

AN UPDATE ON FORMALDEHYDE



UNITED STATES OF AMERICA
CONSUMER PRODUCT
SAFETY COMMISSION

The U.S. Consumer Product Safety Commission (CPSC) has produced this booklet to tell you about formaldehyde and its potential impact on indoor air quality.

This booklet describes what formaldehyde is, what products it may be found in, where you may come in contact with it, how exposure to formaldehyde may affect your health, and how you might reduce your exposure to it.

What is Formaldehyde?

Formaldehyde is a colorless, reactive, strong-smelling gas at room temperature. It is one chemical in a large family of chemical compounds called volatile organic compounds (VOCs). The term volatile means that the compounds vaporize or become a gas at room temperature. Formaldehyde can be manufactured as a liquid (formalin) or a solid (paraformaldehyde). Formaldehyde is an important industrial chemical used to make other chemicals and different types of products, such as: home furnishings, household cleaners, paints, textiles, landscape and yard products, medicinal and personal care products, and pesticides. Chemicals that are created with formaldehyde or have formaldehyde added to them include the following:

- resins and lubricants
- polyoxymethylene plastics
- 1,4-butanediol
- methylene diphenyl diisocyanate

Formaldehyde can be released into the air (off-gas) from materials and products made with it. Formaldehyde can also be released into the air by automobiles, cigarettes, and burning wood, kerosene or natural gas. It is also a naturally occurring substance.

Why Should You Be Concerned?

Formaldehyde exposure may potentially cause a variety of symptoms and adverse health effects, such as eye, nose, throat, and skin irritation, coughing, wheezing, and allergic reactions. Long-term exposure to high levels of formaldehyde has been associated with cancer in humans and laboratory animals. Formaldehyde can affect people differently. Some people are very sensitive to formaldehyde at a certain level while others may not have any noticeable reaction to the same level.

Formaldehyde is just one of several gases present indoors that may cause adverse health effects and illnesses. Many other gases, as well as respiratory illnesses (e.g., colds and the flu), can cause similar symptoms to those caused by formaldehyde.

What Levels of Formaldehyde Are Present in Consumer Environments?

Formaldehyde is normally present at low levels, usually less than 0.03 parts per million (ppm), in both outdoor and indoor air. The outdoor air in rural areas has lower concentrations while urban areas have higher concentrations (due to sources such as automobile exhaust). Residences or offices that contain products that release formaldehyde into the air can have levels greater than 0.03 ppm.

What Affects Formaldehyde Levels in Indoor Air?

Formaldehyde levels in indoor air can vary depending on temperature, humidity, and air exchange rate within the indoor space. In addition, several studies have shown that, in the presence of ozone, formaldehyde levels increase; therefore, the outdoor and indoor ozone levels are also relevant. Formaldehyde levels in a residence may change with the season, day-to-day, and day-to-night. Levels may be high on a hot and humid day and low on a cool, dry day. Understanding these factors is important when one is considering measuring formaldehyde levels.

| Categories | Results |
|---|---|
| Formaldehyde source | <ul style="list-style-type: none">• Products with sealed surfaces or edges emit¹ less• Products with larger surface areas or those treated with certain finishes (i.e., acid-cured) have potentially increased emissions• Emissions generally decrease as the product ages |
| Temperature | <ul style="list-style-type: none">• Increased emissions with increased temperature• Lowered emissions with lower temperature |
| Humidity | <ul style="list-style-type: none">• Increased emissions with increased humidity• Lowered emissions with lower humidity |
| Air exchange rate ² | <ul style="list-style-type: none">• Increased formaldehyde buildup with a decreased rate |
| Ambient outdoor or indoor ozone concentration | <ul style="list-style-type: none">• Increased creation of formaldehyde in houses that ventilate with:<ul style="list-style-type: none">○ Outdoor air on days with high levels of pollution (i.e., ozone-action days)○ Portable or in-duct devices that intentionally emit ozone into the air or as a chemical by-product |

¹ Release

² The amount of outdoor air entering or leaving the indoor area

What are Some Historical Sources of Indoor Formaldehyde Emissions?

Urea-formaldehyde foam insulation (UFFI): During the 1970s, UFFI insulation was very popular, and many homeowners installed it to save energy. A substantial number of these homes had high levels of formaldehyde in the indoor air soon after installation; however, these levels decreased rapidly after the first few months and reached background levels a few years later. Recently, another urea-formaldehyde (UF) spray foam product has been used for insulation. It is technically classified as a UF material, but it is functionally different from UFFI. Previously, UFFI materials were made of liquid resins with more formaldehyde to maintain their shelf lives, which was directly responsible for the off-gassing issues associated with it. This recent UF spray foam product's liquid resin is produced by reacting controlled amounts of urea and formaldehyde and then drying the liquid to remove any VOCs, including free formaldehyde. Therefore, less formaldehyde would be expected to be released.

Durable-press fabrics, draperies and coated paper products: In the early 1960s, several allergic reactions to formaldehyde were reported from the use of durable-press fabrics and coated

paper products. Such reports have declined in recent years as industry has taken steps to reduce formaldehyde levels, and a recent investigation by the Government Accountability Office (2010) demonstrated only a small number of clothing items with low formaldehyde levels.

What are the Major Sources of Indoor Formaldehyde Emissions in Our Homes Today?

Measuring formaldehyde emissions from *individual* consumer products is difficult because a variety of products in the home can release formaldehyde or trap formaldehyde emitted from other sources. Products with greater emissions and larger surface areas in the home will most likely have a greater contribution to indoor air formaldehyde levels. Keep this in mind when prioritizing the different product types below. Also, not all brands within each product type contain formaldehyde.

Wood floor finishes: Wet commercial, base- and top-coat floor finishes.

- May emit high levels of formaldehyde.
- Emissions decrease 24 hours after application.
- Finishes are not typically available to the consumer, but they can be (re-) applied by commercial floor contractors at residences or factories.

Pressed-wood and wood-based products: Pressed-wood (i.e., hardwood plywood, particleboard, and medium-density fiberboard (MDF)) and wood-based products, especially those containing UF resins, may be a significant formaldehyde source.

- Formaldehyde emissions from pressed-wood products have been reduced 80-90% from levels in the 1980's and earlier due to mandatory formaldehyde emission standards in California and national voluntary formaldehyde emission standards, which are described later in this booklet.
- Emissions decrease 6-10 months after initial testing.

Wallpaper and paints:

- Moderate levels of formaldehyde initially following application.
- Levels formed during the curing process may be higher than after initial application.
- Emissions are sometimes still detectable 1-3 months following application.
- Some paints are now found with low-VOC formulations.

Combustion: Cigarette smoke and the combustion of other materials, such as wood, kerosene, oil, natural gas, and gasoline, produce formaldehyde.

Other materials: Formaldehyde can be created from the chemical reaction between ozone and other VOCs during the use of personal computers, laser printers, and photocopiers.

Re-emitters: Because they are porous, products, such as carpets or gypsum board, do not contain significant amounts of formaldehyde when new. However, they may trap formaldehyde that is emitted into the air from other products and later release it into the indoor air.

What are Some of the Symptoms and Potential Adverse Health Effects of Formaldehyde Exposure?

Formaldehyde exposure can cause a variety of symptoms and potential adverse health effects. A person's ability to smell a chemical odor, such as formaldehyde, does not always mean that the levels of the chemical are of concern or will cause an adverse health effect. Therefore, some people can smell formaldehyde before being adversely affected by it.

| Affected Areas/Systems | Potential adverse health effects |
|-------------------------------|---|
| Eyes | <ul style="list-style-type: none">• Stinging, burning, or itching• Excessive tearing |
| Nose or throat | <ul style="list-style-type: none">• Stinging, burning, or itching• Sore throat• Runny nose• Blocked sinuses• Sneezing• Cancer (human and laboratory animals) |
| Respiratory | <ul style="list-style-type: none">• Chest tightness• Wheezing• Asthma |
| Skin | <ul style="list-style-type: none">• Allergic contact dermatitis<ul style="list-style-type: none">○ Skin rashes, blisters, and flaky dry skin |
| Neurological | <ul style="list-style-type: none">• Headaches• Mood changes (i.e., depression, irritability)• Insomnia• Attention deficit• Nausea• Impairments in dexterity, memory, and equilibrium |

Do You Have Formaldehyde-Related Symptoms?

As discussed above, formaldehyde can induce several symptoms, such as watery eyes, runny nose, burning sensations in the eyes, nose, and throat, and headaches. These symptoms may also occur because of the common cold, the flu, or other pollutants that may be present in the indoor air. In general, if your symptoms lessen when you are away from the home or office but re-occur upon your return, they may be caused by indoor air factors including pollutants, such as formaldehyde.

Examine your environment. Ask yourself a few questions to determine if your symptoms may be related to formaldehyde exposure.

- * Have the flooring or cabinets recently been refinished?
- * Has remodeling occurred using pressed-wood products (i.e., wall paneling)?

- * Have new cabinets, wall coverings, or furniture been installed?
- * Has a wood-burning stove or other combustion source been used?
- * Has an indoor air-cleaner that intentionally generates ozone been used?
- * Have you recently worn new, unlaundered crease-, stain-, or static-resistant clothes?
- * Do you or others smoke indoors?
- * Has your house been tightly insulated recently for energy efficiency?

If the answer is yes to any of these questions and you have re-occurring symptoms as described above, you could have been exposed to formaldehyde. Therefore, you may want to contact your physician and/or state or local health department for further assistance.

How Do You Reduce *Existing* Formaldehyde Levels?

The choice of methods used to reduce indoor air formaldehyde levels is unique to each situation. The most common methods used include:

Remove formaldehyde-emitting products from your home

- Directly reduces formaldehyde levels
- Prevents other materials in the area, such as carpet and gypsum board, from absorbing and then re-emitting formaldehyde

Bring large amounts of fresh air into the home

- Increases ventilation by opening doors and windows and by using an exhaust fan(s) to air out indoor spaces.

Seal the surfaces of formaldehyde-emitting products that are not already laminated or coated

- Use a vapor barrier, such as some paints, varnishes, or a layer of vinyl or polyurethane-like materials
- Seal completely *with a material that does not contain formaldehyde*
- Many paints and coatings emit other VOCs when curing; therefore, ventilate the area well during and after treatment

Install “manufactured-home,” pressed-wood products

- Made with composites meeting the Ultra Low Emission Formaldehyde (ULEF) or No Added Formaldehyde (NAF) requirements¹

Additional specific advice can be obtained from your state or local health department, physician, or professional experts in indoor air quality.

¹ NA-based resins are resins formulated with no added formaldehyde. ULEF resins are formaldehyde-containing resins formulated such that the formaldehyde emissions from composite wood products are consistently below applicable California emission standards. See http://www.arb.ca.gov/toxics/compwood/naf_ulef/naf_ulef.htm for more information.

One method **NOT** recommended by CPSC is a chemical treatment with strong ammonia (28-29% ammonia in water), which results in a temporary decrease in formaldehyde levels. **We strongly discourage such treatment because ammonia in this strength is extremely dangerous to handle.** Ammonia may damage the brass fittings of a natural gas system, adding a fire and explosion danger.

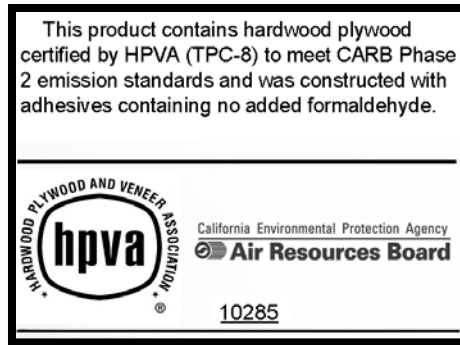
How Do You Reduce Your Exposure to Formaldehyde?

CPSC, the Department of Housing and Urban Development (HUD), the Environmental Protection Agency (EPA), and other federal agencies have historically worked with pressed-wood and other formaldehyde-using industries to reduce the content and release of formaldehyde from their products. As discussed earlier, levels in some products that were historically high have been substantially reduced.

However, many people deliberately or unknowingly come in contact with other products that contain formaldehyde on a daily basis. For most people, a low-level exposure to formaldehyde will not produce any adverse effects. For sensitive people, however, the effects may be different. If you are sensitive to formaldehyde, you will need to avoid many of these everyday items to reduce the possibility of suffering from symptoms.

You can reduce exposure to high levels of formaldehyde by:

- * Installing wood floors or finishes that are not “acid-cured”, which is a type of finish that is formaldehyde-based.
- * Installing pressed-wood products, such as particleboard, MDF, or hardwood plywood, for construction or remodeling of homes or for do-it-yourself projects that are labeled or stamped in compliance with the American National Standards Institute (ANSI) or California Air Resources Board Air Toxics Control Measure (CARB ACTM) criteria.
 - Particleboard should conform to ANSI A208.1-2009 (label designated “-F18” or “-F09” (Grade D2) or “-F20,” “-F18”, or “-F09” (Grade D3)) or the CARB ACTM.
 - MDF should conform to ANSI A208.2-2009 (label designated with “-F21” or “-F11” for MDF > 8 mm thickness; “-F21” or “-F13” for MDF ≤ 8 mm thickness) or the CARB ACTM.
 - Hardwood plywood should conform to ANSI/HPVA HP-1-1994 or the CARB ACTM.
 - The Composite Panel Association (CPA) or Hardwood, Plywood, and Veneer Association (HPVA) stamps (examples below) also certify that products conform to the ANSI standards. These standards all specify lower formaldehyde emission levels.



- * Installing furniture or cabinets that contain a high percentage of panel surface and edges that are laminated or coated. Unlaminated or uncoated (raw) panels of pressed wood products will generally emit more formaldehyde than those that are laminated or coated.
- * Installing alternative products not made with urea-formaldehyde glues, such as wood lumber or metal.
- * Installing “manufactured-home”, pressed-wood products bonded with a phenol-formaldehyde resin system or other pressed-wood products made with composites meeting the ULEF or NAF requirements.
- * Installing insulation that is not based on UF foam.
- * Avoiding high household temperatures.
- * Maintaining humidity in the house at 40-50% by:
 - Installing or using exhaust fans where moisture is generated
 - Using dehumidifiers in humid climates
 - Reducing moisture in crawlspaces or basements (i.e., constructing appropriate drainage or applying vapor barriers)
 - Not using humidifiers or other products to add moisture to already humid air
- * Washing durable-press fabrics before use and not choosing clothing and fabrics that are likely to contain formaldehyde, such as rayon, blended cotton, corduroy, wrinkle-resistant 100% cotton, shrink-proof wool, and heavy stiff fabrics.

Should You Test for Formaldehyde?

It should not be necessary to measure formaldehyde in your indoor air if you reduce existing formaldehyde levels and do not introduce products that emit formaldehyde into your home. However, if you become ill following installation of a product that has been manufactured with formaldehyde, you should consult a physician to determine whether or not your symptoms might relate to indoor air quality problems. If your physician believes that you may be sensitive to formaldehyde, you may want to have the levels of formaldehyde measured.

There are three different ways to measure formaldehyde in indoor air.

1. Indoor air professional: Indoor air quality (IAQ)-related issues can be complex and are often related to building design and function. Trained professionals can:

- Accurately sample for formaldehyde using a variety of methods (some which are not generally available to consumers)
- Control or account for complex factors (home closure, standard temperature/humidity and sample number/location/duration) that might affect formaldehyde levels
- Interpret the results
- Determine if additional sampling is necessary

Currently, there are no state or federal certification programs for IAQ professionals except for lead and asbestos. Therefore, before hiring an IAQ professional, collect information on your IAQ problem.

When interviewing IAQ professionals, consider the following questions:

- * Have they performed similar jobs, and what were the outcomes?
- * Will they include a written report with the data including recommendations?
- * Do they have client references with similar IAQ issues?
- * Do they have certifications and/or memberships in IAQ- related organizations (see below), and what do these certifications or memberships mean?
 - American Board of Industrial Hygiene Certified Industrial Hygienist (CIH)
 - Board of Certified Safety Professionals' Certified Safety Professional (CSP)
 - American Indoor Air Quality Council-Certified Indoor Environmental Consultant (CIEC), Certified Indoor Environmentalist (CIE), or a Certified Indoor Air Quality Manager (CIAQM)
 - American Industrial Hygiene Association member
 - Indoor Air Quality Association member
 - Institute of Inspection Cleaning and Restoration Certification member
 - American Council for Accredited Certification member

Be cautious of persons or businesses advertising formaldehyde testing - there may be unqualified or dishonest individuals seeking to take advantage of consumers. State and local health departments or regional US EPA offices may have listings of licensed professionals in your area.

2. Consumer sampling kits: These kits provide a sample vial or badge (passive sampler) that must be opened and then attached to or hung in a representative area for a prolonged period of time (1-7 days). Following sample collection, the sampler is sealed and mailed to a lab for analysis. Currently, labs are available in the U.S. for analyzing passive samplers.

As with IAQ professionals, sampling kits can vary in their ability to detect formaldehyde. In general, the buyer should consider the following questions before buying a sampler kit:

- * Is the test based on a known method for assessing formaldehyde in air (i.e., NIOSH 3500)?

* Has the test been validated by a reputable laboratory? In searching for a reputable laboratory, consider the following:

- Accreditation by the Industrial Hygiene Laboratory Accreditation Program (IHLAP) of the American Industrial Hygiene Association (AIHA)
- Participation in a Proficiency Analytical Testing (PAT) program collaboratively sponsored by AIHA and the National Institute for Occupational Safety and Health (NIOSH)

- * Does the test have a low detection limit ($\leq 20\text{-}30$ ppb)?
- * Does the test have good accuracy ($\pm 20\%$)?
- * Does the test have minimal interference from other chemicals, such as VOCs or ozone?
- * Does the test have very specific instructions on where to place the sampler and for how long?
- * Does the test include a detailed report with potential recommendations?
- * Does the test include technical support?

3. Consumer Sampling and Analysis Kits: At least one type of combined sample and analysis test kit is available for formaldehyde that provides a one-time reagent and test protocol to analyze for atmospheric formaldehyde without sending the sample off to a lab. This combined kit requires the user to carefully follow instructions and is useful for short-duration exposures only. The accuracy of this combined sampling and analytical test kit is unknown. The buyer should consider the same questions above before buying combined sampler and analysis kits.

Although many air sampling or analysis kits advertise accuracy ranging from 2 to 10 ppb of formaldehyde, these claims may not be supported by rigorous testing or scientific analysis using standard laboratory methods. Also, test results may be difficult to interpret. *Therefore, the reliability of many kits may not be scientifically verified, and the test results may not be of any practical use.*

For more information about formaldehyde, biological pollutants, combustion pollutants, asbestos, and indoor air quality in your home, write or call:

U.S. Consumer Product Safety Commission
4330 East West Highway
Bethesda, MD 20814
CPSC's toll-free hotline: 800-638-2772 (TTY 301-595-7054)
CPSC's web site: <http://www.cpsc.gov>

The following references provide more formaldehyde information:

<http://www.epa.gov/ttn/atw/hlthef/formalde.html>

<http://www.epa.gov/iaq/formalde.html>

<http://www.cdc.gov/niosh/topics/formaldehyde/>

References

The following additional references can be consulted to obtain more information on product emission rates, health-related issues, and regulatory and voluntary standards for formaldehyde.

California Environmental Protection Agency - Air Resources Board. 2004. Indoor air quality guideline: Formaldehyde in the home. <http://www.arb.ca.gov/research/indoor/formaldGL08-04.pdf>. 16pp.

Composite Panel Association. 2009. American National Standard: Particleboard; ANSI A208-.1-2009; Composite Panel Association. Leesburg, VA. 12pp. <http://www.nssn.org/search/DetailResults.aspx?docid=651906&selnode=>

Composite Panel Association. 2009. American National Standard: Medium Density Fiberboard (MDF) for Interior Applications; ANSI A208-.2-2009; Composite Panel Association. Leesburg, VA. 22pp. <http://www.nssn.org/search/DetailResults.aspx?docid=651907&selnode=>

Gilbert, N. 2005. Proposed residential indoor air guidelines for formaldehyde. Health Canada. <http://hc-sc.gc.ca/ewh-semt/pubs/air/formaldehyde/abstract-resume-eng.php>. 31pp.

Hardwood Plywood & Veneer Association (HPVA). 1994. American National Standard: Hardwood and Decorative Plywood. ANSI/HPVA HP-1. 1994. 25pp. <http://www.nssn.org/search/DetailResults.aspx?docid=1091704&selnode=>

Kelly, T.J., Smith, D.L., and Satola, J. 1999. Emission rates of formaldehyde from materials and consumer products found in California homes. Environ. Sci. & Technol. 33:81-88. <http://pubs.acs.org/doi/abs/10.1021/es980592%2B> .

Mason, M, Xiaoyu L, Krebs, K, and Sparks, L. 2004. Full-Scale Chamber Investigation of Air Freshener Emissions. Journal of Environmental Science and Technology.

Morrison, G.C. and Nazaroff, W.W. 2002. Ozone interactions with carpet: secondary emissions of aldehydes. Environmental Science Technology 36: 2185-2192.

Myers, G.E. 1986. Effects of post-manufacture board treatments on formaldehyde emission: a literature review (1960-1984). Forest Products Journal. 36(6):41-51.

Salthammer, T., Mentese, S., and Marutzky, R. 2010. Formaldehyde in the indoor environment. Chem. Rev. 110(4): 2536-2572. <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2855181/> .

Toxics Use Reduction Institute (TURI). 2006. Five Chemicals Alternative Assessment Study. Formaldehyde. http://www.turi.org/About/Library/TURI_Publications/2006_Five_Chemicals_Alternatives_Assessment_Study. 42pp.

U.S. Agency for Toxic Substances and Disease Registry. 2010. Formaldehyde ToxFAQs. <http://www.atsdr.cdc.gov/tfacts111.pdf> . 2pp.

U.S. Consumer Product Safety Commission. 1997. An update on formaldehyde: 1997 Revision. <http://www.cpsc.gov/cpscpub/pubs/725.html>. 12pp.

U.S. Environmental Protection Agency. 2010. Toxicological review of formaldehyde inhalation toxicity (External Review Draft): In support of summary information on the Integrated Risk Information System (IRIS). EPA/635/R-10/002A.. http://cfpub.epa.gov/ncea/iris_drafts/recordisplay.cfm?deid=223614.

U.S. Government Accountability Office. 2010. Report to Congressional Committees. Formaldehyde in textiles: While levels in clothing generally appear to be low, allergic contact dermatitis is a health issue for some people. <http://www.gao.gov/new.items/d10875.pdf> . 53pp.

Weschler, C. J., Hodgson, A.T., and Wooley, J. D. 1992. Indoor Chemistry: Ozone, Volatile organic compounds and carpets. Environmental Science Technology 26: 2371-2377.

World Health Organization. 2010. WHO Guidelines for Indoor Air Quality: Selected Pollutants. 3. Formaldehyde. <http://web.jrc.ec.europa.eu/radpar/docview.cfm?docid=104>. p103-156.



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