



Building America Case Study

Technology Solutions for New and Existing Homes

Moisture Durability of Vapor Permeable Insulating Sheathing

PROJECT INFORMATION

Construction: Existing homes with vapor open wall assemblies

Type: Residential

Climate Zones: All

PERFORMANCE DATA

Insulation Ratio

The R-value ratio of exterior to interior insulation (e.g., R-15 exterior insulation on R-11 cavity insulation has a ratio of 0.58). This variable controls sheathing temperature.

Vapor Permeable Insulation

An insulation with vapor permeance greater than five U.S. perms (e.g., rigid mineral fiber insulations). This variable controls water vapor flow and sheathing temperatures.

Water Resisting Barrier

A membrane that resists liquid water transfer. Permeable WRBs allow water vapor flow (e.g., 30+ U.S. perms). Impermeable WRBs inhibit water vapor flow (e.g., <1 U.S. perm). This variable controls the rate of vapor flow.

Vapor permeable exterior insulation is beneficial in that it elevates sheathing temperatures (by adding thermal resistance outside of the existing sheathing) and enables outward drying (by virtue of its vapor permeability). However, it also allows inward-driven moisture to flow through the insulation and contact the water resisting barrier (WRB), which is located between the exterior insulation and the sheathing. If the WRB is also permeable, then the sheathing is at risk of damage due to the inward-driven moisture. An impermeable WRB solves problems of inward-driven moisture, but inhibits outward drying of the sheathing. If the sheathing temperature is not kept above the indoor dewpoint temperature by having the appropriate ratio of exterior to cavity insulation, then air leakage condensation may occur. Therefore, the right balance of the ratio of interior to exterior insulation and the right WRB permeance is required to minimize the risks of moisture damage to the sheathing.

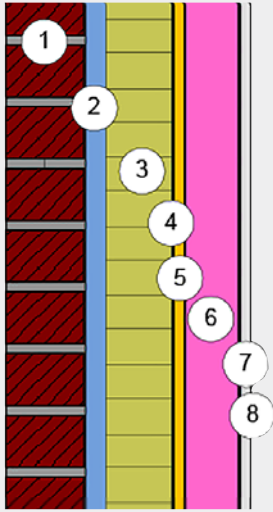
U.S. Department of Energy Building America team Building Science Corporation researched some of the ramifications of using exterior, vapor permeable insulation on retrofit walls with vapor permeable cavity insulation. Retrofit strategies with exterior insulation are a key factor in reducing existing building stock energy consumption.

A series of hygrothermal simulations were conducted to assess multiple variables in the wall's moisture performance. Some of the variables modeled include building orientation, climate, interior relative humidity, cladding type, exterior insulation type and thickness, and the vapor permeability of the WRB. (See Performance Data at left.)

The hygrothermal simulations are intended to provide a good preliminary estimate of wall performance, but because of the great range of factors involved in working with existing buildings, additional analysis may be required on a project-by-project basis.

Research Details

The following wall template was used for the hygrothermal simulations:

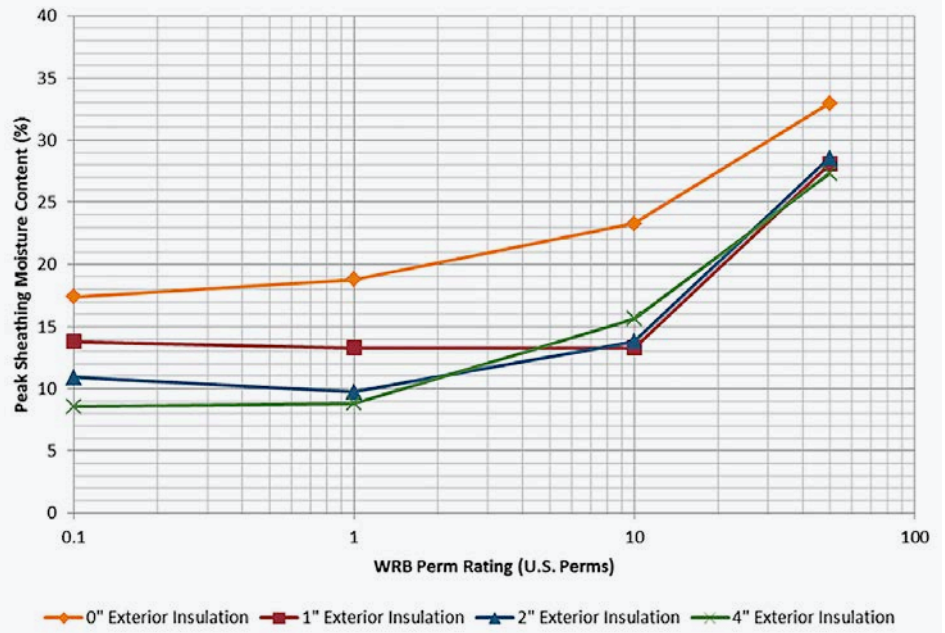


1. Reservoir cladding (e.g., brick, stucco, fiber cement, or wood siding)
2. Air gap
3. 2-in. + rigid mineral fiber insulation
4. Water resistive barrier
5. .5-in. oriented strand board or existing wood sheathing
6. R-13 batt insulation in wood framing
7. .5-in. gypsum wall board
8. Latex paint

Variations to multiple parameters (i.e., amount of exterior insulation, WRB permeance, etc.) were conducted in climate zones 1 through 7. The model was sensitive to interior relative humidity, the outdoor climate, and the saturation moisture content of the exterior cladding.

For more information, see the Building America report, *Moisture Management with Highly Permeable Sheathing Insulation Over Existing Walls with Permeable Cavity Insulation*, at www.buildingamerica.gov

Image credit: All images were created by the BSC team.



The graph above shows that the exterior moisture content depends greatly on the permeance of the WRB. A high permeance WRB, regardless of the amount of exterior insulation, will result in dangerously (i.e., 28% MC) high moisture levels in the wood-based sheathing. Exterior insulation, and WRB permeances less than 10 U.S. perms, are highly recommended.

Conclusions

The conclusions of this research include:

- A saturated reservoir cladding (i.e., one that holds water after a rain event, like brick, stucco, wood, or fiber cement cladding), when exposed to solar radiation, can cause significant inward driven moisture. WRBs with a permeance greater than 10 U.S. perms should not be used in conjunction with storage claddings to avoid the risk of saturation.
- Interior vapor barriers, such as polyethylene, are to be avoided. A class III vapor retarder is often sufficient (e.g., two coats of interior latex paint).
- Follow the relevant codes for the amount of required exterior insulation for the use of a class III vapor retarders.
- A WRB permeance in the range of 1-10 U.S. perms, in combination with one inch minimum of exterior insulation, can provide good performance in Climate Zone 6 and warmer.

To best understand this research and the context for these conclusions, see the full report, *Moisture Management with Highly Permeable Sheathing Insulation over Existing Walls with Permeable Cavity Insulation*.