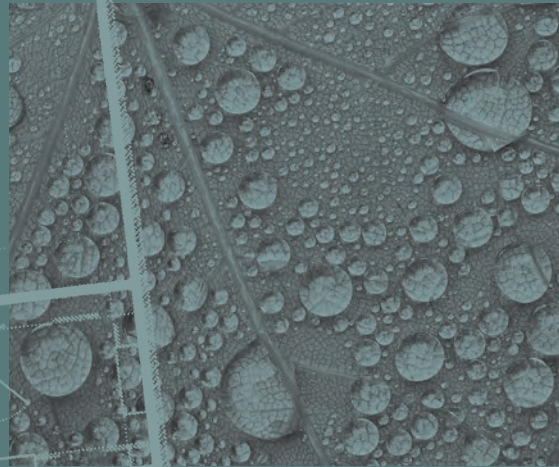
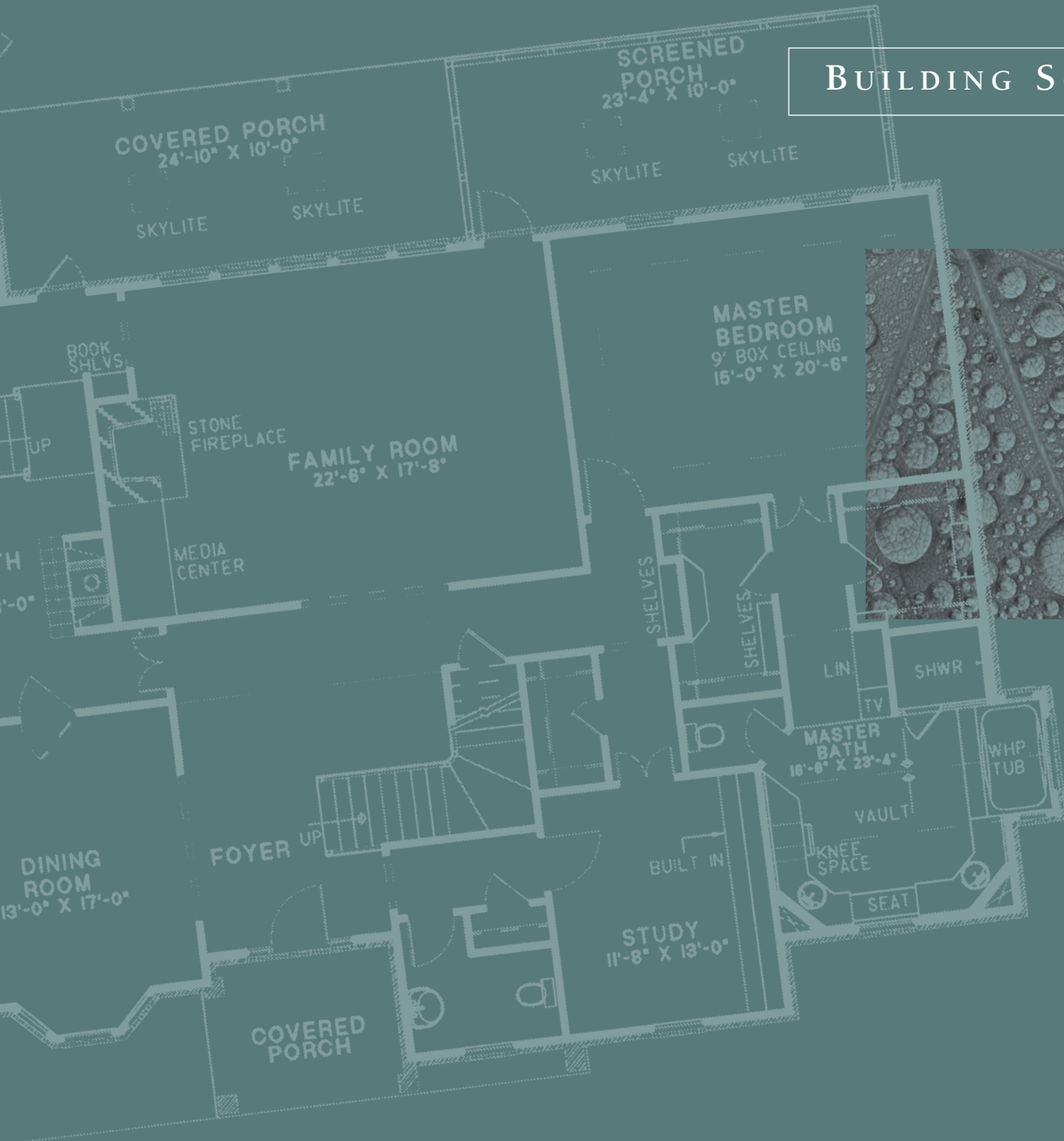


CertainTeed

Smart Vapor Retarders

Insulation

BUILDING SCIENCE



CertainTeed 

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SMART VAPOR RETARDERS: A TECHNOLOGY PRIMER

For years, builders have relied on a dual climate-zone classification for the placement of vapor retarders in a home. The prevailing wisdom has called for vapor retarders to be located at the interior in heating-dominated climates and at the exterior in cooling-dominated climates. However, large portions of the United States are considered “mixed-climate,” where the moisture drive direction is balanced between winter and summer seasons. In these regions, choice and placement of vapor retarders, air barriers and other materials become critical in minimizing the potential for water vapor condensation, while allowing for drying of wet building materials.

Just as the industry is looking at different ways to classify climate conditions in the United States, so too are building product manufacturers looking at new airborne moisture management technologies. In fact, today, there is a vapor retarder technology that reacts to the varying humidity conditions prevalent in much of the U.S. This technology is drawing a great deal of attention from home builders in these “mixed-humid” climates as a method for reducing or even eliminating moisture problems.

MIXED-HUMID CLIMATES

Mixed-humid climates are defined as regions that receive more than 20 inches of annual precipitation, with approximately 4,500 heating degree days and a monthly average outdoor temperature below 45°F in the winter. This winter temperature is critical for building design since air at 70°F, 35% relative humidity (RH) has a dew point temperature of approximately 40°F. As a result, interior air at 70°F, 35% RH (a realistic condition in a tightly constructed home) will condense on a surface that is 40°F or cooler, thus leading to homeowner comfort issues.

How much water will condense on the interior surface of the exterior sheathing (the first condensing surface) is a function of the dew point temperature of the interior air, the amount of air leakage into the wall and the vapor permeability of the materials in the wall. Small amounts of condensation will not be a problem if the wall is allowed to dry to the exterior.

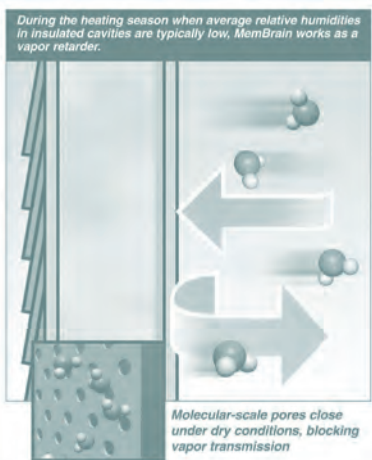
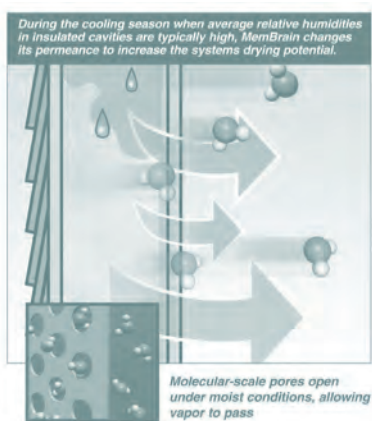
Moisture is more of a significant problem in this climate than in areas that receive 20 inches of rain per year in a single climate area. That's because the ambient air in mixed-humid climates tends to have significant levels of moisture most of the year. In addition, since air conditioning is installed in most new homes, cold surfaces are present on which condensation can occur.



Since both heating and cooling occur for extended periods in mixed-humid climates, it can be difficult to determine the correct method for moisture control. To add to the confusion, The American Society for Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) and the Energy and Environmental Building Association (EEBA) recommend that wall systems be allowed to dry toward the interior or exterior environment in mixed-humid climates, and if possible, allow some drying in both directions.

VAPOR RETARDERS

The American Society for Testing and Materials (ASTM) defines vapor retarders as materials or systems that adequately retard the transmission of water vapor under specified conditions (ASTM C755).



Historically, building codes have classified vapor retarders as having a water vapor permeance of 1 perm or less when tested in accordance with the ASTM E96 desiccant, or dry cup method. Therefore, most products are only evaluated under dry conditions. The test procedure also allows products to be tested under wet, more humid conditions using the water, or wet cup method. Some hygroscopic materials, like asphalt-backed kraft paper—a common facing on fiber glass insulation— increase in permeance slightly between dry and wet cup testing.

Products like polyethylene film or aluminum foil have very low permeance values that remain constant between dry and wet conditions. Existing building materials can generally be classified into four categories (see next page) with respect to water vapor permeance under varying conditions.

Perm: A unit of measurement typically used in characterizing the water vapor permeance of materials. It measures the flow of water vapor through a material.

GENERAL CLASSIFICATION OF BUILDING MATERIALS WITH RESPECT TO WATER VAPOR PERMEANCE

Vapor Barrier Materials: 0.1 perm or less

(rubber membranes, polyethylene film, glass, aluminum foil, sheet metal, foil-faced insulating sheathings)

Vapor Retarder Materials: 0.1-1 perm

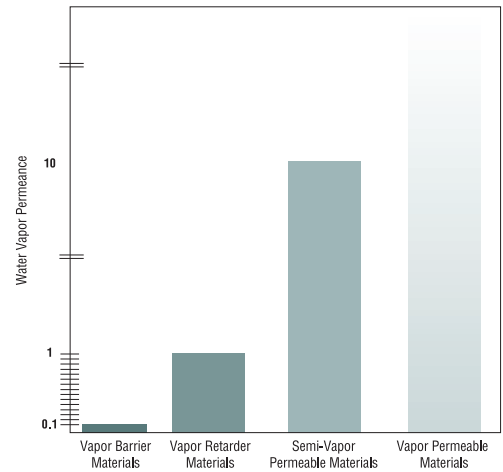
(asphalt-backed kraft paper*; vapor retarding paint, oil-based paints, vinyl wall coverings, extruded polystyrene, plywood, OSB)

Semi-Vapor Permeable Materials: 1-10 perms

(unfaced expanded polystyrene, fiberfaced isocyanurate, heavy asphalt impregnated building papers, some latex-based paints)

Vapor Permeable Materials: 10+ perms

(unpainted gypsum board and plaster, unfaced fiber glass insulation, cellulose insulation, unpainted stucco, cement sheathings, spun bonded polyolefin or some polymer-based exterior air barrier films)



* Current research shows that the perm of CertainTeed kraft faced insulation ranges from 0.3 to 3.0 depending on moisture conditions. Published data detailing the permeance range of several common interior building materials is available upon request.

Vapor retarders slow the rate of water vapor diffusion, but do not totally prevent its movement. However, as water vapor moves from a warm interior through construction materials to a cooler surface, the water vapor may condense as liquid water that could damage the building. It is for this reason that vapor retarders are needed.

Keep in mind that vapor retarders not only retard moisture penetration, but also the potential of wet materials to dry. Therefore, it's important that the drying potential be greater than the wetting potential so that the amount of moisture that can get into a system is less than the amount of moisture that can leave it.

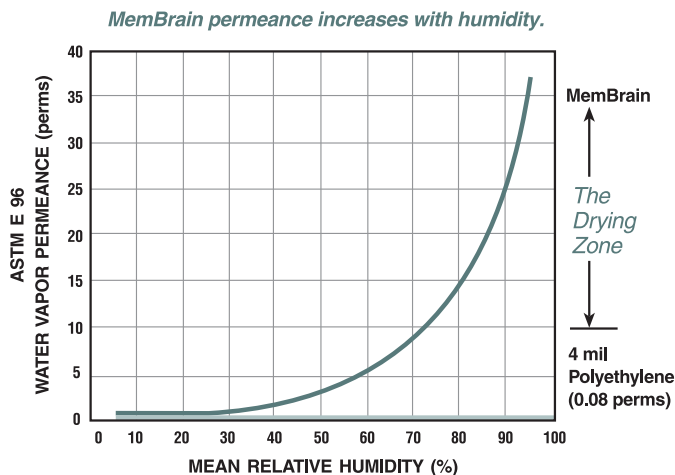
SMART VAPOR RETARDERS

Vapor barriers made of polyethylene film consistently have a very high vapor diffusion resistance throughout the whole year. However, while these films resist vapor movement into the wall assembly, they also reduce the potential for summertime drying of wet building materials, especially in mixed-humid climates. During the summer, when the sun is stronger, exterior surfaces are warmed—often to the point where the exterior is warmer than the interior, thus creating a reverse vapor drive into the interior.

Many in the industry are calling for “breathable” walls as a solution to this problem. The concept here is an airtight drywall construction with a slightly more permeable vapor retarder that allows some moisture diffusion. Drying could occur via vapor diffusion in either direction, and the vapor retarder would actually react to varying conditions of humidity.

This concept is now a reality in MemBrain™, The Smart Vapor Retarder from CertainTeed Corporation. Originally developed, tested and commercialized in Europe, this vapor retarder looks like polyethylene, but is actually nylon-based, which gives it high tensile strength. (A 2-mil sheet of MemBrain™ has equivalent strength properties to a 6-mil polyethylene sheet.)

MemBrain™, The Smart Vapor Retarder reacts to changes in relative humidity by altering its physical structure. During the winter, when relative humidity is low, it provides high resistance to vapor penetration from the interior. However, when the relative humidity increases to 60 percent or above, its permeance dramatically increases, thus allowing water vapor to pass through, which facilitates drying of wet building systems.



This “reactive” ability works as follows.

In conditions of low relative humidity, the membrane’s plastic molecules form a tight, impermeable network (1 perm or less using ASTM E96, dry cup method). As soon as the membrane comes into contact with moisture (60% RH), it swells up and becomes soft as the polar water molecules penetrate between the nylon molecules. As a result, the nylon acquires pores through which further water molecules

can penetrate, and the permeance increases to greater than 10 perms when tested in accordance with ASTM E96, wet cup method. In summer, when the air is humid, the moisture penetrates through the pores into the building interior, allowing building materials to dry out. If the relative humidity decreases, the pores close up again, and the membrane then acts as a retarder to moisture. In the winter, this retarder protects the building materials behind the membrane from condensation.

Field tests have proven that this Smart Vapor Retarder effectively reduces the risk of moisture damage in the building envelope by increasing the construction's tolerance to moisture load. It is appropriate in cold and mixed climates, but it is not suited for hot climates with high outdoor humidity because it would always be under high relative humidity conditions. Therefore, it would always be permeable and would not provide vapor retarding benefits. It also would not work well in buildings with exceptionally high, constant indoor humidity levels, such as swimming pools and spas. However, in rooms with short peaks of high humidity (bathrooms and kitchens), the smart retarder's performance would not be affected because of the buffering action of interior finishes.

As an added benefit, it was discovered during testing that the membrane also protects against wood preservatives used to treat roof structures and timber frameworks. That's because—unlike the polar water molecules—non-polar organic compounds cannot penetrate the pores.

CONCLUSION

As homebuilders continue to be concerned about mold and other moisture-related home comfort issues, this new smart vapor retarder may be an ideal replacement for traditional vapor retarders with unfaced fiber glass insulation. It provides an insulation system that is ideal in the “mixed-humid” and “cold” climate condition areas in North America, allowing closed building envelope systems to increase their drying potential with seasonal climactic changes.

INFORMATION

For more articles and information on the Building Science of moisture management and smart vapor retarders, visit www.certainteed.com/buildingscience.

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