BY MARTIN HOLLADAY

"Musings of an Energy Nerd" showcases the best of Martin Holladay's weekly blog at GreenBuilding Advisor.com, where he provides common-sense advice about energy issues to residential designers and builders. His conclusions usually fall between minimum code compliance and the Passive House standard, which often makes them controversial to both building-science geeks and everyday builders.

Green Building Advisor

Green Building Advisor is for designers, engineers, builders, and homeowners who craft energy-efficient and environmentally responsible homes.

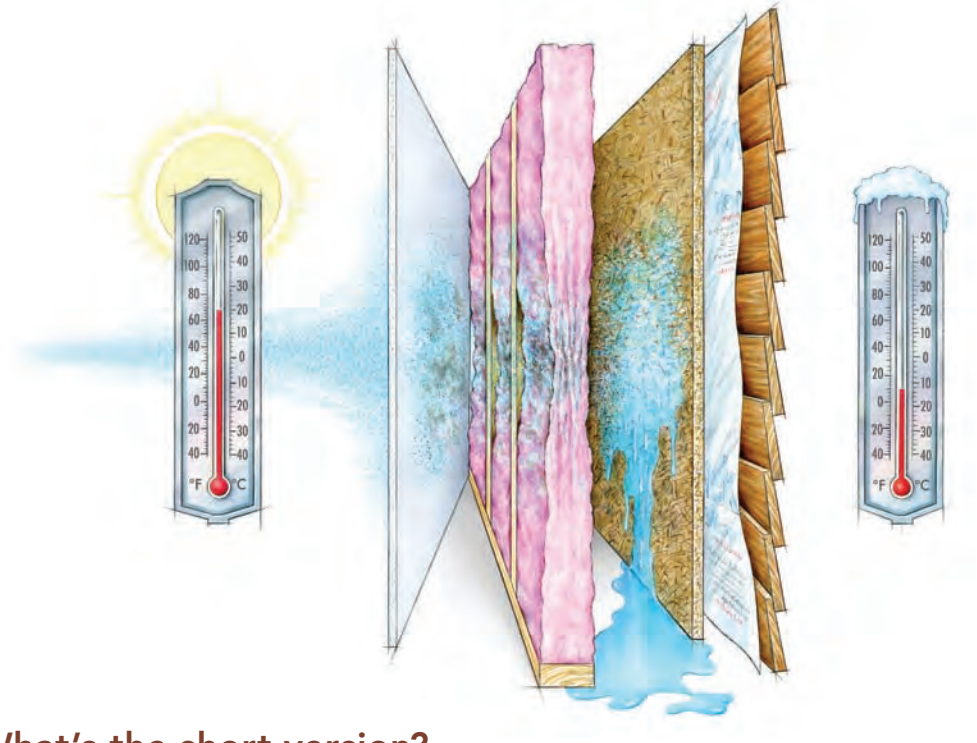
Do I need a vapor retarder?

Every couple of weeks, someone emails me a description of a proposed wall assembly and then asks, "Do I need a vapor retarder?" The short answer I give is that if the wall doesn't have a vapor retarder, then there probably is no need to worry. It's rare for a building to have a problem that's caused by water-vapor diffusion. (*Vapor retarders* slow vapor movement and have a permeance rating of between 0.01 and 1. With a permeance of less than 0.01, *vapor barriers* essentially halt vapor flow.)

Water vapor is water in a gaseous state—that is, water that has evaporated. The passing of water vapor through building materials is known as vapor diffusion.

From the 1970s through the early '80s, builders were taught that it was important to install a vapor barrier (usually polyethylene sheeting) on the warm-in-winter side of wall insulation and ceiling insulation. Many textbooks and magazines explained that this step was necessary to keep the walls dry during the winter, and that any walls without vapor barriers would get wet because the vapor would condense when it hit

HOW VAPOR DRIVE WORKS During winter, moisture driven outward by interior warmth can enter walls and ceilings by diffusing as vapor through building materials (although it's far more likely to be carried by air leaks). This moisture can condense on the cold back of the exterior sheathing, causing problems such as mold and rot.



What's the short version?

- Most buildings don't need polyethylene anywhere, except directly under a concrete slab or on a crawlspace floor.
- The main reason to install an interior vapor retarder is to keep a building inspector happy.
- If a building inspector wants you to install polyethylene in a wall or ceiling, try to convince him to accept a layer of vapor-retarder paint or a smart retarder instead.
- Although most walls and ceilings don't need a vapor barrier, it's always good to include an interior air barrier. Air leakage is far more likely to lead to problems than vapor diffusion.

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a cold surface (for example, the interior face of the sheathing).

This was bad advice for several reasons, although there are exceptions, which I'll get into later. Outward vapor diffusion during the winter almost never leads to wet walls or ceilings. In conventional walls or ceilings, the problem is almost always due to air leakage, not vapor diffusion. Far more moisture is transported by air leaks than by vapor diffusion. And since it prevents wall assemblies from drying inward during the summer, an interior polyethylene vapor barrier can actually make the wall wetter than it would be without the poly.

Air leakage and vapor diffusion create wet walls in different ways

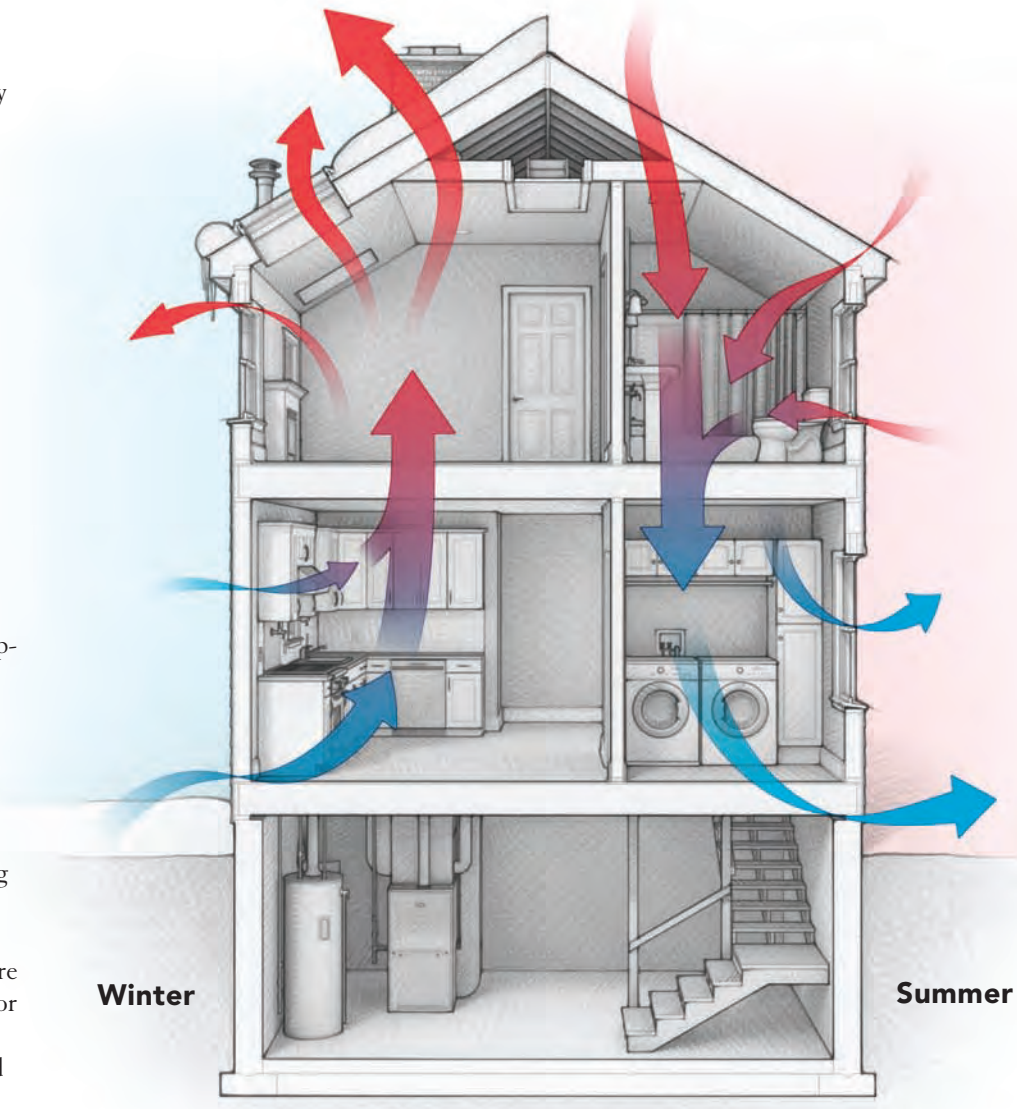
Water vapor can diffuse through vapor-permeable materials—for example, gypsum wallboard—even when the wall assembly is perfectly airtight. If the air on one side of the drywall is hot and humid, and the air on the other side of the drywall is dry and cold, the drywall absorbs moisture from the humid side. Once the drywall is damp, some of its moisture evaporates from the side facing dry air.

Air leakage is a different phenomenon. A hole in the drywall (at an electrical box, for example) allows warm interior air to enter the wall cavity and then escape through cracks in the sheathing. This is especially likely to occur if there is a strong driving force such as the stack effect or a fan that is pressurizing the house. If the wall sheathing is cold, some of the moisture in the air may condense on the sheathing or cause the sheathing to absorb moisture. If the sheathing gets sufficiently wet, rot and mold can result.

An air barrier is a material that stops air leakage. A vapor barrier is a material that stops vapor diffusion. Materials such as gypsum wallboard or plastic housewrap are vapor permeable but are still air barriers, while others, such as vapor-retarder paint on a leaky plaster wall or the kraft facing on fiberglass batts, meet the legal definition for a vapor retarder without being an air barrier. Finally, it's possible for some materials, such as polyethylene sheeting with taped seams, to act as both vapor barrier and air barrier.

WORRY ABOUT AIR, NOT WATER VAPOR

Holes in the drywall (which usually serves as the interior air barrier)—such as around electrical switches and outlets, lights, and at the bottom of walls—can admit far more moisture than will diffuse through the drywall as vapor. Airflow can reverse seasonally.



When vapor diffusion does cause trouble

Still, you can't quite ignore vapor diffusion. Vapor diffusion can transport a significant amount of moisture in rooms with high humidity—for example, greenhouses, rooms with indoor swimming pools, or rooms that are deliberately humidified—especially in a cold climate. If your building includes a greenhouse or indoor swimming pool, get expert advice from a specialty contractor on your wall and ceiling details before proceeding with the project.

In very cold climates (climate zone 8 as well as the colder parts of climate zone 7),

Drawing: Christopher Mills

interior polyethylene vapor barriers are often beneficial. That said, interior polyethylene sometimes can cause problems even in these climates, especially in buildings that are air-conditioned during the summer. When in doubt, a "smart" vapor retarder is always safer than polyethylene. The permeance of smart retarders (for example, MemBrain or Intello Plus) increases as they become wetter, allowing inward drying to occur.

When open-cell spray foam is used on the underside of roof sheathing to create an unvented conditioned attic in a cold climate (zones 5 and colder), outward vapor diffusion during the winter can lead to damaging moisture accumulation in the roof sheathing. For this reason, closed-cell spray foam is a better choice for this application. If you do use open-cell spray foam, protect it on the interior with a layer of gypsum wallboard coated with vapor-retarder paint.

In double-stud walls, outward vapor diffusion during cold-climate winters can cause moisture accumulation in the exterior sheathing. Builders should include details that reduce the risks associated with this type of moisture accumulation. A ventilated rain screen with a vapor-permeable sheathing such as fiberboard or DensGlass Gold speeds drying to the exterior. Installing a layer of OSB or plywood sheathing in the center of the wall creates a vapor retarder where the wall is still warm. If you don't want to include sheathing in the center of the wall, installing a smart vapor retarder on the interior side of the wall is a good idea. Smart vapor retarders limit outward diffusion while allowing drying to the interior in warm weather.

In homes sided with a material that holds water (for example, brick veneer) and sheathed with a vapor-permeable material such as fiberboard, water vapor can diffuse inward during summer. Sun heating wet brick can drive moisture inward, and the moisture can condense on polyethylene installed under the drywall if the house is air-conditioned. These problems can be avoided if the wall doesn't have any interior poly and if OSB, plywood, or rigid-foam sheathing is specified instead of fiberboard.

Diffusion also can be a builder's friend. During the summer, inward vapor diffusion through drywall can dry a damp wall assembly. That's why the use of interior polyethylene or vinyl wallpaper often leads to problems.