WATER POLLUTION

Pollution means the addition of any foreign material i.e. inorganic, biological and radiological or any physical change in the natural water which may harmfully effect the living life i.e. human agricultural or biological, directly or indirectly, after a very long time.

Thus water pollution disturbs the normal uses of water for irrigation, agriculture, industries, public water supply and aquatic life. Actually it represents the state of deviation from the pure conditions, where by its normal functions and properties and affected.

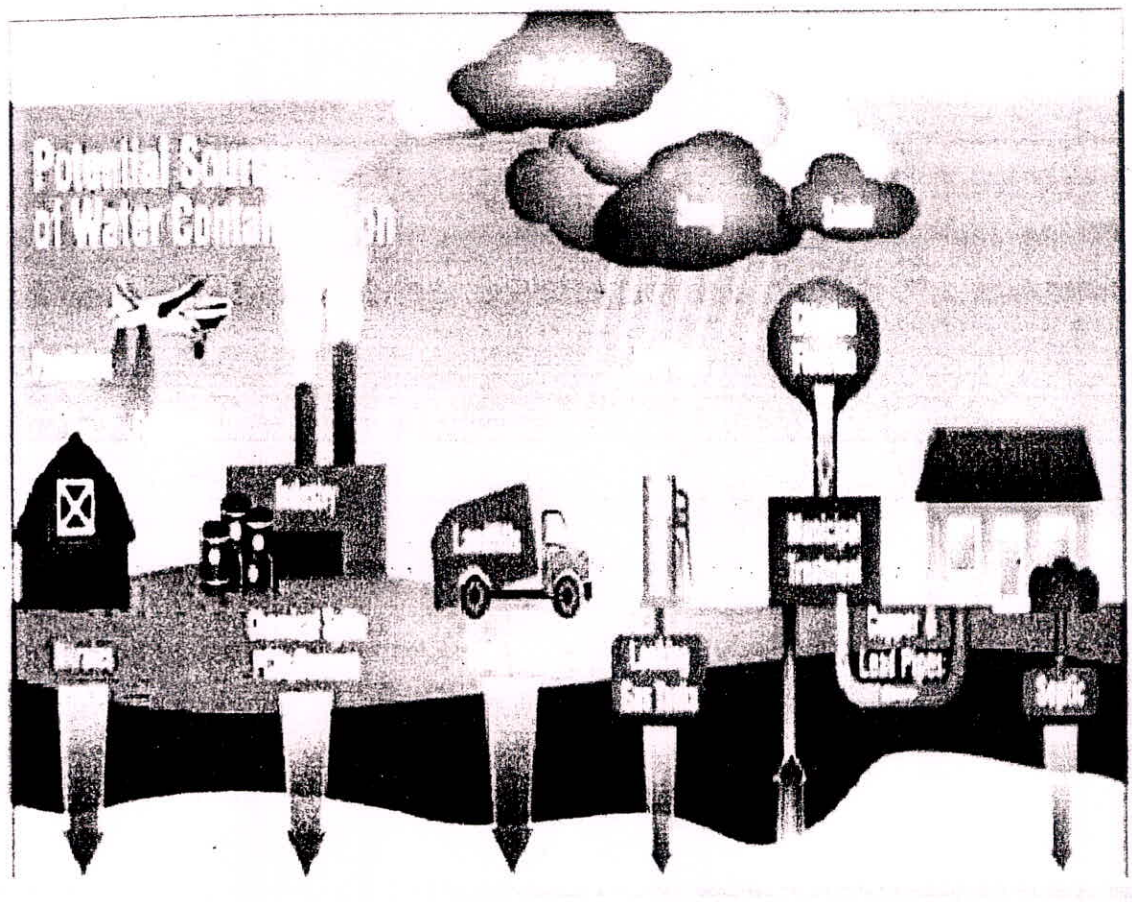


Fig.1.4 - Potential source of water contamination

Industrial effluents containing alcohol, acid, alkalis, heavy metals and other chemical form diversified industries, domestic sewage containing dyes, detergents etc and agricultural runoff having fertilizers and pesticides and major sources of pollutant which degrade the quality of our aquatic resource. Municipal water pollution mainly consists of a mixture of human waste, household sewage ad wastes from other facilities.

Water is rarely is in pure state in a chemical sense it contain various types of impurities such as dissolved gases i.e. N_2, NH_3, CO_2, and H_2S, dissolved minerals salts of Na, Mg ,Ca and even microbes . These natural contaminants or impurities

are received from atmosphere and soil. The amount of the impurities are normally very low and do not pollute water so it is potable water but the excess addition and contamination of impurities makes the water polluted and non-potable. Polluted water however turbid unpleasant foul smelling unfit for drinking purpose. They are harmful and are carried of several water born diseases such as dysentery, typhoid, yellow fever, hepatitis, malaria, dengue, trachoma, etc. The surface water and ground water pollution are described in the succeeding paragraphs.

Source of Water Pollution

Source of water pollution along with the constituents which pollute the River, streams and ground water has been described below:

a: - **Domestic sewage** – It is very serious pollutants of wells and Rivers which are important sources of our drinking water. These rivers and wells are polluted with our own excreta besides that of animals and birds. The drinking water from these sources contains high amount of Nitrate, nitrite, B.O.D, C.O.D, chloride, sulphate, total dissolved solids. These effluents in high concentrations pollute the environment.

b:- **Industrial waste** – Industrial waste are highly toxic and therefore it must be avoided for draining into water bodies without treatment . The contaminats in the effluents from different type of industries discussed below:

1. **Pesticides manufacturing industries** :- The use of pesticides has increased all over the world due to human's describe to increase the production of grains and other agricultural products. These compounds when sprayed on plants to kill harmful pests and weeds, percolate through soil and get dissolved in soil water thus polluting it.

2:-**Fertilizer industries**: - Fertilizer contains Nitrogen and Phosphorous which are nutrients for plants. But if they are applied in excess quantity on the field then it dissolves into runoff and drained into water bodies which cause eutrophication.

3:- **Cane sugar industries**:- The effluents are discharge during manufacture of sugar. They contain high polluted contents. Total solid is present 870 to 3500 mg/L. Generally the sugar mills effluents pollute small rivers and give foul smell in the nearby places of mills.

4:- **Detergent industries manufacturer**: - The detergent cause serious pollution in water resources as they contain phosphates. The phosphates are responsible for the growth of the algae which deplete the dissolved oxygen. Generally they give amino acid and ammonia in water.

5:- **Steel plants**: Water containing 0.002mg/L of phenol gives unpleasant taste of water when chlorinated. Iron and manganese if more than 0.1 mg /L give rise to bad taste in drinking water. The high pH value also causes toxicity in the water. When dissolved oxygen depleted to zero, anaerobic conditions set in giving ugly conditions and foul odour. At low value of dissolved oxygen fish also die out.

6:- **Radioactive waste** : They can also be used to prepare bombs etc. The wastes from atomic reactors, hospitals etc are most dangerous because their radioactivity can not be destroyed at human's will. These wastes destroy the aquatic plants and animals to a great extent.

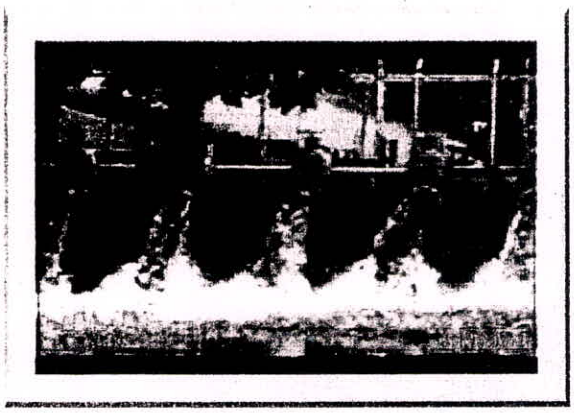


Fig. 1.5 – source of water pollution

WATER QUALITY

Water quality describes the condition of the water including chemical, physical and biological characteristics , usually with respect to its suitability for a particular purpose such as drinking or irrigation.

Water quality is that of a simple property that tells weather water is polluted or not.

Water quality tends to be found focused on water that is treated for human consumption, industrial use or in the environment.

Water quality is measured by several factors, such as the concentration of dissolved oxygen, bacteria levels the amount of salt or the amount of the material suspended in water (turbid).

WATER QUALITY ANALYSIS

Water quality refers to the chemical, physical, biological and radiological characteristic of water. It is a measure of the condition of water relative to the requirements of one and more biotic species and or to any human need or purpose. It is most frequently used by reference to a set of standards against which compliance can be assessed. The most common standards used to assess water quality relate to health of ecosystems, safety of human contact and drinking water. Therefore, it is used to assess the physical, chemical and biological characteristics of water.

Water quality analysis including following parameters:

I. PHYSICAL PARAMETERS
II. CHEMICAL PARAMETERS
III. BIOLOGICAL PARAMETERS

I. PHYSICAL CHARACTERISTICS OF WATER:

1. Smell / order
2. Taste
3. Color
4. Solids
5. Turbidity
6. Temperature
7. Conductivity

II. CHEMICAL CHARACTERISTICS OF WATER:

1. Hardness
2. Alkalinity
3. pH
4. Nitrate
5. Nitrite
6. B.O.D.
7. C.O.D.
8. D.O.
9. Major Cations (Na^+, K^+, Ca^{2+}, Mg^{2+})
10. Major Anions (Cl^-, SO_4^{--}, NO_3^-, HCO_3^-)

III. BIOLOGICAL CHARACTERISTICS OF WATER:

1. Bacteria
2. Algae
3. Viruses

CHAPTER-2

➢ PURPOSE OF STUDY

PURPOSE OF STUDY

In India 12% of people get clean drinking water , the rest 88% quench their thirst from polluted lakes , tanks , rivers and wells due to which more than three million people get affected or die from enteric diseases every year.The water borne diseases are jaundice, cholera, typhoid and gastro enteritis etc. This surface water and groundwater is mainly polluted by anthropogenic activities viz. urbanization, industrialization, disposing garbage etc.

Water quality of lakes is deteriorating due to solid and liquid disposal of wastes. Lakes, being stagnant water bodies, are more prone to pollution than the rivers as in lakes self purification process are less effective than rivers. Any contamination or pollution of lakes effects greatly the flora and fauna and also the human health if the water is used for domestic supply. The environmental health of any lake system depends upon the nature of that lake and its exposure various environmental factors such as temperature, depth of water, wind speed, soil types and land uses of the catchment.

Groundwater level is declining and also groundwater contamination is reported in various part of India especially in shallow aquifer. Hence, Guwahati, Assam, has been selected for ground water quality assessment for suitability of drinking purpose.

Six samples of Guwahati ground water has been analyzed for determine the anion that is fluoride, chloride, nitrate, sulphate and cation that is sodium, potassium, calcium and magnesium etc. In Guwahati ground water samples by using ion chromatography. And also determination the water quality parameters viz. pH, Electrical Conductivity, Alkalinity and Hardness.

CHAPTER-3

- STUDY AREA
- PHYSICO-CHEMICALPARAMETER ANALYSED
- AUTO-TITRATION

EXPRIMENTAL WORK

Study Area:

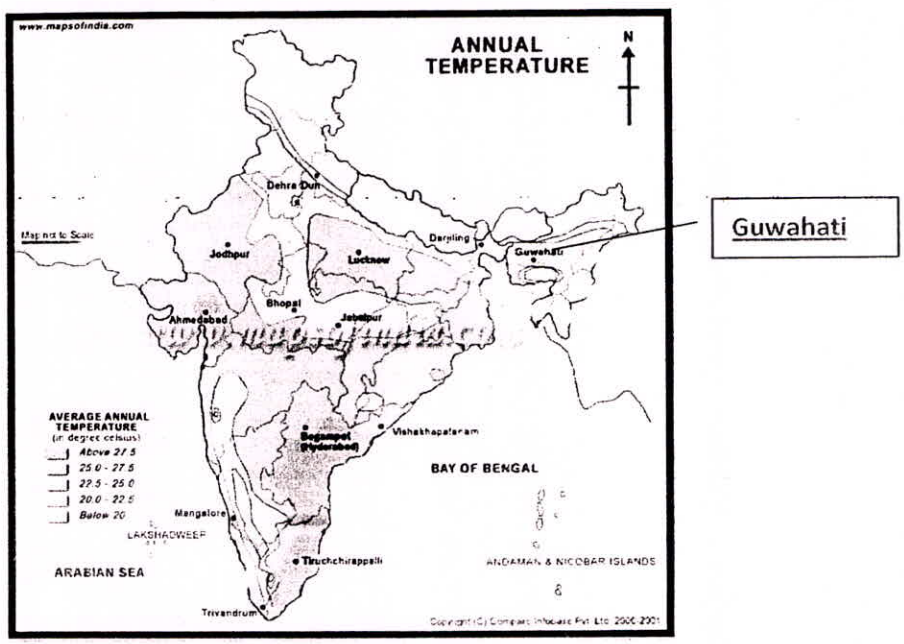


Fig.3.1- Guwahati

Guwahati is the largest city of Assam and Northeastern India, a major riverine port city and one of the fastest growing cities in India, situated on the South Bank of the Brahmaputra River.

The ancient cities of Pragjyotishpura and Durjaya (North Guwahati) were the capitals of the ancient state of Kamarupa under the Varman and Pala dynasties. Many ancient Hindu temples are in the city, giving it the name "City of Temples". Dispur, the capital of Assam, is in the circuit city region located within Guwahati and is the seat of the Government of Assam.

Guwahati lies between the banks of the Brahmaputra River and the foothills of the Shillong plateau, with LGB International Airport to the west and the town of Narengi to the east. It is gradually being expanded as North Guwahati to the northern bank of the Brahmaputra. The noted Madan Kamdev is situated 30 kilometres (19 mi) from Guwahati. The Guwahati Municipal Corporation (GMC), the city's local government, administers an area of 216 square kilometres (83 sq mi), while the Guwahati Metropolitan Development Authority (GMDA) is the planning and development body of greater Guwahati Metropolitan Area. With an area of 1,528 square kilometres (590 sq mi), Guwahati is the second-largest metropolitan region in eastern India, after Kolkata.

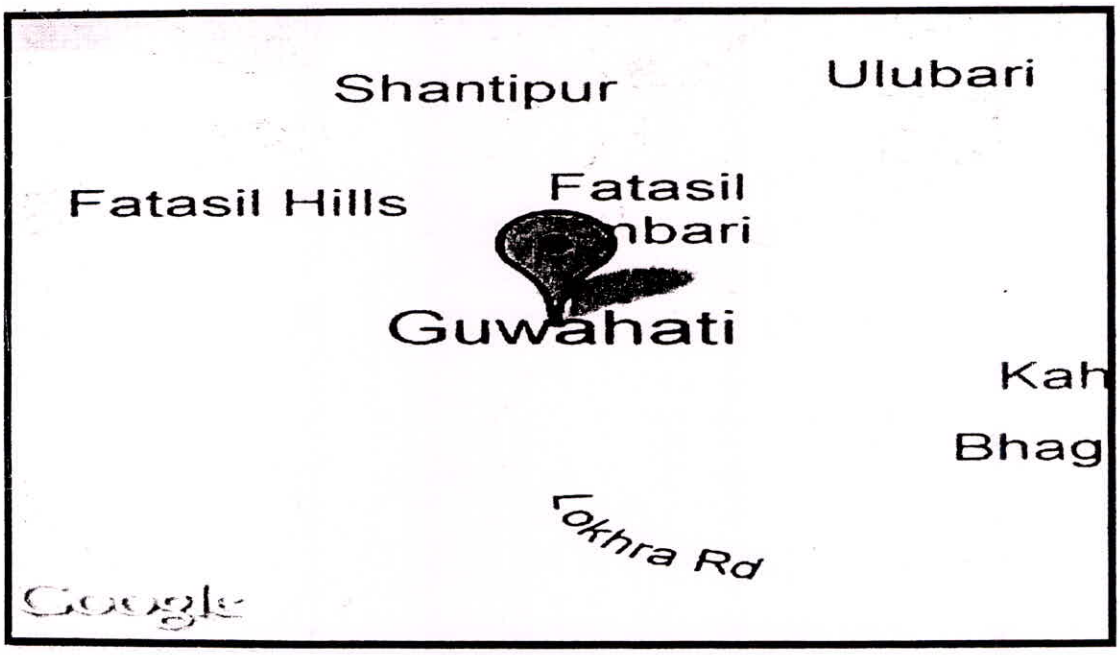


fig.3.2 - Location of Guwahati

SAMPLING:

fig.3.3 – Ground water samples of Guwahati

TABLE-3.01 – Table for Samples location and Identity

S.NO.	SAMPLE SITE	SAMPLE ID	DATE	VOLUME OF SAMPLE
1.	GUWAHATI	N-41	25-01-2017	1 LITRE
2.	GUWAHATI	N-42	25-01-2017	1 LITRE
3.	GUWAHATI	N-43	25-01-2017	1 LITRE
4.	GUWAHATI	N-44	25-01-2017	1 LITRE
5.	GUWAHATI	N-45	25-01-2017	1 LITRE
6.	GUWAHATI	N-46	25-01-2017	1 LITRE

PHYSICO-CHEMICAL PARAMETER ANALYSED:

1. pH
2. Alkalinity
3. Hardness

Method- pH, Alkalinity, Hardness, these parameters are analysed by the Auto-titration.

pH

pH is the measure of the intensity of acidity or alkalinity and measures the concentration of hydrogen ions in water . It does not measure total acidity or alkalinity. Infact, the normal acidity or alkalinity depends upon excess of H^+ or OH^- ions over the other, and measured in normality or gram equivalents of acids or alkali. If free H^+ are more than OH^- ions, the water shall be acidic, or alkaline the other way round.

pH is generally measured on a Log scale and equals to negative $\log_{10}$ of hydrogen ion concentration.

$$pH = - \log_{10}[H^+]$$

$$= \log_{10} 1/[H^+]$$

pH scale ranges from 0 – 14 with 7 as neutral , below 7 being acid and above 7 as alkaline .

PRINCIPLE

The pH can be defined as a negative logarithum of hydrogen ion concentration expressed molarity. The pH scale is series of number that express the degree of acidity or alkalinity of a solution. The pH scale ranges from 0 – 14 with 7 as neutral, below 7 being acid and above 7 as alkaline.

ALKALINITY

Alkalinity in natural water is due to free hydroxyl ions and hydrolysis of salts formed by weak acids and strong bases.

$$A^- + HOH = HA + OH^-$$

When a salt of weak acid and strong base is hydrolysed . The number of milliequivalents of acid used in the titration of combine all the hydroxyl ions is called a as total alkalinity.

$$CO_2 + H_2O \leftrightharpoons H_2CO_3$$

$$H_2CO_3 \leftrightharpoons H^+ + HCO^-_3$$

$$HCO_3^- \leftrightharpoons H^+ + CO_3^{2-}$$

$$CO_3^{2-} + 2HOH \leftrightharpoons H_2CO_3 + 2OH^-$$

$$HCO_3^- + HOH \leftrightharpoons H_2CO_3 + OH^-$$

Mostly of the alkalinity in natural waters is formed due to dissolution of CO_2 In water. Carbonate and bicarbonate thus formed are dissociated to yield hydroxyl ions. Carbonate salts produce double the hydroxyl ions than the bicarbonates. Alkalinity is also produsded by the action of water on limestone or chalk.

$$CaCO_3 + H_2O + CO_2 \leftrightharpoons Ca(HCO_3)_2$$

PRINCIPLE

Total alkalinity is the measure of the capacity of the water to neutralize a strong acid. The alkalinity in the water is generally imparted by the salts of carbonates, bicarbonates , phosphates ,nitrates , borates , silicates , etc. Are rich in carbonates and bicarbonates with little concentration of other alkalinity imparting ions .

Total alkalinity , carbonates and bicarbonates can be estimated by titrating the sample with a strong acid (HCl or H_2SO_4) , first to pH 8.3 using phenolphthalein as an indicator and then further to pH between 4.2 and 5.4 with methyl orange or mixed indicator . In first case , the value is called as phenolphthalein alkalinity (PA) and in second case , it is total alkalinity (TA) .

HARDNESS

Hardness is associated with capacity of water to precipitate soap or it is the property which reduced the lather formation with soap and it also increase the boiling point of the water . Temporary hardness is due to the presence of bicarbonate of Ca^{2+} and Mg^{2+} which can be remove only by prolonged boiling and bicarbonate of Ca and Mg are precipitated as normal carbonate by less of CO_2 on heating .

Total hardness is defined as the sum of the calcium and magnesium concentration , both expressed as $CaCO_3$, in mg/ L . The degree of hardness of drinking water has been classified in terms of the equivalent $CaCO_3$ concentration as follows :

Soft 0-60 mg /L

Medium 60-120 mg/L

Hard 120 – 180 mg/L

Very hard >180 mg/L

PRINCIPLE

Hardness is generally caused by calcium and magnesium ions present in water . Polyvalent ions of some other metals like strontium , iron , aluminium , zinc and manganese etc. are also capable of precipitating the soap and thus contributing to the hardness . However , the concentration of these ions is very low in natural water , therefore , hardness is generally measured as concentration of only calcium and magnesium , as calcium carbonate , which are far higher in quantities over other hardness producing ions .

Calcium and magnesium from a complex of wine red color with Eriochrome black – T at pH 10.0 ±0.01 . The EDTA had got a stronger affinity towards Ca^{++} and Mg^{++} and , therefore , by addition of EDTA , the former complex is broken down and a new complex of a blue colour is formed .

CALCULATION

$$Ca^{2+} \text{ hardness} = Ca^{2+} \text{ concentration (mg/ L)}/0.401$$

$$Mg^{2+} \text{ hardness} = Mg^{2+} \text{ concentration (mg/L)}/0.243$$

$$\text{Total hardness} = (Ca^{2+} + Mg^{2+}) \text{ hardness}$$

AUTO TITRATIONS

A titration is a technique where a solution of known concentration is use to determine the concentration of an unknown solution . Typically , the titrant (the known solution) is added from a burette to a known quantity of the analyte (the unknown solution) until the reaction is complete .

The whole process of titration is made much easier by making it automated. We simply add a predetermined amount of reactant and the machine will add the other reactant and measure the products to find the end point . Many samples can be done in short time. The accuracy is increased due to the finely calibrated computer instead of our eyes. The amount of hands on interaction is drastically reduced. The Auto- titration was carried out in the laboratory using **888-TITRANDO METROHM.**

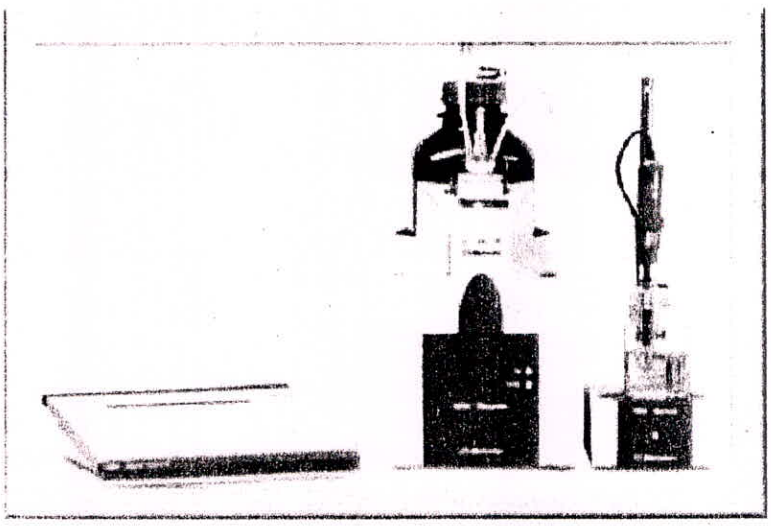


fig.3.4 -888Titrando Metrohm

AUTOTITRATOR

Automated titrators are micro-processor controlled instruments which allow the automation of all operations involved in titration :

- Titrant addition
- Monitoring of the reaction
- Recognition of the end point
- Data storage
- Calculation
- Results storage
- Transfer of data to printer or computer

In addition to the automatic titrator can be potentiometric titration , including acid-base titration , redox titration but can also be a constant pH measurements when the automatic titrator and automatic sample changer multi line use , not only can efficiently automate the measurement of large number of samples , but also improve the analysis of repeatability , reliability, easy operation, saving time and effort . suitable for quality control , inspection , analysis all aspects of research , development and so on .

CHAPTER-4

- ION CHROMATOGRAPHY
- PRINCIPLE
- METHODOLOGY OF ION CHROMATOGRAPHY
- ADVANTAGES
- DISADVANTAGES

ION CHROMATOGRAPHY

INTRODUCTION

Ions – exchange chromatography (IEC) is part of ion Chromatography (IC) which is an important analytical technique for the separation and determination of ionic compounds , together with ion –partition / intersection and ion-exclusion chromatography .

Ion chromatography separation is based on ionic (electrostatic) interactions between ionic and polar analytes , ions present in the eluent and ionic functional groups fixed to the chromatographic support . Two distinct mechanisms as follow ; ion –exchange due to competitive ionic bonding (attraction) and ions exclusion due to repulsion between similarly charged analyte ions and the ions fixed on the chromatographic support , play a role in the separation process in the ion chromatography .

PRINCIPLE

Ion-exchange chromatography separates molecules based on their respective charged groups. Ion-exchange chromatography retains analyte molecules on the column based on coulombic (ionic) interactions. Essentially, molecules undergo electrostatic interactions with opposite charges on the stationary phase matrix. The stationary phase consists of an immobile matrix that contains charged ionizable functional groups or ligands. The stationary phase surface displays ionic functional groups (R-X) that interact with analyte ions of opposite charge. To achieve electroneutrality, these inert charges couple with exchangeable counterions in the solution. Ionizable molecules that are to be purified compete with these exchangeable counterions for binding to the immobilized charges on the stationary phase. These ionizable molecules are retained or eluted based on their charge.

This type of chromatography is divided into cation exchange chromatography and anion-exchange chromatography. Positively charged molecules bind to anion

exchange resins while negatively charged molecules bind to cation exchange resins.

Cation exchange chromatography retains positively charged cations because the stationary phase displays a negatively charged functional group.

Anion exchange chromatography retains anions using positively charged functional group.

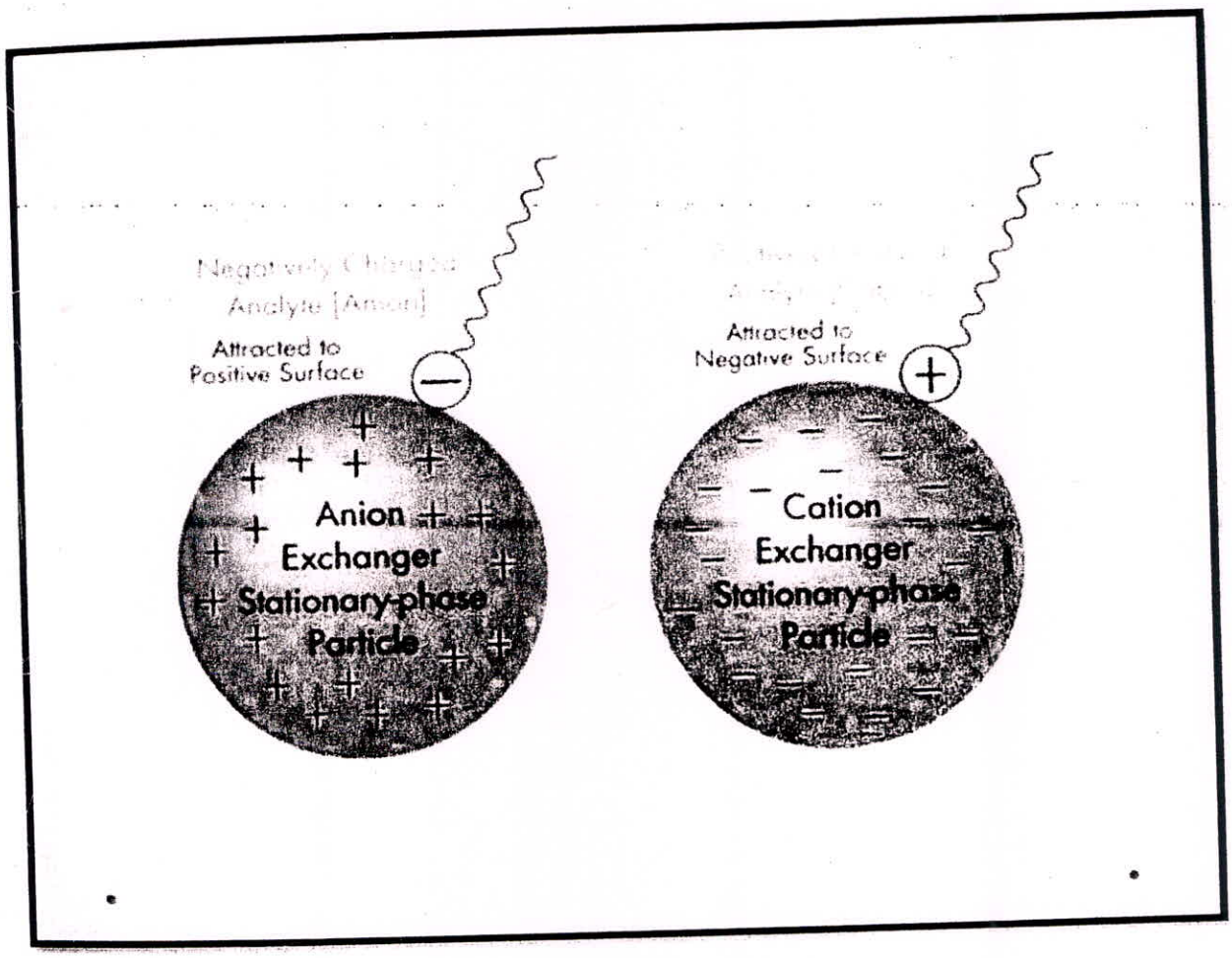


fig.4.1 - Anion Exchanger and Cation Exchanger

ION EXCHANGE MECHANISM

Ion- exchange chromatography which is designed specifically for the separation of differently charged or ionizable compounds comprises from mobile and stationary phases similar to other forms of column based liquid chromatography techniques . Mobile phase is consist an aqueous buffer system into which the mixture to be resolved . The stationary phase usually made from inert organic matrix chemically derivative with ionizable functional groups (fixed ions) which carry displaceable oppositely charged ion . Ions which exist in a state of equilibrium between the mobile phase and stationary phase giving rise to two possible formats , anion and cation exchange are referred to as counter ion .

Exchangeable matrix counter ion may include protons (H^+), hydroxide group (OH^-) single charged mono atomic ions (Na^+ , K^+, Cl^-) , double charged mono atomic ions (Ca^{++} , Mg^{++}) and polyatomic inorganic ions (SO_4^{2-} , PO_4^{3-}) as well as organic bases (NR_2H^+) and acids (COO^-) . Cations are separated on cation exchange resin column and anion on an anion exchange resin column . separation based on the binding of analytes to positively or negatively charged groups which are fixed on stationary phase and which are in equilibrium with free counter ion in the mobile phase according to differences in their net surface charge .

Working of ion chromatography

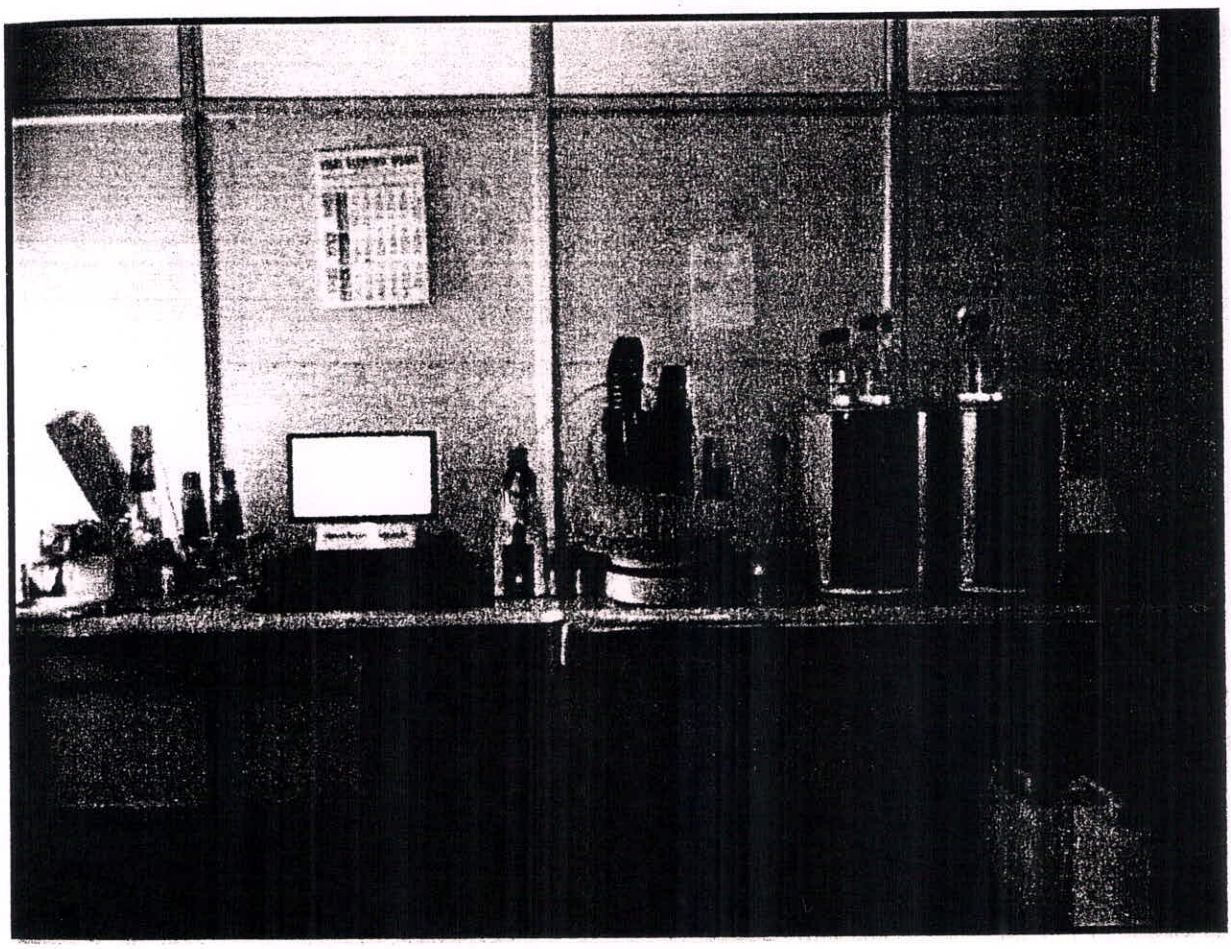


fig.4.2- 930-Ion chromatography instrument

Ion chromatography , a form of liquid chromatography measures concentration of ionic species by separating them based on their interaction with a resin . Ionic species separates differently depending on species type and size . Sample solution pass through a pressurized chromatographic column where ions are absorbed by column constituents . As an ion extraction liquid , known as eluent runs through the column , the absorbed ions begin separating from the column . The retention time of different species determines the ionic concentration in the sample .

Methodology of ion – chromatography

Ion chromatography is used for water-chemistry analysis . Ion chromatographs are able to measure major cation and anions . It is the separation and quantitative analysis of anion and cation in an ionic solution using the ion exchange method of liquid chromatography .

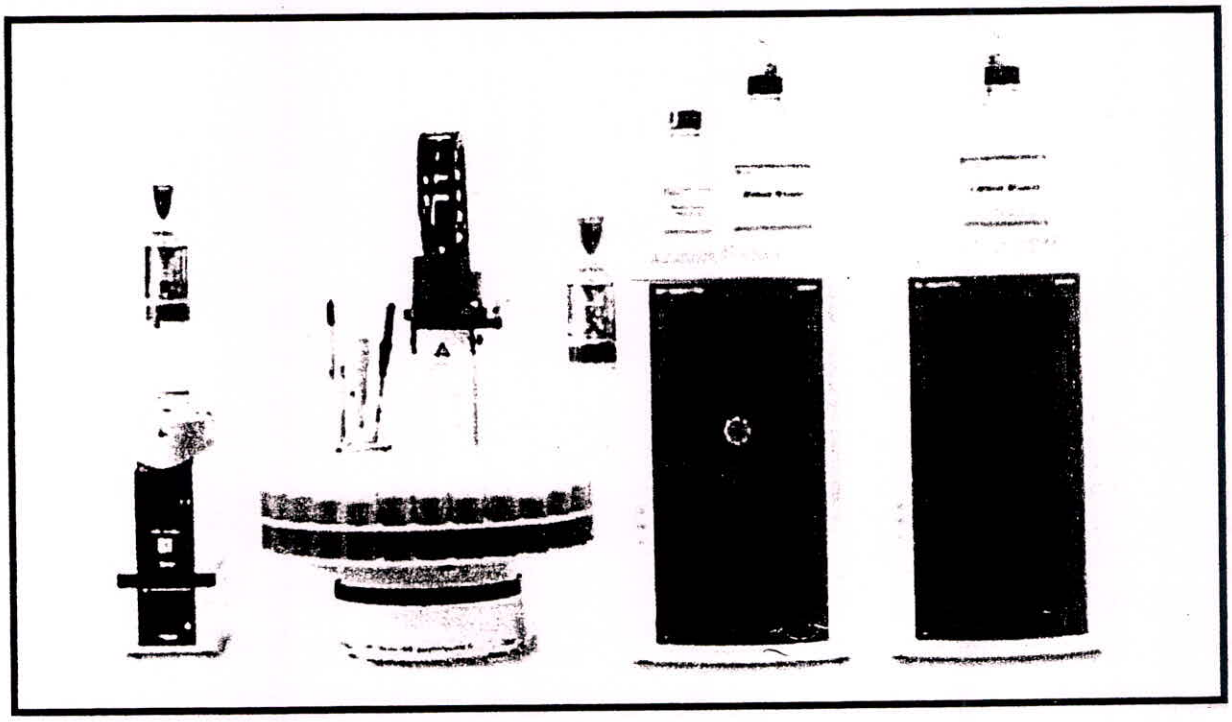


fig.4.3 - Ion chromatography instrument

The chromatography process separates the different ions with in the sample.

Following major anions such as:

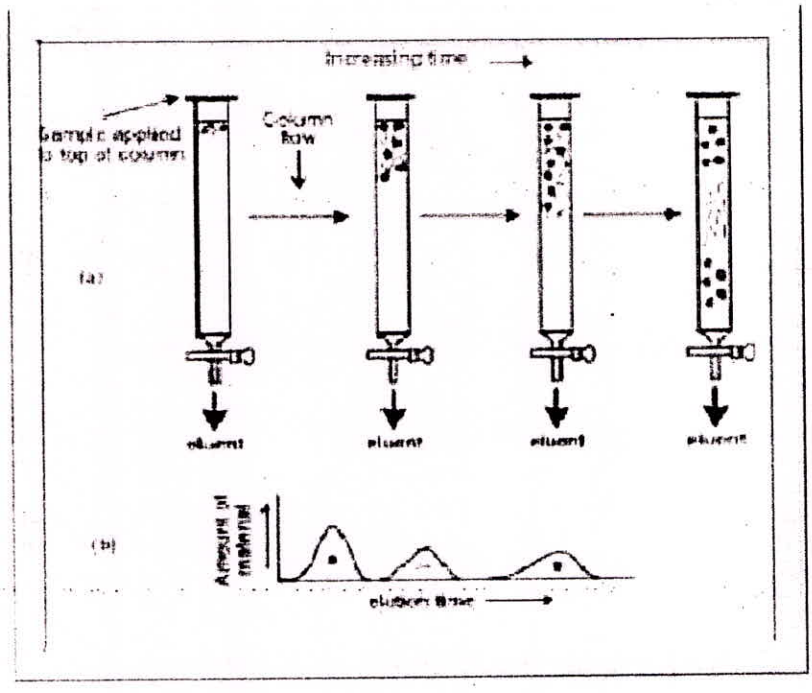
- Flouride
- Chloride
- Nitrate
- Sulphate

As well as major cations such as:

- Ammonium
- Sodium
- Potassium
- Calcium
- Magnesium
- Lithium

It measures the anions and cations in ppb range. Concentation can also be measured through ion chromatography.

Ion chromatography, is a form of liquid chromatography measures concentrations of ionic species by separating them based on their interactions with a resin. Ionic species separates differently depending on species type and size.



Sample solution pass through a pressurized chromatographic column, where ions are absorbed by column. As an ion extraction liquid, known as eluents, runs through the column, the absorbed ion begin separating from the column. The retention time of different species determines the ionic concentration in the sample.

Ion chromatography is a part of ion chromatography which is an important analytical technique for the separation and determination of anionic compounds, together with ion partition or interaction and ion exclusion chromatography. Ions present in the eluent and ionic functional group fixed to the chromatographic support. This chromatography is one of the most important adsorption technique used in the separation of:

- Peptides
- Proteins
- Nuclic acids
- Bio- polymers

Which are charged groups or molecules in different molecular size and nature.

PREPARTION OF MOBILE PHASE :

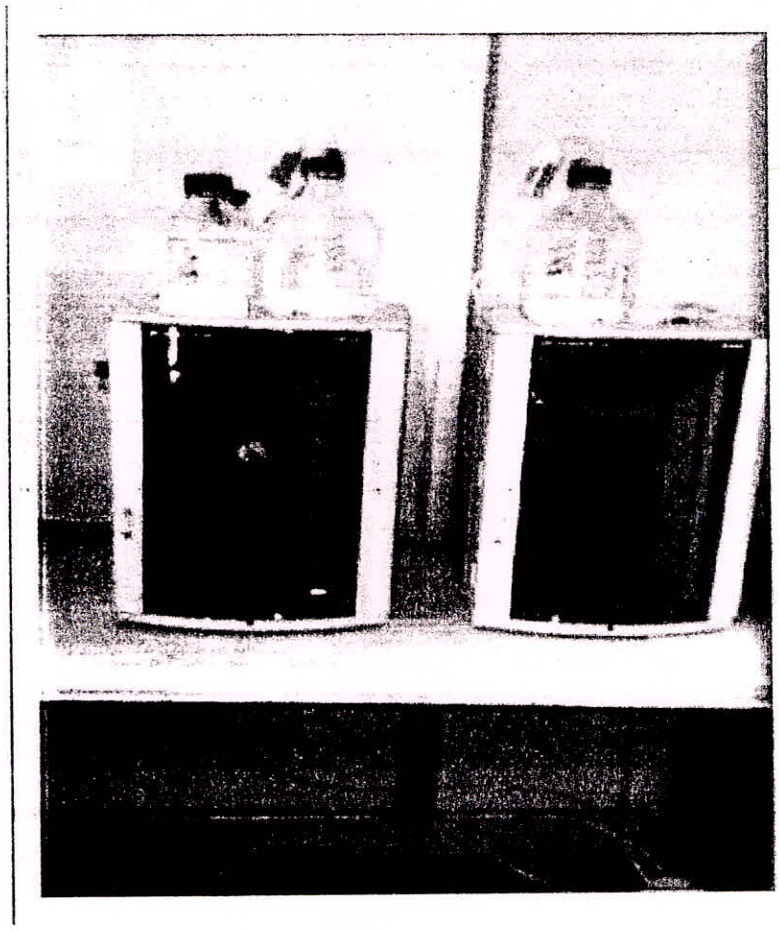


fig.4.4 – Cation and Anion chamber

CATION – Take 284mg dipiclonic acid in distilled water and heat to dissolve then cool and add 1.7ml of HNO_3 and make up to 1 litre with distilled water .

ANION – Take 339mg of sodium carbonate and 84mg of sodium bicarbonate dissolve in distilled water and make up to 1 litre .

FOR TITRATION - 0.01 M H_2SO_4

ADVANTAGES AND DISADVANTAGES OF ION CHROMATOGRAPHY

ADVANTAGES

- The main advantage of ion chromatography is that multiple ions can be analyzed at once since each ion elutes at different rate. Further more, the time it takes to analyse a sample is typically around 10 minutes.
- Shorter analysis time for simpler sample (generally 10-12 minute)
- small sample volume
- Long life of resins
- Cheap maintenance
- Metal –free peak system
- Powerful separation
- Ion chromatography developed into a powerful analytical technique versatility , speed of operation and reasonable cost are some of the factors that have contributed to its
- Usage of cheap, safe and environmental friendly chemicals.
- Highly selectivity for the detection of compounds like- halogens, peroxides, quinines , nitrates etc .

DISADVANTAGES

- Soil , sediment , geological sample prepration is more extensive .
- Longer analysis time for more complex samples.
- Can't select specific compounds for high speed analysis.
- Some time overlap can occur in chromatogram when compounds have similar separation characteristics.
- Least sensitive to compounds whose molecules have negligible affinity for electron.
- Carrier gas used should be of pure from like- pure nitrogen.

APPLICATIONS OF ION CHROMATOGRAPHY

- This technique has been used for the analysis of anions and cation, including metal ions, mono and oligosaccharides , and other compounds amino glycosides, organic acids , amines , alcohol , phenols and other polar molecules .
- It has been successfully applied to the analysis of raw material, bulk active ingredients, impurities and degradation products ,excipients, diluents and at different stages of the production equipment cleaning solutions , waste streams and other applications.

- Drinking water analysis for pollution and other constituents.
- Determination of water chemistries in aquatic ecosystems.
- Determination of sugar and salt content in foods.
- Isolation of select proteins.
- Softening of hard water.
- Demineralization of water.
- To separate protein mixtures
- To measure the additives in food and drug sample.

- It can be used for almost any kind of charged molecule including large proteins, small nucleotides, nucleic acids and amino acids.

- It is often used in protein purification, water analysis.

- Separation conditions are within physiological range of salt and pH and in the most cases a native protein can be obtained.

- IC is well establish as regulatory method for the analysis of inorganic anion in environmental samples as there are few alternatives methods which can determine multiple anions in a single analysis.

- IC has been approved for compliance monitoring of the common inorganic anions in drinking water. in a addition to the use of IC for environmental water and water analysis, a considerable number of IC method are employed for air analysis.

CHAPTER-5

➢ RESULTS AND DISCUSSION

The following results were obtained after the water quality analysis of Guwahati ground water samples for potable purpose :

TABLE 5.01– RESULTS OF PHYSIO-CHEMICAL CHARATERISTICS OF VARIOUS SAMPLES :

S.NO.	SAMPLE ID	pH	HARDNESS (mg/l)	ALKALINITY (mg/l)
1.	N-41	7.6	113.147	110.071
2.	N-42	7.2	190.859	182.329
3.	N-43	7.6	197.918	212.879
4.	N-44	7.6	120.833	123.793
5.	N-45	7.8	206.842	230.979
6.	N-46	7.2	259.682	285.079

Table 5.02 - STANDARD RANGE pH, ALKALINITY, HARDNESS ACCORDING TO BIS - 2012:

PARAMETERS	pH	HARDNESS (mg/l)	ALKALINITY (mg/l)
ACCEPTABLE RANGE	6.5 – 8.5	600	400

TABLE 5.03 – RESULTS OF CONCENTRATIONS OF ANIONS IN VARIOUS WATER SAMPLES OF GUWAHATI GROUND WATER SAMPLES FOR POTABLE PURPOSE:

ANIONS SAMPLE ID	FLUORIDE mg/l	CHLORIDE mg/l	NITRITE mg/l	NITRATE mg/l	SULPHATE mg/l
N-41	0.176	21.242	-	2.156	6.412
N-42	0.179	31.327	-	5.632	12.957
N-43	0.123	10.594	0.137	1.049	2.820
N-44	0.177	2.868	-	0.087	6.520
N-45	0.257	2.469	-	1.609	4.220
N-46	0.250	2.699	0.062	0.107	1.456

Table 5.04 - STANDARD RANGE OF ANIONS ACCORDING TO BIS-2012:

ANIONS	FLUORIDE (mg/l)	CHLORIDE (mg/l)	NITRITE (mg/l)	NITRATE (mg/l)	SULPHATE (mg/l)
ACCEPTABLE RANGES	1.0	250	0 - 8	45	200

TABLE 5.05 –RESULTS OF CONCENTRATIONS OF CATIONS IN VARIOUS WATER SAMPLES OF GUWAHATI GROUND WATER SAMPLES FOR POTABLE PURPOSE:

CATIONS / SAMPLES ID	SODIUM mg/l	AMMONIUM mg/l	POTASSIUM mg/l	CALCIUM mg/l	MAGNESIUM mg/l
N-41	16.397	0.153	0.060	26.457	11.456
N-42	24.008	0.394	3.997	44.949	19.129
N-43	8.915	0.306	3.889	52.398	16.328
N-44	5.441	0.293	3.373	28.442	12.120
N-45	15.531	0.473	2.116	51.013	19.336
N-46	7.341	5.298	4.511	59.757	26.877

Table 5.06 - STANDARD RANGE OF CATIONS ACCORDING TO BIS-2012:

CATIONS	SODIUM (mg/l)	AMMONIUM (mg/l)	POTASSIUM (mg/l)	CALCIUM(mg/l)	MAGNESIUM(mg/l)
ACCEPTABLE RANGES	30	0.5	0 -10	200	100

DISCUSION

The ground water samples of Guwahati are N-41, N-42, N-43, N-44, N-45, N-46 analyzed for pH, alkalinity, hardness, major catios (sodium, potassium, calcium, lithium, ammonium, magnessium) and major anions (fluoride, chloride, nitrite, nitrate, sulphate) analysed for drinking purpose.

Suitability for drinking purpose

1. pH-

The pH values of water samples of present study range from 7.2-7.8 where as acceptable range according to BIS is 6.5-8.5. So all studied ground water samples are good for drinking purpose .

2.Alkalinity-

The alkalinity values of water samples of present study range from 110-285mg/l which is within the acceptable range according to BIS of 400mg/l. So all studied ground water samples are good for drinking purpose .

3.Hardness-

The hardness values of water samples of present study varies from 120-260mg/l. These values are below the acceptable range according to BIS is 600mg/l. Therefore the ground water samples are good for drinking purpose .

4.Sodium and potassium-

The sodium and potassium values of water samples of present study range from 5-16mg/l and 0.06-4.5 respectively where as acceptable range according to BIS is 30mg/l and 0-10mg/l respectively. So ground water samples are good for drinking purpose .

5.Calcium and magnesium-

The calcium and magnesium values of water samples of present study range from 26-60mg/l and 11-26mg/l respectively where as acceptable range according to BIS 200mg/l and 100 mg/l respectively. So ground water samples are good for drinking purpose .

6.Chlorides-

The chiorides values of water samples of present study range from 2-31mg/l. which is within the acceptable range according to BIS of 250mg/l. All studied ground water samples are good for drinking purpose .

7.Nitrate-

The nitrate values of water samples of present study range from 0.08-6mg/l where as acceptable range according to BIS is 45mg/l. All studied ground water samples are good for drinking purpose .

8.Fluoride-

The fluoride values of water samples of present study varies from 0.1-0.3mg/l. These values are below the acceptale range according to BIS is 1.0mg/l. Therefore the ground water samples are good for drinking purpose .

9.Sulphate-

The sulphate values of water samples of present study range from 1-13mg/l where as acceptable range according to BIS is 200mg/l. So ground water samples are good for drinking purpose .

CHAPTER-6

- CONCLUSION

CONCLUSION

Analysis of six water samples of Guwahati were performed at National Institute of Hydrology Roorkee according to standard method of IS for their pH , alkalinity , hardness , major cations and major anions . The results of all the parameters are found within the permissible limit of BIS .Thus all the six ground water samples can be recommended for potable purpose.

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ANNEXURES

NIH IC REPORT

Date2017-02-22 20:57:55 UTC+5:30

N-41

Anion

Component name	Retention time	Height	Area	Concentration
	min	µS/cm	(µS/cm) x min	mg/L
Fluoride	5.81	0.092	0.022	0.176
Chloride	8.97	7.714	1.734	21.242
Nitrate	16.04	0.231	0.099	2.156
Sulfate	27.43	0.620	0.371	6.412

Cation

Component name	Retention time	Height	Area	Concentration
	min	µS/cm	(µS/cm) x min	mg/L
Sodium	11.77	4.510	1.225	16.397
Ammonium	13.79	0.020	0.005	0.153
Potassium	23.27	0.006	0.002	0.060
Calcium	29.11	1.901	1.409	26.457
Magnesium	41.06	1.410	1.354	11.456

% Error----------0.116
Sample pH----------7.6
M-alkalinity as CaCO3----------110.071
P-alkalinity as CaCO3----------0.000
Total Hardness by IC----------113.147

NIH IC REPORT

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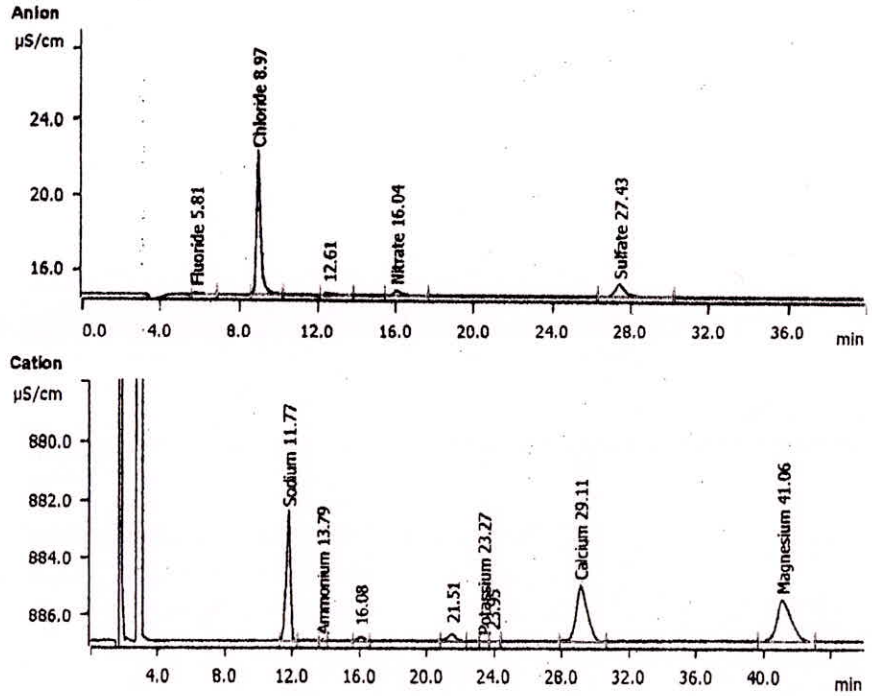

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N-42

Anion

Component name	Retention time min	Height µS/cm	Area (µS/cm) x min	Concentration mg/L
Fluoride	5.81	0.062	0.014	0.179
Chloride	8.97	6.799	1.534	31.327
Nitrate	16.04	0.365	0.156	5.632
Sulfate	27.43	0.751	0.450	12.957

Cation

Component name	Retention time min	Height µS/cm	Area (µS/cm) x min	Concentration mg/L
Sodium	11.77	3.952	1.076	24.008
Ammonium	13.79	0.022	0.008	0.394
Potassium	21.54	0.167	0.085	3.997
Calcium	29.09	1.935	1.436	44.949
Magnesium	41.06	1.409	1.357	19.129

% Error----------0.844
Sample pH----------7.2
M-alkalinity as CaCO3----------182.329
P-alkalinity as CaCO3----------0.000
Total Hardness by IC----------190.859

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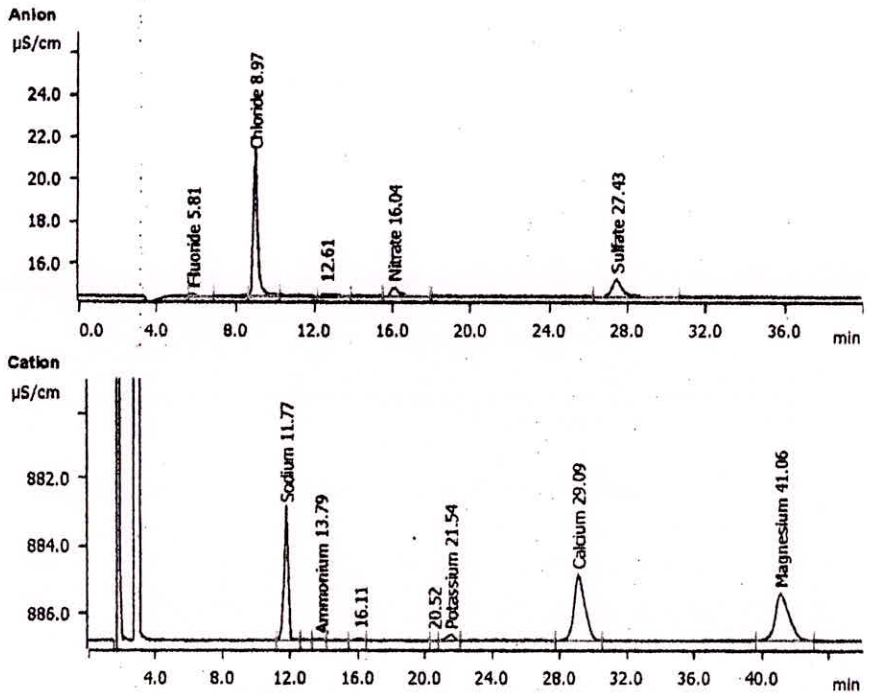

N-43

Anion

Component name	Retention time	Height	Area	Concentration
	min	µS/cm	(µS/cm) x min	mg/L
Fluoride	5.78	0.043	0.009	0.123
Chloride	9.13	2.206	0.519	10.594
Nitrite	11.89	0.012	0.004	0.137
Nitrate	17.03	0.058	0.029	1.049
Sulfate	27.11	0.168	0.098	2.820

Cation

Component name	Retention time	Height	Area	Concentration
	min	µS/cm	(µS/cm) x min	mg/L
Sodium	11.90	1.442	0.399	8.915
Ammonium	13.96	0.021	0.006	0.306
Potassium	22.47	0.157	0.083	3.889
Calcium	27.98	2.217	1.675	52.398
Magnesium	40.33	1.240	1.158	16.328

% Error----------.-1.967
Sample pH----------7.6
M-alkalinity as CaCO3----------212.879
P-alkalinity as CaCO3----------0.000
Total Hardness by IC----------197.918

IC REPORT

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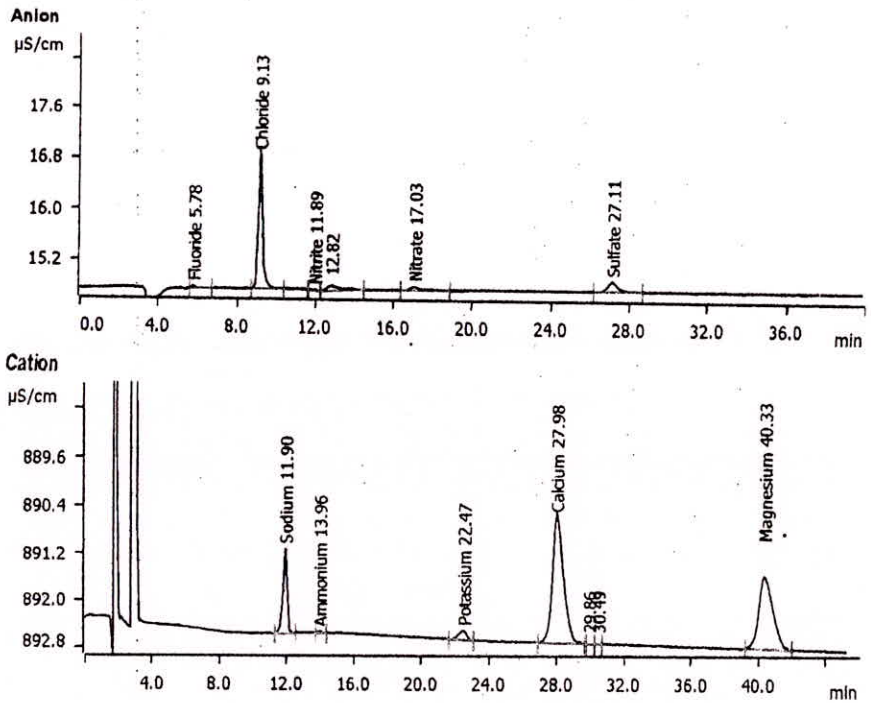

NIH IC REPORT

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N-44

Anion

Component name	Retention time	Height	Area	Concentration
	min	µS/cm	(µS/cm) x min	mg/L
Fluoride	5.81	0.105	0.022	0.177
Chloride	8.99	0.984	0.234	2.868
Nitrate	16.62	0.007	0.004	0.087
Sulfate	27.42	0.622	0.377	6.520

Cation

Component name	Retention time	Height	Area	Concentration
	min	µS/cm	(µS/cm) x min	mg/L
Lithium	7.72	0.007	0.001	0.005
Sodium	11.77	1.508	0.406	5.441
Ammonium	13.81	0.032	0.010	0.293
Potassium	21.59	0.228	0.120	3.373
Calcium	29.02	2.061	1.515	28.442
Magnesium	40.95	1.576	1.433	12.120

% Error----------0.955
Sample pH----------7.6
M-alkalinity as CaCO3----------123.793
P-alkalinity as CaCO3----------0.000
Total Hardness by IC----------120.833

NIH IC REPORT

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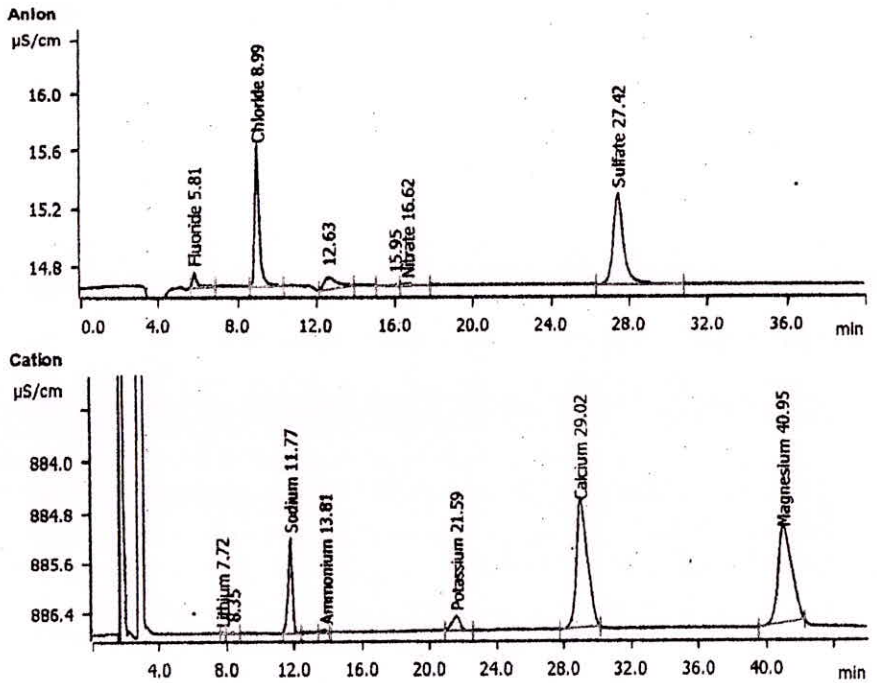

NIH IC REPORT

Date2017-02-23 00:22:04 UTC+5:30

N-45

Anion

Component name	Retention time	Height	Area	Concentration
	min	µS/cm	(µS/cm) x min	mg/L
Fluoride	5.81	0.088	0.020	0.257
Chloride	8.99	0.508	0.121	2.469
Nitrate	16.14	0.099	0.044	1.609
Sulfate	27.41	0.228	0.147	4.220

Cation

Component name	Retention time	Height	Area	Concentration
	min	µS/cm	(µS/cm) x min	mg/L
Sodium	11.78	2.566	0.696	15.531
Ammonium	13.80	0.027	0.009	0.473
Potassium	21.62	0.085	0.045	2.116
Calcium	28.97	2.166	1.630	51.013
Magnesium	41.05	1.428	1.372	19.336

% Error----------0.772
Sample pH----------7.8
M-alkalinity as CaCO3----------230.979
P-alkalinity as CaCO3----------0.000
Total Hardness by IC----------206.842

NIH IC REPORT

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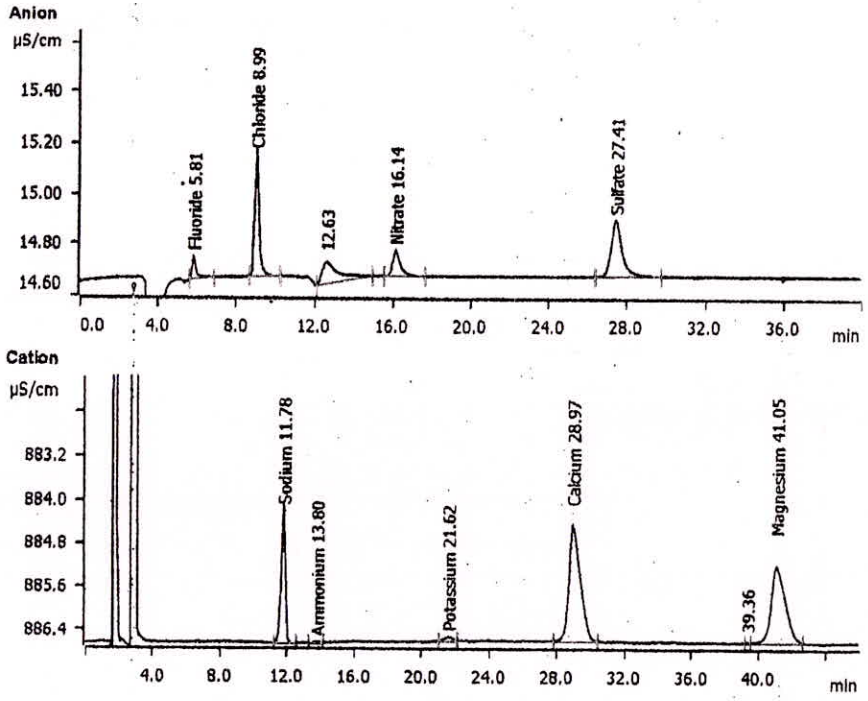

NIH IC REPORT

Date2017-02-23 10:48:02 UTC+5:30

N-46

Anion

Component name	Retention time min	Height µS/cm	Area (µS/cm) x min	Concentration mg/L
Fluoride	5.76	0.105	0.019	0.250
Chloride	9.04	0.444	0.132	2.699
Nitrite	11.20	0.006	0.002	0.062
Nitrate	17.20	0.005	0.003	0.107
Sulfate	26.89	0.081	0.051	1.456

Cation

Component name	Retention time min	Height µS/cm	Area (µS/cm) x min	Concentration mg/L
Sodium	12.38	1.152	0.329	7.341
Ammonium	14.51	0.324	0.105	5.298
Potassium	23.23	0.170	0.096	4.511
Calcium	29.92	2.344	1.910	59.757
Magnesium	44.33	1.717	1.907	26.877

% Error----------0.809
Sample pH----------7.2
M-alkalinity as CaCO3----------285.079
P-alkalinity as CaCO3----------0.000
Total Hardness by IC----------259.682

NIH IC REPORT

Date2017-02-23 10:48:02 UTC+5:30