I hear it all the time: “Houses are too tight.” “Houses didn’t used to make people sick.” These assertions seem well founded: The most serious chronic illness of American children is asthma, and the Environmental Protection Agency lists poor indoor-air quality among its top five environmental threats. Are tight houses poisoning us?

There’s no disputing the cause-and-effect relationship between tight houses and indoor-air pollution. In theory, the solution is simple: If you build tight, you must ventilate right. In practice, though, ventilating right is complicated and controversial. In 2003, I chaired an American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) committee that passed the country’s first residential ventilation standard, which gives builders and designers guidelines for providing good indoor air while keeping utility costs low (see p. 69).

Ventilation is manifold in house systems

Before I go farther, let me define ventilation. The word ventilate comes from the Latin ventilare, and it means to expose to the wind. Although this may sound like some creep in a raincoat, the real story is more complex. Ventilation is used many ways when describing how a house works: There’s crawlspace ventilation (often bad), ventilated siding assemblies (good), and roof ventilation (sometimes bad, some-
A tremendous amount of energy. You could plaster that 3 ft. of holes. Infiltration is a pretty bad way to ventilate because it wastes a lot of energy. The average house in the United States has about 3 sq. ft. of holes in it, but infiltration is a pretty bad way to ventilate because it wastes a lot of energy. On average, the air in older homes is replaced once every hour (1 ACH, or air change per hour) because older homes have a built-in ventilating method that’s simple and reliable: leaks (or infiltration). Leaky houses are not the answer. Many builders and designers are tempted to take the Goldilocks approach and to look for that level of leakage that is just right, neither too little nor too much. Unfortunately, there is no hole for all seasons. The best a leaky house can do is waste energy much of the year and be underventilated the rest of the year.

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The simplest way to make sure contaminants don’t build up in a house is to suck them out with one or more continuously running exhaust fans. This approach is the least expensive, is the least invasive, and has the advantage of working in houses without existing ductwork. For whole-house ventilation, existing kitchen and bath fans must be left running, a noisy prospect unless you’ve got super-quiet models. A better solution is to use a multiport fan (drawing p. 68) in the attic that exhausts many rooms simultaneously.

In this exhaust-only system, makeup air comes in through open doors and windows, or through leaks if you’ve got a leaky house. If you’ve got a tight house, passive vents serve the same purpose. The Thermastor vent pictured here comes from www.efi.org and costs about $35. Similar vents are available from www.aldesamerican.com and www.panasonic.com.

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Three design choices for hot, humid climates

In a hot, humid climate, sucking fresh air into your house can be a problem. You inadvertently can introduce 8 gallons of water a day from the ventilation air. When combined with internally generated moisture sources, this is way too much. There are three design options to consider or combine.

1. TOLERATE

You can accept periods of high-moisture levels if you use moisture-tolerant materials. Hard, cleanable surfaces are better choices than fuzzy ones. Use hardwood floors instead of carpet, or tile, plaster, or brick rather than paper-faced drywall.

2. DESICCATE

Get the extra moisture out of the air by condensing it and draining it. Air conditioners can remove moisture, but they usually are sized and designed for controlling temperature. In some climates, they won’t dehumidify enough under normal use. A better option is a standalone dehumidifier or enhanced dehumidification gear.

3. PROCRASTINATE

Some humid climates have dry seasons. It may be possible to use reservoir-type buffer materials that store moisture during hot, humid periods, then release it during dry ones. Examples of such materials are brick interior walls, cellulose insulation, and solid-wood exposed beams.
A SUPPLY SYSTEM REMOVES BAD AIR AND BRINGS IN FRESH

system (drawing above). This way, outdoor air is pulled in to the house through the air handler whenever it operates.

Such an air intake must have controls (such as a timer or cycler) to turn on the air handler to make sure there is enough ventilation air. This system also should have a damper to prevent overventilating when the heating or cooling system is operating most of the time (very hot or very cold weather). Without these controls, this supply system is just a hole in the return duct, which is worse than a leaky house.

Supply systems must temper ventilated air to moderate temperatures in all but the mildest climates. The system above does this, when there is no heating or cooling call, by running the air handler and mixing unconditioned outside air with large volumes of conditioned indoor air. While this process tempers the outside air, it uses a lot of electricity because the air-handler fan is overkill for the amount of ventilation air being sucked in.

Balanced ventilation brings in the good air, banishes the bad, and conserves energy

The best way to temper incoming air while reducing HVAC energy consumption is to use a heat-recovery ventilator (HRV) or an energy-recovery ventilator (ERV) (drawing p. 68). These systems are balanced approaches that use the temperature and humidity of an exhaust-air stream (which otherwise would have been wasted) to temper the air of a supply stream, thereby reducing the HVAC energy cost. HRVs heat or cool incoming fresh air and can recapture up to 80% of the energy that would be lost without them. ERVs are better suited for...
A balanced system removes bad air, brings in fresh, and can save heat (or cold)

The problem with exhausting stale air from your house is that you’ve likely paid good money to heat or cool that air, and venting it directly outside is like throwing away money. A balanced system with a multiport vent fan (from $185 at www.sheltersupply.com or www.iaqsource.com) channeling all exhaust through some type of heat exchanger can mitigate the energy loss.

Active exhaust and intake with energy recovery

The best approach to whole-house ventilation employs either a heat-recovery ventilator (HRV, from $700; pictured below) in cold climates or an energy-recovery ventilator (ERV, from $800) in hot climates. These units, which can be incorporated into a house with or without existing ductwork, bring in fresh air and exhaust stale air. But in addition, an HRV tempers incoming air with outgoing air, thus lowering the amount of energy necessary to condition the fresh air. An ERV looks and functions similarly, but it dehumidifies and cools hot, humid air, which reduces the load on the air conditioner.
hot, humid climates because they dry incoming air, thus reducing the work that the air conditioner has to do.

You still need to clean up

Ventilation is good at diluting gaseous compounds and small particles because small particles act like gases. They mix quickly in the air and follow air currents when air is expelled. But large particles such as pollen, pet dander, and dust mites must be cleaned up or vacuumed rather than exhausted or diluted because they’re too heavy to mix with air. Other large particles, semi-VOCs, are solids or liquids at room temperature. While they’re not gaseous, as with VOCs, they are volatile enough to emit lots of gaseous vapor. This is important because if you filter out SVOC particulates, you haven’t really done anything until you clean the filter; the SVOCs keep emitting gaseous vapor from the filter. If you don’t replace filters on your HVAC system regularly, the system itself becomes a contamination source.

The three ventilation systems discussed here are by no means comprehensive; they can be combined in various recipes to meet particular conditions. In addition to climate and house tightness, cost can be a big consideration, but it shouldn’t be the major one. Be sure to consider long-term durability and maintenance requirements. Systems with heat recovery (HRV/ERV) require a lot more maintenance than those without. Systems with multiple filters or requiring seasonal adjustment can be confusing.

Tight houses are good, and they should breathe

Excessively leaky houses are one way for a house to breathe, but not the best. While there’s a lot of ongoing research and a robust scholarly debate on the best way to achieve acceptable indoor-air quality, building scientists all agree that houses need to breathe.

As houses become higher and higher performance, they need to breathe in a steady, reasonably controllable way. We cannot afford to let them breathe at the whim of the weather or with windows only. We also sometimes need to be able to have them hold their breath when conditions outside are exceptionally bad. Only with designed ventilation systems can we make sure that indoor-air quality and energy efficiency advance hand in hand.

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The major requirements of 62.2 are:

- **Whole-house mechanical ventilation**
  Exhaust, supply, or balanced ventilation. For a typical house, 50 cubic feet per minute (cfm) will do.

- **Mechanical exhaust in kitchens and bathrooms**
  In addition to the whole-house ventilation requirement above:
  - **Kitchen**: a user-operable vented range hood of at least 100 cfm; or a fan giving 5 kitchen air changes per hour of continuous or intermittent exhaust.
  - **Bathroom**: a user-operable fan of at least 50 cfm; or a continuously operating 20-cfm exhaust fan.

- **Fans must meet performance levels**
  A third-party rating is required for airflow under reasonable operating conditions. The sound rating is 1 sone for continuously operable fans and 3 sones for intermittently used kitchen and bath fans in item 2.

- **Combustion appliances must follow building codes**
  For some circumstances, vented combustion appliances are prohibited from being indoors. Because 62.2 is not about combustion safety, it addresses the few cases where combustion and ventilation equipment can interact.

- **Garage duct systems must be airtight**
  Air handlers or return ducts in an attached garage must be tested for tightness. While tight ducts save energy, 62.2 sets only minimum requirements to protect indoor-air quality.

- **Particle filtration upstream of air handlers**
  Dirty ducts and coils can become a pollution source, so 62.2 requires pleated furnace filters (MERV 6 or better). To clean the air inside the house, more aggressive filtration would be needed.