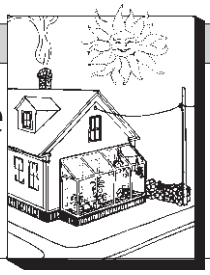
The Real R-Value of Fiberglass



by J.D. Ned Nisson

We have all heard claims that the "effective" R-value of walls insulated with fiberglass batts may be drastically reduced by installation defects such as gaps, voids, compression, etc. I've seen advertising brochures, for example, that state the "effective" R-value of an installed R-19 fiberglass batt may actually be as low as R-8. Like many such assertions, the brochure claimed there was government research data to support its statements.

How real are those claims? Is it possible that installation defects can cause a 50% or 60% reduction in wall R-value? And are there really research studies that prove it? When your insulation contractor smilingly stuffs that fluffy 6-inch batt into wall cavities, are you getting an R-19 wall or an R-8 wall?

The Rest of the Story

To answer those questions, I reviewed the most relevant laboratory research studies. Here's what I found.

First of all, yes, there are experimental test results that grow up to 75% loss of R-value due to air gaps, insulation voids, and air convection around the batts. But in none of those instances did the test walls resemble typical walls in houses; they were all designed as research experiments to investigate a specific property of insulation. The results cannot be applied directly to real walls in real houses.

Several research experiments, however, did simulate actual house walls. These produced the most informative and useful results. In general, installation defects such as gaps, voids, and compression can cause reduced R-value in walls. For typical installations, the loss is probably in the 10% to 15% range. But by eliminating the defects, the full R-value of the batts can be retained.

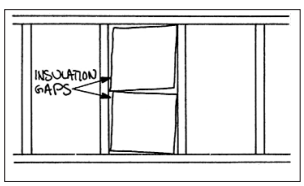


Figure 1. *Gaps are common along studs and plates and where two batts join together. Such voids can reduce R-value by 10% to 15%.*

Gaps and Voids

Gaps and voids in the insulation are perhaps the most commonly cited cause of poor performance. In addition to obvious missed areas, voids may be created wherever a batt doesn't perfectly fit the stud cavity, or where two batts are not butted together well (see Figure 1).

One frequently stated claim is that a 4% void area can reduce the overall R-value of an insulation system as much as 50%. That statement is a good example of misinterpreted research data; the experimental test wall used to produce that result (a 2x4 wall with a 2-inch batt suspended in the middle) did not resemble normal construction practices in houses. A more realistic study, performed at the same lab, showed that when 4% insulation voids intentionally were placed in a normal 2x4 wall with R-11 batts, the overall R-value was reduced by about 13%.

Wrinkles and Air Spaces

In a typical batt installation, it is almost impossible to avoid leaving some gaps between the insulation and sheathing. Even if the batt completely fills a stud cavity, the surface is often wrinkled, creating small air gaps near the edges or at the corners. Any obstructions in the stud cavity, such as nails, wiring, or plumbing, can also cause gaps between the batts and sheathing (see Figure 2).

Several different research studies have shown that gaps and air spaces can allow air to flow around and through a batt even without gaps at the top or bottom. Air actually flows through the upper and lower portions of the batt (Figure 3, left, on facing page). The loss in total wall R-value from that "convective loop" can be as high as 10% or 15% for typical situations.

But the most important finding concerning this phenomenon is that except under extreme temperature differences, air will not flow around the insulation unless there are air gaps on both sides of the batt. As long as one surface makes good contact with an impermeable surface such as drywall, polyethylene vapor retarder, kraft facing, etc., there will be no appreciable loss of thermal performance (Figure 3, right).

(By the way, this raises another example of misinterpreted research results. An experiment performed at the State University of New York at Stony Brook showed that the R-value of a wall panel with R-19 batts was only R-8 — 58% less than expected. But in that experiment, there was a full 1_-inch air gap on both sides of the insulation – not a situation normally found in real walls. When one air gap was eliminated, the measured R-value of the wall was a full R-19.)

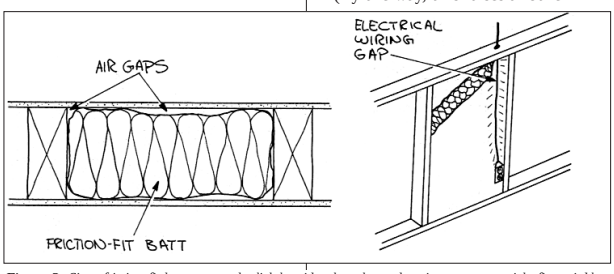


Figure 2. *Since friction-fit batts are made slightly wider than the stud cavity to assure a tight fit, wrinkles often form and create air gaps (left). Wiring and other obstructions also create gaps (right).*

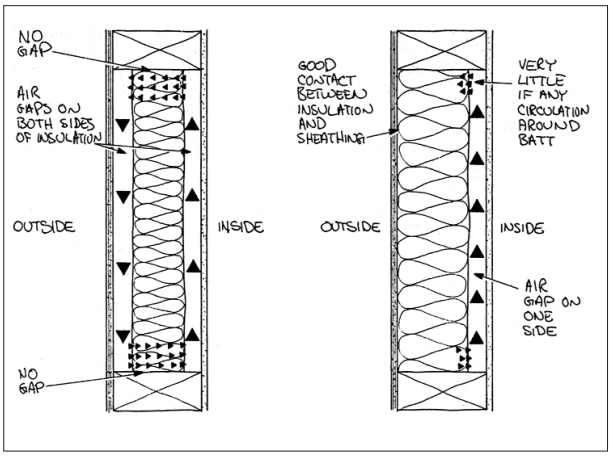


Figure 3. *With gaps on both sides of a batt (left), air can flow around or through the insulation, lowering R-values, even if the batt touches the top and bottom plates. However, if one side of the batt is in good contact with an impermeable surface such as plywood or drywall (right), air will not circulate except at extreme temperature differences.*

What happens when wind blows through the outer surface of a wall and impinges on the exterior surface of the insulation? If the wall has a good air barrier on the inside and if there are few if any gaps in the insulation, the wind can only affect the very outer surface of the insulation. Swedish research has shown that under those conditions the R-value may be reduced, but no more than 9% to 10%.

If, on the other hand, the interior surface of the wall is not airtight, then wind forces may push outdoor air, all the way through the insulation. The same Swedish experiments found that under "worst case" conditions (2-inch gap in the insulation and air space between insulation and sheathing), the total R-value of a wall could be reduced up to 40% by wind intrusion. However, under more moderate conditions (asphalt sheathing in contact with the insulation), the loss in R-value was between 5% and 15%.

The actual effect of wind intrusion in real houses is naturally variable. If an air-impermeable sheathing is nailed directly to the studs and is in good contact with the insulation, the effect of wind-driven air intrusion into the insulation is probably minimal – 5% or less. Improving the exterior air barrier by installing housewrap or taping joints would reduce that effect.

In a Perfect World…

Is it possible to build a batt-insulated wall with absolutely no measurable defects? The answer is unquestionably yes. In one test performed at Construction Technologies Laboratory, in Illinois, a full-scale wall insulated with R-11 batts was tested at four different temperatures. In every case, the measured R-value of the wall was actually higher than expected from the R-11 batts. Two similar tests at the National Bureau of Standards also showed that typical stud walls can be successfully insulated with batts without loss of R-value.

It is important to note that in these research studies, the walls often are built and insulated by technicians in lab coats. Quality control is therefore likely to be better than on a typical construction site. Nonetheless, the tests prove that defects can be avoided and walls can perform as expected.

The Commonsense Solution

It is highly unlikely that gaps, voids and other installation defects in batt-insulated walls with cause 50% or even 30% loss of total R-value under normal conditions. But 10% to 15% is quite possible. To limit that loss, a few installation guidelines are suggested.

- Make sure air cannot circulate over and under installed batts. If faced batts are used, staple the facing to the top and bottom plates. If unfaced butts are used, make sure they make good contact with the plates.
- Unfaced batts must be thick enough to completely fill the stud cavity. Normally, this will not be a problem with 2x4 or 2x6 studs since manufactured batts are made in the proper thickness to fill those cavities. But if the studs are built up with vertical furring or if some other framing system is used, there must not be air spaces or gaps on both sides of the insulation. At least one side of the batt must be in full contact with an impermeable surface.
- Avoid holes or voids. This is common sense. Even though they only result in 10% to 15% loss of R-value, voids in the insulation are easy to eliminate during installation.
- Provide a good wind barrier on the building exterior to prevent one-sided air intrustion into the insulation. ■

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