CASE STUDY

BETTER INDOOR AIR QUALITY EVALUATION WITH PID-TECH®

Using sensors donated by AMETEK MOCON, a CU research team evaluated impact on indoor air quality after a fire.

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"When the fire broke out, there was an immediate need to get sensors into homes and see the impact - piD-TECH sensors came in at the top of our list."

Evan Coffey
University of Colorado, Boulder

MARSHALL FIRE AIR QUALITY

Burned neighborhood in Louisville, Colo.

A need for immediate indoor air quality evaluation.

On Dec. 30, 2021, a grass fire was reported in Boulder County, Colorado. Although firefighting units arrived almost immediately, high winds were already spreading the fire, which quickly grew out of control. Within two hours, the nearby town of Superior and city of Louisville were ordered to evacuate as the fire continued to spread.

By the time heavy snowfall contained the fire on Jan. 1, more than 1,000 homes and 30 commercial structures had been damaged, and two deaths were reported. In terms of property damage, it surpassed the 2013 Black Forest Fire as Colorado's most destructive wildfire. Almost 1,000 homes were completely destroyed, and hundreds more were severely damaged.

Many structures were left standing, but with lingering smoke damage from the fire. Residents with damaged but inhabitable homes felt they had no clear guidance when it came to safety or cleaning procedures, and some community members were deeply concerned about the long-term effects of odors and pollutants left behind by the fire. Some experienced physical symptoms like headaches, nosebleeds and breathing problems.

"At first, a lot of homeowners were just in shock. Many of these homes were badly damaged or right next to homes that had burned down," said Evan Coffey, a senior research assistant at the University of Colorado, Boulder whose research focuses on air quality impact and pollution emissions. As part of an effort to assist with the disaster response, a team of researchers, including Coffey, began efforts to measure air quality in smoke-damaged homes.

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Evaluating VOC levels across multiple homes.

The team received over 50 responses from home-owners willing to participate, all with homes varyingly affected by smoke damage. "It was a really stunning show of enthusiasm from the community," said Jon Silberstein, a graduate student at CU Boulder who participated in the research efforts. "It really just shows how many people were wondering, 'Is my house safe to live in?' You don't know what kinds of particulates are getting into the air."

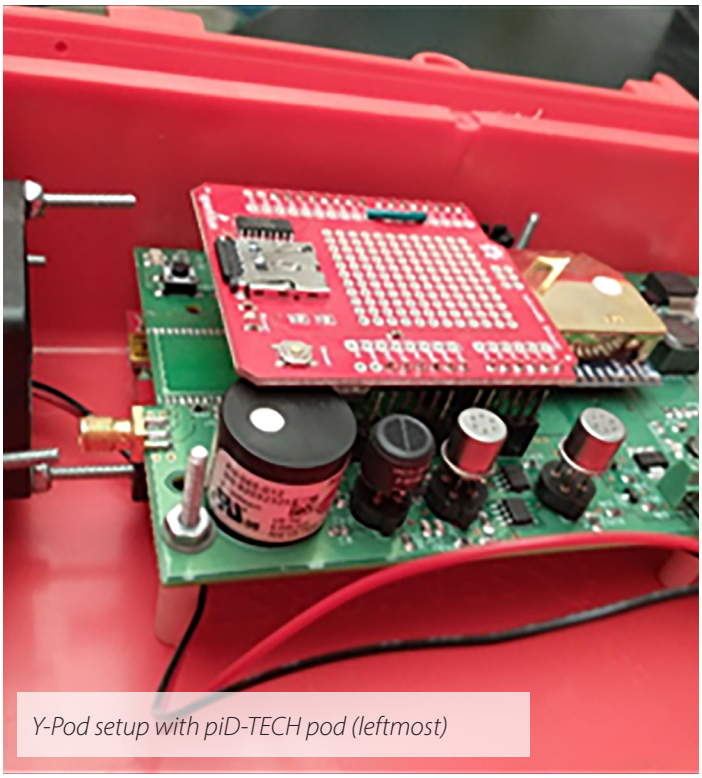
Within a week after the fire occurred, the team was able to deploy air sampling instrumentation to a "field lab household." Researchers planned to use "high-cost" air sampling methods like gas chromatography–mass spectrometry instruments (GC/MS) to calibrate lower-cost, mobile air measurement tools.

Hannigan Research Group, a lab at CU Boulder centered around air quality evaluation via lower-cost, accessible sensors, had a head start when it came to the Marshall Fire Study; researchers like Coffey had already developed an innovative tool called a Y-Pod (bottom right). Because of its relatively low cost and portability, the Y-Pod enables new ways of monitoring air quality.

Coffey explained that from its first iteration, the Y-Pod was unique: it incorporated multiple sensors of differing technologies in order to provide the most comprehensive data possible. A crucial early component of the Y-Pod was the piD-TECH® eVx sensor, a plug-in photoionization sensor available in multiple detection ranges. They're ideal for monitoring Volatile Organic Compounds (VOCs), which can be generated by combustion and are often harmful.

"When we were first designing [the Y-Pod], the piD-TECH sensors were the most interesting to us," Coffey said. "They were low cost but easy to integrate into platforms for VOC monitoring."

Example of research setup in home



Y-Pod setup with piD-TECH pod (leftmost)

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Improving data quality with piD-TECH.

The Hannigan Research Team liked piD-TECH sensors because of their "plug and play" capability, which enabled simple swapping out. They also provided more accurate data. "It was better performing compared to other lower-cost sensors, and we saw strong data linearity," explained Coffey.

AMETEK MOCON donated 12 piD-TECH sensors to the research team, enabling the creation of additional Y-Pods to aid in research efforts. They were working quickly to obtain measurements directly after the fire, and the piD-TECH sensors helped speed up preparations. "The fact that it was so easy to integrate in our pods was excellent, and made it a lot quicker to deploy everything after the wildfire," said Silberstein.

The Y-Pods were installed in 12 homes across the burn area for periods varying from three weeks to three months post-fire, in order to collect the maximum amount of data.

The team was able to compare the accuracy of VOC measurements from the Y-Pod before and after the piD-TECH sensors were added. When compared with data produced by a mass spectrometer, the overall relationship improved, increasing the R^2 value from 0.51 to 0.64.

More accurate data means more reliable results, which helps the team feel more confident in sharing their findings. "Some of those numbers can seem really small, but if we can explain an additional 10% variability with a new sensor, that's a big step," said Coffey. "[The piD-TECH sensor] made a really big difference to our data quality."

The actual results from the homes being monitored were also reassuring. The team found that compared with unaffected homes, houses damaged by smoke and fire showed relatively normal VOC levels just weeks after the fire. Most spikes in VOC levels could be explained by professional cleaning days (household cleaners commonly use hydrocarbons and chlorinates), or by the normal combustion produced by cooking.

"The results were really uplifting - there wasn't a lot of particulate matter in the air after the fire, even in homes directly in the path," Silberstein said.

Compared with outdoor monitoring, efforts to track indoor quality and indoor pollutant levels are relatively new. This study joins a larger push to investigate the long-term effects of combustion and pollution on air quality in homes and commercial spaces, but it had several unique aspects.

The Marshall Fire study differs in part because the fire occurred in a more suburban area than many wildfires. Because more than just trees burned, it was important to consider a wider range of VOCs when collecting the data.

Accuracy of custom sensor box improved with the addition of piD-TECH Sensor

piD-TECH Sensor made it easy to swap out different models for varying detection ranges and compounds

Intrinsically safe sensor design meant no additional wiring or insulation was needed

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Considerations for the future.

Speaking to the impact of the team's research, Silberstein was happy they were able to do their part and respond to the community's needs so quickly.

"We just tried to help in the best way we could after such a traumatic event," he said. "We were thankful that they were willing to welcome us into their homes, and I think they got some comfort from the fact that what we measured was relatively clean. I hope we gave people some peace of mind going forward."

The research indicated that chemicals of concern, like VOCs, were relatively short-lived after a major polluting event. With proper ventilation, most residents in homes affected by smoke could safely return.

Although the wildfire didn't directly cause long-term air quality problems, the research team had some intriguing findings around VOC levels related to normal household activities.

"We found that there's a lot of variability within people's homes in terms of VOC levels that should raise awareness about air quality," said Coffey. Not just after wildfires, he explained, but for everyday activities and household products.

Coffey continued, "We spend a lot of time indoors, so there's definitely a place for this type of low-cost sensor technology in people's homes. Not everyone can fit a GC/MS in their house, so to some extent it's up to us. Indoor air quality is unregulated, so… I think these sensors are opening the door to a larger world of indoor air quality monitoring."

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