BY DOUG HORGAN

Humidifying Homes

Why would you want to add moisture to a house? As anyone who's dealt with an expensive and challenging mold issue knows, moisture is often the *problem* in houses. Why would we deliberately add more? There are three answers I know of:

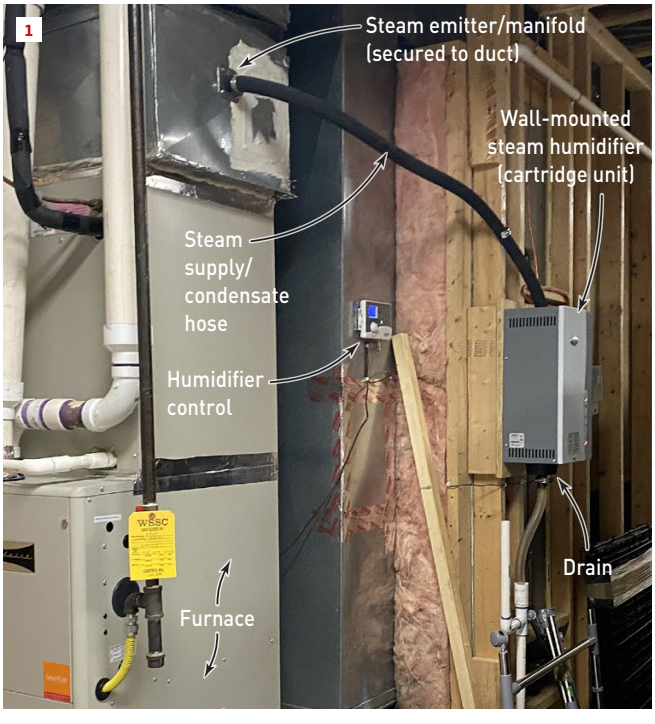
- Low humidity causes wood to shrink (when it dries out); this can cause aesthetic issues or even cause things to break.
- People are less comfortable when humidity is very low. Static shocks, dry nasal passages, and itchy skin are common issues.
- There is some evidence that low humidity allows some illnesses to transmit more effectively, so higher humidity may reduce the likelihood of these spreading—but there are important reasons to be cautious with this information.

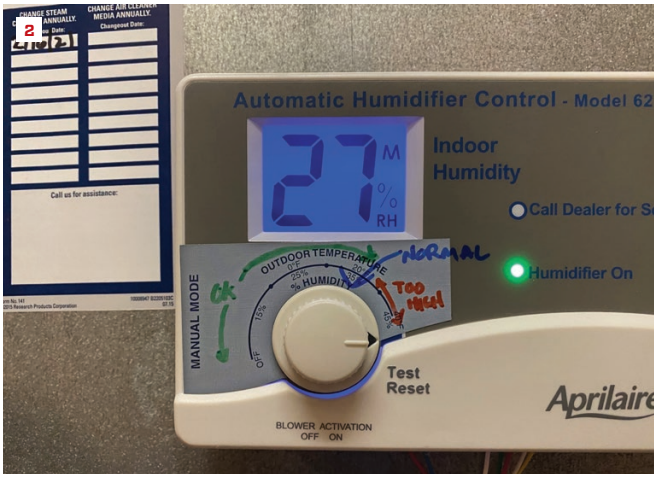
WHAT IS THE RIGHT LEVEL OF WINTER HUMIDITY?

To prevent wood from moving around too much, we want to keep humidity somewhat even, so the correct level in winter varies with climate. Where I work, the Washington, D.C., area, it's common for indoor humidity to run well above 50% for the humid half of the year. (I'll be using relative humidity (RH) at indoor temperatures in this article.) Wood will condition to this level of humidity and measure around 9% to 11% EMC (equilibrium moisture content) during the humid months.

In winter, we want to limit how much the wood shrinks from its summer level, so the closer we stay to 50% RH, the less movement. Having said that, 50% is too high for normal buildings to handle in many climates, and in my experience, problems develop only when humidity runs close to 20%, drying wood to about 4% EMC. If we can keep humidity between 30% and 40%, EMC will drop only to 6% or 7%, and wood shrinkage will be acceptable. After all, it's normal for hardwoods to have small gaps in winter; we just don't want them to be so wide they are objectionable. We find even wider baseboards and crown moldings won't shrink enough to break caulk lines as long as humidity stays above 30% most of the time.

If your summers are drier (typical of northern locations), you may not need to keep winter humidity levels as high as 30% to keep wood in good shape, whereas if your summers are wetter, your buildings may need to be humidified to more than 30% to prevent problems with wood. In other parts of the country, there may not be





Cartridge steam humidifiers emit steam into HVAC ductwork when called for by the humidistat **(1)**. In the author's climate, his company recommends clients set controls at 35% RH or lower (shown here marked up with colored pens), based on its experience that most buildings can handle 40% to 45% relative humidity in winter without moisture problems, and allowing for some inaccuracy or drift in the sensor **(2)**.

Photos by Doug Horgan; illustrations by Tim Healey

a significant difference in humidity between summer and winter, so it may not make sense to have a humidifier—at least for limiting seasonal wood movement.

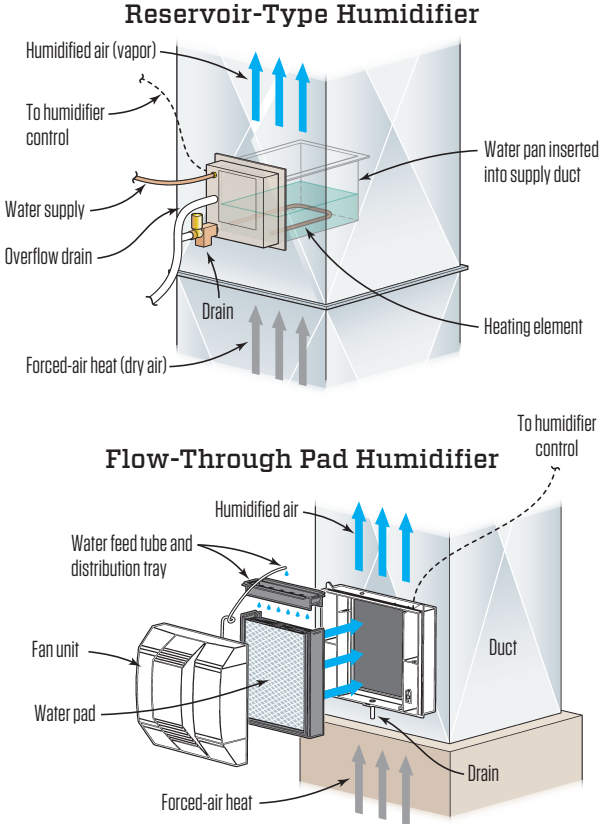
Engineered flooring seems to have the biggest problem with large seasonal humidity swings. We've seen several floors, from multiple manufacturers, rip apart at glue joints between layers in homes with low winter humidity (around 20%—so far, no issues at 30% or higher). A look at the warranties may be disheartening; some "require" that humidity be kept in small ranges like 35% to 45% RH year round, which is possible only in tight houses with closed windows, humidifiers, dehumidifiers, and perfect operation and maintenance.

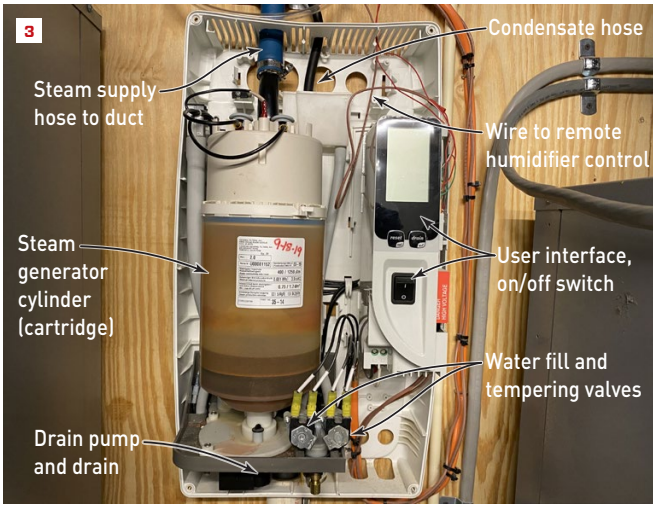
Striving for 30%. For human comfort, I have heard few complaints once humidity is maintained in the 30% range—despite what you may read. We work on many leaky houses and buildings where humidity can't be kept much above the low 30s, or even high 20s in some cases. These houses don't have super-dry static electricity issues or even many complaints about dry noses or skin; those start when houses run in the low 20s or lower for a few weeks.

In fact, John Straube, a principal at RDH Building Science, recently spoke of a client with itchy eye complaints on an ASHRAE Journal podcast (ashrae.org) with Joe Lstiburek. A doctor recommended a humidifier, but the symptoms became worse once it was in use, because the irritation was caused by mold growing in the walls, and the humidifier made the mold problem worse. This brings us to the wisdom of the internet.

If you search online for the "correct" level of humidity, you'll come across a diagram that seems to state that optimal relative humidity is between 40% and 60%. The main evidence about keeping humidity this high comes from hospital wards where influenza has been shown to spread much more effectively below 40% RH.

I would never minimize this important data point, which has been shown in multiple studies. But, it's crucially important not to overhumidify buildings in cold climates. Many houses in my area (climate zone 4) should not be operated at humidity levels above 40% or 45% in winter, or they will suffer from moisture damage, including growth of mold, bacteria, and other water-loving organisms (which themselves cause human health problems), wood rot and damage in walls and roofs, and also undesirable window condensation that can drip down walls, damage floors, and wet window shades. In colder climates than ours, the building envelope is that





Reservoir humidifiers can be high maintenance and may present an indoor air quality risk; typical designs stay wet all winter, allowing the potential for organisms to grow in them (illustration, top left). Flow-through pad humidifiers (illustration, bottom left) use disposable pads. Water trickles down from the top while air is blown through the pad. Pads are often treated to resist biological growth. Steam humidifier cartridges do accumulate minerals and debris from the water supply, but they are easily replaced—typically annually **(3)**. They are designed to fully drain in the off cycle.

much colder, and condensation and moisture accumulation can happen at even lower humidity levels.

It's easy to overhumidify ordinary buildings in cold climates. Standard windows, doors, and even walls and roofs are prone to condensation problems when indoor humidity levels are high. If you want to run a house at higher humidity, you have to build differently: more insulation, better windows, minimal air leaks, and thermal bridge protection—pretty much the recipe for a passive house—or use materials that can handle high levels of moisture and freeze-thaw conditions—the old recipe for hospitals and museums.

The respiratory pandemic we're in has increased this kind of talk, but it's not clear that higher humidity is helpful against SARS CoV-2. In fact, the one study I know of that tangentially addresses it indicated lower humidity may be helpful.

Whatever data or study one is looking at, high levels of humidity will definitely cause problems and must be avoided.

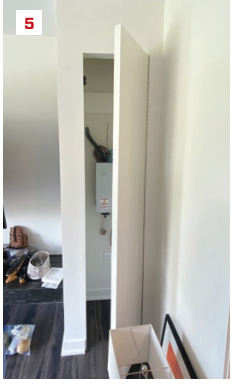
PORTABLE VS. WHOLE-HOUSE HUMIDIFIERS

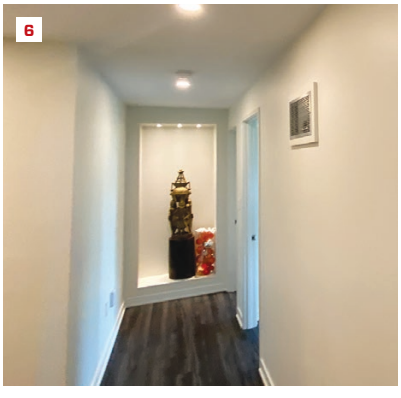
Many people use portable or plug-in humidifiers, which they refill regularly. Some scientists are concerned about using tap water in one type of portables, "ultrasonic" humidifiers, because the minerals and other junk in the water are turned into indoor air pollution. Other than that, and the inconvenience of managing them every day (including moving them to where people are), these can work.

Most of our clients install whole-house or automatic humidifiers so they don't have to spend as much time and energy managing them. It helps that most houses in our area have ductwork for air conditioning and heating, which makes it easy to install automatic equipment. There are several different types of automatic humidifiers, but we use only two: flow-through pad humidifiers, and steam cartridge humidifiers.

Flow-through pad humidifiers use a disposable pad about a foot square by 2 inches thick. Water is piped to the top of the pad and trickles down, while air is blown through the pad. The large surface area encourages evaporation. In the off cycle, the pad dries quickly so mold doesn't seem to grow on it, and some pads are treated with coatings that resist biological growth. These humidifiers are reasonably effective and are not expensive to install or maintain. They do use a lot of water, depending on how they are set. Much of the water doesn't evaporate and instead heads down the drain. When you're paying a lot for water and sewer, this adds up. Not to mention that many of these devices recommend using hot water, which obviously increases energy use.

We've seen a lot of pad humidifiers leak a bit of water, especially on startup in the fall. For this reason, we usually recommend them only for areas that can handle some splashing. Adding a pad humidifier to an upstairs system is risky, even when we're able to install the oversized drain pan we insist on for new installations. (When possible, we run HVAC closet drain pans from frame to frame, before drywall, so even splashing or spraying can land in the pan.)





Wall emitter boxes are used with steam cartridge units where ductwork is not available to distribute the humidity **(4)**. Humid supply air is hosed from a steam cartridge unit, typically housed in a nearby mechanical room or closet **(5)**, to the emitter box, which has a built-in fan to mix air with the steam. Grills can be a bit obtrusive unless hidden in a hallway or other less visible location **(6, 7)**.

Steam cartridges. The second type of humidifier we use is a steam cartridge unit. This heats water in a replaceable plastic cartridge and pipes the resulting steam into an emitter in the ductwork.

Steam humidifiers are powerful and can put out terrific amounts of moisture—so much that we have to be careful with them. We've learned to install at least one safety device when we use these, either an "airflow proving switch" that won't let the humidifier run if the HVAC fan is off, or a humidity safety switch that turns it off if levels inside the ductwork get too high. One of our HVAC subs installs both devices in case one fails. A problem with a steam humidifier is a big problem! I've seen two failures; both were discovered when water poured out of seams in the ductwork and soaked through ceilings and walls. The cleanups were big projects. Other issues I've seen with these are melted PVC drain pipes (follow installation instructions—usually the first few feet of drain should be metal) and a strange situation where all the steam went down one branch duct, overhumidifying one part of the house while leaving the rest of the house dry. (Moving the emitter solved that issue.)

If your building doesn't have ductwork, there are options. We've installed a few steam humidifiers with a special wall emitter box that has a fan to mix air with the steam to help blow it around the home. I also recently saw a pad-type unit with its own built-in fan for a free-standing installation.

Reservoir humidifiers. Taking a cue from my indoor air quality friends, we no longer install reservoir humidifiers—whole-house units that fill a bucket with water and energize a heating element in the water. Because organisms grow in the water easily, this type of humidifier is a maintenance headache, requiring multiple thorough cleanings per heating season. An even worse version runs a wicking device (like a belt or disks) through the reservoir so water evaporates off the wick. These gunk up even quicker.

Cost comparison. Steam humidifiers are significantly more expensive than pad humidifiers. Installed cost is usually closer to $3,000, and annual replacement cartridges cost around $100, while the pad style usually installs for around $1,000, and replacement pads (also annual) are only around $20. Steam humidifiers use a small amount of cold water, which costs a lot less than the nearly constant stream of hot water that pad humidifiers use, so some of the cost is offset that way, but steam humidifiers also use a fair amount of electricity. Also, most steam units need a 240-volt dedicated circuit, while the pad units can be added to existing furnace electrical circuits.

In short, in our area we recommend flow-through pad or cartridge steam humidifiers, and we warn people not to set humidistats higher than 35% to 40% RH based on the typical buildings and typical winter around here. In colder climates, this should usually be lower, but with better construction, it can be higher.

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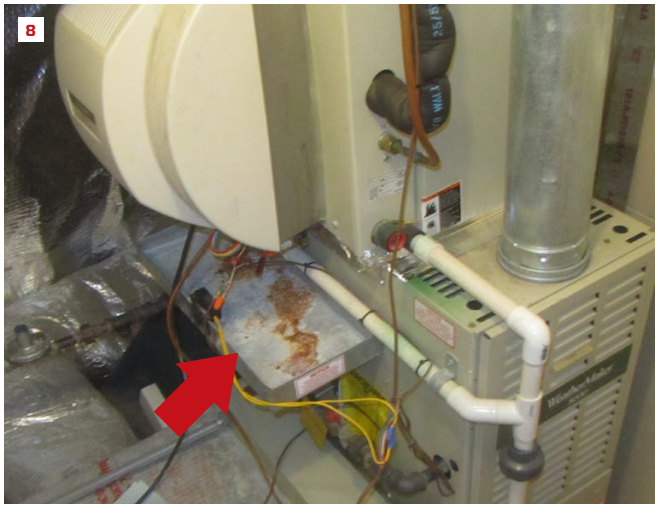

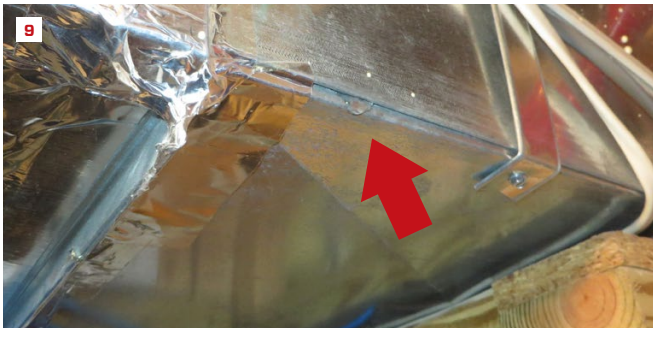

Pad humidifiers often drip or splash a bit of water, as on this galvanized metal pan, which has seen enough water to start rusting **(8)**. Steam humidifiers put out a tremendous amount of moisture, and if the HVAC fan doesn't circulate it throughout the house, it will turn into water in the ductwork and leak, as seen in the two photos at right **(9, 10)**. The author's company now uses a secondary safety device to ensure the fan is operating before the humidifier will run.