A

PROJECT REPORT ON

"ANIONIC AND CATIONIC ANALYSIS OF ALAKNANDA RIVER BY ION CHROMATOGRAPHY"

Carried out at

NATIONAL INSTITUTE OF HYDROLOGY (NIH), ROORKEE

Submitted in partial fulfillment of the requirements for the award of

The degree of
MASTER OF SCIENCE
IN
CHEMISTRY

(Commercial method of chemical analysis)

Of

GURUKULA KANGRI VISHWAVIDYALAYA, HARIDWAR

Submitted by

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UNDER THE SUPERVISION OF

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TO WHOM IT MAY CONCERN

This is to certify that **Ms. Priyanka Yadav**, Student of M.Sc. (Chemistry),4th Semester, **Kanya Gurukul Campus of Gurukul Kangri Vishwavidyalaya, Haridwar** has carried out the Project Work on the topic **"Anionic and Cationic Analysis of Alaknanda River 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 am sure that this training will help her in taking up related assignment in her career.

I wish her all success in life.

28.3.17

(C. K. Jain)

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(NAAC 'A' Grade Accredited Deemed To Be University u/s 3 of UGC Act 1956)

Ref. No. 166 Date 25/3/17

CERTIFICATE

This is to certify that Ms. **Priyanka Yadav** 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 **"Anionic and Cationic Analysis of Alaknanda River 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 :

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(Dr. Abha Shukla)
Supervisor

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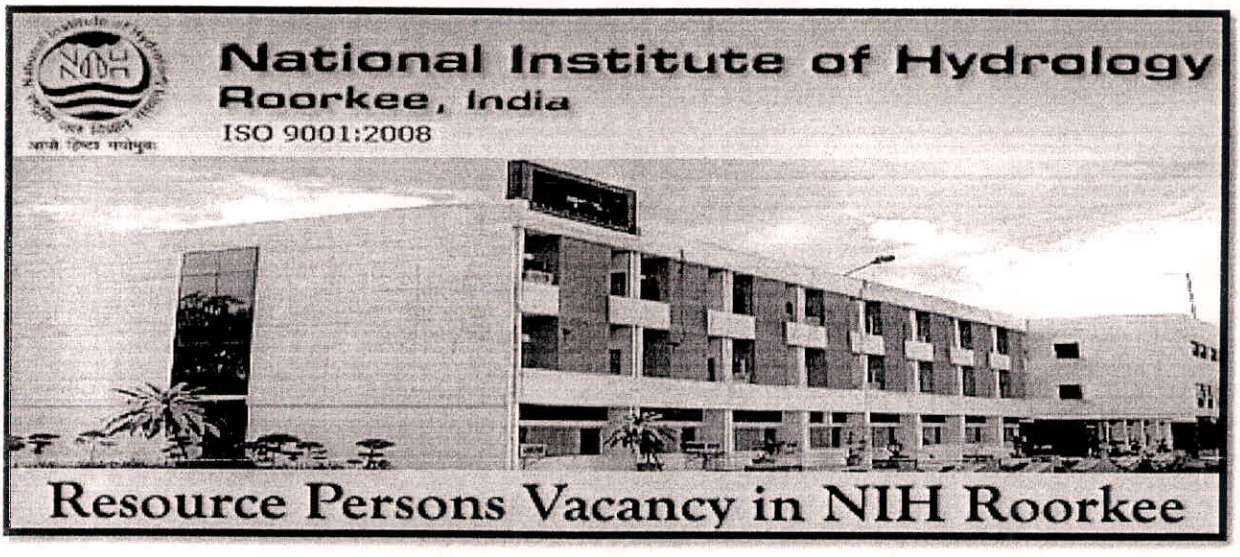
Lastly, I am thankful to my parents and family for being a constant source of inspiration.

Priyanka Yadav

Priyanka Yadav

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-ordinatingsystemating 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 waterhydrology division.

CONTENTS

CHAPTER- 1

INTRODUCTION-

- WATER
- SURFACE WATER
- WATER POLLUTION
- WATER QUALITY

Chapter-1

WATER

Water is a transparent fluid which form the world 's streams, lakes, oceans and rain and is the major constituent of the fluids of organisms . As a chemical compound , a water molecule contains one oxygen and two hydrogen atoms that are connected by covalent bonds . Water is a liquid at standard ambient temperature and pressure , but it often coexist on earth with its solid state , ice and gaseous state, steam (water vapour).

Even today man has brought about changes whether through urbanization and growth of population centre by introduction and employment of auxiliary means in agriculture which has disturbed or destroyed the natural healthy quality of water bodies .

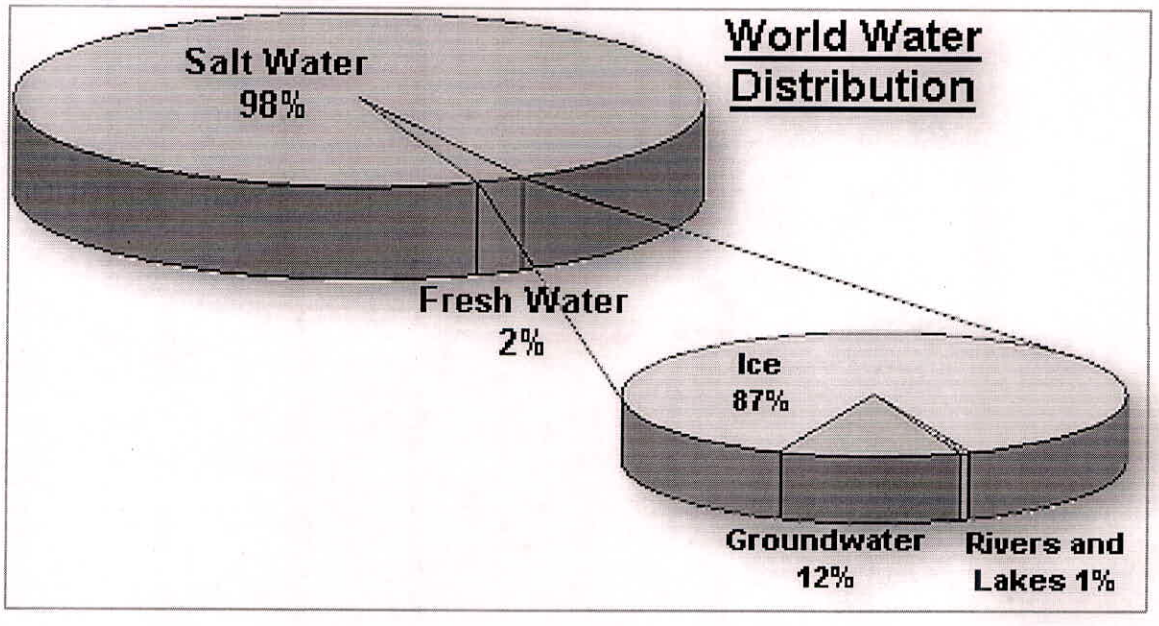
Water is very important for life because it is vital . The human and animal needs 75% water to do exercise EX- walk. Water cover 70% of the earth like two third part of earth . Pure water has no colour ,no taste and does not smell of any things. The water is a chemical substances with formula H2O .

Water exist in three form on the earth :

1. SOLID (ice , snow)

2. LIQUID (lakes, oceans,rain,fog)

3. GAS(steam or water vapour)

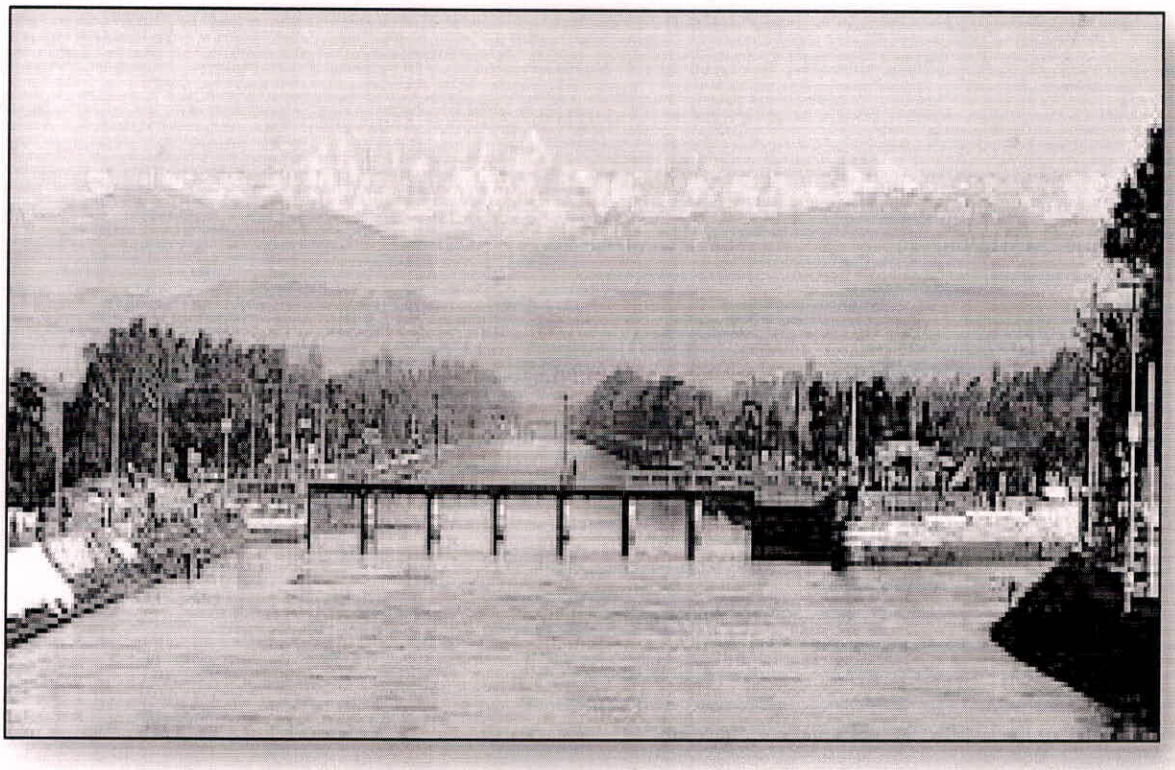


About 97% of the water on the earth's surface in the world' ocean ,this is where can find most of other 3%

LAKE , RIVER , RAIN , CLOUDS , SEA ICE .

SURFACE WATER

Surface water referto water found on the surface of the earth. Lakes , river , stream and wetland are all examples of surface water . In ontaria , we rely on the largest surface water system in the world , the great Lake , for clean water to drink and for everyday use . The largest of the lake , lake superior , is the SOURCE of the municipal residential drinking water apply for the city of thunder bay. Currently , lake superior is healthy and provides us with clean and abundant water , a valuable resource that we should not take for granted . Protecting the quality and quantity of our SURFACE WATER now and for the future use is a goal of drinking water source protection under the "CLEAN WATER ACT".



Natural surface water can be augmented by importing surface water from another watershed through a canal or pipeline . It can also be artificially augmented from any of the other source listed here , however in practice the

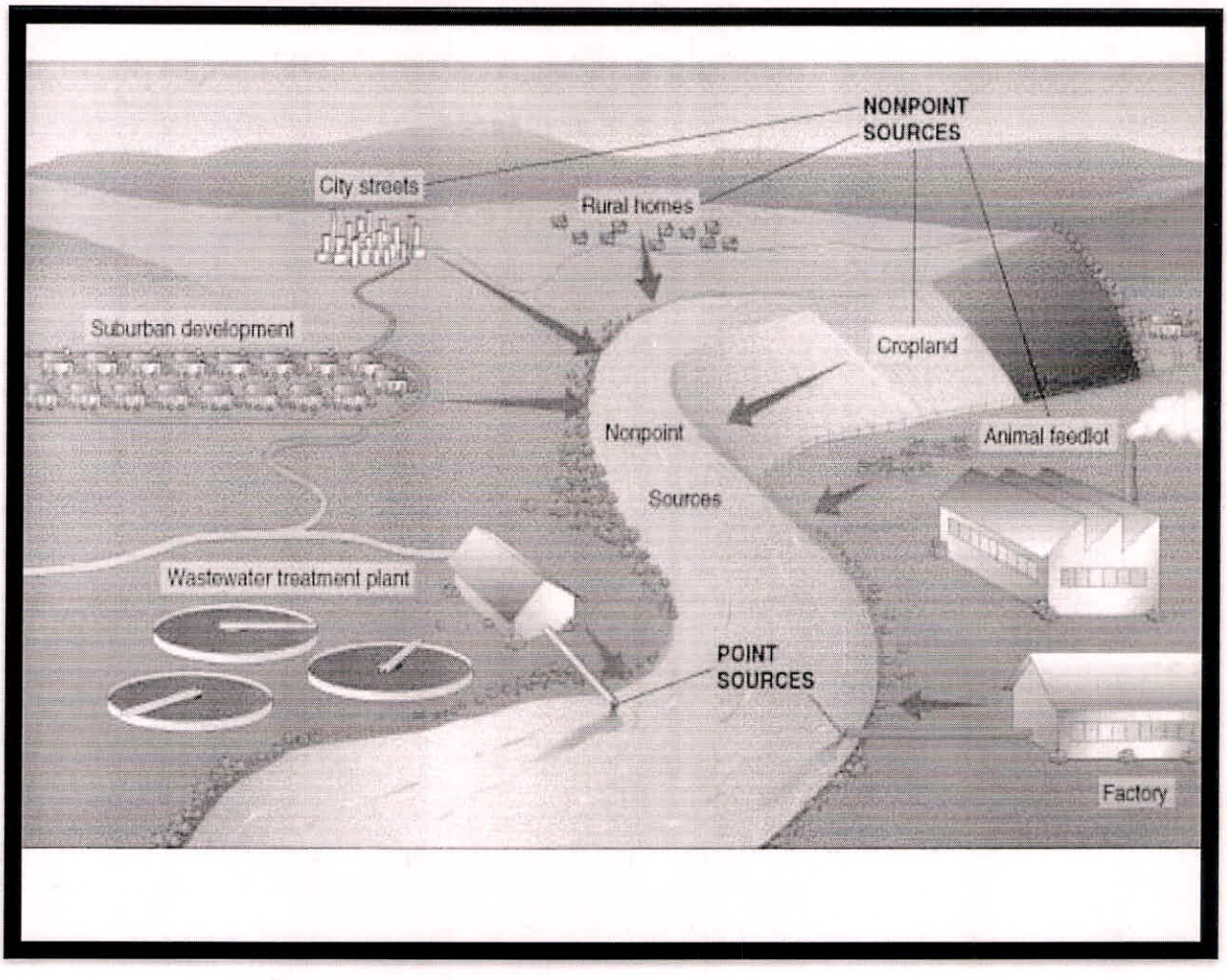
quantities are negligible . Humans can also caused surface water to be "lost" through Pollution .

Human activities can have a large and sometime devastating impact on these factors . Human often increase storage capacity by construction reservoir and decrease it by draining wetland . Humans often increase runoff quantities and velocities by paving areas and channelizing stream flow .

Surface water is water in a river , lake or fresh water wetland . surface water is naturally replenished by precipitation and naturally lost through discharge to the ocean and evaporation .

WATER POLLUTION

The problem of pollution continues to pose a serious challeng as the threat of nuclear war.it is expected that due to urbanization , population growth , industrial , proliferation , increasing living standards and wide spheres of human activities in India or in developing countries , the river get polluted every year . the situation is very much critical due to in proper management of water .



The water pollution defind as "any change in physical , chemical and biological properties of water or discharge any sewage as industrial waste into water bodies without enough treatment to remove harmful compunds .

Pollutant get into water mainly by human causes or factor .water pollution the entire biosphere – plants and organisms living in these bodies of water .

Water pollution is a major problem which affects drinking water , rivers, lakes and ocean all over the world . many developing countries , it is usually a leading cause of death , by people drinking from polluted water sources .

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 condition , where by its normal function and properties are affected .

WATER POLLUTION CAUSES BY

1. **Industrial waste**
2. **Sewage**
3. **Mainly from household**
4. **Nuclear waste**
5. **Marine dumping**
6. **Oil pollution**
7. **Underground storage leaks**

HEALTH EFFECTS OF POLLUTION

1. Diseases like cholera , malaria
2. Typhoid
3. Respiratory illness
4. Headache fatigue
5. Jaundice
6. Gastroenteritis (through bacteria ,parasites , chemicals)

WATER QUALITY

Water quality describe the condition of water including chemical , physical , biological characteristic usually with respect to its suitable 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 is measured by several factor such as the condition of dissolved oxygen bacteria . Level the amount of salt or the amount material suspended in water .

ENVIRONMEMTAL WATER QUALITY

Environmental water quality also ambient water quality relates to water bodies such as lake , river and oceans .Water quality standard for surface water vary

significantly due to different environmental condition , ecosystem and intended human uses .

Toxic substance and high population of certain micro-organism can present a health hazard for non drinking purpose such as irrigation , swimming , fishing , rafting , boating and industrial use . This condition may also affect wild life , which use the water for drinking or as a habitat .

Modern water quality laws generally specify protection of fisheries and recreational use and require as a minimum retention of currentquality standard.In some countries these designation allow for some water contamination as long as the particular type of contamination is not harmful to the designated use .

Landscape changes in the watersheds of many fresh water bodies , returning to pristine condition would be a significantchallenge . In these case environmental scientist focus on achieving goal for maintaining healthy ecosystem and many condition on the protection of population of endangered species and protecting human health.

Environmental Indicator

These are following three types

1. **PHYSICAL INDICATOR**
2. **CHEMICAL INDICATOR**
3. **BIOLOGICAL INDICATOR**

PHYSICAL INDICATOR :

1. **Water temperature**
2. **Total Dissolved solid**
3. **Specific conductance or electrical conductance**
4. **Turbidity**
5. **Odor of water**
6. **Color of water**
7. **Taste of water**

CHEMICAL INDICATOR:

1. pH
2. Biochemical oxygen demand (B.O.D.)
3. Dissolvedoxygen
4. Total hardness
5. Chemical oxygen demand (C.O.D.)
6. Nitrate
7. Heavy metals
8. Major Anions (Cl^- , F^- , SO_4^{2-}, PO_4^{3-})
9. Major Cations (Na^+, K^+ , Mg^{2+} , Ca^{2+} , NH_4^+, Al^{3+})

CHAPTER-2

➢ PURPOSE OF STUDY

Chapter-2

PURPOSE OF THE 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 .

Six samples of Alaknanda river 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 Alaknanda river surface water samples analyzed by using ion chromatography . And also determination the water quality parameters viz. pH , EC , Alkalinity and hardness .

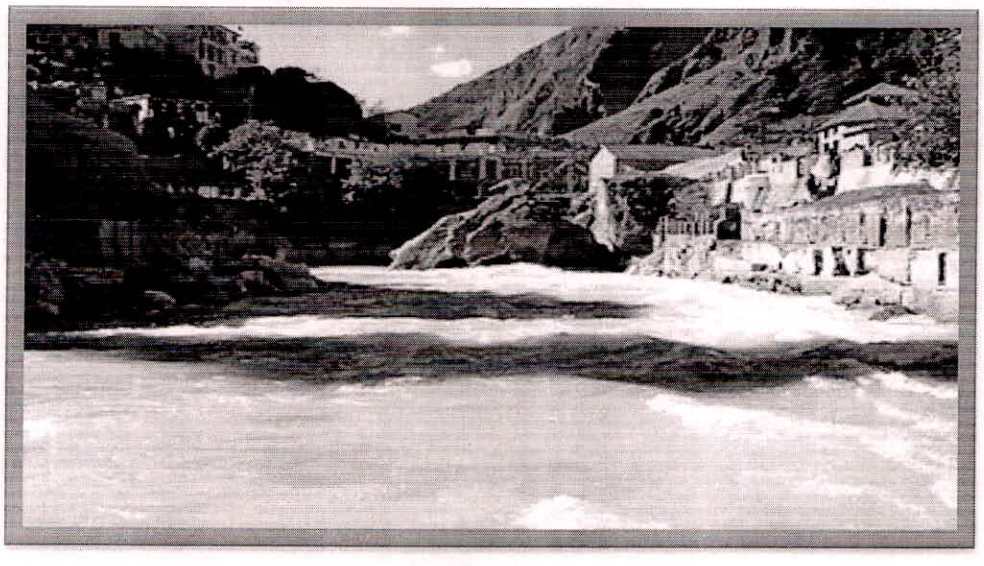
CHAPTER-3

- STUDY AREA
- SAMPLING AND PRESERVATION TECHNIQUES
- PHYSICO-CHEMICAL ANALYSIS
- AUTO-TITRATION

Chapter-3

Study Area

The Alaknanda is considered to rise at the confluence and foot of the Satopanth and BhagirathKharakglaciers in Uttarakhand, though the Saraswati River tributary flowing from Mana Pass is longer; the two meet at Mana, India, 21 km from Tibet. Three km below Mana the Alaknanda flows past the Hindu pilgrimagecentre of Badrinath. It meets the .after flowing for approximately 190 km (118.1 mi) through the Alaknanda valley. Its main tributaries are the Mandakini, Nandakini, and Pindar rivers. The Alaknanda system drains parts of Chamoli, Tehri, and Pauridistrict .



River Alaknanda near Badrikashram

Following the merging at Devprayag, the river is known as the Ganges. The Alaknanda contributes a significantly larger portion to the flow of the Ganges than the Bhagirathi. The Alaknanda is also known for adventure sports such as rafting.Inmythology, the GoddessGanga descended to earth at Gangotri, the original source of the Bhagirathi before the Gangotri Glacier receded to its

current.location at Gomukh.The origin of Alaknanda River is of special interest to the tourists who visit the important pilgrimages in Uttarakhand.

SAMPLING AND PRESERVATION TECHNIQUES

Sampling is the first step leading to the generation of water quality data and is an exceedingly important ; care must be taken to ensure obtaining a sampie that is truly representative thoroughly cleaned plastic or glass bottles fitted with screw caps may be used for water sample collected with depth integrating samplers , plastic container are generally preferred for inorganic samples and glass is preferred for organic samples .

Compact system for routine analysis of anion ,cations and polar substances are in the range of µgm/ L to gm/L . The samples of water were collected weekly at 8 :30 am on every Sunday . The displacement between each sampling site is 2 km (approx.) .

Determination of pH should be done in the field . Sample for metal analysis can be preserved by addition of Nitric acid , sample for organic constituent 's determination by chilling or freezing . A list containing method of sample preservation and time allowed between sample collection and analysis is presented in following table :

TABLE - Sample location and Identity

S.NO.	SAMPLE SITE	SAMPLE ID	DATE	VOLUME OF SAMPLE
1.	ALAKNANDA	A-1	12-02-2017	1 LITRE
2.	ALAKNANDA	A-2	12-02-2017	1 LITRE
3.	ALAKNANDA	A-3	12-02-2017	1 LITRE
4.	ALAKNANDA	A-4	12-02-2017	1 LITRE
5.	ALAKNANDA	A-5	12-02-2017	1 LITRE
6.	ALAKNANDA	A-6	12-02-2017	1 LITRE

TABLE -Adopted preservation technique

Parameter	Preservation	Maximum storage time
Color	Cool to 3-4°C	24 hours
Turbidity	Cool to 3-4°C	7 days
pH		Immediately
Alkalinity	Cool to 3-4°C	24 hours
Hardness	Add 2ml HNO_3 /L ,cool to 3-4°C	7 days
sulphate	Cool to 3-4°C	7 days
Chloride		7 days
Phosphate	Cool to 3-4°C	7 days
Nitrogen,Nitrate	Add 2ml H_2SO_4/ L, Cool to 3-4 °C	7 days
B.O.D	Cool to 3-4°C	6 hours
Metals	Add 5 ml HNO_3/L	6 months

PHYSICO – CHEMICAL ANALYSIS:

1.pH

2. Alkalinity

3. Hardness

4. Electrical Conductivity

pH

In chemistry, **pH**(potential of hydrogen) is a numeric scale used to specify the acidity or basicity of an aqueous solution. It is approximately the negative of the base 10 logarithm of the molar concentration, measured in units of moles per liter, of hydrogen ions. More precisely it is the negative of the logarithm to base 10 of the activity of the hydrogen ion. Solutions with a pH less than 7 are acidic and solutions with a pH greater than 7 are basic. Pure water is neutral, at pH 7, being neither an acid nor a base. Contrary to popular belief, the pH value can be less than 0 or greater than 14 for very strong acids and bases respectively.

pH measurements are important in agronomy, medicine, biology, chemistry, agriculture, forestry, food science, environmental science, oceanography, civil engineering, chemical engineering, nutrition, water treatment and water purification, as well as many other applications.

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 .

ALKALINITY

Alkalinity is the name given to the quantitative capacity of an aqueous solution to neutralize an acid. Measuring alkalinity is important in determining a stream's ability to neutralize acidic pollution from rainfall or wastewater. It is one of the best measures of the sensitivity of the stream to acid inputs. There can be long-term changes in the alkalinity of streams and rivers in response to human disturbances.

Alkalinity is related to the pH of a solution, (its basicity) but measures a different property. Roughly, the alkalinity of a solution is a measure of how "strong" the bases are in a solution, whereas the pH measures the "amount" of chemical bases. A good example is a buffer solution, which can have many available bases (high alkalinity) despite having only a moderate pH level.

$$CO_2 + H_2O \leftrightharpoons H_2CO_3$$

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

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

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

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

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 .

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

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

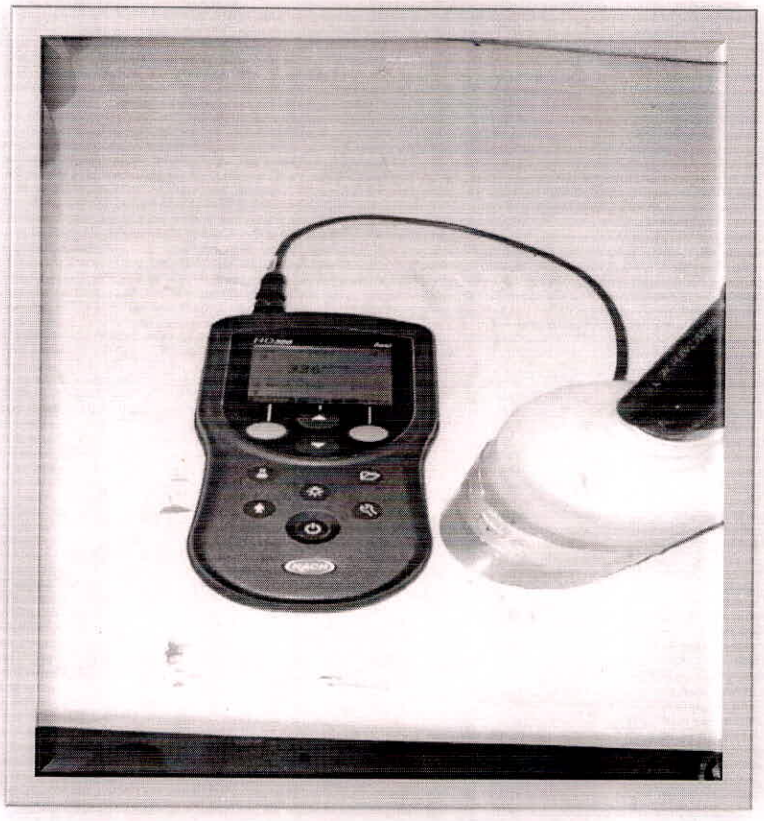
CALCULATION

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

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

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

ELECTRICAL CONDUCTIVITY(SPECIFIC CONDUCTANCE)



Specific Conductance is a measure of how well water can conduct an electrical current. Conductivity increases with increasing amount and mobility of ions. These ions, which come from the breakdown of compounds, conduct electricity because they are negatively or positively charged when dissolved in water. Therefore, SC is an indirect measure of the presence of dissolved solids such as chloride, nitrate, sulfate, phosphate, sodium, magnesium, calcium, and iron, and can be used as an indicator of water pollution.

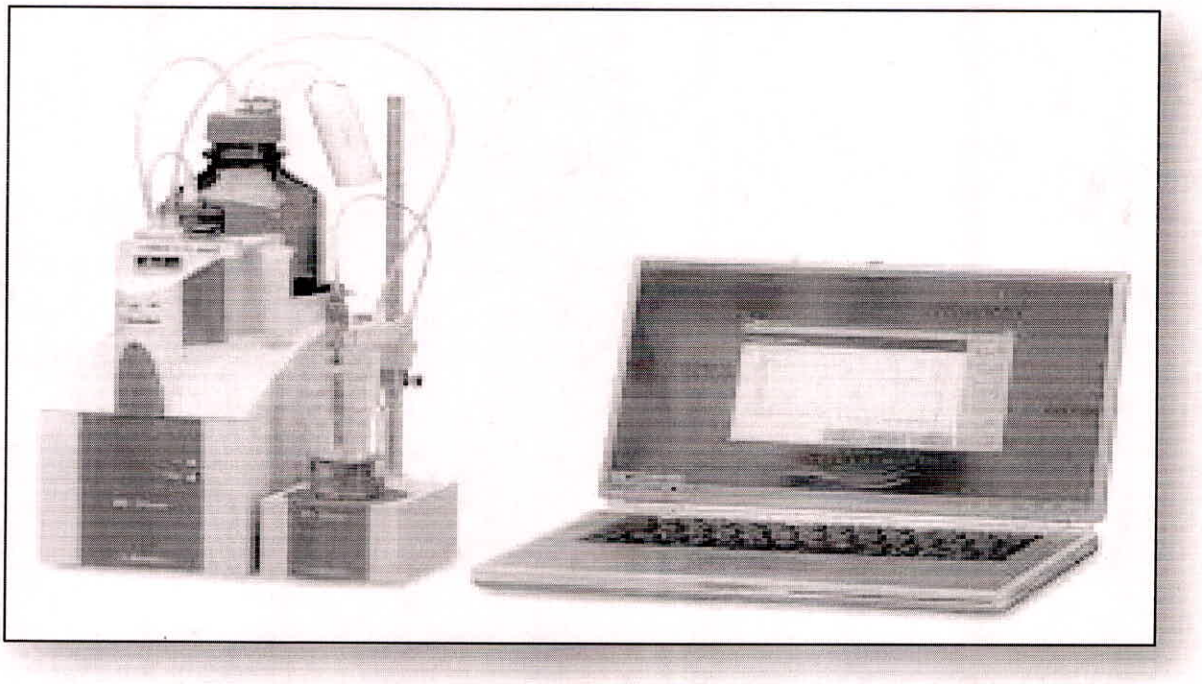
Specific Conductance measures how well water can conduct an electrical current for a unit length and unit cross-section at a certain temperature. More specifically, it is defined as the "reciprocal (opposite) of the resistance in ohms measured between opposite faces of a centimeter cube of an aqueous solution at a specified temperature .

conductance = 1 / resistance

Specific conductance is measured using a sensor which measures resistance. Resistance means how well something can *resist* an electrical current, and is reported in ohms. The unit of conductance was originally ohm spelled backwards "mho." More recently, however, the name "siemen" has been used to match the term used by the International System of Units. So both "mho" and "siemen" are sometimes seen in water quality reports. One siemen is equal to one mho. Because SC in natural waters is usually much less than 1 siemen/cm, SC is usually reported in **microsiemens per centimeter**, or **µS/cm**. SC is affected by temperature, so for consistency SC values are converted to what they would be at room temperature (25° C).

pH , Alkalinity is measured by

AUTO TITRATION



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 .you 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 no time at all . The accuracy is increased due to the finely calibrated computer instead of your eyes . The amount of hands on interaction isdrastically reduced . The Auto- titration was carried out in the laboratory using **888-TITRANDO 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**
- **Result 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

INSTRUMENTATION-

- CHROMATOGRAPHY
- ION CHROMATOGRAPHY
- APPLICATIONS

chapter – 4

CHROMATOGRAPHY

Chromatography is a laboratory technique for the separation of mixture . The mixture is dissolved in a fluid called mobile phase which carries it through a structure holding another material called stationary phase .The various constitutentof the mixture travel at different speed causing them to separate.

The separation is based on partitioning between mobile and stationary phase. Subtle difference in a compounds. Partition coefficient result in a differential retention on a stationary phase and thus changing the separation.Analytic chromatography is done normally with smaller amount of material and is for measuring the relative proportion of analytes in the mixture.

DEFINITION OF CHROMATOGRAPHY

CASSID

According to CASSID , Chromatography is a separation process applicable to essential molecular mixture , in which the distribution of mixture occurs between two dimensional phase which are brought into contact in a differential counter current manner .

PRINCIPLE :

Chromatography is based on the principle of separation of components into different bands and then identification of those bands. The samples are subjected to flow by mobile liquid onto or through the stable stationary phase. The sample components are separated into fraction based on their relative affinity towards the two phase during their travels. The fraction with a greater affinity to stationary layer travels slower and at a shorter distance while that with a lesser affinity towards faster and longer.

ION CHROMATOGRAPHY

Ion –exchange chromatography is the process that allows the separation of ions and polar molecules based on their affinity to the ion exchanger. It can be used for almost any kind of charged molecules including large protein, small nucleotides and amino acids.

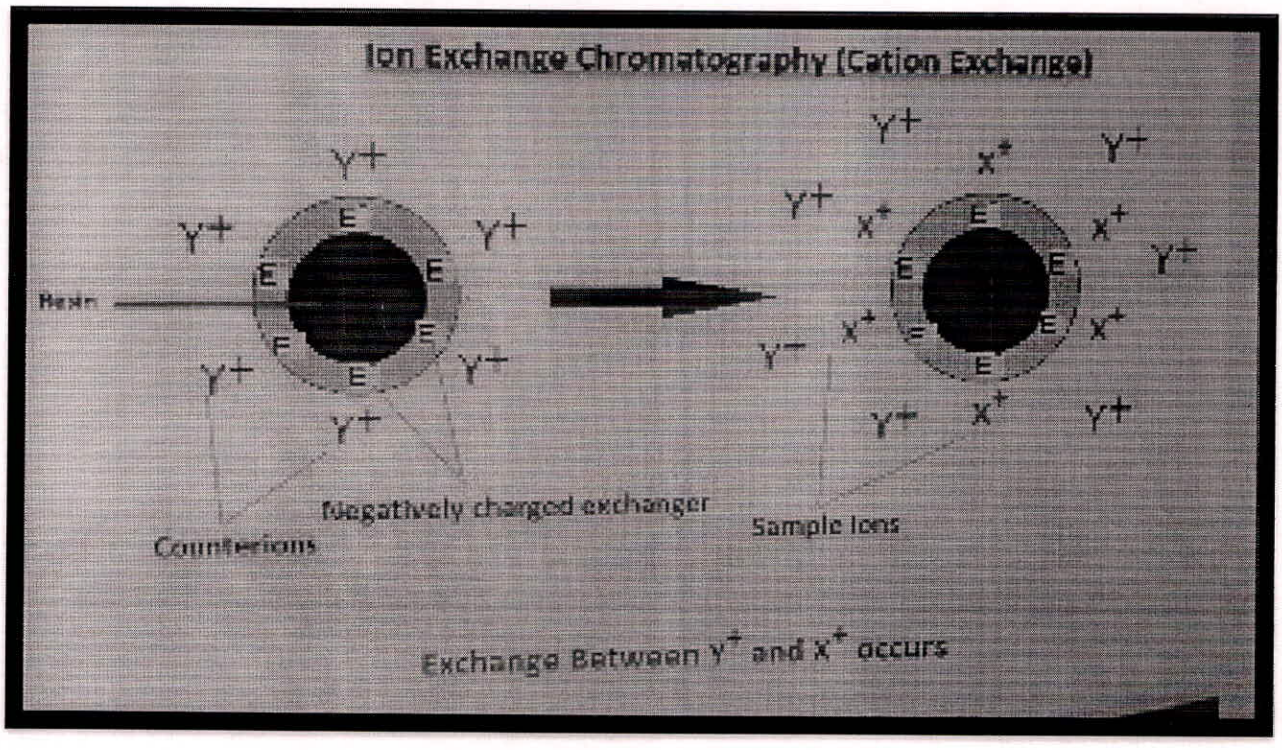
Anion and cation can be separated using this method.In ion chromatography,retention is based on the attraction between the solute ion and charged sites bound to stationary phase.Colume used for ion exchange are characterized by the presence of charged group covalently attached to the stationary phase.

Anion exchanger contain bound positive group,where ascation exchanger contain bound negative group. Its major use at present is for the analysis of common anion (F^- ,Cl^-,Br^-,I^-,NO_2^-,NO_3^-,SO_4^{2-},PO_4^{3-}) in aqueous solution .

Ion chromatography can be performed on standard HPLC equipment rather than using an ion chromatography but it is difficult to choose a solvent system with the correct elution characteristic and UV absorption.

PRINCIPLE

Ion chromatography relies on the attraction between oppositely charged stationary phase, known as an ion exchanger and analyte. The ion exchanger consist of an inert support medium coupled covalently to positive (anion exchanger) or negative(cation exchanger) functional groups. To these covalently bound functional groups the opposite charged ions are bounded,which will be exchanged with like charge ions in the sample having charge magnitude morethan the ion bounded to the matrix.



Thus if anion chromatography is performed , negative charged sample components will interact more with the stationary phase and will be exchanged like charged ions already bounded to the matrix.

ION EXCHANGERS

An ion exchanger consist of two basic components:

- Ion exchanger resin
- Exchange medium (cation exchanger and anion exchanger).
  - Charged functional group.
  - Mobile counter ion.

ION EXCHANGE RESIN:

The two main groups of material are used to prepare ion exchange resin like – polystyrene, cellulose. Resin made from both of these material differ in their flow properties , ion accessibility and chemical and mechanical stability.

EXCHANGE MEDIUM:

The choice of ion exchangers depend upon the stability, molecular weight, ionic strength of the sample component. The volume of exchanger used for separation is usually 2.5 fold greater than to exchange with the ion in the sample.

The ion exchangers are two type:

- Anion exchanger
- Cation exchanger

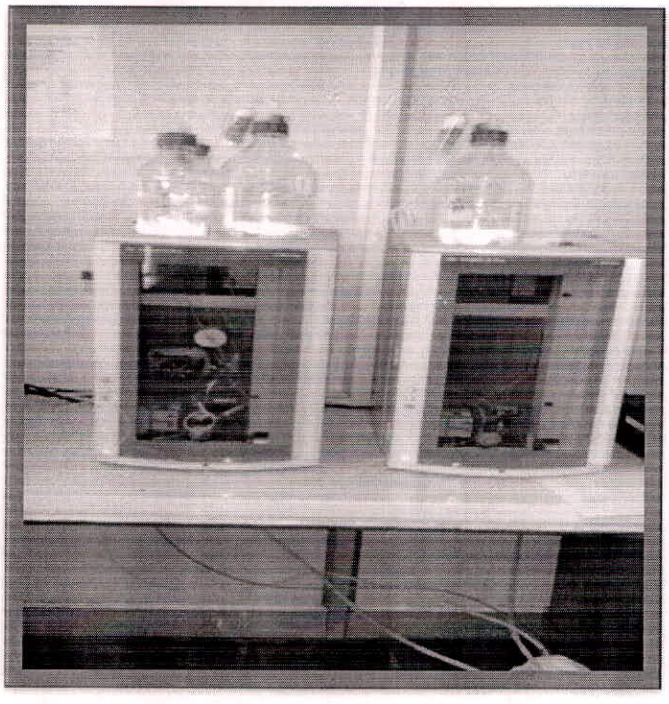
ANION EXCHANGERS:

The anion exchanger have positively charged exchanger with negatively charged mobile counter ion available for exchange. If the basic functional group are introduced, the resin becomes anion exchanger.

CATION EXCHANGER:

The cation exchangers have negatively charged exchanger with positively charged mobile counter ion available for exchange.If the acidic functional group are introduced, the resin becomes cation exchanger.

PREPARTION OF MOBILE PHASE



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 84ml of sodium bicarbonate dissolve in distilled water and make up to 1 litre.

FOR TITRATION-0.01 M H_2SO_4

ION CHROMATOGRAPY PROCESS

First of all the sample is introduced then flows through the guard and into the analytical ion exchange columns where the ion exchange occurs. After separation, the suppressor reduces the conductivity of the eluent and increase the conductivity of the analytes. So they are delivered to the detector. A computer and software are used to control the system.

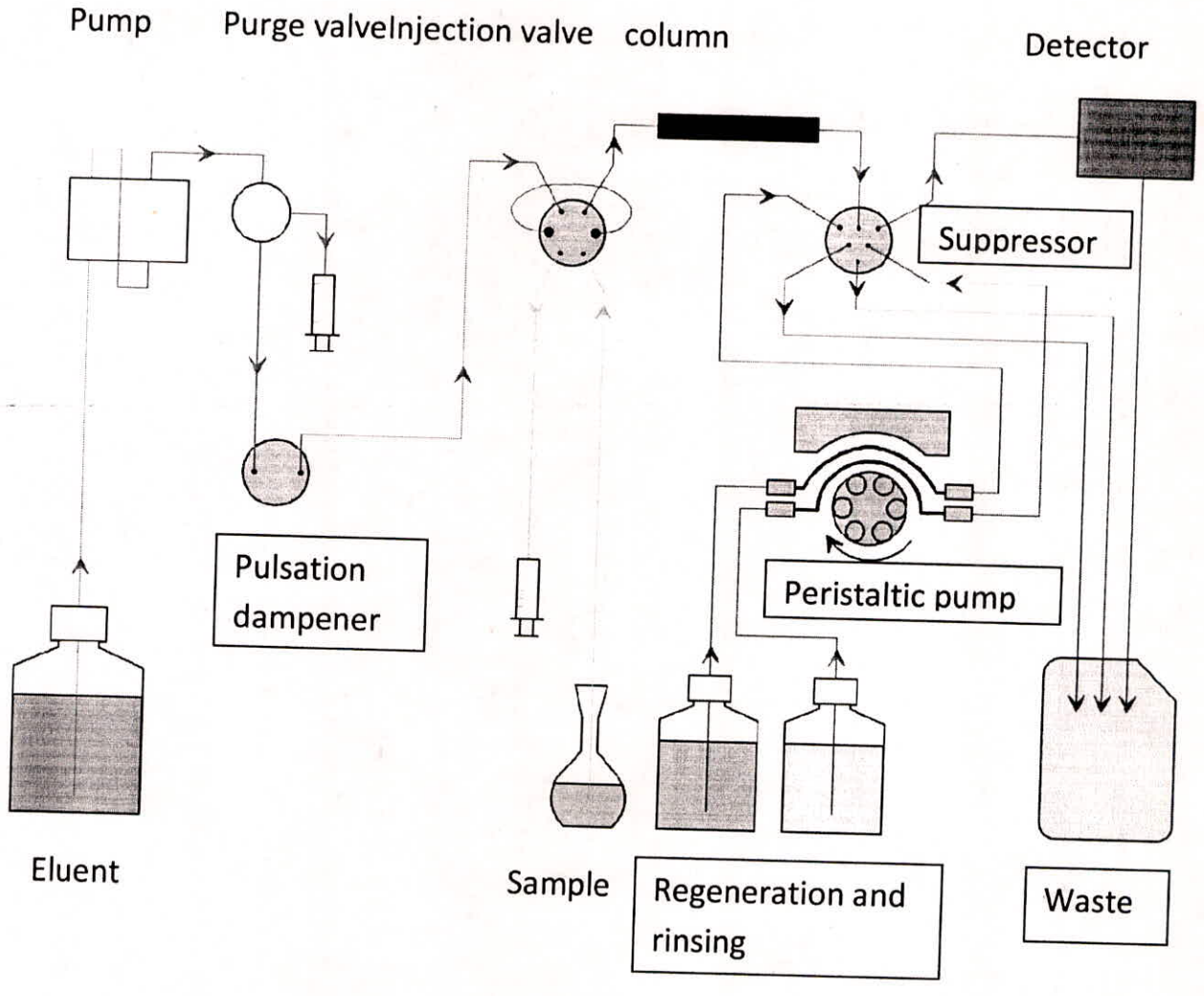
STEP-1 The sample solution is injected into loop by injection port.

STEP - 2 The pump push the solvent through the loop taking the sample and carringit into the analytical column.

STEP - 3 Theanalytes separated by the analytical column reach the detector (UV spectrophotometer, conductivity detector) in different times.

STEP - 4 An interface links the ion chromatography instrumentation to the pc. The chromatogram is displayed on the pc screen.

INSTRUMENTATION



Ion chromatography consist of following components-

- **PUMP**
- **INJECTOR**
- **COLUMN**
- **SUPPRESSOR**
- **DETECTOR**
- **RECORDER**

PUMP-

The ion chromatography pump is considered to be one of the most important components in the system which has to provide a continuous constant flow of the eluent through the ion chromatography injector, column and detector.

The solvent then passes from the selector to a high pressure pump. The mobile phase passes form the pump to the sampling device, usually a sample rotating valve that on rotation places the sample in the line with the mobile flow which then passes on to the column.

INJECTOR-

Sample introduction can be accomplished in the various ways. The simplest method is to use an injection valve. In more sophisticated LC, automatic sampling devices are incorporated where sample introduction is done with the help of auto samplers and microprocessors. Injector should provide the possibility of injecting the liquid sample.

COLUMN-

Ion exchange column are vary widely in size, packing material and material opf construction. The column where the components of interest are separated. The column material may be stainless steel, titanium, glass or plastic. The life of a column will depend largely on the type of samples it is used to separate.

SUPPRESSOR-

Ion chromatography suppressor are membrane based devices. Suppressor can be used with the aqueous /organic eluents needed to elute organic analytes which are retained on the stationary phase.

The suppressor reduces the background conductivity of the chemical used to elute samples from the ion exchange column. Which improves the conductivity measurement of the ions being tested.

DETECTOR-

In ion chromatography the electrical conductivity is commonly used.An electricalfield is applied between the electrodes. Detector measures the electrical resistivity of ions in the solution. Conductivity is the reciprocal of resistance.

AMPLIFIER-

The amplifier output is then either digitized, and the binary number sent to a computer for storage and processing or the output is passed directly to a potentiometric recorder.

APPLICATION OF ION CHROMATOGRAPHY

- Industry is one of the most important source of not only environmental pollution. In recent year, the importance of monitoring and controlling environmental pollutants has become apparent in all parts of the part.
- The chemical analysts have increased their efforts to identify and determine toxic substance in air,water, waste water , soil and other sector of the environments .
- Every day in thousand of laboratories around the world,million analysis of different substance are carried out .
- The development of new method and improvement to existing ones are major task for analytical chemists.
- Advance in analytical instrument, detection system and separation technique have , in many instance , provide analytical chemist the tools require to continuouslly lower detection limits and improving method reliability .
- The most often determination analytes are inorganic ions. In this range ion chromatography is a dominant instrumental analytical technique.
- Ion exchange remains the primary separation mode used in ion chromatography today, although the apparatus used for the separation of the ionic species include ion pairing and ion exclusion chromatography.

- Different type of ion chromatography can be used for the determination of ion such as inorganic anion and cation(including alkaline metals , alkaline earth metals , transition metals and rare earth metals .)
- It can be determine the carboxylic , phosphoric and sulphonic acids , detergent , organic base , carbohydrate and ionic form of metals .
- Separation of inorganic ion .
- concentration of ionic solution .
- Organic separation , mixture of pharmaceutical compound can be separate .
- Biochemical separation like isolation of drugs or metabolites form blood , urine etc .
- Determination or deionisation of water .
- Softening of water .
- Purification of solution to be free from ionic impurities .
- To measure the additive in food and drug sample .
- To separate a protein mixture .
- Polyvalent ion such as pyrophosphate, tripolyphosphate, and tripolyphosphate can be distinguished by ion chromatography .
- Organic acid , amino acid and peptides can be determined by selecting the proper polymetric column , mobile phase and detector.

- Drinking water analysis for pollution and other constituents.
- Determination of water chemistries in aquatic ecosystems.
- Determination of sugar and salt content in food.
- Isolation of selected protein.
- To analyze base composition of nucleic acid.

CHAPTER-5

- RESULTS AND DISCUSSION
- REFERENCES

RESULTS:

The following results were obtained after the water quality analysis of Alaknanda River:

TABLE – RESULTS OF PHYSIO CHEMICAL CHARATERISTICS OF VARIOUS SAMPLES :

S.NO.	SAMPLE ID	pH	HARDNESS	ALKALINITY
1.	A-1	8.0	101.112	64.757
2.	A-2	8.2	94.282	69.407
3.	A-3	8.2	96.747	84.050
4.	A-4	8.2	96.360	74.943
5.	A-5	8.2	93.128	73.129
6.	A-6	8.0	55.994	49.086

TABLE – RESULTS OF CONCENTRATIONS OF ANIONS IN VARIOUS WATER SAMPLES OF ALAKNANDA RIVER:

ANIONS:

SAMPLE ID	FLUORIDE Mg/L	CHLORIDE Mg/L	NITRITE Mg/L	NITRATE Mg/L	PHOSPHATE Mg/L	SULPHATE Mg/L
A-1	0.129	1.146	_	1.243	_	40.958
A-2	0.247	0.907	_	1.011	_	27.658
A-3	0.176	0.688	0.030	0.697	0.198	12.491
A-4	0.234	1.016	0.033	0.945	_	23.359
A-5	0.228	1.016	0.033	0.988	_	22.602
A-6	0.216	1.108	0.039	0.888	_	13.416

TABLE –RESULTS OF CONCENTRATIONS OF CATIONS IN VARIOUS WATER SAMPLES OF ALAKNANDA RIVER :

CATIONS:

SAMPLE ID	SODIUM Mg/L	AMMONIUM Mg/L	POTASSIUM Mg/L	CALCIUM Mg/L	MAGNESIUM Mg/L	LITHIUM Mg/L
A-1	3.931	0.265	2.493	27.228	8.063	0.009
A-2	3.460	0.106	2.575	25.262	7.595	0.008
A-3	2.082	0.228	2.214	26.622	7.370	_
A-4	3.229	0.186	2.582	25.882	7.724	0.008
A-5	3.226	_	2.631	25.656	7.076	_
A-6	3.994	0.098	2.473	18.778	2.221	_

NIH IC REPORT

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A-1 Feb 2017 [NMSHE]

Anion

Component name	Retention time	Height	Area	Concentration
	min	µS/cm	(µS/cm) x min	mg/L
Fluoride	5.80	0.244	0.049	0.129
Chloride	9.02	1.201	0.281	1.146
Nitrate	16.28	0.406	0.172	1.243
Sulfate	27.35	13.083	7.111	40.958

Cation

Component name	Retention time	Height	Area	Concentration
	min	µS/cm	(µS/cm) x min	mg/L
Lithium	7.64	0.037	0.006	0.009
Sodium	11.73	3.233	0.881	3.931
Ammonium	13.73	0.076	0.026	0.265
Potassium	21.63	0.510	0.267	2.493
Calcium	27.92	4.724	4.351	27.228
Magnesium	39.73	2.645	2.860	8.063

% Error----------.1.461
Sample pH----------8.0
M-alkalinity as CaCO3----------64.757
P-alkalinity as CaCO3----------0.000
Total Hardness by IC----------101.112

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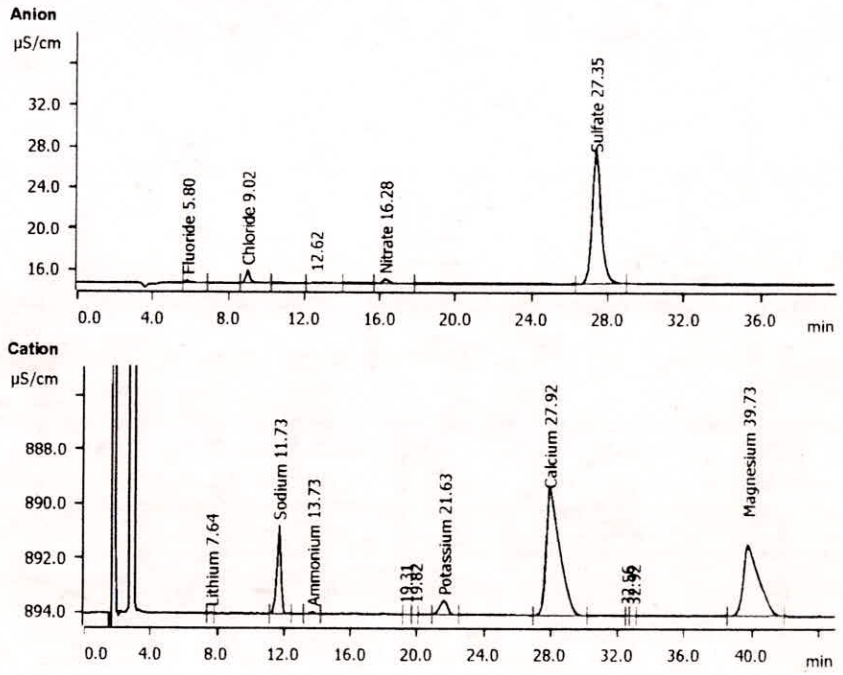

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A-2 Feb 2017 [NMSHE]

Anion

Component name	Retention time min	Height µS/cm	Area (µS/cm) x min	Concentration mg/L
Fluoride	5.81	0.483	0.094	0.247
Chloride	9.03	0.949	0.222	0.907
Nitrate	16.32	0.329	0.140	1.011
Sulfate	27.39	8.737	4.802	27.658

Cation

Component name	Retention time min	Height µS/cm	Area (µS/cm) x min	Concentration mg/L
Lithium	7.65	0.036	0.006	0.008
Sodium	11.73	2.849	0.775	3.460
Ammonium	13.74	0.028	0.011	0.106
Potassium	21.64	0.523	0.275	2.575
Calcium	27.96	4.485	4.037	25.262
Magnesium	39.78	2.527	2.694	7.595

% Error----------2.177
Sample pH----------8.2
M-alkalinity as CaCO3----------69.407
P-alkalinity as CaCO3----------0.000
Total Hardness by IC----------94.282

NIH IC REPORT

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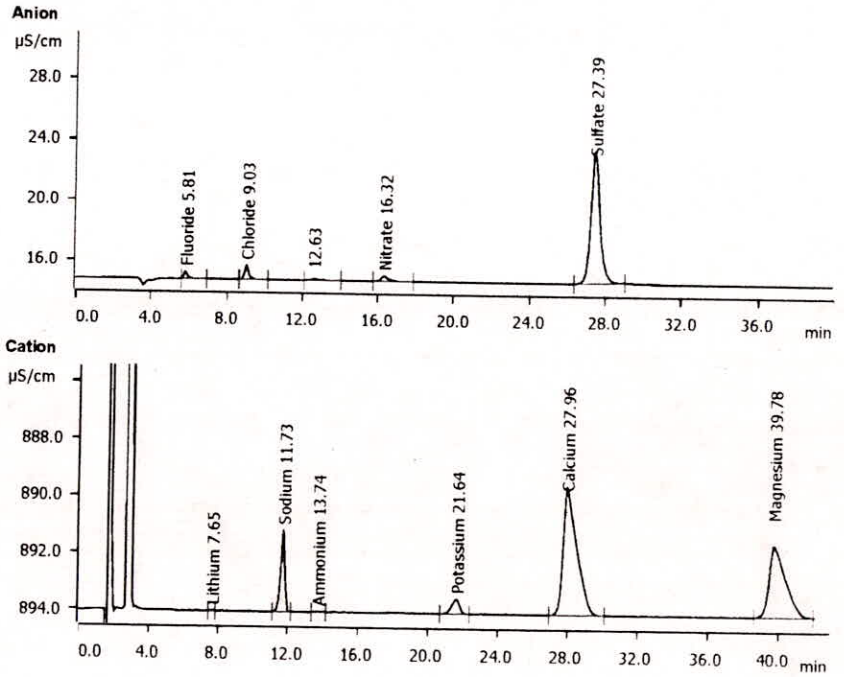

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A-3 Feb 2017 [NMSHE]

Anion

Component name	Retention time	Height	Area	Concentration
	min	µS/cm	(µS/cm) x min	mg/L
Fluoride	5.80	0.339	0.067	0.176
Chloride	9.01	0.715	0.168	0.688
Nitrite	11.69	0.013	0.004	0.030
Nitrate	16.28	0.223	0.096	0.697
phosphate	23.20	0.023	0.012	0.198
Sulfate	27.43	3.854	2.169	12.491

Cation

Component name	Retention time	Height	Area	Concentration
	min	µS/cm	(µS/cm) x min	mg/L
Sodium	11.71	1.732	0.467	2.082
Ammonium	13.74	0.064	0.023	0.228
Potassium	21.58	0.458	0.237	2.214
Calcium	27.95	4.676	4.254	26.622
Magnesium	39.75	2.542	2.614	7.370

% Error----------2.619
Sample pH----------8.2
M-alkalinity as CaCO3----------84.050
P-alkalinity as CaCO3----------0.000
Total Hardness by IC----------96.747

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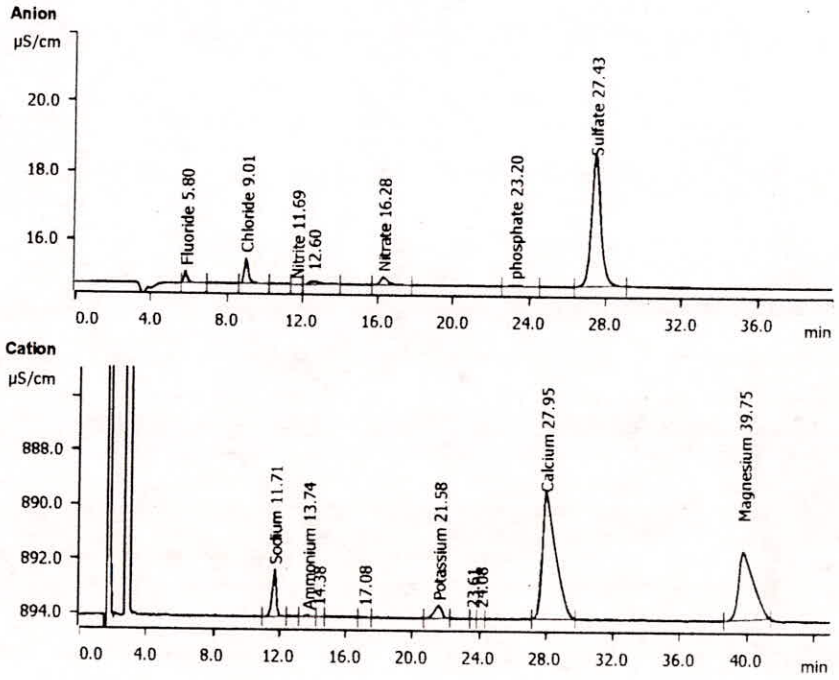

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Anion

Component name	Retention time	Height	Area	Concentration
	min	µS/cm	(µS/cm) x min	mg/L
Fluoride	5.81	0.456	0.089	0.234
Chloride	9.01	1.060	0.249	1.016
Nitrite	11.67	0.014	0.005	0.033
Nitrate	16.24	0.307	0.131	0.945
Sulfate	27.44	7.292	4.056	23.359

Cation

Component name	Retention time	Height	Area	Concentration
	min	µS/cm	(µS/cm) x min	mg/L
Lithium	7.64	0.029	0.006	0.008
Sodium	11.70	2.674	0.724	3.229
Ammonium	13.69	0.049	0.018	0.186
Potassium	21.52	0.529	0.276	2.582
Calcium	28.01	4.562	4.136	25.882
Magnesium	39.75	2.573	2.740	7.724

% Error----------.2.455
Sample pH----------8.2
M-alkalinity as CaCO3----------74.943
P-alkalinity as CaCO3----------0.000
Total Hardness by IC----------96.360

NIH IC REPORT

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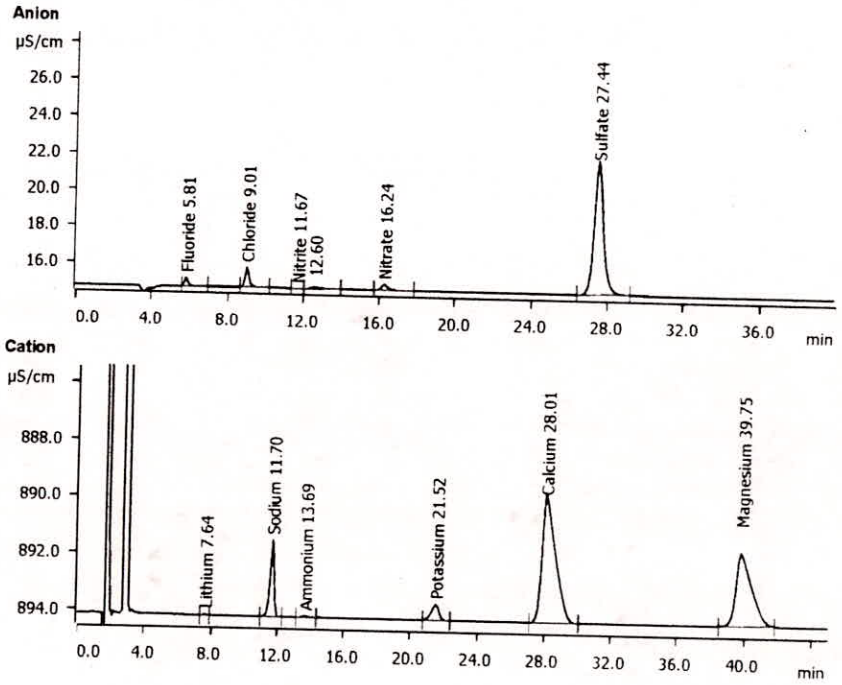

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A-5 Feb 2017 [NMSHE]

Anion

Component name	Retention time	Height	Area	Concentration
	min	µS/cm	(µS/cm) x min	mg/L
Fluoride	5.81	0.443	0.087	0.228
Chloride	9.01	1.058	0.249	1.016
Nitrite	11.65	0.014	0.005	0.033
Nitrate	16.18	0.321	0.137	0.988
Sulfate	27.44	7.058	3.924	22.602

Cation

Component name	Retention time	Height	Area	Concentration
	min	µS/cm	(µS/cm) x min	mg/L
Sodium	11.70	2.680	0.723	3.226
Potassium	21.47	0.528	0.281	2.631
Calcium	28.06	4.541	4.100	25.656
Magnesium	39.78	2.471	2.510	7.076

% Error----------.1.960
Sample pH----------8.2
M-alkalinity as CaCO3----------73.129
P-alkalinity as CaCO3----------0.000
Total Hardness by IC----------93.128

NIH IC REPORT

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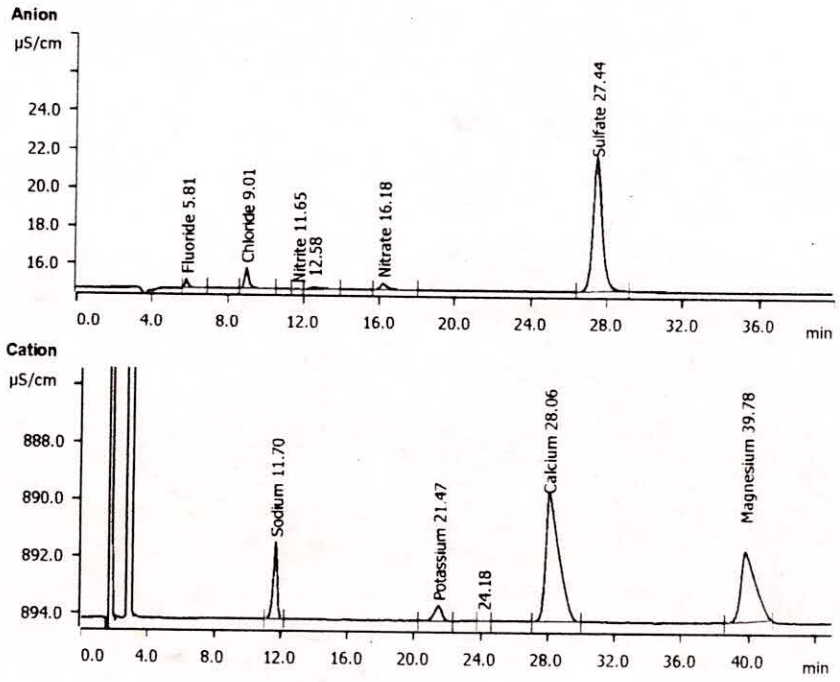

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A-6 Feb 2017 [NMSHE]

Anion

Component name	Retention time	Height	Area	Concentration
	min	µS/cm	(µS/cm) x min	mg/L
Fluoride	5.81	0.419	0.082	0.216
Chloride	9.00	1.158	0.271	1.108
Nitrite	11.63	0.015	0.006	0.039
Nitrate	16.16	0.287	0.123	0.888
Sulfate	27.47	4.153	2.329	13.416

Cation

Component name	Retention time	Height	Area	Concentration
	min	µS/cm	(µS/cm) x min	mg/L
Sodium	11.69	3.323	0.895	3.994
Ammonium	13.71	0.034	0.010	0.098
Potassium	21.46	0.496	0.264	2.473
Calcium	28.28	3.578	3.001	18.778
Magnesium	40.49	0.877	0.788	2.221

% Error----------.1.655
Sample pH----------8.0
M-alkalinity as CaCO3----------49.086
P-alkalinity as CaCO3----------0.000
Total Hardness by IC----------55.994

NIH IC REPORT

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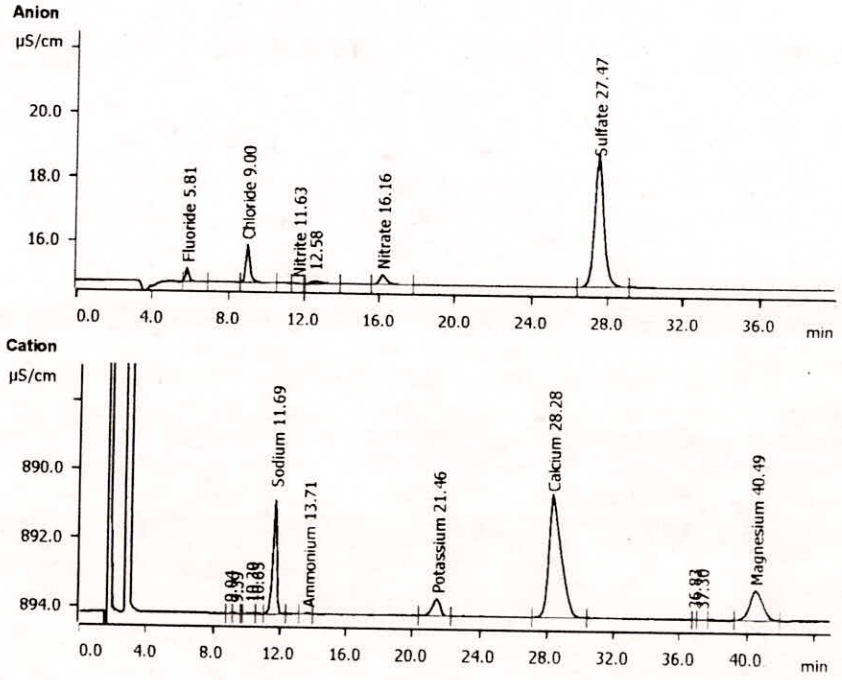

CONCLUSION

Analysis of six water samples of Alaknanda River 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 Surface water samples can be recommended for irrigation purpose.

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