Research Institutes | Chemical Insights

TECHNICAL BRIEF

A Strategic Research Initiative on Chemical Analysis of WUI Fire Emissions

Chemical Insights Research Institute (CIRI) is developing field and laboratory-scale sampling and analysis techniques for the characterization of chemical emissions from wildland-urban interface (WUI) fires.

Introduction

The chemical emissions and post-fire residues of WUI fires pose a significant environmental and societal challenge, with repercussions for air quality, ecosystem health, and human health. Human populations continue to expand into forested areas, and the number of residences and businesses that exist at the interface between urban and wildland environments continues to grow. These WUI areas are becoming increasingly susceptible to fires, creating a complex web of possible consequences. Emissions from wildland fires have been extensively studied due to their well-established, significant environmental implications, and structural fires have been studied for their impact on firefighter health and safety; however, little data exists on the emissions resulting from WUI fires where community structures burn with forest biomass. The emissions and residues from a WUI fire can differ from a wildland fire in composition due to the presence of urban infrastructure. The combustion of building materials, such as wood, plastics and other synthetic substances, as well as the contents of modern homes, such as electronics and synthetic furnishings, release a mix of toxic compounds, including particulate matter, carbon monoxide, volatile organic compounds (VOCs), flame retardants, polycyclic aromatic hydrocarbons (PAHs), heavy metals, and other pollutants. This can result in a more complex and hazardous emission profile compared to a vegetation-based wildland fire.

Examples of health-relevant VOCs commonly found in emissions from wildfires and structural fires like acrolein, benzene, and formaldehyde, have been linked to numerous negative health impacts on humans. Acute health impacts include respiratory, eye, and throat irritation.[1] Individuals with respiratory conditions like asthma or chronic obstructive pulmonary disease (COPD) may experience exacerbation of their symptoms.[2,3] Some VOCs, such as benzene, formaldehyde, and acetaldehyde are known or suspected carcinogens.[3] Thus, understanding the complexities of the chemical profile of emissions from WUI fires is crucial for developing effective strategies to limit their environmental and public health impacts.

Sampling and Analysis Methodologies

Identification and analysis of VOCs in a combustion setting, such as wildland fires, will require optimization of the methods presented in Technical Brief 080[4] using thermal desorption-gas chromatography/mass spectrometry (TD-GC/MS) and high-performance liquid chromatography-ultraviolet detection (HPLC-UV). The selection of solid sorbents, sampling volumes, and collection flow rates will be optimized to collect the widest range of VOCs expected with defined accuracy and precision. These methodologies will be used to chemically characterize the impact of WUI and wildfire smoke on indoor and outdoor air quality and potential effects on human health. Some specialized adaptations may be required, but these methods are expected to be applicable to field studies during active wildfire events and to simulated laboratory studies of combustion.

Field sampling data is important as it provides valuable insight on the composition of both wildland and WUI fire emissions, but only during and after an event has occurred. Laboratory-scale combustion studies, on the other hand, have the advantage of allowing both source-specific studies and measurements of emission at a specific combustion phase. From the laboratory small-scale combustion, the emission factors (amount of a pollutant produced over the amount of material burned) for each source sample can be calculated, which is useful information for builders and homeowners who live in areas that are at high risk for WUI fires. In addition, laboratory studies also allow the researchers to identify source specific VOCs and study how the mixture of synthetic materials affects the emission profile.

Study Objectives

- Develop field and laboratory scale sampling and analysis techniques for the characterization of VOC emissions from fire and combustion sources.
- Establish the range of applicability and performance limits.

Scientific Outcomes

1. Defined methodology that can be applied to both in-field and laboratory settings for the collection of combustion emission data.

2. Identification of additional research needed for more targeted analysis of specific VOCs of concern.

Research Partner

United States Environmental Protection Agency, Office of Research and Development, Center for Environmental Measurement and Modeling (U.S. EPA ORD CEMM)

West Virginia University

References

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