We're Going Global

GAS CHROMATOGRAPHY….*learning so much from so little*

Just imagine, injecting a 1-microliter sample from a vial of gasoline (see photos below) into a GC and separating it into more than 200 different hydrocarbon components. We not only separate the sample but accurately identify and quantify every component, all representing hundreds of thousands of barrels of gasoline stored in your tank!

In this method, a chemical mixture is carried through a column by a liquid or a gas and is separated into its components. Depending on the carrier, it can be referred to as Liquid Chromatography or Gas Chromatography. This TECHTALK will concentrate on Gas Chromatography only.

Let's compare chromatography to a 5-mile road race. At the starting line, you have a mixture of chemicals, much like a pack of runners waiting for the start gun. Minutes into the road race the runners separate and spread out because some move faster through the course than others. Chemicals compounds will also move at different speeds and spread out in a GC column with different elution times (when they exit the GC column).

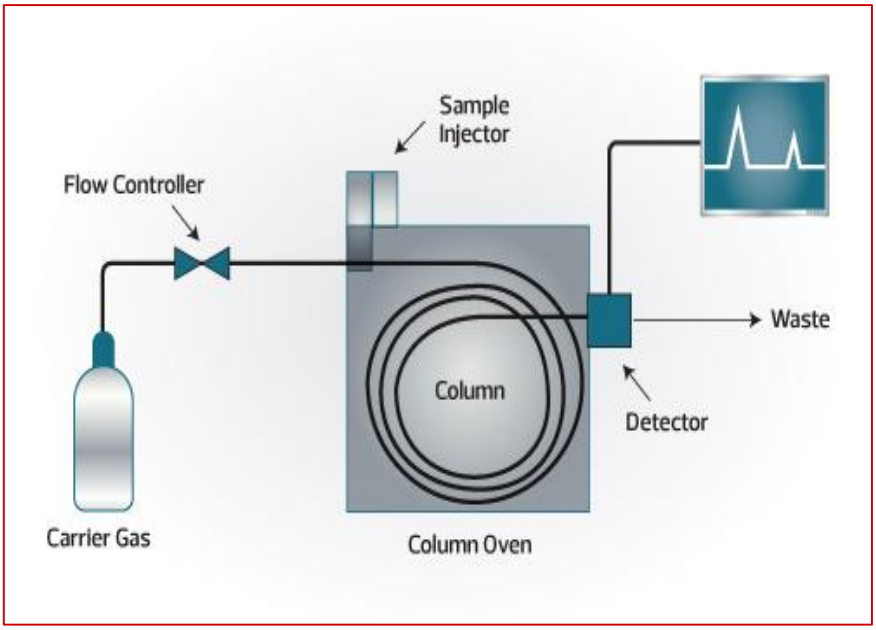
GAS CHROMATOGRAPHY

Gas Chromatography is an analytical technique in which a very small amount of sample mixture is vaporized to a gas and injected into a stream of carrier gas moving through a column containing a stationary phase. The injected gas is separated into its component compounds per their affinity for the stationary phase.

GAS CHROMATOGRAPH

The analytical equipment used to separate the components of a mixture by Gas Chromatography is called a Gas Chromatograph. It is essentially a temperature controlled oven with temperature ramping capability.
On one end is the injector for introducing the sample and the other end is the detector for identification. A column is connected between the injector and the detector.

The sample is introduced into the column and is carried by an inert gas (usually Helium). This is where the separation of the mixture takes place and the individual components coming out from the detector end are identified by their retention time and quantified by the size of their signal.



ESSENTIAL COMPONENTS OF A GAS CHROMATOGRAPH

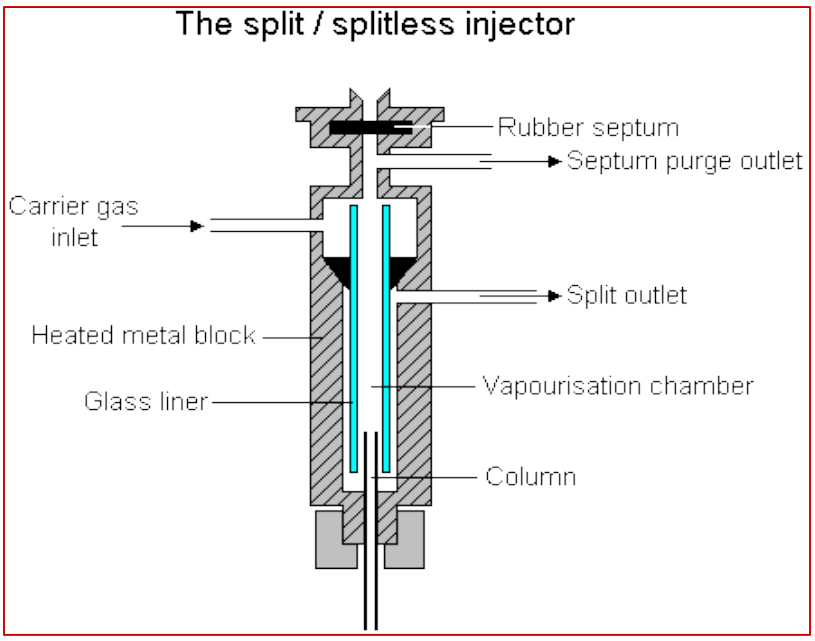
- Temperature Controlled Oven
- Injector
- Detector
- Column
- Carrier gas
- Gases for Flame Ionization Detector (Hydrogen & Air) if is FID used
- Chromatogram Processing / Data Handling Software

It must be noted that depending on the desired sample separation, a proper injector, the right column and the right detector must be used. Gas Chromatography has become a very well established and standardize technique. Today we can use it to separate a simple mixture or a very complicated mixture by just configuring the Gas Chromatograph to the desired needs.

Various ASTM methods employ special hardware configuration and at times more than one column is used making it a Multidimensional Gas Chromatography.

INJECTOR SYSTEM

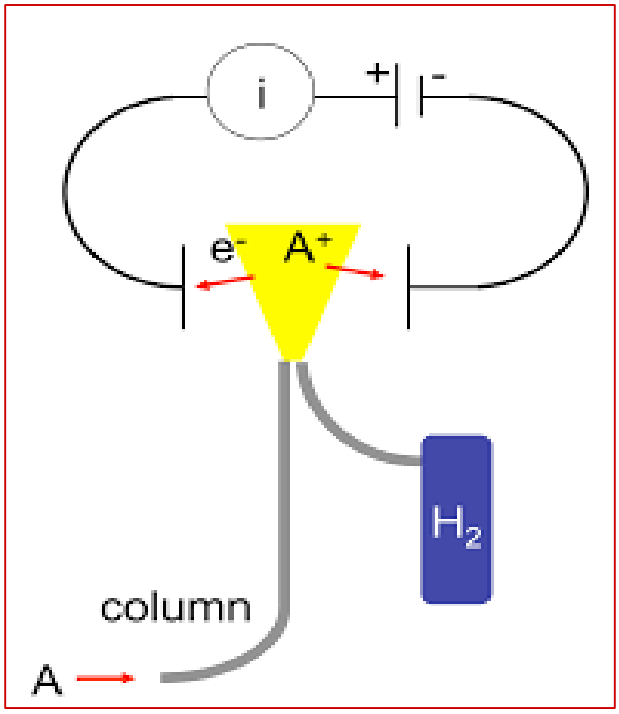
A simple split / split-less injector shown below. Injection of a sample can be manual or by auto injection system. The injection can be direct on column or by split injection where only a portion of the injected sample goes into the column and the rest is pushed out. Care is always taken not to overload the column with sample amount. The injector is kept at higher temperature to help vaporization of the sample.



DETECTORS

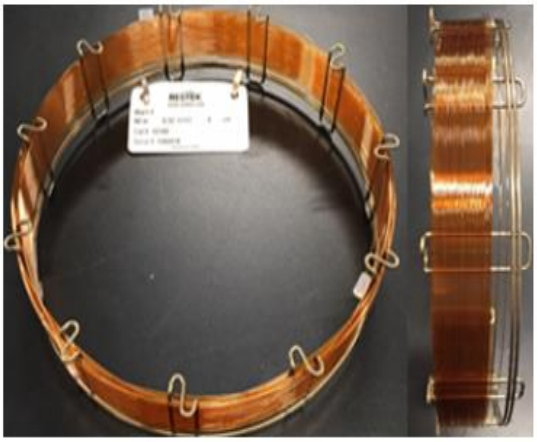
There are several different types of detectors. The choice of detector is based on the desired analytical method used for separation. The most common detector for hydrocarbon mixture separation is Flame Ionization Detector (FID). This detector uses Hydrogen and Air to light the detector flame. Other detectors used are Thermal Conductivity Detector (TCD), Electron Capture Detector (ECD), Flame Photometric Detector (FPD), Photo Ionization Detector (PID), Sulfur Chemiluminescence Detectors (SCD) and a few others. Different detectors have specific functions to identify the separated components of a mixture sample.

A simple description of Flame Ionization Detector is shown on the right. Hydrogen and Air are lit to make a flame. The separated hydrocarbon are ionized and elute from detector end, and are detected as an electrical signal. The larger the signal (peak), the more the concentration of that component.



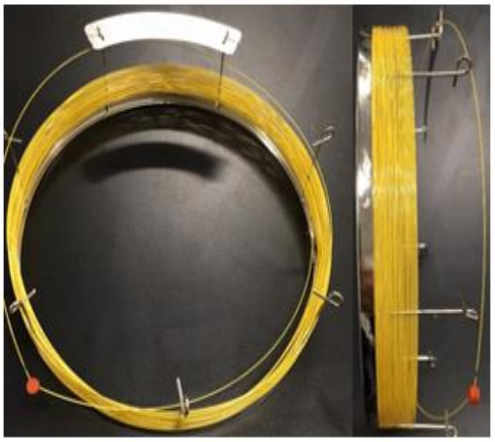
COLUMNS

A Column is the heart of Gas Chromatography and where the separation takes place. Generally, there are two types of columns, Packed Columns and Open Tubular Coated (Capillary) columns.



Wall Coated Open Tubular (WCOT) Capillary Column

Packed Steel Column



Porous Layer Open Tubular (PLOT) Column

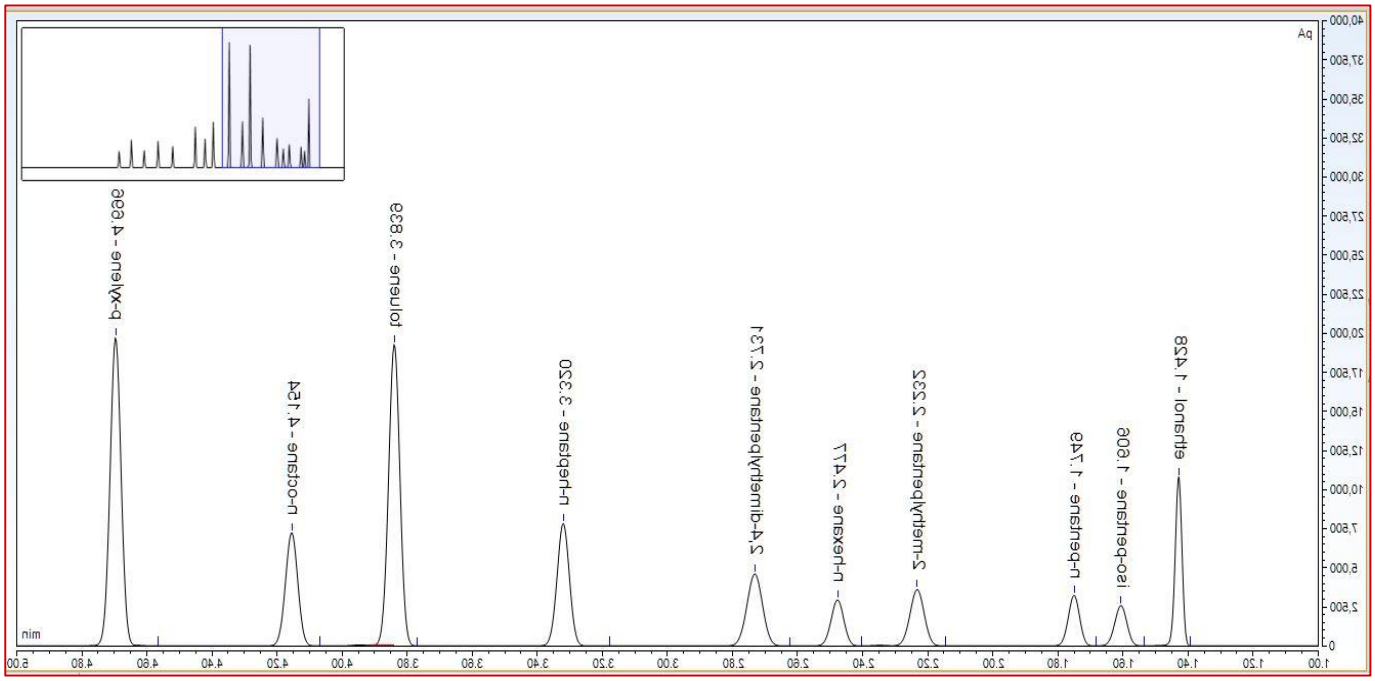
A desired stationary phase is properly **packed** in Packed Columns whereas stationary phase of desired thickness is **coated** inside the open tubular capillary column. The selection of the stationary phase is dictated by the method used. Column efficiency and resolution ability are monitored by the analysts.

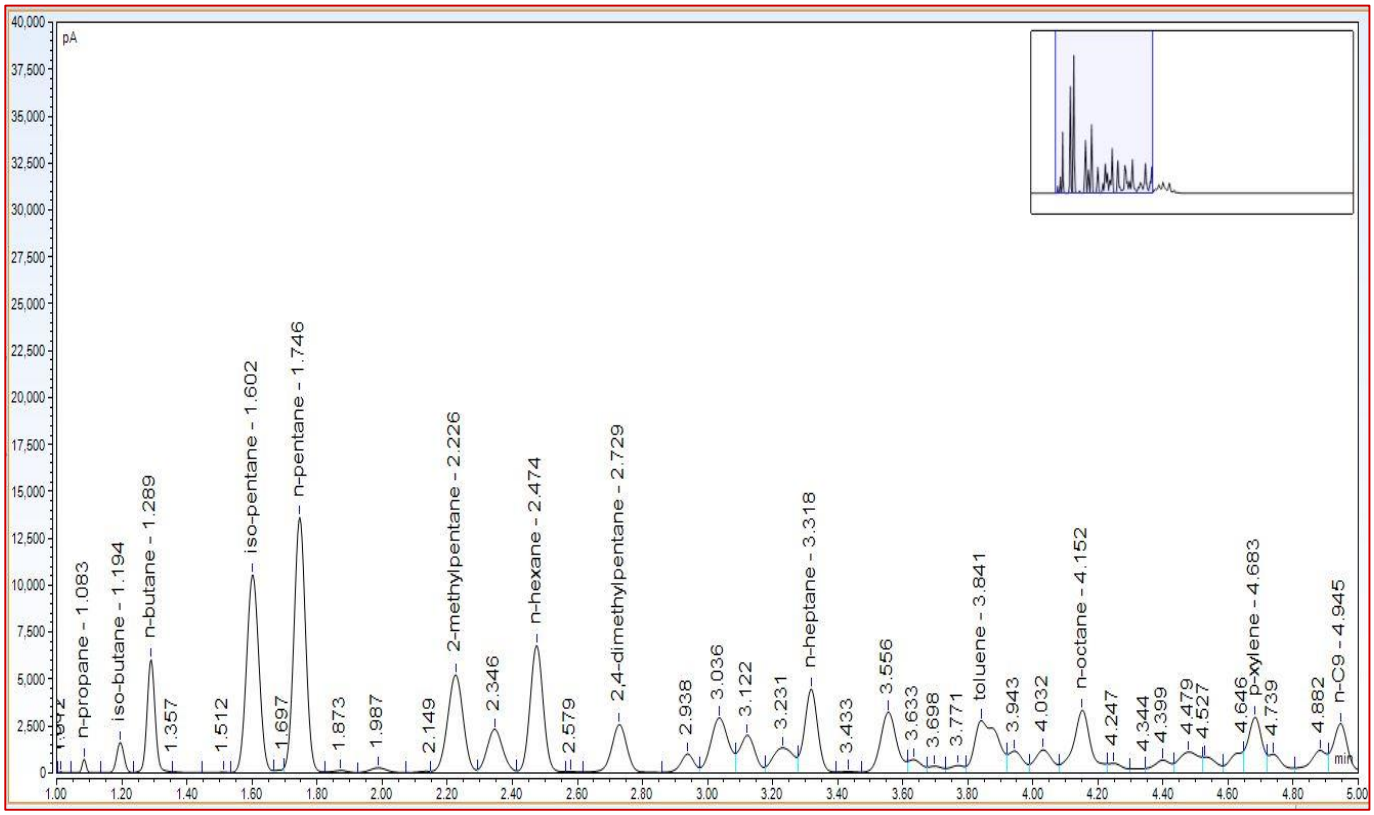
In Gas Chromatography (GC), the sample is vaporized and injected on the head of a chromatographic column either manually or by using an auto injector. Elution of the components is brought about by the flow of an inert gaseous mobile phase (carrier gas). The mobile phase does not interact with molecules of the analyte; its only function is to transport the analyte through the column. The separation takes place in the order of the retention times (the time each component stays in the column).

The components are detected by the detector and size of the signal determines the quantity of each component. The signals are usually represented by the peaks coming out at different intervals.

It must be noted that like any other Analytical Technique, the GC is first calibrated with the standards of known composition. The identification is done by the respective retention times and quantities of each component calculated by their peak areas and their relative response factors.

Shown below are two examples of the peaks on a GC chart.





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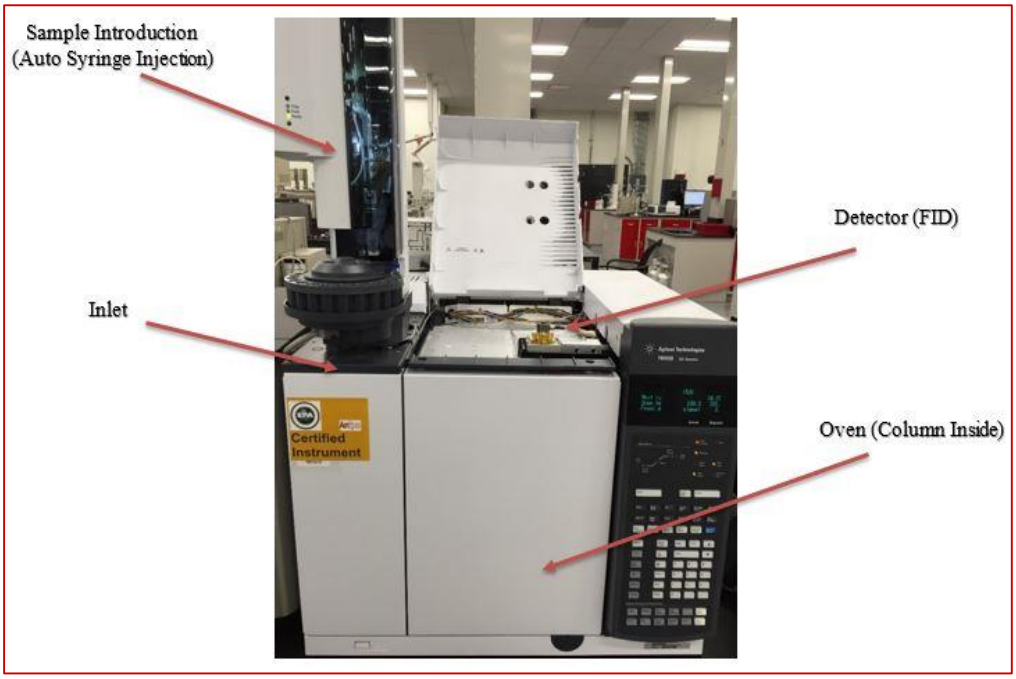
GC used in the laboratory to separate and analyze Gasoline and other Hydrocarbons.



Lab GC with the front door of the oven in the open position, showing the column.

Due to the complexity of the subject matter, this AmSpec TECHTALK only briefly described the Gas Chromatography Techniques used in Analytical Laboratories. This by no means covers every detail available to today's chemists.

If you require more detailed information or would like to visit to our world class, state of the art, AmSpec Houston Technical Center, please contact:

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