



# The Spectrum of Volatile Organic Compounds (VOCs) In Our Life

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**Abstract:-** These days the range of Volatile organic compounds (VOCs) has spread over our health, comfort, daily life and furthermore in climate. This distribution outlines diverse VOCs, their sources and connection among VOCs and human health. The volatility organic compounds (VOCs) are available in huge sum in indoor air just as outside air. The level of about 0.2mg/m<sup>3</sup> of unstable natural compound have no impact and about 3mg/m<sup>3</sup> irritatingly affect us. So we are going to contemplating the Volatile organic compounds (VOCs) as a piece of our everyday life through the proof we've gathered.

**Keywords:** Volatile Organic Compounds (VOCs); Sources, classification, Rate of Emission of VOCs; Human health effects and it's control.

## I. INTRODUCTION

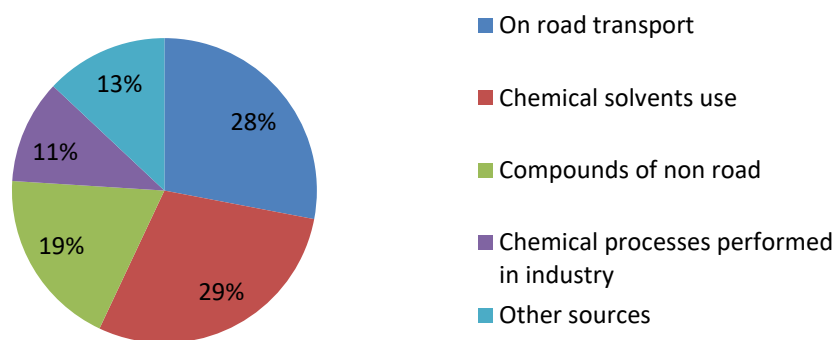
Nowadays, volatile organic compounds have become a part of our lives, because they are present not only in all the places around us, but also in the air. These compounds have low boiling temperatures, which is why they can evaporate at normal room temperature. As a result compounds are present both indoors and outdoors. Volatile organic compounds are chemical compounds (carbon) that are photochemical reactants. VOCs in a range of boiling points range from 50 -100°C lower range, to 240-260°C higher range (WHO, 1989). VOCs have a molecular weight of about 50-30 Daltons. These organic compounds are derived from fuels, automobiles, industries, furnishings, oil transportation and storage, cooking oil fumes. It has short and long term health effects in our body too and through this the spectrum of VOCs spreads in our body and environment.

## II. RESEARCH METHODOLOGY

In this paper we attempt to focus the overwhelming the range of VOCs in our life. In this work, very fundamental investigation system is used as auxiliary information sources like news, articles, ecological science books, web pages, Government's act and guidelines of VOCs pollution, sources, human wellbeing impacts and control.

## III. SOURCES OF VOCs

The sources of VOCs in different ways with percentage are shown below through the pie diagram (Fig.1): <sup>[18]</sup>



**Fig.1- Approximate Percentage of VOCs Sources**

#### **NATURAL SOURCE:**

1. Dairy farms: As we know methane ( $\text{CH}_4$ ) is most commanding greenhouse gas and it is emitted from dairy farm. It is a major volatile compound which polluted air. <sup>[1]</sup>
2. Forest fire: Fire in forest also emitted a large amount of contaminants such as carbon monoxide, nitrous oxide ( $\text{N}_2\text{O}$ ), methane ( $\text{CH}_4$ ).
3. Plant source: Plant discharge some gaseous substances composed of carbon, which is used to attract pollinators are also called volatile organic compound. <sup>[2]</sup>
4. Volcanic exaggeration: Volcanic eruption released huge amount of organic and inorganic compounds, such as  $\text{CO}_2$ ,  $\text{H}_2\text{S}$ , alkanes, aromatic compounds. <sup>[3]</sup>

#### **INDOOR SOURCES:**

- 1) House equipment:
  - a) Paint: painting of walls produce volatile organic compounds in air. Paints are composed of different chemical substances like Toluene which vaporize in the air during painting.
  - b) Dry cleaning: Dry cleaning of clothes is done by using some petroleum compounds which emits VOCs. <sup>[4]</sup>
  - c) Carpet: carpets are made up of different types of polyester and nylons. After few years of installation, they start emitting odorant substances containing VOCs. <sup>[5]</sup>
- 2) Household accessories: Aerosol spray -perfumes, disinfectant, cosmetics pesticides discharge VOCs in air.
- 3) Activities: Indoor activities like smoking contain high levels of volatile gaseous component which polluted indoor. Indoor firewood also releases gaseous substances during burning of woods.

#### **OUTDOOR SOURCE:**

- 1) Busy areas: Busy areas like in traffic signals lots of vehicles release gasoline or diesel exhaust particles which contain hydrocarbon like alkenes, aromatic compound like benzene in the air which harmful to our health. <sup>[6]</sup>
- 2) Industries: Industries are main outdoor source of VOCs which manufactures different kind of products by using huge number of chemicals like fuel oxygenates, trichloroethylene, carbon dioxide, carbon monoxide, chloroform benzene.

#### **ANTHROPOGENIC SOURCE:**

Fossils fuels are evaporated in the air like ethyl acetate. Bio fuels like cooking oil are also act as source of VOCs.

IV. CLASSIFICATION OF VOCs: <sup>[7]</sup>

VOCs are classified in the table below according to the power of instability.

Types of volatile compound	Melting point (°C)	Examples
Highly volatile compounds	<0 to 50- 100 °C	Methyl chloride, propane, butane
Volatile organic compounds	50-100 to 240- 260 °C	Ethyl alcohol, acetone, formaldehyde, toluene
Moderately volatile compounds	240-260 to 380-400 °C	DDT, plasticizer like different pesticides, fire retardant

## V. RATE OF EMISSION FROM DIFFERENT SOURCES

Dairy cows have a role on formation of ozone potential per volatile compound release from biological sources such as dairy farms. Amounts are listed below in the table: <sup>[16]</sup>

Names of volatile compounds	Amounts release (microgram cow <sup>-1</sup> sec <sup>-1</sup> )
Isoprene	0.28 ± 0.08
Methanol	11.2 ± 4.8
Acetaldehyde	0.61 ± 0.19

Performing the test chamber experiment to determine the emission rate of some volatile organic compound by Meteusz Kozicki, we get the average value of emission after 3 days from the emission chamber. Values are given below in the table: <sup>[17]</sup>

Name of the compound	Concentration(microgram/m <sup>3</sup> )
N Butanol	11 ± 2
Benzene	7 ± 1
Benzaldehyde	19 ± 3
Propyl benzene	4 ± 1

## VI. EFFECTS OF VOCs ON HUMAN HEALTH

Different volatile compounds which enters through the respiratory tract results nausea, dizziness, irritation of eyes. High concentration of volatile organic compounds causes disease in lungs, liver, kidney. Sometimes it causes cancer. Long term exposure to volatile organic compounds is injurious to health. Volatile organic compounds (VOCs) are emitted as gases from certain solid substances also. Health effects depend on level of duration type of VOCs and strength of exposure (shown in Fig.2). <sup>[8]</sup>

Acute Health Effects:

- Irritation- Irritations of eyes, nose and throat is caused by Acrylonitrile, Benzene, Xylene. <sup>[11]</sup>
- Headaches- Styrene, Benzene, Acrylonitrile causes headaches <sup>[11]</sup>
- Nausea- Mainly Benzene and also other VOCs cause nausea in workers. <sup>[9]</sup>
- Dizziness-Dizziness is observed as an acute health effects due to long term exposure to VOCs like Acrylonitrile, Xylene. <sup>[9]</sup>
- Visual disorder- Sometimes blurred vision is occurred due to Hexane and other VOCs. <sup>[9]</sup>
- Memory impairment- Short term effects like memory difficulties is caused by VOCs. <sup>[10]</sup>

### Chronic Health Effects:

- Neurological effects - Styrene, Toluene, Chlorobenzene, Ethylidene dichloride, Hexane, Xylene effects on the central nervous system which can lead to problems in concentration, depression, weakness of muscle, anxiety, memory loss and peripheral neuropathy. <sup>[11]</sup>
- Reproductive effects - Volatile organic compounds impacts on reproductive system as a result low birth weight, birth, birth defects, miscarriage. <sup>[12]</sup>
- Respiratory response - Reduced lung function, asthma, lung cancer, difficult to breathing, upper respiratory symptoms and lower respiratory symptoms occurs due to long term exposure to VOCs such as Acrolein, Benzene, Formaldehyde, Xylene. VOCs also can cause bronchitis. <sup>[11] [12]</sup>
- Allergic or immune response - Exacerbated allergies caused by VOCs.
- Liver damage - Long term exposure to Chloroform, Tetrachloroethylene (by inhalation) in humans, they effect liver, and promote hepatitis and jaundice. <sup>[11]</sup>
- Kidney damage - VOCs like Xylene affects the function of kidney. <sup>[9]</sup>
- Leukemia/cancer - Indoor air VOCs causes blood cancer. <sup>[13]</sup>
- Cardiovascular response – VOCs, like Benzene elevate blood pressure and enhance cardiovascular disease like irregular heartbeat. <sup>[10] [12]</sup>

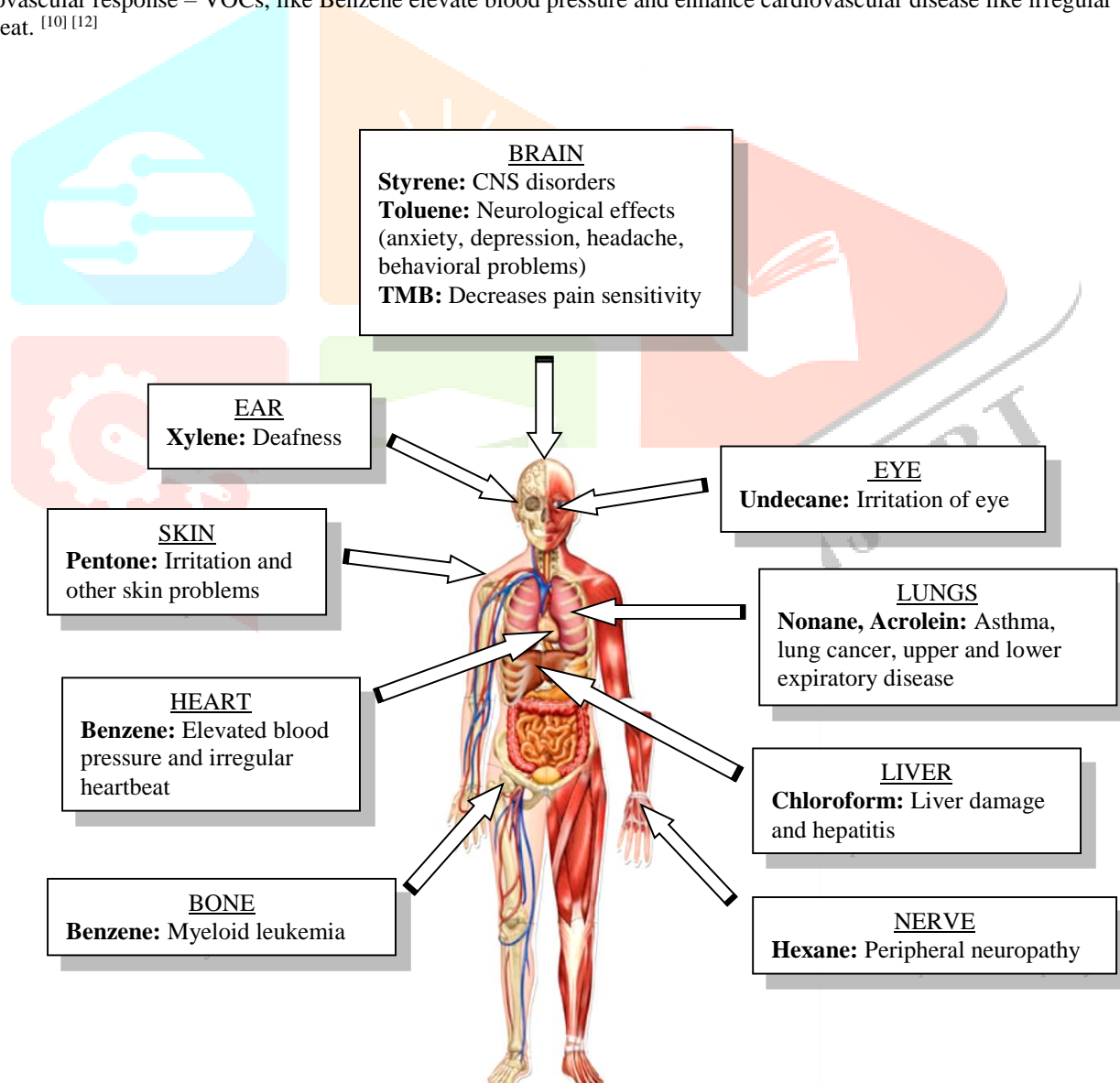


Fig.2: Effects of VOCs on different organs.

### VII. CONTROL

As VOCs are an essential part of our daily life, we can't totally cut sources of VOCs and it's difficult to ban the products as it create so many hazards. But we can control the uses and productivity of the products.

**Control Techniques:**

Since VOCs are an essential part of our daily lives, we cannot completely cut out the sources of VOCs and it is difficult to ban products due to the variety of uses. However we can control the use and productivity of the product.

Control strategies:-

1. General household strategies: -

- A. Increase ventilation when using the product.
- B. Do not store unused paints and similar materials in open containers.
- C. Formaldehyde, one of the most well-known VOCs, can be measured. Identify and remove the source if possible. <sup>[4]</sup>
- D. Use household products according to the manufacturer's direction.
- E. Dispose of unused or underused utensils safely
- F. The best way to control VOCs is to buy a limited amount of products or to purchase products that have no VOCs.
- G. Eliminate benzene exposure (main internal source) by eliminating smoking indoors. Provide maximum ventilation during painting. <sup>[4]</sup>

2. Industry level control:-

Two main methods are applied at the industry level to control the emission of VOCs. <sup>[14]</sup>

- A. Installation of control equipment to destroy or purify organic vapors from exhaust gases. (Capture system). <sup>[14]</sup>
- B. Changing raw materials that reduce or eliminate vapor emissions. (Control device)

**Governmental work to control VOCs emissions:**

1. To tackle regional VOC pollutants problem government has implemented a wide range of measures to reduce VOC emission including-

- a) Controlling emissions from motor vehicle, industrial and commercial processes and VOC containing products.
- b) GPG or Guangdong Provincial Government is also working on this to reduce VOC emissions in the Pearl River Delta region. <sup>[15]</sup>

2. Keeping the target same, some control regulations are implemented by HKSAR government:-

- a) Under Air Pollution Control Ordinance (APCO) in April 1999 remunerate recuperation of petroleum fume released during petroleum dumping at petroleum filling stations distributed the guideline in March 2005 to stretch out the recuperation to vehicle refueling. <sup>[15]</sup>
- b) Severe the Emission Standard Law of the engine vehicle in the European Union.
- c) Implemented VOC guideline laws from stages 1<sup>st</sup> April 2007, to control the VOC in design covering, printing inks and so forth. In 2017 the law is additionally reached out to cover wellspring arrangements and printing machine cleaning specialists with impact from 1<sup>st</sup> Jan 2018.

3. In the metro cities there are 19 VOC monitor sites. Use at least one VOC monitoring machine to collect data in Air Monitoring project sites. <sup>[15]</sup>

**Rules and Regulations for controlling VOCs:**

YEAR	REGULATIONS
2010	For the first time VOC was added into the list of priority air pollutants.
2011	For the first time different thoughts on the construction of monitoring system for VOCs were submitted.
2012	The 12 <sup>th</sup> Five Year Plan for priority area of Air Pollution Control (APC) requested VOCs to be controlled.
2013	The Air Pollution Prevention and Control Action Plan were disseminated.
2014	The plan to prevent pollution of VOCs in the Petrochemical industry was disseminated.
2015	"The Air Pollution Control Act" was recognised and for the 1 <sup>st</sup> time VOCs were added into the laws of supervision.
2016	March: The 13 <sup>th</sup> Five Year Plan requested VOCs to be consolidated 10% by 2020 July: The VOCs reduction plan for priority industries was disseminated.
2017	"The 13 <sup>th</sup> Five Year Plan" for VOCs reduction was disseminated.
2018	January: The Environmental Protection Tax Act came into force, embedded to part of VOCs. July: "The Three Year Action Plan" to prevent Air Pollution was notified, which include VOCs as important target.
2019	June: The extensive plan to VOCs in priority industries was proclaimed. July: The Industrial Furnace Air Pollution Prevention Plan was proclaimed. Standards and guidelines for emission of volatile organic compounds came into force.
2020	March: A total of seven standards for limit of VOCs content in fixatives and limit of harmful substances in industrial protective coating etc. were notified. June: The countermeasure strategy for VOCs emission was notified.

**N.B-** Before 2016 there was not any particular VOCs notifying Acts for supervision of VOCs. 2015 is the turning point for VOC management system. After 2016 the supervision of VOCs, grab attention and controlling guidelines improved. <sup>[19]</sup>

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