"R" Fairy Tale, The Myth of Insulation Values

by David B. South

The R-value is a modern fairy tale. It's a fairy tale that has been so touted to the American consumer that it now has a chiselled in-stone status. But the saddest part of this fairy tale is that the R-value by itself is almost a worthless number.

It is impossible to define an insulation with a single number. To do so, we must know more. So why do we allow the R-value fairy tale to perpetuate? I don't know. I don't know if anybody knows. What we do know is that the R-value fairy tale obviously favours fibre insulation.

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 fibre insulations goes to zero. But those same conditions barely affect solid insulations. That's why I believe that R-value numbers are misleading, meaningless numbers unless we know other characteristics.

In all probability, no one would ever buy a piece of property knowing only one of its dimensions. Suppose someone offered a property for $10,000 dollars and told you it was a seven. You would instantly wonder what that number referred to: Seven acres? Seven square feet? Seven miles square? What? You would also want to know the property's location: In a swamp? On a mountain? In downtown Dallas? In other words, one number cannot accurately describe anything, and that includes the value of an insulation.

Nevertheless we have Code bodies mandating R-values of 20s or 30s or 40s. But a 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. Maybe the R-value is accurate when the material is lab tested. But a lab environment may not even remotely duplicate 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 the R-value of an insulating material after it is subjected to real world conditions.

As it is currently used, an 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.

Test to Determine the R-Value

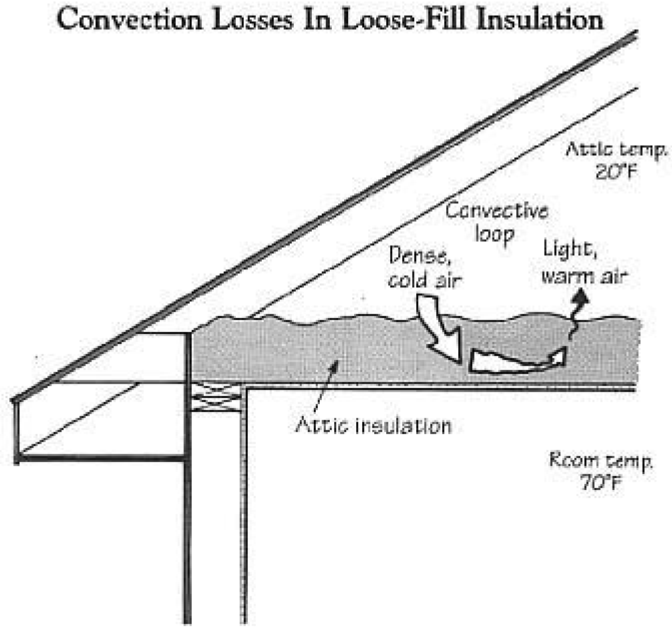
The test used to produce the k-value is an ASTM (American Society for Testing and Materials) test. This ASTM test was designed by a committee to give us measurement values that -- they hoped -- would be meaningful. Unfortunately, the test was designed with a flaw or bias. Because of the way it's designed, the test favors fiber insulations: fiberglass, rock wool and cellulose fiber. Very little input went into the test for solid insulations, such as foam glass, cork, expanded polystyrene or urethane foam.

Nor does the test account for air movement (wind) or any amount of moisture (water vapor). In other words, the test used to create the R-value is a test in non-real-world conditions. For instance, fiberglass is generally assigned an R-value of approximately 3.5. It will only achieve that R-value if tested in an absolute zero wind and zero moisture environment. **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 walls and ceilings. If an attic is not properly ventilated, water vapor from inside a house will very quickly semi-saturate the insulation above the ceilings. Even small amounts of moisture will cause a dramatic drop in a fiber insulation's R-value — as much as 50 percent or more.

Vapor Barriers

We are told, with very good reason, that insulation should have a vapor barrier on the warm side. Which is the warm side of the wall of a house? Obviously, it changes from summer to winter — even from day to night. In a wintry 20 F below zero environment, the inside of an occupied house will certainly be the warm side. But during sun-shiny summer months, the outside will be the warm side.

Sometimes a novice owner or builder will put vapor barriers on both sides of the insulation. Vapor barriers so placed generally prove to be disastrous. It seems the vapor barriers stop most of the moisture but not all. Consequently, small amounts of moisture move into the fiber insulation, between the two vapor barriers and become trapped. The moisture accumulates as the temperature swings back and forth. This accumulation can become a huge problem. It can eventually total buckets of water that saturate the fiberglass. We have re-insulated a number of potato storages that originally were insulated with fiberglass and a vapor barrier on both sides. Fiber insulation needs ventilation on one side; therefore, the vapor barrier should go on the side where it will do the most good.



Convection Losses In Loose-Fill Insulation

Most people know that air penetrates the walls of a house. In fact, when the wind blows across some homes, its tenants can feel it. But what most people, including many engineers, do not realize is that there are very serious convection currents that occur within fiber insulations. These convection currents rotate vast amounts of air, but they are not fast enough to feel or even measure, with any but the most sensitive instruments. Nevertheless, the air constantly carries heat from the underside of the fiber pile to the top side, letting it escape. If we seal off the air movement, we generally seal in water vapor. That additional water often condenses and can become a moisture-source that rots the structure. The water, as a vapor or condensation, seriously decreases an insulation value — the R-value. The only way to deal with a fiber insulation is to ventilate. But ventilating means moving air that also decreases the R-value

Air Penetration

The filter medium for most furnace filters is fiberglass — the same spun fiberglass used as insulation. Fiberglass is used for an air filter because it has less impedance to the airflow, and it is cheap. In other words, air flows through a furnace filter very readily. All well and good for a furnace filter -- but can that same material effectively insulate a structure? Can you imagine insulating a house by stuffing furnace filters into the walls and ceiling? Tremendous air currents blow through the walls of a typical home. To demonstrate, hold a lit candle near an electrical outlet on an outside wall when the wind is blowing. That flame will flicker and may even go out. The average home with all its doors and windows closed has a combination of air leaks equal to the size of an open door. Even if we do a perfect job of installing fiber insulation in our house and bring the air infiltration close to zero from one side of the wall to the other, we still do not stop air from moving vertically through the insulation itself, in ceilings and walls.

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