

Analysis of Volatile Organic Compounds

Pre-seminar Material



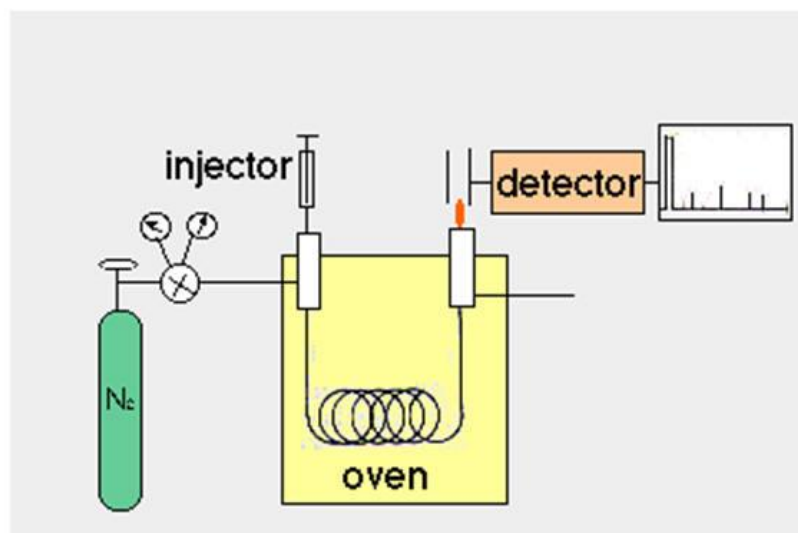
Speaker: Mr. Tim Wong
Hong Kong Accreditation Service



Curriculum Link

This seminar builds on knowledge learnt in the DSE curriculum:

- **Chemistry: Topics V, XI & XV**
- **Combined Science (Chemistry): Topic V**





Volatile Organic Compounds

- Volatile organic compounds (usually abbreviated as VOCs) are organic compounds which have high vapour pressure (i.e. low boiling point) at room temperature.
- VOCs are common air pollutants as they are released in car exhausts, paints, coatings, solvents, new furnishings and office equipment, etc.

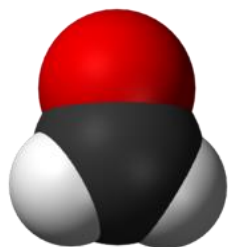
Effects of VOCs

- VOCs pose adverse health effects to humans, such as allergies, skin and respiratory irritations, headache, and immune effects.
- VOCs are also pre-cursors to photochemical smog which decreases visibility.

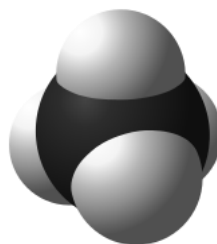
(Different countries may have slightly different definitions about VOCs.)

Examples of VOCs

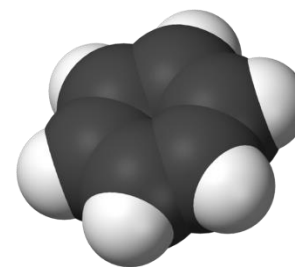
Organic Compounds	Chemical Formula	Boiling Point (°C)	Sources
Formaldehyde (methanal)	HCHO	-19	Adhesive and paints
Methane	CH ₄	-160	Biological wastes
Benzene	C ₆ H ₆	80	Solvent



methanal



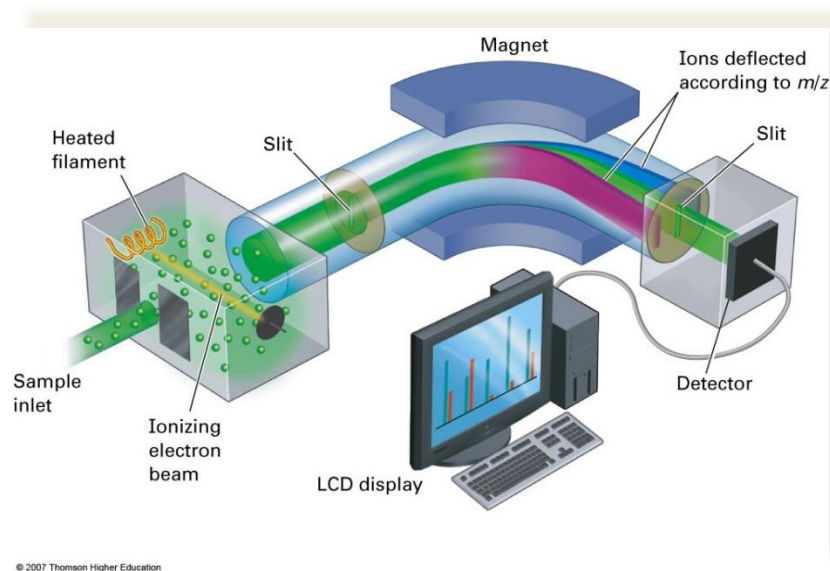
methane



benzene

Analysis of VOCs

- The analysis of VOCs in air samples involves two techniques, namely chromatography and mass spectrometry.



Mass Spectrometer (MS)



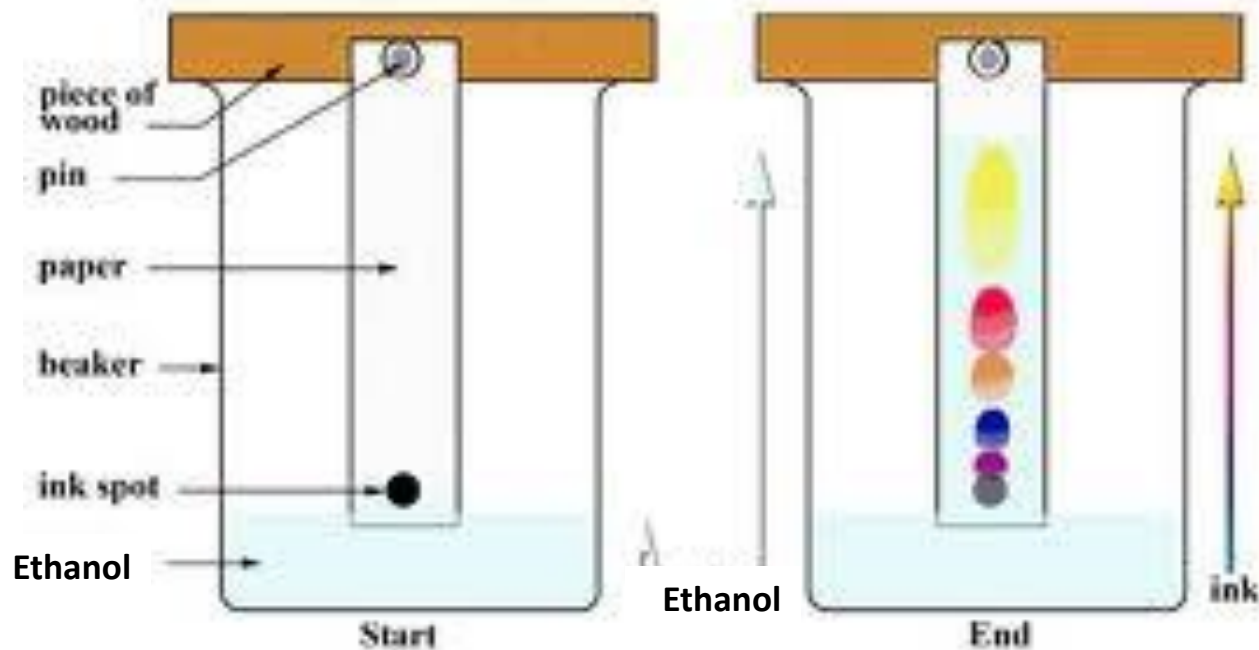
Gas Chromatograph (GC)

Chromatography

- Chromatography is a technique used for separating a mixture of chemicals.
- Gas chromatography (GC) and liquid chromatography (LC) are two commonly used chromatographic techniques in the analysis of VOCs.

A Paper Chromatography Experiment on the Separation of the Components of Ink

Simple chromatography



Chromatography

- In chromatography, two phases (mobile phase and stationary phase) are involved.
- The mobile phase contains the analyte (the substance to be analyzed) and the carrier gas or solvent.
- The compound used as the stationary phase depends on the physical properties of the analytes. The stationary phase used in the analysis of VOCs is usually a polar polymeric material, such as silica gel or alumina.

Chromatography

- In the paper chromatographic experiment, the mobile phase is the solvent (ethanol), and the stationary phase is the water adsorbed on the surface of the chromatographic paper.
- Two commonly used chromatographic methods: gas chromatography (GC) and liquid chromatography (LC).
- Mobile phase of GC and LC are gas and liquid respectively.

Mass Spectrometry

- Mass spectrometer (MS) is commonly coupled with GC or LC as a detector for identification of the compounds in the sample after separation.



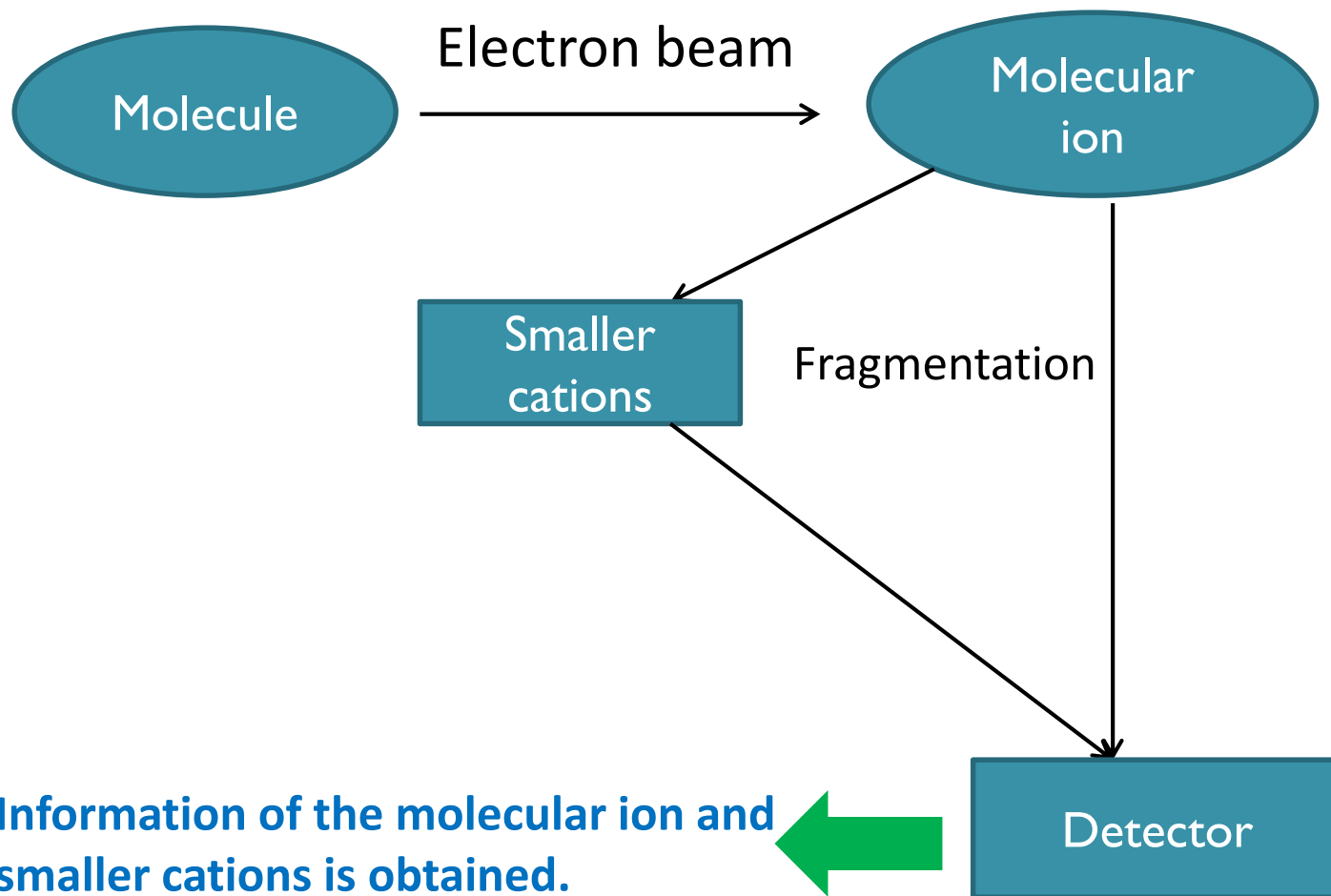
Mass Spectrometry

- MS involves the bombardment of molecules of a compound (M) with an electron beam to give cations of M (the molecular-ion).



- The molecular-ion can undergo fragmentation inside the mass spectrometer to give smaller fragmented ions.
- The molecular-ion and the fragmented ions are detected by the detector in MS.

Pictorial Explanation of MS





This seminar covers the following aspects of VOCs:

- their definitions
- their sources
- hazards of VOCs
- commonly used sampling and analytical methods
- accreditation

Glossary (詞彙)

Volatile organic compound (VOC)	揮發性有機化合物
Gas chromatography (GC)	氣體色譜法
Liquid chromatography (LC)	液體色譜法
High performance liquid chromatography (HPLC)	高效液體色譜法
Paper chromatography	紙色譜法
Mobile phase	移動相
Stationary phase	固定相
Carrier gas	載體氣
Polar molecule	極性分子
Photochemical smog	光化煙霧
Visibility	能見度

External Resources

Education Bureau (EDB) of HKSAR

- <http://resources.edb.gov.hk/chemtech/>

(You need to install Shockwave in order to be able to view it.)

Royal Society of Chemistry

- <http://www.youtube.com/watch?v=08YVWhLTjlfo>

- http://www.youtube.com/watch?v=kz_egMtdnL4

EDB Glossary

- The link to EDB Glossary (Chinese/English) is

<http://www.edb.gov.hk/tc/curriculum-development/kla/science-edu/ref-and-resources/glossary.html>