Extreme Heat and the Built Environment

Inside the foundational change for public health protection and building resilience

By Talia Sager

Editor's Note: This is the first in a series of content from the Chemical Insights Research Institute (CIRI). Located in Marietta, Georgia, CIRI provides actionable data and resources that help manufacturers, educators, healthcare providers, and consumers alike. For more information, Visit chemicalInsights.org.

The changing climate and greenhouse effect often elicit thoughts of the outdoor environment, but what's happening inside our buildings?

Research reveals common building materials release higher amounts of potentially harmful chemical emissions when exposed to elevated heat for extended periods of time. Poor indoor air quality is a leading health issue that affects everyone. The construction industry is in a unique position to respond to this public health challenge with innovative solutions.

Construction practices have evolved in recent years to highlight an increased priority on providing more energy-efficient buildings, including tightening the building envelope.

Tighter buildings may improve insulation, but they can also trap indoor air pollutants due to lack of necessary ventilation. Creating a healthier environment, both internally and externally, requires a balanced project plan and a proper assessment of material use.

Air Apparent

We breathe more than 15,000 liters (530 ft^3) of air every day, meaning we consume four times more air than food and liquid combined. The average person spends approximately 90% of their time indoors, making the quality of that air crucial to wellbeing.

Indoor air is generally two to five times higher in pollutant concentration than outdoor air with new buildings having concentrations up to 100 times higher. Pollutants found inside are a complex mixture of volatile organic compounds (VOCs) like formaldehyde, semi volatile organic compounds (SVOCs) like PFAS and pesticides, respirable fine particles, ozone and inorganic gases, allergens, mold, and infectious viruses.

Exposure can lead to eye, nose and throat irritation, headaches, skin rashes, dizziness, fatigue, and, in extreme cases, respiratory illness and cancer. Some populations are more vulnerable to air quality issues, such as children, pregnant women, and the elderly.

Materials used to construct and furnish buildings are sources for indoor chemicals, including insulation, drywall, manufactured wood, paint, and adhesives. Using these

kinds of materials is unavoidable but opting for resilient alternatives will cultivate a healthier indoor landscape.

For a material to be considered resilient, it must maintain its function through temperature intensification and humidity fluctuation, while not releasing elevated levels of chemicals into the air.

Hazards of Heat

Chemical Insights Research Institute conducted a study testing common building materials at two temperatures, an average room temperature of 73.4°F (23°C) and an elevated temperature of 95°F (35°C). The higher temperature could simulate a home exposed to a heatwave, equipped with a poorly functioning HVAC system or lack of an HVAC system to condition the air.

Basic indoor materials included in this study were ceiling tiles, wall coverings and flooring popular in modern home construction. The emitted chemicals of focus for this study were VOCs and aldehydes, including formaldehyde, a known carcinogen.

Studies were conducted in an exposure chamber, allowing scientists to control real-life climate scenarios to accurately assess and measure pollutant production. Prolonged exposure at the higher temperature was found to increase overall chemical emissions from the building materials, especially the flooring.

Choosing resilient materials and pivoting to practices that emphasize keeping environmental conditions controlled will help to combat the consequences of more intensive and frequent occurrences of heatwaves.

Beat the Heat for Health

There are many effective ways to cool a building and counteract the negative effects of extreme heat while minimizing health risks:

Roofing – Cool roofing options reflect sunlight and absorb less heat, helping the building interior maintain a cooler temperature without relying on the HVAC system.

Insulation – Proper insulation reduces heat transfer and helps to regulate indoor temperatures. There are also options for high-temperature insulation specifically designed to manage extreme temperatures.

Windows – Installing energy-efficient windows with low-emitting coatings reduces heat gain while still letting in natural light. Although a more costly option, dynamic windows are an innovative solution that self-adjust tint to adapt to the external environment.

Passive Systems – Implementing passive cooling systems in building design allows natural processes to regulate temperature without using mechanical systems. Some common passive methods include shading devices, thermal mass and roof space, windcatchers, cross ventilation, and integrating landscaping with tree canopies.

Material Selection – There are many opportunities to include heat-resistant and low-emitting resilient materials throughout the construction process to protect the building and its occupants.

Crafting buildings with these proven practices will help with the longevity of buildings and foster a healthier indoor environment. Almost every strategy provided can also be utilized in projects for upgrading existing structures. Retrofitting with resilience in mind will allow older buildings to face a brighter and hotter future for longer.

Client Satisfaction

Making the shift to resilient building materials may sound costly, but indoor air pollution and lack of ventilation might be the real wallet drainers. Annual economic impacts are estimated to be in the hundreds of billions of dollars due to loss of productivity, absenteeism, and healthcare costs stemming from poor indoor air quality.

Meanwhile, a study in the International Journal of Environmental Research and Public Health concluded that improved ventilation and air quality increased employee performance equivalent to $6500 annually.

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Striking Balance in a Changing World

Proactively considering environmental variables, such as extreme heat, is an important step in project planning and risk management. Buildings constructed in the past did not have to endure the same intensity and frequency of extreme weather events as our modern built environment.

Temperature intensification and harmful weather events are expected to continue, but current standards do not reflect the needs of the present or predicted climate experience. This dilemma may feel daunting but with a holistic approach, the construction industry can enact tangible change and protect public health. CCR

Talia Sager is a Content Specialist at Chemical Insights Research Institute. She leverages her experience in healthcare and digital marketing to translate research findings into impactful messages.