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Review Article

GAS CHROMATOGRAPHY TROUBLESHOOTING STRATEGY FOR ANALYTICAL CHEMISTRY

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ABSTRACT
The most utilized of all the chromatographic techniques is gas chromatography. This technique gives good precision and accuracy. Essentially a gas chromatography separates of a gaseous mixture in a column and detects the components as they are eluted. The response of the detector is plotted as a function of time & carrier gas volume on a strip chart recorder. Gas chromatography is one of the sole forms of chromatography that does not utilize the mobile phase for interacting with the analyte. It can be configured for analysis of specific compounds using a wide choice of options. GC is a very well- established technique for determination of residual solvents, non chromophoric impurities in drug substance, drug product and environmental contaminant identification. Troubleshooting GC instrumentation and separation require a fundamental understanding of how the instrument functions and how the separation works. This article helps the reader to understand the relationship between the problems and remedy. The objective of this work is it serves as both troubleshooting guide and a GC learning tool.
KEY WORDS: GC, Troubleshooting

INTRODUCTION

[1]Gas chromatography as an instrumental technique was first introduced in the 1950's and has evolved into a primary tool used in many laboratories. [2]The introduction of Gas–Liquid Partition Chromatography by James & Martin. Perkinclmer set out make GC more accessible to researchers by introducing their first gas chromatography in 1955. [3]Gas chromatography is also known as vapor phase chromatography (VPC) or gas- liquid partition chromatography (GLPC). There are two types of GC one is gas –solid (adsorption) and gas- liquid (partition) chromatography. [4]Gas solid chromatography was developed by G.D.Kohler &K.Thiele in 1943.[5]Separation by using a solid stationary phase is primarily based up on the relative adsorption of the sample components on the solid. Separation by using a liquid stationary phase can be based on either relative solubility of sample components in the stationary phase. Comparatively [6]Gas Solid chromatography is of greater value in the separation of permanent gases and low boiling hydrocarbons. [7]The amount of column bleed (vaporization of stationary liquid phase) must be minimized to prolong the column life, to prevent any tailing of the detector, and to maintain baseline stability on the chromatogram.[8]The ruggedness testing of a temperature programmed gas chromatographic method with flame ionization detection used for the determination of residual solvents in steroids.[9]This method is simple the sensitivity is high and used in the separation of cis-trans isomers of oxygen isotopes or of pesticides of choosing the proper column and condition. [10]GC is commonly coupled with Mass spectroscopy, where the eluting compounds move directly into the Mass Spectrometer.

TROUBLES FACED IN GAS CHROMATOGRAPHY DURING OPERATION[11-22]

Problem	Possible cause	Remedy
No peaks	Plugged syringe	Clean the syringe or inject sample with a new syringe; Immediately lower the column oven temperature to 35°c
	No carrier gas	Verify the carrier gas flow rate; Check for leaks at column connection& septum
	Sample injected into the wrong injector	Re inject sample into the proper injector
	Column installed into the wrong detector	Reinstall the column into the proper detector
	Column broken	If broken at the inlet or the detector end, make clean cut & reinstall column; Replace column
	Detector not on	Check detector & gas settings
	Column temperature too low	Verify temperature

Columns and Fittings Leaks

Problem	Possible cause	Remedy
Injector leaks	Injector leaks reduce the peak height of the most volatile components of a sample more than less volatile.	Find and fix any leaks
	A possible source of leaks may be the gas bottles / gas chromatograph connection.	Check these lines before the others, If specific symptoms indicate that the leak is outside the gas chromatograph
Leak at pump	Pump seal failure	Replace pump seal; check piston for scratches and, if necessary replace

Change in Retention Time

Problem	Possible cause	Remedy
Increased retention time or differing retention time	Speed of gas too low	Increase flow
	Column connection leaks, column nor properly installed	Check column installation search for leaks; Replace ferrules
	Oven temperature too low or unstable	Check temperature program; Oven temperature (external thermometer) If the analytes are stable increases the temperature
	Strong decrease of gas pressure	Replace septum for an instrument with pressure/ temperature control; Flow pressure must be higher than 15 psi above the demand at maximum temperature of the program

	Tubes/ column/ capillaries constricted or blocked	Compare flow at column entrance and outlet with preset flow; Check or clean gas tubes
Decrease or differing retention time	Speed of gas too high	Compare flow at column entrance and outlet with preset flow; Check gas tubes and pressure gauge
	Oven temperature too high	Check temperature program, oven temperature (external thermometer) decrease the temperature
	Column length too short	Replace column
	Film thickness in column too low	Replace column

Baseline

Problem	Possible cause	Remedy
Noise	Contaminated carrier gas	Check to see if a new tank was replaced recently; Replace with a different lot number
	Contaminated injector	Clean the injector
	Contaminated detector gases (hydrogen or gas)	Clean detector
	Incorrect combustion gases or flow rates.	Check and reset gases to their proper values
	Air leak/applicable to an ECD(electron capture detector)	Verify proper installation length and reinstall column
	Column contamination	Bake out the column solvent rinse the column
	Un-equilibrated detector	Allow detector to stabilize
	Incompletely conditioned column	Fully condition column
Increasing baseline at high temperature bleeding or noise	Decomposition of the stationary phase	Check for leaks, matrix check for compatibility with the column
	Column contamination	Use gas graders recommended for GC
	Detector contamination	
	Poor gas quality	
Declining baseline	Gas flow changes with temperature gradient	Check gas content in gas cylinder, Pressure must be a few bars above the required pressure at maximum temperature
	Contaminated gas	Check gas supply
	Column not properly installed	Check column installation(FID)flame ionization detector
Base line drifting	Column contamination	Clean the injector; Use guard column to prolong column life
	In complete conditioning of column	Condition the column until a stable baseline is achieved
	Un equilibrated detector	Allow the detector sufficient time to equilibrate
	Septum bleed	Use higher temperature septum or analyze sample at lower injector temperature
	Carrier gas cylinder pressure too low to allow control	Replace the carrier gas cylinder or increase the pressure
Wander	Contaminated carrier gas if using isothermal conditions.	Change the carrier gas or use carrier gas impurity traps
	Detector thermal or current instability	Check temperature; power
	Contaminated injector	Clean injector; Replace inlet liner, glass wool and seals
	Contaminated column	Bake out the column; Cut off first 10 cm of column,if it does not help replace the column
Offset	Column is inserted into the flame of an FID, NPD& FPD.	Reinstall the column
	Poor electrical changes	Check electrical connections, tighten any loose connections
	Contaminated detector	Clean the detector if possible
	Line voltage changes	Monitor line voltage for correlation with offset, if correlation is found, install voltage regulators or ensure stable power supply
Irregular shape (s- shape)	Excessive column bleed during column temperature programming	Reduce the upper column temperature ;Back out the column install a high temperature column
	Detector contaminated	Back out or clean the detector

Pressure

Problem	Possible cause	Remedy
pressure	Strong decrease of gas pressure	Replace septum for an instrument with pressure /temperature control, flow pressure must be higher than 15psi above the demand at maximum temperature of the program
Temperature	Too high an injection temperature though will tend to degrade the rubber septum & cause dirtying of the injection port.	Maintain the injection temperature

Peaks

Problem	Possible cause	Remedy
Tailing peaks	Column contaminated	Trim the column solvent rinse the column
	Column activity	Irreversible
	Poor column installation	Re install the column
	Solvent – phase polarity mismatch	Change sample solvent install a retention gap
	High injector temperature	Maintain proper temperature
Split peaks	Injection technique	Change technique
	Mixed sample solvent	Change to single solvent
	Poor column installation	Reinstall column in the injector
	Sample degradation in the injector	Reduce the injector temperature, Change to an on column injection.
Irregular peaks	Using too high temperature	Maintain low initial oven temperature
Larger peaks	Auto sample injection volume	Check the auto sample injection volume; check configured syringe size
Spike peaks	Contamination from vials/septa or sample preparation.	Control SPE& or auto sample vials; use low bleed or high temperature septa
	Dirty syringe	Use a different syringe or clean it
	Sample decomposition	Check temperature program, oven temperature (external thermometer), if analytes are not temperature stable reduce injector temperature replace liner

	Column absorbs or decomposes analytes.	Check capillary ends, or replace column; Use a column with thicker film; Use phase with better de activation; Use column with special selectivity
Ghost peaks	Contamination of the injector or column	Clean the injector or liner; Rinse the column with solvent
	Septum bleed.	Use a higher temperature septum; Lower the injector temperature
	Previous run terminated too soon.	Use a higher temperature to elute all of the sample components, Prolong the run time to allow the complete elution of the sample
Negative peaks	All peaks are negative.	Check the polarity of the recorder connections
	Select peaks on a TCD.	Compound has greater thermal conductivity than the carrier gas, negative peak is expected in this case
	Incorrect setup in the software	Set-up right parameters in your chromatography software
Broad ghost peaks	Contaminated inlet or pneumatics.	Remove the column and bake out the inlet; Use a high quality septum
	Incomplete elution of previous sample	Increase the final oven program temperature or total run time, increase the column

CONCLUSION

Gas chromatography has a place in research, development of techniques for the analysis of is flavones in soy foods and neutraceuticals, cereal based products. It has strong separation power & even complex mixture can be resolved into constituents. One thing that makes gas chromatography very different than LC is the limited number of mobile phases. Two basic capillary mobile phases are hydrogen and helium with a few short years GC was used for the analysis of almost every type of organic compounds.

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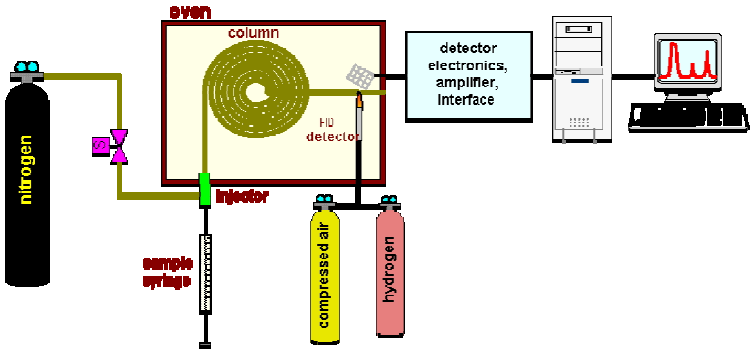

Gas Chromatography Instrument

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