5th Semester

INSTRUMENTATION AND CONTROL ENGINEERING

SUBJECT
ANALYTICAL AND ENVIORONMENTAL INSTRUMENTS

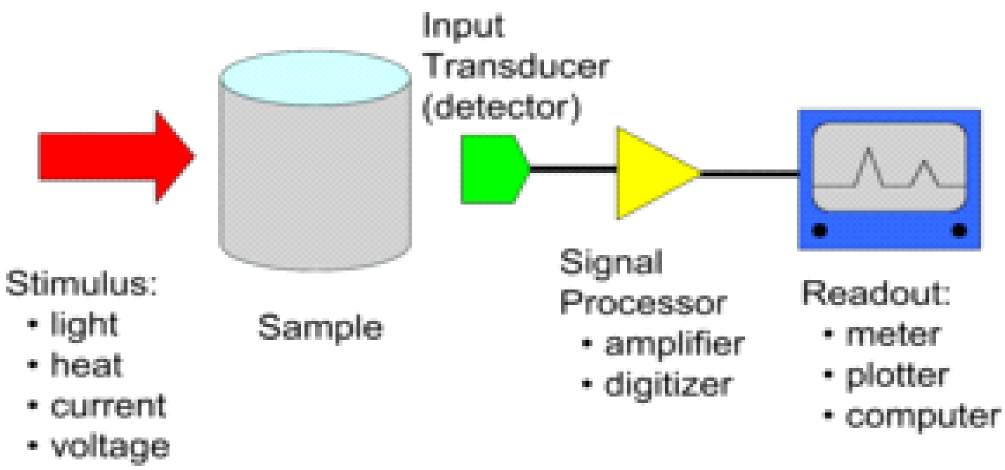
SUBJECT CODE
181552

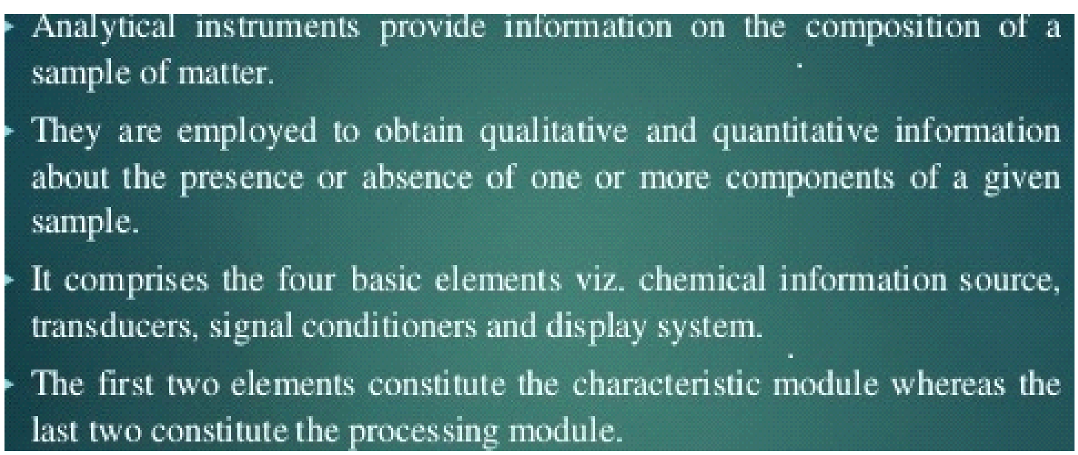
DISCLAIMER

ANALYTICAL AND ENVIORONMENTAL INSTRUMENTS (SEMESTER -5)

UNIT : 1 Introduction

- ## Fundamental blocks of analytical instruments:





Analytical instruments provide information of the composition of sample of matter. They examine things very carefully. They give information about the presence or absence of one or more components of samples. They provide quantitative data .These instruments have four basic units:

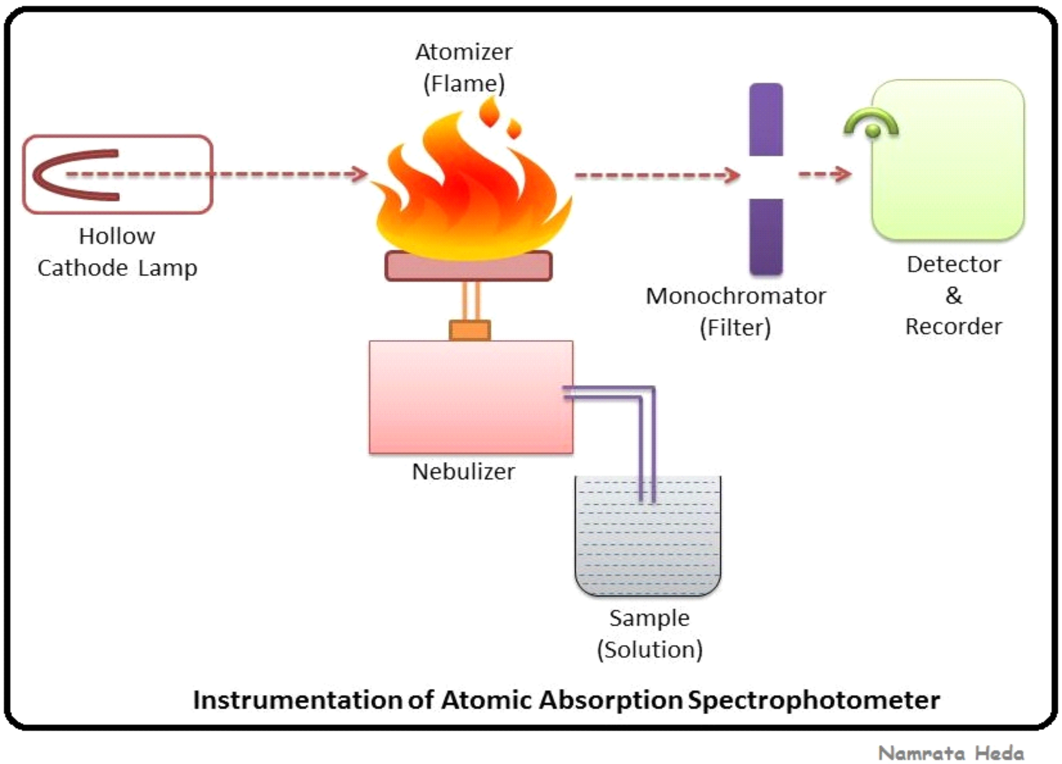
- **Chemical information source / sample** : It generates a set of signal conditioning , important information about the source which is in the sample.
- **Transducer** : It converts non – electrical quantity into electrical quantity.

  Example : Photocell and Photomultiplier tube, these are transducer that convert radiant energy into electrical energy.
- **Signal conditioner** : It converts output of transducer into an electrical quantity which is suitable for operation of display system. They help in increasing the sensitivity of instrument.
- **Display system :** It provides a variable representation of the quantity .

Unit 2 : Spectroscopic analysis

Spectroscopy : Spectroscopy is the measurement and interpretation of electromagnetic radiation absorbed or emitted when the molecules or atoms or ions of a sample moves from one energy state to another energy state.

2.1 Absorption spectroscopy :



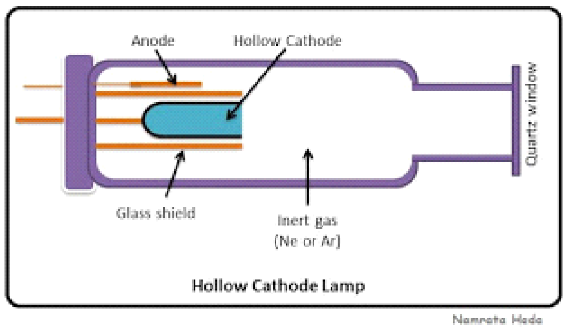
Atomic absorption spectroscopy (AAS) is similar to flame photometry with the difference that it measures the absorption of a beam of monochromatic light by the atoms in the flame.We will discuss the principle, instrumentation and applications one by one.

Principle:

The basic principle behind the AAS is that the free atoms normally remain in the ground state which are capable of absorbing the energy of their own specific resonance wavelength. If light of the resonance wavelength is passed through the flame containing the atoms (in sample), then part of the light will be absorbed. The atoms absorb UV or visible light and make the transitions to higher energy levels. The absorption will be directly proportional to the number of atoms in the ground state in the flame.

Instrumentation:

The major difference in the instrumentation of AAS and flame spectrophotometry is the presence of a radiation source (a particular resonance wavelength cannot be isolated from the continuous source using a prism or diffraction gratings). So, for this purpose, a **hollow cathode lamp** is used.



Light Source: *(Hollow Cathode Discharge Lamp):* It contains a tungsten anode and cathode (as can be seen in the diagram on the right) is a hollow cylindrical tube which is lined by the element to be determined. These are sealed in the glass tube filled with an inert gas like neon or argon at a low pressure. At the end of the cylinder is a window, made up of quartz or pyrex, transparent to the emitted radiation. Each element in question will thus emit monochromatic radiation characteristic of the emission spectrum of that particular element involved. So, each element has its own unique lamp which must be used for the analysis.

Nebulizer: It creates a fine spray of the sample for the introduction in the flame. The aerosol and the fuel and oxidant are mixed thoroughly for the introduction into the flame.

Atomizer: The elements which need to be analysed need to be in the atomic state. Here comes the role of atomizer. It breaks down the molecules into the atoms by exposing the analyte to high temperatures in a flame of graphite furnace.

Monochromator: A monochromator is used to select the specific wavelength of light which is absorbed by the sample and to exclude other wavelengths. The selection of the specific wavelength allows the determination of the element.

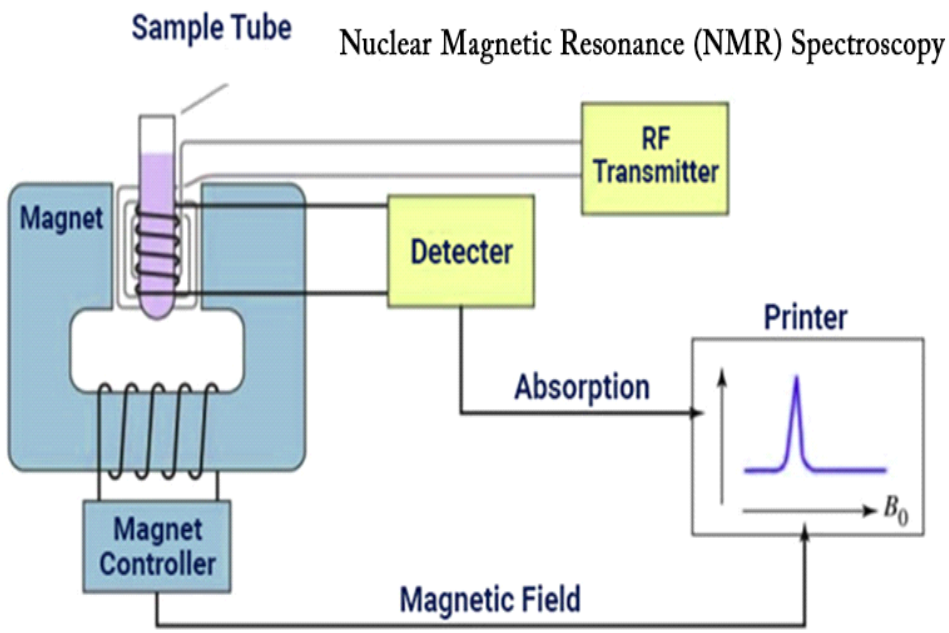
Detector: The light selected by the monochromator is directed onto the detector that typically is a photomultiplier tube that converts the light signal to electrical signal proportional to the light intensity.

Applications of Atomic Absorption Spectrometry

- It is highly sensitive technique and can measure upto parts per billion of a gram (ugdm-3)
- It is used to detect the presence of metals as impurity or in alloys.
- The minute levels of the metals could be detected in biological samples like copper in the brain tissues.
- The quantity of elements can be determined be agricultural and food products.
- It can also be used to determine the impurity in the environmental water sources like in the ocean water, river and stream water, waste water, sludge and suspensions.

2.2 NMR spectroscopy :

- Nuclear magnetic resonance spectroscopy, most commonly known as NMR spectroscopy or magnetic resonance spectroscopy (MRS), is a spectroscopic technique to observe local magnetic fields around atomic nuclei.
- It is a spectroscopy technique which is based on the absorption of electromagnetic radiation in the radio frequency region 4 to 900 MHz by nuclei of the atoms.
- Over the past fifty years, NMR has become the preeminent technique for determining the structure of organic compounds.
- Of all the spectroscopic methods, it is the only one for which a complete analysis and interpretation of the entire spectrum is normally expected.



Principle of Nuclear Magnetic Resonance (NMR) Spectroscopy

- The principle behind NMR is that many nuclei have spin and all nuclei are electrically charged. If an external magnetic field is applied, an energy transfer is possible between the base energy to a higher energy level (generally a single energy gap).
- The energy transfer takes place at a wavelength that corresponds to radio frequencies and when the spin returns to its base level, energy is emitted at the same frequency.
- The signal that matches this transfer is measured in many ways and processed in order to yield an NMR spectrum for the nucleus concerned.

Working of Nuclear Magnetic Resonance (NMR) Spectroscopy

- The sample is placed in a magnetic field and the NMR signal is produced by excitation of the nuclei sample with radio waves into nuclear magnetic resonance, which is detected with sensitive radio receivers.
- The intramolecular magnetic field around an atom in a molecule changes the resonance frequency, thus giving access to details of the electronic structure of a molecule and its individual functional groups.
- As the fields are unique or highly characteristic to individual compounds, NMR spectroscopy is the definitive method to identify monomolecular organic compounds.
- Besides identification, NMR spectroscopy provides detailed information about the structure, dynamics, reaction state, and chemical environment of molecules.
- The most common types of NMR are proton and carbon-13 NMR spectroscopy, but it is applicable to any kind of sample that contains nuclei possessing spin.

Instrumentation of Nuclear Magnetic Resonance (NMR) Spectroscopy

- Sample holder

Glass tube with 8.5 cm long, 0.3 cm in diameter.

- Permanent magnet

It provides homogeneous magnetic field at 60-100 MHZ

- Magnetic coils

These coils induce magnetic field when current flows through them

- Sweep generator

To produce the equal amount of magnetic field pass through the sample

- Radio frequency transmitter

A radio transmitter coil transmitter that produces a short powerful pulse of radio waves

- Radio frequency receiver

A radio receiver coil that detects radio frequencies emitted as nuclei relax to a lower energy level

- Read out systems

A computer that analyses and record the data.

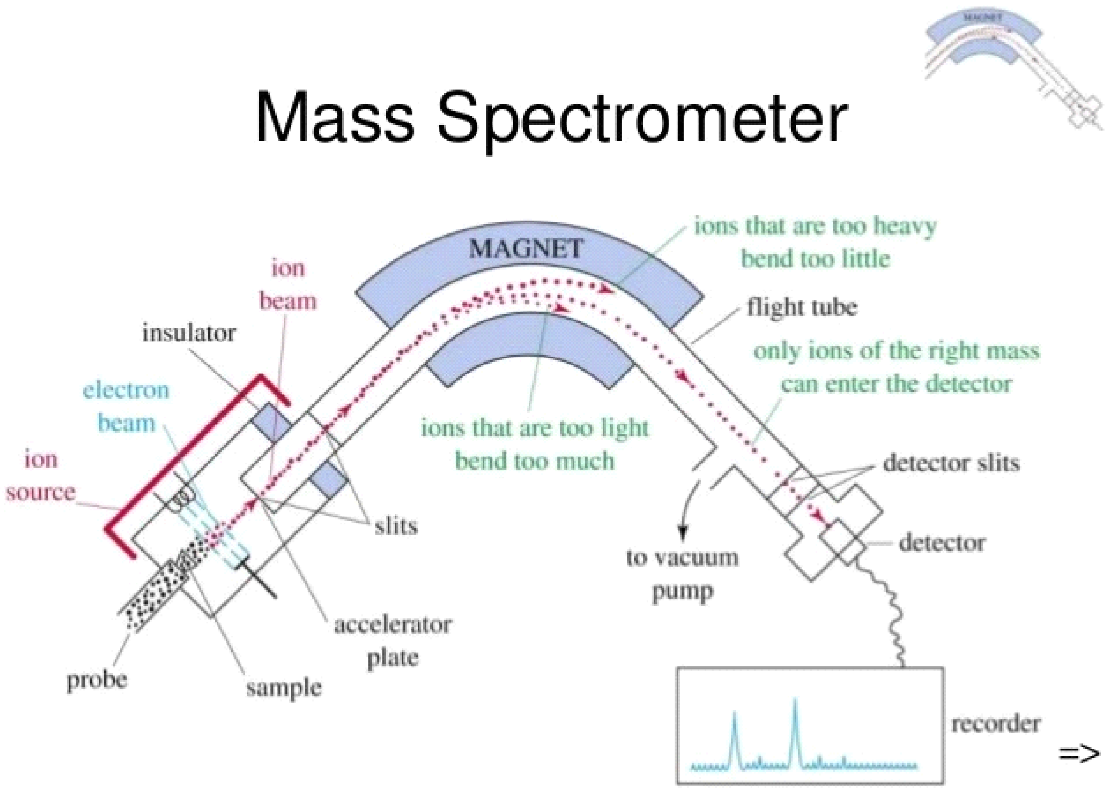
Applications of Nuclear Magnetic Resonance (NMR) Spectroscopy

Spectroscopy is the study of the interaction of electromagnetic radiation with matter. NMR spectroscopy is the use of the NMR phenomenon to study physical, chemical and biological properties of matter.

- It is an analytical chemistry technique used in quality control.
- It is used in research for determining the content and purity of a sample as well as its molecular structure. For example, NMR can quantitatively analyze mixtures containing known compounds.
- NMR spectroscopy is routinely used by chemists to study chemical structure using simple one-dimensional techniques. Two-dimensional techniques are used to determine the structure of more complicated molecules.
- These techniques are replacing x-ray crystallography for the determination of protein structure.
- Time domain NMR spectroscopy techniques are used to probe molecular dynamics in solution.
- Solid state NMR spectroscopy is used to determine the molecular structure of solids.
- Other scientists have developed NMR methods-of measuring diffusion coefficients.

2.3 Mass spectroscopy

Mass spectrometer is an apparatus for measuring the masses of isotopes, molecules, and molecular fragments by ionizing them and determining their trajectories in electric and magnetic fields.



Mass Spectrometers can be divided into three convenient parts:

The Ionization Chamber: “Ionization” simply refers to the creation of ions or charged particles. This is the most important part as only charged particles are detected by the Mass Analyzer. Often times this is done in a vacuum but can also be done at ambient pressure. There are many different techniques of Ionization and this one of the huge research areas within the field right now. Different Ionization techniques include: MALDI, ESI, EI, CI etc.

The Mass Analyzer: Since all these particles are charged a magnet arcs (not really; nowadays other techniques are used to simply create a magnetic field but the principles still apply!) the particles. This separates particles using the molecular mass (in reality it separates them by m/z ratio), as smaller particles reach the mass analyzer quicker and larger ones later. The mass-analyzer generally used nowadays is called a quadrupole mass analyzer.

The Mass Detector: These are generally large metal plates that detect the ions. The technicalities of how the the metal plate converts those signals to spectrums is quite complicated and would require a lot of math. In essence, the computer is programmed to reverse engineer using the arc lengths created.

Applications of Mass Spectrometry

Pharmaceutical analysis
- Bioavailability studies
- Drug metabolism studies, pharmacokinetics
- Characterization of potential drugs
- Drug degradation product analysis
- Screening of drug candidates
- Identifying drug targets

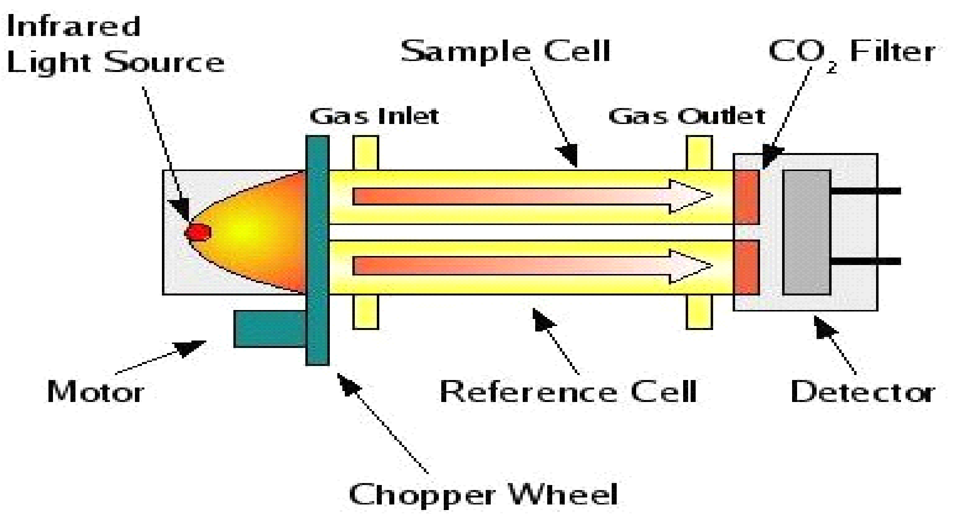
Biomolecule characterization
- Proteins and peptides
- Oligonucleotides

Environmental analysis
- Pesticides on foods
- Soil and groundwater contamination

Forensic analysis/clinical

Unit 3 Gas analysis

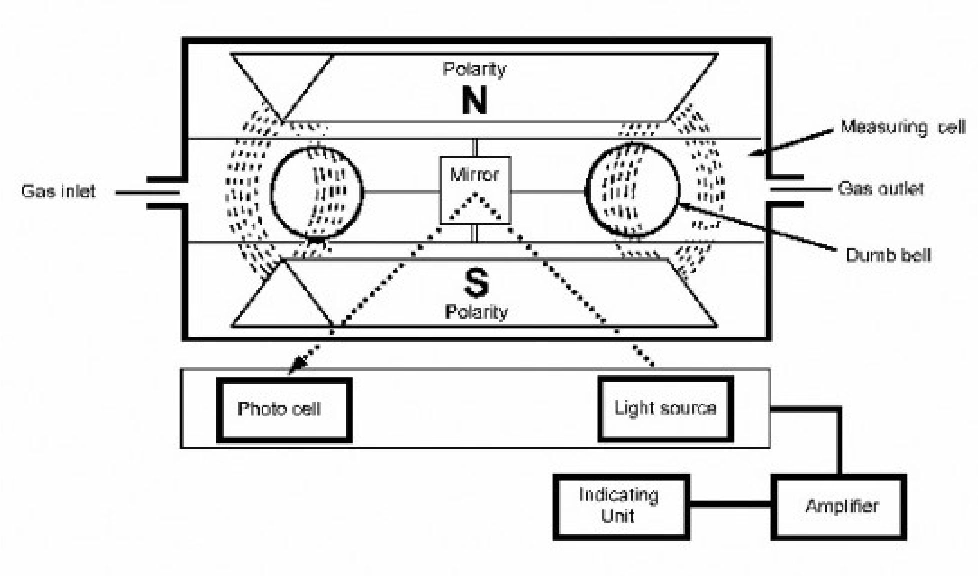
3.1 Infra-red gas analyzer :



Infrared Gas Analyzer depend on the fact that some gases and vapors absorb particular wavelength of infrared radiations . We can test large no of components and gases like carbon dioxide , carbon monoxide, sulphur dioxide , water , nitric acid.

In a simple NDIR instrument, Infrared energy passes through two identical tubes and falls on a detector. The first tube is the reference cell and is filled with a non-absorbing gas such as nitrogen. The second tube is the measurement cell and contains the gas sample to be analyzed. The IR Source continuously sends an IR waves through the gas tubes and detector measures the intensity of two different wavelengths, one at the sample gas absorption wavelength and the other is at reference gas absorption wavelength. As the reference gas generally contains nitrogen so the detector receives 100% signal. If the CO2 gas is present in sample gas means the received signal will be attenuated at the detector side. The detector measures these two signals and their difference is proportional to the amount of absorbing gas in the sample cell .i.e. CO2 gas. So Finally the CO2 gas concentration is measured with the difference in absorption of IR radiation in the sample and reference cells. CO2 gas concentration measuring unit is ppm.

3.2 Paramagnetic oxygen analyzers



Oxygen is a paramagnetic gas and is attracted into a strong magnetic field. Because this measurement is a purely physical effect, nothing is consumed and in principle the cell has an unlimited life. However, contamination of the cell by dust, dirt, corrosives or solvents can lead to deterioration. Measurement range is typically 0.05% to 100% O_2.

Theory

The operating principle of the paramagnetic sensor is the paramagnetic susceptibility of the oxygen molecule, a physical property which distinguishes oxygen from most other gases.

The sensor incorporates two nitrogen-filled glass spheres mounted on a rotating suspension. This assembly is suspended in a strong magnetic field. The oxygen in the surrounding gas is attracted to the magnetic field, resulting in a force on the glass spheres. The strength of the torque acting on the suspension is proportional to the oxygen content of the surrounding gases

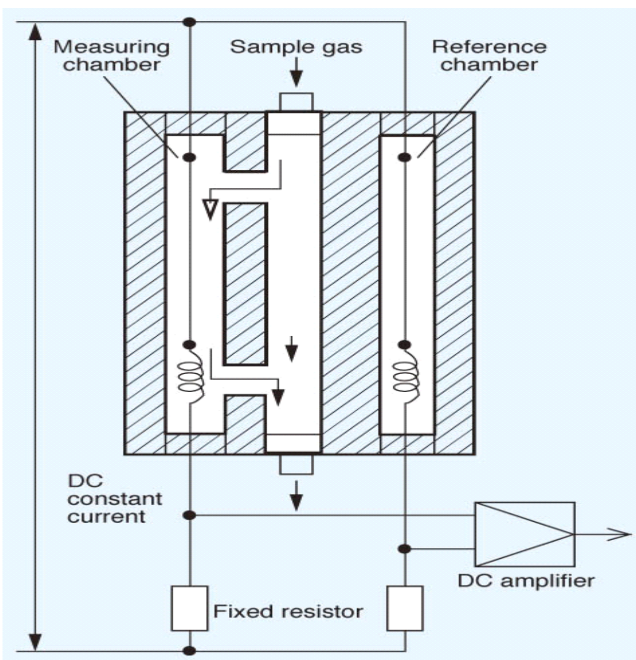
Principle of Operation : The measuring system is “null-balanced”. First the “zero” position of the suspension assembly, as measured in nitrogen, is sensed by a photo-sensor that receives light reflected from a mirror attached to the suspension assembly. The output from the photo-sensor is fed back to a coil around the suspension assembly. This feedback achieves two objectives.

First, when oxygen is introduced to the cell, the torque acting upon the suspension assembly is balanced by a re-storing torque due to the feedback current in the coil. The feedback current is directly proportional to the volume magnetic susceptibility of the sample gas and hence, after calibration, to the partial pressure of oxygen in the sample. Therefore, the current gives an accurate measurement of the concentration of oxygen in the gas mixture.

Second, the electromagnetic feedback “stiffens” the suspension, damping it heavily and increasing its natural frequency, making the suspension resilient to shock

Application	**Uses**
Gas Producers	for ensuring product quality; monitoring for oxygen purity or by measuring for an oxygen impurity.
Gas Users	or ensuring product quality to ensure reliability of inert gas blankets to monitor for oxygen in contaminated gas streams.
Food Packaging	to ensure sufficient oxygen is present in a working atmosphere where the atmosphere can become oxygen deficient.

3.3 Thermal conductivity analysis



Thermal conductivity analyser

Thermal conductivity : The thermal conductivity of a material is a measure of its ability to conduct heat.

Principle : This thermal conductivity gas analyzer measures gas concentration by utilizing the difference of thermal conductivities between two gas components.

Working : In the detector, there are a reference chamber and a measuring chamber, in each of which a thin platinum wire is stretched. The reference chamber is filled with reference gas. The sample gas is flowed through the measuring chamber. Each platinum wire composes a bridge circuit in combination with an external fixed resistor, and is heated by flowing a constant current. When there is a change in the concentration of the component under measurement, the thermal conductivity of sample gas will change to affect the temperature of the platinum wire in the measuring chamber. The resulting thermal change is taken out as a change in electric resistance, according to which the concentration of measured gas is calculated.

Applications :

- H_2 monitoring in semiconductor manufacturing equipment, hydrogen generation equipment, calcining furnaces
- Ar, He, CH_4 measurement in gas generation plants
- He measurement in superconducting devices
- Ar measurement in air-separation plants

UNIT -4 GAS CHOMATOGRAPHY

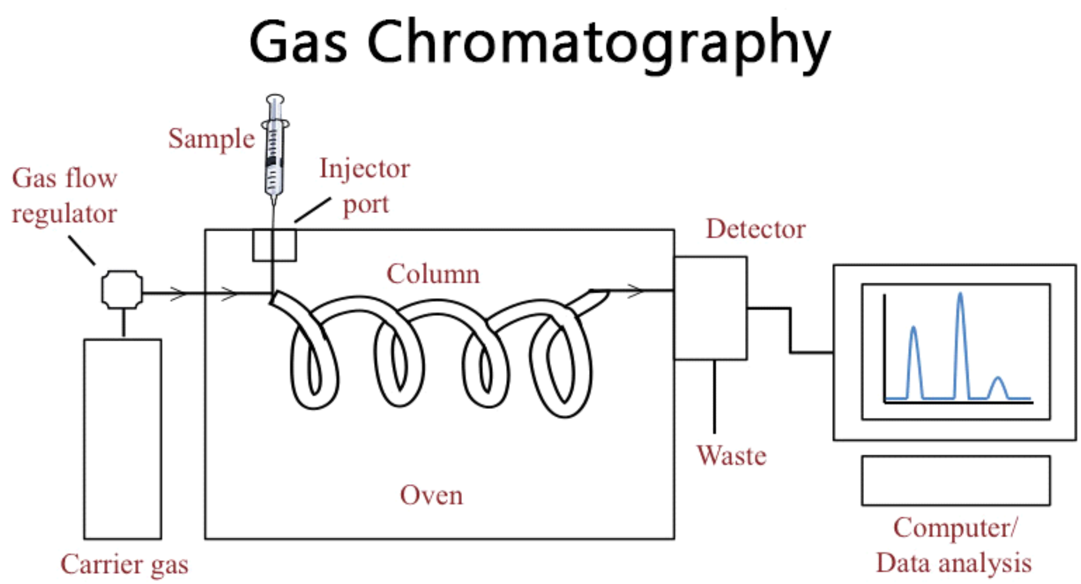
• Introduction

Gas chromatography differs from other forms of chromatography in that the mobile phase is a gas and the components are separated as vapors.

It is thus used to separate and detect small molecular weight compounds in the gas phase.

The sample is either a gas or a liquid that is vaporized in the injection port. The mobile phase for gas chromatography is a carrier gas, typically helium because of its low molecular weight and being chemically inert.

The pressure is applied and the mobile phase moves the analyte through the column. The separation is accomplished using a column coated with a stationary phase.



Principle : The sample solution injected into the instrument enters a gas stream which transports the sample into a separation tube known as the "column." (Helium or nitrogen is used as the so-called carrier gas).

- **Instruments : injectors, oven, column and detectors**

Injectors : Injector, a device for injecting liquid fuel into an internal-combustion engine. ... The term is also used to describe an apparatus for injecting feed water into a boiler. In gas chromatography :

- Liquid samples are injected by a microsyringe with a needle inserted through a self-scaling, silicon-rubber septum into a heated metal block by a resistance heater.
- Gaseous samples are injected by a gas-tight syringe or through a by-pass loop and valves.
- Typical sample volumes range from 0.1 to 0.2 ml.

Columns :

- The heart of the gas chromatography is the column which is made of metals bent in U shape or coiled into an open spiral or a flat pancake shape.
- Copper is useful up to 250^0
- Swege lock fittings make column insertion easy.
- Several sizes of columns are used depending upon the requirements.

Detector

- Detectors sense the arrival of the separated components and provide a signal.
- These are either concentration-dependent or mass dependant.
- The detector should be close to the column exit and the correct temperature to prevent decomposition.

Oven

The oven is a special feature present in Gas Chromatography where absent in other chromatography systems. This basically fulfill two main requirements, first is that column is installed in the oven. Second is adjusting a suitable environment for the chromatogram development.

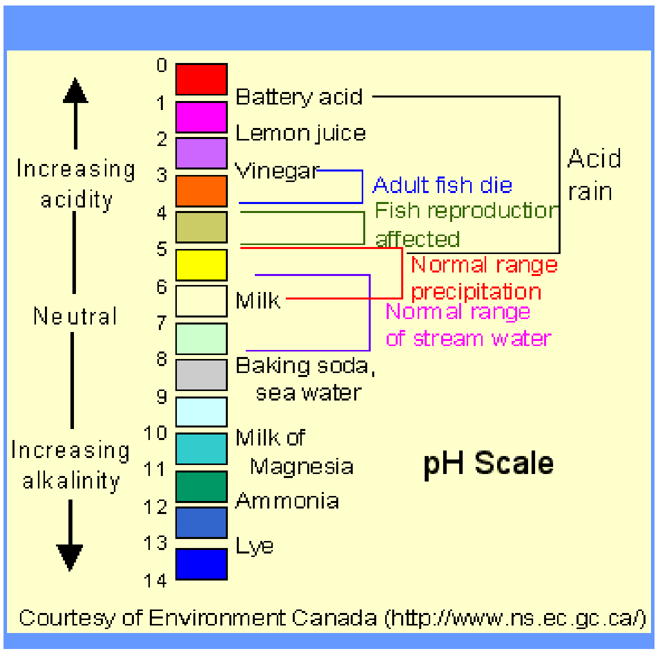
The column temperature must be uniform throughout the time period until the components are eluted out. Thus to maintain the temperature of the column the oven is an essential system in a GC.

The oven has three functions: It keeps the column temperature constant. It allows operation at elevated temperature (faster; perhaps necessary to vaporize the sample).

UNIT – 5 Liquid Analysis

5.1 Principle of pH measurement :

Ph Value : pH is a measure of how acidic/basic water is. The range goes from 0 to 14, with 7 being neutral. pHs of less than 7 indicate acidity, whereas a pH of greater than 7 indicates a base. pH is really a measure of the relative amount of free hydrogen and hydroxyl ions in the water.



Principle of pH measurement : pH Measurement specifies the degree of relative acidity or alkalinity of an aqueous solution at a given temperature. It is generally measured using a pH Meter. All living beings depend on a proper pH level to sustain life and hence pH Measurement becomes an important aspect of our lives.

How is pH Measurement Done :

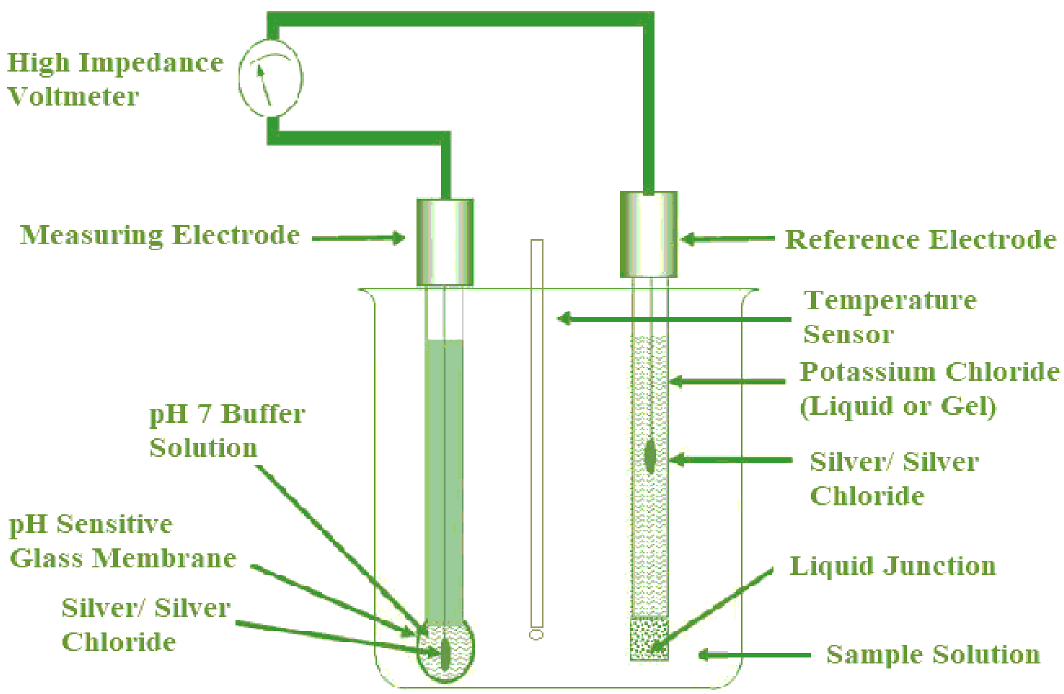
Generally, pH Measurement is obtained precisely using a pH Meter. It has few key components namely Measuring Electrode, Reference Electrode, Temperature Sensor and the Sample Solution being measured. The pH Meter measures the voltage of an electro chemical cell and based on the Temperature Sensor determines the pH of a solution. Off late, in most of the pH Meters the electrodes and the Temperature Sensor are fabricated into a single body and are called as Combination Electrodes. Fig. 3 shows pH Measurement using

Measuring Electrode made of glass, Reference Electrode, Temperature Sensor and Liquid junction.

The overall potential or the voltage is the algebraic sum of the potentials of the Measuring Electrode, Reference Electrode and the Liquid Junction. The Reference Electrode provides a stable voltage as it has a fixed concentration of Potassium Chloride solution which is a neutral solution. On the contrary, the potential of the Measuring Electrode depends only on the pH of the solution. The potential difference (voltage) between a glass membrane of Measuring Electrode and a Reference Electrode which is dipped in the Sample Solution to be tested is measured.

When the two Electrodes are dipped in the Sample Solution, ion-exchange process occurs where in some of the Hydrogen ions move towards the outer surface of the Measuring Electrode and replace some of the metal ions inside it. Similarly, some of the metal ions move from the Glass Electrode into the Sample Solution. The sensitivity of the Reference Electrode potential to changes in pH is negligible or it is unaffected by changes in pH and hence provides a stable voltage.

Ion-exchange process also takes place on the inner surface of the Glass Electrode from the sample solution. This creates a potential difference (Hydrogen- ion activity) between them. The Liquid Junction potential is usually small and relatively constant which mainly depends on the concentration of the ions in the sample solution. All three potentials are summed up and measured by High Impedance Voltmeter.



Applications of pH Measurement

The applications include:

- pH Measurement is very crucial in Agriculture industry for soil evaluation. Major crops require alkaline environment and hence pH Measurement becomes necessary.
- It is also used in Food industry especially for dairy products like cheese, curds, yogurts, etc.
- It becomes mandatory for chemical and pharmaceutical industries.
- It becomes a significant factor in the production of detergents.
- pH level monitoring is essential in water treatment plants and RO water purifiers.

Advantages of pH Measurement

The advantages are:

- pH Measurement is inexpensive and robust.
- Pocket size pH Meters are user friendly.
- Readings are accurate and precise.

Disadvantages of pH Measurement

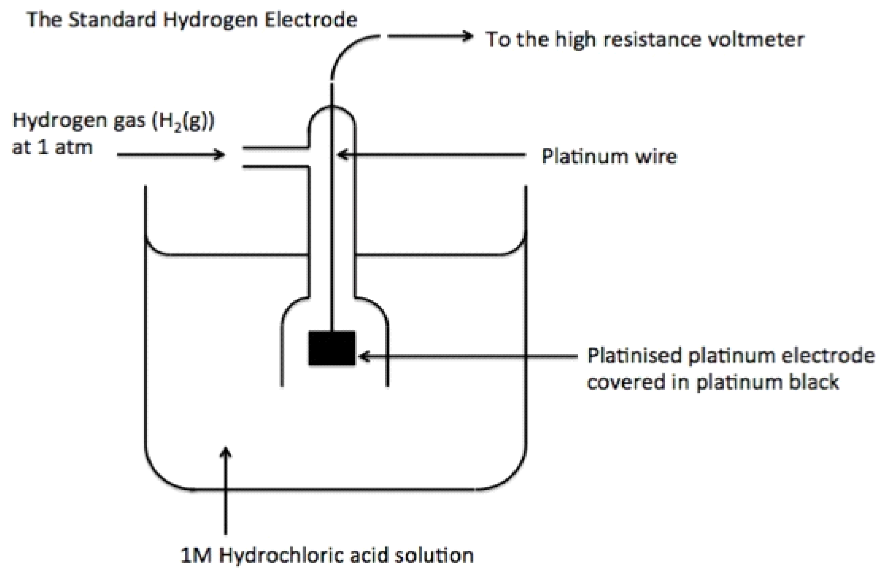
The disadvantages are:

- Temperature impacts the output readings.
- pH Measurement using glass electrodes must be clean as deposition on the electrodes affects the readings.

5.2 Electrodes used for pH measurement

To measure the pH of a solution the electrodes are used as probes , they are dipped into test solution and held there so that hydrogen ions in test solution becomes equal to the ions on surface of bulb or glass electrode .There are two types of electrode for pH measurement .

- **Hydrogen Electrode :**



The hydrogen electrode potential is declared to be 0 at a temperature of 298K. This is because it acts as a reference for comparison with any other electrode .

The redox half cell of the hydrogen electrode is where the following reaction takes place:

$2H^+ (aq) + 2e^- \rightarrow H_2 (g)$

The reaction given above generally takes place on a platinum electrode. The pressure of the hydrogen gas present in this half cell equals 1 bar.

Use of Platinum in the Hydrogen Electrode:

Platinum is used in the Standard Hydrogen Electrode due to the following reasons:

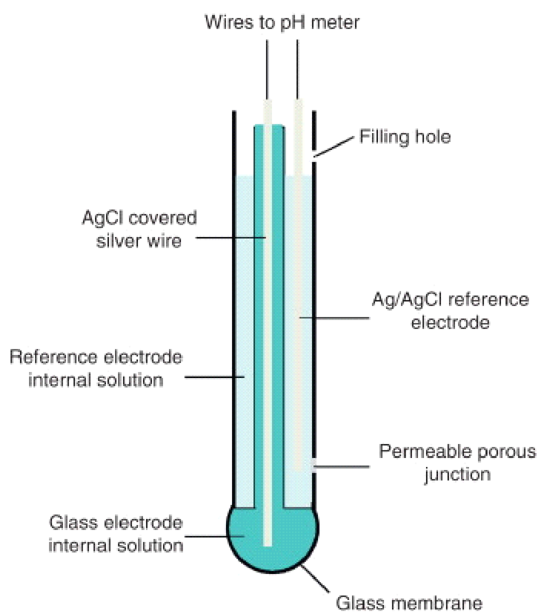
- Platinum is a relatively inert metal which does not corrode easily.
- Platinum has catalytic qualities which promotes the proton reduction reaction.
- The surface of platinum can be covered with platinum black, a fine powder of platinum. This type of platinum electrode is called a platinized platinum electrode.
- Platinum also improves the reaction kinetics by adsorbing hydrogen at the interface.

Hydrogen Electrode Construction:

The parts that make up a Hydrogen Electrode are listed below.

- A platinum electrode which is covered in finely powdered platinum black (platinized platinum electrode).
- A hydrogen Blow.
- A solution of acid having a H^+ molarity of 1 mole per cubic decimeter.
- The SHE also contains a hydroseal which is used to prevent the interference of oxygen.
- The other half-cell of the entire Galvanic cell must be attached to the Standard Hydrogen Electrode through a reservoir in order to create an ionically conductive path. This can be done through a direct connection, through a narrow tube, or even through the use of a salt bridge.

- **Glass Electrode :**



Glass electrode is a hydrogen-ion responsive electrode usually consisting of a bulb, or other suitable form, of special glass attached to a stem of high resistance glass complete with internal reference electrode and internal filling solution system. Glass electrode is also available for the measurement of sodium ions.

The glass electrode, which consists of a thin wall glass bulb, has an extremely high electrical resistance. The membrane of a typical glass electrode (with a thickness of 0.03 mm to 0.1 mm) has an electrical resistance of 30 MΩ to 600 MΩ. The surface of a glass membrane must be hydrated before it will function as a pH electrode. When a glass surface is immersed in an aqueous solution then a thin solvated layer (gel layer) is formed on the glass surface in which the glass structure is softer. This applies to both the outside and inside of the glass membrane.

he simplest explanation for the working of the thin glass electrode is that the glass acts as a weak acid (Glass-H).

Glass-H $\rightarrow\leftarrow$ $Glass^{-} + H^{+}$

The hydrogen ion activity of the internal solution is held constant. When a solution of different pH from the inside comes in contact with the outside of the glass membrane, the glass is either deprotonated or protonated relative to the inside of the glass. The difference in pH between solutions inside and outside the thin glass membrane creates electromotive force in proportion to this difference in pH.

Advantages of glass electrode :

- Fast response .
- It is reliable.
- A long life.

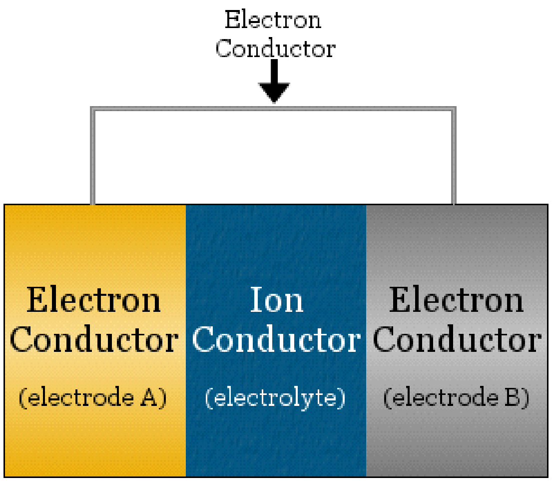
Disadvantages of glass electrode :

- Glass membrane can be easily broken.
- Measuring solution contains that type of particles that can damage the glass.

UNIT – 7 Electrochemical Instruments

7.1 Electro chemical cell :

At its simplest, an electrochemical cell consists of two electron conductors separated by an ionic conductor and linked by an electron conductor.



- the ionic conductor is called the electrolyte
- the electron conductors separated by the electrolyte are called electrodes
- the electron conductor used to link the electrodes is often a metal wire, such as copper wiring

Two Types of Cell

There are two fundamental types of electrochemical cell: galvanic and electrolytic.

Galvanic cells convert chemical potential energy into electrical energy.

The energy conversion is achieved by spontaneous ($\Delta G < 0$) redox reactions producing a flow of electrons.

Electrolytic cells are driven by an external source of electrical energy.

A flow of electrons drives non-spontaneous ($\Delta G \geq 0$) redox reactions.

Examples

- A battery powering something is an example of a galvanic cell.
- Rechargeable batteries are examples of both types of cell: they operate as galvanic cells when they are powering a device and as electrolytic cells when they are being recharged.
- Examples of electrolytic cells also include those used to split water into hydrogen and oxygen, and those that convert aluminum ore to aluminum metal.

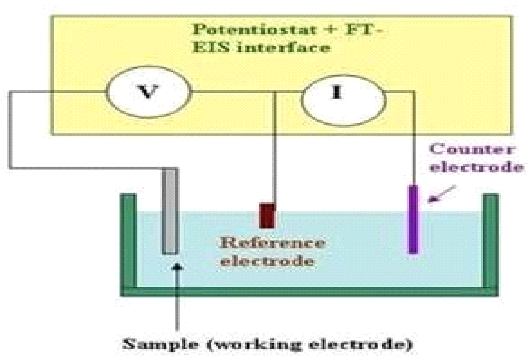
. Electrochemical cells can:

- supply electricity, or
- convert metal ores to the metal, or
- provide thermodynamic data,

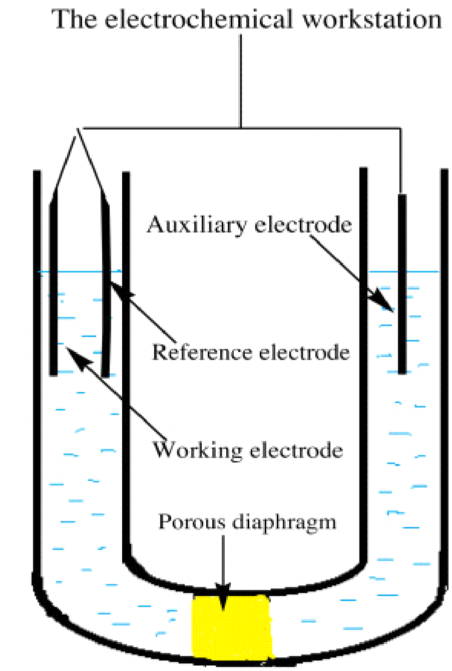
7.2 Types of electrodes

A wide variety of electrodes are used for different electro chemical techniques. Basically, they can be classified as working electrode, auxillary electrode , reference electrode.

- **Working electrode :** The working electrode is the electrode in an electrochemical system on which the reaction of interest is occurring. The working electrode is often used in conjunction with an auxiliary electrode, and a reference electrode in a three electrode system.



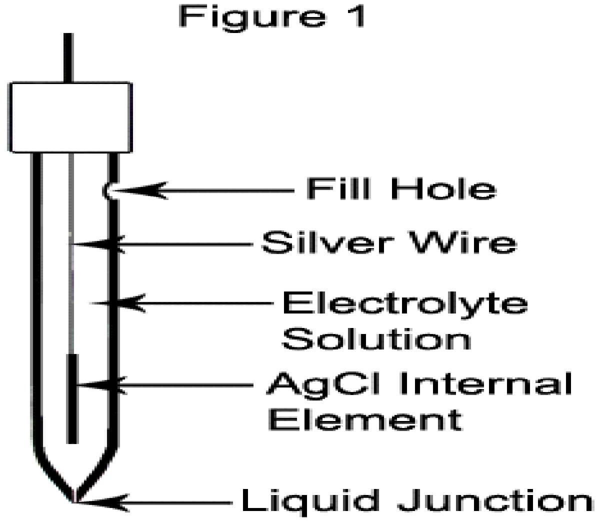
- **Auxiliary electrode** : The auxiliary electrode, often also called the counter electrode, is an electrode used in a three electrode electrochemical cell for voltammetric analysis or other reactions in which an electric current is expected to flow.



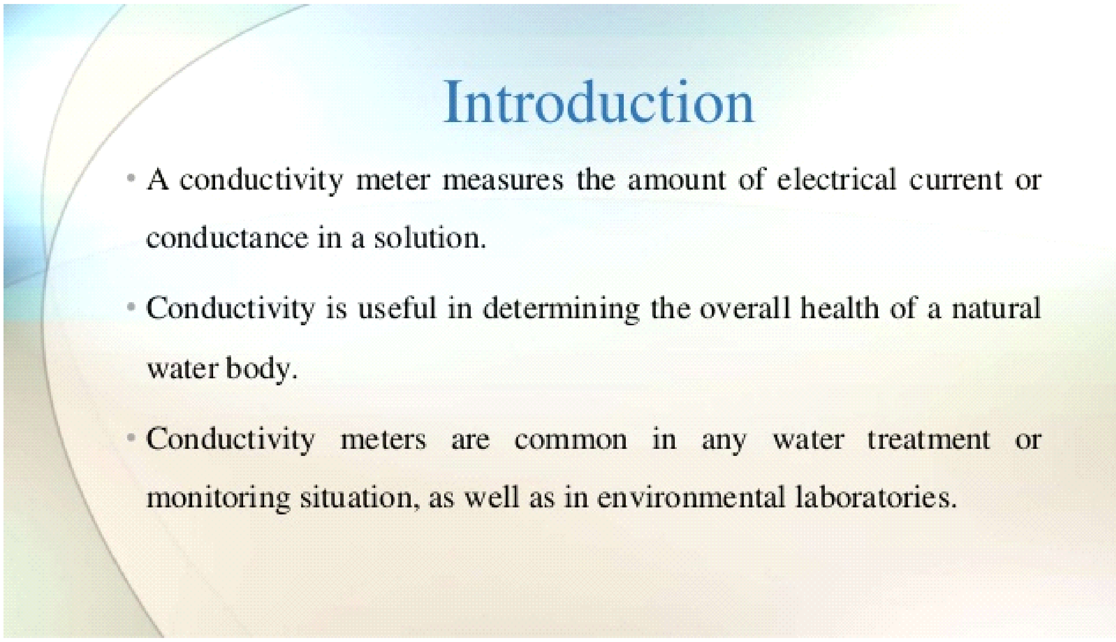
- **Reference Electrode** :

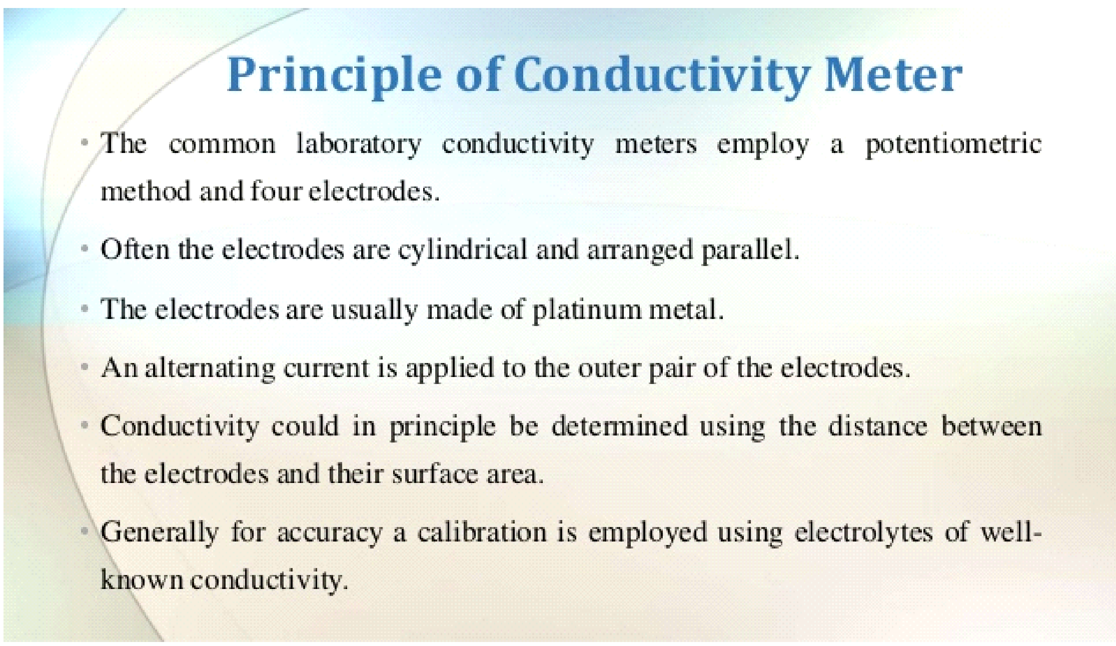
  An electrode having an accurately maintained potential, used as a reference for measurement by other electrodes.

Figure 1



7.3 Conductivity meters





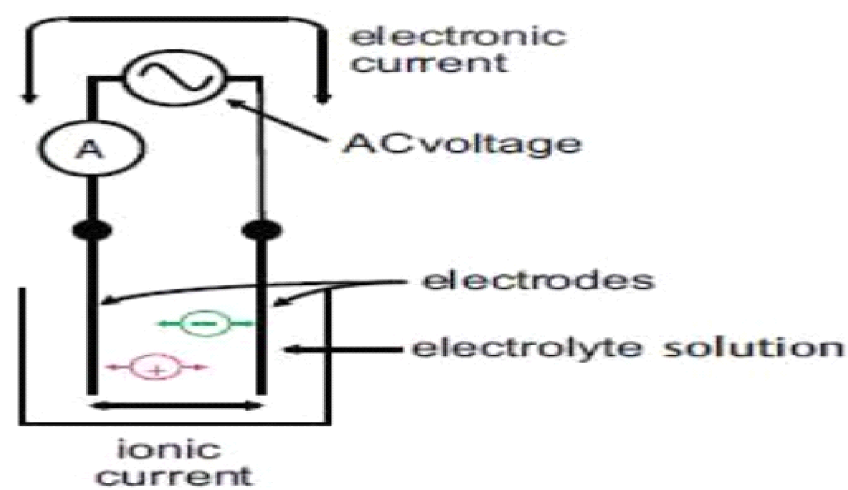
Conductivity Meter Types

Two types of conductivity meters use in industry and Laboratory

- **Contacting-type Conductivity Meter**
- **Inductive Conductivity Meter**

Contacting-type Conductivity Meter

- Most contacting conductivity sensors consist of two metal electrodes.
- Usually stainless steel or titanium, in contact with the electrolyte solution.
- The analyzer applies an alternating voltage to the electrodes.
- The electric field causes the ions to move back and forth producing a current.
- The charge carriers are ions, the current is called an ionic current.



Temperature Dependence

- The conductivity of a solution is highly temperature dependent therefore it is important to either use a temperature compensated instrument.
- Calibrate the instrument at the same temperature as the solution being measured.
- The conductivity of common electrolytes typically increases with increasing temperature.
- Over a limited temperature range, the way temperature affects the conductivity of a solution.

Conductivity Meter Applications

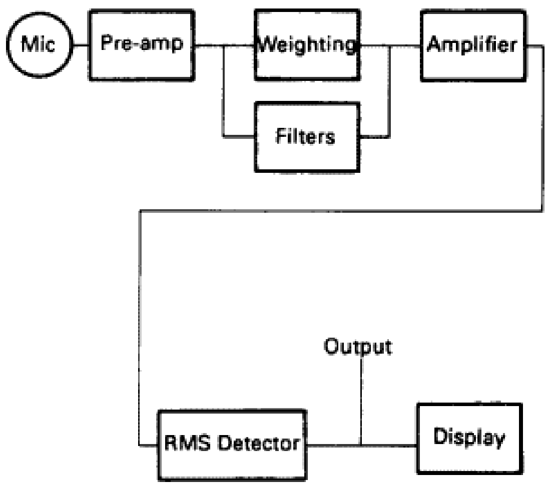
- The instrument is used in concentration Measurement. This is the simplest and one of the most widely used applications.
- Conductivity meters are also used in Leakage detection.
- Water used for cooling in heat exchangers and surface condensers.
- Heat exchangers contains large amounts of dissolved ionic solids.
- Leakage of the cooling water can result in potentially harmful contamination.

UNIT : 8 Instrumentation used for water and noise pollution and their monitoring

Noise Pollution monitoring :

Noise pollution is measured by a sound level meter. It is an instrument that measure sound pressure. It is commonly used in industrial and environmental pollution studies .Sound is an oscillation in the air ,it travels as a wave of pressure increasing or decreasing . The strength of pressure waves determines the volume of sound . Sound volume is usually measured in decibels (dB).

Sound level meter :



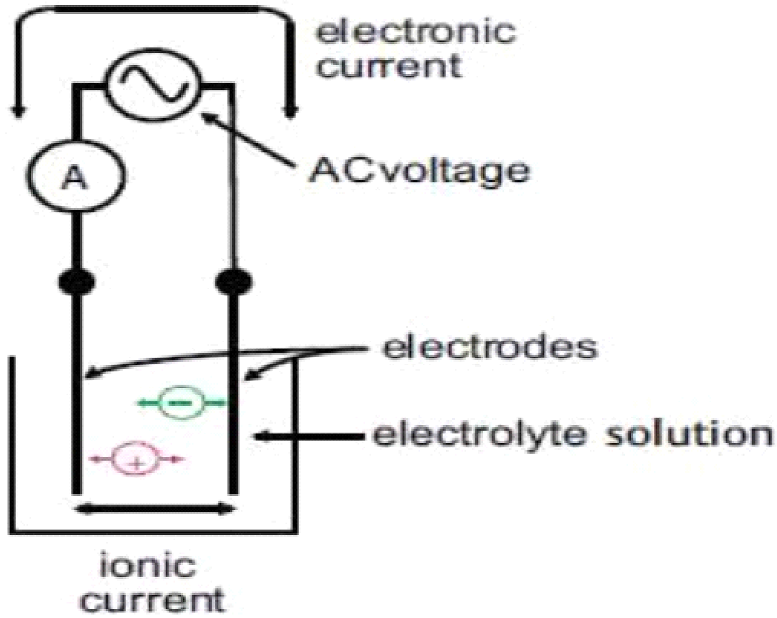
The simplest sound level meter consists of a microphone, an amplifier and a meter of some type. Microphone samples and measures the sound. The stick keeps the microphone away from the body of instrument , and gives accurate measurement. Inside the square box , there is a electronic circuit that measures the sound detected by microphone. The sound detected is amplified , filtered and display the reading on DPM.

Water pollution monitoring :

The water pollution is a type of pollution which is spread due to mixture of unwanted materials in the water . These pollutants may be solid or gases. If we want to keep our water clean ,then there are many process that we can follow in our everyday life .

The different type of water pollution monitoring are :

- Coductivity meter : Coductivity is measure of dissolved ions present in water . Conductivity is temperature dependant and its more than standard value which is 26 degree Celsius .A sudden increase in conductivity is an indication of pollution by strong acid ,base and other highly ionized substances.



- TDS (total dissolved solid) : The TDS is a measure of combine contact of organic and inorganic substance present in a solution . The principle application of TDS is the study of water quality of rivers ,lakes etc . The principle method of measuring TDS is conductivty . Electrical conductivity of water is directly related to the concentration of dissolved ionized solids in the water .