Wildland Fires: Enhancing Understanding of Indoor Air Exposures*

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Background. Wildland fire smoke is a global public health issue. Many communities are exposed to smoke from wildland fires, both wild and controlled burns, for days, weeks, or even months in a given year. With that smoke comes high concentrations of fine particles (PM$_{2.5}$) and other pollutants that may cause adverse health effects. A common recommendation during smoke events to reduce exposure is to go indoors away from the smoke; however, smoke can infiltrate indoors, emphasizing the importance of creating cleaner air spaces that effectively reduce exposures. The U.S. EPA has partnered with Missoula City-County Health Department, Hoopa Valley Tribe Land Management Department, and others on the Wildfire ASPIRE Study to expand our understanding of indoor exposures and air filtration approaches that are most effective during smoke episodes.

Objectives. Multiple study components are addressing the following research questions: (1) How effective are air filtration systems during smoke events and how does effectiveness vary with type of air handling system and ambient air concentrations? (2) How effective are portable air cleaners (PACs) in reducing exposures to PM$_{2.5}$ and what factors (e.g., operation and maintenance) are important in air cleaner effectiveness? (3) What innovative approaches can help reduce wildfire smoke exposures?

Approach. Air measurement technology allows for indicative measurements of PM$_{2.5}$ using very small sensors. Sensors placed both indoors and outdoors in commercial and public buildings throughout Missoula, MT (Jul. – Sept. 2019; Jul. – Nov. 2020) and the Hoopa Valley Tribal lands (Dec. 2019 – Mar. 2022) were used to evaluate indoor versus outdoor PM$_{2.5}$ concentrations during typical ambient conditions and opportunistically when smoke occurred. Building selection criteria prioritized spaces where people may stay for extended durations or seek out cleaner air and interested building owners. Inspections of building characteristics and ventilation systems were conducted to better understand factors affecting smoke infiltration and indoor air quality. Additional field studies in Hoopa and Tulare County, CA are assessing the effectiveness of PACs, including do-it-yourself (DIY) and commercial air cleaners, in homes to improve indoor air quality and protect health during smoke events. Complementary laboratory studies are evaluating the effectiveness of a range of DIY and commercial PACs under moderate and high concentrations of smoke.

Results. Large differences in PM$_{2.5}$ reductions were observed across and within the public/commercial buildings in Missoula and Hoopa. DIY and commercial PAC usage in pilot residential studies showed significant reductions in infiltrated PM$_{2.5}$. DIY air cleaners can effectively reduce smoke concentrations and designs evaluated in a laboratory setting using multiple filters and shrouds increase their overall effectiveness.

Conclusions. In evaluating indoor air quality in commercial/public buildings during smoke events, filter MERV rating is not the most important factor. A well-functioning HVAC system improves indoor air quality and occupant behavior impacts smoke infiltration and indoor sources of air pollutants. DIY and commercial PACs were associated with improved indoor PM$_{2.5}$ in homes, but the loudness of DIY PACs hindered use. In laboratory effectiveness studies, DIY air cleaners are effective at reducing smoke concentrations. Additional laboratory analyses of commercial air cleaners are underway.

(Note: The views expressed are those of the authors and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency.)

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