TECHNICAL BRIEF

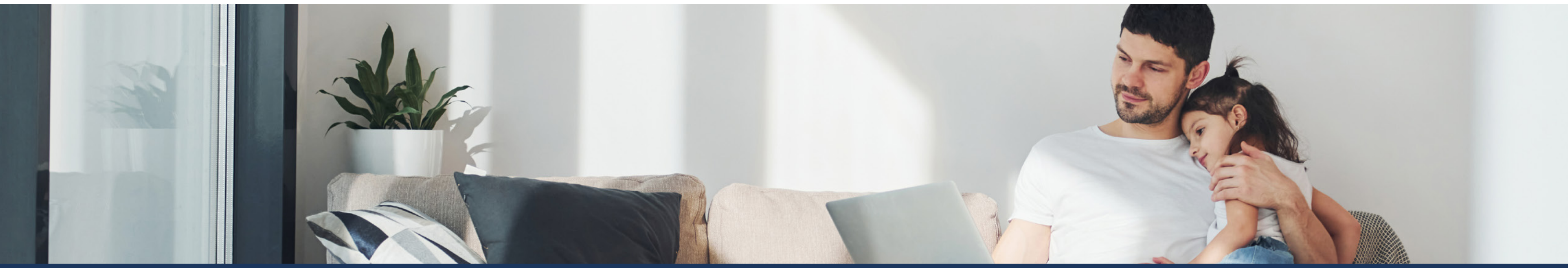
A Strategic Research Initiative on the Impact of Extreme Weather on Indoor Air Quality

Introduction

The worldwide chemical landscape, viewed from the perspective of pollution and exposure pathways, currently presents significant knowledge gaps. Given the 40-fold increase in chemical production in the last century, chemical exposures, largely stemming from the prolific presence of synthetic or anthropogenic sources in the indoor environments, leads to toxicity and human health concerns. Studies show that chronic exposure may lead to cognitive, reproductive, and carcinogenic effects, depending on specific chemicals and their exposure levels.[1] With much scientific focus on the environment and the effect of climate change on the outdoor chemical landscape, the indoor environment has often been neglected in research. An exception to this trend is the characterization of volatile organic compound (VOC) exposure and human health. In fact, independent studies have suggested that levels of indoor chemical pollutants exceed those of the outdoor environment by at least a factor of two. Yet the full spectrum of toxicological implications associated with this finding remains elusive.[2-6] Several government and non-governmental organizations, such as Occupational Safety and Health Administration (OSHA), the California Department of Health, the U.S. Green Building Council, National Institutes of Occupational Safety and Health (NIOSH), and the American Council of Governmental Industrial Hygienists (ACGIH) have released regulations and guidelines regarding VOC levels present in occupational and indoor environments. Although knowing the levels of VOCs is useful for characterizing indoor air quality, it does not address how these contaminants may transform over time, under changing conditions, or during product use. As climate change continues to be a concern, increases in ambient temperature and adverse weather events are expected to increase in frequency and intensity. However, few studies have investigated the effects of rising global temperature and modulation of other environmental variables on the chemical landscape of the indoor environment.

This study aims to investigate the connection between a changing environment and the air quality of the indoor environment. The physicochemical integrity of a substance, such as a building material, used in the indoor environment must resist breakdown across a range of real-world environmental conditions. To be termed resilient, these materials persist through temperature intensification, vast humidity fluctuations, and other adverse environmental conditions. The findings of this study will highlight the relationship between a changing environment and the air we breathe. Ultimately, this information can assist with selection of materials to create a more resilient indoor environment and atmosphere. This study will address the following research questions:

- Do building material emissions change as a result of modulation of relevant environmental variables in the indoor environment?
- How do these changes in emissions impact human health?



Study Objectives

- Investigate common building material VOC and aldehyde emissions across a range of environmental variables beginning with elevated temperature and humidity conditions.
- Model material emission rates, determine exposure rates, and compare modeled concentrations to established professional building practitioner guidelines and regulatory thresholds for airborne chemical agents.

Study Plan Overview

Temperature effects will be investigated first, and the study objectives will be met using the following initial sampling and analysis plan:

1. Common building materials sourced for affordability and popularity will be used in this study.
2. An 80-L stainless steel test chamber equipped with a heating device will provide the test indoor environment, and samples will be tested for 90-minute periods for both room temperature and elevated temperature conditions.
3. Standard VOC and aldehyde analysis by thermal desorption-gas chromatography-mass spectrometry (TD-GCMS) and high-performance liquid chromatography (HPLC) will be performed.
4. Exposure modeling following the outline of the Standard ANSI/CAN/UL 2904 in a small residential bedroom will be used to describe emission rates and concentrations.

Scientific Outcomes

01

Characterization of VOC and aldehyde emission profiles of building materials due to extreme weather events.

02

Determination of material specific emission rates for use in indoor air quality modeling.

03

Correlation between extreme weather events and chemical resiliency.

04

Identification of alternate or "greener" building materials.

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