

MAX NO. 9001

SUBJECT: MOISTURE AND R-VALUE PERFORMANCE UNDER EXTREME ENVIRONMENTAL CONDITIONS:

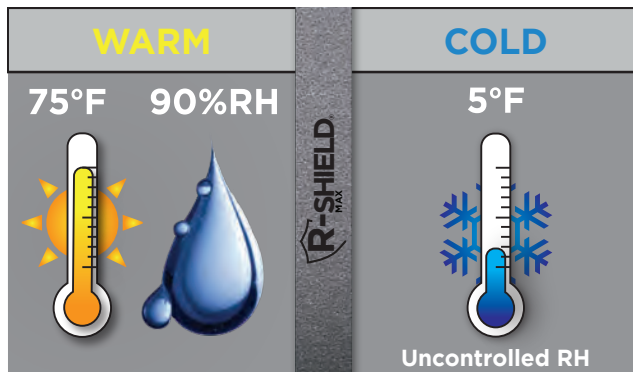
DATE: JULY 2018 (REVISED JANUARY 2019)

R-Shield® MAX is well known for its embedded graphite particles that reflect heat radiation like a mirror to increase R-value. This innovative rigid foam insulation is also known for its excellent moisture performance. Its exceptional breathability and permeability help reduce the risk of mold, rot, and structural damage associated with moisture condensation and long-term water retention.

In order to confirm the thermal, moisture, and structural properties of R-Shield MAX under environmental extremes, Intertek Testing Services was commissioned to conduct rigorous ASTM C1512 testing. ASTM C1512 is a standard test method for characterizing the effect of extreme temperature variations and exposure to moisture on the thermal performance of the insulation products. Testing was conducted on R-Shield MAX 100, 130, 150, and 250.

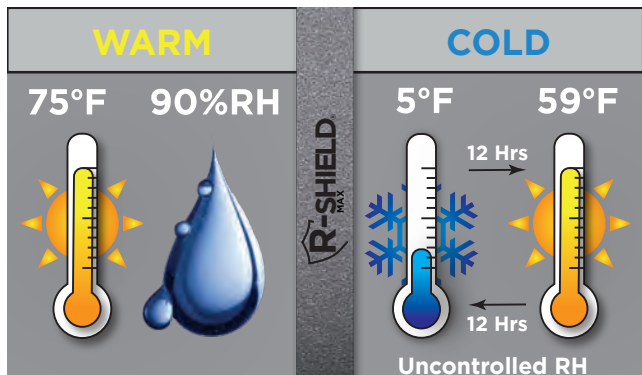
ASTM C1512 Preconditioning

In the first stage of the ASTM C1512 test, the R-Shield MAX samples were subjected to conditioning in a test chamber for 28 days to artificially increase moisture content due to vapor diffusion associated with constant thermal gradient. The specimens divide two environments. The warm side is at 75°F and 90% relative humidity and the cold side is a constant 5°F with uncontrolled ambient humidity. The intention of the extreme temperature and humidity gradient between the warm and cold side is to artificially accumulate moisture by vapor diffusion into the test specimens.



ASTM C1512 Cycling Stage

After 28 days of preconditioning, the samples were removed and weighed, and then returned to the test chamber to undergo another 20 days of testing comprised of alternating 12-hour cycles. In this cycling stage, the warm side was still at 75°F and 90% relative humidity, but the cold side was cycled every 12 hours from 5°F to 59°F for 40 cycles. This rigorous testing regime is designed to determine the moisture management properties of the insulation under common field exposure conditions. The cycling stage is where the drying potential of the insulation under common field exposure conditions is measured.



ASTM C1512 Results


At the end of the testing all of the R-Shield MAX samples were weighed, dried, and moisture content was measured. The samples were subjected to compressive strength (ASTM D1621) and R-value (ASTM C518) testing to measure the effects of the extreme environmental exposure on the material's physical properties.

R-Shield MAX held its R-value, didn't retain moisture, and maintained its physical properties after undergoing severe environmental testing.

Conclusions

The series of tests conducted by Intertek was designed to see how R-Shield MAX insulation responded to extreme environmental conditions in terms of thermal performance, moisture performance, and compressive strength. After the rigorous ASTM C1512 testing was complete, R-Shield MAX proved itself in a number of key areas:

- R-Shield MAX doesn't retain moisture, drying quickly after cycling from low to high humidity.
- R-Shield MAX held its R-value after undergoing 48 days of extreme environmental testing that involved both a constant thermal gradient and cycling between large temperature and humidity variations.
- R-Shield MAX holds its properties after exposure to extreme environmental cycling, further confirming and quantifying what building professionals have observed in the field

ASTM C1512 ENVIRONMENTAL CYCLING RESULTS		
	Moisture Retained After Cycling (%)	R-value Retention After Cycling (%)
100	< 0.05	100
130	< 0.05	100
150	< 0.05	100
250	< 0.05	100

MAX NO. 9002

SUBJECT: EXPOSURE TO MOISTURE

DATE: JULY 2018 (REVISED JANUARY 2019)

R-Shield® MAX is a graphite polystyrene rigid foam insulation with high R-value and superior moisture resistance. R-Shield MAX is a closed cell foam manufactured to resist moisture absorption in wetting conditions and release absorbed moisture quickly during drying periods.

R-Shield MAX, like all insulation, may be exposed to challenging moisture conditions in building insulation applications. The behavior of any insulation when exposed to moisture is critical to understanding the potential impact of water absorption on the insulation's R-value.

The exposure of insulation to moisture varies widely in the most common building insulation applications:

- Roof insulation is protected by a membrane and is not exposed to rain
- Wall insulation is protected by a weather resistive barrier and is not exposed to rain
- Below Grade insulation installed with ground sloping away from the foundation and drainage at footings experiences little moisture exposure

The insulation industry for years has conducted water absorption testing as a means of quality control. ASTM C578¹ has very specific requirements for testing the water absorption of polystyrene insulation following ASTM C272². The ASTM C272 test method involves placing a 1 in. x 12 in. x 12 in. sample of polystyrene insulation under water for 24 hours. After 24 hours the sample is taken out of the water, surface water on the sample is removed, and a determination of the water absorption by volume is made. The ASTM C578 requirements for this quality control test are as follows:

PRODUCT	R-SHIELD [®] MAX		
	100	150	250
Water Absorption max., volume %, ASTM C272	4.0	3.0	2.0

Some building industry representatives have long referenced these ASTM C578 short-term quality control test results and inappropriately considered the values as the expected water absorption in building applications.

Researchers from Dow Chemical³ as early as 1983 concluded "that moisture gain in perimeter insulation cannot be predicted accurately by any one laboratory test". More recently, building science professionals rely on complex software, such as WUFI⁴, to attempt to predict the transient heat and moisture transport in buildings.

More useful information on the performance of R-Shield MAX insulation when subjected to the normal wetting and drying conditions of building applications is now available.

R-Shield MAX samples which completed 24 hours of submersion in water in accordance with ASTM C272 testing were stored for an additional 24 hours in 50% RH air immediately upon removal from the water. This additional time period provides critical insight into the full cycle of R-Shield MAX wetting and drying behavior.

PRODUCT	R-SHIELD [®] MAX		
	100	150	250
Water Absorption max., volume %, ASTM C272 and additional 24 hour in 50% RH air.	< 0.3	< 0.3	< 0.3

The results above from the full cycle of a 24 hour under water exposure followed by a 24 hour air exposure clearly demonstrates R-Shield MAX resists moisture absorption in wetting conditions and releases absorbed moisture quickly during drying periods, which means R-Shield MAX will maintain R-value performance under the most demanding building applications.

- Reference: ¹ ASTM C578, Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation. ASTM.
- ² ASTM C272, Standard Test Method for Water Absorption of Core Materials for Sandwich Constructions. ASTM.
- ³ Laboratory Methods for Determining Moisture Absorption of Thermal Insulations. II: Comparison of Three Water Absorption Test Methods with Field Performance Data. Journal of Thermal Insulation Vol. 7, 128-137. (1983). A.O. Forgues, Dow Chemical Canada Inc.
- ⁴ WUFI®. WUFI is a family of software products that allows realistic calculation of the transient coupled one- and two dimensional heat and moisture transport in walls and other multi-layer building components exposed to natural weather. www.wufi.de/en/