Insulating With Cellulose

Blown in behind the drywall, high-density cellulose air-seals as it insulates

BY FRED LUGANO

Technicians determine insulation R-values in a lab, at *75°F* in a horizontal chamber. Insulation is fully fluffed and precisely fitted to all sides of this compartment. There are no gaps or air currents. Under these conditions, for example, $6\frac{1}{4}$-in. thick fiberglass batts achieve R-19.

However, compress this R-19 insulation into a $5\frac{1}{2}$-in. wall where it is exposed to subzero air leaking past gaps in the sheathing; where wires, pipes and ducts push aside the insulation to create uninsulated gaps; and where air circulates within the cavity. The actual whole-wall R-value may then fall somewhere in the range of R-6 to R-10.

Install these R-19 batts in an open attic, and outdoor air circulates through uncovered insulation, heating or cooling the ceiling. Insulation that doesn't firmly contact the ceiling, or fit snugly to the joists, or whose ends are wind-washed with air from soffit vents, can functionally disintegrate to R-4.

For batt insulation to be fully effective, its framing cavity must be sealed against air infiltration. That means caulking the sheathing and drywall to the plates, sealing all the holes where wires, pipes and ducts penetrate the plates, and sealing the electrical boxes to the drywall. On real construction sites, this type of preparation is rare.

Cellulose can blow into tight spaces. Here, the author has reduced the original 3-in. hose to 1-in. pipe that he's worked into a tight attic bay.

Clogs occur where the hoses reduce in size. Disassembling the joint and blowing the blockage from the large hose clears both of the pieces.

A helper is needed to keep the blower filled. The cellulose in the hopper must be poked with a stick occasionally to keep it flowing.

Cellulose fills the gaps

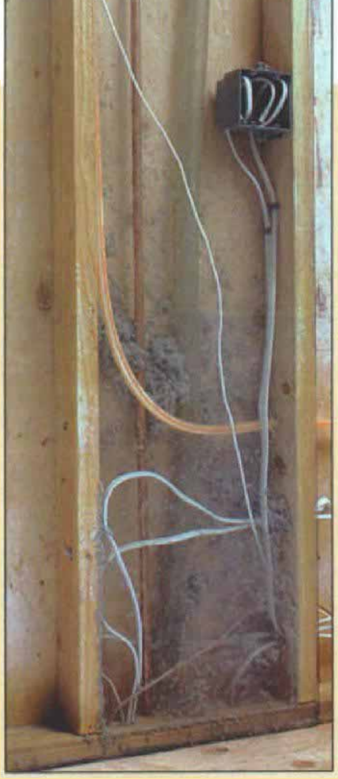
Dissatisfied with insulation performance, I sought better methods. This search led me to blown cellulose (top photo). Although cellulose also requires good installation to insulate to its full potential, I found that near-perfect installation is much easier to achieve with blown cellulose than with fiberglass.

Cellulose is composed mostly of recycled newsprint, which originates, of course, from wood pulp. Aluminum and borate salts added to cellulose make it fire- and pest-resistant. Because it retains wood's cellular structure, cellulose is naturally nonconductive. It isn't wholly dependent on trapped air, as is fiberglass, for its insulative value. Therefore, cellulose holds its R-value at high densities, which allows a particularly effective insulation method called dense-packing.

Dense-packing requires a blowing machine (photo bottom left) and hoses to transport the material to the house and into walls and ceilings. I insert the hose into the entire lengths of enclosed framing cavities such as joist and stud bays and turn on the blower (top photos, p. 72). When the pack becomes dense enough to stall the machine, I yank the tube out about 1 ft. This step restarts the flow and places the hose tip in loose cellulose to begin packing again. You can expect insulation packed into walls and ceilings this way to offer a reliable R-3.5 per in. of thickness.

Dense-packed cellulose works well for two chief reasons. First, it flows around obstacles to insulate cavities fully, even those chock full of wires and pipes (photos facing page). Second, it seals air leaks as it's installed. By physically blocking cold infiltration and the

Photo bottom left this page: Lake Construction



1. Blowing cellulose circulates, filling tiny air leaks.

2. With air leaks filled, cellulose begins to dense-pack.

3. Dense-packed to R-3.5 per in., and also air-sealed.

CELLULOSE UNDER GLASS

in this mocked-up wall, it's easy to see how cellulose fills a rat's nest of a stud bay. In photo 1, insulation particles follow escaping air to fill cracks between the studs and the glass, as well as the holes for wire and pipe. With most of the air leaks dammed, photo 2 shows the cellulose beginning to fill the spaces between the pipes and wires. All the voids are filled in photo 3, and in a real wall, the insulation would make virtually full contact with the drywall Little air could infiltrate this assembly.

escape of heated indoor air, we always get substantially more comfort and energy conservation than the insulation could produce from simply resisting conduction.

With dense-packed cellulose, I don't install vapor diffusion barriers (typically plastic sheets behind drywall). Almost all moisture entering framing cavities is blown in on air currents; no air leaks mean little chance of moisture trouble.

Cellulose blowers can be rented

In most cases, there's no reason an experienced construction hand can't tackle cellulose installation. Blowers and hoses are available at rental centers; some suppliers loan them when you buy cellulose insulation. There are two types of blowers: fan and air lock. Both use rotating paddles that break up compressed insulation bales. Both require two operators, one feeding the machine and one manning the hose. The ratio of air and insulation is adjustable on both, and the hose operator starts and stops each type with a radio remote or with a switch on a wire. Some machines let the operator purge the hose by remotely switching to an air-only mode.

The blowers of fan machines spin at routerlike speeds, sucking the insulation out of the hopper and sending it down the hose to the house. Air-lock machines are more complicated. Loosened cellulose drops into a paddle wheel that carries the material into the air lock. There, air pumps blast the cellulose into the hose at a greater pressure and volume than can fan machines.

As hose length, vertical lift and insulation flow increase, you need more power. Air-lock machines can deliver this power. I've strung 400 ft. of hose up three floors to deliver 3 tons of insulation in a workday. Daily professional use calls for an air-lock machine. Mine is from Krendl Machine Company (419-692-3060).

I start at the blower with a 3-in. hose made of transparent corrugated plastic (Flexaust Co.; 219-267-7909). Such large hoses carry insulation with minimal resistance but are hard to handle and won't fit tight access holes. I snake into walls with 1-in. and 2-in. clear vinyl hoses about 10 ft. long. Their small diameters speed the flow to pack cavities tightly.

Steel couplings connect the 3-in. hoses, but joining the smaller hoses is decidedly less el-

To dense-pack, the hose must extend the depth of the bay. The author first gauges the depth of the bay on its outside. When filling stud bays, he starts at the top so that at least some of the unavoidable waste floats down into the lower region of the bay.

Cut with a hole saw, these 3-in. openings accommodate the hose. The author saves the cutouts and, when he's through insulating, glues them back in,

egant (photo bottom right, p. 70). I wrap one end of the smaller hose with duct tape until it fits snugly into the larger hose, then duct-tape the connection. If I need to push the hose in more than a few feet, I tape a guide rod of 1-in. plastic conduit to the hose end (top photo, facing page). Each conduit length has a belled end that friction-fits onto the next piece. By connecting 10-ft. lengths of conduit together, I've pushed hoses 36 ft. into otherwise inaccessible areas.

For very tight cavities, I've bushed the hose down to fit 1-in. pipe and pushed it home (top photo, p. 70). For cellulose to flow down such a narrow pipe, I adjust the blower for maximum air and minimum insulation. A richer insulation mix will clog the pipe.

Start on a practice wall

I train my helpers to install cellulose by making a practice wall of 2x4s sheathed with plywood. They fill the bays and remove the plywood to see how they did. They did well if insulation fills the cavity and feels firm.

You can gauge the density of the pack by filling a few bays and dividing their volume by the weight of the cellulose that it took to fill them. I generally shoot for 3.5 lb. to 4 lb. per cu. ft., unless I'm insulating behind drywall that's nailed on greater than 12-in. centers. Then I fill only to about 3 lb. per cu. ft. to avoid pushing the drywall off the wall.

By filling a practice wall a few times and mathematically checking the density of the pack, you should soon be able to tell from the sound of the blower and the sight of the cellulose flowing through the hose when you're achieving a good density.

Insulating might seem to go faster with a higher ratio of insulation to air, but too much insulation will slow down the airstream in the hose and lower the density of the pack. Also, the hose can plug. When it does, I take apart the last joint in the hose where the diameter is reduced, turn off the insulation feed and blow air through the hose to clean it out. I start again with less material feed.

Houses are full of holes, and cellulose finds them all. I've accidentally filled closets, ducts, vanities, cellars and bedrooms (photo bottom left, facing page). When a bay seems to be taking too long to fill, I turn off the blower and look inside.

Cellulose is nontoxic but dusty. You should wear good-quality dust masks. I like Moldex (800-421-0668) masks. If the house has furniture and people inside, I ask the occupants to cover electronic items and to leave the house while I am insulating.

Getting inside the walls

I've gained access to walls in many ways. Recently in a new house, I had the drywallers leave out a 3-in. strip at the horizontal joint in the exterior walls (photo top left). Where the bottoms of windows fell below this strip, I drilled holes into the stud bays with a 3-in. hole saw, saving the cutouts (photo bottom left). When I was finished insulating, I nailed in the strip and glued the circular drywall cutouts back in place with some low-expanding foam (Pur-fil; Todol Products; 508-651-3818).

The edges of the floor joists in this house, a spot that's difficult to fill with blown insulation, were insulated during framing with 2-in. polyisocyanurate foam board placed between the sheathing and the rim joist. Stud bays less than 2 in. wide, where sneaking in the

hose would have been tricky, were insulated with foam before the drywall went up.

I prefer to work from outside or from the attic to minimize the mess. I can sometimes access balloon-frame walls from the attic. With balloon-frame walls, I close off the stud bays in the basement before blowing any cellulose. Often, I remove one or more courses of siding and drill access holes in the sheathing. As a last resort, I use a hole saw to make 3-in. holes in the interior walls.

A guide rod supports the hose. Simply 1-in. conduit duct-taped to the hose end, guide rods can be joined together to coax floppy hoses deep into building cavities.

Blowing over existing insulation

Cellulose is also effective loosely blown over existing insulation—whether fiberglass, rock wool or vermiculite—in open attics. Some preparation is called for before overblowing an open attic. I air-seal the interior surfaces, using expanding foam to plug holes around wires and pipes and to seal cracks that could leak conditioned air into the attic (for more on air-sealing, see *FHB* #105, pp. 92-97). I isolate all sources of ignition, such as chimneys, knob-and-tube wiring and non-IC-rated recessed lights. I build a plywood dam around the attic access hatch and plug the soffit vents so that insulation doesn't pour out. With a large hose, I then blow 12 in. to 36 in. of cellulose into the attic.

A common problem in existing houses is incompletely filled framing, such as when too-thin batts are installed in walls and ceilings, or when an airspace is left to vent cathedral ceilings. In my experience, such installations merely allow air to flow through the insulation and steal its R-value. By snaking a hose over the existing insulation, I can crush it with dense pack to stop air movement. In sloped ceilings, the foam trays meant to maintain below-roof ventilation make a smooth chute to slide the hose down. I usually gain access to sloped ceilings by removing the ridge vent, then shingling over the opening when I'm finished insulating.

Blocking roof and soffit vents violates many building codes and shingle warranties, and seemingly invites ice dams. But I've found that properly insulating an attic does more to prevent ice dams than any roof-ventilation scheme. And filling rafter bays solid with cellulose keeps out moisture that roof venting is supposed to control. As to heat buildup, ventilation does little to remove roof heat, which chiefly escapes by radiation.

SCENE FROM A HORROR MOVIE

It's important that cellulose be blown into sealed cavities. If large openings exist, cellulose finds them and can fill unintended areas with Bloblike relentlessness.

Insulating attic walls

I sheathe the backsides of attic sidewalls and skylight shafts with oriented strand board, drywall, even 1/4-in. lauan plywood—whatever is cheap and effective—and then blow in cellulose. Sometimes, though, the space is too tight to maneuver sheet goods in. Then I install a mesh-reinforced plastic membrane such as ParPac (800-850-8505), holding it to the studs with furring strips (photo bottom right). Behind a membrane, I can achieve a density of 2 lb. to 3 lb. per cu. ft., enough to prevent settling. Membrane installations are hard for a novice to judge. The membrane can break loose or burst at higher densities.

When rigid sheathing isn't practical, membranes can work. They won't hold the density that sheathing can, but membranes seal irregular areas more easily.

Unsheathed walls behind porch roofs, missing floors in side attics and voids over the sloped ceilings of stairways can be a challenge. These spaces are often too tight or dangerous for access to install a rigid skin or even a membrane to contain the cellulose. In such cases, I fill the whole thing. Cellulose is cheap, and using a few hundred pounds of it to avoid ripping the house open for access is economical. All I need is a 3-in. by 8-in. slot to peek into the space. I guide in the hose with rods, start the blower and hum show tunes while the entire volume fills. □

Fred Lugano owns Lake Construction in Charlotte, VT. Photos by Andy Engel, except where noted.

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