Understanding R-Value

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Do we really understand R-Value?

Insulation is used in both residential and commercial applications to control the transfer of heat through the building envelope and maintain an acceptable level of thermal comfort for building occupants. Heat transfer is an extremely complex topic, which is often oversimplified using linear models and test procedures. This is mainly the result of attempts to develop a system that the consumer could understand, allowing them a yardstick with which to make insulation purchasing decisions.

However, simplicity of a complex topic such as heat transfer comes at a cost, real world relevance. US DOE supported research, Wall R-Values that tell it like it is revealed that the center of cavity performance values stated on most insulation products is often misrepresented as wall performance ratings, resulting in performance being overstated by as much as 27 to 58%.

So How is Insulation Performance Currently Evaluated?

Most of the thermal performance testing completed on conventional insulations focus on their resistance to conductive heat transfer as measured by R-Value in the ASTM C518 Test.

The test is meant to provide a level playing field when comparing the thermal resistance of various types of insulations to determine the most suitable for a particular application.

However, what most people fail to consider (or realize) is that R-value is not a material property; it is a measurement under a specific set of conditions.

In reality, the R-value of a particular material is dependent on a number of environmental and installation parameters, external to the material itself.

R = *f*(material properties, time, thickness, moisture content, system configuration, installation deficiencies, …)

If any of the properties listed in the above equation are changed, the measured R-Value of the material may also change, affecting different materials in different ways.

Current regulations require the thermal resistance of insulations to be measured at temperatures that vary significantly from installed conditions. In addition, real world factors that have been documented to affect some insulation types are not considered such as:

* Air/moisture infiltration
* Installation deficiencies
* Thermal bridging
* Extreme temperatures
* Physical and thermal degradation

This is not an exhaustive list by any means. However, inclusion of any or all of these parameters may affect the overall performance of an insulation product, resulting in a product with a high labeled R-Value performing worse than another product that would appear to be inferior from a tested R-Value perspective.