VOCs in carpet and carpet pads

From Appropedia

Contents

Introduction

This page describes VOC levels in carpets and carpet pads, which is a standard United States of America home construction material.

U.S. material use: Used for floor covering in commercial and residential buildings.

U.S. material consumption: Carpet use in the U.S. rose from about 17 billion square feet in 1999 to over 20 billion square feet in 2004. Projected use in the United States for 2009 is 22 billion square feet.[1] An estimated 6 billion pounds of carpet will go in to landfills in 2010.[2]

Your Carpet and VOCs

70% of floors in residential homes in the US are carpeted. It adds comfort, hides dirt, absorbs sound, and adds texture and color to the home. Unfortunately it also emits VOCs, and can additionally act as a reservoir for a wide array of the chemical and biological toxins introduced in to your home, from other VOC sources to bacteria, pesticides, allergens, dust, and mites.[3]

VOCs come not only from the carpet itself, but in a large portion due to the adhesives and padding installed with the carpet. Many health symptoms are reported in connection with the installation of new carpet such as fatigue, headaches, eye, nose, throat and skin irritation, and coughing or shortness of breath.[4]

Cleaning Carpets

The regular cleaning of carpets helps reduce VOCs and indoor pollutants not only from carpets, but from many other sources in the house. [5] Improper maintenance, however, can let particles build up in carpet. These particles can be re-emitted in to the air during daily activity, putting children, who play on the floor, especially at risk. It cannot be said enough that proper cleaning and maintenance is of paramount importance to ensuring a healthy flooring system. In order to protect your indoor air quality and give your carpet longer life, regular vacuuming with a good vacuum that has high performance filtration bags and strong suction, along with periodic wet extraction cleaning, is a necessary measure. The Carpet and Rug Institute has a Green Label Vacuum Cleaner Indoor Air Quality Testing Program to help identify the vacuum cleaners most effective for maintaining high air quality and carpet health. Make sure that your carpet cleaning system is approved, that it is verified to dry the carpet in no more than 12-24 hours after cleaning, and that it will remove 98% of allergens, dust , and surface mold. [6]

Mold growth can be begin with 24 hours of a spilled liquid being left undried in a carpet. [5] Other liquid spill require immediate clean-up as well as being dried within 24 hours. [7] It is also important to use VOC free cleaners when cleaning carpet, along with good ventilation to speed drying and remove any released VOCs. [8]

Cover carpeted surfaces when using potentially hazardous products such as pesticides or when using any product containing VOCs. Place mats at entry points so that dirt and debris isn't tracked on to the carpet, you may even want to remove your shoes at the door. [6] Lastly, remember to take care to heed the manufacturer's instructions for proper care and maintenance. [4]

Installing Carpets

You should air out your carpet somewhere else before installation. You could do it somewhere dry outside, or in a clean ventilated area inside, or you can request when you order it that the supplier roll it out in the warehouse to air out for some time before delivery. After installation, and before you move in, make sure to ventilate the area for about a week or until the odor dissipates. [8] The EPA recommends not only opening windows, but also using window fans and air conditioning units to exhaust harmful emissions outside during installation, and for 48-72 hours after installation. The EPA also recommends leaving the premises during this time. [4] People have reported feeling suddenly ill, having headaches, experiencing eye, nose and throat irritation, and having difficulty breathing 1 to 3 days after new carpet is installed. [6] Studies have shown that during ventilation, a high concentration of VOCs are brought up to the breathing plane, so it is best to not be present. [9]

Carpeted surfaces act as sinks for VOC adsorption from other sources, and re-emit them later, so it is important during construction or remodeling to sequence your installation to install soft fabric surfaces such as carpet as late as possible in the process. If you must apply VOC high materials such as paint or adhesives after the carpet is installed, cover the carpet and use direct ventilation until the paint dries completely. If you plan on installing carpet over a concrete floor, it is necessary to wait until the concrete is sufficiently cured and dry. [7] You may also choose to employ the use of a vapor barrier such as plastic sheeting, in conjunction with sub-flooring (insulation covered with plywood) to avoid future moisture issues. [6]

Adhesives and Sealants

A large amount of conventional sealants and adhesives used on structural components emit large amounts of VOCs. There are, however, less toxic water-based formulas available. In addition, require that your installer use the minimum amount of adhesive to fulfill the manufacturers specifications. You can also specify tack-down carpet to avoid gluing. Adhesives used in carpet installation may off-gas for long periods of time. [7]

VOC Content

Emissions from carpets can persist at low levels for long periods. A study showed that while carpets emitted lower levels of VOCs than paint or vinyl flooring, all types emitted 4-PC as the main VOC emitted from carpets. Deep dust tends to store VOCs, and continues to rise and become surface dust, which is then re-emitted into the house. Worst of all is that children are most prone to exposure, since they play and crawl on the floor. Flat, level carpets are more easily cleaned and less likely to act as reservoirs for VOCs than plush or shag carpets. [5] Some studies have shown that 4-PC, a major VOC

found in carpet, and one of the main sources of new carpet odor is not a health hazard in the levels present in carpet. Emissions from new carpet are generally at very low levels in a week after installation, and the odor should dissipate within a month. Chemicals that may be present in carpet installed with adhesive are:

- Styrene
- 1,2-Dichloroethane
- Ethyl benzene
- Toluene
- 1,1,1-Trichloroethane
- Xylenes

Formaldehyde is not a concern as it is no longer used in the manufacturing process in the US. No formaldehyde emissions were detected in a study of 19 new SBR latex-backed carpets. Where formaldehyde is found in carpet it is most likely absorbed from other building materials. Styrene can be stored in body fat for up to 13 days from exposure, but has few proven immediate health effects. A major chemical used in carpet latex, Butadiene, is found in larger amounts in tobacco smoke, and exhaust from fossil fuels.

Dust mites can also be a concern in some carpets where high humidity occurs. Some studies show that loop carpets have 8-9% more dust mites than pile carpets.[6]

Following several lawsuits against major carpet manufacturers concerning indoor air quality, emission standards began to be formed for particular products. Carpet testing was well publicized in the USA in the early 1990s. CRI tests cushions and adhesives as well as carpets and claims that the industry has made significant reductions in the total level of VOCs in carpets. [10]

Although the EPA has stated that there have been no proven cause-and-effect relationship between carpet emission and health problems, the carpet industry and the EPA came together to dialogue on reduction of VOCs. The result was the Carpet and Rug Association which began in 1993 to institute a voluntary program for testing air quality for chemical emissions and providing a labeling for carpets that pass the tests. Qualifying carpets are given a label with the letters “CRI” inside a house, and are independently tested and verified on a quarterly basis. [6] Still, the program does not necessarily ensure that emission from carpet systems will not pose problems for some people. CRI has more recently come out with the Green Label Plus program which adds on new requirements to meet California's Collaborative for High Performance Schools (CHPS) emissions criteria. [7] The current criteria for the program are based on a maximum EF measured in milligrams per square meter hour as listed below. Criteria for CRI carpet system testing program:[10]

VOCs are measured in mg/m2•hr and are as follows:

- Total Volatile Organic Compounds 0.50
- 4-PC (4-Phenylcyclohexene) 0.05
- Formaldehyde 0.05
- Styrene 0.40

In 10 separate air samples the total VOCs in one study of old carpet in an office building were 3,149 micrograms per square meter per hour (µg/m2/hr). The emission rate was 6 times the amount rated for low emission carpets by the Carpet and Rug Institute. [11]

The below table shows test results at 24 and 72 hours for the VOCs in four different types of carpet. New carpets made from wool, synthetic and mixed-fiber were used. Carpets came directly from the manufacturers and were wrapped in foil, and stored in a temperature maintained laboratory. All carpets were used within one month. Carpets tested were as follows:

- Carpet 1 (Cp-1): 100% polyamide and 100% synthetic backing.
- Carpet 2 (Cp-2): 80% wool, 10% polyamide and 10% polypropylene and 100% synthetic backing (SBR).
- Carpet 3 (Cp-3): 100% wool and 100% synthetic backing (SBR).
- Carpet 4 (Cp-4): 100% polyamide and 100% synthetic backing (SBR).

Table 1. Chamber concentrations of individual VOCs after 24 and 72 h (concentration in µg m−3 in a space of 0.45 m3). ND = Not Detected.

Time (h)	Benzene	Toluene	Ethylbenzene	Xylenes	Styrene	4-PCH	2-2-BEE
Cp-1 24	1.6	2.1	ND	ND	ND	ND	ND
Cp-1 72	ND	2.1	ND	ND	ND	ND	ND
Cp-2 24	ND	0.8	ND	ND	ND	71	11
Cp-2 72	ND	0.3	ND	ND	ND	71	1
Cp-3 24	0.66	2	ND	0.29	0.53	17	ND
Cp-3 72	0.97	0.97	ND	ND	0.27	12	ND
Cp-4 24	0.32	0.45	ND	ND	ND	32	ND
Cp-4 72	ND	0.24	ND	ND	ND	29	ND

[12]

The following table shows emissions of select VOCs over averaged over a 168 hour experiment, and at the bottom, the Carpet and Rug Institute's criteria for low-emission carpet.[13]

Experiment	Alkyl benzenes	Styrene	4-PC
Experiment 1	0.00	0.13	0.07
Experiment 2	0.00	0.02	0.05
Experiment 3	0.01	0.15	0.07
CRI Criteria	NA	0.4	0.05

Natural Carpet Choices

Carpet and carpet pads are generally made from unsustainable materials, which can off-gas for up to 3 years after installation. Synthetic carpet fibers are made from fossil fuels, and carpets made of nylon and olefin are usually backed with harmful PVC plastic. Fortunately, there are many natural carpet alternatives. A model green carpet material is wool, it is long-lasting, soft, naturally stain resistant and anti-allergenic, and the dense fibers of wool help keep dust down. Cotton is a good alternative to wool, and hemp is requires less water and pesticide to grow than cotton. The same can be said about sisal, and it is rough and fire resistant like wool, though it should be avoided in damp areas as it absorbs water. Jute is a durable grass fiber that is naturally mildew and mold resistant ,and soft but will degrade in sun or dampness. It does make a very good natural backing for other carpets. Sea grass has a grassy smell and is a very stain resistant woven plant fiber, but it is only seen in natural colors as it is dye resistant. Spun from flax plant fibers, Linen is a slightly shiny, supple, durable carpeting fabric. Coir is made from the husk of coconuts and is durable, water resistant, naturally insect resistant, and extremely rough and durable, making it ideal for damp areas or outdoor usage. When appropriately maintained, a wool carpet should last 50 years, and other natural carpets should far outlast the usual 10-year life of synthetic carpets.

When shopping for carpet attempt to use recycled or natural fiber content, with natural backing instead SB synthetic latex, which is a known carcinogen. Avoid vinyl or PVC in the backing, and use natural adhesives, or adhesives without 4-phenylcyclohexene (4-PCH). There are recycling programs available for discarded carpeting. The Carpet and Rug Institute has a Green Label program that certifies eco-friendly, low emission carpets, tested for VOCs. Hard flooring, especially wood, will usually outlast carpet, and is has much higher value in the resale sector, but carpet is the obvious choice for comfort. [3]

Resilient, or hard flooring is recommended for use in high traffic areas such as hallways at a school, or anywhere liquid spills are likely. There is a program called the FloorScore IAQ Certification Program, run by the Resilient Floor Covering Institute, that works much the same as CRI in certifying low emission flooring from manufacturers on a voluntary basis. [7]

Carpet prices range from $10 per square yard for cheap polypropylene up to $90 per square yard for fine wool, with an array of eco-groovy selections available in between. Cheap padding runs about $5 per square yard, while green padding goes for about $9, though you wouldn't want to use toxic padding under eco-friendly carpet. [3] You can always ask your retailers for help selecting carpets, carpet pads, and adhesives that have low VOCs. [4] I personally called carpet suppliers in the area, and the prices I was quoted were $1-$15 per square yard for standard residential carpeting, and $1.50-$15 per square foot for Green Label certified residential carpeting, with most of the Green Label carpets starting at $2 and standard starting at $1. Not a big price difference unless you're planning on buying the very cheapest carpet available.

Overview of Conventional Carpet and Carpet Pad Materials

Carpet pads are the foundation for carpets. Carpet pads are the reason why your carpet at home is softer, more luxurious than the carpet you would find at the work place or schools. Carpet pads can be made out of many materials and have different thickness depending on preferences. Heavy traffic areas such as stairwells and hallways require cushions that are no thicker than 3/8 inch, while softer trafficked areas such as bedrooms would choose a 1/2 inch pad. To expand the life of your carpet choose a high density cushion. [14]

Types of Carpet Pads

1. **Felt** - This pad is made by needle-punching various materials together. They can be made from 100 percent hair, 100 percent various fibers, or a combination of hair and other fibers.

Characteristics of Felt

- Wears well
- Stretches out of shape
- Sheds
- Resilient when 100 percent hair
- May cause problems to people with allergies
- Collects dust mildews in damp areas such as on concrete stretches out of shape

2. **Felt (rubberized or latex)** - Similar to the first felt pad except for rubber and latex coating on one or both sides.

Characteristics of Felt(rubberized or latex)

- Coating covers pad so it would make this pad less
- Receptive to stretch out of shape
- Slide
- Absorb moisture

- Cause allergic reactions

3. **Sponge Rubber (flat and waffle sponge)**.

- Consists of natural and/or synthetic rubber or other chemicals.

Flat Sponge Rubber-

- Made into continuous sheets

Waffled Rubber

- Made by continuous flat sheets, then formed into the waffle shape.

Characteristics for both Flat and Waffle sponge.

- Sensitive to heat
- Good resilience
- Waffle pad holds more moisture
- Damage by dry cleaning solvents
- Loss of resilience with age
- Moth, beetle, mildew, and mold proof
- Non-allergenic

4. **Urethane (prime and densified prime)**.

- Both the prime and densified urethane have

a material applied to one or both sides for easy installation.

Prime Urethane

- Made by a reaction process of polymeric materials

Densified Urethane

- Manufactured by changing the cell structure of prime urethane

Characteristics of both

- Non-flammable
- Not as resilient as rubber
- Not affected by heat
- Not affected by dampness or insects
- Used on concrete slabs in basements
- Non-allergenic

5. **Urethane (bonded)**.

- Bonded urethane is nothing more than little pieces of prime urethane bonded together by pressure and a gluing agent.

Characteristics

- Used on concrete slab and in basements
- Resistant to heat, dampness, and insects
- Not as resilient as rubber or plain urethane
- Non-flammable [15]

What are Carpet Fibers?

Carpet can be made from many single, blended natural, or synthetic fibers. "Fiber is the basic material that a carpet is made up of. Over ninety percent of all of the carpet made today is made up of synthetic fiber. The rest is natural fiber, most commonly wool." [16] Fibers are chosen for durability, appearance, and cost. Carpet can be woven by three types of fibers; single, blended natural, or synthetic. Two main types of fibers used are nylon and polypropylene which account for 95% of the carpet made in the USA. [17]

Why Nylon and Polypropylene

- Nylon by far is the most common material used for construction of carpets. Nylon is easily printable with above average wear characteristics. One problem with nylon carpets is they are not spill resistant because of the dyes on the fibers. Prices for nylon vary with oil prices since nylon is petroleum based.

- Polypropylene is meant to be used for light traffic areas in residential areas, too heavy of traffic wears the material out which tends to mat down. Polypropylene is relatively inexpensive compared to nylon since the price of nylons changes with oil prices. commercial polypropylene is a different story, since they use small loops compared to the residential large loops. Small loops tend to be more durable for higher trafficked areas, good stain resistance, but not against oil based products. [18]

Advantages and Disadvantages of Certain Carpet Fibers

1. Acrylic

Advantages:

- Wool-like appearance
- Low moisture absorption
- Cleans easily
- Good stain resistance
- Resilient and bulky
- Resistant to moths and mildew

- Resistant to sunlight damage

Disadvantages:

- Not as strong as other synthetics
- Produced in short fibers and crimped
- Poor resistance to matting
- Stained by oil and grease

2. Nylon

Advantages:

- Easy to clean
- Extremely strong
- Excellent resistance to matting
- Available in a wide price range
- Good abrasion resistance
- Absorbs little moisture
- Resists moths, mildew, and fungi
- Good stain resistance
- Third and fourth generation fibers are anti-static
- Fibers modified to hide soiling

Disadvantages:

- Stained by oil and grease
- Degrades and fades in sunlight

3. Olefin (polypropylene)

Advantages:

- Easy to clean
- Colorfast
- Strong fiber
- Soil and water resistant
- Good stain resistance
- No static problem
- Resistant to moths and mildew
- Makes good short pile indoor/outdoor carpet

Disadvantages:

- Depending on construction, tends to mat
- Grabs onto oil and grease
- Dry-cleaning solvents degrade fibers

4. Polyester

Advantages:

- Soft luxurious feel
- Excellent resistance to abrasion
- Excellent resistance to mildew
- Good stain resistance
- Less expensive than nylon

Disadvantages:

- Long exposure to sunlight weakens fiber
- Grabs onto oil and grease

5. Wool

Advantages:

- Crush resistant
- Limited snagging problems
- Durable

Disadvantages:

- Soils easily
- Imported because domestic fibers are finer and weaker
- Expensive [15]

See also

- Links for VOCs in other standard construction materials

VOCs in plywood (http://www.appropedia.org/VOCs_in_plywood)

VOCs in fiberglass insulation (http://www.appropedia.org/VOCs_in_fiberglass_insulation)

VOCs in foam insulation (http://www.appropedia.org/VOCs_in_foam_insulation)

- Other carpet links

A History of the U.S. Carpet Industry (http://eh.net/encyclopedia/article/patton.carpet)

CRI's Green Label Program (http://www.carpet-rug.org/residential-customers/selecting-the-right-carpet-or-rug/green-label.cfm)

Indoor Air Quality Resource Center (http://aerias.org/DesktopDefault.aspx)

EPA's "Environmentally Preferable Purchasing" carpet site (http://www.epa.gov/epp/pubs/products/carpets.htm)

CARE is an organization that is implementing a plan to recycle 40% of used carpet in the US by 2012 (http://www.carpetrecovery.org/mou.php)

VOCs in Carpet and Carpet Pads PPT (http://www.slideshare.net/SalPopanopolis/vocs-in-carpet-and-carpet-pads)

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15. http://extension.usu.edu/files/publications/factsheet/HI_05.pdf
16. http://www.wfca.org/carpet/howmade.aspx
17. http://www.carpetbuyershandbook.com/carpet-basics/construction-fibers/pile-fibers.php
18. http://en.wikipedia.org/wiki/Carpet#Fibres_and_yarns_used_in_carpet

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