U.S. DEPARTMENT OF
ENERGY

Office of
ENERGY EFFICIENCY &
RENEWABLE ENERGY

Mitigating Moisture with High-R Walls

Understanding the moisture characteristics of high-R wall systems will guide solutions for lower-cost, more comfortable, and more durable energy-efficient homes.

Energy-efficient building enclosures are key to decreasing energy load demand and enabling advanced space-conditioning systems for high-performance homes. One efficient enclosure design solution is high-R walls, which feature increased insulation levels as an effective solution for reducing air leakage and permeance of material layers.

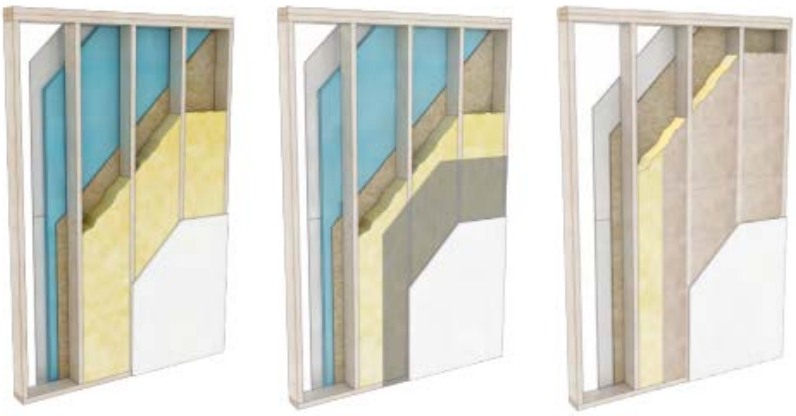
To increase builder confidence and encourage greater market adoption of high-R walls, Home Innovation Research Labs sought to demonstrate the long-term moisture performance of several high-R wall configurations in cold climate zones. The team monitored 22 newly constructed, occupied homes located throughout climate zones 4–7, where a substantial vapor drive to the exterior is present during the winter.

High-R walls are an efficient enclosure design solution for high-performance homes.
Photo from iStock 182186960

In the studied homes, sensors were installed in wall cavities to measure the moisture content of the sheathing material, studs, and rim joist, and both interior and exterior sensors measured temperature and relative humidity at each location.

Researchers observed various moisture loads within the wall assemblies, including bulk water, built-in moisture, water vapor, and capillary transport through materials in contact with water or the ground. Data were used to:

- Demonstrate high-R wall moisture performance;
- Identify wall systems with marginal moisture performance and recommend improvements; and
- Develop design criteria that will further ensure the durability of high-performance walls.



Wall configurations studied include continuous insulation and cavity insulation (no dedicated interior vapor retarder; temperature-controlled cavity) (left); continuous insulation, cavity insulation, and an interior vapor retarder (hybrid wall) (center); and cavity-only insulation (vapor-open walls or walls with an interior vapor retarder) (right).
Illustration from Home Innovation Research Labs

Project Information

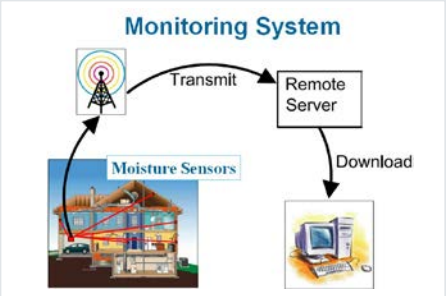
Building Component: Walls

Team and Partners: Home Innovation Research Labs, National Association of Home Builders, American Chemistry Council, Vinyl Siding Institute, USDA Forest Products Lab

Application: Residential, Commercial, Multifamily

Year Tested: 2015–2017

Climate Zones: 4–7



Sensors were installed in wall cavities of occupied homes to measure the moisture content of sheathing material, studs, and rim joists. Interior and exterior sensors measured temperature and relative humidity at each location. *Illustration from Home Innovation Research Labs*

Key Research Findings

A technical report offers detailed discussion and performance data from the individual homes within the study, as well as research findings related to studied configurations of wall design, vapor retarders, and insulation. Key findings include:

The majority of walls showed moisture content levels less than the fiber saturation point during the monitoring period or following the initial drying.

Exterior insulation can be an effective method for controlling the effects of interior vapor drive.

Walls that showed an upward moisture content trend in the winter showed a drying trend in the spring. This performance pattern included walls with exterior foam sheathing, confirming that these types of walls have a capacity for drying.

Recommendations

The research generated several recommendations for builders considering high-R walls for new homes:

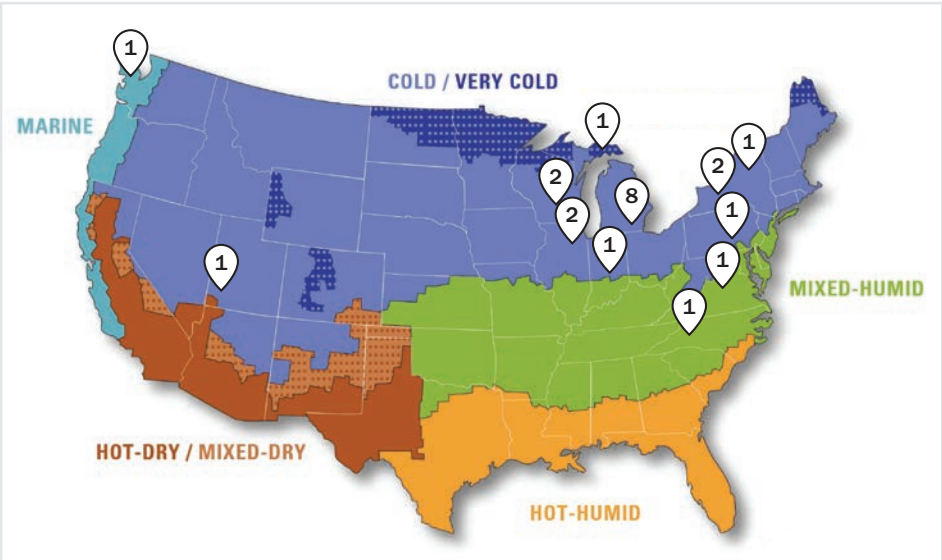
- Polyethylene interior vapor retarder systems should be accompanied with air sealing details and drainage plane details to minimize water leaks or moisture accumulation.
- Avoid installing polyethylene over materials with elevated moisture content, particularly if the cladding/drainage plane is not vapor-open.
- "Hybrid" walls combining exterior insulation and a Class II vapor retarder show promise for increased R-value with minimum changes to construction practices.
- Deep cavity walls with damp-sprayed cellulose insulation should dry before drywalling to allow walls to reach manufacturer-recommended moisture content levels.
- For walls without exterior insulation or for any walls that rely on a Class II or III vapor retarder in climate zones 5A and higher, an air sealing strategy at the interior drywall is recommended to control airflow from inside the house into the cavity.
- Quality of installation of Kraft paper batts can be a potential factor in moisture performance.

Read the full report and addendum for findings and additional recommendations related to each of the researched wall configurations. ■

Learn More

Technical Report:
www.homeinnovation.com/trends_and_reports/featured_reports/~/media/Files/Reports/Moisture-Performance-of-High-R-Wall-Systems-2018.pdf

Report Addendum:
www.homeinnovation.com/trends_and_reports/featured_reports/moisture_performance_of_high-r_wall_systems_-_addendum



22 newly constructed occupied homes were monitored for moisture performance in various locations across the U.S. *Illustration by Christopher Schwing, NREL*

U.S. DEPARTMENT OF ENERGY
Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Building America U.S. Department of Energy

Home Innovation RESEARCH LABS

For more information, visit: energy.gov/eere/buildings/building-america

DOE/GO-102020-5252 · February 2020

Produced for the U.S. Department of Energy, Energy Efficiency and Renewable Energy, by the National Renewable Energy Laboratory (NREL).