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Perspective

Basic Overview on Gas Chromatography and its Mechanism

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DESCRIPTION

Gas Chromatography (GC) is certainly one of the main techniques used for the selection, identification, and separation of many non-polar and semi-polar food toxicants. A carrier gas, injector, gas chromatographic column, detector, and data processing unit were the main components of gas chromatography. The main carrier gases mainly used are nitrogen, helium, and hydrogen. The separation characteristics mainly depend on the nature of the carrier gas. The flow rate of helium carrier gas is 0.20-0.32 mm. Helium gas is a commonly used carrier gas in gas chromatography as it provides good separation results. Although expensive, it is safe and has a relatively wide optimum linear velocity range. In order to control the flow rate of the carrier gas, there are three methods used by :

- Pressure control,
- Column flow rate control, and
- Linear velocity control

The injector comprises a heated chamber lined by glass into which the sample is introduced through the septum. Once the sample gets injected, it gets vaporized to form a mixture of carrier gas, vaporized solvent and vaporized solutes. The injector should maintain a temperature ranging from 10–20 degrees Celsius, the boiling point of the sample. As the temperature increases, the sample gets evaporated through the needle. The main injection procedures mainly used are :

- Syringe injection,
- Auto sampler injection,
- Programmable Temperature Volume (PTV) injection, and
- Gas switching valves.

During injection of the sample, a micro syringe is used for liquid samples, whereas a gas-tight syringe is used for gas samples. There are two types of columns that are used in gas chromatography, packed columns and capillary columns. The columns are mainly made of stainless steel and glass. The packed columns are mainly used in official analytical methods and for gas analysis. As the length of the column increases, the retention time will also increase. Columns are considered the "heart" of the chromatograph as they are responsible for the separation process. While passing through the column, its components are separated based on their efficiency of interaction with the stationary phase. A capillary column, which is also known as an open tubular column, is made up of a glass or fused-silica tube of very small internal diameter, 0.53 mm.

The inner surface of a capillary column is coated with a thin layer of stationary phase. It is still probable for the solute molecules to come into contact with the inner walls of the tube. Most of the capillary column's stationary phases are cross-linked and covalently bonded to the fused-silica surface. The volume of the stationary phase in a capillary column is represented by its film thickness, which is usually 0.1-5 m. Compound retention is directly proportional to film thickness in capillary columns, as the retention time increases as the film thickness increases, and the film thickness decreases with the decreasing compound retention. The capillary columns have a very high separation capacity. This permits the determination of peaks in complex samples that are not sufficiently separated by packed columns. Capillary columns, rather than packed columns, are commonly used in gas chromatography due to their superior well separation performance.

The efficacy of GC analyses can be distinctly improved by using a column switching technique. In order to attain an effective and consistent separation, the gas chromatographic column has to be thermostated at a persistent temperature (isothermal separation mode). The use of a temperature gradient significantly increases the efficiency of the separation. Column temperature is a critical parameter in GC analysis, and its precise regulation is critical. Detectors interrelate with the solute molecules as they leave the column.

This interface is converted into an electrical signal that is directed to a recording or data storage device. A chromatogram is then created, which is a plot of the intensity of the signal versus elapsed time. The main characteristics of detectors are the lowest amount of a compound that is detectable (sensitivity) and which compound, at the same amount, produces the strongest detector response (selectivity). There are many different detectors used in our daily lives are Flame Ionisation Detectors (FID),

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Nitrogen- Phosphorus Detectors (NPD), Flame Photometric Detectors (FPD), Electro Lytic Conductivity Detectors (ELCD), Chemiluminescence, etc.

A flame-ionization detector uses hydrogen gas as a carrier gas. The mixture is burned, the analyses are burned, and the ions formed during the burning process are taken into a cylindrical electrode at a high current that is used between the jet of the flame and the electrode. The resultant current is amplified and detected. The nitrogen-phosphorus detector is similar to the flame ionisation detector. It consists of rubidium or cesium beads inside a heater coil near to the hydrogen jet.

In conclusion, 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 how much is present. These chemical components are usually organic molecules or gases.