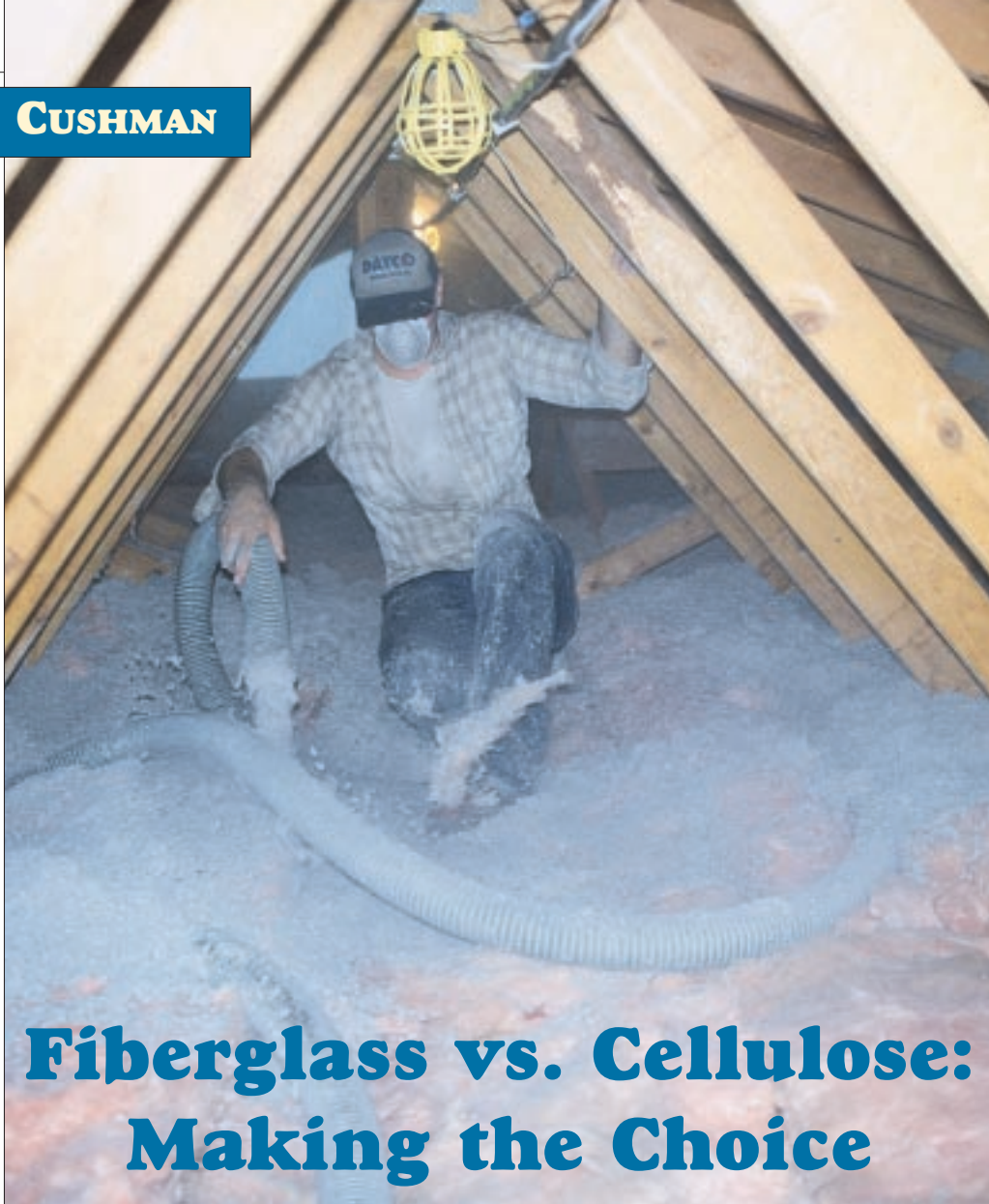


BY TED CUSHMAN

Blowing cellulose over fiberglass batts is an inexpensive way to increase attic R-value.



Fiberglass vs. Cellulose: Making the Choice

Ignore the hype — when matched to the job, either insulation will perform well

When it comes to cavity insulation, an energy-conscious builder has a lot of products to pick from and a lot of conflicting information to consider. In the running public-relations brawl between cellulose and fiberglass manufacturers, talking down the other guy's product has become a common marketing strategy.

Even after you sort through competing claims for fire resistance, health effects, and "green" benefits (see "Marketplace Madness"), you still have to evaluate claims about cost and performance. In this article, we'll take a look at the real-world conditions that affect the performance of fiberglass and cellulose insulation, and give some tips for using each of them effectively.

Of Price and Performance

Many builders ignore the competing claims about performance and just buy the cheapest product. But there's no simple formula here: Prices vary from area to area and installer to installer, and can change rapidly. Direct price comparisons between products are also complicated by the variety of product types. For example, both fiberglass and cellulose are available as a loose-fill blown product for attics and as a densely blown wall insulation. But only fiberglass is available in batt form (though the cellulose industry has been trying for years to create a batt), and only cellulose is widely used in wet-spray applications.

Differences in installation practices also cloud the price picture. A low installed price for fiberglass batts, for instance, may not include the cost of careful air barrier and vapor retarder details necessary to achieve good performance; the higher price of a premium blown-in product includes some beneficial air-sealing properties. In addition, the increased cost for a thicker wall may vary among products, so builders who want to superinsulate will have to make a direct comparison based on the specific wall thickness of a given job.

Insulating values, or R-values, of the different cellulose and fiberglass products are not, by themselves, a strong basis for making a choice, either. In the real

world, a claimed difference of R-1 or R-2 has very little effect on fuel bills. For that reason, the performance comparison between cellulose and fiberglass products usually goes beyond R-value to two other characteristics: the ability to completely fill all voids and the ability to slow or stop air movement. As it turns out, this comparison is not strictly between fiberglass and cellulose, but between fiberglass batts and blown products.

Air Sealing

Loose-fill fiberglass and fiberglass batts have little resistance to air pressure; loose-fill cellulose, at commonly installed densities, performs slightly better. But dense cellulose, which is installed at 3.5 pounds per cubic foot (pcf), blocks airflow very well, as does the fiberglass-based Blown-In-Blanket system by Ark-Seal, which contains an adhesive binder.

Weatherizers often choose blown-in cellulose as the most cost-effective way to insulate and tighten up an old house. Cellulose not only adds R-value to formerly uninsulated walls, it also blocks heat loss by sharply reducing air infiltration. And blowing cellulose into an old building's framing voids is often the simplest course: Other strategies for air sealing and insulating large areas of wall in an older building will usually mean tearing off a lot of siding or removing interior wall finishes.

Insulation's resistance to airflow is a less important consideration in most new construction, but it's still a controversial issue in the industry. Cellulose makers point to studies showing better energy performance with their product, and Ark-Seal cites the air-resisting and void-filling attributes of its system as a major improvement over batts. On the other hand, the batt industry has data to support its argument that insulation doesn't need to block air.

Experimental data. Proponents of cellulose often back their arguments by citing the "Colorado Study," a comparison of test structures performed



Figure 1. While housewrap helps cut air leakage, foam sheathing is the most effective way to reduce conductive heat loss through the framing.

by researchers at the University of Colorado at Denver. During a side-by-side winter test of two unoccupied buildings, the one insulated with wet-spray cellulose had 38% less air infiltration and used about 24% less heating energy than the one insulated with fiberglass batts.

The Colorado study was not, however, representative of most real buildings. No housewrap or poly vapor barrier was installed on either test building, and no effort was made to seal cracks such as joints in the sheathing material. This meant that the insulation material was required to provide an air barrier for the building, which is usually not the case in a new home.

To counter the cellulose air-sealing argument, the North American Insulation Manufacturers Association (NAIMA) measured air infiltration through test wall assemblies insulated with batts and covered with foam sheathing and housewrap. The batt industry says the results prove that most air infiltration into new buildings happens not

through wall cavities, but under the wall plates, through the band joist area, and at similar framing points. Housewrap and poly, insists NAIMA, can reduce infiltration more cost-effectively than cellulose.

But critics of the NAIMA study say the test assemblies were unrealistically perfect. For instance, none of the bays in the NAIMA test walls had holes at both the top and bottom plates such as might be cut for a vertical plumbing or electric run. The stack effect of heated air rising in the cavity would not occur in such a test assembly as it might in a real house. And the stud cavities in the NAIMA test were all exactly the right size, so that the batts fit perfectly.

Jesse Aragon of Ark-Seal says of the NAIMA test: "The results they got in a perfect wall with a perfect vapor barrier and perfect housewrap are the same as we got with our product installed just the way it is in the field, with no poly and no housewrap."

The Real World

It's always risky to draw conclusions about real buildings based on test data. But studies of actual buildings show that builders have been able to develop cost-effective insulating and tightening strategies using either fiberglass or cellulose.

Steve Andrews, a Denver-based energy consultant, worked with production builder Columbine Homes as the company searched for economical ways to tighten up their buildings. Andrews's analysis of Columbine's blower-door test data revealed that switching from fiberglass batts to spray-applied cellulose was the single most effective measure in lowering the leakage rate in new houses. But in another study of 30 Denver houses built by various companies, the tightest house Andrews examined (and the least expensive to build) was insulated with fiberglass batts. The builder simply insisted on attention to detail, says Andrews.

Marketplace Madness: The Manufacturers Duke It Out

Salespeople pushing insulation products have drawn a lot of attention to properties other than price and performance. Charging that the competing products are unsafe, unhealthy, or environmentally unfriendly, manufacturers hope to land a knockout punch and push their opponents out of the market. But so far, the facts behind the hype aren't all that impressive. For example:

Claim *Cellulose is a fire hazard.*

Facts: Cellulose is treated to resist fire. When treated cellulose ignites, it smolders slowly and is difficult to put out, a behavior some proponents of fiberglass cite as a big disadvantage. But a careful look at fire statistics does not show cellulose insulation to be an overall fire hazard.

The federal government has created a flame-spread and smolder standard for cellulose insulation; most cellulose manufacturers rely on independent certification from Underwriters Laboratories to demonstrate that they have met the federal standard.

Either cellulose or fiberglass can create a fire hazard if installed too close to a source of heat like a recessed ceiling light or a chimney. To avoid the hazard, builders should stick to insulation-compatible (IC) lighting fixtures and keep insulation away from any heat source.

Claim *No, wait! Fiberglass is a fire hazard!*

Facts: Glass is an inherently non-flammable material. Although fiberglass itself does not burn, a fire in a fiberglass-insulated space is likely to burn faster than a fire in a cellulose-filled cavity, since the cellulose tends to prevent oxygen from reaching the

flames. For that reason, cellulose has performed slightly better than fiberglass in tests of fire-rated wall assemblies.

However, the type of insulation is a minor factor in house fires: Fewer than 3% of house fires start in framing voids. Nor is insulation an issue in building fire-rated walls — a one-hour assembly can be built using any kind of insulation or no insulation at all, by covering the framing with two layers of 1/2-inch type-X gypsum board.

Claim *Cellulose is environmentally friendly because it's made from recycled newspapers.*

Facts: It's true cellulose insulation is made from recycled newspapers. But fiberglass insulation also has recycled content — usually 20% to 25%. In fact, one fiberglass industry spokesman claims that since fiberglass is less dense than cellulose, insulating a house with either material requires the same quantity of virgin material: The quantity of fire-retardant mineral used in a typical cellulose insulation job is roughly the same as the quantity of virgin glass that goes into insulating a house with batts.

Claim *Yeah, but it takes far more energy to manufacture fiberglass than cellulose!*

Facts: The amount of fuel energy saved by either material in the service lifetime of a home far exceeds any energy cost for making the insulation. Considered from this standpoint, both kinds of insulation are environmentally friendly overall.

Claim *Fiberglass causes cancer.*

Facts: In 1994, the National Toxicology Council listed fiberglass as a substance "reasonably anticipated" to cause cancer, based on two laboratory studies where hamsters that were *injected in the abdomen* with specially manufactured glass fibers developed more tumors than hamsters that didn't receive such treatment. But other animal studies and large-scale studies of human populations considered by the council did not show any clear link to cancer, so the council chose not to list fiberglass as a "probable" or "known" cancer risk.

Fiberglass carries a cancer warning label because of the federal listing. However, OSHA rules do not require any protection of installers beyond the use of a nuisance dust mask, and the government has never suggested that fiberglass insulation installed in buildings is a health risk for the occupants.

Claim *But did you hear? Borate-treated cellulose is toxic.*

Facts: In response to negative publicity about the suggested link between fiberglass and cancer, the fiberglass industry has sponsored a few general scientific papers discussing possible health risks of borate-treated cellulose insulation. However, neither the scientific community nor the government is concerned. Although boric acid is listed as a toxic substance, its toxicity to humans is quite small, and borate-treated insulation is not considered a hazardous material.

At this point, any suggested serious health risk to humans from either cellulose or fiberglass is speculative.



Figure 2. Loose-fitting fiberglass batts (left) will reduce the overall performance of a wall or ceiling system; a snug fit and a carefully installed air/vapor barrier ensure that the batts will yield close to advertised R-value (right).

Look, Ma, no cavities. Other builders have found that upgrading wall cavity insulation is not worth the cost. Solar builder Paul Neuffer of Reno, Nev., after analyzing the performance of wood-framed walls with University of California professor Donald Aitken, doesn't even use 2x6 framing in the houses he builds because infrared photos show significant losses through wall plates, studs, and corners. "Your wall is one-third wood — you can write that part off," says Neuffer. "Another third is windows and doors."

Neuffer's solution is to apply 1½-inch insulating foam sheathing to the outside of the house, covered with one-coat stucco. This assembly minimizes air infiltration and wind-washing as well as conduction through framing members, he says. As for cavity insulation, he uses standard fiberglass batts, because they're cheap. "Our walls spec out at R-25, but they actually perform much better than that," claims Neuffer.

Steve Andrews's experience over many years of consulting with Colorado builders bears out Neuffer's point. "The more foam you put on the outside of a building," he says, "the less it matters what you use in the cavity (see Figure 1)."

What About the Attic?

Attics are a prime area for beefing up a home's insulation. With unused attic space, it's usually cheap and simple to add a layer of batts or blown insulation to the attic floor. While blown cellulose is often the least expensive material for attic jobs, costs vary from town to town. But raising

attic ceiling insulation from R-19 to R-30 is usually worth it: Energy savings will commonly pay back the cost of any material you use.

Research does show a slight performance advantage for cellulose in attics because of its resistance to air movement. On very cold days in very cold climates (below 10°F), convection currents can be set up when air warmed by the ceiling gypsum board rises through the insulation above, carrying off heat. Fiberglass batts and blown cellulose are dense enough to resist this very small convective air pressure, but blown fiberglass is not. Researchers at the Oak Ridge National Laboratories (ORNL) in Tennessee measured this phenomenon in a test roof assembly and concluded that on the coldest days of the year, blown fiberglass could lose up to 50% of its listed R-value. The state of Minnesota is now requiring manufacturers to demonstrate that their attic insulation products do not lose R-value in very cold weather, a requirement that blown fiberglass cannot meet.

The dollar impact of the convective losses is pretty minor, though. Minnesota estimates that a typical homeowner with blown fiberglass insulation in the attic might spend \$20 a year in increased energy costs because of convective losses. This estimate is small enough that it would be hard to confirm with field measurements of actual houses.

Loose insulation is not an air barrier.

While blown cellulose cuts convective losses, it can't stop air leaks in attics. The air pressures created when heated air leaks out through holes in the ceiling are

much stronger than the convection currents measured by ORNL. To stop air from moving under those high pressures, cellulose has to be installed at a density of 3.5 pcf; loose-fill cellulose isn't that dense.

While loose-fill cellulose won't stop airflow, it can slow it down: Weatherizers who use loose-fill cellulose in attics report that the product improves blower-door tests more than using blown or batt fiberglass. It's not wise, however, to rely on either fiberglass or loose-fill cellulose as a ceiling air barrier: Cases have been reported of loose-fill cellulose in the attic becoming saturated with moisture when warm, humid air from inside the building leaked through ceiling penetrations.

Moisture could be a problem in any ceiling that lacks a good air barrier, and the heat losses caused by air leaks are much bigger than losses caused by low R-values. So whether you insulate the attic space with blown fiberglass, blown cellulose, or fiberglass batts, it's important to provide a good ceiling air barrier. Either drywall or poly can do the job, as long as all seams are sealed. But you also have to plug any holes the electrician or plumber makes.

If you're looking for an insulating material to provide an attic air seal, you'll have to turn to a spray-in-place foam like Icynene's Insealation or Foam-Tech's Supergreen.

Installation Issues

With both cellulose and fiberglass, the quality of installation is a factor. Loose-fitting fiberglass batts are known to be less effective than correctly installed

batts: Studies of test wall and roof assemblies show that even small spaces between the framing and the insulation reduce the system's R-value in cold weather (Figure 2). By the same token, cellulose installed at insufficient densities can settle and leave gaps at the top of a wall, lowering the performance of the system.

Suppliers of blown products like wet-spray cellulose or Ark-Seal's Blown-In-Blanket argue that it's worth switching to their products to avoid the heat losses caused by poor fit (Figure 3). Ark-Seal's Aragon says that batt installers, even if they are careful, can never get a perfect fit in practice. Aragon points to field studies of house framing conducted by Tennessee Tech professor David Yarbrough, who found that 70% of stud cavities were not within 1/4 inch of the correct size. Beyond that, says Aragon, around half the cavities contained some kind of obstruction, such as a wire, a pipe, or an electrical box. "On 50% of it, you don't even have the opportunity to do it right," says Aragon.

Professional energy consultants who analyze buildings with blower doors and infrared scanners are virtually unanimous in their preference for blown treatments of walls. Their feelings are summed up by Gary Nelson of Minneapolis Blower Door, who has looked at hundreds of homes with infrared cameras over the past seven years. "Any kind of bulk insulation that is pumped or blown in — whether wet-spray, dry-blown cellulose, or blown fiberglass — always looks better than one insulated with batts," says Nelson.

But the infrared pros also admit they aren't sure what the pictures reveal about actual energy costs. "Thermography is better at qualitative than quantitative analysis," says Peter Brooks of Infrared Analyzers in Williston, Vt. And there isn't a lot of evidence to show that such installation imperfections are a big factor in the annual fuel use of real homes. Most buildings probably perform close to



Figure 3. The fiberglass-based Blown-In-Blanket system provides an effective air barrier and an insulating value of R-4 per inch. The installer blows loose fiberglass mixed with a latex binder behind a nylon netting stapled to the face of the framing.

the level that would be predicted from the R-value of the insulation used in them, according to Richard Faesy of the nonprofit Energy Rated Homes of Vermont. "We've had the chance to compare actual and predicted fuel use in 2,500 homes that we've rated," says Faesy, "and they're pretty close." Any material will provide close to its rated R-value if it's installed with reasonable care, concludes Faesy.

Minnesota weatherizer Jim Fitzgerald says that a big difference between actual and predicted building performance is usually a sign that there is some major gap in the building's air barrier, like a large open plumbing chase. Differences related to the air resistance of cellulose or caused by installation defects are "trivial in the real world," says Fitzgerald. "Far more important are big gaps in the framing." Fitzgerald is the pioneer of using cellulose at very high densities to insulate and seal up existing buildings. But for new construction, he says, "When batts or cellulose are put in

right, either one will work just fine."

Also, the performance problems measured in test assemblies are most significant under extreme conditions: The tests show high air infiltration when there is a simulated 20-mph wind, and big R-value losses when the temperatures are below zero. In most places, the real weather only gets that bad on a few winter days. Although performance drops in occasional harsh weather, it may not have a big impact on annual heating bills. However, some customers may think improved comfort on really bad days is worth the cost of a premium system.

Making the Choice

What's the bottom line? If installed price and simplicity of installation are your biggest concerns, you'll probably use standard batts in the walls and your supplier's cheapest blown product for the attic. If you need to get a higher R-value to satisfy local codes or energy program require-

ments, you'll have to step up to a high-density batt or a blown product in the walls, and add inches in the attic.

If you're looking for maximum energy performance, and your customers can afford the cost, it's probably worth your while to use dense-blown or wet-spray cellulose or the Blown-In-Blanket on the walls and blown cellulose in the attic. But you might get close to the same results with fiberglass batts and a very careful air-sealing job. If you're working on an old house with a lot of air leaks or a lot of irregular framing, a spray or blown cellulose is probably your best choice.

In any case, you should make sure that your air barrier is continuous for the whole house. And keep an eye on your framing and your subs to avoid creating channels for air movement: Regardless of your choice of products, a few big, undetected leaks can ruin the performance of the best-insulated home. ■

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