

Volatile Organic Compounds and the Office Environment

Limited Exposure Assures Occupant Health and Comfort

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The term "volatile organic compounds" (VOCs) refers to all organic compounds with a boiling point of greater than 50°C and less than 260°C. Major VOC sources in buildings include furnishings, construction materials, occupant operations, maintenance and custodial chemicals, infiltration of external contaminants and the occupants themselves.

Exposure levels referenced in Labour Canada legislation (Threshold Limit Values) are set for general industry, where exposures may be in the range 100 to 1,000 milligrams per cubic meter (mg/m³), to protect against the known toxic effects at these levels. However, the same compounds, present as a mixture of emissions in offices and other non-industrial workplaces, may cause irritation and discomfort at much lower levels.

There are no Canadian or US standards outlining target and action units for total volatile organic compounds (TVOCs) available at present. However, the following references are useful in the interpretation of these measurements.

1. A tentative dose response relation for discomfort from exposure to TVOCs was proposed by Dr. Lars Molhave at Indoor Air 1990, and since then, has received considerable acceptance among IAQ practitioners:

Total Concentration (mg/m ³)	Irritation & Discomfort	Exposure Range
<0.20	No irritation or discomfort expected	Comfort range
0.20 - 30	Irritation and discomfort possible if other stressors (uncomfortable lighting, temperature etc.) or exposure interact expected	Multi-factoral Exposure Range
3.0 - 25.0	Exposure effect and probable headache possible if other exposures intact	Discomfort Range
>25.0	Additional neurotoxic effects other than headaches may occur	Toxic Range

2. A Federal - Provincial Advisory Committee published a guideline, "Indoor Air Quality in Office Buildings," in 1995. This guideline states, "In an exposure rang of 0.3 to 3.0 mg/m³, odours, irritation, and discomfort may appear in response to the presence of TVOCs together with thermal comfort factors and stressors. Above 3.0 mg/ m³ one may expect complaints; above 25.0 mg/m³ temporary discomfort and respiratory irritation have been demonstrated for a common mix of chemicals in an office building."

3. ASHRAE Draft Standard 62-1989R (1996) recommends that concentrations should be no higher than 1.0 mg/m³, a value given as the high end of typical TVOC levels reported in a

number of major multi-building non-residential indoor air surveys.

Based on these references, TVOC concentrations could be managed to be less than the no-effects level of 0.2 mg/m³. However, this may be difficult to achieve at times in office buildings, particularly where the indoor environment is continually exposed to such things as paint, new furnishings, etc.

Variety of Sources

A variety of sources for VOC emissions can be found in indoor and outdoor environments. Outdoor sources include vehicle exhaust or vapours from industrial facilities depending upon the exposure of the building, location of outside air intakes, filtration efficiency etc..

The majority of VOC found indoors originate from indoor air sources. Typically these sources of VOC include:

HIGHLIGHTS

- ◆ The presence of VOC's can cause occupants irritation and discomfort
- ◆ Occupant comfort can be improved by:
 - implementation of control strategies during construction
 - ensuring fabrics and furnishings are carefully selected

- Building materials and fabrics
- New furniture
- Vinyl wall coverings
- Office equipment
- Cleaning materials
- Perfumes, colognes, deodorizers etc.,

Adverse comfort or health effects that may be experienced by building occupants, particularly those who are sensitive to indoor air contaminants, include headaches, irritation to the eyes, nose, skin and throat. There are some building occupants with a low tolerance to VOCs who may become sensitized to further exposure or to specific indoor air compounds.

Materials used during construction of new offices can be a major source of VOCs indoors and often for several months after installation. These materials include paints, carpeting, adhesives, ceiling tiles, particleboard, plywood, new office furniture and so on.

Typical total volatile organic compound (TVOC) levels in the absence of new construction can be in the range of 0.1 to 2.0 mg/m³. However, these ranges will fluctuate as all buildings contain a large range of chemical sources such as plastics, floor cleaners, printers etc.

After construction and without control strategies, these levels could be in a range of 25.0 mg/m³ or higher. These higher levels would cause a response and discomfort from most occupants.

New building materials, if not appropriately selected or installed, can result in VOCs "off gassing" for about six to eight months following completion of construction. Careful selection of new building materials can help reduce VOC concentrations in an occupied space.

Certification and Identification

Manufacturers have voluntarily established initiatives for producing low chemical-emitting products. For example, the Canadian Carpet and Rug Institute (CCI) has adopted a carpet labeling program. This program is a joint effort from carpet manufacturers and the CCI to minimize release of total VOC from carpeting to less than 0.6 mg per square meter per hour.

These emissions would include TVOC, styrene, 4 phenylcyclohexan (4P-C) and formaldehyde. The manufacturer must meet these emission requirements or corrective action will be taken, including re-testing of the

product. The carpeting is tested on an annual basis and labeled to certify conformity.

Formaldehyde emissions from pressed wood products such as plywood and particleboard are a concern, but emissions from these products have decreased as many manufacturers are striving to reduce these emissions. Concerns have also been expressed about exposure to trades who cut these products with power tools.

The CMHC provides good information and guidance to help architects and specifiers choose environmentally friendly building materials.

An example of some strategies that can be adopted to minimize VOC "off gassing" during the construction process include:

1. Use water-based paints, varnishes and adhesives or low-chemical-releasing products.
2. Apply varnish or lacquers to doors or furniture off site in a workshop.
3. Select low-VOC-emitting carpets
4. Request that manufacturers or suppliers "air out" products for several days in their warehouse or in an empty floor before delivery and/or installation.
5. Use plywood, chipboard and other wood products with low VOC and formaldehyde emission properties.
6. Create a good air exchange in the work area, including placing the area under a negative pressure.

Soft fabric materials in a building - such as carpeting, office partitions and furniture - can act as a sink and absorb chemical odours and VOCs. These fabrics also include acoustically insulated ductwork or other insulated HVAC components that are either installed or stored on site during painting, awaiting installation.

Over a longer period of time, those fabrics that have absorbed odours and compounds will "off gas" VOCs back into the occupied space or VOCs absorbed into internally insulated ductwork can also be introduced into the airstream. Consequently, a planned order of construction is important for optimum indoor air quality. For example carpeting and other fabric products should be installed after painting, varnishing and use of adhesives.

Fresh Air

Before occupancy, it would be ideal to maximize the introduction of heated outside air

into the area prior to occupancy for a minimum of 72 hours or more at the completion of all construction. This process will accelerate "off gassing" from newly installed materials and furnishings.

For concerned occupants, air samples could be collected following completion of construction and after an approximate time period, say six months, to evaluate the concentration of TVOCs collected on these two occasions.

A special concern for VOCs and renovation is the possible impact on occupants who suffer from environmental sensitivity or multiple chemical sensitivity (MCS). MCS is a poorly understood and controversial disorder whose sufferers are believed to manifest a wide variety of symptoms in response to low levels of exposure to chemicals.

With the increase in demand from prospective tenants or buyers of new buildings, landlords and developers will have to keep up with current indoor air quality requirements to attract and retain clients.

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