Indoor Air Quality

Description of the Problem

Don't you just love that factory fresh 'new car smell'? Actually, that iconic smell is the mixture of about sixty volatile organic compounds (VOCs) emitting (or off-gassing) from the materials inside the vehicle, some of which are considered to be irritants and carcinogenics.[1] A sobering thought.

In the indoor environment, indoor air quality (IAQ) affects occupants and their ability to perform; and creates positive or negative impressions of customers, clients and other visitors to a building. When the IAQ is good, buildings are great places to work, to learn, and to heal.[2] When it is not, satisfaction with the indoor environment and productivity decrease; and health concerns increase. Poor IAQ hinders comfort, attention span and productivity. The Occupational Safety and Health Administration (OSHA) estimates that poor IAQ costs employers $15 billion annually due to worker inefficiency and days off for illness.[3]

IAQ problems are associated with indoor contaminant sources that are emitted in the environment while not efficiently removed by ventilation. Many contaminants are released by typical building materials and furnishings, especially when new. Strategies that provide a practical guide to limit their IAQ impacts include the following three objectives:[2, 4]

1. Appropriate source selection
2. Strategies to limit the impact of emissions
3. Strategies to limit the IAQ impacts associated with cleaning and maintenance

Understanding and controlling common indoor pollutants is fundamental for providing quality indoor air. Indoor Air Quality (IAQ) is the quality of the air within the built environment, based on concentrations of pollutants and thermal conditions that affect the health, comfort, and performance of occupants.[5] Acceptable IAQ is defined by ASHRAE (The American Society of Heating Refrigeration and Air Conditioning Engineers, Inc.) as air in which there are no known contaminants at harmful concentrations based on set standards; and where at least 80% of the occupants do not express dissatisfaction with the air quality.[6]

Hazards & Risk Assessment

Examples of common VOCs are benzene, formaldehyde, toluene, xylene, styrene, and tetrachloroethylene. Some VOCs, such as styrene and limonene, can react with nitrogen oxides or with ozone to produce new oxidation products and secondary aerosols, which can cause sensory irritation symptoms[7]. The ability of VOCs to cause health effects varies greatly from those that have no known health effects to those that are highly toxic. The effects of VOC exposure depends on several factors including the type of VOC, the amount of VOC and the length of time a person is exposed.[8]

Exposure to elevated levels of VOCs may cause irritation to the eyes, nose, and throat or may have more serious, chronic affects. Some people do not appear to have any kind of reaction to moderately "low" amounts of VOCs, while other people are fairly sensitive.[8] Eye and respiratory tract irritation, headaches, dizziness, nausea, allergic skin reactions, fatigue, visual disorders, loss of coordination, and memory impairment are among the immediate symptoms that some people have experienced soon after exposure. Long-term exposure to volatile organic compounds can cause damage to the liver, kidneys, and central nervous system.[9] Respiratory, allergic, or immune effects in infants and children have been associated with exposure to VOCs and other indoor or outdoor air pollutants.[10] Several VOCs are classified as carcinogenic, including formaldehyde and benzene, suspected or known to cause cancer in humans.[5]

Declarations and Certifications

The International Living Future Institute (ILFI) is composed of leading green building experts whose mission is to influence a transformation toward communities that are socially just, culturally rich and ecologically restorative through reconciling humanity's relationship with the natural world.

ILFI programs include the Living Building Challenge, a building performance certification program for buildings that produce more energy than they consume, avoid known toxins and harmful chemicals, and collect and reuse their own water. The Living Product Challenge is a certification program for products that are informed by biomimicry and biophilia, manufactured in facilities that are powered only by renewable energy, and that use water conservation practices toward the manufacturing of regenerative and sustainable products.

The ILFI Declare certification is process for disclosing product ingredients in a transparent way, allowing manufacturers an opportunity to connect with consumers. For designers, the Declare product database streamlines material specification and certification for sustainable design. The ILFI Materials Red List is a chemical guide that calls out chemicals of concern with a description and links to additional information.

The Environmental Product Declaration (EPD) is an independently verified and registered document that communicates transparent and comparable information about the life-cycle environmental impacts of products.

The Health Product Declaration Collaborative® (HPDC) is an organization focusing on building performance through transparency, openness and innovation in the practice of reporting, disclosing, specifying and selecting building products. The health Product Declaration (HPD) Open Standard is a process for the accurate, reliable and consistent reporting of product contents and associated health information.

The Pharos Project, a program that is part of the Healthy Building Network, evaluates building products and components across fifteen major product categories to assess the ingredients of products to be disclosed by the manufacturers. This program has profiles of chemicals and materials for health and environmental hazards; and rates product certifications and standards to use in building product evaluations.

NSF/ANSI 140 Standard is a sustainability assessment for carpet. The standard quantifies the reduction of the environmental footprint of carpet, including landfill diversion, carbon dioxide emissions, energy consumption, waste generation, water usage, and hazardous air pollutants per square yard of carpet; and identifies economic, environmental, and social benchmarks throughout the supply chain.

The Carpet and Rug Institute (CRI) Green Label Plus is a standard for indoor air quality program for carpet, adhesives, and cushion. The purpose of the program is to ensure that customers are purchasing the very lowest emitting products on the market. Products are tested by Underwriter Laboratories (UL) using the ASTM D5116-Standard Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials/Products.

FloorScore,® a program developed by the Resilient Floor Covering Institute (RFCi) along with Scientific Certification Systems (SCS) to test and certify resilient flooring materials and adhesives for compliance with indoor air quality emission requirements adopted in California. Recognized by a variety of environmental programs, certified products will contribute to good IAQ.

Flooring Selection Guide & Recommendations

Flooring selection depends on many factors including aesthetics, thermal comfort, building acoustics, and light levels (reflectance effects on daylighting performance and considerations for glare). Due to the predominance of surface area, flooring materials can have a substantial direct impact on IAQ via emissions of contaminants, therefore flooring materials will have a major impact on a building's indoor environment.[2]

Appropriate Source Selection

Commercial flooring material options are varied, but emission concerns focus on two categories - resilient (linoleum, LVT, Rubber, Sheet vinyl, and VCT), and soft (broadloom carpet, carpet tile, and vinyl cushion tufted tile)[11]. When evaluating potential emissions, the potential impacts of adhesives, underlayments or cushion materials, and substrates must be considered.

Resilient Flooring

- Test for VOC emissions under the Resilient Floor Covering Institute (RFCI) FloorScore program.
- Select flooring that can be easily cleaned and maintained with low-VOC cleaners and finishes.
- Install flooring with low-VOC adhesives and coatings to minimize the indoor air pollution load and health risks to both installers and occupants.
- Use the smallest amount of adhesive necessary to fulfill the manufacturer's performance specifications for the material product.
- Provide the space with additional ventilation for a minimum of 72 hours after installation.

Soft Flooring

- Test for VOC emissions under the Green Label Plus testing program.
- Select flooring that can be easily cleaned and maintained.
- Select flooring that has a permeable backing to prevent liquids from penetrating the backing layer or subfloor where moisture can result in mold and bacterial growth.
- Roll out and condition new flooring in a clean, dry space prior to installation to minimize emission rates after installation.
- Use the smallest amount required of the least toxic adhesive system compatible with the selected soft flooring product.

Limiting Impact of Emissions

While the best strategy to reduce the impact of material emissions is to control indoor contaminant sources through appropriate flooring selection, the next line of attack is to limit the impact of emissions. Practical strategies include:

- Material conditioning is a strategy to reduce emissions from new materials prior to installation by rolling out the materials in a well-ventilated, clean space for a period of time to off-gas.
- Products, like caulks, sealants, and adhesives that have been formulated to undergo a curing process that results in reduced contaminant emissions should be considered.
- Textiles and soft flooring should be installed after completion of construction activities that release high levels of VOC contaminants so to minimize the potential to act as a reservoir of VOCs, leading to long-term re-emission into the indoor air.[2]

Limiting IAQ Impacts Associated with Cleaning and Maintenance

Good IAQ requires a clean indoor environment, however, cleaning agents can have a detrimental effect on IAQ, if materials and protocols are not chosen carefully. It all begins with the design and specification of the interior. Flooring materials that minimize the need for cleaning and utilizes nontoxic and noncorrosive chemical materials with proper cleaning methods contributes to a clean and healthy indoor environment.[2]

- Select durable flooring materials and finishes that are easy to clean and maintain – minimizing the need for harsh chemical cleaning agents, material replacements, and refinishing.
- Use cleaning products with minimal emissions to limit introduction of irritant or harmful chemicals and reduce the risk of secondary emissions.[12]
- Provide appropriate storage and protocol documentation for cleaning products - store cleaning materials and equipment in a well ventilated janitorial

closet with posted instructions for the preparation and delivery of cleaning processes.

- Protocols for cleaning should be provided through documentation and effective training of personnel – including equipment, materials, and scheduling of cleaning and maintenance activities and processes.

Specifying appropriate flooring is a complex project, requiring knowledge about the comfort, health and safety of occupants and an understanding of how to control common indoor pollutants to provide quality indoor air. Determining the floor material type is the beginning of a process that includes how to mitigate exposure to VOCs and minimize the impact of cleaning and maintaining the flooring. There are a number of programs, organizations, and certifications that can assist in determining the right flooring for the building, occupants and activities.

References

1. Brunning, A. The Chemicals Behind the 'New Car Smell". 2015 [cited 2016 09/22/2016]; Available from: http://www.compoundchem.com/.
2. ASHRAE, Indoor Air Quality Guide. 2009, Atlanta, GA: ASHRAE.
3. OSHA. Safety and Health Topics: Walking/Working Surfaces. 2016 [cited 2016 8/30/2016]; Slips, trips, and falls constitute the majority of general industry accidents. They cause 15% of all accidental deaths, and are second only to motor vehicles as a cause of fatalities. The OSHA standards for walking/working surfaces apply to all permanent places of employment, except where only domestic, mining, or agricultural work is performed.]. Available from: https://www.osha.gov/SLTC/walkingworkingsurfaces/index.html.
4. Black, M. and K. McIntosh, IAQ study of schools in relation to flooring types and cleaning processes. 2012: Atlanta, GA.
5. EPA. An Introduction to Indoor Air Quality. Indoor Air Quality (IAQ) [Web Site] 2016 08/08/2016 [cited 2016 09/21/2016]; Available from: https://www.epa.gov/indoor-air-quality-iaq/introduction-indoor-air-quality#tab-2.
6. ASHRAE, Ventilation and Acceptable Indoor Air Quality, in ANSI/ASHRAE STandard 62.2-2013. 2013, ASHRAE: Washington DC.
7. Wolkoff, P., et al., Organic compounds in office environments – sensory irritation, odor, measurements and the role of reactive chemistry. Indoor Air, 2006. 16(1): p.7-19.
8. Vermont Department of Health. VOCs (Volatile Organic Compounds). 2016 [cited 2016 09/23/2016]; Available from: http://healthvermont.gov/enviro/indoor_air/voc.aspx#three.
9. NIH. Volatile Organic Compounds (VOCs). Tox Town 2016 06/27/2016 [cited 2016 09/23/2016]; Available from: https://toxtown.nlm.nih.gov/text_version/chemicals.php?id=31.

10. Mendell, M.J., Indoor residential chemical emissions as risk factors for respiratory and allergic effects in children: a review. Indoor Air, 2007. 17(4): p.259-277.

11. Harris, D. and L. Fitzgerald, A life-cycle cost analysis for flooring materials for healthcare facilities. Journal of Hospital Administration, 2015. 4(4): p.92-100.

12. Huang, Y., et al., Physical parameters effect on ozone-initiated formation of indoor secondary organic aerosols with emissions from cleaning products. Journal of Hazardous Materials, 2011. 192(3): p.1787-1794.