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# Tech Hotline

**No. 0806-BSc**

## Vapor Barriers: Frequently Asked Questions

An important aspect of exterior wall design is the proper selection and placement of materials to control water vapor diffusion through the wall. Building codes require this so that water condensation is minimized within wall assemblies. Condensation can lead to deterioration of the structure and mold growth. The use of vapor barriers on the inside of exterior walls in northern climates is common practice. The widespread use of central air conditioning has changed the location (or need) for a vapor barrier in certain climates, such as the hot humid climate of Florida. The recent use of housewrap materials applied over exterior sheathing to serve as air and/or water barriers has complicated the question of why, when, and where to place a vapor barrier in wall assemblies.

**What is a vapor barrier?**

A vapor barrier is a material that serves to restrict the movement of moisture in the form of water vapor.

**What is the difference between a vapor barrier and a vapor retarder?**

For the purposes of construction, this is only a difference in terminology. Some codes refer to materials as vapor barriers because that is their intended function: to stop the movement of water vapor. Other codes refer to the materials as vapor retarders because few products, as installed, are truly 100 percent impermeable to water vapor.

- The International Energy Conservation Code (IECC) uses the term “vapor retarder”.
- The Massachusetts Commercial Energy Code (MAEC) uses the term “vapor barrier”.
- The National Building Code of Canada (NBCC) uses the term “vapour barrier”.

In order for a product to be 100 percent impermeable to water vapor, it would have to have absolutely no pores or defects, or the size of the pores would have to be smaller than a water vapor molecule. Many low vapor permeance products perform satisfactorily as vapor “barriers” because they have very few and very small pores which significantly restrict the amount of water vapor that can pass through them over a period of time.

**What are some typical vapor barrier materials?**

Some common vapor barriers include polyethylene, aluminum foil, some rubber membranes, and polyurethane coatings. This list is not all-inclusive.

**How do I know if a material is a vapor barrier?**

The applicable building code or energy conservation code defines the maximum rate of water vapor that can pass through a vapor barrier or vapor retarder. This property is called “permeance”. It is very important to recognize that the permeance requirement is NOT standardized among different codes. The limits for three important codes are:

| Code | Section | Maximum Permeance |
|---|---|---|
| IECC | 501.2.1 Moisture Control | 1 perm (60 $ng/Pa \cdot s \cdot m^2$) |
| MAEC | 1304.1.2 Moisture Control | 0.1 perm (5.7 $ng/Pa \cdot s \cdot m^2$) |
| NBCC | 9.25.4.2 Vapour Barrier Materials | 1 perm (60 $ng/Pa \cdot s \cdot m^2$) |

**How is water vapor permeance measured?**

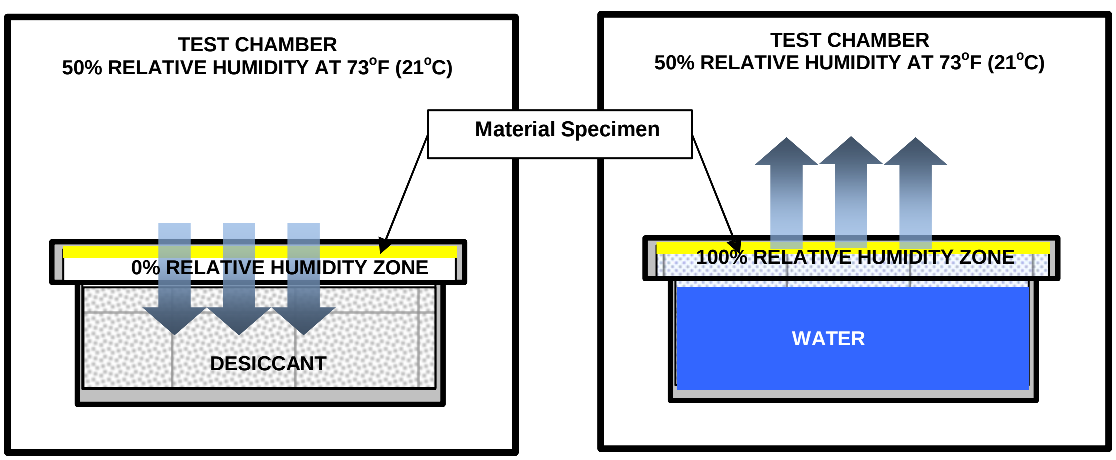
Water vapor permeance is measured using ASTM E 96, *Standard Test Methods for Water Vapor Transmission of Materials.* E 96 has two options, the desiccant method (“dry cup” or Procedure A) or the water method (“wet cup” or Procedure B).

**What are the differences in the two testing options?**

Both procedures are performed at 73ºF (21ºC) in a test chamber that has a controlled relative humidity of 50 percent.

The dry cup procedure is performed by filling a metal test cup with a desiccant (a material which attracts water vapor), then sealing a sample of the test material to the open end of the cup . The initial mass is measured and the test cup is placed in the test chamber. In the test chamber the relative humidity is 50% outside the test cup, but the desiccant keeps the relative humidity inside the test cup near 0%. This results in water vapor being drawn from the test chamber into the desiccant through the test specimen. As the desiccant absorbs water it gains mass. The test cup is reweighed at specific intervals for several weeks until a constant rate of water vapor diffusion is determined. The permeance is calculated from the mass change of the test cup.

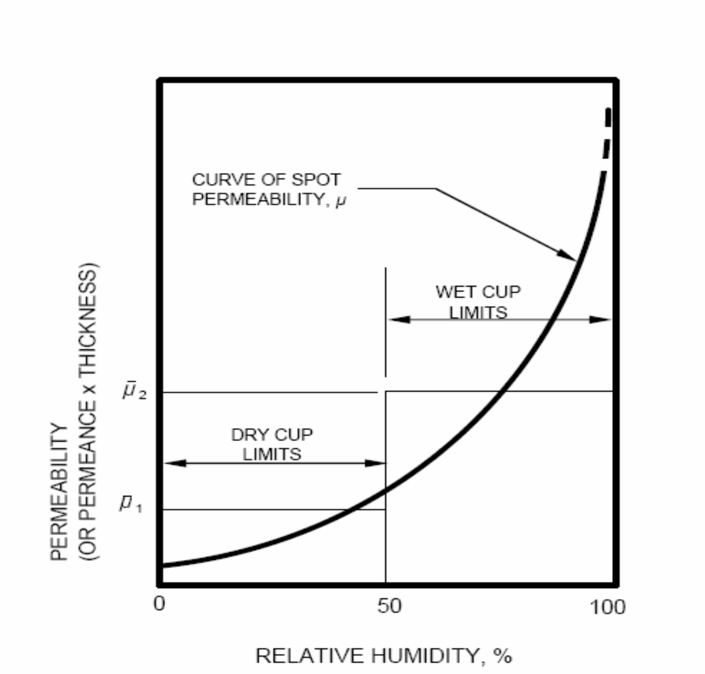
The wet cup procedure is performed using the same procedure, except the test cup is filled with water instead of desiccant. A small air space is left below the test material resulting in a relative humidity near 100% in the test cup, which is surrounded by the 50% relative humidity environment in the chamber. In this procedure water vapor is driven from the cup into the chamber through the specimen and the cup loses mass. The permeance is again calculated from the mass change of the test cup.




ASTM E 96 Desiccant Method (Dry Cup)
(water vapor diffusion direction indicated by arrows)

ASTM E 96 Water Method (Wet Cup)
(water vapor diffusion direction indicated by arrows)

If the same material is tested using both methods, the measured permeance will not be the same. The wet cup procedure for permeable materials will result in a higher measured permeance than the dry cup method. This is a valid result based on thermodynamic principles that are explained in the ASHRAE Handbook — Fundamentals and shown in the graph below.




(Adapted from 1989 ASHRAE Handbook – Fundamentals, Chapter 20, Figure 11)

The curved line in the graph represents the vapor permeability of a single material measured at different relative humidities. While the curve is only an illustration, the general shape of the curve represents the behavior of most materials, and exhibits how the vapor permeability increases with an increase in relative humidity.

**Why are there two testing options and which is appropriate for measuring water vapor permeance of a material?**

One method may more accurately reflect the conditions that will occur during intended use of the product than the other.

Materials that are applied to walls as vapor barriers will be in an essentially dry environment, thus the dry cup procedure is often specified to evaluate materials used in walls. All of the building and energy conservation codes specify the permeance of vapor barriers based on the dry cup method.

Coatings or membranes that are used to prevent water vapor movement through concrete slabs on grade may be essentially saturated on one side, and the wet cup method is typically used to evaluate products for this intended use. The wet cup method is generally used to assess whether a product is considered to be “breathable”. That is, if water is present behind the membrane or coating, will it diffuse through the coating (will it dry)? It is generally accepted that a “breathable” material (i.e., one that is not a vapor retarder) has a permeance greater than 1 perm (60 ng/Pa·s·m$^2$), however, the method chosen to determine permeance is dependent on service or end use conditions, as suggested by ASTM C 755, *Selection of Vapor Retarders for Thermal Insulation.* C755 suggests that the option that best represents service conditions should be used to evaluate whether or not a material can be considered a vapor retarder. For example, Type 15 Building Felt, commonly used as a water-resistive barrier in wall assemblies (sometimes wet conditions), has a reported permeance of 5.6 based on the wet cup method, and is not identified as a vapor retarder. On the other hand, 4 mil polyethylene, commonly used as a vapor barrier on the interior (dry conditions) in wall assemblies, has a reported permeance of 0.08 based on the dry cup method and is identified as a vapor barrier.

**Why are vapor barriers important in wall construction?**

Vapor barriers are important because water vapor will condense within the wall assembly in certain conditions. Significant amounts of condensation or repeated condensation can lead to mold growth and deterioration of materials within the wall.

**Is a vapor barrier required for my project?**

Cold climates are likely to have winter conditions which promote condensation within the wall and therefore a vapor barrier on the warm-in-winter side of the insulation is beneficial. Conversely, hot humid climates should NOT have a vapor barrier on the interior side of the wall.

Energy conservation codes and building codes generally require a vapor barrier, but make exceptions. The exceptions include (but may not be limited to) warm, humid locations, ventilated cavities, and assemblies that use other approved means to prevent condensation.

A viable option for the "other approved means" is exterior insulation coupled with a dew-point analysis to verify that condensation will not occur in the wall. In other words, a vapor barrier product may not be required if EIFS cladding is used.

There are also moderate or mixed climate conditions where the need for a vapor barrier in the wall should be determined by analysis.

**Where should a vapor barrier be located in the wall?**

If a vapor barrier product is used, it should be located on the warm side of the insulation. The most common way that this is accomplished in a cold climate is to install the vapor barrier between the framing and interior wallboard. A layer of 4-mil-thick polyethylene film is often used in this manner to satisfy the vapor barrier requirement.

If a vapor barrier membrane product is to be considered at another location in the wall assembly, a dew-point analysis should be performed to verify that condensation is not an issue. A common example of this is the use of a peel-and-stick membrane over exterior sheathing, which may pose a problem.

The NBCC and MAEC require all materials located outbound of the vapor barrier to have a permeance of at least 10 times the permeance of the interior vapor barrier to prevent condensation in the wall.