

BY TED CUSHMAN

The Science of Kitchen Ventilation

Last September's Passive House conference in San Francisco, Calif., featured a broad array of expert speakers—including many whose interests range much wider than Passive House. *JLC* was at the conference, and we sat in on a presentation by scientists from the Lawrence Berkeley National Laboratory (LBNL) about kitchen ventilation. LBNL researcher Brett Singer, the principal director of Indoor Air Quality efforts with the LBNL Residential Building Systems group, laid out the lab's research into kitchen range hoods and exhaust fans—including some findings that will be as useful to remodelers working in old leaky houses as they are to builders who specialize in high-performance homes.

In the field, Singer and his colleagues have been taking a close look at the pollutants added to indoor air when we cook—including not just the emissions of gas burners, but also the particles generated by electric range elements, and even the particles formed from vol-

atile gases given off by cookware and by the food itself. And in the lab, the LBNL researchers have been working to find out how well different range hoods and fans work, and to learn how cooks can adjust their practices to help the equipment get the job done better.

THE PROBLEM

Scientists have studied indoor air pollution for many decades. Research in the 1970s and 1980s found that indoor cooking on gas ranges was a big source of gaseous pollutants like nitrogen dioxide (NO₂) and carbon monoxide (CO). Cooking also produces fine aerosol particles, with varying chemical makeup, that are potentially risky to human health. How risky? Singer is quick to caution, "You can't compare frying with oil to diesel exhaust." It's clear that outdoor-particle pollution is a health problem—"many studies have found that when outdoor particles increase, more people wind up in the hospital with various health ailments," he says. But indoor cooking-related particles, while similar in size, tend to be chemically different from vehicle or factory emissions—and scientists aren't sure which particles might or might not be dangerous.

"So if you're sitting at a bus stop you're breathing diesel particles, not cooking particles," says Singer, "and those are different. But since we don't know how hazardous the various kinds of fine particles are, it might be wise to take the precaution of trying to limit our exposure to any kind of fine particles. It's your home, right? Why not?"

The good news is that outdoor sources of those pollutants, such as industrial emissions and auto and truck exhaust, are actually decreasing in the U.S. as environmental regulations take hold and technology improves. The bad news is that the indoor sources of NO₂, CO, and particulates haven't been controlled equally well. In studying hundreds of California homes, Singer and his colleagues have learned that when people cook with gas ranges, quantities of indoor-generated pollutants often measure higher nowadays than pollution levels in the outdoor air.

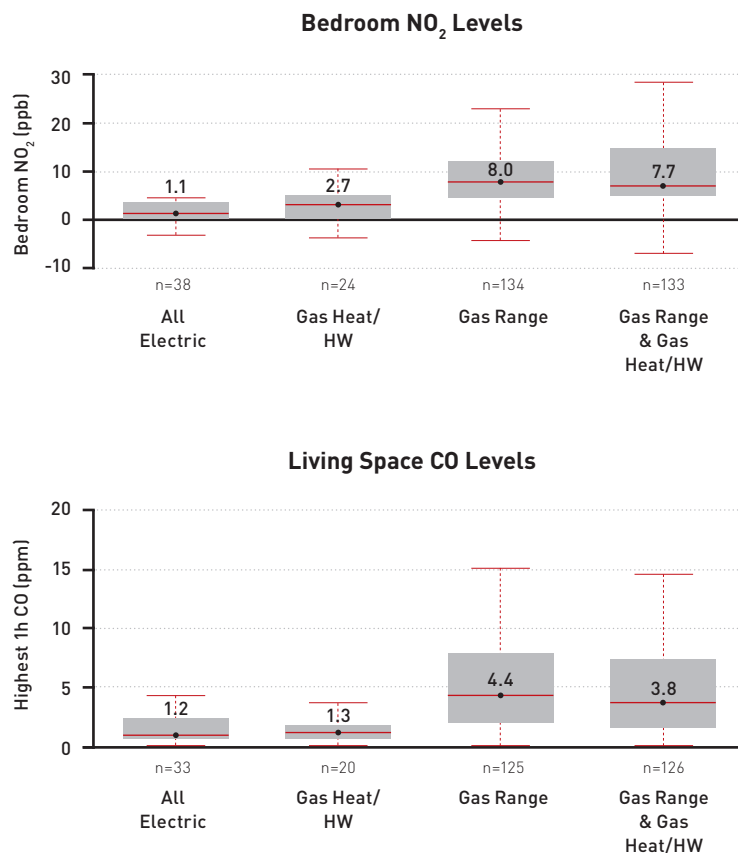
SOURCE CONTROL

If cooking with gas is polluting your house, one easy answer is: Don't cook with gas. Singer's team



Researchers at the Lawrence Berkeley National Laboratory (LBNL) tested the exhaust efficiency of seven different kitchen vent fans with a variety of gas and electric cooktops.

Photo: Berkeley Lab, Roy Katschmidt



Studies done by the Lawrence Berkeley National Laboratory (LBNL) on 350 California homes showed the range of nitrogen dioxide (NO₂) and carbon monoxide (CO) levels from cooking and heating appliances of different fuel types. Electric appliances emit less noxious gases than gas-fired ones, and cooking with gas contributes the highest concentrations of pollutants. The takeaway is to point out to your clients the importance of an effective kitchen venting system that will exhaust pollutants from the kitchen before they spread to other spaces in their home.

measured CO and NO₂ pollution in 350 California houses, and they found that houses with electric ranges showed much lower levels of CO and NO₂ than houses where people cooked with gas. In homes with gas furnaces, it was the cooking—not the furnaces and water heaters—that created the pollution. The data also showed that NO₂ wasn't confined to the kitchen, but spread quickly to bedrooms as well.

But electric ranges, while they don't create NO₂ or CO, do create particles, formed when cooking vapors contact the hot electric coils. New-fangled induction burners don't get hot, but they heat up the pan with magnetism and don't appear to create any particles on contact. "We're not sure about the coils under glass tops," says Singer.

But even induction burners heat up the

pan, and the hot food gives off some quantity of particulates. Says Singer: "Cooking is the act of adding lots of heat to break chemical bonds in the food to produce new things. And when you do that, all kinds of things happen chemically and physically. When you're stir-frying, it's not just the oil that is producing particles. It's the broccoli or beef or whatever you're stir-frying. The chemical bonds in the food are being broken to create different chemicals, which are then going to become particles in the air."

The more you cook, the more of those particles you may breathe in. So no matter what kind of stove a kitchen has, Singer and his colleagues argue that there should be an effective range hood and exhaust fan—and that homeowners should be advised to use it whenever they cook.

RATING THE EQUIPMENT

But that recommendation raises a question: Do range hoods and exhaust fans work? Singer and his colleagues are studying that question in the LBNL test kitchen. In their recent study, Singer and co-researcher William Delp bought seven different range hood and fan combos from local stores and installed the units over a gas range in the lab. Then they measured how well the fans captured CO₂ from the front burners, rear burners, and oven when operated at low, medium, and high speeds.

An ideal range hood and exhaust fan should be affordable enough so people can buy it and quiet enough so that people will use it. The hood should effectively corral the gases rising up off the range (what the researchers call "capture efficiency"). And the

fan should move air well at all speeds.

Unfortunately, Singer's and Delp's results don't make shopping easy: Even with the handful of units they tested, the data was all over the map.

Some units moved air well, but were noisy. Units with good "capture efficiency" didn't always have the best fan performance. And some units that performed well for the back burners didn't necessarily do as well when the front burners were used.

Still, the limited tests did yield a few practical observations. "For one thing, you don't need many hundreds of exhaust CFMs [cubic feet per minute] to be effective," Singer says. "If you can get to 150 cfm and cook on the back burners, most hoods actually do pretty well."

The tighter the house, of course, the more makeup air becomes a concern. In the building code, Singer notes, exhaust fans moving more than 400 CFM must be provided with makeup air. "But if you get down to 3 ACH50 for airtightness, then even a 200-CFM exhaust fan can depressurize the house a little bit," he says.

Ductwork is another issue. "The better fans have more capacity to overcome pressure drops in the ducts," says Singer, "but you pay for better fan performance. But you'll make it easier for your fan if you have straight shots of adequately sized ductwork. So we're talking 6 inches or larger—stay away from the 4-inch ducts—and stay away from a lot of bends or transitions."

Finally, says Singer, "None of these things are effective if a fan doesn't get used. The main reason people don't turn on a fan is that it doesn't occur to them that it is needed." Singer urges contractors to use the vent fan as a selling point—telling clients, for example, "I installed this high-quality unit because I think it's important for your health."

But the other reason people don't use their kitchen fans is because they're noisy. So Singer says, "Ideally you should install something that generates 150 CFM at two sones or less. Then, hopefully, there's a low speed that is one sone or less."

Contributing editor Ted Cushman is based in Peaks Island, Maine.

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