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GAS CHROMATOGRAPHY AS A CHROMATOGRAPHIC TECHNIQUE.

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Abstract:
Gas chromatography (GC or GLC) is a commonly used analytical technique as part of many research and industrial research facilities for quality control and in addition identification and quantification of components in a mixture. GC is also a technique used as part of many environmental and forensic laboratories because it takes into account the detection of very small amounts. A wide variety of assays can be analyzed as long as the compounds are sufficiently thermally stable and reasonably volatile. In gas chromatography (GC), the mobile phase is an inert gas (e.g. helium). The stationary stage is a thin layer of inert fluid on an inert solid support—for example, silica beads pressed into a long, thin tube (this adaptable tube is usually coiled inside a thermostatically controlled oven to maintain a constant temperature. As chromatography (GC) is a common analytical technique used to separation and analysis of volatile and semi-volatile compounds in a mixture. GC is a popular analytical technique because it combines exceptional resolution with speed and sensitivity. It is widely used in many industries, including environmental, petroleum, chemical, food and beverage, and pharmaceutical industries. In in gas chromatography, the stationary phase is either a solid adsorbent, called gas-solid chromatography (GSC), or a liquid adsorbed on an inert support, called gas-liquid chromatography (GLC, or just GC).

Key words: Gas chromatogram, Column, Detector, Stationary phase, Volatile, Forensic, Research, Partition, Inert gases.

Introduction: Gas chromatography (GC) is an analytical technique used to separate the chemical components of a sample mixture and then detect them to determine their presence or absence and/or quantity. These chemical components are usually organic molecules or gases. Gas chromatography is also sometimes known as vapor phase chromatography (VPC) or gas-liquid partition chromatography (GLPC). These alternative names, as well as their respective abbreviations, are often used in the scientific literature Gas chromatography is the process of separating compounds in a mixture by injecting a gaseous or liquid sample into a mobile phase, usually called a carrier gas, and passing the gas through the stationary phase. The mobile phase is usually an inert gas or a non-reactive gas such as helium, argon, nitrogen or hydrogen. The stationary phase is a microscopic layer of viscous liquid on the surface of solid particles on an inert solid support inside a piece of glass or metal tubing called a column. The surface of solid particles can also act as a stationary phase in some columns. A glass or metal column through which the gas phase passes is placed in an oven where the gas temperature can be controlled and the eluent exiting the column is monitored by a computerized detector.

Principle : In gas-solid chromatography, a solid adsorbent is used as the stationary phase and the separation takes place through an adsorption process, while in gas-liquid chromatography the stationary phase consists of a thin layer of non-volatile liquid bound to a solid support and the separation takes place through a partition process. Gas-liquid chromatography is the most commonly used technique. The sample to be separated is first vaporized and thus mixed with the gaseous mobile phase. Sample components that are more soluble in the stationary phase move slower and components that are less soluble in the stationary phase move faster. The components are thus separated according to their partition coefficient.

TOOLS: A good gas chromatography instrument contains the following important components: 1. Pressure regulator
2. Sample injection port
3. Column for gas chromatography
4. Stationary phase
5. Detector
6. Signal recorder

INSTRUMENTATION :

A good gas chromatography machine contains the following important components,

1. Pressure regulator
2. Sample injection port
3. Gas chromatography column
4. Stationary phase
5. Detector
6. Signal recorder

Pressure regulator:

The pressure is adjusted in the range of 1 to 4 atmospheres, while the flow control valve measures 1 to 1000 liters of gas per minute. Flow valves are adjustable using a needle valve mounted on the base. Preferred carrier gases may be helium, argon, nitrogen and hydrogen due to their high thermal conductivity.

Sample injection port:

Samples are injected with a microsyringe through a self-sealing silicone rubber septum into the heated metal. The metal box is heated by an electric heater. We used different sizes of injection ports for sample injection.

Gas chromatography column:

A gas chromatographic column can be made of tubing wound into an open spiral. For high temperature operation we used copper or stainless steel. The flow rate of the carrier gas depends on the internal diameter of the chromatography column. The usual size of the column is 2 meters. Detector: The detector can detect the arrival of components coming from the column and provide an electrical signal. The pressure and temperature detector are the two main groups of detectors used in gas chromatography. The detector in gas chromatography instruments is placed near the column to prevent liquids from condensing or to detect the sample before decomposition. In the instrumentation of packed column gas chromatography, we mostly used a thermal conductivity

Detector (TCD) or a flame ionization detector (FID). •

Among these TCD is the most popular. • A flame ionization detector (FID) is most useful where the effluent is suitably damped by a flow divider. • The TCD detector contains four temperature sensors consisting of thermistors or resistance wires. Thermometers are electronic semiconductors made of fused metal oxides, whose electrical resistance changes with temperature. Stationary phase in gas chromatography: Gas liquid chromatography can be available in an almost infinite number of different liquid separation materials. The liquid or stationary phase in gas chromatography can be divided into non-polar, intermediate polarity, polar carbowaxes and hydrogen-bonded compounds such as glycol. The maximum temperature of the stationary phase can be determined by its volatility. Excessive volatility of the stationary phase can shorten column life. The loading of the column with the stationary phase can be expressed in mass percentages. For example, 15% means that a 100 g column has 15 g of stationary phase.

Gas Chromatogram:

The choice of recorder determines the final accuracy of the gas chromatogram. There should be a full response

be 1 second. Sometimes signal amplification is necessary to obtain a gas chromatogram.

In a gas chromatogram, we have a Gaussian curve of the error function, which is symmetrical. If the substance has no affinity for the stationary phase the partition coefficient K = 0. Therefore, it will not be retained by the column.

How gas chromatography works:

Separation in gas chromatography is possible by partitioning the sample between a mobile gas phase and a thin layer.

The stationary phase of a non-volatile, high-boiling liquid held on a solid support. The idea of separating

gases by passage.

The sample is injected into a heating block where the compound is easily vaporized. The sample steam is

carries the carrier gas to the column inlet.

The solute is absorbed in the head of the column by the stationary phase. It is traveled at one's own pace

column by its partition coefficient value Solutes are eluted according to their partition coefficient and loaded into the detector. In the detector, the dissolved substances give a series of signals resulting from changes in concentration and different velocities vElution.

The recorder provides a graph of the time ageistic composition of the carrier gas stream. Plot highlights

report the quantitative data in the gas chromatogram.

Stationary phase in gas chromatography	
Type	Stationary phase
GLC	Squalene, silicon oil, nonpolar polyethylene, glycol, glass Teflon beads, etc.
GSC (usual)	Silica gel, alumina, charcoal, molecular sieve inorganic salts, mineral, porous polymers.
GSC (reverse-phase)	Silica alumina coated with organic or inorganic compounds or complexes.

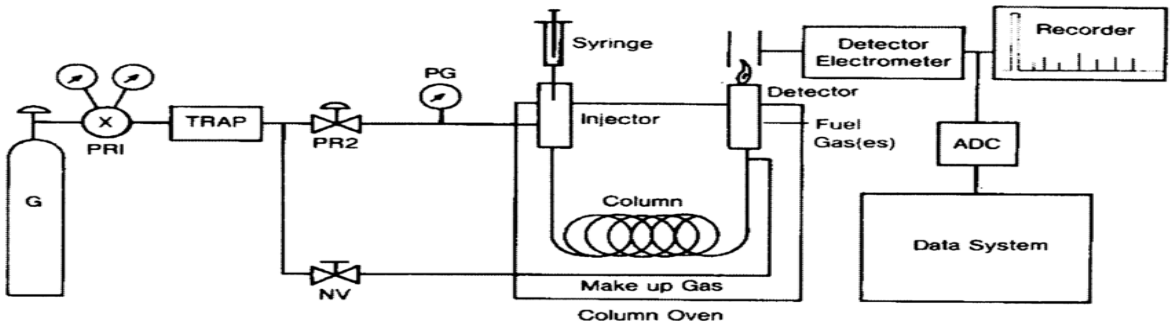

FIG.INSTRUMENTATION DIAGRAM

Applications :

1.Food Analysis

The food industry relies on the technique of gas chromatography for several applications, including the quantitative and qualitative analysis of food, the analysis of food additives, components of flavor and aroma, and the detection and analysis of contaminants such as environmental pollutants, pesticides, fumigants, and naturally occurring toxins.Gas chromatography is vital to the food industry for ensuring the safety of food products, preventing contaminated products from becoming available for consumption. The technique is also essential to ensuring the quality of food products, ensuring that the flavor and taste, texture, and smell remain consistent. While other techniques are implemented by the food industry, gas chromatography remains a highly favored method due to its ease of use and cost-effectiveness.

2.Quality Control

Manufacturing relies on gas chromatography for quality control, companies that produce cars, chemicals, and pharmaceuticals, in particular, are big adopters of the technology.The pharmaceutical industry uses gas chromatography to help produce pure products in large quantities. The method is used to ensure the purity of the produced material, eliminated inconsistencies in pharmaceutical products. The industry also uses gas chromatography to analyze compounds to check for trace contaminants. Currently, there is also a growing use of the method within the pharmaceutical industry to separate chiral compounds.Studies have shown that the interiors of new automobiles release a significant amount of volatile organic compounds (VOCs). For this reason, gas chromatography has been adopted by the automotive industry to identify and measure the chemicals that are released into the air inside the car from its carpets, door linings, pedals, seat covers, and other interior materials. Scientists aim to reduce the levels of harmful toxins released into the interiors of new vehicles.Producers of chemicals also heavily rely on gas chromatography, particularly when making emulsifiers, solvents, and co-solvents, to ensure that they maintain the same quality when production is scaled up.

3.Research

Gas chromatography is fundamental to many research areas, in particular, for the analysis of meteorites and natural products. Scientists use gas chromatography to analyze the composition of meteorites that fall to the earth.This provides vitally important information regarding the nature of life outside of earth, as well as revealing details about primitive life on earth. Specifically, many studies have been conducted with gas chromatography to determine the presence of ribose in meteorites, the building block of RNA.

4.Forensics :

For many years gas chromatography has been used in forensic science. Mostly, it is used to determine the circumstances of a person’s death, such as whether they ingested poison, or consumed drugs or alcohol in the hours prior. Scientists take samples of blood and fibers from the crime scene and analyze them using gas chromatography to help investigators piece together the facts.

5.Measuring air pollution :

Air pollution has become an increasing problem in recent decades. Rapid urbanization has lead to more people living in cities where they are exposed to the pollutants expelled by vehicles and industry. Also, there is a growing body of evidence that has implicated air pollution as a risk factor in developing numerous diseases, such as cancer.Gas chromatography is being used to combat the problem, by monitoring the levels of harmful pollutants in the air so that scientists can visualize where air pollution is more concentrated, and how this changes throughout the day and the year to develop effective preventative methods.

6.Blood alcohol analysis :

Gas chromatography has been used since the 1950s to detect blood alcohol levels. Since then, it has continued to be used to detect how much alcohol a person has consumed to help gauge how impaired their normal functioning may be. Also, it has been adopted by forensic science to determine blood alcohol levels at the time of death.

Advantages of Gas Chromatography

Although the technique does have some limitations, there are clear advantages to using gas chromatography compared to other chromatography techniques. These include:

- **Improved Resolution –** Closely related peaks in the data can be resolved more easily with GC techniques than with other chromatographic methods such as thin-layer chromatography (TLC.) Parameters can be adjusted in real-time, meaning appearing peaks can be resolved better. GC is suitable for incredibly complex mixtures such as smoke which are almost impossible to resolve with TLC.
- **Improved analysis speed –** Operational parameters can be easily changed (including during the experiment) meaning that analysis of a sample can be completed in the space of a few minutes. Optimum resolution can be achieved quickly with GC.
- **Wider sample choice –** A wider choice of volatile samples can be analyzed with GC. The ability to control the temperature of the process allows for samples with high boiling points to be analyzed.
- **Fully quantitative –** The software used in gas chromatography provides more accurate data than other techniques, making it a fully quantitative technique. TLC, for example, requires extra equipment such as densitometers or treatment steps, increasing the cost of any experiments.
- **More sensitive –** Specialized detectors can detect target compounds at much lower limits than other techniques, meaning that gas chromatography has a high degree of sensitivity.
- **Nondestructive testing capabilities –** Detectors used in gas chromatographers, such as flame photometric detectors and thermal conductivity detectors, are nondestructive. This makes GC a technique suitable for nondestructive testing of samples.
- **Column choice –** Columns available for use in a gas chromatographer have a wide range of sizes, meaning that they can be used for a wide range of applications. GC experiments can also be carried out using different stationery and liquid support phases.
- **Software capabilities –** GC has a range of improved software capabilities. Increased normalization, peak, and baseline optimization leads to improved real-time control and results reporting. This confers a distinct advantage upon gas chromatography compared to more traditional techniques as increased data analysis capabilities lead to better and improved results.
- **Column reuse –** The columns used in gas chromatography experiments can be reused, significantly reducing the operational costs of experiments. However, they must be stored properly as per the manufacturer's instructions.

- **Storage of results and records** – In TLC, the solid plates can degrade over time, meaning that there is a finite shelf-life of results unless they are digitized. Data produced by the software in GC equipment, however, can be stored indefinitely..

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