Building America Building Science Advisor

VAPOR OPEN WALLS

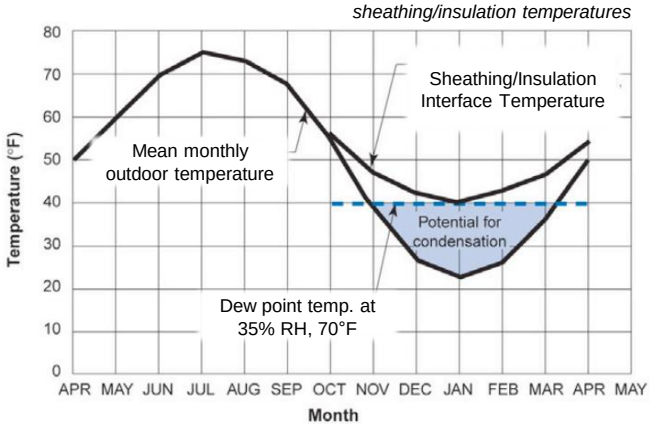
The purpose of a vapor retarder is to slow down the transportation of water vapor (diffusion), which is a result of properties of humid air. The amount of water that air can hold depends on the temperature. The higher the temperature, the higher the potential water vapor content. Since large variations in temperature may exist between the inside and outside of an exterior wall, this natural phenomenon, if not accounted for, may result in critical humidity levels and condensation. All building materials provide some level of resistance to vapor transportation. However, instead of referring to a resistance, materials are classified based on their permeance (perm) to vapor transfer. The higher the perm, the more vapor permeable. The following classification is used:

Class I	Vapor impermeable - 0.1 perm or less	*(Foil-faced Polyisocyanurate, Polyethylene film)*
Class II	Vapor semi-impermeable - 1 perm to 0.1 perm	*(Unfaced XPS 1" thick or greater, Coated sheathing)*
Class III	Vapor semi-permeable - 10 perms to 1.0 perm	*(OSB, Plywood, unfaced EPS less than 3" thick)*
	Vapor permeable - Greater than 10 perms	*(Building paper, House wrap)*

Cause and Effect

One must look at an exterior wall as a system, and not at each material separately. Regardless of vapor permeance classification, any building material can considerably impact diffusion and the balance of how moisture is distributed. It mainly comes down to how the permeance for each material stands against all other materials in a wall assembly.

Figure 1: *Required sheathing/insulation temperatures*



A Class III vapor retarder, such as an OSB, can dominate the moisture distribution profile (relative humidity etc.) in a wall if all other materials are vapor permeable. Whilst, an OSB, together with a Class I (vapor impermeable) material, will have very little impact on variations in relative humidity inside a wall. Vapor moves from a higher concentration to a lower, typically inward in a warm/humid climate, and outward in a cold climate. As a result, humidity levels inside a wall range between outdoor and indoor conditions, and the largest variation in humidity occurs around the boundaries of the least permeable material. Therefore, critical humidity levels and condensation, if seen, will typically progress at a surface of, or adjacent to, a vapor retarder.

Preventive Actions

Vapor retarders can be used for any climate, but there are also ways of going without them. For colder climates, a vapor retarder (Class I and II) can be neglected if moisture sensitive materials are kept at temperatures of 45°F or higher (Figure 1). Table 1 provides minimum exterior insulation level needed to ensure temperature criterion is met. As an example, Climate Zone 5 requires a minimum of 30% continuous insulation *R*-value to total.

Table 1: *Required insulation ratio*

Minimum R-value ratio of continuous insulation to total insulation	
Climate Zone	Ratio
4C	15%
4A, 4B	20%
5	30%
6	35%
7	45%
8	50%

In a warm climate (Climate Zone 1 to 3), the wooden sheathing (Class III) or insulation board will provide enough vapor transfer resistance. Here, it is crucial that no materials with lower permeance is constructed on the interior side. Again, it comes down to the permeance of all wall materials. If the major humidity change occurs in a material closer to the interior, condensation or high humidity levels may be seen. Remark that no alkyd (oil based), epoxy interior paints, or vinyl wall coverings should be used in a warm/humid climate.

References and Further Reading

BSI-100: Hybrid Assemblies
Info-311: Vapor Open Assemblies
Info-312: Vapor Permeance of Some Building…
BSI-091: Flow-Through Assemblies
BSI-071: Joni Mitchell, Water and Walls

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