TECHNICAL BRIEF

UL Research Institutes | Chemical Insights

A Strategic Research Initiative on Microchamber Protocols for Material Changes with Extreme Heat and Moisture

Chemical Insights Research Institute (CIRI) is using microchambers to answer questions about how chemical emissions from building materials change with increasing heat and humidity conditions.

Introduction

Changes in climate from extreme weather events, wildfires, and other natural disasters can impact the indoor environment and the health of building occupants. Periods of extreme heat and humidity indoors along with lack of sufficient climate control can be disruptive to this environment. Of particular concern is chemical pollution resulting from a myriad of building materials, furnishings, finishes and activities in the indoor environment. A typical home or building may have hundreds of chemicals present in the air and, surprisingly, less than 10 percent of all known chemicals have been studied for their effects on human health. While there are plenty of atmospheric global models and empirical studies of how the outdoor environment may change due to extreme climate events coupled with unknown chemical stressors, less is known about the overall situation indoors. Independent research has confirmed that indoor air quality suffers more than the outdoor environment due to the presence of a higher chemical load.[1,2] Since the potential for greater numbers of extreme weather events is increasing, combined with greater consumption of chemicals in our everyday lives, it is now more important to assess the combined impact of these phenomena related to our human environment and health. One instrument that may support this essential investigation is the environmental exposure chamber.

Specialized environmental exposure chambers are research apparatuses that provide a controlled testing environment in which to place a product or process for assessment of its chemical and particle air emissions. This allows accurate and reproducible measurements at defined environmental conditions. However, these specialized chambers, as research tools, are sophisticated and not readily available. Two common outcomes resulting from utilizing these chambers are the measurements of volatile organic compounds (VOCs) and aldehydes, which are types of chemicals that can be emitted from materials and activities (e.g., cooking or cleaning). When present in the indoor environment at high enough levels, these chemicals may be harmful to human health[3].

As an alternative, microchambers provide key advantages over larger exposure chambers. These include rapid screening of chemical emissions and the ability to test small amounts of representative products. While microchambers cannot yet be used to test daily activities or processes, the opportunity exists to more easily evaluate climate-related temperature and humidity changes on a material's chemical emissions.[4] A small portion of a material (approximately 4 in^2), such as a piece of wood flooring or drywall, can be placed inside a well of the microchamber. The temperature of the microchamber can be controlled, and clean air can be supplied at a specific rate with a known humidity to the microchamber containing the product to be tested. Rapid screening of a range of construction and indoor materials can be conducted for the measurement of chemical emissions. When teamed with specific analytical techniques, a large range of VOCs can be identified and measured for emission rates. CIRI will use microchambers to address the following research questions:

1. Do chemical emissions from building materials change with increasing heat and humidity conditions, as being experienced in extreme weather conditions?
2. Based on the specific chemicals measured and their relative levels, can the overall impact on the indoor air quality and related health concerns for occupants be predicted?
3. Can specific chemicals of concern associated with specific product types that result from extreme weather conditions be identified?

Figure 1: A microchamber equipped with a heating device and humidity apparatus.

Study Objectives

- Investigate common building materials for VOC and aldehyde emissions at standard room temperature as well as elevated temperatures and humidity.
- Measure exposure rates and concentrations of chemicals of concern to evaluate potential health impacts and compare them to established professional building practitioner guidelines and recommended indoor air quality thresholds.

Study Plan Overview

1. Common building materials will be sourced for market affordability and popularity.
2. A microchamber equipped with a heating device and/or humidity apparatus will provide the test environment, and samples will be taken for 15–30-minute periods for both room temperature and elevated temperature conditions.
3. Standard VOC and aldehyde analysis by thermal desorption-gas chromatography/mass spectrometry (TD-GC/MS) and high-performance liquid chromatography (HPLC) will be performed.
4. Exposure modeling following the outline of standard method UL 2904 in a small residential bedroom will best describe emission rates and concentrations.

Figure 2: TD-GC/MS instrument.

Scientific Outcomes

1

Investigate common building material emissions and their response to changing heat and humidity conditions.

2

Identify a standard process to screen materials for their chemical emissions and model exposure scenarios in a more rapid manner.

3

Identify health concerns resulting from extreme heat and humidity in the indoor environment.

Research Partner

The American Society of Interior Designers

References

1. Mansouri A, Wei W, Alessandrini JM, Mandin C, Blondeau P. Impact of Climate Change on Indoor Air Quality: A Review. Int J Environ Res Public Health. 2022;19:15616. https://doi.org/10.3390/ijerph192315616.
2. Salthammer T, Morrison GC. Temperature and indoor environments. Indoor Air. 2022;32:e13022. https://doi.org/10.1111/ina.13022.
3. Kanazawa A, Saito I, Araki A, Takeda M, Ma M, Saijo Y, Kishi R. Association between indoor exposure to semi-volatile organic compounds and building-related symptoms among the occupants of residential dwellings. Indoor Air. 2010;20:72-84. https://doi.org/10.1111/j.1600-0668.2009.00629.x.
4. American Society for Testing and Materials. Standard Practice for Rapid Screening of VOC Emissions from Products Using Micro-Scale Chambers, 2017, https://doi.org/10.1520/D7706-17 (2017).
5. Underwriters Laboratories. ANSI/CAN/UL 2904, Standard Method for Testing and Assessing Particle and Chemical Emissions from 3D Printers, 2019, https://chemicalinsights.org/wp-content/uploads/2022/04/3DPrint_Standard_Brief_Version-2.pdf (2022).

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