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Understanding Vapor Barriers

Interpreting the codes and the science behind one of home building's most misunderstood materials.

By: Mark LaLiberte

President of LaLiberteOnline Inc. and a principal of Building Knowledge Inc., Mark LaLiberte is a highly regarded green building consultant who helps builders nationwide understand and apply proper building science construction principles to improve their homes. www.buildingknowledge.com; www.laliberteonline.com.

The residential building industry has enough controversial construction techniques, incorrect product applications, antiquated codes, and old wives' tales to confuse anybody seeking the right way to build. And vapor barriers rank high on that list. Few builders truly understand how they work and why to use them. Adding to the confusion is the fact that determining whether or not you should be installing a vapor barrier depends on the home's location. Unfortunately, this misunderstanding can lead to catastrophic envelope failures and mold issues.

Air and Vapor Barriers Defined

First I want to clear up the common confusion between "vapor barriers" and "air barriers." This misunderstanding arises because air typically holds a great deal of moisture in the form of vapor. When vapor-laden air moves from one location to another, the vapor moves with it. A well-installed air barrier controls both the flow of air and the flow of moisture. If you were looking for another reason to be paying close attention to the proper installation of air barriers, this is it.

Controlling air movement should be your first priority in the energy-efficiency game, and it also provides excellent moisture control. Pay close attention to every location that air will flow, using blocking, gaskets, and foam. For more information on the correct use of air barriers, visit the Web sites of Building Science Corp. at www.buildingscience.com, Building America at www.buildingamerica.gov, or the Air Barrier Association at www.airbarrier.org.

Properly defined, a vapor barrier alone does not control air movement; it controls the movement of moisture. In fact, a vapor barrier is not actually a barrier; it's a vapor diffusion retarder (VDR). A VDR regulates moisture flow from inside out or from outside in at the molecular level. This moisture control function happens wherever the VDR is used in the structure. Therefore, unlike an air infiltration barrier, the VDR does not have to be continuous, sealed, or free of holes; a perforation in a VDR simply allows more vapor diffusion in that area compared with other areas where vapor diffusion is less restrictive.

VDRs are rated by the level of vapor diffusion control they provide.

A material's ability to retard the diffusion of water vapor is defined in terms of its permeability in units known as "perms." This is a measure of the number of grains of water vapor passing through a square foot of material per hour at a known differential vapor pressure. Any material with a perm rating of less than 0.10 is considered a Class 1 vapor retarder.

The Problem With Vapor Barriers

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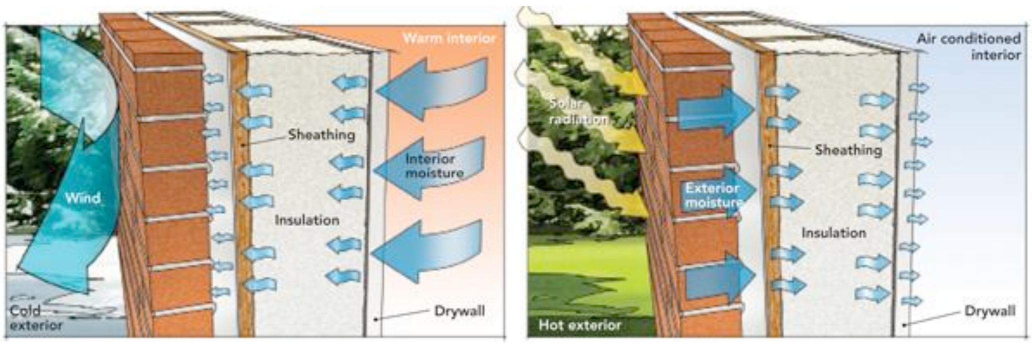
The original reason for using vapor barriers was a good one: to prevent wall and ceiling assemblies from getting wet. In practice, we now understand that when VDRs are installed on the interior of an assembly, they also prevent inward drying. This can lead to significant moisture problems and mold; problems occur when walls get wet during construction or more often throughout the home's life. These wetting cycles can be from air flow, window leaks, pressure imbalances, and a host of lifestyle issues. Below-grade spaces are particularly vulnerable. The increasing complexity of wall systems also fuels the issue.

Then there's the climate variable. Much of the confusion about the correct use of VDRs is the result of research reports and anecdotal information. Almost all of this research was conducted in cold climates and focused on the flow of vapor from inside to outside in winter months; it did not consider vapor movement in other climates, nor how moisture flow occurs from outside to inside when using air conditioning in humid summer months. When moisture flows from a more humid exterior environment into the wall system in air-conditioned climates, condensation could occur on the cooled interior VDR. You can see that if low- perm poly were used, condensation on this surface is possible.

Cladding choices can further complicate the exterior-to-interior vapor flow. When some claddings, such as brick and traditional stucco, get wet, they can retain significant amounts of water and require longer drying times. In hot and humid weather, moisture is drawn inward as the sun heats these surfaces, increasing the vapor pressure on the assembly. This could add unwanted moisture as well. The best strategy for this one is venting the masonry claddings and replacing the poly VDR with a higher-perm product like paint that will let the wall system cycle over the seasons.



Moisture movement is affected by seasonal changes as well as climate characteristics, which will define your best strategies and options. Even in cold climates, moisture will move from hot exteriors to cooler interiors in the summer, which places new emphasis on proper selection and placement of vapor retarders.

Best Practices

It's not just builders who are confused. Many building code officials misunderstand or misinterpret the requirements. Just because it was done that way 20 years ago, doesn't mean it will work the same way in today's modern wall systems. Some jurisdictions are becoming more flexible, and that is a welcome change.

The Numbers

The current code has the following definitions:
Class I Vapor Retarder: 0.1 perm or less
Class II Vapor Retarder: 1.0 perm or less and greater than 0.1 perm
Class III Vapor Retarder: 10 perm or less and greater than 1.0 perm
The current proposals are to define them this way:
Vapor impermeable: 0.1 perm or less
Vapor semi-impermeable: 1.0 perm or less and greater than 0.1 perm
Vapor semi-permeable: 10 perms or less and greater than 1.0 perm
Vapor permeable: greater than 10 perms

Current IBC/IRC specifications (see "The Numbers," left) for VDRs factor the classification of the material's perm rate with the location's climatic conditions. Future code directions will most likely specify the use of more permeable products in building assemblies: the use of paint, rather than poly, for instance. Until all codes reflect current building science knowledge, and provide climate-specific material specifications, you need to be wary of selecting a VDR with a perm rating that's too low or placing it in the wrong location.

If in doubt, I recommend using Class I and Class II VDRs only in the coldest Zones, 7 and 8. In these zones, use a product like MemBrain from CertainTeed. This innovative product looks and installs like poly, but it behaves like a vapor diode, allowing the perm rate to increase as the vapor pressure increases. This means that if installed on the interior side of the wall system, it will meet the Class II requirements by reducing the amount of vapor entering the wall in the winter months. But should the wall system be subjected to a larger flow of moisture from outside or from wet materials inside the wall system, the product becomes more vapor open. The perm rate rises, based on the increased vapor pressure. This sounds like magic, but in the world of materials science it's actually quite simple.

For other zones, I recommend applying a good quality wall primer to all unprimed drywall, in lieu of traditional VDRs. Prior to priming, drywall has a perm rate of about 50. After a couple coats of latex paint, that perm rate is reduced to 2 or 3. In most climates, this degree of vapor control will be quite adequate and meets the Class III requirements shown in "The Numbers."

For more information, visit the IRC Web site at www.iccsafe.org, where you can purchase and read the latest code book. Otherwise, get a copy of the Builders Guide Series for your climate from Building Science Press (www.buildingsciencepress.com).

A Final Note

Though I advocate a more liberal approach to VDRs, this doesn't mean I am unconcerned about moisture control. On the contrary, I believe it is absolutely critical that we control and manage the movement of moisture in structures. Used correctly and in the right climate, vapor diffusion retarders can be an important part of a comprehensive solution to effective moisture management.

To manage moisture effectively, we need to control both air movement and moisture flow. The two are always intertwined. Sometimes one product, such as spray foam, addresses both issues. In other cases, we can achieve success with a well installed and properly sealed weather resistive barrier like housewrap or an alternate system of spray-on coatings, or even SIPs. Remember: Always give careful consideration to the location and quality of the air barriers and water management details you use, and train the people on your crews to properly install them.

Joseph Lstiburek, Ph.D., principal of Building Science Corp., contributed to this article.

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