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# The Study of Volatile Organic Compounds (VOCs) From Vehicular Pollution

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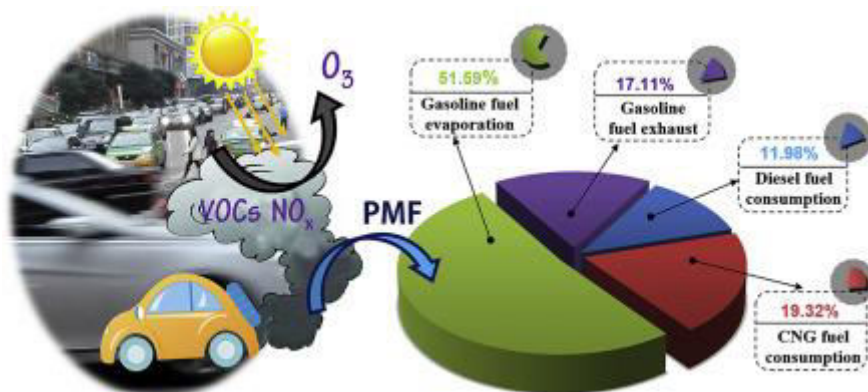
**ABSTRACT:** Volatile organic compounds (VOCs) include a variety of chemical gases emitted from solid objects or liquids. Thousands of common, every-day-use household products contain VOCs, including paint, varnish, wax, and various cleaning, degreasing, and cosmetic products. Burning fossil fuels also results in the release of VOCs into the atmosphere. Common emissions sources of VOCs include dry cleaners; auto body shops; cars, trucks, and buses; lawn mowers and other landscaping equipment; and industrial painting and coating operations. Natural processes, like plant and animal respiration and organic decomposition, also release VOCs into the atmosphere. VOCs are an important pollutant because of their contribution to the formation of ground-level ozone. When VOCs are released into the atmosphere, they react with nitrogen oxides (NO<sub>x</sub>) to create ozone molecules. UV radiation from the sun speeds up the reaction, which is why ground-level ozone production is higher on hot, sunny days. Ground-level ozone can have many impacts on human health, and is the key pollutant that causes smog.

**KEYWORDS:** VOCs, vehicles, emissions, atmosphere, pollution, health, smog, respiration, ozone

## I. INTRODUCTION

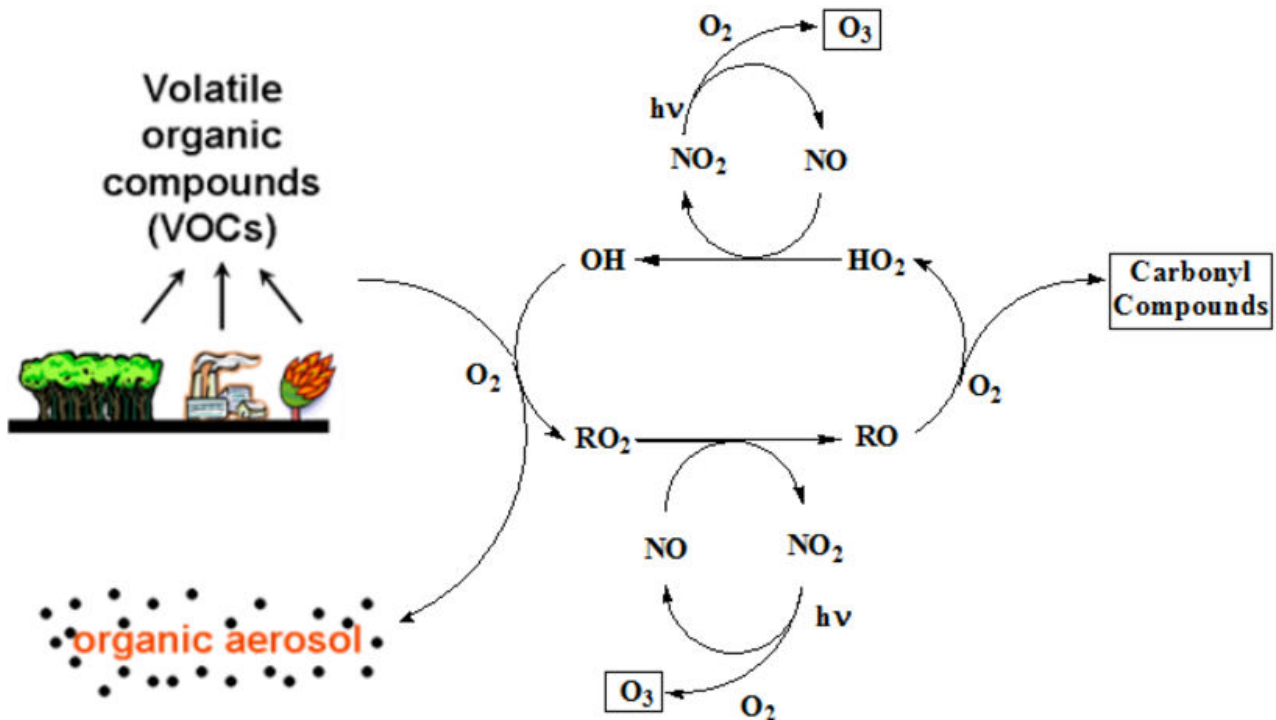
Volatile organic compounds are compounds that have a high vapor pressure and low water solubility. Many VOCs are human-made chemicals that are used and produced in the manufacture of paints, pharmaceuticals, and refrigerants. VOCs typically are industrial solvents, such as trichloroethylene; fuel oxygenates, such as methyl tert-butyl ether (MTBE); or by-products produced by chlorination in water treatment, such as chloroform. VOCs are often components of petroleum fuels, hydraulic fluids, paint thinners, and dry cleaning agents. VOCs are common ground-water contaminants.[1,2]

Volatile organic compounds (VOCs) are emitted as gases from certain solids or liquids. VOCs include a variety of chemicals, some of which may have short- and long-term adverse health effects. Concentrations of many VOCs are consistently higher indoors (up to ten times higher) than outdoors. VOCs are emitted by a wide array of products numbering in the thousands. Examples include: paints and lacquers, paint strippers, cleaning supplies, pesticides, building materials and furnishings, office equipment such as copiers and printers, correction fluids and carbonless copy paper, graphics and craft materials including glues and adhesives, permanent markers, and photographic solutions.

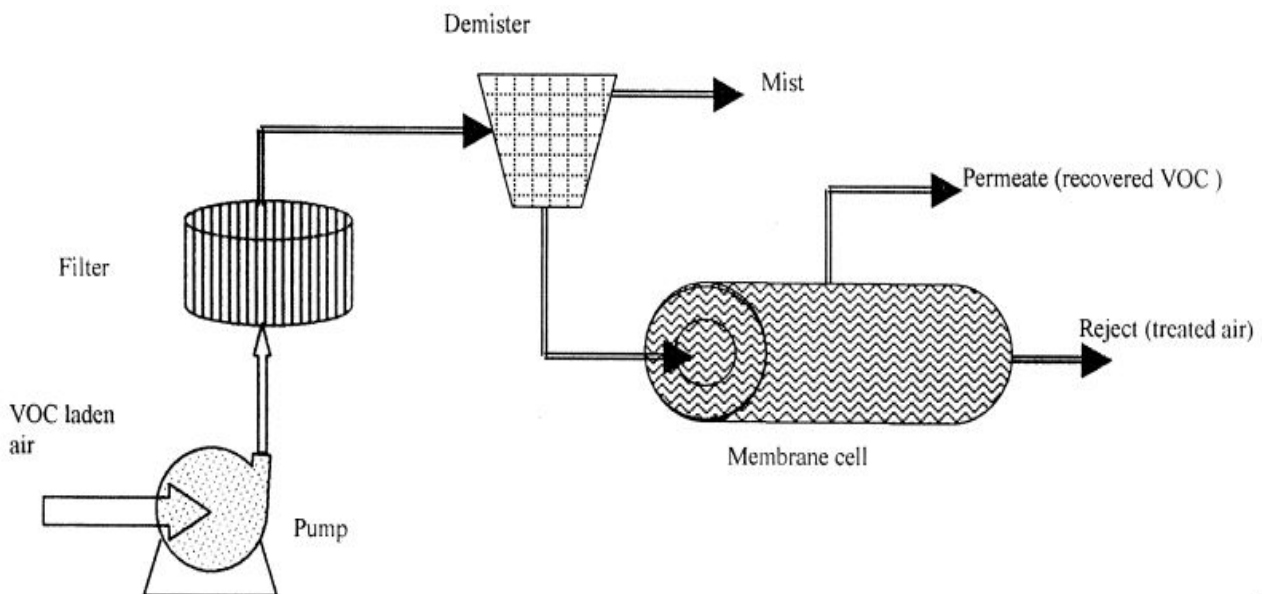


Organic chemicals are widely used as ingredients in household products. Paints, varnishes, and wax all contain organic solvents, as do many cleaning, disinfecting, cosmetic, degreasing, and hobby products. Fuels are made up of organic

chemicals. All of these products can release organic compounds while you are using them, and, to some degree, when they are stored.[3,4]



EPA's Total Exposure Assessment Methodology (TEAM) studies found levels of about a dozen common organic pollutants to be 2 to 5 times higher inside homes than outside, regardless of whether the homes were located in rural or highly industrial areas. Additional TEAM studies indicate that while people are using products containing organic chemicals, they can expose themselves and others to very high pollutant levels, and elevated concentrations can persist in the air long after the activity is completed.



VOCs removal from polluted air

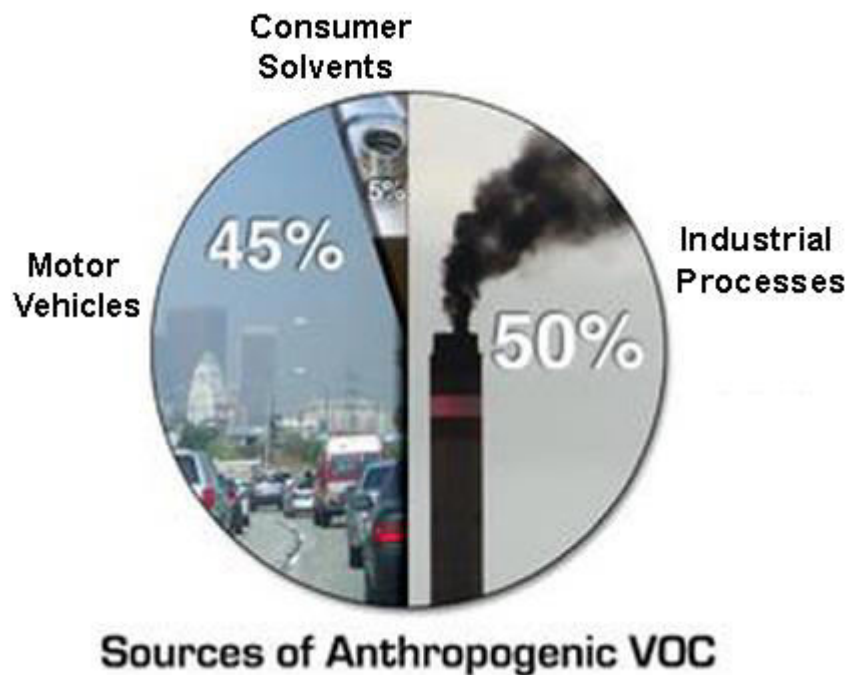
Health effects may include:

- Eye, nose and throat irritation
- Headaches, loss of coordination and nausea
- Damage to liver, kidney and central nervous system
- Some organics can cause cancer in animals, some are suspected or known to cause cancer in humans.[5,6]

Key signs or symptoms associated with exposure to VOCs include:

- conjunctival irritation
- nose and throat discomfort
- headache
- allergic skin reaction
- dyspnea
- declines in serum cholinesterase levels
- nausea
- emesis
- epistaxis
- fatigue
- dizziness

The ability of organic chemicals to cause health effects varies greatly from those that are highly toxic, to those with no known health effect.



As with other pollutants, the extent and nature of the health effect will depend on many factors including level of exposure and length of time exposed. Among the immediate symptoms that some people have experienced soon after exposure to some organics include:



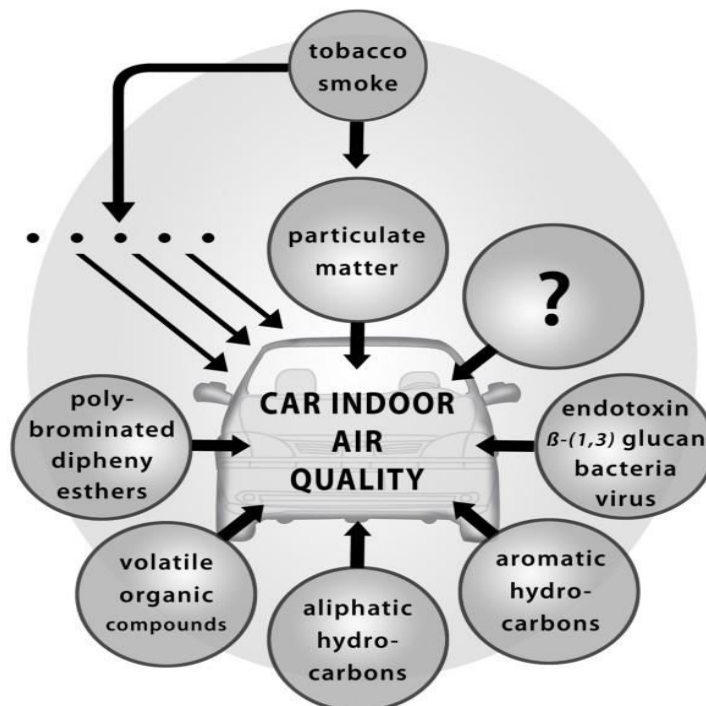
- Eye and respiratory tract irritation
- headaches
- dizziness
- visual disorders and memory impairment

Studies have found that levels of several organics average 2 to 5 times higher indoors than outdoors. During and for several hours immediately after certain activities, such as paint stripping, levels may be 1,000 times background outdoor levels.[7,8]

## II. DISCUSSION

### Steps to Reduce Exposure

- Increase ventilation when using products that emit VOCs.
- Meet or exceed any label precautions.
- Do not store opened containers of unused paints and similar materials within the school.
- Formaldehyde, one of the best known VOCs, is one of the few indoor air pollutants that can be readily measured.
  - Identify, and if possible, remove the source.
  - If not possible to remove, reduce exposure by using a sealant on all exposed surfaces of paneling and other furnishings.
- Use integrated pest management techniques to reduce the need for pesticides.
- Use household products according to manufacturer's directions.
- Make sure you provide plenty of fresh air when using these products.
- Throw away unused or little-used containers safely; buy in quantities that you will use soon.
- Keep out of reach of children and pets.
- Never mix household care products unless directed on the label.[9,10]



Follow label instructions carefully.

Potentially hazardous products often have warnings aimed at reducing exposure of the user. For example, if a label says to use the product in a well-ventilated area, go outdoors or in areas equipped with an exhaust fan to use it. Otherwise, open up windows to provide the maximum amount of outdoor air possible.

Throw away partially full containers of old or unneeded chemicals safely.

Because gases can leak even from closed containers, this single step could help lower concentrations of organic chemicals in your home. (Be sure that materials you decide to keep are stored not only in a well-ventilated area but are also safely out of reach of children.) Do not simply toss these unwanted products in the garbage can. Find out if your local government or any organization in your community sponsors special days for the collection of toxic household wastes. If such days are available, use them to dispose of the unwanted containers safely. If no such collection days are available, think about organizing one.[11]

Buy limited quantities.

If you use products only occasionally or seasonally, such as paints, paint strippers and kerosene for space heaters or gasoline for lawn mowers, buy only as much as you will use right away.

Keep exposure to emissions from products containing methylene chloride to a minimum.

Consumer products that contain methylene chloride include paint strippers, adhesive removers and aerosol spray paints. Methylene chloride is known to cause cancer in animals. Also, methylene chloride is converted to carbon monoxide in the body and can cause symptoms associated with exposure to carbon monoxide. Carefully read the labels containing health hazard information and cautions on the proper use of these products. Use products that contain methylene chloride outdoors when possible; use indoors only if the area is well ventilated.

Keep exposure to benzene to a minimum.

Benzene is a known human carcinogen. The main indoor sources of this chemical are:

- environmental tobacco smoke
- stored fuels
- paint supplies
- automobile emissions in attached garages

Actions that will reduce benzene exposure include:

- eliminating smoking within the home
- providing for maximum ventilation during painting
- discarding paint supplies and special fuels that will not be used immediately

Keep exposure to perchloroethylene emissions from newly dry-cleaned materials to a minimum.

Perchloroethylene is the chemical most widely used in dry cleaning. In laboratory studies, it has been shown to cause cancer in animals. Recent studies indicate that people breathe low levels of this chemical both in homes where dry-cleaned goods are stored and as they wear dry-cleaned clothing. Dry cleaners recapture the perchloroethylene during the dry-cleaning process so they can save money by re-using it, and they remove more of the chemical during the pressing and finishing processes. Some dry cleaners, however, do not remove as much perchloroethylene as possible all of the time.



Taking steps to minimize your exposure to this chemical is prudent.

- If dry-cleaned goods have a strong chemical odor when you pick them up, do not accept them until they have been properly dried.
- If goods with a chemical odor are returned to you on subsequent visits, try a different dry cleaner.

VOCs play a significant role in the formation of ozone and fine particulates in the atmosphere. Under sunlight, VOCs react with nitrogen oxides emitted mainly from vehicles, power plants and industrial activities to form ozone, which in turn helps the formation of fine particulates. The accumulation of ozone, fine particulates and other gaseous pollutants results in smog that reduces visibility. The economic growth in the Pearl River Delta comes with increased formation of these pollutants, thus aggravating the regional smog phenomenon. Smog is particularly severe under strong sunlight and stagnant weather conditions, e.g. a typhoon approaching, or northerly winds that are common in autumn. Smog can irritate our eyes, nose and throat, or can worsen existing heart and respiratory problems such as asthma. People with heart and lung problems, the elderly and children whose respiratory systems are still developing are most at risk. Healthy adults of all ages who exercise or work vigorously outdoor are more sensitive to the pollution because of their higher level of exposure than people who are less active outdoors. Prolonged exposure to severe smog condition may cause permanent damage to lung tissue and affect our immune system. In addition, smog impairs visibility and has a negative impact on tourism.[12]

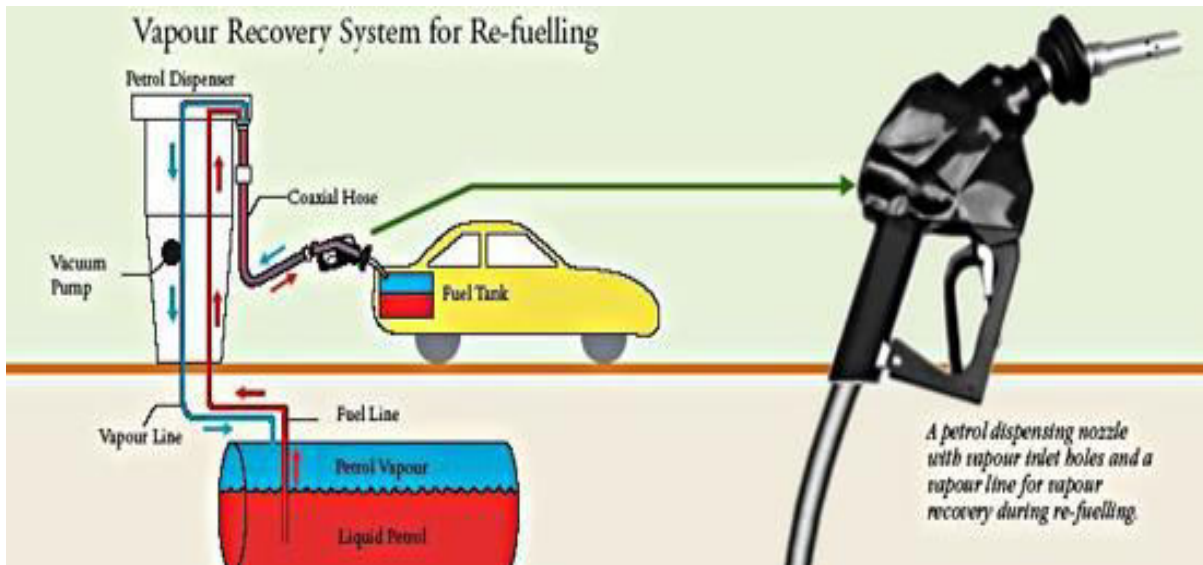
### III. RESULTS

To tackle the regional smog problem, the Government has implemented a wide range of measures to reduce VOC emissions including:

- Controlling emissions from motor vehicles, industrial and commercial processes, and VOC containing products.
- Working with the Guangdong Provincial Government to set targets to jointly reduce VOC emissions in the Pearl River Delta region.

To achieve the VOC reduction targets, the HKSAR Government has implemented the following control measures:

- Introduced a regulation under Air Pollution Control Ordinance (APCO) in April 1999 to require recovery of petrol vapour released during petrol unloading at petrol filling stations and amended the regulation in March 2005 to extend the recovery to vehicle refuelling.



- Tightened emissions standards of motor vehicles in line with the European Union.
- Implemented VOC Regulation in phases since 1 April 2007 to control the VOC content in architectural paints/coatings, printing inks and six selected consumer products (i.e. air fresheners, hairsprays, multi-purpose lubricants, floor wax strippers, insecticides and aerosol insect repellents), and require emission reduction devices to be installed on certain printing machines. The regulation was amended in 2009 to extend the control in phases starting from 1 January 2010 to vehicle refinishing paints/coatings, vessel and pleasure craft paints/coatings, adhesives and sealants. In 2017, the regulation was further amended to cover fountain solutions and printing machine cleaning agents with effect from 1 January 2018.

Help reduce emission of VOCs to the air

- Avoid using aerosol consumer products such as hairsprays, air fresheners, deodorants, and insecticides that often use VOCs as their propellants. Non-aerosol consumer products are usually in pump, solid, liquid, gel, or roll-on forms.
- Replace solvent-based paints with water-based paints. If solvent-based products cannot be avoided, apply them with hand brushes or rollers instead of sprayers to reduce the use of thinners (which are almost 100% VOCs). This also minimizes overspray and wastage. See also A Simple Guide for Architects, Home Owners and Painters to Reduce Paint VOC Emission
- Avoid using VOC-containing products such as organic cleaning solvents.
- Store VOC-containing products in air-tight containers.
- Buy products with less packaging as the printing of packaging materials generates VOCs.
- Drive less, share rides and use public transportation.[13]

#### IV. CONCLUSIONS

Protecting yourself from VOCs

Avoid or limit use of products with high VOCs

- Use products that are low in VOCs, including some sources like paints and building supplies. Look for "Low VOCs" information on the label.
- Use a different approach that reduces the need for products that contain VOCs. For example, integrated pest management can help eliminate or greatly reduce the use of pesticides.





- Buy only as much as you need for the project. Dispose of any leftover or unused products safely.
- Always follow manufacturers' directions when using these products.
- Don't smoke and keep all buildings smokefree. Tobacco smoke contains VOCs among other carcinogens.

Add ventilation when you use products with VOCs indoors

- Open windows and add a fan to pull the indoor air outside while you're using products with high VOCs. Increasing the amount of fresh air in your home will help reduce the concentration of VOCs indoors.
- Let new carpet or new building products air outside to release VOCs before installing them.
- Don't store products with VOCs indoors, including in garages connected to the building.
- Make sure your office or school ventilation systems are working effectively to reduce VOCs produced by printers or copiers.[13]

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