Gas solid chromatography and gas liquid chromatography chemistry essay

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Gas chromatography mainly consists of Gas solid chromatography and Gas liquid chromatography, in both types gas is used as mobile phase and either solid or liquid used as stationary phase. Gas solid chromatography is not used widely because of limited number of stationary phases available. In Gas solid chromatography, the principle of separation is adsorption. It’s mainly used for solutes which having less solubility in stationary phase.

Principle and criteria required for gas chromatography

Principle of separation in Gas liquid chromatography is partition only. Gas is used as mobile phase and the liquid is coated on a solid support used as stationary phase. Hence those compounds can be separated according to their partition-coefficients.

Criteria for the compounds to be analysed by gas chromatography are volataility and thermostability.

Liquid Chromatography

Liquid chromatography is a separation technique in which the mobile phase is a liquid. Liquid chromatography can be carried out either in a column or a plane. Liquid chromatography it utilizes very small amount of particles and relatively high pressure is applied called as high performance liquid chromatography.

Liquid chromatography mainly described as non-instrumental method. Since sample doesn’t need to vaporize as like in gas chromatography. Potentially any compound can be analysed by this method. Elution can be done by surface adsorbtion , solvent partitioning, ion-exchange , relative solute size ,

and relative solubility. Both solute and solvents are attached to the polar sites on stationary phase

Selection of solvent

It’s is depend upon various factors such as Solvent strength , polarity index.

2. Using of more than one column in gas and liquid chromatography :

The significant advantage over single column system rather than one or two dimensional systems are coupled in such a way that individual or group peaks are transfer from one column to another column for increase in resolution.

Various things supporting for using of multidimensional systems are by observing results from various journals such as-

Increase in resolution – better separation

Shortly analysis time – Faster results

Avoidence of column and detector contamination –

Increase of volume lifetime and reliability

Increase in sensitivity – improved detection by removal of overlapped peaks.

Using of combinational approach for the improvement of conditional probabilities.

To improve the analyte signal probability, nothing but Application of hyphenation.

To minimize model residual error.

The main approaches for using more than one or two columns in chromatography or analytical seperations are as follows:

1. Enrcihment

2. Heart-cutting

3. Back-flushing

1. Enrichment :

This is the main approach that to identify or increase in amounts of trace components.

Initially pre-concentration of trace elements can be packed on a column, and then more samples can be placed on packed column than a capillary.

2. Heart-cutting :

For a complex mixture containing not only single column to resolve the all components of interest and very large peaks may appears those may masks the other components , by passing the resolved area to second column can be used to treat heart-cutting or cut and transfer.

The main use of heartcutting inmulti dimensional chromatography either gas or liquid is the physical separation of a few trace target compounds in the presence of major interferences. The complete multi dimensional characterization of a sample requires a different approach. The arrangement

of the adjacent heartcuts are performed within the samerun. By this we able to find out the maximum peak capacity of a system averagely.

The second column using also must having different polarity from first column.

3. Back-flushing:

If the sample contains both volatile and non-volatile substances respectively, the total experiment should have to done in one direction only. For this reason only one column is needed.

In normal operations flow normally occers , after all faster eluting species has resolved. The value is switch, reversing the flow.

In reverse phase For high moleculer weight species it would evolves and finally first portion of column to done the separation.

Back-flushing reverse mode:

Background work for Multi Dimensional Chromatography:

It represents a powerfull tool and an alternative procedure to classical one dimensional High performance liquid chromatography. To obtain multiheartcut, 2-D GC has been developed. Narrow slices of effluent are periodically injected through a primary column into a short, high-speed secondary column. Components which are not resolved in the first dimension undergo a second separation step. The process is analogous to routine GC/MS and is also known as comprehensive 2-D GC. In both processes, the entire sample is sliced into narrow packets for further analyzation. The

practical implementation of comprehensive 2-D GC is done by brainchild of Phillips who invented a thermal modulator as a sample introduction device. The main origin of multi dimensional gas and liquid chromatography is lies in planar chromatography i. e., partition between a liquid moving by capillary action across a strip of paper presented with second liquid.

Most of the devolepments in past two decades, how ever, The multi dimensional chromatography is using for quantitative measurements.

Introduction to Multi Dimensional Gas and Liquid Chromatography:

Multidimensional chromatography is also known as coupled column chromatography or column switching chromatography or multiphase chromatography or boxcar chromatography or sequential analysis.

Multidimensional chromatography includes the separation of complex mixtures by using multiple columns with different stationary phases. Those columns are coupled orthogonally, that the fractions from first column can be selectively transferred to the other columns for additional separation.

This enables separation of trace elements from complex mixtures that cannot be separated by using a single column.

Multi dimensional systems in chromatography:

A chromatographic dimension is determined as a constant value of the distribution constant of an analyte within the same analysis. The experimental arrangements leading to its change within one run (such as

different stationary phases, different temperatures) belong to multidimensional chromatography systems.

Multi dimensional switching in chromatography:

A switching dimension is “ sample inlet-separation part-detector” within one analysis run. An experimental arrangement leading to multiplication of any part of the path of the moving object belongs to multi-dimensional switching systems.

In multidimensional chromatography, the distribution constant is diferent in each part, and thus the analytes will behave different by them. Therefore, the separation in a one-dimensional system will be enhanced in proportion to the number of chromatographic dimensiones.

It is describes that the multidimensional chromatography without mulditimensional switchning (temperature or program modes) and multidimensional switching without multidimensional chromatography.

Hyphenated techniques can be both multidimensional separation systems (HPLC-GC) and multidimesional switching systems (FID-MS). Interfaces of different techniques (GC-FTIR) are very often considered as hyphenation but they are not necessarily multidimensional.

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Instrumentation:

Multi dimensional Gas and liquid chromatography :

Mainly those injecting of samples via:

Gas injector

Liquid injector

1. Gas injector :

This instrument is a controlled analyzer chamber which contains 6-way diaphragm valve and an injector loop in switching position A)clear path of the value the sample flows continuously over connections 5, 6, 3, 4 through the injector loop, while the carrier gas supplies the separation column via the path1 and 2.

In switching position B) dotted path samples is shorted via 5, 4 the carrier gas flushes the samples which was measured in the injector loop to the separation column via 1, 6, 3, 2 after the completion of the injection , time of injection will takes nearly 1 to 10 sec. Switching back to switching position A occurs .

For gas injection , volume between 0. 5 and 3ml are used depends upon analytical needs.

2. Liquid injector :

Liquid samples can be introduced in liquid form. The required

amount of liquid is the vapourized and supplied to the separation coloumn as a gas by using liquid gas injector valve which consists of 3 sections the pneumatic drive , sample through the vapourization system.

Those techniques can be available with the multi dimensional gas and liquid chromatography are:

Multi dimensional Thin Layer chromatography

Multi dimensional Gas Chromatography

Multi dimensional High Performance Liquid Chromatography

Multi dimensional by using on-line coupled HPLC and capillary gas chromatography

Multi dimensional super critical fluid chromatography

Ultra high pressure multi dimensional liquid chromatography

Interpretation of results :

Chemometric study may useful for study of highly fused peaks, when multi channel detectors are used , this chemometric analysis is successful when they having potential peaks may occering with in chromatographic peaks , the chemometric methods automated so as to defuse regions of a chromatogram.

Only problem with this technique when having one dimensional data and its mainly applicable for proteomics.

Advantages of Multi dimensional chromatography

Over one dimensional and two dimensional systems

In both gas and liquid chromatographic systems:

Mainly includes the separation of complex mixtures those cannot be separated by using a single column. Some of the separations can be done by multi dimensional chromatography are given below those are the main advantages for the multi dimensional liquid chromatography.

Increase in resolution

Shorter analysis system

Extended column life

Decrease in detection limits

Preventing detector contamination

Disadvantages of multi dimensional chromatographic systems:

Detection through liquid chromatography may have limited sensitivity and thus for dilute analytes .

It’s necessary to introduce a concentration step.

Requirements for multi dimensional systems

(Both Gas and Liquid chromatographic systems)

Those requirements for collaborative study or validated things for multidimensional system is

Rapid analysis:

If the samples having like high boiling point range , necessary to backflush the all components eluting from the first column after the components of interest have been transferred. This ensures an exact analysis and this end as well as clean analysing path for the next analysis.

Precission:

The measured things should be separate entirely from any interfearing ones are coupling columns and using heart cutting technique those can be estimated quantitatively.

Reliability:

By these pre-separation with first column and by transferring only the peak interest into second column that is the main analytical column and detector contamination can be prevented that may interrupt analysis.

Wide range of analysis:

Those components of different techniques having different techniques and having different characteristics such as boiling point , polarity and by using the same analytical system and the analytical method can be selected for optimum separation.

Applications for multi dimensional gas and liquid chromatography:

Common applications for

Multidimensional Liquid Chromatography are:

- Proteins and peptides

- Drug isolation from urine and plasma

- Polysaccharides

- Homopolymers, oligomers, copolymers

- Surfactants

- Polycyclic aromatic hydrocarbons

- DNA fragments

The most important application and the recent trend for this multi dimen

sional chromatography is proteomics, The complex protein is separated by multi-dimensional liquid chromatography instead of using the two dimensional gel electrophoresis.

Recent results obtained from journals through Multiple dimensional chromatography system:

Identification of selenium species in urine by ion-pairing HPLC-ICP-MS

Elemental Speciation by LC-ICP-MS: A Practical Tool for Environmental Analysis

Effect of metal ions on the molecular weight distribution of humic substances derived from municipal compost: ultrafiltration and SEC with spectrophotometric and ICP-MS detection

Environmentally friendly sample treatment for speciation analysis by hyphenated techniques. Green Chemistry.

Trace humic and fulvic acids determination in natural water by cloud point extraction/ preconcentration using non-ionic and cationic surfactants and a FI-system with spectrophotometric detection.

Liquid Chromatography-Inductively Coupled Plasma Mass Spectrometry

Sequential extractions of selenium soils: total selenium and speciation measurements with ICP-MS detection.

Elemental Speciation. Ecotoxicology and Environmental Safety

Elemental Speciation Studies, New Directions for Trace Metal Analysis. Ecotoxicology and Environmental Safety

Preliminary Studies on Selenium-Containing Proteins in Brassica juncea by Size Exclusion Chromatography and Fast Protein Liquid Chromatography Coupled to ICPMS.

Additives in polymers

Large scale analysis of yeast proteome by multiple dimensional protein identification technology

Phosphorous speciation in functional foods

Applications in industrial analysis

Environmental analysis – solves complex problems in environmental analysis

Used to study peptidones and peptidomics by selective protein degradation turnover of enzymes can be studied

We can list the following areas prime targets e. g essential oil and natural products analysis, chiral analysis (e. g fragrances) trace multi residue analysis, pesticide monitoring, petroleum products application, in fact any separation simply and greater resolution and sensitivity is mainly required.

Determination of PCB’S (Poly chlorinated bi-phenyl’s)

Rapid determination of isoprenes.

Proteome analysis of low-abundance proteins using the global profiling of endogenous small proteins and peptides of < 0. 5 KDa to 8 KDa molecular weight from the whole tissues.

Selective protein degradation and to study turnover of enzymes e. g Ubiquitin-proteasome , endosome-lysozome. etc.

Solid phase, synthesis reagents and automated scrrening systems by multi dimensional chromatography coupled with mass spectrometry.

In environmental analysis – it might be used for solving of complex problems in environmental analysis.

Multi dimension chromatography is used as bio-marker for discovery

Especially for ovarian cancer and brest cancer

Recent trends in Multi dimensional gas and liquid chromatography:

With respect to multi dimensional chromatography lots of applications in bio-technology, earlier many electrophoresis techniques were used to analyze the DNA or such compounds. And now the major analytical separations are going through the multi dimensional chromatography and analysis of petroleum in Egypt also and for purification of proteins.

Coupled multi dimensional chromatography and tandem mass spectrometry systems for complex peptide mixture analysis.

SCX-RP/MS/MS

SCX/RP/MS/MS

HPLC using monolithic silica columns

RP-RP 2D HPLCusing two different columns

RP-RP 2D HPLCusing two similar columns

Ion-exchange reversed phase 2D-HPLC using a monolithic column for two dimensional.

IEX-RP 2D HPLC using a monolithic RP capillary column for two dimensional.

SCX/RP/MS/MS

MUDPIT

Proteome analysis or Proteomics:

It’s a biochemical method which is using instead of two dimension gel electrophoresis, its mainly require very low flow rates in combination with small inner diameter columns for its high detection sensitivity.

The micro valve, with low internal volume, can be positioned closely to the mass spectrometer for highest separation performance. In the first dimension, fractions of the peptide mixture elute from an ion exchange column by using a salt step gradient. Then each fraction is trapped on a small reversed-phase trapping column and then separated after the valve switches to a reversed column (the second dimension). Then the trapping column is first used to prevent salt from entering the mass spectrometer (ion suppression). Second, the column allows an enrichment step, which together with the low flow rate in the 2nd dimension provides high detection sensitivity.

Conclusion:

For the growing importance and to determination of various analytes like those present in complex mixtures such a techniques like multi dimensional chromatography are being proposed and those techniques having importance because of their precission and reliability and rapid analysis of samples , now-a-days these techniques might be used as bio-markers and also through such a improvement we achieved by this multi dimensional chromatographic systems are more advanced than orthogonal systems and two dimensional systems. This technique having various applications in industrial analysis and environmental analysis and as well as bio-markers and useful to identify trace amounts in complex mixtures.