Exhaust-Only Ventilation Systems

One builder's approach to providing 7.5 CFM of fresh air per occupant

By Michael Chandler | February 13, 2010

An occupancy sensor / timer + an Energy Star 110-cfm bath fan + a back-draft damper + an exterior filter holder = a system that provides 7.5 cfm per occupant.

After trying a variety of ventilation approaches, I've settled on exhaust-only ventilation systems with ventilation rates that are on the low side of most recommendations.

Most third-party certified green building standards require homes to have mechanical ventilation systems capable of providing 7.5 cfm of fresh air per occupant plus 1 cfm per 100 square feet of conditioned space. As explained in Martin Holladay's excellent overview of ventilation options, this requirement is based on ventilation rates established by ASHRAE Standard 62.2.

Ventilation schemes inspire vigorous debate, as evidenced by the 40 responses to Martin's article. This is how I do it and why. Other builders may have differing climates and indoor air pollutants to contend with and will therefore choose different solutions. I'm still struggling with several issues, including the question of passive air inlets.

You don't want to bring in too much humid air
Here in North Carolina, the outdoor air is often oppressively humid. Because we've eliminated many of the sources of indoor air contamination, I feel that the ventilation rate recommended by ASHRAE 62.2 rate is excessive — especially when work and school schedules often mean that a home's occupancy level is low.

My solution has been to use a simple and inexpensive form of exhaust-only ventilation controlled by very robust and attractive Lutron MS-OPS5AM or the slightly less attractive Watt Stopper RS-250 occupancy sensors with adjustable timers. These controls give me the fresh air I need when people are in the home but automatically scale back when the people are gone.

Do the math first
To provide 7.5 cfm per occupant, we need to provide 7.5 x 60 = 450 cubic feet per occupant per hour. That can be provided by a 110-cfm bath fan (hood tested at 80 cfm actual) for 5.6 minutes. If the average individual spends 12 hours per day at home and 12 hours away from home, we need to run that bath fan 5.6 minutes times 12 hours — or 67.5 minutes per day — to provide adequate fresh air for that occupant.

If some of the occupants are teenagers or adult children who only occupy the home intermittently, there should be a mechanism by which the house can dynamically respond to variations in occupancy levels. Time-delay occupancy sensors (used as bath fan switches) allow the home to respond to varying occupancies without conscious input from the homeowners.

We set the master bath fan at a 30-minute time delay. This is based on the assumption that it will get triggered on average four times a day by two occupants.

We put the kids' bath fan on a 15-minute delay and the powder room on a 15-minute delay. If the kids are away at school, there will be no additional ventilation (since their bath will not see any use), but during a family reunion the venting will be stepped up automatically.

We use Energy Star rated 110-cfm Panasonic bath fans, but any Energy Star rated bath fan will do. Our flow-hood testing has shown that a 110-cfm fan actually removes about 80 cfm, so that is what we design for. It is essential to have your Energy Star certifier or HVAC contractor verify the output of the fan to confirm the efficacy of your timer calculations. You may also want to adjust the timer settings upwards if the homeowners have a lot of houseplants or pets.

This is just one way to do it — there are many different approaches

Our goal is to provide balanced and filtered makeup air for the exhaust-only ventilation system, so we provide designed exhaust and a balancing intake.

Some builders put a filtered fresh-air duct from the exterior to the return-air duct of the HVAC system. However, with this approach the volume of makeup air changes with the operation of the HVAC system rather than with building occupancy. On the hottest and coldest days of the year, when the HVAC system is operating for many hours per day, the home does not need additional makeup air.

Joe Lstiburek's Building Science Corporation and Masco's System Vision program advise using a FanCycler timer combined with an intake vent from the exterior to the return-air plenum. During the swing seasons (spring and fall), when the HVAC blower rarely operates, the FanCycler energizes the HVAC fan on a schedule to assure adequate ventilation. The FanCycler control also shuts a motorized damper when necessary (usually in very cold or very hot weather) to prevent overventilation.

According to Brian Coble of Advaned Energy, however, homeowners tend to disable these devices. (We designed Coble's house and therefore got to spend a lot of time talking building science with him.)

Some builders, especially those in the North, design their ventilation systems around Energy Recovery Ventilators, generally using them in place of bath fans. This is a very valid solution if you can locate the filters in easily accessible locations and if your budget can handle the $2,000 installed cost.

Passive air intakes are still a good idea (I think …)
We still use a passive intake air vent to provide for the clothes dryer (which needs up to 200 cfm of makeup air) and the range hood (which can need well over 100 cfm). Even a sealed-combustion wood stove needs enough air to minimize smoking when you are loading the wood.

We know that the houses we build do have air leaks; flow-hood testing on homes with air changes of less than 2 ach at 50 pascals depressurization (<2 ach-50) shows the passive intake vents typically provide 50 cfm for every 80 removed from house by bath fans. we generally locate a behind dryer in laundry room. we choose this location because is used much more than range hood and don't want to use conditioned air dry clothes. we butterfly dampers prevent vent back-drafting. lately, though, we've switched cape dampers, also called "nylon sock" (see photo supply information below). these are sensitive durable dampers. they make that irritating "tink tink" sound as open close. sock can be located directly wall horizontal orientation, so end up taking less room installation. (butterfly need oriented vertically little difficult integrate into room.) to keep pollen insects entering house, install washable range-hood filters. easy inspection cleaning, filters installed at an accessible on exterior of house.

Variations and ambiguity
Martin's suggestion that we eliminate passive intakes and rely instead on random envelope leakage is very compelling. This is an issue I've been struggling with, and one that I have been arguing with my Energy Star / Builders Challenge rater about.

One cold-climate builder told me that he pulls his fresh-air intake through a long section of six-inch steel duct in his conditioned crawl. This approach pre-warms the incoming air, reducing the chance of cooling the laundry room too much in cold weather.

When we build on a sealed crawl space we will generally install a Panasonic 80-cfm bath fan in the crawl space to continually cycle 80 cfm of air from the conditioned space into the crawl space and out through a 4-in. steel duct. This approach keeps the crawl space depressurized with respect to the conditioned space above. There are a lot of variations on the concept, and many have value. There is still much ambiguity in the building code, and in some cases the intent of the building code and green building standards are unclear.

With green building’s emphasis on eliminating sources of indoor air pollution, a good argument can be made that it’s acceptable to ventilate a certified green home at a rate that is less than the rate recommend by the ASHRAE 62.2 standard. If I can use really good and quiet bath fans and a few $32 occupancy sensors to achieve my indoor air quality objective — without the cost of an ERV — then I can use that money for a better thermal envelope.