

Air Barriers vs. Vapor Barriers

Research Report - 0004

2000

Joseph Lstiburek

Abstract:

Most of us are not aware of just how differently these two barriers work in building assemblies. This article makes the differences as clear as the polyethylene film that should (or more likely should NOT) be in your walls.

Air Barriers vs. Vapor Barriers

The key to moisture control is the control of air transported moisture. This requires an air barrier system or air pressure control that may or may not be combined with an air barrier system.

There is a big difference between air transported moisture and vapor diffusion. Proponents of vapor barrier systems tend to confuse these two transport mechanisms ? do they control the vapor diffusion part, the air transport part or both? It is not always clear.

What is clear is that air transport is far more significant than vapor diffusion. What is also clear is that you do not need a 6-mil polyethylene barrier to control air transported moisture. Permeability values of materials are irrelevant in air barrier systems. Although 6-mil polyethylene is an excellent vapor barrier it is often a very poor air barrier. I will agree that it is possible to install 6-mil polyethylene as an air barrier. The key point that needs to be made is that although air barriers are a good idea everywhere, vapor barriers are not.

Moisture flow by vapor diffusion is governed by the second law of thermodynamics (basic physics to some, not so basic to others). Moisture will flow by diffusion because of a concentration gradient as well as a temperature gradient (from "more to less" as well as "from warm to cold"). This means that it tends to go from the inside out up north and from the outside in down south. In the middle of the country part of the year it goes from inside out and part of the year it goes from outside in.

It is easy to say lets put a vapor barrier on the inside up north and on the outside down south. It is much harder to define "north" and "south". Everyone can agree to put a vapor barrier on the inside in Burlington, VT, and on the outside in Miami, FL. It is a little more difficult to agree on where to put a vapor barrier in other locations. If you put a vapor barrier on the inside in Washington, D.C., half of the year it will be in the wrong place. You certainly do not want to put a vapor barrier on both sides of the wall. It's pretty obvious that you do not want a vapor barrier at all in most assemblies in mixed climates. "Flow-through" design makes more sense in mixed climates where vapor diffusion is slowed down, but not stopped. Hence, the term vapor retarders.

When moisture storage effects are added, things get real interesting. Take a brick veneer cladding that experiences rain-wetting followed by exposure to solar radiation. The sun tends to drive moisture inward. It makes sense to put a vapor barrier behind a brick veneer to stop this inward flow. But what happens when you install a vapor barrier behind a brick veneer in a cold climate? Do you also want to install a vapor barrier on the inside? I think not ? that would be a vapor barrier on both sides. Maybe we want a vapor barrier on the outside behind the brick veneer and a vapor retarder on the inside. Maybe we should use an insulating sheathing that is vapor semi-permeable on the outside with sufficient thermal resistance to elevate the temperature of the condensing surface during the heating season, and have a vapor permeable

interior finish to permit drying to the interior? It sounds complicated and it is.

It turns out that the distinction between a vapor barrier and a vapor retarder is a necessity. Let us examine a common building material: kraft-faced fiberglass insulation. Is the kraft facing a vapor barrier or not? It depends on the time of year. If the facing is installed towards the interior in a climate such as Washington, D.C., it is a vapor barrier in the winter and a vapor retarder in the summer. How is this so?

Well, kraft-facing is impregnated with bitumen and the paper-bitumen composite is hygroscopic. It adsorbs water as the relative humidity it is exposed to rises. As the quantities of adsorbed water increase, the vapor permeability of the composite changes. This reflected by the differences between dry-cup permeability test values and wet-cup permeability test values. Under dry-cup testing, one side of the material is maintained at 0 percent RH and the other side is maintained at 50 percent RH. Under wet-cup testing one side of the material is maintained at 50 percent RH and the other side is maintained at 100 percent RH. So under dry-cup testing the kraft facing has a perm rating of 1 perm, and under wet-cup testing the kraft facing has a perm rating of 5 perms. In the winter months, when the inside relative humidity is high, we have vapor retarder on the inside, that permits drying to the inside. It sure would be a dumb idea to replace this kraft facing with a 6-mil polyethylene sheet that would trap water in the wall assembly during the summer.

One of the problems in the building industry is that we have a spreading "cult-like" mentality that worships at the "church of polyethylene". This cult views the answer to all moisture problems as the installation of a polyethylene vapor barrier condom on the inside of buildings. This cult is responsible for many more building failures than building successes. It's time that the cult deprogramming started.

About the Author

Joseph Lstiburek, Ph.D., P.Eng., is a principal of Building Science Corporation in Westford, Massachusetts. He has twenty-five years of experience in design, construction, investigation, and building science research. Joe is an ASHRAE Fellow and an internationally recognized authority on indoor air quality, moisture, and condensation in buildings. More information about Joseph Lstiburek can be found at www.buildingscienceconsulting.com

Direct all correspondence to:
Building Science Corporation, 30 Forest Street, Somerville, MA 02143

Limits of Liability and Disclaimer of Warranty:

Building Science documents are intended for professionals. The author and the publisher of this article have used their best efforts to provide accurate and authoritative information in regard to the subject matter covered. The author and publisher make no warranty of any kind, expressed or implied, with regard to the information contained in this article.

The information presented in this article must be used with care by professionals who understand the implications of what they are doing. If professional advice or other expert assistance is required, the services of a competent professional shall be sought. The author and publisher shall not be liable in the event of incidental or consequential damages in connection with, or arising from, the use of the information contained within this Building Science document.