

## THE EFFECT OF AIR & WATER ON R-VALUES OF INSULATION MATERIALS

### QUESTION:

**What real world factors can affect a product's insulating power?**

### ANSWER:

R-value is a reliable measurement of how materials will perform in a static test environment, however real world application will differ from laboratory circumstances. The insulation used in an exterior wall will be part of the overall building envelope, not used in isolation. Factors such as moisture, air infiltration, and convective flows within the wall all can play a part in the overall thermal efficiency of a wall system.

### QUESTION:

**How do products obtain their R-value?**

### ANSWER:

#### Air

Closed-cell foam insulations derive their R-value from the blowing agents/gases contained within the cells. The blowing agents for different types of foam plastics will vary, but all are selected for their ability to enhance the thermal performance of the foam. Because of their closed-cell composition, all closed-cell foam products provide excellent resistance to moisture and air intrusion along with thermal performance.

Fibrous materials derive their R-value from air trapped within pockets between the fibers. Air and/or water movement through fibrous insulation products will reduce the insulating power, which is why fibrous insulations have traditionally been used within interior stud cavities with barriers (walls) which restrict air & water movement on all 6 sides of the cavity.

To illustrate how fibrous insulations work and how air or water can impact insulating power, think of a person who wears a sweater outside on a cool day to keep warm. On a calm, cool day the sweater does a nice job keeping them warm. If the wind picks up, the air penetrates the fibers and the sweater no longer insulates the way it did when the air was not moving, in fact they may put a wind breaker over the sweater to try to keep warm. If it rains, the sweater gets wet as water penetrates the fibers, again impacting the insulating ability. When the sweater dries out, it will insulate well again, but how long does it take to dry and how quickly will that person want to put it back on? What happens if the weather is consistently wet or there is a significant amount of wind? Would a sweater be your first choice to keep you warm in such conditions?

#### Moisture

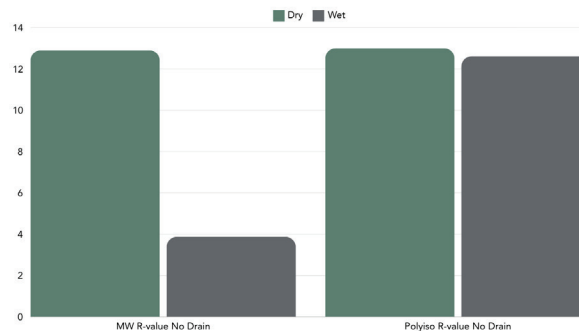
Both bulk water and water vapor should be considered when making choices for continuous insulation or "ci". There are a number of tests utilized to measure water resistance of various building materials, and it is important to understand what they measure and how those measurements apply to various product applications.

ASTM C209	2 hour immersion with 10 minute drain
ASTM C272	24 hour immersion with no drain
ASTM C1104	Measures exposure to water vapor, no actual water immersion

The ASTM C209 and ASTM C272 are most frequently utilized for products used in an exterior environment where the presence of water is likely. ASTM C272 has been predominantly used when focusing on below-grade application. ASTM C209 has been more closely associated with abovegrade exterior walls due to the inclusion of a drainage period. ASTM C1104 is a test created specifically for mineral fiber insulations that does not include the presence of bulk water.

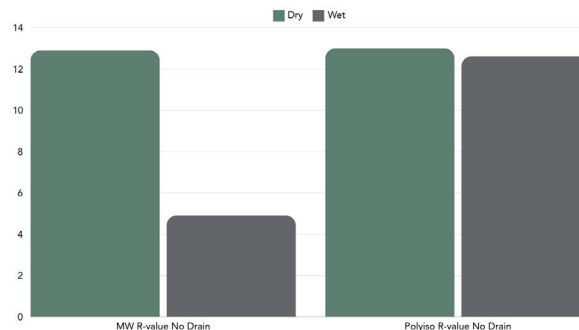
Independent tests performed on Hunter Xci polyiso and a leading dual density mineral fiber board product yielded telling results. Both materials were subjected to identical test procedures at accredited independent facilities. R-value measurements used were taken at both 75°F and 40°F mean reference temperatures.

**2 Hour Immersion with No Drain**



In the dry state, the measured average R-values were in line with published R-values for both the 2" ISO (R-13) and 3" dual-density mineral fiber (R-12.9). In the wet state, test averages resulted in the polyiso product performing within 3% of published R-values. In the same wet state, test averages resulted in the mineral fiber product R-values being diminished by 70% from published Rvalue.

**2 Hour Immersion with 10 Minute Drain (ASTM C209 Criteria)**



In the dry state, the measured average R-values were in line with published R-values for both the 2" Dual-Density Mineral Fiber (R-12.9). In the wet state, test averages again resulted in the polyiso product performing within percentage points of published R-values. In the same wet state, test averages resulted in the mineral fiber product R-values being diminished by 62% from published R-value.

Closed cell foam insulation products have excellent moisture resistance, while fibrous materials do not. Tech bulletins or FAQ from fibrous insulation manufacturers state that when product is wet, R-value will be reduced, but they do not typically reference how much reduction will be seen. The above results show the R-value reduction to be substantial, even when drainage opportunity is provided.

**CONCLUSION:**

Polyiso insulation performs better in retaining R-value in wet environments, such as exterior wall cavities, than mineral fiber. Consideration should be given to such factors when selecting insulation materials.