PIMA Technical Bulletin #303

Moisture Control with Polyiso CI

About Polyiso Insulation

Polyiso is a rigid foam insulation used in more than 70% of commercial roof construction and offers a continuous insulation solution for commercial and residential wall assemblies. As one of North America's most widely used and readily available building products, Polyiso is a cost-effective insulation option for reducing building energy use and improving the overall service-life of roofs and walls.

The benefits of using Polyiso include:

- High R-value per inch of thickness
- Excellent fire test performance
- Extensive building code approvals
- Cost-effective continuous insulation (ci) solution
- Compatible with most roof and wall systems
- Dimensional stability
- Compressive strength
- Moisture resistance
- Thinner walls and roofs with shorter fasteners
- Long service life
- Preferred insurance ratings
- Virtually no global warming potential
- Zero ozone depletion potential
- Recyclable through reuse
- Recycled content (amount varies by product)
- Regional materials (nationwide production network)
- QualityMark[CM] certified LTTR-values

POLYISO

Surround yourself with the best.

The Superior Insulation System – Polyiso CI

The use of polyisocyanurate continuous insulation (Polyiso CI) is a time-tested, yet advanccilding concept. Utilizing Polyiso CI (with foil or coated glass facer) to provide a continuous layer of insulation on the exterior of a home is extremely beneficial when used with wood or steel framed construction to minimize thermal bridges. Providing insulation over the entire opaque wall surface significantly increases the overall thermal performance and energy efficiency of a home.[1]

Use of Polyiso CI to Control Moisture in Residential Walls

Moisture accumulation in the exterior walls of a home can present serious problems. Moisture can result from intrusion of rainwater or transfer and condensation of water vapor from the building interior or exterior. Polyiso CI can help minimize rainwater intrusion, air leakage, and condensation when incorporated into a properly designed and detailed wall system.

How Does Water Enter the Stud Cavity?

Moisture Transfer Through Bulk Water

Rainwater can enter walls from the exterior as a result of wind-driven rain penetrating the cladding and/or water resistive barrier (WRB). The drained cavity and surface sealed wall systems manage bulk water in different ways **(Figure 1)**. The drained cavity utilizes a pressure equalized cavity or an air space behind the cladding to drain and re-direct the water to the exterior. The surface sealed wall system relies on the waterproof integrity of the outer cladding surface to resist water intrusion.

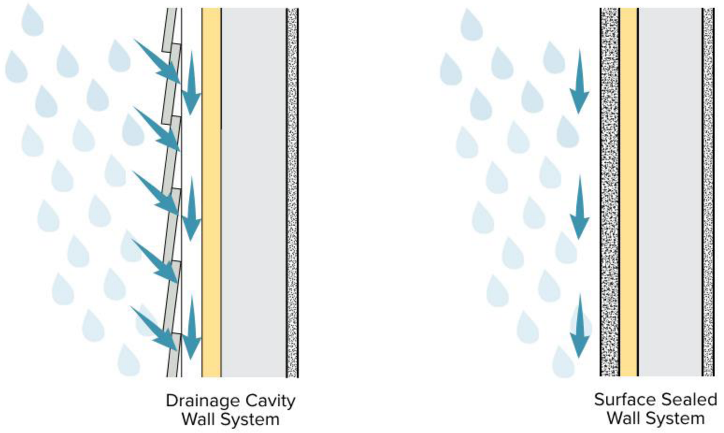


Figure 1. A demonstration of how walls with a drained cavity versus a surface sealed system manage bulk water intrusion.

1 Savings vary. Find out why in the seller's fact sheet on R-values. Higher R-values mean greater insulating power.

In residential applications, the exterior walls may include an air space or a gap between the cladding and the supporting wall. Any bulk water that penetrates the cladding is managed through the use of drainage planes that integrate WRBs and flashings. This allows the moisture to be collected and redirected out of the wall. In addition, the use of gutters and spouts allows the rainwater from the roof to be collected and re-directed away from walls. Sloping the grade away from the building helps keep rainwater away from foundations.

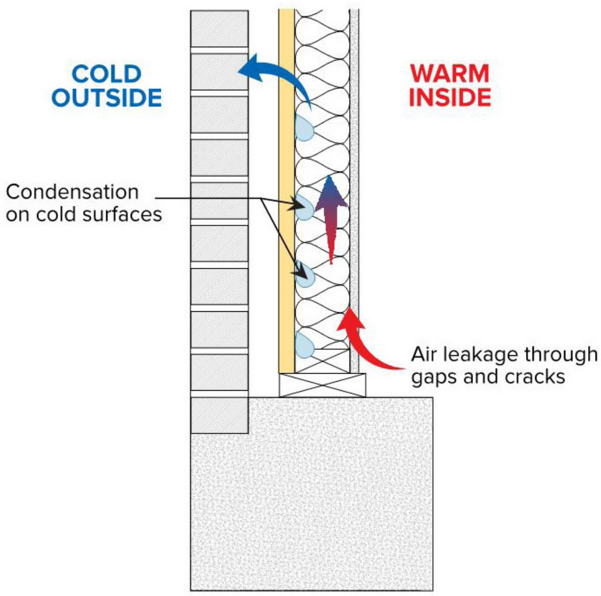


Figure 2. A demonstration of moisture transfer through air leakage in a cold climate wall assembly.

Moisture Transfer Through Air Flow

Air leakage can transport a significant amount of moisture across exterior walls. Moisture delivered via air leakage can occur through infiltration (air flow from outside into the home) and exfiltration (air flow from inside the home to the exterior). Air leakage occurs in the presence of a pressure difference between two points and a continuous air flow path. The wind, stack effect, and mechanical air handling systems are the primary mechanisms that generate pressure differences. Gaps between wall components and service openings can create an unobstructed path for air flow. In cold climates when air exfiltration is present, indoor air may be transported into the wall and cause condensation to occur at locations below the dew-point temperature. Condensation typically occurs on the interior facing surface of the exterior sheathing **(Figure 2)**. The same phenomenon may take place in hot-humid climates in the presence of air infiltration, except the condensing plane is typically the outer facing surface of gypsum board.

Moisture Transfer Through Diffusion

Water vapor is generated inside the home through everyday activities including: cooking, bathing (use of showers), washing/drying clothes, and occupant generated moisture (perspiration). Humidifiers and plants can also contribute to a home's indoor moisture load **(Table 1)**[2] . Water vapor may be transported across exterior walls by air or a process known as diffusion.

In cold climates, water vapor will diffuse from the interior of a home and across the exterior walls.[3,4] As water vapor diffuses across a wall system (water molecules move from warm interior to cold exterior), it may reach a dew-point temperature. In wall systems without continuous insulation, condensation tends to occur on the interior facing surface of the structural sheathing **(Figure 3)**. Without

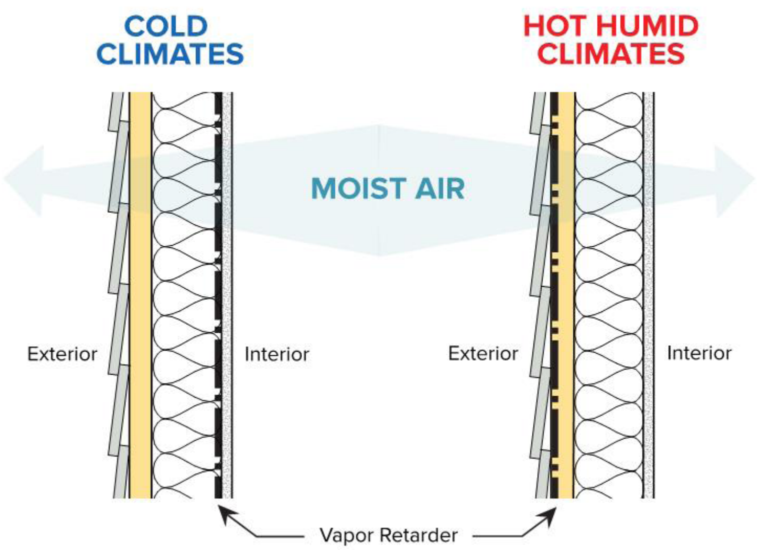


Figure 3. Direction of water vapor diffusion through wall systems in cold climates and hot-humid climates.

2.The table is reproduced from *Moisture in Buildings*, John F. Straube, ASHRAE Journal (January 2002). Available at: https://www.civil.uwaterloo.ca/beg/Downloads/ASHRAE%20Journal%20Jan%202002%20Moisture.pdf.

3. Research Report: Assessment of Water Vapor Control Methods for Modern Insulated Light-Frame Wall Assemblies (available at: http://www.appliedbuildingtech.com/rr/1410-03).

4. Research Report: Model Moisture Control Guidelines for Light-Frame Walls: A Building Code Supplement for Builders, Designers, and Building Officials (available at: http://www.appliedbuildingtech.com/rr/1701-01).

Source	Moisture Production Liters per Day
People (Evaporation per Person)	0.75 (Sedate), 1.2 (Avg.) to 5 (Heavy Work)
Humidifier	2–20+
Hot Tub, Whirlpool	2–20+
Firewood, per Cord	1–3
Washing Floors etc.	0.2
Dishwashing	0.5
Cooking for Four	0.9 to 2 (3 with Gas Range)
Frost-Free Fridge	0.5
Typical Bathing/Washing per Person	0.2 to 0.4
Shower (ea.)	0.5
Bath (ea.)	0.1+
Unvented Gas Appliance	0.15 kg/kWh for Natural Gas, 0.10 kg/kWh for Kerosene
Seasonal Desorption (or New Materials)	3-8 Depends on the House Construction
Plants/Pets	0.2–0.5 (Five Plants or One Dog)

Table 1. Sources of interior moisture.

adequate provisions to control moisture entry and accommodate drying, the condensed liquid can accumulate overtime leading to potential growth of mold and mildew. If the problem persists and remains undetected, it can lead to rot and wood decay. This can compromise the structural integrity of the wall system.

In hot-humid climates where the moisture content and the temperature of the outside air are high and the occupied space is kept cool (air-conditioned), water vapor will migrate in the opposite direction (water molecules move from the exterior to the occupied space). Condensation may occur on the cooler interior wall components, usually within the stud cavity on the exterior facing surface of the gypsum wall board. The condensed moisture if allowed to accumulate can contribute to mold growth and potentially result in rot and wood decay. Vapor flow control strategies become critical to long-lasting wall systems and are required by the model building codes. Always be sure to consult local building codes for vapor retarder requirements.

Diffusion Versus Air Flow

To illustrate the difference between moisture transfer through diffusion versus moisture carried by air flow, consider that the amount of moisture contributed by vapor diffusion through a 4-foot by 8-foot sheet of gypsum wall board is approximately 1/3 of a quart of water per day. In contrast, the amount of moisture contributed to a building by air flowing through a 1-inch by 1-inch hole in a sheet of gypsum board is approximately 30 quarts of water per day **(Figure 4)**. Positive pressurization from the HVAC system can help combat air and moisture infiltration. However, this requires far more energy than simply ensuring that the building is sealed to minimize air leakage when constructed. Always be sure to consult local building codes for air barrier requirements.

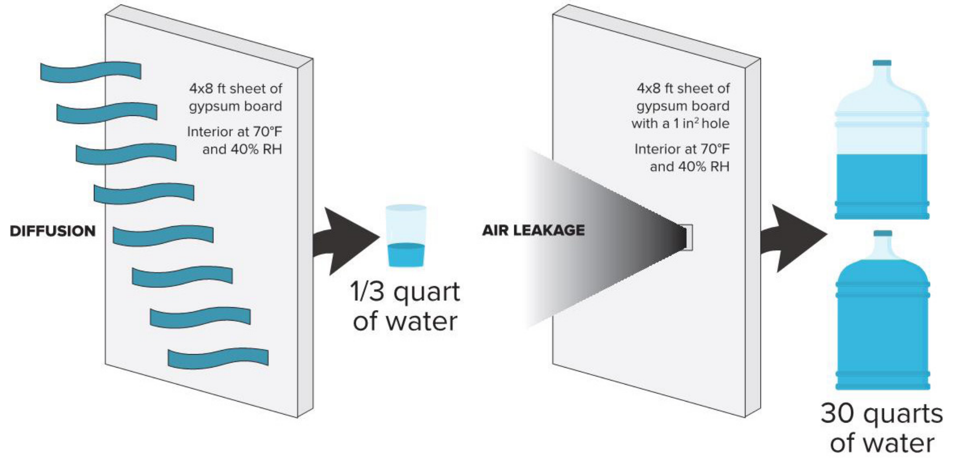


Figure 4. A comparison of moisture transfer through a wall via diffusion versus air flow.

Minimizing Moisture Problems

In general, problems caused by moisture sources inside a home may be minimized through:

- Application of continuous insulation to maintain the wall cavity above the dew-point temperature;
- Proper indoor ventilation and dehumidification strategies;
- Use of air barrier systems to control moisture transport carried by leaking air; and
- Use of vapor retarders to control water vapor migration through exterior walls.

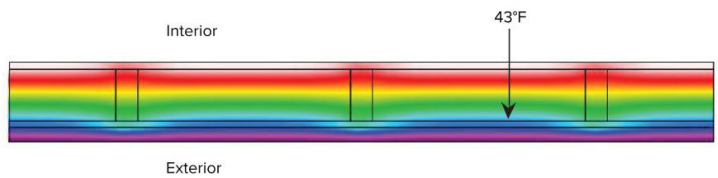
The Polyiso CI Solution

Polyiso CI can increase energy efficiency and also contribute to moisture control in walls. Placing the thermal insulation on the exterior side of the structural framing helps increase the temperature of the wall cavity and minimize thermal bridging, thus reducing or eliminating the risk for condensation.

For example, consider a home with R-13 cavity insulation and wood studs, where the exterior temperature is 30ºF and the interior temperature is 70ºF and the interior relative humidity is 30%. The calculated dew-point temperature is 38ºF. If wood sheathing is used, condensation in the cavity will likely occur because the cavity facing surface of the wood sheathing is about 32ºF. With 1-inch Polyiso CI installed on the exterior side of the framed wall, the temperature on the interior facing surface of the wood sheathing is approximately 43ºF. This reduces the risk for moisture condensation in the wall cavity. A similar temperature increase for the interior facing surface of the wood sheathing is predicted when using 1-inch Polyiso CI with steel stud framed walls. (Figure 5).

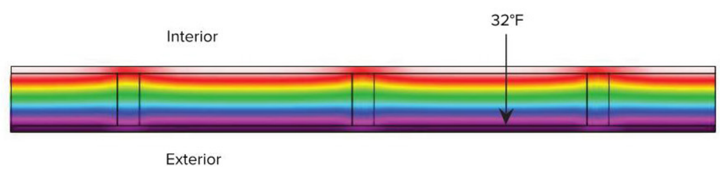
Additionally, taping the joints of Polyiso CI can provide a code-compliant air barrier. This will reduce or eliminate air infiltration and exfiltration, which may eliminate the need for house wraps or other materials along with the cost of labor to install these materials. With taped joints, Polyiso CI also can comprise a code-compliant WRB and provide resistance to bulk water intrusion into the walls. Best practices require the proper sealing of windows, doors, and service penetrations to achieve a functioning WRB.

NOTE: Use an approved tape per Polyiso CI manufacturer installation instructions. Good construction practices are essential to well performing wall systems. Always follow the manufacturer recommended installation instructions.



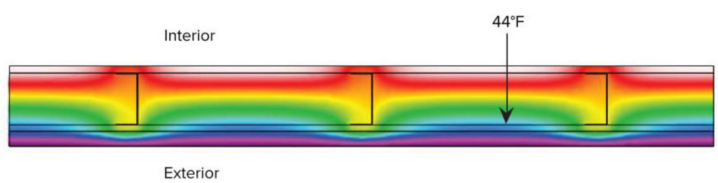
Wood Wall Section With Polyiso CI

1/2" gypsum wallboard, 2" x 4" wood studs, cavity insulation, 7/16" OSB sheathing, 1" polyiso CI



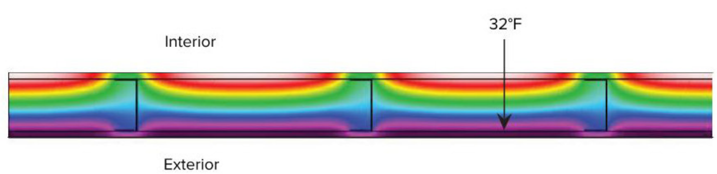
Wood Wall Section Without Polyiso CI

1/2" gypsum wallboard, 2" x 4" wood studs, cavity insulation, 7/16" OSB sheathing



Steel Wall Section With Polyiso CI

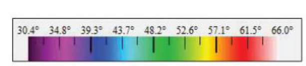
1/2" gypsum wallboard, 2" x 4" steel studs, cavity insulation, 7/16" OSB sheathing, 1" polyiso CI



Steel Wall Section Without Polyiso CI

1/2" gypsum wallboard, 2" x 4" steel studs, cavity insulation, 7/16" OSB sheathing

Figure 5. Temperature distribution profiles of various wall assembly types with and without Polyiso CI.



In cold climates, a vapor retarder should generally be installed on the interior side of the wall assembly to help prevent transport of moisture from the occupied space. Some jurisdictions in cold climates require a Class I vapor retarder on the interior side of the wall. Note that this provision assumes the exterior side of the wall is vapor permeable. A Class II or III vapor retarder on the interior side of the wall should be considered with a low vapor permeance sheathing. If insulation products such as foil-faced Polyiso CI are selected, it is important to ensure the correct R-value has been installed.

In hot-humid climates (where the primary energy use is air conditioning), a vapor retarder should generally be installed on the outboard side of the exterior wall. This may be accomplished by taping joints of Polyiso CI in addition to sealing all service penetrations and openings.

General information on vapor retarder classifications can be located in the *2018 International Residential Code*.[5] Climate zone maps and definitions can be found in the *2018 International Energy Conservation Code*[6] *or the National Energy Code of Canada for Buildings 2017*.[7]

5. Chapter 2 Definitions, "Vapor Retarder Class." Available at: https://codes.iccsafe.org/content/IRC2018.

6. Chapter 3 General Requirements, Section R301 Climate Zones. Available at: https://codes.iccsafe.org/content/IECC2018P3.

7. Available at: http://publications.gc.ca/collections/collection_2018/cnrc-nrc/NR24-24-2017-eng.pdf.

KEY FACTS:

- Moisture inside walls can occur due to rainwater intrusion and/or water vapor transport via air infiltration/exfiltration or diffusion.
- Using Polyiso CI in exterior walls can provide a continuous thermal insulation plane, reducing the risk for moisture condensation and accumulation in the wall assembly.
- Water in walls can cause rot, mildew, corrosion, and damage to interior finishes. These can be both structural and environmental safety issues.

DEFINITIONS:

Dew-Point Temperature: The temperature to which air must be cooled to become saturated with water vapor. When further cooled, the airborne water vapor will condense to form liquid water.

PIMA

For more than 30 years, PIMA (Polyisocyanurate Insulation Manufacturers Association) has served as the unified voice of the rigid polyiso industry proactively advocating for safe, cost-effective, sustainable and energy-efficient construction. PIMA's membership includes manufacturers of polyiso insulation and suppliers to the industry. The products of PIMA's members comprise the majority of the polyiso produced in North America.

PIMA produces technical bulletins to address frequently asked questions about polyiso insulation. These publications update and inform architects, specifiers, and contractors about and build consensus on the performance characteristics of polyiso insulation. Individual companies can provide specific information about their respective polyiso products.

For more information on polyisocyanurate insulation, visit www.polyiso.org

PIMA
POLYISOCYANURATE INSULATION MANUFACTURERS ASSOCIATION

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