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## Volatile Organic Compounds (VOCs)

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#### What are VOCs?

**VOCs, or volatile organic compounds, are chemicals used to manufacture and prepare many building materials, interior furnishings, textiles, office equipment, cleaners, personal care supplies, and pesticides.** "Volatile" is a term meaning that these chemicals evaporate, or get into the air easily at room temperature. That is why they are an indoor air concern. Studies by the [EPA](#) and other researchers have found that VOCs are common in the indoor environment and that their levels may be ten to thousands of times higher indoors than found in the outdoor air. There may be anywhere from 50 up to hundreds of individual VOCs in an indoor air sample. The majority of these VOCs are found to emit from indoor materials and processes. Some may produce odors at very low levels that are considered objectionable. **Many VOCs are irritants and can result in headaches and eye, nose and throat irritation, and dizziness.** At high concentrations, some VOCs are toxic.

**"Organic" is another chemical term meaning that these types of chemicals contain carbon.** Since carbon burns, many of these chemicals, including organic solvents, are flammable. Common VOCs in homes, offices, and schools include [formaldehyde](#), decane, butoxyethanol, isopentane, limonene, styrene, xylenes, perchloroethylene, [methylene chloride](#), toluene, and vinyl chloride.

**Nevertheless, not just man-made materials produce VOCs.** Some [molds and fungi](#) can give off VOC gases known as microbial VOCs. These MVOCs are responsible for the characteristic odors produced by molds characterized as "musty, earthy, and moldy." Microbial VOCs are unique and include certain aldehydes, alcohols, and ketones that are not typically found to emit from building materials. Frequently found MVOCs include geosmin, hexanone, and octanols. Some of these MVOCs have been found to be irritants to humans and contribute to [sick building syndrome](#). MVOCs can be easily measured in the air at very low levels, and their presence is an indication of mold contamination. Since mold is frequently found inside walls and other inaccessible areas, MVOC measurements are used as a way of confirming and locating mold contamination.

**VOCs can even be found in small amounts in the air we breathe out of our lungs.** Normal human breath can contain a mixture of several hundred VOCs. Some researchers have even found a combination of 22 VOCs that may even help detect lung cancer since those with lung cancer exhale more VOCs than those without lung cancer. However, this is NOT a way to accurately diagnose lung cancer at this time.<sup>1</sup>

**The total of all volatile organic compounds measured in an air sample is called TVOC or total volatile organic compounds.** The concentration of TVOC is expressed as microgram (ug) per cubic meter of air (m<sup>3</sup>). The TVOC level in a building or home is a good indicator of whether or not there are elevated levels. Most buildings will have TVOC levels ranging from 100 to 500 µg/m<sup>3</sup>. Newly constructed or renovated buildings may temporarily have higher levels that decrease over time. Residential environments may have levels reaching 1000 µg/m<sup>3</sup>, primarily because of frequent use of cleaners, consumer products, and on-going processes such as cooking. In general, residential environments also will have lower air exchange rates, which may result in less dilution of VOCs. Most standards and guidelines consider 200-500 µg/m<sup>3</sup> TVOC an acceptable level in buildings. Levels higher than this may result in irritation to some occupants. However, lower levels can also be an issue if a particularly toxic substance or odorant is present.

### Where are VOCs found?

**One of the biggest contributors to VOCs in the outdoor environment is a gasoline-powered vehicle.** One study in 1994 indicated that motor vehicle emissions could account for more than 70% of VOC emissions in industrialized countries. Gasoline vapors from gasoline stations and refueling operations are another important source of VOCs in urban areas.<sup>2</sup> These can contribute to indoor air quality problems if they are brought in through the fresh air intake of the ventilation system. This can occur in industrialized and urban areas. However, the majority of VOCs found in the indoor environments originate from building materials, indoor furnishings, cleaning supplies, consumer products, and processes such as printing, cooking, hobbies, cleaning, interior renovations, and pesticide applications.

Recent studies conducted as part of the state of Washington's East Campus Plus Program showed that **96% of the VOCs found in a large office building following construction resulted from the materials used to construct and furnish** the building. Contributors included hard surface and carpet flooring materials, paints, adhesives and sealants, office furniture, computers, insulations, vinyl wallcoverings, ceiling tile, cabinetry, fireproofing, and textile furnishings. Significant VOCs included ethylene glycol from paint, 2-butenal from carpet tile adhesive, and nonanal from office furniture.

**Studies show that VOC concentrations are usually higher indoors than outdoors.** In Britain, there was a study of 174 homes in the Avon district of England. As part of the study, they found that TVOC concentrations indoors was usually ten times higher than the TVOC concentration outside.<sup>3</sup> In addition, during and for several hours immediately after certain activities, such as paint stripping, levels could be 1,000 times background outdoor levels.

### VOCs are commonly found in hundreds of things including:

- Furniture
- Paint
- Paint strippers
- Adhesives/glues
- Solvents
- Upholstery
- Contaminated water
- Carbonless (NCR) copy paper
- Building materials
- Aerosol sprays
- Disinfectants
- Fuels
- Tobacco smoke
- Air fresheners/deodorizers

- Draperies
- Carpet
- Spray cans
- Clothing
- Cleaning products
- Copy machine toners
- Felt-tip markers/pens
- Correction fluid
- Pesticides
- Mothballs
- Dry-cleaned clothing
- Hairsprays
- Perfumes
- Nail polish
- Fabric softeners

### Are there health problems that can be caused by VOCs?

There are many factors that determine if one might get sick due to exposure to VOCs. These include:

- **The concentration and amount** of the chemical as well as its ability to evaporate into the air
- **Personal characteristics** such as age, gender, weight, general health status
- **How is one exposed** to the chemical? Do they **breathe** it in? Does it get on the **skin**?
- Is a person **exposed to just one chemical** or is it a variety of chemicals?
- **How long is one exposed** to the chemical? In general, **the longer the exposure, the more risk**. Health problems caused by VOCs can either be acute, which occur immediately or within a few days of exposure, or they can be chronic, which are long-term health effects that might not show up for many years.

### Some immediate health effects to VOCs may include:

- Eye, nose, and throat **irritation**
- **Headaches**
- Allergic **skin** reaction like a rash
- Difficulty **breathing**
- **Nausea** and/or vomiting
- **Nosebleeds**
- **Fatigue**
- **Dizziness**
- **Loss of coordination**
- **Confusion**

**Some long-term health effects may occur after repeated exposure** including damage to the heart, liver or kidneys; cancers; or damage to the central nervous system. For example, more than 3,000 excess leukemia cases annually can be linked to benzene. In the late 1980s, the U.S. Environmental Protection Agency showed that, although most benzene in the atmosphere comes from car exhausts and refineries, these sources account for only one fifth of the benzene people breathe in. The rest comes from cigarette smoke, solvents in the home and the use of other chemical-based products, such as spray bathroom cleaners.<sup>4</sup> The use of benzene has decreased dramatically in the U.S., and it is seldom seen in emissions of newly manufactured products. In many cases, its presence has been replaced by toluene, which is the most commonly found VOC in buildings.

Recent studies have shown a correlation between exposures to organic solvents and pesticides and Alzheimer's disease.<sup>5</sup>

### What about TVOC (total VOC)?

**The TVOC level in air is used as an indicator of whether or not elevated VOCs exist in a building.** There have been some studies that show that mixtures of low levels of VOCs can cause sensory irritation responses from those exposed. Human responses can include perception of poor indoor air quality or "general discomfort"; irritation to the eyes, nose, and throat; discomfort due to odor; and headache. TVOC can be easily measured in the air. Results are usually compared against the following guide:<sup>5</sup>

Less than 0.20 mg/m <sup>3</sup>	No irritation or discomfort expected
0.20-3.0 mg/m <sup>3</sup>	Irritation and discomfort may be possible
3.0-25.0 mg/m <sup>3</sup>	Discomfort expected and headache possible
Greater than 25 mg/m <sup>3</sup>	Toxic range where other neurotoxic effects may occur

### How can exposure to VOCs be decreased?

- The best way to reduce your exposure to VOCs is by **reducing products in your home and workplace** that contain VOCs. Try to **find safer substitutes**. When buying paints and stains, look for labels that describe a "**low-emitting formula**" and state that the product has a low VOC content. Even when using a low-VOC product, be sure to have adequate ventilation. Look for formaldehyde-free products.
- **Purchase and use building materials and furnishings** that have been certified to emit low levels of VOCs and have been tested for their indoor environment acceptability.
- Use **detergent-based cleaners** that are biodegradable; avoid ones that say "danger," "caution" or "flammable." Use non-fragranced cleaners or polishes you rub on rather than spray. Often cloths dampened with water work well to control dust.
- **Buy furniture and cabinets made from solid wood**, not pressed wood, which is bound together with formaldehyde. If necessary, seal any pressed wood shelving and cabinetry with coatings shown to seal in formaldehyde.

- **To minimize VOCs from carpet, buy carpets that have a "Green Label"** to show they have been tested for lower levels of VOCs by the **Carpet and Rug Institute's** indoor air-quality carpet testing and labeling program. These products have met the testing standards of the Institute-the national trade association for the carpet and rug industry-and carry a label with "**CR!**" inside a house icon. It is a voluntary program in which carpet has to meet certain emissions criteria for VOCs. The program has complementary VOC emissions criteria for carpet adhesives and cushions so only use those with the Green Label.
- **Avoid air fresheners/deodorizers aerosolized products** and other fragranced products that add additional VOCs to the air.
- **Minimize the use of pesticides** indoors. Instead, use procedures to manage cleanliness and avoid them. If necessary, use only pest-control companies licensed by the state; call the **EPA** to make sure that company has not had any violations. **Avoid indoor "smoke bombs"** that kill insects while blanketing everything in the home in pesticides.
- **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. 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.
- **Purchase in quantities you will use soon.** 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.
- **Store chemicals out of reach of children and pets.**
- Products containing **VOCs should be stored in tightly sealed containers** in a secure and well-ventilated area.
- **Never store opened** pesticide, paint, or other chemicals in containers indoors or in air handling rooms of commercial buildings.
- **Use household products according to manufacturers' directions.** Read labels carefully and follow directions closely.
- **Never mix household care products** unless directed on the label.
- Use **household products** outdoors or in **well-ventilated places**.
- **Keep exposure to vapors from products containing methylene chloride** to a minimum. These products include paint strippers, adhesive removers, and aerosol spray paints. Methylene chloride is known to cause cancer in animals. It is also converted to **carbon monoxide** in the body and can cause

symptoms associated with exposure to carbon monoxide.

- **Air out freshly dry-cleaned clothes before wearing.** This is because of perchloroethylene off-gassing from newly dry-cleaned materials. 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. Taking steps to minimize your exposure to this chemical is important. If dry-cleaned items 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.
- **Prevent moisture build-up** inside that could result in the growth of VOC-producing molds. Keep humidity levels below 60% and make sure that all water leaks are cleaned up rapidly.
- **Air out newly manufactured homes and buildings** or newly renovated or furnished areas with fresh, clean outdoor air for a minimum of one week or until the new odors dissipate.
- **Maintain building ventilation** with a minimum of 15-20% of outdoor air per person during normal operation so adequate dilution air is provided.
- **Avoid products with long-lasting odors.**
- **Place VOC processes** such as photocopy machines, printers, and photographic development in **rooms with special ventilation systems** so that process exhaust is taken out of the building and not recirculated.
- **Provide local exhaust systems** for processes and machines that may emit VOCs.
- **Use low-emitting, non-fragrant cleaning materials, and personal care items.**

Though you will not be able to get rid of all sources of VOCs, the more you decrease your exposure to VOCs, the less there will be to get inside your body.

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## References

1. Phillips M, Gleeson K, Hughes J, Michael B, Greenberg J, Cataneo RN, Baker L, McVay WP. Volatile organic compounds in breath as markers of lung cancer; a cross-sectional study. *Lancet*. 1999;353(9168):1930-3.
2. Jo WK, Moon KC. Housewives' exposure to volatile organic compounds relative to proximity to roadside service stations. *Atmospheric Environment*. 1999;33:2921-8.

3. Yu C, Crump D. A review of the emission of VOCs from polymeric materials used in buildings. *Building and Environment*. 1998;33 (6):357-374.
4. O'Connell A. "Unseen perils are lurking in your home." *The Times* (London), April 11, 2000.
5. Mølhave L. Indoor air quality in relation to sensory irritation due to VOCs. *ASHRAE Transaction*. 1992.

#### **Other Resources**

- Miller JD, et al. Fungi and Fungal Products in Some Canadian Homes. *International Biodeterioration* 1988;24:103-120.
- Mølhave L. Volatile Organic Compounds, Indoor Air Quality and Health. Presented at The 5th International Conference on Indoor Air Quality and Climate, Toronto, Canada, 1990.
- Morey PR, Horner WE, Epstien BL, Worthan AG, Black MS. Indoor Air Quality in Nonindustrial Occupational Environments. In: Harris RL, ed. *Patty's Industrial Hygiene*, 5th ed. New York, NY: John Wiley & Sons, 2000:3149-3241.
- State of California Air Resources Board. Indoor Air Quality Guideline for Formaldehyde in the Home, September 1991. (916) 323-5043
- Strom G, et al. Microbial Volatile Organic Compounds (MVOCs). Presented at the International Conference on Building Design, Technology and Occupant Well-being, ASHRAE, Atlanta, Georgia, 1993:351-357. (404) 636-8400

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