16 Ways to Improve the Air You Breathe

BY JAMIE LYONS

Discovering the causes of poor indoor-air quality is the first step in creating a healthful home

From the spotless houses of the Cleavers and the Bradys to the showcases featured in contemporary advertising, we've been taught that a good house is a clean house. So we sweep, spray, and scrub with an ever-increasing arsenal of tools and cleansers. But what about the part of a house that we don't see yet breathe into our lungs thousands of times every day? Indoor air is a fundamental part of how our houses affect us, but it's often overlooked and misunderstood.

Americans spend up to 90% of their time indoors. According to the Environmental Protection Agency (EPA), indoor air can actually be more polluted than outdoor air. The consequence of spending so much time indoors and breathing polluted air can be seen in the increase of asthma and chronic respiratory disease among Americans.

What makes indoor-air quality (IAQ) most difficult to understand is that it can't be easily or accurately tested. There's a vast world of contaminants to test for, and for most of them, there aren't clear exposure limits to compare against. Plus, testing is just a snapshot of a home's conditions. Because many factors can affect IAQ, testing is not a realistic option in most cases. Instead, looking at the sources of pollutants and the way they enter the living space is the best way to determine if your house is as healthful as it can be.

Both tight houses and leaky houses have issues

We didn't hear much about IAQ 30 years ago. Building science was still in its infancy, and our houses were different.

In the name of energy efficiency, modern houses are wrapped, caulked, and spray-foamed until air leakage through the building shell is reduced to a mere whisper of outside air. This has eliminated the natural air infiltration that once served as an IAQ Band-Aid by diluting pollutants and, occasionally, helping to dry out moisture.

Before you call a tight house an unhealthful house, though, remember that the air infiltrating a leaky house can cause just as many problems as it fixes. For example, hot, humid outside air that finds its way inside simply adds moisture to your house. Incoming outside air can

Relative humidity levels greater than 70% spur mold growth, and a 50% level allows dust mites to thrive.

Photos this page: dust mite, courtesy of American Academy of Allergy, Asthma & Immunology; mold, Dan Sahl. Photo facing page: Scott Phillips.

introduce pollutants such as car exhaust. Although tight houses can prevent pollutants from escaping, they also decrease the amount of contaminants that are entering the living space and allow indoor conditions to be better managed.

Three threats revealed

While a number of pollutants can create poor IAQ, there are three common sources: poor construction, faulty or improperly designed mechanical systems, and human activity.

Poorly designed and poorly executed construction details can allow moisture to enter a house. Bulk-water leakage leads to IAQ problems such as mold growth. High levels of water vapor, which is measured as relative humidity (RH), can result from water leakage or a host of other problems. High RH can have just as serious an impact on IAQ as bulk-water leakage. RH levels greater than 70% spur mold growth, and a 50% RH level allows dust mites to thrive. (Dust mites foster asthma.) A variety of factors influence indoor-moisture levels. For example, incorrectly flashed windows, unsealed rim joists, and cracked foundations all can contribute to excess moisture in a house.

Monitoring your house's RH is easily accomplished with a battery-powered digital hygrometer, which can cost as little as $10, and could tip you off to much larger moisture problems. While different people will be comfortable at different indoor RH levels, certain limits can be established to help maintain healthful IAQ. To help control dust mites and mold growth, keep indoor RH at a level below 50%.

When you're analyzing mechanical systems, the goal is relatively simple. They should operate as they were designed. When these systems fail, prob-

HUMAN ACTIVITIES

1 **Cooking generates strong odors,** smoke, grease, and humidity. These contaminants should be exhausted directly outdoors (not recirculated) with a range hood. For best performance, match the hood's flow rate with the range's heating capacity (about 1 cfm per 100 Btu). The fan's noise rating should be 1.5 sones or less at low speed.

2 **Cabinets and pressed-wood products** are often made with adhesives containing formaldehyde, which is emitted into the home. Whole-house ventilation can remedy existing sources of formaldehyde, but it's best to select materials free of the compound or that meet standards for low emissions.

3 **Carpets harbor dust mites,** and new carpeting can emit VOCs into a home. Dust mites can be controlled by maintaining RH below 50%. When installing new carpeting, select products with low VOC emissions, and ventilate the area for 48 to 72 hours following its installation.

4 **Many household-cleaning products** emit harmful VOCs when they're used and stored. When choosing cleaning products, select items that are listed as solvent-free. If using a product made of harmful chemicals, provide ample ventilation with your house's mechanical systems and open windows.

5 **Showers add humidity** to indoor spaces. Control this moisture load with exhaust fans ducted to the outdoors. These fans should move air at a rate no less than 50 cfm. (Fans often deliver less flow than their nominal rating.) Increase airflow with short, direct duct runs, and look for fans with 6-in. ports that can accommodate 6-in. ductwork. These fans should be quiet—2 sones or less.

6 **Garages often are home to toxic chemicals, car exhaust, and VOCs** that can migrate into a house. Isolate the garage from the house with self-closing and weatherstripped entry doors and tightly air-sealed ducts (if routed through the garage, which they shouldn't be) and through-wall penetrations. It's also wise to consider using exhaust ventilation to the outdoors.

MECHANICAL SYSTEMS

Poor mechanical systems and faulty appliances can increase indoor-pollution levels. The resulting IAQ issues range from mold exposure to death by carbon-monoxide poisoning.

7 **Clothes dryers generate large amounts of humidity** and also draw about 150 cfm of air from the surrounding space when they're operating. Vent dryer exhaust directly to the outdoors with approved ducting. If natural-draft combustion appliances are nearby, make sure the dryer isn't causing backdraft issues.

8 **Leaky return ducts** in crawlspaces or basements can draw contaminants into a house. Seal joints with duct mastic, and design floor plans to keep ducts out of unconditioned spaces.

9 **Radon,** a naturally occurring radioactive gas found in soil, needs to be kept from indoor spaces. Radon levels in houses should be measured with a test kit. If levels are too high, install an active mitigation system, which uses a fan and vent piping to exhaust radon from under the slab to the exterior of the house, usually through roof vents.

CONSTRUCTION

When a home is built or remodeled without attention to construction details, then the home as a system can fail. Below are some of the most problematic areas of a house. By addressing them properly, you can manage your home's IAQ more easily.

13 **Poorly flashed windows,** doors, and other through-wall penetrations can allow moisture to enter the living space. Install pan flashing, integrate the housewrap with the unit, and seal the flanges with flashing tape. Spray foam between the jamb and the rough opening to help keep moist air out of the house.

14 **Gaps in construction** allow dust, humidity, and other pollutants to enter. Seal gaps in the exterior envelope with caulk or spray foam. Pay particular attention to attics and rim joists, which are prone to leakage. A blower-door test helps to reveal the areas that you've missed and that need attention.

lems arise. Return-air ducts in a forced-air system can be particularly troublesome. The ducts are under negative pressure, so they pull air from wherever it's available. Ideally, they draw air only from the living space, but leaky ducts can draw air from crawlspaces, attics, and basements where dust, pollen, mold spores, moisture, and even radon can be lurking.

Other mechanical-system failures can have a more dire affect. A combustion appliance that's not working correctly can emit carbon monoxide into a house, and a radon-mitigation system that's not performing can allow the cancer-causing gas to seep into living spaces.

Not all contaminants are nature's fault (like radon) or the result of poor construction. The truth is that homeowners introduce many contaminants. These pollutants include the formaldehyde found in cabinets and plywood, and the volatile organic compounds (VOCs) found in carpets, adhesives, and paints. Homeowners also introduce contaminants like cooking by-products and more subtle offenders such as the products used to clean the house. Product and material substitution works in some instances. Look for sources at LEED for Homes (www.usgbc.org) and GreenGuard (www.greenguard.org). However, installing a ventilation system is the best way to rid a home of contaminants.

Clean air in, bad air out

The solution to existing IAQ problems in a house is proper ventilation. This is true of old houses and new houses. There are two types of ventilation to consider: whole-house ventilation and spot ventilation.

Spot ventilation—also referred to as local exhaust ventilation—includes range hoods and bathroom exhaust fans.

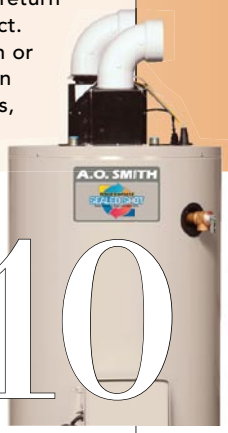
Knowing whether you need spot ventilation can be pretty obvious. Lingering odors, condensation, and mildew are all easy signs to recognize.

Whole-house ventilation systems supply fresh outdoor air,

Photos this page: 7, courtesy of Dryerbox; 8, John Curtis; 9, Rob Yagid; 13 and 14, Chris Ermides.

Backdrafting from combustion appliances can introduce deadly carbon monoxide. Backdrafting occurs when the negative pressure around a combustion appliance, such as a water heater, pulls combustion gases back down a flue instead of letting them flow to the outdoors. Backdrafting can be caused by exhaust devices (fans, dryers), fireplaces, leaky return ducts, and the stack effect. Select sealed-combustion or power-vented combustion equipment (water heaters, furnaces, boilers) to ensure that combustion gases are exhausted properly. In any house, ensure that all mechanical equipment is vented properly, and install carbon-monoxide alarms close to the appliance and sleeping areas.

10



11

Unvented or "vent-free" combustion appliances, such as gas fireplaces, can transfer combustion by-products into the house and also add to indoor humidity. In new construction, opt for vented combustion appliances, such as a woodstove, instead. For pre-existing unvented units, closely review and follow operating instructions for the unit, particularly the requirements for make-up air and run-times. In any house with combustion appliances, install a carbon-monoxide alarm near sleeping areas and close to the combustion appliance.

12

Prevent contaminants from circulating through the house by equipping the central blower with a minimum efficiency reporting value (MERV) 8 filter. Be sure filters on air handlers (like HRVs) are cleaned regularly. When designing an HVAC system, account for the increased static pressure of the filter. A more powerful central blower might be needed to achieve proper airflow.

15

Basements with moisture problems increase humidity levels and promote mold growth. Keep a foundation dry by properly grading the exterior soil, by installing gutters and downspouts properly, and by waterproofing foundation walls correctly. If bulk-water infiltration is an issue, make sure you've got a working sump pump, and add a dehumidifier if necessary to keep relative humidity below 50%.

A cracked slab can allow radon and moisture into the house. Cracks and openings in the slab, such as those around drainpipes, should be sealed to keep moisture and radon at bay.

16

exhaust stale indoor air, or do both to help manage IAQ. Whole-house ventilation provides a steady, predictable amount of indoor-outdoor air exchange. Not all systems perform well in every climate, so it is wise to do some research before installing a ventilation system in your house.

Exhaust-based whole-house systems use one or more bath exhaust fans to pull stale air out of a house. The fresh air from the outdoors makes its way into the home through cracks and openings in the building's shell. Alternatively, passive vents or dampers can be built in to provide a specific entry point for fresh air. These systems are the easiest to install in an existing house, and they don't rely on central ductwork.

If central ductwork is accessible, supply systems and balanced whole-house systems are options. A supply system draws outside air into the central blower and distributes it through the house. Because the house is pressurized, it forces stale air and its contaminants out of the house through cracks and gaps. These systems rely on a much bigger blower to introduce fresh air, so they're best used in combination with high-efficiency models.

Balanced systems draw fresh air into a house and exhaust stale air at the same rate. Balanced systems usually use a heat-recovery ventilator (see "How It Works," p. 16) or an energy-recovery ventilator to improve the efficiency of the system.

While ventilation technology has improved over the years and has helped to improve the air quality in our houses, keep in mind that it doesn't negate the importance of preventing IAQ problems at their source. Ventilation doesn't trump proper design and construction. □

Jamie Lyons, P.E., is a member of ASHRAE and is a senior consultant at Newport Partners, LLC, where he focuses on energy performance, moisture management, technology development, and indoor-air quality.

Photos this page: 10, courtesy of A.O. Smith; 11, courtesy of Wittus; 12, Rodney Diaz; 15, Eric Nelson; 16, Randy O'Rourke.