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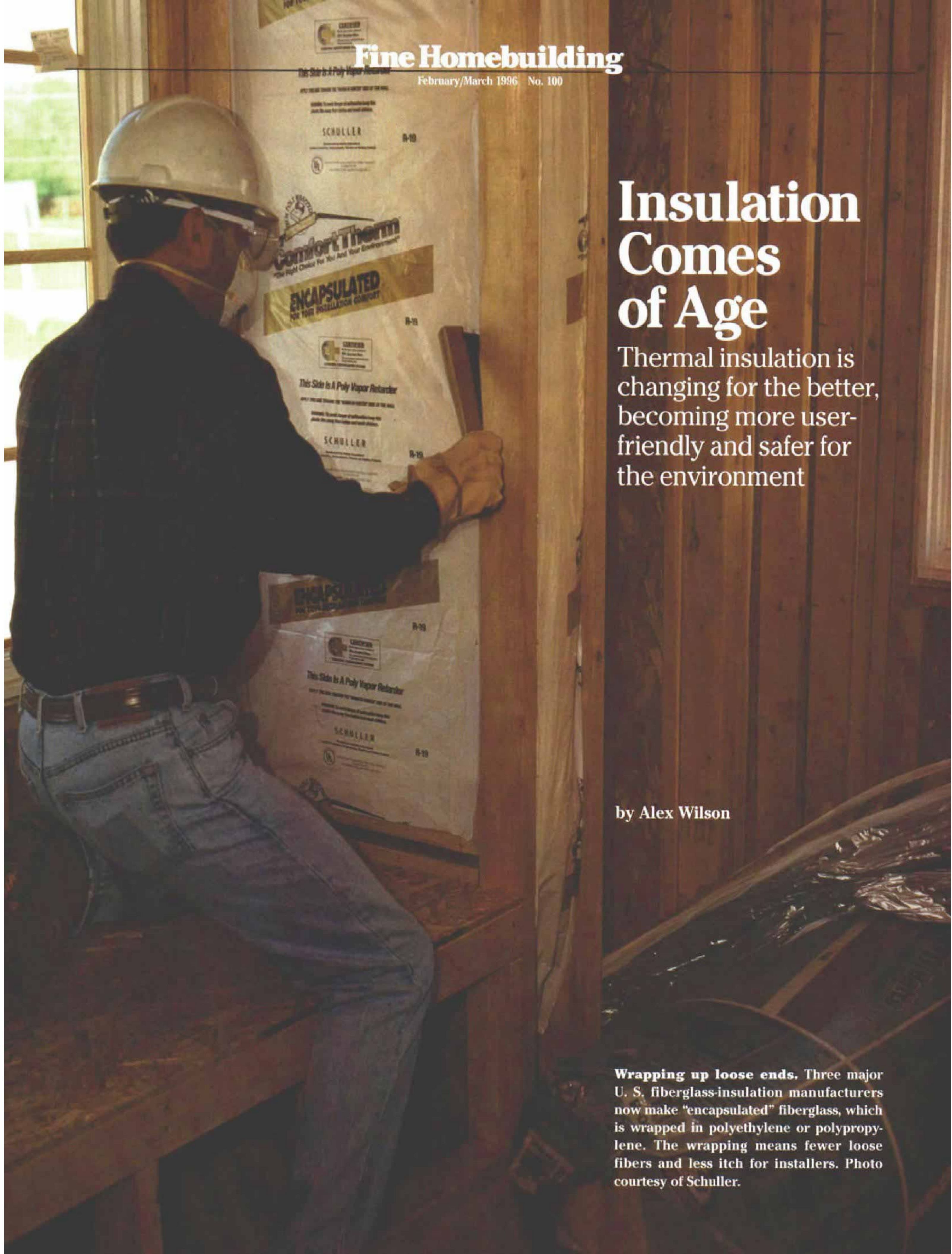


Insulation Comes of Age

Thermal insulation is changing for the better, becoming more user-friendly and safer for the environment

by Alex Wilson

Wrapping up loose ends. Three major U. S. fiberglass-insulation manufacturers now make "encapsulated" fiberglass, which is wrapped in polyethylene or polypropylene. The wrapping means fewer loose fibers and less itch for installers. Photo courtesy of Schuller.

Wet-spray cellulose is trimmed after installation. After a cavity is filled with a cellulose spray, the cellulose is rolled to remove any excess, which is then thrown back into the hopper for reuse. (A mask should be worn during installation of cellulose.) Photo courtesy of Green-Stone Industries.

Blown-in cellulose for new construction. Before the drywall goes up, cellulose insulation can be blown into cavities through holes in a taut layer of reinforced plastic installed over the studs. Photo courtesy of ParPack.

It wasn't a job for the squeamish. Just to squeeze beneath the massive log joists of my old cape, I first had to dig my way through two centuries of bat droppings and crawlspace dirt. Then I had to drag in boards of 2-in. polystyrene, nail them between the joists and seal the polystyrene to the joists with the kind of foam sealant that works only when the can is upside down.

The thought occurred to me—there in the dark dampness, my back on a bed of filth, my face up against the spiderwebs—that it would be a lot easier just to keep burning cordwood and enduring the cold drafts. I let the thought pass and kept working.

To this day, that insulation project lives vividly in my mind as the worst job I've ever undertaken. Yet it was also one of the most satisfying. One day of filthy, cramped labor cut our wood consumption by a third and reduced the home's 30°F floor-to-ceiling temperature difference to an acceptable 10°F. It also demonstrated to me what a difference insulation can make. In one day I changed the thermal dynamics of the house more dramatically than at any other time in its 200 years. I used the right type of insulation and an understanding of issues such as moisture flow to ensure a continuing long life for the joists and floor of the historic house.

That was a dozen years ago. In the relatively short time since, thermal insulation has changed a lot. Today, those changes are coming fast and being driven by a variety of causes. Health and safety concerns, better understanding of building science, changes in regulations, environmental awareness and economics all contribute to the rapid evolution of the ways we protect our homes from temperature extremes. In the six years since *Fine Homebuilding* last tackled this broad issue (*FHB* #56, pp. 36-42), new materials have become available, and existing products have gone through redesigns.

I'll walk you through the changes and look at the insulation industry material by material, highlighting what's new both with markets and with products, and along the way I'll revisit some old standards (chart p. 51).

Fiberglass continues to lead the batt pack—The largest share of the cavity-fill insulation market belongs to fiberglass. Although this insulation material has been around for decades, even fiberglass has had changes recently.

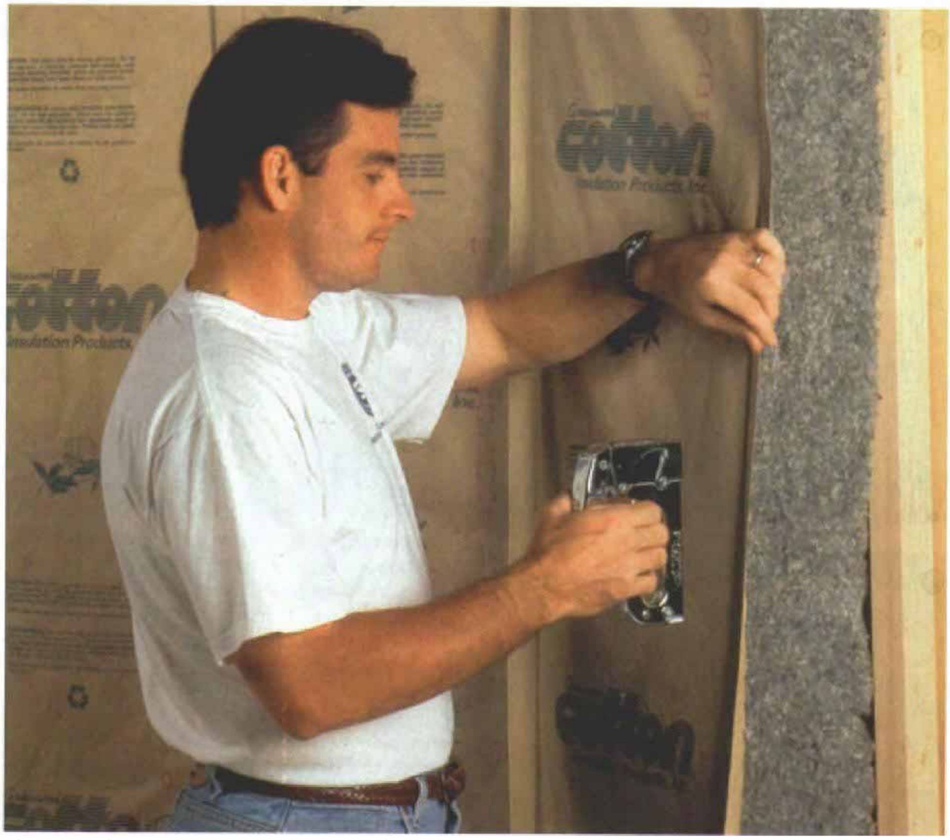
The biggest issue driving change in the fiberglass-insulation industry is concern over health and safety. Although hotly disputed by the fiberglass industry, some researchers claim that breathable glass fibers can cause cancer, which led to a requirement by the federal Occupational Safety and Health Administration (OSHA) that fiberglass and mineral-wool insulation packaging carry warning labels.

Manufacturers found that the best way to prevent fibers from escaping into the air was to contain them. Consequently, all three major manufacturers of fiberglass insulation—Owens-Corning, Schuller and CertainTeed—addressed the perceived risk by introducing "encapsulated" fiberglass-batt products for the do-it-yourself markets (photo facing page). Batts are wrapped in a perforated polyethylene or, in the case of CertainTeed's (800-433-0922) new product, a nonwoven polypropylene fabric.

BIBS encapsulates a different way—Abiff Manufacturing (800-852-1369) developed the Blow-In-Blanket System (BIBS) for fiberglass and other fiber insulation materials to achieve a better seal around wires and pipes. The BIBS system is marketed nationally by Ark-Seal International (800-525-8992). With BIBS, a mesh netting is stapled over the faces of frame walls and ceiling cavities, and a mixture of the fiber insulation and binders is blown in the holes. The binder ensures a good seal and prevents settling.

High density gives more R per inch—The three major fiberglass manufacturers—and the smaller Guardian Industries (800-562-0863)—also introduced higher-density, higher-R-value batts. Fibers are tightly packed together; airspaces are smaller and more effective at preventing air circulation. So you get more insulation for a given thickness. Now there are 3½-in. R-15 batts for 2x4 walls; 5½-in. R-21 batts for 2x6 walls; 8¼-in. or 8½-in. R-30 batts for 2x10 rafters where an airspace is required; and 10¼-in. R-38 batts for 2x12 rafters where an airspace is required.

The new high-density fiberglass costs about 20% more, however, depending on the product



An idea America might cotton to. Cotton insulation comes loose fill or in batts and is billed as providing R-values comparable to fiberglass. Photo courtesy of Greenwood Cotton.

Fiberglass that doesn't get under your skin. Miraflex blends two types of fiberglass threads to produce the first new type of fiberglass insulation in years. The product was developed as an environmentally friendly alternative to conventional fiberglass. Photo courtesy of Owens-Corning Miraflex.

to be used. You can accomplish pretty much the same effect by cramming a thicker standard batt into an insulation cavity. A standard R-19 6-in. batt stuffed into a 2x4 wall cavity, for example, will provide R-14—almost as much as the high-density 3½-in. batt. But this approach also costs more and doesn't work as well with insulated cathedral ceilings where you need an airspace. Here, the new high-density batts can be used without a vent spacer, while thicker batts require a vent spacer to maintain the airspace.

They've finally done something about those irritating fibers—The biggest news with fiberglass insulation in years is Miraflex (photo above right), a new type of fiber from Owens-Corning (800-752-1986). Miraflex rolled out nationally in the company's R-25 Pink Plus product in September 1995. While more expensive than standard fiberglass, it is the same price as Owens-Corning's other encapsulated fiberglass.

Miraflex is the fusion of two different types of glass. Because the two types of glass expand at different rates as they cool, the fibers curl and twist together, which means they can be held together in batts without the need for a phenol formaldehyde binder. The result is a fiberglass material that's soft to the touch—not scratchy like ordinary fiberglass—and easy on the skin.

Perhaps even more significant, Miraflex fibers are more flexible and have greater tensile strength than conventional glass fibers, so they don't break off and become airborne. As a result, Owens-Corning omits the cancer-warning labels on Miraflex.

Mineral wool costs more than fiberglass, but it can take the heat—Mineral wool once held the largest share of the insulation market but lost most of it to fiberglass during the 1960s and 1970s. Mineral wool is similar to fiberglass, except that natural stone or iron-ore blast-furnace slag is the raw material for the insulation. If stone is used (typically basalt or diabase), the product usually is called rock wool. If iron-ore blast-furnace slag is used, the product is usually called slag wool.

Mineral wool often is used in commercial applications because it can withstand higher temperatures than fiberglass and has better acoustic insulation properties. However, it's a lot heavier, tends to be more expensive and generates the same health concerns as fiberglass.

The European company Roxul (800-265-6878), which has a manufacturing plant in Canada, uses a 50-50 mixture of stone and slag in its mineral wool. Roxul is the only mineral-wool company known to be producing batt insulation. Called Flexibatt, the Roxul product has a flexible edge that allows it to be compressed and squeezed into a joist bay, where it is supposed to stay without the need for fasteners or holders. Some industry observers believe Roxul may significantly expand its market in North America.

All the news that's fit to be fiberized-Cellulose insulation is ground-up newspaper that's treated with fire retardants and used as loose-fill attic and wall insulation. There's not a lot new with cellulose, except for the cost of the raw material. The price of newsprint recently increased a great deal, so manufacturers are switching from the old "hammer-mill" process of chopping up newspaper to a newer "fiberizing" process for the material.

Installed densities as low as 1.3 lb. per cubic foot (pcf) are possible with fiberized cellulose, according to some manufacturers, although values of 1.5 pcf are more typical. (For comparison, the density of fiberglass is usually 0.5 pcf to 0.75 pcf.) With fiberized cellulose, material savings of 25% are typical, and the R-value per inch increases slightly, according to some manufacturers. To reduce settling of cellulose attic insulation—especially with lower-density material-some installers are going to a "stabilized" installation process. A small amount of moisture-

A house in sheep's clothing. Shear factor takes on a new meaning when wool insulation is installed in a house, such as this New Zealand house that's being fitted with batts of Woolhouse insulation. Photo courtesy of Woolhouse.

activated acrylic binder and water is added to the cellulose during installation to bind the fibers together and to reduce settling greatly.

Cellulose can be blown into walls at a high enough density to prevent settling (typically 3 pcf to 3.5 pcf); mixed with water (and sometimes a small amount of water-activated acrylic binder) as it's sprayed into walls in the "wet spray" process (top photo, p. 47); or blown into cavities through holes in a taut layer of reinforced plastic installed over the studs (bottom photo, p. 47).

The fire safety of cellulose has been challenged for years, largely by the fiberglass industry. Because wood fiber—the basic raw material in cellulose insulation—burns and glass does not, fire-safety concerns are justified. However, most evidence suggests that properly treated cellulose poses no greater fire risk than fiberglass. In fact, because cellulose blocks airflow better than fiberglass, cellulose may be more effective at stopping fire spread.

Cotton insulation fits like a pair of old jeans—Cotton insulation was first introduced about five years ago under the brand name Insulcot, which has since sold the manufacturing rights to Greenwood Industries in Roswell, Georgia (404-998-6888). That company introduced Greenwood Cotton Insulation in 1995. Greenwood is 95% post-industrial recycled textile-mill waste. The insulation is 75% cotton and 25% polyester (photo left, facing page).

Available in both kraft-faced batts and loose-fill forms, the insulation contains flame retardants similar to those used in textiles. There are no formaldehyde binders.

Greenwood Cotton is now marketed primarily in the southeast and mid-Atlantic states (within about a 400-mile radius of the manufacturing plant in Georgia), although Greenwood's Kirk Villar said a lot of special orders have come from California. The product is popular among healthy-home builders who are concerned about possible health and safety problems with fiberglass and other types of insulation.

My experience with preproduction samples of the product was mixed. It was wonderful not ending the work with itchy arms and eyes, as I've experienced with fiberglass. But the product seemed quite different from fiberglass. The batts didn't immediately spring back, or loft, to their full thickness. After I slit the bags open, the batts just laid there. The company has since modified the density and fiber composition, which apparently improved the lofting. The batts are also difficult to cut, another concern being addressed by Greenwood.

A warm blanket for the house—If insulation can be made out of cotton, how about wool? That's exactly what the New Zealand company Woolhouse International Ltd. (011-64-9-486-7020) did in 1992 with Thermofleece Natural Wool Insulation (photo above). The company is looking into the possibility of building a North American manufacturing facility.

In the Thermofleece product, specially processed wool is mixed with other polymer materials to give it spring back, or loft. A boric-acid fire retardant is added to the New Zealand product, but U. S. testing has not been done.

There is at least one other wool-insulation manufacturer in New Zealand, and there are two in Germany. Paul Novak of Environmental Construction Outfitters in New York City says he has looked into importing wool insulation, but that the cost was just too high to compete, even for specialty markets. A domestic manufacturing facility could change the picture.

Board-stock insulation still does the same job, but it's less harmful to the environment—The biggest change with extruded polystyrene (XPS) in recent years was the substitution of HCFC-142b for CFC-12. Dow Chemical and Amoco Foam Products completed this transition in 1990, the other manufacturers by the end of 1993. Although HCFCs are ozone-depleting substances, they are far less destructive than the CFCs.

Amofoam (800-241-4403) offers two product lines that contain recycled materials: Amofoam-RCY and Amofoam-RCX. Both products have 50% total recycled content: 25% post-industrial recycled polystyrene and 25% post-consumer recycled polystyrene. The RCY product has been on the market for several years. The RCX product, which is aimed at residential markets, is thinner (½ in. or ¾ in.) and is faced with polyethylene on both sides. It was introduced in 1995. Amofoam products are available only east of the Rockies, except by special order.

Expanded polystyrene (EPS, or beadboard) is produced by expanding beads of polystyrene in a mold, then slicing the block of molded foam into boards. Pentane, which does not deplete ozone, is the blowing agent.

Because EPS is the only rigid-foam insulation not produced with ozone-depleting substances, it has gained the favor of environmentally concerned builders and designers. Some manufacturing plants, particularly those in California, have pentane-collection systems to reduce plant emissions. In addition, several suppliers of polystyrene beads have introduced low-pentane beads that use about half of the pentane found in typical beads.

While most EPS board stock is 0.9 pcf to 1 pcf, densities up to 2 pcf are available from most manufacturers. At higher densities, compressive strength is greater, R-value is higher, and moisture resistance is better—as is needed below grade. EPS in density of 1.5 pcf to 2.0 pcf is commonly used in insulated foundation forms for below-grade applications. Cost is greater for the higher-density EPS.

AFM Corporation (800-255-0176) began incorporating a borate insect repellent into some of its EPS foam in 1990. The repellent is now standard in AFM's R-Control panels and available as an option in other EPS products, such as its Diamond Snap-Forms (bottom photo, p. 52). The repellent is added to address the concern that termites and carpenter ants often tunnel through foam-core panels or foam insulation on the outside of foundations and may use the foam as a way into a house. So far, the borate treatment seems to work successfully.

A final development with EPS is the appearance of polyethylene facings on some products to improve durability, both for roofing products and for foam sheathing (top photo, p. 52). With a more durable product, we are likely to begin seeing more EPS sold in building-supply yards, where it's rarely been stocked in the past.

Polyisocyanurate-foam insulation is widely used as an exterior insulative wall sheathing and as roof insulation. Most products are foil-faced,

Spray it on, saw it flat. Icynene, an open-cell polyisocyanurate insulation, is sprayed on like paint and within minutes expands 100% to fill all voids in a building cavity. Excess is trimmed away with a handsaw.

although other, more-rugged facings have appeared in recent years, such as polymer-coated glass fiber.

Polyiso foam used to be blown with CFC-11. The blowing agent that is being used now, HCFC-141b, is much less damaging to ozone. However, this one is among the worst of the HCFCs, relative to ozone depletion, and is slated to be phased out by 2003. Suppliers of chemical blowing agents are hard at work on so-called third-generation compounds that have no impact on ozone.

Water is replacing hydrocarbons in polyurethane insulation—Chemically similar to polyisocyanurate-foam board stock, spray polyurethane is used in cavities or applied over surfaces to be insulated. The use of spray-polyurethane insulation dropped off significantly as the cost of the CFC-11 blowing agent increased. But now that the shift to HCFC-141b is complete (as of January 1, 1994) and as the cost of wet-spray cellulose insulation increases, use of polyurethane is picking up again.

The most significant developments in this area are products foamed with carbon dioxide or water in place of CFCs or HCFCs. The leading product in this area is Icynene (800-758-7325), a carbon-dioxide-blown, open-cell modified polyurethane foam developed in Canada about 10 years ago (photo above). The company recently expanded into the United States and now has 60 licensed installers in 25 states.

Icynene is sprayed into open wall cavities in a very thin layer, almost like spray paint, and it expands immediately. In a few seconds Icynene expands 100-fold, filling the cavity. Because the expansion is so rapid and so great, installers often overfill cavities and have to go back and cut off the excess using a handsaw.

As an open-cell foam, Icynene is spongy to the touch. It adheres extremely well to most surfaces and is effective at providing an air seal. Marketed in Canada as InSealation, Icynene expands to a density of approximately 0.5 pcf, or roughly one-fourth the density of standard spray polyurethane or polyiso board stock. Its insulating value is approximately R-3.6 per inch.

Icynene recently introduced a second product designed for installation into closed cavities. A carefully measured volume of the unexpanded foam is poured into the cavity, where it expands from bottom to top to fill the cavity. This product insulates to R4 per inch. Also, Icynene

Photo this page: Steve Culpepper

Insulation specs

Type of insulation	Average R-value per inch	Available thickness	Where used	How installed	Resistance to:** Water absorption	Moisture damage	Direct sun	Fire	Temperature*
Batts, rolls									
Fiberglass	3.2	1 in.-13 in.	Wall, floor, ceiling	Fitted between studs, joists and rafters	2	1	1	2	180°F
Mineral wool	3.2	3 in.-8 in.	Wall, floor, ceiling	Fitted between studs, joists and rafters	2	1	1	1	500°F+
Cotton	3.2	3½ in.-12 in.	Wall, floor ceiling	Fitted between studs, joists and rafters	4	3	2	2	N/A
Loose, blown, poured									
Fiberglass	2.2	Variable	Ceiling, wall	Poured and fluffed, or blown	2	1	1	2	180°F
Rock wool	31	Variable	Ceiling, wall	Poured and fluffed, or blown	2	1	1	1	500°F+
Cellulose	32	Variable	Ceiling, wall	Blown by machine	4	4	2	3	180°
Cotton	32	Variable	Ceiling, wall	Poured and fluffed, or blown	4	3	2	2	N/A
Rigid board									
Expanded polystyrene (EPS)	40	¼ in.-10 in.	Wall, ceiling, roof	Glued, nailed	3	2	4	4	165°F
Extruded polystyrene (XPS)	50	¾ in.- 2 in.	Foundations, subslab, wall, ceiling, roof	Glued, nailed	1	1	4	4	165°F
Polyiso-cyanurate	65	½ in -4 in.	Wall, ceiling, roof	Glued, nailed	3	2	4	4	200°F
Rigid fiberglass	4.4	1 in. 3 in.	Wall, roof, ceiling and foundation	Glued, nailed	2	1	1	2	180°F
Contractor-applied									
Wet-spray cellulose	3.5	Variable	Wall	Sprayed into open cavities	4	3	2	3	165°F
Blown fiber with binder (BIBS)***	3.5-4.0	Variable	Wall, ceiling	Blown dry into cavities faced with mesh screening	**	**	**	**	165°F
Polyurethane	6.2	Variable	Wall, ceiling, roof	Foamed into open cavities	1	1	4	4	165°F
Open-cell polyurethane	3.6****	Variable	Wall, ceiling	Foamed into open or closed cavities	3	2	N/A	3	165°F
Phenolic foam	4.8	Variable	Wall	Foamed into closed cavities	2	2	N/A	3	212°F
Magnesium silicate	3.9	Variable	Wall	Foamed into open cavities	3	2	N/A	1	500°F+

*Maximum temperature insulation is rated to withstand. **1=Excellent; 2=Good; 3=Fair; 4=Poor.
***Properties depend on fiber insulation used. ****4.0 for closed-cavity installation

A close-up look at innovations in batt insulation

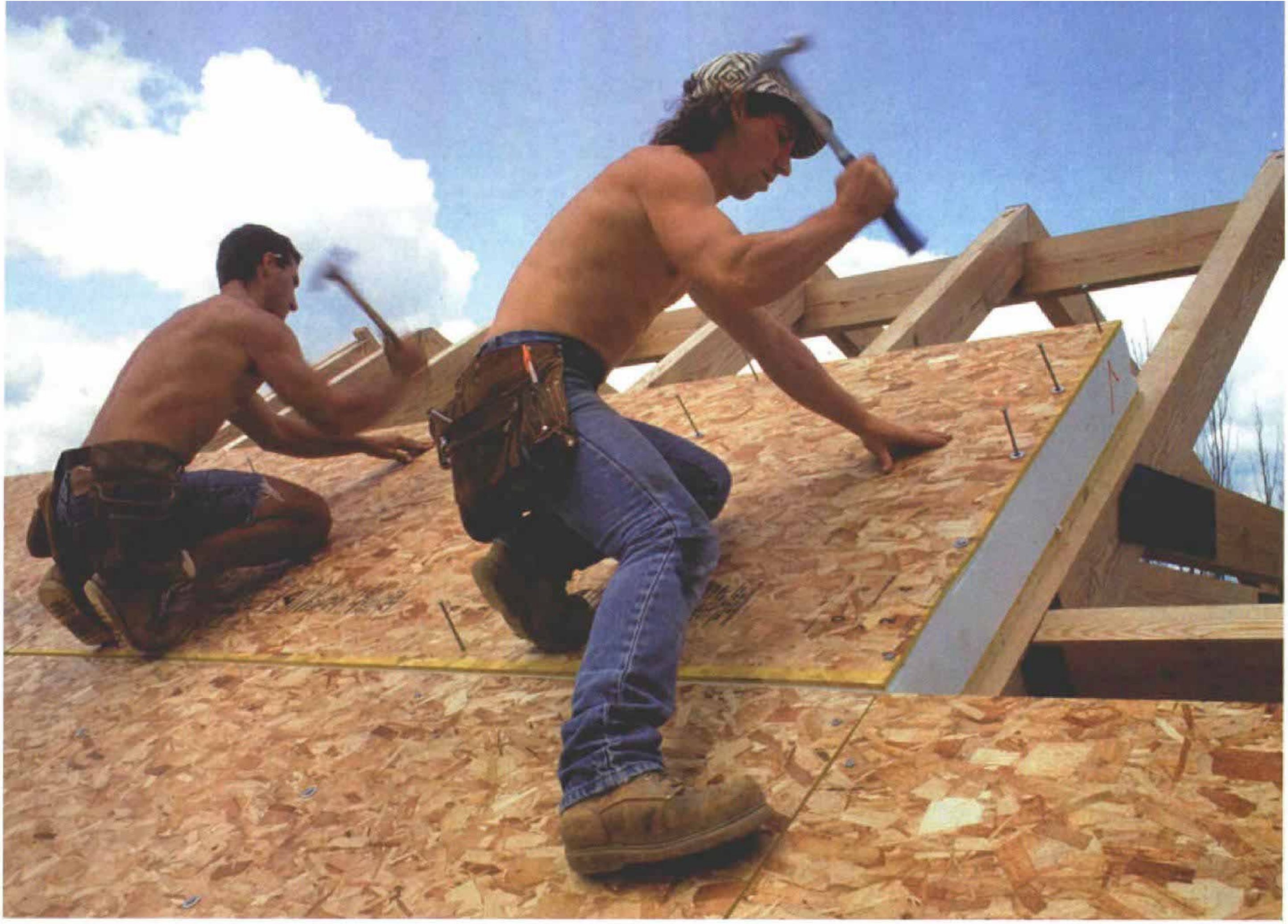
"Itch-free" Miraflex fibers won't get into your lungs.

Encapsulated fiberglass is wrapped up to stay put.

New cotton insulation is made from cotton-mill waste.

From New Zealand come wool insulation blankets.

Photos this page: Scott Phillips



Structural panels add strength to R-value. Polystyrene foam insulation is fixed to oriented strand board and used as sheathing. These R-40 roofing panels made by Insulspan are covered with 7⁄16-in. OSB on both sides. Photo courtesy of Insulspan Inc.

An insulating; concrete form that resists termites. AFM Corporation adds borate to its expanded polystyrene Diamond Snap-Forms to help prevent invasion of concrete foundations by termites and carpenter ants. Photo courtesy of AFM Corporation.

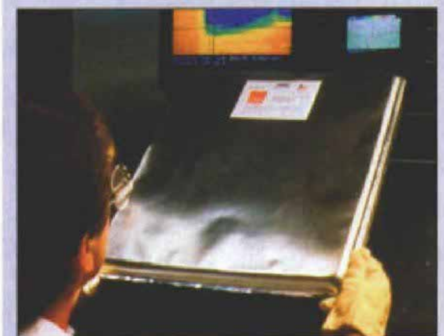
isn't the only non-ozone-depleting spray foam. Resin Technology Company (909-947-7224) of Ontario, California, produces both open-cell and closed-cell water-blown polyurethanes and may begin marketing the foams for building insulation. FoamTech of North Thetford, Vermont (802-333-4333), produces SuperGreen, a non-ozone-depleting HFC-blown polyurethane foam. Introduced in 1993, this product costs about 10% more than conventional polyurethane, but it insulates just as well. It's used both as a building insulation and as an air seal for cracks and gaps.

Other spray-ins are abandoning CFCs, too—Spray-foam sealants, which are sold in aerosol cans or larger canisters, also have undergone significant change. These products are either one-part or two-part polyurethane foams. Like spray polyurethane, they have abandoned use of CFC-11, but several different propellants and blowing agents are now being used. Most domestic products are using HCFC-22 as the blowing agent, the same chemical used in home air conditioners.

The German product PurFill, distributed in this country by Todol Products (508-651-3818) of Nat-

A glimpse into the future

Insulating with gas-filled pillows. Batts filled with low-conductivity gases may be used in attics to achieve high R-values at lower cost. Photo courtesy of Lawrence Berkeley Laboratory.



Would you believe R-75 per inch? High-insulation-value vacuum panels, such as this one developed by Owens-Corning, may eventually be used in ceilings. Photo courtesy of Owens-Corning.

ick, Massachusetts, switched from HCFC-142b to non-ozone-depleting HFC-134a in 1995. (HCFCs are being phased out in Europe much more quickly than in the United States.) Manufacturers here are also likely to shift to the HFC blowing agent. Insta-Foam already sells one product that uses only HFC-134a. Another approach is to use hydrocarbons, such as isobutane and propane, as the blowing agents. Convenience Products (800-325-6180) makes several such foam sealants under the Touch 'n Foam product name. While much more flammable than HFC-foamed products, the hydrocarbons are ozone-safe and, unlike HFCs, are not greenhouse gases that contribute to global warming.

Tripolymer Foam, made by C. P. Chemical (914-428-2517) of White Plains, New York, is foamed with compressed air, so it doesn't result in ozone depletion. Tripolymer is typically used for filling closed-wall cavities and masonry-block cores, but it can also be surface-sprayed into open cavities. The product insulates to about R-4.8 per inch but experiences shrinkage of 1½% to 3%, which reduces overall R-values. It can be installed only by licensed insulation contractors using the proper equipment.

Magnesium silicate oozes in like shaving cream—Air Krete (301-898-7848), an inorganic, foamed magnesium-oxide cement, is unique in the insulation industry. It's one of the few insulation materials people with acute chemical sensitivity can tolerate, which makes it popular among healthy-home builders. First commercialized in the late 1970s, the insulation is highly stable with virtually no shrinkage after setting, it is noncombustible, and it is free of virtually all volatile organic compounds (VOCs).

During installation, Air Krete is the consistency of shaving cream. It can be installed from the top of cavity walls, through holes or gaps in the drywall, or through screening attached to the interior face of framing. The cured foam has a typical density of 2 pcf and insulates to R-3.9 per inch. It is friable, so it must be protected within a wall or ceiling cavity.

There are currently about 50 installers of Air Krete in the United States. Like other foam-in-place insulation materials, Air Krete requires specialized equipment and training to install. The price of the installation depends on the size of the project and the distance the installer has to travel, but Air Krete is generally considered a premium product.

In the right place, radiant insulation makes sense—In the past 15 years, a number of products that work by blocking radiant heat flow have come onto the market. A few companies marketed their products with grossly exaggerated performance claims, which gave the industry a bit of a black eye.

There are really three distinct types of products that work by reducing radiant heat flow: radiant barriers, reflective insulation and radiant-control coatings. A radiant barrier is a foil or foil-coated plastic film that is installed next to an airspace. Reflective insulation is any board-stock, batt or bubble-pack insulation with a reflective component. Bubble-pack products have an airspace next to the radiant surface by function of their design. Board-stock and batt insulation with reflective facings only block radiant-heat flow if the reflective surface is installed next to an airspace. Finally, radiant coatings are applied to roofs or exterior-wall surfaces to reflect heat from sunlight.

In the right applications, radiant-insulation systems make a lot of sense, but they are rarely good substitutes for conventional insulation. The most common uses for radiant barriers are in unheated attics that are beneath the roof sheathing. In these applications, unwanted summertime-heat gain can be significantly reduced. This benefit of radiant barriers will only be achieved if there is little or no attic insulation. If attics are properly insulated, adding a radiant barrier is rarely cost-effective.

Beyond the blue horizon—While not yet available for building applications in the United States, a number of products are in the works that you may see in the not-too-distant future.

Among the most exciting insulation products to come along in many years is an R-75-per-inch vacuum panel now being produced by Owens-Coming (photo bottom left). Introduced in 1995, the Aura panel is a 1-in. thick layer of rigid fiberglass surrounded by an airtight skin of stainless steel. After the edges are sealed, a vacuum is drawn in the panel (air is removed), and a high R-value is achieved.

Aura insulation is currently being used to insulate freezer compartments of certain models of Whirlpool refrigerators—the 1-in. panels replace 2 in. to 4 in. of ozone-depleting polyurethane foam and provide far-superior insulation. In typical dimensions for refrigerators, 1-in. Aura panels have average insulating values of R-30 to R-40 (including edge losses). Whether this technology will ever make it into house-building applications is doubtful given the high cost and risk of puncture.

However, a similar vacuum technology that was developed at Oak Ridge National Laboratories is being tested in mobile-home ceilings. Researcher Ken Wilkes said the vacuum panels being used in the test contain a silica powder rather than rigid fiberglass. The panels yield R-values up to R-30 per inch, according to Wilkes, which makes them ideal for the shallow ceilings of mobile homes.

Researchers at Lawrence Berkeley Laboratory have been working for a number of years on an insulation idea borrowed from windows. Researcher Dariush Arasteh is pursuing the idea of putting low-conductivity gases, such as argon and krypton, into multilayer plastic pillow materials (photo top left). Because these gases have lower conductivity than air, they provide higher R-values.

Abiff Manufacturing of Denver, Colorado, is developing a new type of insulation made of fly ash, a waste product from coal-fired power plants. The company has developed a process to create little low-density clusters of fly ash that could be used in blow-in or loose-fill insulation applications. Inventor Henry Sperber hopes to have the product on the market sometime in 1996. Researchers at Oak Ridge National Laboratory and Denver University also are assisting in the effort. □

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