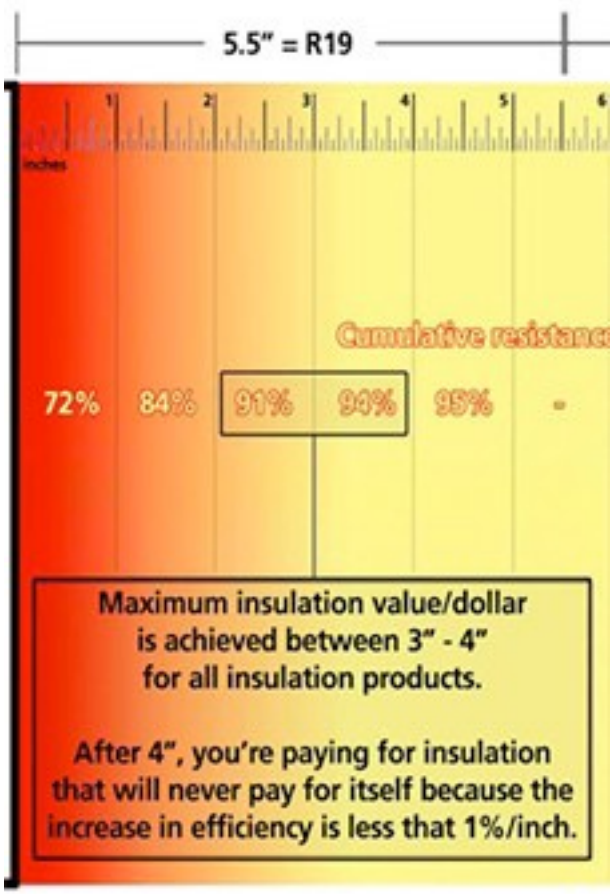
The Truth About R-value

For all its popularity, R-value offers very little in terms of assessing an insulation products ability to stop heat transfer and thereby save energy. Unfortunately, this metric has been so heavily used – and exploited – by fiberglass insulation manufacturers that it has become the standard by which all insulation products are judged.



Why have these manufacturers promoted a bogus metric as the primary means of measuring insulation effectiveness? Well I'm glad you asked! It's because the metric heavily favors fibrous insulation products because the test used to determine R-value exaggerates the performance of fibrous insulation.

Yes, for all practical purposes R-value is a near worthless number. R-value loosely measures a product's ability to resist conductive heat movement but - as we in the building science community have known for decades - conductive heat movement accounts for only a fraction of total heat movement in/out of buildings. Insulation must also stop convective and radiant heat movement. (Recall our earlier discussions about the Three Methods of Heat Transfer) As with all products, it is difficult, and perhaps even impossible, to define over-all effectiveness with a single number. To truly assess insulation product's ability to stop heat transfer, we must know several metrics including: R-value, vapor permeability, steady state time, emissivity, and etc. Don't worry if you're head is starting to hurt. We'll boil it down to a simple formula very soon.

So why do we allow the R-value fairy tale to perpetuate? I guess you'd have to ask fiberglass manufacturers with their full-time political lobbying efforts and their billion dollar businesses.

So why NOT R-value?

Consider the R-value of an insulation after it has been submersed in water or as a 20 mile-per-hour wind blows through it. In either of these scenarios, the R-value of fiber insulations goes to zero. But you wouldn't know this from looking at the label on the package. But wait . . . aren't those conditions present in our world affecting our houses at one time or another?
Doesn't the R-value test take these scenarios into consideration? Nope. If it did, we'd discover that the R-value of fiberglass – when the wind is blowing or when it gets wet – is actually zero. The R-value test is performed in a vacuum with zero moisture and zero air present. So at best – it offers you an indication of how fiber insulation would perform if you were building a house in outer space. Valuable information to be sure.

Incidentally, water, wind, and other conditions present in our atmosphere barely affect the performance of Suber. This is why Suber will perform better than inches of fiberglass. Unfortunately consumers and code bodies have adopted the R-value propaganda and view R-value as the true measure of insulation's effectiveness.

Code bodies mandate R-values of 20s or 30s or 40s and consumers go to Home Depot and buy bags of insulation to add more R-value to their attics in an attempt to save energy. But fiber insulation with an R-value of 25 placed in an improperly sealed house will allow wind to blow through it as if there were no insulation. Again, R-value is accurate when the material is tested in the absence of air and moisture. But these conditions not even remotely resemble the conditions in the real world.
Consequently, we must start asking for some additional dimensions to our insulation. We need to know its resistance to air penetration, to free water, and to vapor drive. We must begin demanding to know the R-value of an insulating material after it is subjected to real world conditions.

Test to Determine the R-Value

As it is currently used, R-value is a number that is supposed to indicate a material's ability to resist heat loss. It is derived by taking the k-value of a product and dividing it into the number one. The k-value is the actual measurement of heat transferred through a specific material.

The test used to produce the k-value is an ASTM (American Society for Testing and Materials) test. This ASTM test was designed by a committee to give us measurement values that – they hoped – would be meaningful. Unfortunately, the test was designed with a flaw or bias. The test was designed with input primarily from the manufacturers of fiber insulation products like fiberglass, rock wool and cellulose fiber and the like. Very little input went into the test for solid insulations, such as foam glass, cork, expanded polystyrene or urethane foam because these products were adopted as building insulation products several years later.

Thus, in order to enable their products to achieve high scores, the fiber insulation manufacturers lobbied heavily to have the test exclude air movement (wind) or any amount of moisture (water vapor). And therefore fiberglass is generally assigned an R-value of approximately 3.5 per inch. However, it will only achieve that R-value if tested in an absolute zero wind and zero moisture environments.

Zero wind and zero moisture are not real-world. Our houses leak air, all our buildings leak air, and they often leak water. Water vapor from the atmosphere, showers, cooking, breathing, etc. constantly moves back and forth through the building envelope. If an attic is not properly insulated, water vapor from inside a house will very quickly semi-saturate the fiber insulation above the ceilings. Even small amounts of moisture will cause a dramatic drop in fiber insulation's R-value — as much as 50% or more.