New From Canada: Icynene Insulation

by Richard Harrington

This spray-in-place foam offers airtight insulation with no CFCs or air quality worries

When I first heard about Icynene foam in 1988, I was intrigued. It sounded like a good product — an insulation with the advantages of spray-in-place foams but without the environmental side effects. I was planning a 480-square-foot addition to my home at the time and began to look at Icynene as an insulation option. But, as with any new building product, I approached Icynene with a healthy degree of skepticism.

I spent months weighing the advantages and disadvantages before I was ready to try it. I wanted to know what was in it, what kind of fumes it outgassed, what it did when exposed to flame. I compared Icynene to fiberglass, high-density fiberglass, cellulose, and other urethane foams for cost, R-value, and air-sealing capability. I also asked every imaginable question to make sure that Icynene wouldn't be another ureaformaldehyde, which was used to insulate houses in the late '70s and early '80s and was later banned in the U.S. and Canada when problems were discovered (see "The Long Road to Code Approval," page 38).

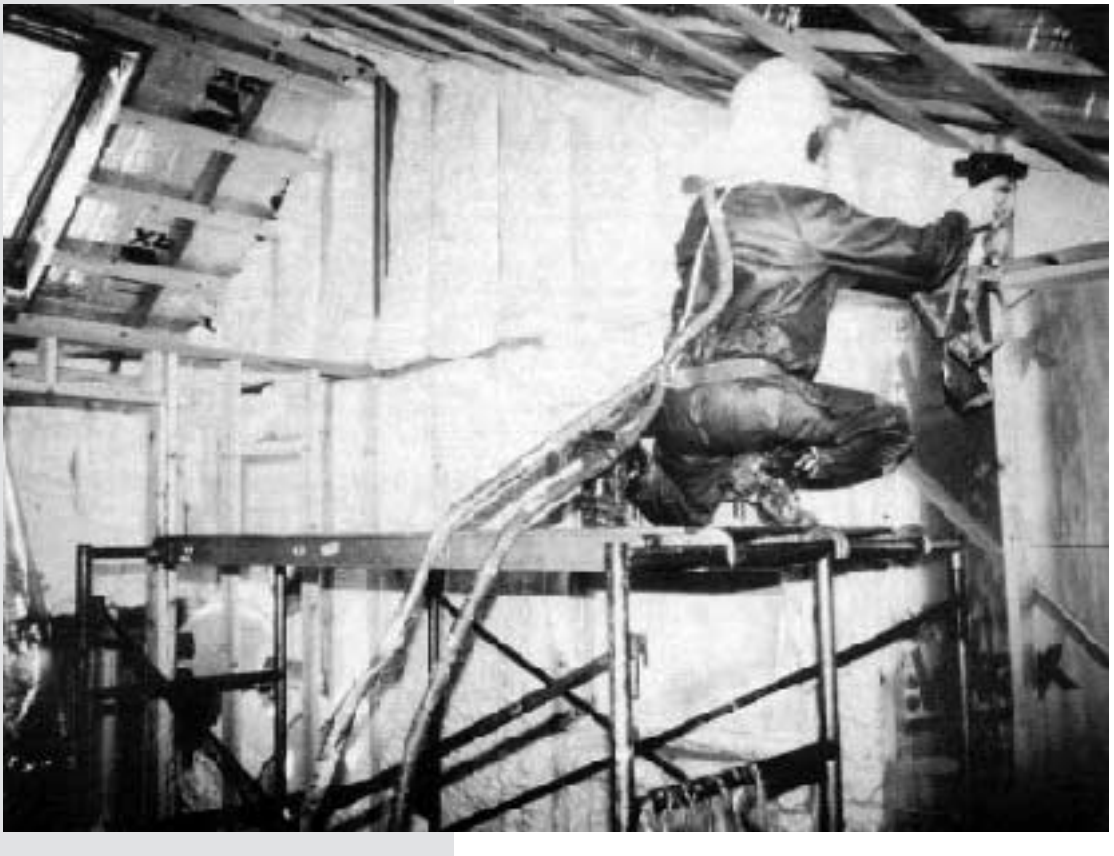
After looking closely at Icynene over a period of two years, I came to the conclusion that it was a good product and decided to insulate my addition with it. Two of my colleagues at Delhi College who were building new houses at the time did their own research and decided to use Icynene as well. Because there were three houses involved, we were able to get a crew to come down from Canada to do the work. They sprayed two houses and my addition in three days. I was on all three sites and did some spraying myself. I have little doubt today that Icynene was an excellent choice. Here's a report on what I found out.

What's in It

Icynene has been used in Canada since 1982 and has been installed in over 3,000 homes. Marketed under the names Goldseal 50 and the Insealation System, the foam is manufactured and sold by Icynene Inc. (376 Watline Ave., Mississauga, ON L4Z 1X2, Canada; 800/361-3155). Installation is by manufacturer-certified contractors who use the same type of equipment used to spray ordinary urethane foams. Though it's not yet widely available in the U.S., a few insulation contractors in New York and Alaska are now spraying Icynene. One contractor I know has plans to offer Icynene as an air-seal upgrade to the blown fiberglass or cellulose that he normally installs.

No CFCs. Icynene is a modified urethane. Unlike most foams, it is made without ozone-depleting CFCs or HCFCs in the foaming agent. With Icynene, carbon dioxide (CO_2) is the foaming agent. Icynene is sprayed onto a surface as a two-part liquid. A reaction occurs that produces CO_2 and the liquid expands to about 100 times its volume (regular urethane foams expand about 15 times). Icynene foam adheres to everything it touches and expands to connect all the components of a wall into a continuous draft-free assembly.

Icynene foam is a stable material, and there is strong evidence that it will not sag or settle over time. This virtually eliminates the need for caulking and air retarder materials to prevent air infiltration from outside or exfiltration from inside the house into the wall cavi-



An insulation contractor sprays Icynene foam at a new house site in Delhi, N.Y.

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Icynene expands to 100 times its liquid volume (1) and often overfills the wall cavity (2). The installers trim the excess (3) and haul it away from the site (4).

ty. A combination of closed and open cells within the foam allows moisture to escape if the foam gets wet, while at the same time preventing unrestricted air passage. When Icynene gets wet it is slow to dry, but it is no worse than fiberglass.

R-value. Icynene has an R-value of 3.6 per inch, slightly better than ordinary fiberglass batts. This yields an average R-value of 12 for a 2x4 wall and 19 for a 2x6 wall. By comparison, urethane foams with CFCs have an R-value of 6 to 7 per inch.

Flammability. Fire is always a concern with any foam product. Based on the tunnel test (ASTM E-84) Icynene has a low flame-spread rating (less than 20) and requires large quantities of oxygen to burn. When installed between wood framing members, the risk from fire is actually less than with other products because Icynene acts like a firestop, completely eliminating airflow in the wall. I experimented and found that Icynene does not burn when the source of ignition is removed.

Air-sealing ability. Icynene's ability to significantly reduce heat loss due to air leakage may be its greatest virtue. Any builder who has spent time trying to seal a home knows that considerable effort is required to prevent air leakage. Warm air escaping (exfiltration) and cold air entering (infiltration) are difficult problems to control. The time and effort required to control air movement are accomplished only by those possessing the utmost dedication. Caulking, gasketing, sealing, chinking, and applying air retarders are the normal first line of defense in preventing air leakage. These methods are extremely time consuming and are usually perfected only by the truly dedicated.

Icynene eliminates the need for most of this fussy energy detailing. Because the foam completely fills the wall cavity and has very low air permeance, infiltration and exfiltration are eliminated and there is little possibility for convection in the wall. As Icynene expands, it fills mechanical penetrations in the top and bottom plates. It fills even small holes where electrical wires pass through plates, and completely surrounds and seals electrical boxes. The foam closes up sheathing seams and seals plates and studs to the sheathing. In addition, Icynene's resiliency ensures an airtight building as the structure expands and contracts.

Moisture. Icynene should function well without a vapor retarder. This is because most moisture problems in wall cavities are caused by moist household air leaking into the wall — from around electrical boxes and other penetrations in the drywall. Because Icynene eliminates air leakage, most vapor movement is prevented. Diffusion of moisture (moisture movement directly through materials) into the thermal envelope is not significant enough to present a concern in normal households.

However, because a house insulated with Icynene can be very tight, it will require good ventilation to address potential backdrafting problems and high humidity levels.

Outgassing. One of the biggest problems associated with ureaformaldehyde was that certain people suffered allergic reactions to the product's outgassing. This required total removal in many cases.

Icynene, however, is not like ureaformaldehyde foam and should not be associated with those problems. Icynene has undergone extensive research by the National Research Council of Canada and has had no identified toxic emissions. When first applied, a slight ammonia odor is present, similar to the odor of latex paint, but this quickly dissipates. Within a few days there is no odor.

Cost. Icynene is more expensive than fiberglass batts, which is the insulation option I have always preferred. For a 2x6 wall cavity, the installed cost is around $1 per square foot (the price may vary depending upon house size and location). Current cost for installation of fiberglass with a vapor barrier is between 55¢ and 65¢ per square foot. If housewrap and caulking are factored in, the cost difference with Icynene is reduced.

Installation. Icynene is usually sprayed into open walls during construction, so the installation can be inspected for voids and imperfections. (At present it is not being marketed as a retrofit option.) Installation is quick — a 2,000-square-foot home can be insulated

Icynene does a good job of insulating odd-shaped cavities, such as at the band joist (left) and around doors and windows (right).

The Long Road to Code Approval

Any new spray-in-place foam insulation coming on the market faces more than its share of suspicion and scrutiny. The problem is guilt by association with ureaformaldehyde — a product banned in the 1980s due to fears that it caused homeowners to have respiratory problems. And nowhere is this more true than in Canada, where lawsuits over ureaformaldehyde foam have been going on for years.

Though many in Canada believe that the general hysteria about ureaformaldehyde occurred more because of exaggerated press reports than science, still the regulatory agencies are taking no chances. Ureaformaldehyde is banned in Canada, with no sign that its use will be allowed in the future (though it is again being used in the U.S.).

The problems with ureaformaldehyde are believed to have stemmed from poor field preparation. It was found in some cases that moisture was causing the foam to emit formaldehyde, a known irritant and a suspected carcinogen. It was unfortunately never clear how extensive or real the dangers were, but because of fears prompted by press coverage, thousands of homeowners had the ureaformaldehyde insulation removed from their homes. A recent Canadian court decision unfortunately sheds little light because no blame was assigned or damages awarded.

When Icynene Inc. President Graeme Kirkland set out to bring a new spray-in-place foam to the Canadian residential market, he knew that scrutiny by the regulatory agencies would be intense. He also knew that the public would have to be reassured that the foam had been tested for toxicity and that none had been found. Testing of Icynene took place over several years, beginning in 1982.

Icynene Test Results

Icynene has an R-value of 3.6 per inch, a little better than ordinary fiberglass batts (R-3.17) and not quite as high as high-density fiberglass (R-3.8) or cellulose (R-3.7). Its STC (Sound Transmission Class) rating in a 2x4 wall is 37 — roughly the same rating adding a second piece of drywall to an uninsulated 2x4 wall would achieve. Its air permeability at 5 inches thick is 0.2 cfm per square foot, which means it performs as an air barrier as well as most housewraps, such as Tyvek and Typar.

The vapor barrier question. Icynene's moisture permeance is rated at 10 perms in a 5-inch-thick installation. One perm or less qualifies a material as a vapor retarder — 4-mil poly has a 0.08-perm rating. This means that, in spite of Icynene's ability to drastically reduce airborne moisture from getting into a wall assembly, you may still have a hard time convincing your local code official to let you use Icynene without a vapor barrier.

Burn characteristics. All foam plastics must pass the Steiner Tunnel Test (ASTM-84) before getting building code approval in Canada and the U.S. The tunnel test measures flame spread and smoke developed. Under the major U.S. building codes, a foam plastic must have a flame-spread rating of less than 75 and a smoke-developed rating of less than 450, based upon an index that rates asbestos cement at 0 and red oak flooring at 100. The ratings for Icynene are as follows:

Thickness	*Flame Spread*	*Smoke Developed*
2 inches	20	180
3 inches	20	350
5 inches	15	400

As the samples got thicker, the flame spread was less, but because of less efficient burning, more smoke was produced.

Another flame test required for Canadian code approval, though not for the U.S. codes, is the corner wall test (CAN4-S102 4 FSC3), which more closely approximates an actual building installation. The material is installed on the walls and ceilings of a 4-foot cube and a flame source is placed on the floor in one corner. The test measures the time it takes for the flame to "flash over" — to travel up the walls and over the ceiling and down the other side to a certain point.

In the corner wall test, Icynene scored 510 to 530, which means that it reached flash-over in about ten seconds. This is too high to allow its use in non-combustible construction, according to John Roberts at UL Canada (wood and wood products are not allowed either). However, the corner wall smoke-developed rating of 95 to 150 places Icynene at the low end for urethane foams, which typically have smoke-developed ratings of 150 to 500. Some foam plastics commonly used in construction, like polystyrene and polyethylene, rate well above 500.

Toxic emissions. Icynene was tested by the National Research Council (NRC) of Canada using a test designed to identify and measure the components of rigid foam outgassing. The results were further submitted to an independent test lab. Both the NRC and the lab concluded that the irritants identified in Icynene's outgas were present in such small quantities that they present no health hazard. Finally, Health and Welfare Canada reviewed the test results and gave its approval.

Icynene contains no formaldehyde at all. And, according to Graeme Kirkland, the irritants that the test labs identified are only present in the foaming catalyst; once they have outgassed, they are no longer present. Further, says Kirkland, it is virtually impossible for an installer to produce a faulty mix at the job site, as happened with ureaformaldehyde foam.

What this doesn't tell us is what Icynene gives off when it burns — a subject of increasing importance in commercial construction. (At present, the major residential codes don't require tests for emissions during combustion.) Like all urethane foams, including insulation and upholstery foams, Icynene gives off cyanides when it burns. And like all foam insulation, it must be protected by a minimum 1/2-inch drywall.

Code Approval in the U.S.

To gain acceptance by the major U.S. codes, Kirkland submitted results from the tunnel test to the National Evaluation Service Committee, which operates under the CABO umbrella (Council of American Building Officials). This committee determined that Icynene complies with the most recent versions of the Standard Building Code, the Uniform Building Code, the BOCA National Building Code, and the CABO One and Two Family Dwelling Code. Compliance is subject to five conditions:

- Icynene must be covered on the interior by 1/2-inch drywall
- it can't be used in greater thickness than 5 inches
- it can't be assumed to add structural strength to a wall assembly
- it can't be used on the exterior
- it must be protected from the weather before, during, and after installation

The 5-inch-thickness limitation is imposed because a material has to be tested at the thickness intended for use. Icynene was only tested (in the tunnel test) up to 5 inches thick. This could present a possible hang-up for the product in the U.S. market, since it would limit its use in joist and rafter bays. However, such a limit may also be open to interpretation by the local code official. There is no thickness limitation in Canada.

As for the toxicity tests, the National Evaluation Service Committee never looked at them because, at present, the U.S. building codes have no rules about plastic foam emissions.

— Don Jackson

and sealed against air leakage in an average working day. The building is ready for drywall when the insulators leave.

Icynene is most impressive at insulating those typically hard-to-insulate locations — rim joist areas above the top plate, short cripple stud cavities above headers, stud-wall corners and intersections, irregular stud spacings, and around doors and windows. And even though the foam expands to fill a cavity, because of its lower density it does not distort door and window openings the way higher density urethane foams do. Icynene can be sprayed into openings as narrow as 1/4 inch.

Attic corners next to soffits have typically proven difficult to insulate while still providing a clear path for attic ventilation. With Icynene this problem is solved by placing an air chute in the normal manner and then foaming it in place.

What to Do With the Waste?

Currently, a big problem with Icynene is the waste generated on site during installation. When Icynene foams, it often overfills the cavity and then has to be trimmed off. (This is done by the installer with a handsaw. It's fairly labor-intensive, but it is included in the square-foot price.) Trimming creates a large volume of waste that, at the moment, has no use. One solution the manufacturer is considering is to shred the waste and blow it into the attic. Another possibility is to shred it and use it as a potting soil lightener, similar to Perlite.

Conclusion

After having my home addition insulated with Icynene, I doubt that I could justify the time, nuisance, and discomfort associated with other insulations. I've spent long hours trying to seal around doors and windows. I've tried every outlet gasket available, and I cringe at the thought of trying to insulate band joist areas. Also, cutting and fitting fiberglass batts around mechanicals and in odd cavities always left something to be desired.

The Icynene crew was in and out of my home in half a day and left the building ready for gypsum board. The only detailing I did was to apply a bead of one-part urethane caulk below the sill and bottom plates, and behind the flanges on the windows to keep water out.

The addition increased the surface area of the house by 35% and the volume by 25%. I ran a blower door test before and after construction and found .23 air changes per hour before the addition and .17 after — a 26% reduction in total infiltration. ■

Richard Harrington was a builder for seven years and is now a professor of building technology in Delhi, N.Y.