Filling Cavities: Retrofit Foam Update

by Marylee MacDonald

Dials and gauges regulate Tripolymer foam's chemical mix. The gun's precision and mechanic's experience make or break a foam installation.

New retrofit foams raise hopes... and questions

The foaming frenzy of the late 1970s, created by energy tax credits and high fuel costs, came to a crashing halt in December 1985. A highly publicized court case, a nine-month ban on urea-formaldehyde foam, and the public's suspicion that all inject-in-place foams contained urea-formaldehyde (UF) put the brakes on what had been a promising young industry.

Most foam contractors hung up their hoses, but others went back to the drawing boards and quietly developed a new generation of foams to retrofit sidewalls. The new foam contractors report improvements in technology and product reliability. Critics, on the other hand, question the products, pointing to alleged installation problems and inconclusive test data. Two of the new foams that sell nationwide—Tripolymer foam and Air-Krete—are the focus of this article.

Both products use a foaming agent that traps air in a chemical matrix. Both leave the gun fully expanded, making them suitable to fill existing wall cavities. There are no chlorofluorocarbons (CFCs) to worry about (see "A Flair for Foam") since air trapped in the foams' cells provides the insulating value. But how about formaldehyde? Do any of these foams outgas formaldehyde or other toxic chemicals? And finally, how about quality control, which can be a problem with any field-manufactured foam? Much of the problem with the banned UF foams was blamed on poor quality control.

Tripolymer Foam

Tripolymer is chemically similar to UF foams. The company describes Tripolymer as a "phenol-based synthetic polymer." More specifically, it calls the foam a phenol resorcinol methylene interconnected urea (PRMIU).

The numbers for this foam look good. The reported R-value scores a high 4.6 per inch at 75°F. Fire test data by Factory Mutual show flame spread of 5, smoke density of 0, and fuel contribution of 0 (current codes require values below 25). One possible problem is minor shrinkage, which field information indicates to be about 1 to 3 percent—1/16 to 1/8-inch on either side of the stud space.

Minnesota installer Gary McCabe says prices compete handily with cellulose fill. For a two-story farmhouse, foam costs $1,500 to $2,400, while the same job with cellulose comes in at $1,000 to $1,500. McCabe says he's using the foam on a lot of commercial jobs—filling 8-inch block cores. He says the foam doesn't expand as it comes out of the hose, so it's good for sidewall retrofit too.

Quality control. Contractors who have installed the foam swear by it. "We looked at the product for two years before we took the line on in '86," says Dick Perkins, a Kansas City installer. He says the manufacturer has done a lot to improve the technology—better (centrifugal pump), in-line heaters for the hose, and state-of-the-art application equipment.

Because the insulating contractor manufactures the product at the job, it's the contractor who makes or breaks the job. Gary McCabe believes, "To install foam correctly, you've got to make sure the set-up and application are right. That boils down to applicators. The essentials of a good job are maintaining the proper pressure, the right temperature, and the right chemical mix. Bad jobs happen when the applicator doesn't know how long it takes to fill a cavity." McCabe's crew does three openings for every 8-foot run. "If there are obstructions, you'll see them. The foam won't come out the next opening."

Because the foam contains water, it can take two to three weeks to dry. The contractors haven't noticed that moisture migration causes peeling paint, but they acknowledge that Tripolymer has a noticeable odor. "When the material is in a contained area, and when it's still wet, there is a distinctive smell to it," McCabe says. "What we notice is the smell from old batts of insulation. The air coming out of the batts smells like a backed-up sewer."

The biggest deterrent to its use is cost: It's more expensive than loose fill. "In spite of [the higher cost], we do 70 percent of our jobs with foam," he says. "We looked into Air-Krete and talked to other contractors who had used it. What we liked about Tripolymer was the cleanliness of the equipment. There are no particles or flakes. It's easy to keep clean. We can mix our catalyst weeks ahead. The resin is mixed by the manufacturer. We can store it 45 to 90 days. We've heard from other contractors that Air-Krete leaves a flaky residue. When the flake hits the nozzle, it stops the equipment. It's harder to keep the equipment consistently clean. And you have to mix it within a day or two. The product is harder to control."

Contractors using the product have gone back and looked at past jobs to see how it holds up. Opening up cavities, they report finding the product still intact with shrinkage within the expected range.

What about formaldehyde? Furniture, drapes, carpet, particleboard, and plywood emit formaldehyde. But the public worries more about formaldehyde vapors from foam insulation than from couch cushions. At airborne formaldehyde levels of 1 ppm (part per million), eyes smart and noses run. Chemically sensitive people detect levels lower than that. You'd want to see levels below .5 ppm to avoid any complaints, according to health experts.

The hybrid phenolic foam is similar to Koppers' rigid insulation, except that it has a component (urea) which, according to several scientists we spoke with, makes it possible for the formaldehyde to outgas, even after the foam has cured.

So how does Tripolymer stack up on the formaldehyde issue? Judging by the company's literature, it's not even a concern. Even the installers we talked to don't believe there's any formaldehyde in it. But formaldehyde is one of the components of the resin. In fact, Tripolymer is a hybrid phenolic foam, somewhat similar to Koppers' rigid insulation, except that it has a component (urea), which according to several scientists we spoke with, makes it possible for the formaldehyde to outgas, even after the foam has cured.

A building researcher at the National Bureau of Standards (NBS) explained it this way: "No one worries about Koppers foam giving off formaldehyde because its chemical bond is so strong no free formaldehyde escapes. It doesn't matter if you have formaldehyde in the product. It matters if it releases from the product." (A former Koppers polymeric chemist we spoke with concurs, and explained that Koppers adds a "scavenger" to their foam to mop up any formaldehyde that might come out of the product when it's in use.)

"A phenolic urea formaldehyde is much better than a plain urea formaldehyde," explains Ed Kiefer, a foam researcher formerly with Koppers Co. Phenolic Foam Division, "but the urea is a nitrogen product. And it makes the reaction reversible. It hydrolyzes."

In plain English, this means that if you add water to the foam it can break down into its original ingredients. At higher temperatures and under humid conditions, you could get this:
Resin + water + heat › urea + formaldehyde

The manufacturer points to tests on the factory-fresh resin showing that it contains no free formaldehyde. But these tests don't tell the whole story. As one foam researcher explained, "I need to know what impact it has on the quality of the air I'm breathing—on myself and on my family. What is the emission level inside the house? I'd want to know these levels especially if I had it in the sidewalls and roof of my house, and with a low number of air changes per hour."

Are more tests necessary? One researcher explained, "The only way you'll ever be able to tell for sure is to test [for formaldehyde] under ambient conditions. Measure it over time. That way you can get some idea of whether the level is going up or down. If it's going down, it's probably not hydrolyzing. But if it's going up, it may be."

In 1982 the state of Connecticut filed a complaint against Tripolymer's manufacturer, C.P. Chemical, for engaging in deceptive advertising. Karl Meyer, Professor of chemistry at the University of Washington, testified at the time: "There's no question that Tripolymer will release formaldehyde gas both during installation and from the finished product over an extended period of time."

Unfortunately, these findings don't help us much today, because C.P. Chemical has since changed its formula. According to Claire Reinbergen, a company spokesperson, the company has made a marketing decision not to install the product in Connecticut.

In practice, we won't know whether the product does or doesn't release formaldehyde until someone tests it for inservice use (the hardboard industry has developed appropriate tests for this). Alternately, C.P. Chemical could demonstrate that its formaldehyde is so tightly linked to other components that it won't release no matter what. A test called nuclear magnetic resonance could yield this information. In fact, that's the test Connecticut requested, but C.P. Chemical says it is too expensive to conduct.

Currently, there's no true industry standard to test foam-in-place insulations in long-term use. And small companies often have a difficult time completing this important phase of the research and development of a product. So for now, the formaldehyde question remains open.

Air-Krete: The Miracle Cement

Air-Krete is a cementitious foam made from a special type of cement, a foaming agent, and compressed air. Unlike Tripolymer, it poses no potential problem with formaldehyde. In fact, it is so inert that it holds special appeal to customers seeking an environmentally clean product.

Tests at NBS show R-values comparable to cellulose or fiberglass—3.3 to 3.9. The R-values take into account shrinkage cracks (up to 1/8-inch) in the dry material. And, because it's cement, it won't smoke or burn. The installed cost ranges from 28 to 60 cents per board foot.

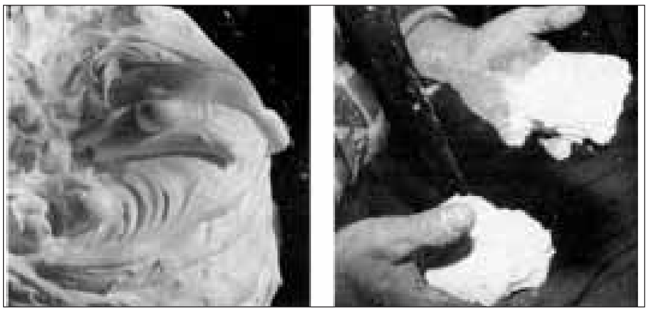

Figure 1. *Puffed up like shaving cream (left), Air-Krete doesn't look anything like its cement components. After it dries a little (right), it looks more like angel food cake.*

Figure 2. *Because Air-Krete will slump, screen is used (left) to hold it in place in an open cavity. Similarly, screen with a temporary brace holds the foam between rafters (right). The installer is smoothing out the foam to keep it from bowing the screen.*

Quality control. Air-Krete foam goes in like shaving cream (see Figure 1). Doug Palmer, a manufacturer/installer who's been with the product for years, describes the installation procedures this way: "The product stays creamy for six to 14 seconds. Then it skins over like Jello, and tears like Jello. It has a preliminary set to it. The cure time is 28 to 48 days; however, you can close it in after 48 hours."

"On new construction, we fill the wall from the inside. We 'screen' the wall, then inject Air-Krete through holes in the screen. When the material's dry, it has the consistency of stale angel food cake. You can crush it in your hands," says Palmer (see Figure 2).

Palmer describes the spray rig as a metering device. Dials and gauges on the gun determine the mix (see Figure 3). They add color to the cement so the installer can spot a mix problem quickly.

The installers monitor water content carefully on all batches. "We measure it by filling a container and watching the run-off," says Doug Palmer. "The foam now has 2 ounces per cubic foot. In the old days we had 8 to 12."

But there are some dissenting voices on this product. The construction manager of a multi-story commercial job completed in 1988 said, "The concept of Air-Krete is good—a cementitious product that won't smoke or burn. But it hasn't dealt with the realities of the job site. We had to put a membrane roof over the [concrete block] walls. We had extra expense during construction trying to protect it. It acts like shaving cream. It dissolves. If it's kept completely dry, it stays in place well. But with vibration or abrasion, it disintegrates."

He also felt that the insulation didn't have good flow characteristics: "You have to manipulate the wand back and forth and lay it a layer at a time. We could see on the end walls that there were globs where the material went back and forth."

Probably one of the biggest ambiguities with the use of Air-Krete is who is responsible if a problem develops. The product was invented by Air-Krete, Inc., a company in Weedsport, N.Y. But bulk ingredients to make it are sent to "manufacturers" who repackage the components in batches for the installer. In fact, the "manufacturers" don't really know what's in the product they're "manufacturing."

Jay Savery, a former "manufacturer," didn't have the technical know-how to help installers when a job turned sour. "The products [we received] changed three times in five months. With new formulations we had no way of telling what would happen. We opened up one wall and found powder at the bottom. Or sometimes we'd have a wall that just wouldn't dry. It was a convenient buffer to have manufacturers—especially if the product was so installer-dependent. The product should have been more installer independent."

Savery had three unhappy clients in New England whose walls became saturated with water after an Air-Krete installation. One of his installers, a reputable builder who "never should have had this problem" took personal bankruptcy.

Doug Palmer, who testified as an expert witness in the case on the behalf of Air-Krete, said the problems were due to "a severe misapplication."

"The most correct product we found," he said "was 50 percent overweight. The most incorrect was 450 percent."

Can We Say Yes or No?

We don't have enough information to know whether Tripolymer poses a health hazard. And until more is known, it would be wise to avoid high-moisture applications due to the risk of hydrolysis: For example, don't use it in walls around a swimming pool.

Air-Krete, on the other hand, poses no environmental problems, but has gone through a rocky "tenting phase."

With walls opened and old insulation removed, this antique cape is ready for a dose of 20th-century foam — manufactured on board the truck (inset).

A Flair for Foam

Joel Schwartz, co-owner of Foam Tech, in North Thetford, Vt., has developed his own system for insulating sidewalls. The system, pioneered by his partner Henri Fennell, uses a high R-value, expanding polyurethane foam—along with an infrared camera for quality control. "We don't think 31/2-inch fiberglass is adequate, and cellulose compacts too much," says Schwartz. "We shoot for R-25 to R-30 walls and R-40 ceilings. You get R-7.5 per inch with foam."

"I can't emphasize enough the need for quality control," he says. "Cellulose is hard for anyone to screw up. But it leaves voids. Many cellulose installers think they're doing well if they insulate all but 10 square feet. But we hunt voids the size of a tennis ball."

To find these voids, Schwartz checks his installations with an infrared camera. The voids shows show up on infrared thermography because the foam generates heat during curing. Water-based foams can be checked with infrared when the foam dries out, but with urethane, Schwartz can look for air pockets while he's still on the job. He also checks the air-change rate with blower doors—one new home recently tested at .03 air changes per hour, which is virtually airtight.

The construction sequence works like this. The general contractor and Foam Tech work together to get any old insulation out. Schwartz uses an industrial vac to take out cellulose. If batts are in the wall, they take off the bottom foot of sheathing and pull out the bottom half of the fiberglass. Then they move up 4 feet, take off another strip, and remove the rest of the batt.

"You'd think balloon framing would be easier, but it's not," says Don Davenport, a general contractor who has worked with Foam tech. "Western framing is cleaner. The cavities aren't blocked with debris and fire blocking." Before refilling the walls in balloon framing, they stuff fiberglass back into the bottom of the cavities to keep the insulation from filling up the cellar.

Even though the polyurethane is a closed-cell foam, the crew still installs a 4-mil poly vapor barrier. As the foam sets up it shrinks slightly. If you don't have a vapor barrier, the foam will suck in the drywall and distort its shape.

"I've been a builder for 17 years, and I've never come across a product that's as thorough as far as insulating. It will penetrate through a 4d finish nail hole," says Davenport.

Filling voids is where the Foam Tech approach shines. If the installers inject too much foam at once, it creates voids. So, instead, they typically shoot he foam for only one or two seconds at a time per cavity and work their way down a 20- to 40-foot section of wall. Then they start again at the first cavity. By the time they start the second pass, the foam is sufficiently expanded to receive the next one-second spurt. All the cavities are gradually filled. If the interior walls are finish painted or papered, the shooting time is reduced further to prevent any damage.

Unlike cellulose, polyurethane foam expands, and there's always the danger of blowing off a panel. To prevent blowouts, the builder and installer have developed some clever gadgets. For example, they brace the drywall with aluminum angle iron predrilled in 4-, 8-, and 12-foot lengths.

Davenport has been using 4 inches of foam in the ceilings and putting 9 inches of fiberglass on top. He gets the seal of the foam and adds fiberglass to boost the R-value. Swimming pools require special treatment. On one recent job, Davenport used 111/2-inch-deep TJIs. The crew strapped down 61/2 inches from the top edge of the TJIs to create cleats. They put up Aspenite against the cleats and created an artificial cavity to fill with foam (creating a "hot roof"). This left a dead air space below for wiring and lights.

"For retrofit we have special forms for custom applications," Schwartz explains. "Here in New England we have old houses and barns with unfinished beams. People want insulation next to the roof, but they want to leave a reveal around the beams. With beams 6x6 or 6x8, we have to make sure we control the depth of our foam carefully. We can do this with drywall. We put the drywall in place, blocking it with nailers against the beam. Then we foam the cavity between the roof and the drywall. Essentially, we're creating a stressed-skin panel in the field. We get 31/2 to 5 inches of insulation, a vapor barrier (because of the closed-cell foam), and a tight ceiling."

"The only drawback to the foam we use is environmental. Cutbacks in the availability of CFCs is changing the composition. We're now receiving less CFC in our product than we were only 6 months ago. This changes the flow characteristics and the way it comes out of the nozzle. Sometimes we have a surprise until we realize the batch is different from the last batch. We're hearing that a different kind of CFC can be used. It has a different molecular structure that doesn't affect the atmosphere. It's still a CFC, but it's ozone-friendly."

When asked whether he had any plans to expand outside New England, Schwartz replied: "In spite of being a small outfit, we do half a million in sales a year—and we're not cheap. But we haven't expanded outside New England because the capital investment for an individual contractor is substantial. Equipment alone can run \$125,000 to \$150,000 for infrared scanning, trucks, and other tools. We've thought about franchising our approach, but rapid expansion was obviously the downfall of urea-formaldehyde. They let anyone pick up the equipment and run with it. Our approach requires a massive training program. You have to be committed to it."

As for the widespread doubts about the future of CFC-based foams and what will replace them, Schwartz adds, "My feeling is that polyurethane is so widespread that it will be around for a long time. But no one in their right mind could be expected to get into the business at this level right now."

—M.M.

Figure 3. *The Air-Krete gun precisely regulates the cement, foaming agent, and air to create the insulation.*

If not installed correctly, the product might still produce bad batches. Also, with its flow characteristics and friability, it's difficult to judge its quality when installed in closed cavities. With this product, you have to depend on well-trained installers who have used the product long enough to know its quirks.

No retrofit cavity insulation is foolproof. Each takes a conscientious, well-trained installer to get a good job. With the foams, however, you have the added complexity of chemistry to manage in the field.

To play it safe, I would use these products primarily on concrete-block commercial jobs. For most residential jobs, I'd stick to cellulose or fiberglass. They're cheaper, and they have a longer track record. ■

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