TECH SOLUTIONS 520.0

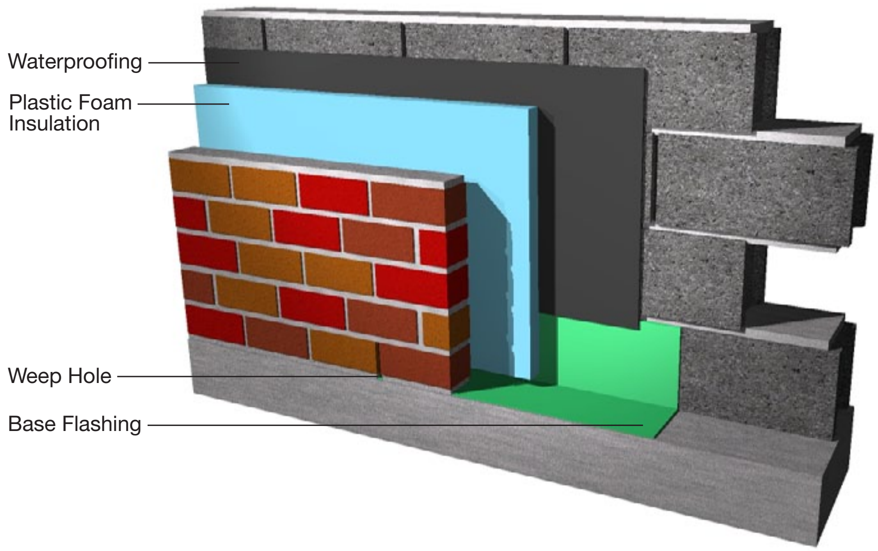
Water Resistance of Rain Screen Cavity Wall Insulation

Summary

Several manufacturers promote mineral wool insulation as an appropriate insulation for use in rain screen cavity walls. However, when basic water absorption tests are performed on a standard mineral wool product, it absorbs water readily, and the absorbed water takes days to drain from the insulation. While it is wet, mineral wool insulation has reduced R-value (RSI)*, resulting in higher heat loss from the building. This creates higher energy costs for the owner. For these reasons, designers should reconsider the use of mineral wool in applications where exposure to water is likely, such as rain screen cavity walls.

Background

Rain screen cavity walls are an old and proven technique for building walls that resist water leakage. The veneer, which is water permeable, acts to block but not stop wind-driven rain. A cavity behind the veneer collects water that penetrates the veneer and drains it to the outside. This water exposure and drainage capability is reflected in the cavity wall design and detailing, with attention paid to waterproofing (flashing) the interior side of the cavity, the bottom of walls and the tops of windows and doors.



The rain screen cavity is carefully prepared to withstand frequent and significant amounts of water intrusion.

In the late 1970s, the need for energy efficiency and the convenient location of the drainage cavity resulted in the placement of thermal insulation within the cavity. The wet and humid nature of the rain screen cavity strongly suggests that any insulation placed there have certain properties. Chief among these is water resistance.

Water Absorption Tests

There are many types of tests for various building materials. The water resistance of plastic foam insulation is determined using one of a series of ASTM standard tests. The most severe but still appropriate of these tests is ASTM D2842 – "Standard Test Method for Water Absorption of Rigid Cellular Plastics." In this test, samples are immersed for 96 hours and then measured for water absorption by volume. The standard CAN/ULC S701-03 "Thermal Insulation Polystyrene Boards and Pipe Coverings," which is used in Canada to classify polystyrene insulation, uses the ASTM D2842 test method to differentiate between types of polystyrene insulation when considering moisture resistance. Extruded polystyrene (XPS) insulation generally absorbs a maximum of 0.7 percent water by volume.

*R means resistance to heat flow. The higher the R-value or RSI (R-Value Système International), the greater the insulating power.

If 96 hours seems like an excessive exposure time with regard to the environment in a drainage cavity, ASTM C272 – “Standard Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions” – immerses a sample in water for 24 hours. ASTM C578 – “Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation” – uses ASTM C272 to differentiate between types of polystyrene insulation. In this test, XPS insulation generally absorbs 0.3 percent water by volume, while expanded polystyrene (EPS) insulation absorbs 2-4 percent water by volume.

If 24 hours still seems like too long of an exposure time, ASTM C209 – “Standard Test Methods for Cellulosic Fiber Insulating Board” – is typically referred to by polyisocyanurate foam manufacturers. In this test, samples are immersed for only 2 hours. Polyisocyanurate insulation typically absorbs <1 percent water by volume.

So, which test is used to determine the suitability of standard mineral wool insulation for the drainage cavity environment? ASTM C1104 – “Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation” – measures what happens to a fibrous material just by being *near* water, not actually exposed to it.

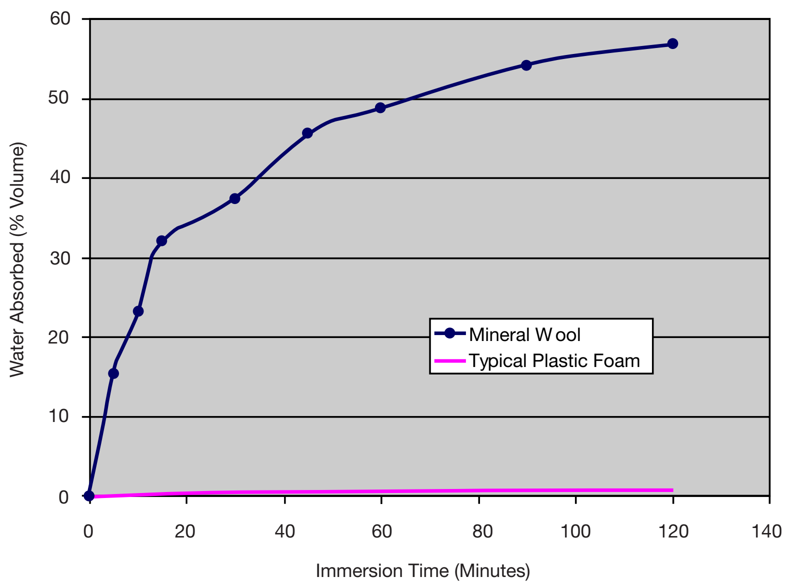
The results might seem impressive at 0.03 percent water absorbed. But this test looks at the effects of water vapor, nothing more. If water vapor was the only kind of moisture exposure expected in a drainage cavity, why are there specifications and details for sealants, tapes, flashings and drainage? The expected entry of bulk water into the cavity is reflected by these design efforts. Because water is expected to enter the cavity, mineral wool should be tested to determine how it will fare when exposed to water.

Put to the Test

What happens when mineral wool insulation is exposed to the *least severe* test for plastic foams – 2 hours of immersion? Figure 1 shows how much moisture mineral wool absorbs over the 2-hour immersion time period as compared to plastic foam insulation.

In only 5 minutes, mineral wool absorbs far more moisture than typical plastic foam insulation does in 2 hours. With such sensitivity to water, should such a product be used in rain screen applications where exposure to water is inevitable?

Figure 1: ASTM C209
Water Absorption of Mineral Wool Insulation(1)



(1) CavityRock insulation manufactured by Roxul Inc. was used as the test material.

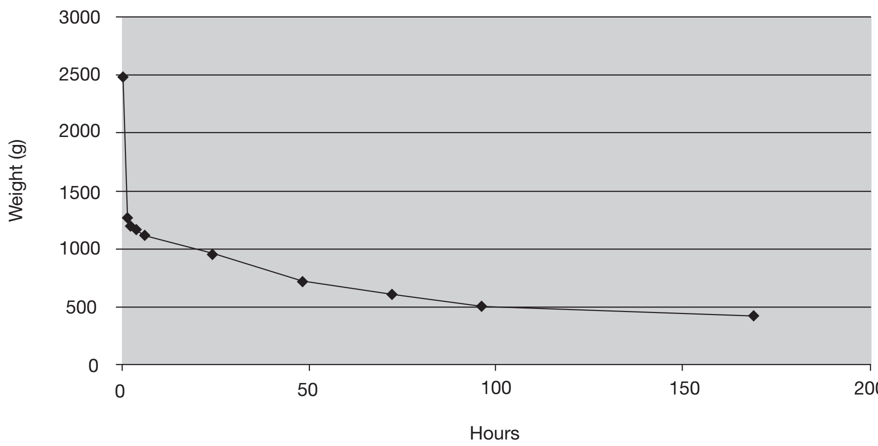
Drainage Test

Mineral wool manufacturers may claim that any absorbed moisture will simply drain from the product. There are no ASTM drainage tests, so the investigation must be conducted without a standard test method. The process is simple enough that it can be conducted without following a test method development process. Researchers from Dow submerged samples of mineral wool for 2 hours in water, then removed the samples and allowed them to drain on edge. The samples were then periodically weighed to determine how much water had drained out (Figure 2).

At first, drainage occurred quite rapidly; a large portion of the water drained out of the sample in a few hours. But rapid draining soon ended, leaving a significant amount of water in the mineral wool. The samples took days to dry completely. When enclosed within a rain screen cavity wall, the mineral wool could even take longer to dry.

From this test, it was determined that a significant amount of water does not drain quickly from mineral wool insulation, but requires a long period of time to leave the material.

Figure 2: Drying of Mineral Wool



Mineral wool samples drain on edge after 2 hours submerged in water.

Effect on R-value

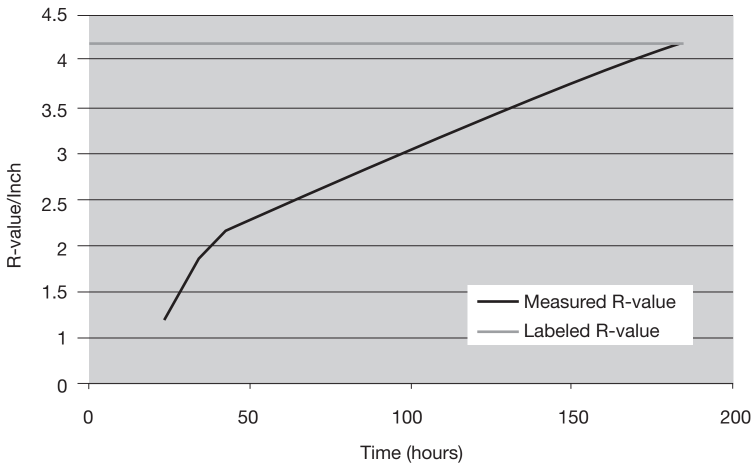
Insulation products use trapped air to achieve the high R-values that make them valuable for reducing heat loss in buildings. The R-value is heavily compromised when a highly heat-conductive substance like water penetrates the insulation. During the drainage test, the R-value of a sample was measured at selected times throughout the drying process (Figure 3).

In the first 24 hours, the water content in the sample was so high that the R-value was ~1 R/inch. This was one-fourth of the original R-value of ~4.2 R/inch. As the sample slowly dried, the R-value slowly increased. More than 4 days were required to recover a significant fraction of the product's advertised R-value.

The slow rate of drainage/drying, combined with the detrimental effect of water on insulation, severely curbs mineral wool's performance when used in an application that can expose it to significant amounts of water.

Designers should consider how many days out of a given year that the value of mineral wool insulation will be compromised by moisture to help determine the insulation product most suited to this application.

Figure 3: R-Value Recovery After Exposure



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